

Enterprise Risk & Portfolio Management
Enterprise Model Governance

Model Risk Guidelines

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Document Version Control

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1.0	Updates to align Guidelines with new Model Risk Corporate Policy and Standard	Mitchell Bernard / Amar Saini	December 28, 2015
1.1	Edits to remove elements of duplication and ambiguity	Mitchell Bernard	February 16, 2016
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1. INTRODUCTION

The purpose of this document is to provide additional detail about the activities that will be undertaken in the management of Enterprise-wide Model Risk, further to the expectations that are outlined in the Model Risk Corporate Policy (the “Policy”), [Ref. 1] and the Model Risk Corporate Standard (the “Standard”), [Ref. 2]. These Guidelines describe the Model Risk Management Framework, including the accountability structure and Model Risk Principles. The full scope of Model Risk Management includes the steps that key stakeholders will follow as they fulfill their responsibilities related to the identification, measurement, management, mitigation, monitoring and reporting of Model Risk in the Enterprise.

This document is not intended to detail the exact procedures that key stakeholders will follow as they execute their accountabilities – those details are the responsibility of the individual stakeholders and are beyond the scope of these Guidelines. However, where applicable, links to the processes that support these guidelines are provided.

1.1. Guideline Applicability

These Guidelines are applicable to all employees who are involved in the Model life cycle from initiation, development, validation, implementation, use of Models, and decommissioning of Models. These guidelines are also applicable to governance and control employees who govern, oversee, measure, monitor, mitigate and report on Model Risk.

These Guidelines cover all Models¹ used in the Enterprise (in-house and vendor). What constitutes a Model is defined in Section 2.2 of the Policy.

These guidelines are intended to assist Model stakeholders in complying with the Model Risk Management Framework (MRM Framework). In some cases Model Owner or Model Developer groups may have their own detailed Operating Procedures (OPs) to address compliance with the MRM framework. If these procedures are deemed consistent with the Model Risk Framework (The Policy & the Standard) by MG through review and agreement, they supersede these Guidelines to the extent inconsistent or duplicative. (See Section 6.3)

2. DEFINITIONS

All terms of reference used in these Guidelines, other than those defined in Appendix 1, are either defined in the Policy [Ref. 1], Standard [Ref. 2] or in the Corporate Operational Risk Management (CORM) Risk Reference Library [Ref. 14].

¹ See Appendix 3 for specific requirements for Mathematical Finance Library (MFL) Utilities

3. MODEL RISK MANAGEMENT FRAMEWORK

3.1. Governance and Oversight

Model Owners and Model Users as the first line of defense are responsible for ensuring that Model risks are appropriately managed and mitigated with an effective approach to Model risk management. Model risk is managed like other risk and is managed at the individual and aggregate level; by identifying sources and assessing the likelihood and magnitude of the risk in order to implement effective risk management practices. An effective Model risk management approach covers all aspects of the Model lifecycle that subjects BMO to Model risk, including:

- i. Model Initiation and Identification
- ii. Model Development
- iii. Model Validation
- iv. Implementation
- v. Model Use & Feedback
- vi. Ongoing Monitoring & Validation
- vii. Model Decommission

Strong Model Risk Management is fundamental to the effectiveness of the MRM Framework. It provides explicit support and structure to risk management through the promulgation and implementation of the Policy, the Standard, these Guidelines and enterprise and unit-specific operating procedures, supported by the allocation of resources and mechanisms to evaluate whether the Framework is being carried out as specified.

The Model Governance (MG) group has the responsibility of providing enterprise-wide oversight of Model risk. MG has authority as designated by the Risk Review Committee (RRC) of the Board of Directors through the CRO and Risk Management Committee (RMC) to ensure Model risk is being appropriately managed across the enterprise. This authority gives MG discretion to require specific actions to be taken to address Model risk. Additionally, MG has the responsibility to inform the Model Risk Management Committee (MRMC) and the RRC of all key Model issues and risks.

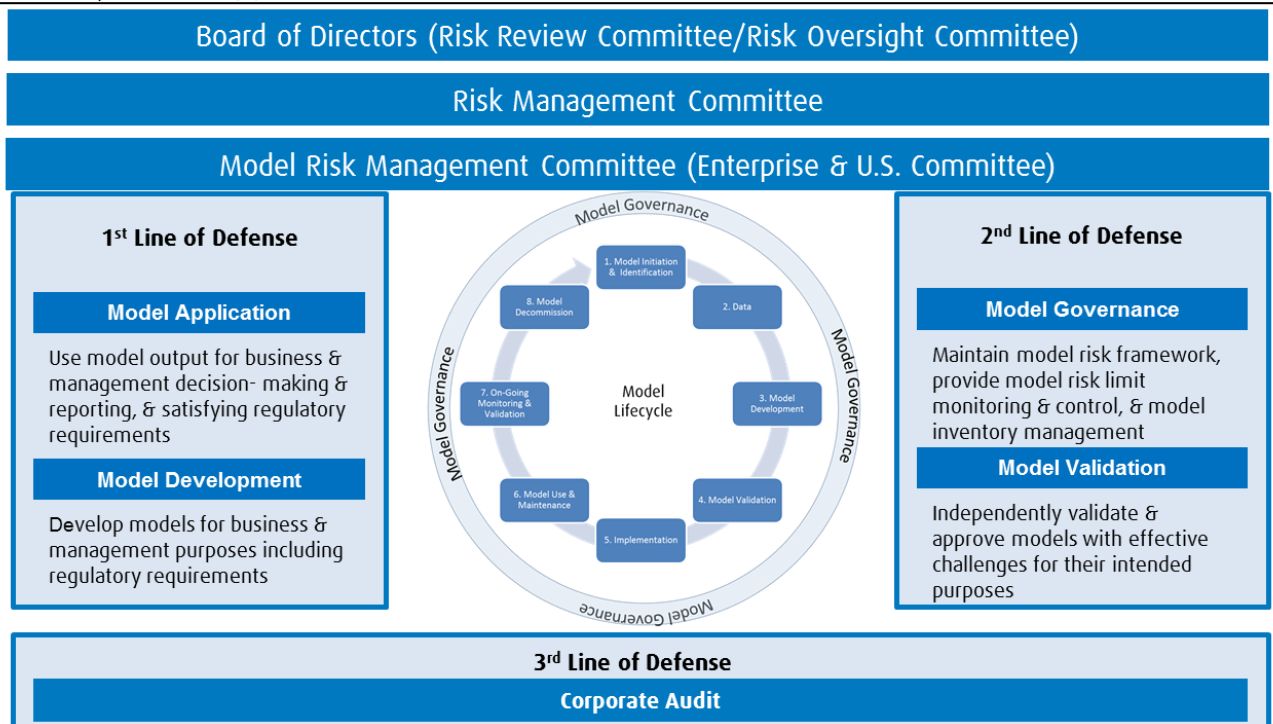
The major levels of Model risk oversight within the enterprise are as follows:

- **Board & Executive Oversight** – The Board of Directors are ultimately responsible for Model Risk Management through its Risk Review Committee (RRC) which approves the Model Risk Policy. Senior management is responsible for managing Model risk through the Risk Management Committee (RMC), which is a senior management committee addressing issues before they reach the RRC, The Chief Risk Officer (CRO) oversees Model Risk by approving the Model Risk Corporate Standard and Model Risk Appetite, and ensuring the Board and senior management receives regular information on significant Model Risk-related issues.
- **Enterprise Model Risk Management Committee (MRMC)** - The MRMC is a sub-committee of the RMC. The MRMC acts on behalf of the RMC and pursuant to the Policy and the Standard

provide oversight to ensure that policies, processes and controls effectively manage Model risk within the enterprise.

- **U.S. Model Risk Management Committee (US-MRMC)** – The US MRMC is a sub-committee of the U.S. Risk Management Committee which in turn is a sub-committee of the Risk Oversight Committee (ROC). The US MRMC acts on behalf of the U.S. RMC and pursuant to the Policy and the Standard provides oversight of U.S.-related Model risk
- **Second-Line Model Risk Oversight** – Oversight of the Model lifecycle across the enterprise is provided by Model Governance (MG). Model Validation (MV) provides independent effective challenge to Models pursuant to their roles and responsibilities as described in the Policy, Standard and these Guidelines.
- **First-Line Model Risk Oversight** – This is provided by the Model Owner, the primary stakeholder, the Model developer, acting on behalf of the Model Owner, and the other Model Users, who are responsible for implementing and maintaining appropriate Operating Procedures to ensure compliance with their responsibilities under the framework

- Model risk is managed in alignment with the three-lines-of-defense principle [Model Risk Corporate Policy, Section 5.2]
- Model Risk Management (MRM) Framework has been developed to meet heightened regulatory requirements (FRB 11-7/ OCC 11-12) and industry practices



3.2. Model Risk Management Approach

Model Risk is managed using a risk-based approach and within the Model Risk Appetite.

3.2.1. Model Risk Appetite

The Model Risk Appetite is described in the Model Risk Appetite Statement [Ref. 3] which is approved by the CRO on recommendation of the Head, Enterprise Risk and after review by the MRMC. The Model risk appetite controls Model risk at the Enterprise and U.S. level through metrics that limit the number of the following key indicators of Model risk:

- Un-validated Models;
- Approved Models with Material Deficiencies;
- Timeliness of Material Deficiency remediation plans;
- Policy exceptions;
- Model Performance Deterioration; and
- Timeliness of revalidations and annual reviews

These key Model risk metrics along with the Model Risk Limits discussed below, will delineate the maximum amount of Model Risk the Bank is willing to accept at the individual Model, Model risk type, major-legal entity and Enterprise levels. (See Section 6.7.1)

3.2.2. Model Risk Assessment

As set forth in the Policy and Standard, Model Risk Management, to the extent possible, will be informed and guided by the Model Risk assessment including Model Materiality and the risk rating of the Model to ensure that the allocation of resources, scope and frequency of Model-related activities are aligned with the significance of a Model and its risk in terms of impact financials, capital and/or reputation.

Model Materiality, as defined in Section 2.8 of the Policy, describes the scope and degree of significance of an individual model in relation to the enterprises financial statements, capital usage, expected loss, agency credit rating, regulatory compliance, business or strategic decision making or business reputation. Model Materiality is determined when a Model is first developed and prior to the assessment of the quality of the model. It is a measure that describes the portfolio against which the Model is applied.

The Materiality Metrics and Thresholds of Models are delineated in Appendix 2 to the Standard. These metrics and thresholds pre-date this Guideline and are currently under review. During the interim period prior to their confirmation or revision, any proposed modification of a Model materiality threshold requires approval as follows:

1. The modification of the Model materiality, rationale for the modification, and impact analysis on the Model materiality rating of the Model type should be submitted to MV for review and approval.

2. The modification of the Model materiality thresholds with MV's approval memo should be submitted to Model Governance for its review and agreement, at which time it comes into effect.
3. If MV and MG disagree, the modification of the Model materiality thresholds then requires the approval of the Head, Enterprise Risk.

The Materiality Thresholds of Models after the date of this Guideline will be recommended by MV and determined by MG. Disagreements between MV and MG will be escalated to the Head, Enterprise Risk.

Model Risk Rating is comprised of the combined Model Error Potential (MEP) and Model Risk Impact (MRI) assessed by MV to provide a measure of the quality of the model post validation. The Enterprise and US Tolerance Thresholds are noted in in tables 3-5 and 3-6. The risk rating can also be as follows:

Model Risk Rating		MRI Rating			
		High	Medium	Low	Non-Material
MEP Rating	High	High	High	Low	Low
	Medium	High	Medium	Low	Low
	Low	Medium	Medium	Low	Low

Note: MFL Utilities or any other Model with no MRI will have a Model Risk Rating of N/A

The MRI and MEP are used to determine the frequency and intensity of subsequent model revalidations.

The Materiality Thresholds of Models, defined in the Standard and pre-dating this Guideline, are currently under review and, during the interim period prior to their confirmation or revision, any proposed modification of a Model materiality threshold requires approval as follows:

1. The modification of the Model materiality, rationale for the modification, and impact analysis on the Model materiality rating of the Model type should be submitted to MV for review and approval.
2. The modification of the Model materiality thresholds with MV's approval memo should be submitted to Model Governance for its review and agreement, at which time it comes into effect.
3. If MV and MG disagree, the modification of the Model materiality thresholds then requires the approval of the Head, Enterprise Risk.

The Materiality Thresholds of Models after the date of this Guideline will be recommended by MV and determined by MG. Disagreements between MV and MG will be escalated to the Head, Enterprise Risk.

3.2.3. Model Risk KRMs & Limits

Model Risk is managed through the use of operational key risk metrics (KRM) and policy limits.

3.2.3.1. Model Risk Appetite KRMs

These KRMs for the Enterprise and U.S. operations include:

- Number of and percentage Models that are un-validated by risk rating (i.e. exceptions from Model validation)

- Number and percentage of Models with open Material Deficiencies
- Number and percentage of Models with issues past due and extended remediation to commitment dates
- Number and percentage of Models with policy exceptions (other than un-validated Models)
- Number and percentage of Models with deteriorating performance (Red)
- Number and percentage of Models delayed more than 30 days past their scheduled/Annual review extension (Model Development)
- Number and percentage of Models delayed more than 30 days past their scheduled/Annual review extension (Model Validation)

The Model Risk Appetite KRMs are used to monitor and manage Model Risk from an operational perspective and to produce an aggregate view of Model Risk. For the Enterprise-wide and US KRM thresholds please, see Table 1 and 2 of Appendix 4 of the Standard (refer to the interim revision of the Model Risk Corporate Standard, effective March 30, 2017)

3.2.3.2. Model Risk Policy Limits

These Enterprise-wide policy limits will apply to all Models used in the enterprise except those used exclusively in the US. US limits will apply to Models used jointly at the Enterprise level and in the US as well as those Models used exclusively in the US. Aggregate Policy Limits are detailed below:

1. **Model Exception Limits** (Models not previously validated but where materiality classification has been assessed By Model Owners/Developers and agreed to by MV): Maximum in place at any one time:

Aggregate Exceptions Limit	High	Medium	Low	Non-Material	Total
BFG	6	7	15	14	42
U.S.	5	6	11	7	29

2. **Modification Exception Limits** (on already approved models): Maximum in place at any one time:

Aggregate Modification Exceptions Limit	High	Medium	Low	Non-Material	Total
BFG	6	7	15	14	42
U.S.	5	5	11	7	28

3. Material Deficiencies Extension Limits:

Material Deficiencies Extension Limits	Maximum in place at any one time:
BFG Material Deficiency Extensions	70
US Material Deficiency Extensions	35

4. Revalidation (Scheduled Review) Extension Limits:

Revalidation (Scheduled Reviews) Extension Limits	Maximum in place at any one time:
BFG Model Review Extensions	60
US Review Extensions	30

For the limits by operating group, see the Table 3-3 & Table 3-4 at the end of this section. (Please note that these limits were based on the thresholds outlined in the Appendix 4, Tables 1 & 2 and Extensions Limits in Table 3 of the interim revision of the Standard.)

For the governance of these limits see Section 6.7.2 below.

MG Discretionary Limits

In addition to the limits designated for specific operating groups, MG has a fixed number of discretionary limits for each materiality band of each limit; see Tables 3-3 and 3-4. MG may allocate one of these limits, if any are available, when a stakeholder has no headroom in their approved limits but otherwise has obtained MV approval for the required Exception or Extension.

For a stakeholder group to be able to use a MG discretionary limit, it must confirm that it has no headroom remaining in its limit and then explicitly apply to the Head, MG for a discretionary limit providing the rationale and the MV approval. The Head, MG will provide approval/rejection via email. Once the MG discretionary limit is no longer required by the stakeholder group, the limit will revert to the MG discretionary category.

Limit Breaches

Exceptions or Extensions that breach the approved limit, at the local or enterprise level, are outside of the enterprise's appetite, and therefore outside this framework. Any Exception or extension that will exceed a limit at the enterprise level must be approved by the CRO as an Exception to the Policy/Framework. Similarly, any Exception or Extension related to a Model used exclusively in the US that will exceed a US limit requires the approval of the CRO.

3.2.4. Model Inventory

Maintaining an accurate and up-to-date inventory of all Models across the enterprise is critical to effective Model risk management. This requires the cooperation of all Model stakeholders across the Model life cycle.

Model Governance with the collaboration of all Model stakeholders maintains an enterprise-wide Model inventory, the Model Risk Inventory System (MRIS), of all Models under development, in use, and recently decommissioned.

The Model inventory captures key information on individual Models including but not limited to:

- Unique Model ID
- Model Name
- Model Purpose
- Effective range of Use
- Materiality
- Model inputs & Outputs
- Model Ownership (Model Owner, Developer, Validator, Legal entity, etc.)
- Validation Status of the Model

A complete list of mandatory and other attributes captured in the Model inventory can be found in the Model Governance Mandatory Model Attributes document. Model Owners, either directly or through Model Developers acting as their agents, are responsible for ensuring that all Models are added to the inventory through the MRIS Workflow submission process.

3.2.4.1. Ongoing Model Inventory Data Quality Control

To test the completeness and accuracy of the model data attributes in the Enterprise-wide Model Inventory, MG performs ongoing model inventory data quality testing and report the results to the appropriate model attribute owner.

MG is responsible for designing the quality control testing approaches and reporting the testing results. Model Owner, Developer and MV are required to remediate issues, identify root causes and implement actions to prevent errors from re-occurring. Quarterly Model Inventory Attestation

In addition to ongoing model data quality control testing and remediation, Model Owners, Developers and MV are required to attest to the model status and the model attribute data quality of their respective Models captured in the MRIS at a minimum of quarterly, or more frequently, if required. The details of the Quarterly Model Inventory Attestation process are outlined in the approved Quarterly Attestation Process [Ref 4].

The scope of the Quarterly Attestation will include all Models in the inventory as follows:

- a) Models in Development
- b) Models in Use

- i. Approved
- ii. Models in use with Validation Exceptions
- iii. Any other identified Models currently in use
- c) Models undergoing Validation
- d) Models not in use but not Decommissioned and Models Decommissioned in the previous fiscal quarter

As part of the Quarterly Attestation, Model Owner, Model Developers will review and attest to, but are not limited to, the following:

- Confirmation of the list of Models used within their respective areas;
- That any Models in Use that have not been validated have an approved Exception

In addition, Model Owner, Model Developers and MV will attest to the following:

- Completeness and accuracy of the Model attributes and information for which they are responsible.
- Up-to-date status of all workflows in the MRIS for which they are responsible to reflect their actual status

MG will oversee the Attestation process and escalate any late or delinquent response to the appropriate stakeholder executive who will be required to provide an acceptable completion date, reconciling any conflicts around ownership or use and prepare a summary report of the attestation for the Head, MG.

Once all Model Owner, Developer and User groups have attested, the Head, MG will attest to the Head, Enterprise Risk that the Attestations have been completed and the inventory is complete and accurate to the best of his/her knowledge.

3.2.5. Model Approvals

All Models must have the necessary approvals prior to use. See Table 3-7 for an approval authority matrix which summarizes the key Model approvals.

Table 3-3: BMO FG Limit Breakdown

Enterprise Limits Breakdown

Model Materiality	AML	Capital Markets	Finance & OSM	P&C ^[3]	PCG	Risk (ERPM)	Other ^[4]	MG Discretionary Limit	Total
Exceptions (Un-validated models within the Enterprise model Inventory) ^[5]									
High ^[1]	0	1	1	0	0	2	0	2	6
Medium ^[1]	0	2	2	0	1	2	0	0	7
Low ^[2]	1	3	2	0	2	4	0	3	15
Non-Material ^[2]	1	5	2	0	0	3	0	3	14
Models with policy exceptions (other than un-validated models)									
High ^[1]	0	1	0	0	0	2	0	3	6
Medium ^[1]	0	2	0	0	1	2	0	2	7
Low ^[2]	0	3	1	0	2	4	0	5	15
Non-Material ^[2]	0	5	0	0	0	3	0	6	14
Material Deficiency Extensions									
Number of Extensions	5	12	8	3	8	17	7	10	70
Review Extensions									
Number of Extensions	4	10	7	3	7	15	5	10	60

Table 3-4: BMO US Limit Breakdown

US Limit Breakdown

Model Materiality	AML	Capital Markets	Finance & OSM	P&C ^[3]	PCG	Risk (ERPM)	Other ^[4]	MG Discretionary Limit	Total
Un-validated models within the Enterprise model Inventory ^[5]									
High ^[1]	0	1	0	0	0	2	0	2	5
Medium ^[1]	0	2	0	0	0	2	0	2	6
Low ^[2]	0	2	1	0	1	3	0	4	11
Non-Material ^[2]	0	3	0	0	0	2	0	2	7
Models with policy exceptions (other than un-validated models)									
High ^[1]	0	1	0	0	0	2	0	2	5
Medium ^[1]	0	1	0	0	0	2	0	2	5
Low ^[2]	0	2	1	0	1	3	0	4	11
Non-Material ^[2]	0	3	0	0	0	2	0	2	7
Material Deficiency Extensions									
Number of Extensions	2	6	4	1	2	10	3	7	35
Review Extensions									
Number of Extensions	2	5	4	1	2	8	2	6	30

[1] Limited to a one year extension

[2] Limited to a two year extension

[3] P&C includes both US and Canada Models collectively

[4] Other includes both Legal Corporate Compliance and T&O

[5] For Risk (ERPM), all Models used the calculation of Regulatory Capital must be validated prior to their official use. Limits are reserved only for Models in this Pillar which are not used for calculating Regulatory Capital.

The tables below (3-5 & 3-6) provide guidance to Model Owners, Users and Developers as to how a Model is to be assessed for Model risk. MV will review such assessments and has discretion to waive such guidelines when determining Model risk provided it documents its reasons and advises MG. MG may, with the approval of Head Enterprise Risk, amend or replace the guidance provided in these tables 3-5 and 3-6 upon notice to Model Developers, affected Model Owners and MV.

Note: For models used for CCAR/DFAST/ICAAP/MST purposes, consistent with previous practice, the base scenario will be used to assess loss estimation.

Table 3-5: Enterprise Model Risk Tolerance Thresholds

1. Quantitative Assessment							
Model Category	Purposes	Model Risk Measure	Rating	Green (Low Risk)	Yellow (Medium Risk)	Red (High Risk)	Threshold
Credit Risk (Wholesale and Retail)	Capital Markets	Risk Capital Impact (Regulatory Capital and Economic Capital w hichever is higher)	MRI	<\$50MM	\$50-100MM	\$100-300MM	>\$300MM
			MEP	<5%	>5-10%	10-20%	>20%
	Commercial		MRI	<\$10MM	\$10-50MM	\$50-100MM	> \$100MM
			MEP	<5%	>5-10%	10-20%	>20%
	Retail		MRI	<\$10MM	\$10-30MM	\$30-50MM	>\$50MM
			MEP	<3%	>3-10%	10-15%	>15%
Market Risk (including Structural Market Risk & Traded Credit Risk)	Market Risk (Trading) including Traded Credit		MRI	<\$10MM	\$10-30MM	\$30-50MM	> \$50MM
	Structural Market Risk		MEP	<3%	3-10%	10-15%	>15%
			MRI	<\$10MM	\$10-30MM	\$30-50MM	> \$50MM
				MEP	<3%	3-10%	10-15%
Operational Risk	Based on one-year horizon			MRI	<\$50MM	\$50-100MM	\$100-300MM
			MEP	<5%	>5-10%	10-20%	>20%
Liquidity Risk (Liability and Asset)	Liability and asset dollar amount	Economic or Accounting Valuation Dollar Impact	MRI	<\$10MM	\$10-50MM	\$50-100MM	>\$100MM
Valuation	Trading Valuation		MEP	<5%	>5-10%	10-20%	>20%
			MRI	<\$5MM	\$5-10MM	\$10-20MM	> \$20MM
	Asset and Liability Valuation		MEP	<3%	3-10%	10-15%	>15%
			MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
	Other Valuation including Insurance		MEP	<5%	5-10%	10-20%	>20%
			MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
Credit Adjudication/Pricing	Annual underw riting volume		Loss or Income-Over-Estimation Dollar Impact	MEP	<5%	5-10%	10-20%
		MRI		<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
ICAAP (PPNR, Loss Estimation and Stress Testing)	Estimated annualized revenue or loss		MRI	<\$10MM	\$10-50MM	\$50-100MM	> \$100MM
			MEP	<5%	5-10%	10-20%	>20%
Business Decision-Making (Fraud, AML, FairLending etc.)	Annualized Income or reputation/regulatory risk	Dollar Impact of Fine Amount	MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
	Fiduciary	Size of asset-under-management (AUM)	MEP	<5%	5-10%	10-20%	>20%
MRI			<\$10MM	\$10-50MM	\$50-100MM	> \$100MM	
			MEP	<5%	5-10%	10-20%	>20%
2. Qualitative Assessment							
Model Category	Criteria						
All	The following qualitative measures will be considered:						
	• The potential negative impact on local LOB and its strategy as a result of model deficiencies;						
	• The negative impact to senior management decisions made based on the model output due to model deficiencies;						
	• Impact on regulatory risk and firm's reputation risk as a result of model errors;						
	• Complexity of the model including concepture soundness, data integrity, and key assumptions and risk drivers;						
	• Model Risk Impact (MRI) should consider sensitivity testing, comparison to alternatives such as challenger and benchmarking, and is the net impact after considering all the existing mitigants including any MOC and Overlay;						

Table 3-6: US Model Risk Tolerance Thresholds

1. Quantitative Assessment							
Model Category	Purposes	Model Risk Measure	Rating	Green (Low Risk)	Yellow (Medium Risk)	Red (High Risk)	Threshold
Credit Risk (Wholesale and Retail)	Capital Markets	Risk Capital Impact (Regulatory Capital and Economic Capital whichever is higher)	MRI	<\$20MM	\$20-50MM	\$50-150MM	>\$150MM
	Commercial		MEP	<5%	>5-10%	10-20%	>20%
			MRI	<\$10MM	\$10-30MM	\$30-50MM	> \$50MM
			MEP	<5%	>5-10%	10-20%	>20%
			Retail	MRI	<\$10MM	\$10-20MM	\$20-30MM
	MEP			<3%	>3-10%	10-15%	>15%
Market Risk (including Structural Market Risk & Traded Credit Risk)	Market Risk (Trading) including Traded Credit		MRI	<\$10MM	\$10-20MM	\$20-30MM	>\$30MM
	Structural Market Risk		MEP	<3%	3-10%	10-15%	>15%
			MRI	<\$10MM	\$10-20MM	\$20-30MM	>\$30MM
			MEP	<3%	3-10%	10-15%	>15%
Operational Risk	Based on one-year horizon		MRI	<\$20MM	\$20-50MM	\$50-150MM	>\$150MM
			MEP	<5%	>5-10%	10-20%	>20%
Liquidity Risk (Liability and Asset)	Liability and asset dollar amount	Economic or Accounting Valuation Dollar Impact	MRI	<\$10MM	\$10-30MM	\$30-50MM	>\$50MM
Valuation	Trading Valuation		MEP	<5%	>5-10%	10-20%	>20%
			MRI	<\$5MM	\$5-10MM	\$10-20MM	> \$20MM
	MEP		<3%	3-10%	10-15%	>15%	
	Asset and Liability Valuation		MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
			MEP	<5%	5-10%	10-20%	>20%
	Other Position Valuation		MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
MEP			<5%	5-10%	10-20%	>20%	
Credit Adjudication/Pricing	Annual underw riting volume	Loss or Income-Over-Estimation Dollar Impact	MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
CCAR/DFAST (PPNR, Loss Estimation and Stress Testing)	Estimated annualized revenue or loss		MEP	<5%	5-10%	10-20%	>20%
			MRI	<\$10MM	\$10-30MM	\$30-50MM	> \$50MM
			MEP	<5%	5-10%	10-20%	>20%
Business Decision-Making (Fraud, AML, FairLending etc.)	Annualized Income or reputation/regulatory risk	Dollar Impact of Fine Amount	MRI	<\$10MM	\$10-20MM	\$20-50MM	> \$50MM
			MEP	<5%	5-10%	10-20%	>20%
Fiduciary	Size of asset-under-management (AUM)	Fiduciary Fine Amount	MRI	<\$10MM	\$30-50MM	\$30-50MM	> \$50MM
			MEP	<5%	5-10%	10-20%	>20%
2. Qualitative Assessment							
Model Category	Criteria						
All	The follow ing qualitative measures will be considered:						
	• The potential negative impact on local LOB and its strategy as a result of model deficiencies;						
	• The negative impact to senior management decisions made based on the model output due to model deficiencies;						
	• Impact on regulatory risk and firm's reputation risk as a result of model errors;						
	• Complexity of the model including concepture soundness, data integrity, and key assumptions and risk drivers;						
	• Model Risk Impact (MRI) should consider sensitivity testing, comparison to alternatives such as challenger and benchmarking, and is the net impact after considering all the existing mitigants including any MOC and Overlay;						

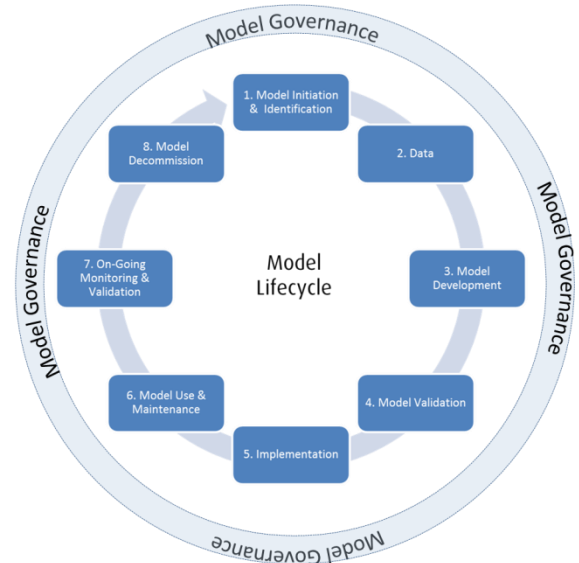
Table 3-7: Overall Model Approval Authority Matrix

Category		Responsible Party							
		Business Executive	MO	MD	RRC	CRO	Head, Enterprise Risk	Head, Model Governance	Model Validation
MRM Governance Documents	MRM Policy				•				
	MRM Standard					•			
	MRM Guidelines						•		
Model Documentation	Model Business Case, Objective & Requirements	•							
	Model Development Documentation Template			•				•	
	Model Development Performance Assessment Template (for AIRB Models)							•	
	Model Development Document			•					
	Model Validation Template								•
Policy Exceptions	Model Validation Exceptions (within limit)								•
	Material Deficiency Remediation Plan Extensions (within limit)								•
	Scheduled Review Extensions (within limit)								•
	Limit Breaches (exceptions and extensions)					•			
Key Model Life Cycle Approvals	Validation Outcomes – Critical Deficiency, Approved, Approved with Material Deficiency, Observations								•
	Remediation Plan Sufficiency								•
	UAT			•					•
	Revalidation (Scheduled Review)/AIRB Annual Validation								•
	Annual Reviews								•
	KPIs / Performance Monitoring Assessment			•					•
	Trigger Reviews								•
Arbitration / Escalations	Decommission Request								•
	Validation outcome disputes							•	
	Remediation Plan Sufficiency Disputes							•	
	Model Decommissioning Disputes							•	
	Policy Compliance Disputes						•	•	

4. THE MODEL LIFE CYCLE

Model Risk will be managed across the Model lifecycle by all stakeholders and governed by Model Governance. The purpose of this section is to define the key stages of the Model Life Cycle as well as key requirements for each stage. The key stages of the Model lifecycle include:

1. Model Initiation, Identification
2. Data
3. Model Development
4. Model Validation
5. Implementation
6. Model Use & Maintenance
7. Ongoing Monitoring & Validation
8. Model Decommission



4.1. Model Initiation & Identification

4.1.1. Model Initiation

Initiation of a new Model for development or an acquisition of a Model begins with a Model Owner identifying a clear business need for which a new tool is required and assessing the potential solution against the definition of a Model as defined in Section 2.2 of the Policy. The Model versus Non-Model filtering tool in Appendix 5 can be used to aid this assessment. Where such an assessment does not result in a clear determination of whether the tool is a Model, the Model Owner should consult with MG to assist with the assessment. The final Model Owner assessment must be provided to Head of MV, via email, for review, challenge and approval, prior to commencement of any development of such a tool/Model. Additionally:

- A Model Owner, or where appropriate Model Developer acting on behalf of a Model Owner, should determine whether the business need can be met with a tool or Model already in use in the Enterprise;
- If an appropriate tool is not internally available, a Model Owner should consider if a Model is the required or preferred approach
- If a Model is required, specify the rationale / business case for a new Model, i.e., improved measurement should be developed which will guide the subsequent development of the Model. The business case should also clearly articulate the intended business use of the Model.
- Engage an appropriate Model developer and define specific business requirements and objectives for the Model
- Identify relevant Model stakeholders across the Model life cycle, including for Basel AIRB Models Independent Review

- Working with the Model Developer, evaluate the Model materiality and submit to MV for concurrence

4.1.2. Model Identification

Business executives in the first line of defence, (i.e. using or relying on a tool which may be a Model), are responsible for the identification of Models already in use but not validated or approved within their respective areas. All Models in the Enterprise must be validated and approved by MV prior to use or otherwise have been granted an Exception.

However, on occasion a situation may occur where a LOB may be using a Model (including a Model from an outsourced service) that has not been identified in the Model inventory and is hence is non-compliant with the MRM Framework. In such cases, it is the responsibility of the accountable executive in the first-line of defence to:

- Immediately flag such a Model to MG & MV (i.e. within 5 business days of identification);
- Enter the Model into the Model inventory;
- Request a temporary Exception for continued use (within 10 business days of Identification); and
- Submit Model for formal validation

A potential Model may be identified by a User or Model Developer through an internal review of its applications, by an Operational Risk officer in the course of their interaction with LOBs, including as part of Risk Control Assessments; by CAD; through the IAAP or Supplier Governance processes. In these cases, whoever identifies the Model should inform the Primary Business User (who will become the Model Owner if the tool is deemed to be a Model) and MG.

To determine whether the identified tool is a Model it should be reviewed against the definition of a Model as outlined in Section 2.2 of the Policy. Appendix 5 provides further guidance on how to determine if the tool is a Model and should be used as an aid to initially distinguish between a Model and non-Model analytical tool (i.e. BMA or TMA). The Model Owner should consult with MG to assist with the assessment. However, if the User remains uncertain whether or not the tool is a Model or has determined it is a Model, it remains the responsibility of the User to provide the rationale for their determination to MV for challenge and approval. MV will assess the tool and issue a memo with its assessment to the Owner and MG. Any disagreement on Model determination should be escalated as per S. 7.2.

If the analytical tool is determined to be a Model, the Business User, now the Model Owner, should immediately notify MG, request an exception approval for continued use from MV and submit the Model to MV for validation through the MRIS workflow system, with all required documentation, for validation and approval.

If the analytical tool is determined by MV to be a non-Model, MV will notify the Owner (and MG) by email of its assessment. It is the responsibility of the Owner of the tool to ensure it is placed under the appropriate governance structure for the tool, i.e. whether it is governed under the Business Managed Application (BMA) or Technology Managed Application (TMA) framework or is a tool relying on expert judgment that is managed pursuant to an internal process inside the first line. The governance structure should be identified to MG.

Those tools previously validated, approved and recorded in the MRIS as a Model that are subsequently determined to be non-Models, should be decommissioned as per Section 4.8 below by the Model Owner or the Model Developer on the Owners behalf, and the new governance structure should be identified to MG.

4.2. Data

The data and other information used to develop a Model are of critical importance and require rigorous assessment of its quality, completeness, accuracy and representativeness. Developers should be able to demonstrate that such data and information are suitable for the Model and that they are consistent with the theory behind the approach and with the chosen methodology. This assessment should be clearly documented in the Model development documentation. In collaboration with the Model Owner, and where appropriate with input from Model Users, the Model Developer should:

- identify the sources of data and the relevant data owners,
- define and specify the data requirements,
- determine the process for collecting and cleansing data (i.e. data extraction process),
- data analysis required and
- define any data transformation processes

Note: for those Model areas where data-related responsibilities generally performed by the Model Developer are divided among two or more groups, the responsibility will be apportioned accordingly, and will be reflected in the Model Development Operating Procedure.

Primary reliance, where appropriate, should be placed on internal data, as this will be the most relevant and representative of BMO's portfolio, lending philosophy and risk management practices. Where internal data is insufficient for statistical purposes, external data sources may be considered to supplement the internal data, or as benchmarks against internal measures. This supplemented external data must be representative of BMO's portfolio, and may, for regulatory Capital Models, require regulatory concurrence.

For Models with economic variables, where appropriate, the Model Owner and Developer must engage the BMO Economics group early in the Model development process to ensure that proper economic data is used in the Model and that consistent economic data is used across Models in the enterprise.

4.2.1. Data Requirements and Specification

In order to generate reliable Models it is important that the underlying data contains sufficient observations and is treated for anomalies as applicable. Hence, it is imperative to collect the relevant data that is fit for Modeling. In principle, all relevant and available data should be used in the selection of the most appropriate underlying risk drivers.

The appropriate Modelling team is responsible for the following data requirements specification tasks (except for specific Model areas where another group has explicit responsibility):

- Defining the data requirements
- Identifying the data sources
- Documenting the data extraction code

It is important that the Model Developer understands the business usage and interpretation of data points and the role the data plays in decision-making when identifying, assessing and selecting data sources for building the Model. Model Owners, Model Users, T&O, and Risk Reporting groups can and should be engaged in the process if their subject matter expertise is required to complete these tasks. These stakeholders can provide input to the data selection criteria or confirmation of the specifications and/or extraction code.

The Model Developer, in Modelling areas where it is applicable, will define and document the data, specifications and requirements, and identify available data sources and map to data definitions, if available. Additionally, where applicable, the Model Developer will document the guidance for the selection of the performance window and required testing. When external or proxy data is needed, the Model Developer should, with the collaboration where appropriate of other responsible stakeholders, assess and justify the use of this data and document its relevance, reliability and representativeness as discussed with key stakeholders (e.g. through the Tollgate Process). The Model Developer working with the Model Owner must also justify and document key assumptions including providing business rationale for any judgmental assumptions used in the data and variable selection process.

If data and information are not representative of the bank's portfolio or other characteristics, or if assumptions are made to adjust the data and information, these factors should be appropriately documented so that users are aware of such assumptions and potential limitations. This is particularly important for external data and information (from a vendor or outside party), especially as they relate to new products, instruments, or activities.

Expert judgment may be necessary to determine the relevancy of data and results of statistical analyses. The Modelling group should apply and document appropriate judgment to the use of available internal or external data which may result in the exclusion of some data used in the analyses. Data may be excluded, provided the rationale is documented, when:

- It is of questionable integrity
- It is no longer representative as the portfolio or sub portfolio characteristics have changed
- External data is not demonstrated by the Modelling group to be sufficiently relevant to BMO's portfolio (e.g. pooled data from different institutions)

The Model Developer should engage MV on critical decisions concerning the choice of data, treatment of data, selection of variables and risk drivers as part of the interactive Model development process. While maintaining the integrity of MV's independence, the interactive process can be leveraged to prevent any unnecessary subsequent re-visiting of the data requirements and specifications.

4.2.2. Data Source and Ownership

After determining the data requirements and specification, the Model Developer will identify the data sources as well as the owner of the data. Typically, for statistically predictive/credit scoring Models, the raw data generated in daily operations by Operating Groups is owned by the Operating Groups. As part of the Enterprise Data Governance Framework, Operating Groups are responsible for the accuracy, integrity and completeness of their data. Operating Groups should be responsible for fixing their raw data errors identified by the Model Developers and other stakeholders including T&O and MV. When the Model Developer decides to use external data or proxies, it is, as appropriate, the Model Owner, Developer and/or any other group designated by the Model Owner or Operating Group with the responsibility to ensure the accuracy, integrity, relevance and representativeness of such data. The

Model Developer is responsible for the data selection, and the relevance and the representativeness of the selected data for Model Development. The Model Developer must document any assumptions associated with the data sample and the rationale for their selection as well as the source and ownership of the data.

4.2.3. Data Extraction

After the data requirements and specification are completed, and the data sources are identified, the Model Developer will collect and extract the data required for Model development from the appropriate data sources. If the Model Developer must rely on T&O or other data service providers to collect and extract raw data, the Model Developer must provide clear instructions and specifications to ensure the correctness and completeness of the collected data. The Model Developer will thus be responsible for the correctness of the extraction instructions, and T&O or the other data service providers will be responsible for the data errors during the extraction and transmission processes. In all other cases, the Model Developer will be responsible for the data errors due to data extraction or transmission. The data extraction process should be clearly documented so an independent third party such as MV can replicate the results.

4.2.4. Data Analysis

Comprehensive data analysis is a fundamental step in the Model Development process. The Model Developer will perform various data analyses to assess the data accuracy, integrity, relevance, reasonability, completeness and representativeness. These analyses should be documented. A list of the types of analysis that should be considered is as follows:

- ensuring the selected/collected data is consistent with the specification and is representative of the risk characteristics of the underlying portfolio and/or risk.
- test variable ranges and fill rates for Model drivers and other key financial variables including trending and seasonality
- using technical/statistical tools to assess data quality by identifying errors, unusual data patterns in key variables and outliers, correcting data errors whenever possible, and documenting the assessment and corrections.
- ensuring the data is relevant, representative and suitable for Modelling.
- when external data or data proxies are used, identifying and documenting them with explicit justification; performing further analysis to ensure their relevance and representativeness.
- tracking, analyzing and documenting any data manipulation and their impact analysis.

Based on any anomalies found in the tests, further investigation and, possibly, additional data cleansing may be required to ensure the quality of the data is sufficient for meaningful statistical analysis.

Missing Value Imputation – as some Modeling algorithms cannot handle missing values, Model developers must resort to various methodologies for substituting or imputing missing values. The methodology selected should be appropriate for the business use of the Model; the precise methodology used, and the rationale for selecting it, must be documented and any risks or limitations clearly described.

Out of bound / Extreme Values – some data processing algorithms use a function that limits Model outputs falling outside of specified bounds. The rationale for such a function should be appropriate for

the business use of the Model; this rationale and any ongoing monitoring requirements must be documented and any risks or limitations clearly described.

As part of core data analysis, the Model Developer, as appropriate, will perform empirical analysis (e.g. univariate / multivariate analysis) of the selected development data to identify empirical and statistical risk drivers and target variables. The analysis will help further determine whether the data's patterns and history is representative of the current circumstances. Such empirical data analysis should be combined with the Model Owner and Users' qualitative analysis of leading factors/drivers. These should be clearly documented, identifying variables available and the variable reduction / selection process. The Model Developer will make the final decision, with input from the Model Owner and Users, on the selection of key risk factors and analyze the impact of any missing factors and document any special treatment required. MV will review and challenge the data and variable selection through the Model Validation process.

4.2.5. Data Weaknesses and Limitations

It is often the case that data is not perfect and may contain errors or insufficiencies. It is critically important for the Model Developer to identify and understand the data weaknesses and limitations and communicate them to the Model Owners and Users through the interactive Model development process (e.g. at the Tollgate Process meetings). The Model Developer should document the weaknesses and limitations and analyse their impact on the overall Model. Significant data weaknesses or limitations that affect the Model's effectiveness should be clearly documented and communicated to the Model Owner and Users and other stakeholders, including MV.

4.2.6. Escalation

If a significant disagreement arises between the Model Developer and MV or the Model Developer/MV and the Model Owner concerning pre-development data for which a consensus cannot be reached, the matter will be escalated (See Section 7).

4.3. Model Development / Redevelopment

Model development is the process of developing a Model that includes acquiring relevant inputs (data and business insight) and transforming these into useful information that serves the intended business purpose. All Models regardless of Model type must be developed following certain standards which reduce Model risk and help ensure safe and sound Model development. The following key development principles apply to all Models:

- Models must be built by individuals who have proper training, skill, knowledge and supervision;
- Model development practices and techniques must be structured to minimize the risk of significant error in the Model or the risk that the Model will not fulfill the intended use;
- Data sources must be adequately understood, and data integrity tested and addressed properly;
- Assumptions made in the development of the Model must be clearly documented and supported or justified;
- Model theory must be appropriate for the use of the Model and be adequately supported in the academic, economic, or business community;

- Adequate testing and controls must be employed to ensure the Model is properly developed for its intended purpose
- The output of the Model must be appropriate for the use of the Model
- Management must exercise sufficient oversight over the development process to ensure that it is proper and that development decisions are reasonable;
- Model development must consider regulatory requirements governing the use of a Model, with supporting documentation, including, where applicable, performing a Basel AIRB compliance assessment.

This phase of the Model life cycle includes the following key aspects:

- Model Development Requirements & Project Planning
- Acquiring & Preparing Development Data & Information;
- Model Design, Development & Documentation
- Model Testing & Use test
- Model Implementation

While the Model Owner has overall accountability for the Model, all aspects of Model development are the responsibility of the assigned Model Developer. Model Owners are responsible for identifying the business need and objective of the Model and working with Model Developers to identify and engage the appropriate Model Users. Model Users are required to participate in the Model development phase by providing business insights to the Model developer and other User perspectives as related to the Model use. Other key stakeholders, including T&O, will contribute to and support Model development. The Model development process should be an interactive process⁽¹⁾ (such as tollgates) that incorporates input and feedback from various Model stakeholders to ensure the Model being developed meets stated business objectives, is conceptually sound and is based on the appropriate Modelling framework.

The areas of respective accountability and responsibility of Model stakeholders are delineated in the Generic Model Stakeholder RACI Chart in Appendix 6, however, where stakeholders have developed a Stakeholder RACI Chart specific to their Model area, and these procedures are deemed consistent with the Model Risk Framework (The Policy & the Standard) by MG through review and agreement, they will supersede the RACI Chart in these Guidelines. (See Section 6.3)

In addition to developing new Models, Model Developers will enhance or redevelop existing Models based on their review of findings, Model Owner / User feedback including overrides, recommendations from MV, new industry practices, regulatory findings, or insights from competitive benchmarking.

Notes:

- (1) Interactive Model Development Process:** In this section, there are references to Model development tollgates. Tollgates are discrete stages intended to ensure proactive and timely stakeholder involvement that must be passed in order for development to continue onto the next phase. For High Risk Models and those used in the CCAR process, tollgates are mandatory. For other Models, tollgates will be used where they are specifically required in the Model Developer's operating procedures. In areas where there is no specific toll gate process, an interactive Model development process should be used that requires stakeholder engagement during the development process between the Model Developers, Model Owner,

other key Model Users and MV. To ensure MV independence, MV participation will be as an observer. They may identify gaps or concerns but will avoid suggesting any approaches or solutions to these concerns.

The interactive Model development framework is applicable to all Models however; it is a framework that can be adapted and vary based on the Model or situation. The intent is to ensure a systematic process to Model development and participation of Model Owners and key stakeholders. Therefore, the actual steps and sequencing of the steps may be consolidated, varied, or adjusted to fit the needs of a particular situation and may vary by Modelling group given the differences in Model type and life cycle, data, and range of stakeholder(s) involvement .

Stakeholder/tollgate panel concurrence should be captured through meeting minutes and email confirmation.

4.3.1. Defining Model Requirements & Project Planning

All Models must be developed for their intended purposes. Defining and understanding the business objectives and requirements is the first important step in the Model development process.

4.3.1.1. Business Objectives and User Requirements

When the decision has been made to develop a new Model, the Model Owner is responsible for identifying the business need and the objectives of the Model. As the quality of the resulting Model is highly dependent on a clear understanding of the business objective and planned use of the Model, it is critical for the Model Developer to fully understand the leading factors considered by the Model Owner / Users in their business decision-making process. The Model Developer should work with the Model Owner / Users to identify these factors and their respective roles in the outcomes of business decision-making. This qualitative process will help to prevent producing counter-intuitive solutions and to improve the effectiveness of the Model. All such qualitative analysis must be documented with evidence of Model Owner acknowledgement.

When applicable, the Model Owner and the Model Users should share industry practices with the Model Developer that may be relevant to Model development.

4.3.2. Model Framework Design

Before beginning Model design, the Model Developer will review the Model inventory to identify if a current Model within the risk area can, with the appropriate adaptation, documentation and validation, fulfill the Model Owner / user requirements and objectives. Even if an existing Model is identified that may serve the intended purposes, the Model Developer will still need to perform sufficient testing to ensure the Model is suitable for the current environment and specific use, produce the required level of documentation and have this independently validated. Otherwise, a new Model should be developed.

Following the identification & collection of the relevant data, the Model Developer will evaluate potential Modeling approaches to address the intended use of the Model. At a minimum, summaries of alternative approaches assessed should be documented along with the appropriate rationale for the selection of the Modeling approach. All elements of the selected Modeling approach should be supported by business/economic insights, published research and /or industry best practices.

The Model design must be conceptually & theoretically sound and supported by empirical evidence where available, including a comparison with alternatives; the Model documentation must include an analysis of how the selected Model design supports the requirements.

4.3.2.1. Model Design and Rationale

The Model Developer will research and investigate the possible choices for the Model framework for the given business and Model Owner requirements and will discuss them in the interactive Modeling process (e.g. Tollgate Process).

4.3.2.2. Key Assumptions and Risk Drivers

As part of the Model development process the Model Developer must identify, justify and document all the key assumptions (quantitative, qualitative and judgmental) used in the Model design and framework, whether explicit or implicit and discuss these with stakeholders during the interactive Modeling process (e.g. Tollgate meeting). Justification of the key assumptions should be tested and supported by sufficient rationale, theory, empirical evidence and statistical analysis and alignment with industry practice when applicable. The Model Developer must communicate the key assumptions to the Model Owners and Users. Some key assumptions may require the Model Owners and Users' understanding and agreement.

The approach taken by the Modelling team for those Models where they select and calibrate the drivers or segmentation, must be clearly and comprehensively documented. The Model Developer should finalize the risk drivers for Modelling based on the Model Owners' and Users' insight into leading factors in business decision-making and quantitative and data analysis (refers to Data Analysis, Section 4.2.4). These final risk drivers for Modelling or segmentation should be reviewed with the Model Owners and Users to ensure that quantitative and business perspectives are aligned.

Qualitative Expert Judgement – is typically based on business experience with minimal empirical support. For example, in cases, where there is limited or no historical data for a new product, the Model Developer may, after consulting the Model Owner and other stakeholders, establish default rates based on experience with similar products. Qualitative Expert Judgement should not be heavily relied upon and should be avoided if alternative empirical approaches are available. The use of Qualitative Expert Judgements should always be documented and supported with underlying rationale.

4.3.2.3. Model Specification, Methodology, Theory and Logic

The Model Developer must clearly document the Model specifications for the selected Model framework and design and discuss them with stakeholders during the interactive Modeling process (e.g. Tollgate meeting). This should include the theory, methodology and logic of the final Model.

- **Segmentation** (if applicable) – based on data analysis and business insights demonstrate the soundness and appropriateness of the proposed segmentation approach and alternative approaches considered
- **Theory** – The Model Developer must demonstrate the conceptual soundness of the selected framework, when possible, through published research, comparative analysis with alternative approaches, empirical evidence or industry practice.
- **Methodology** – Transform a conceptually sound framework into a quantitative relationship between the input data, assumptions, parameters and the Model outcome targets.
- **Logic** – The heart of every Model is the translation of Model inputs into Model outputs. These process steps may include code that applies theory or mathematical equations to the input data and assumptions in order to produce the Models output objective. Some processing steps are

relatively simple application of logic to complex data inputs and assumptions. Some processing steps are extremely complex mathematical formulas. Regardless, the logic or math within the Model must be clearly documented, so that the purpose and intent of the processes can be understood by all key stakeholders and tested appropriately.

- **Calibration** – The Model Developer must demonstrate and document the correct calibration process to ensure the sensitivity of each individual risk driver is appropriately calibrated to either empirical data or market-implied data.

Not all the above steps are applicable to all Models. Applicable steps vary by Model type and business practice. All of the above steps that apply should be comprehensively documented to allow an independent third party (like MV) to replicate and assess the Model.

4.3.3. Model Overrides or Adjustments

Overriding or adjusting aspects of the Model outputs and the Model specification within the Model development process (such as altering a coefficient in a statistical Model) must always be justified, supported and documented.

4.3.3.1. Margins of Conservatism (MOC)

Models will, to the maximum extent practicable, be accurate. Known weaknesses in Models should be clearly identified and documented as part of the Model development process. Where appropriate, weaknesses may be accounted for through the use of conservatism or appropriate mitigation. The Model Developer may, after discussion with the Model Owner and other stakeholders, assess and assign an MOC to mitigate an identified uncertainty as appropriate. Impact analysis should be provided for each MOC and for each Model with or without a MOC, as well as for the aggregated MOCs on the portfolio to which the Model applies. Models with MOCs should be capable of generating outputs without the MOC for transparency.

Each MOC must be documented by the Model Developer with demonstrated evidence and analysis supporting its appropriateness as part of Model Documentation, and clearly communicated to Model Owner and Users to ensure transparency and enable mitigation. MV will review each MOC as part of the Model validation/review process. If the Model Developer does not apply an MOC to mitigate the identified key sources of uncertainty, but uses another type of mitigation, such mitigation should be documented. Regardless of a MOC or other mitigation, weaknesses should be clearly documented in the Model documentation.

4.3.3.2. Post Model Overrides and Overlays

For cases where a Model was developed with limited data and incorporated expert business judgement, there may arise a need to override the Model output. For such cases, Model Developers should provide clear guidance on Model overrides, including appropriate thresholds, and track, analyse and report all overrides as part of the monitoring of the Model.

For Scenario Analysis Models used in the CCAR/DFAST process, the Model Developer will not use In-Model adjustments (e.g. MOC), but will work with the Model Owner and other key stakeholders to put forward appropriate and transparent post-Model overlays to account for any known Model or data limitations. These post Model overlays must be subject to effective challenge by appropriate parties including Model Validation and the Model Owner has the responsibility to ensure appropriate process are in place to provide this effective challenge. (See Section 5 for Capital Planning)

These overlays can be required for the following reasons:

- Adjust for known data limitations and uncertainties;
- Account for unique risks not adequately captured in the Model or;
- Account for new products or business strategies not included in the data used to develop the Model

4.3.4. Model Development Testing

Comprehensive Model Development testing is an integral part of Model development, in which the various components of a Model and their overall functionalities are tested and evaluated to assess the performance of the Model over a sample (or multiple samples, where practical) to demonstrate if the Model can serve as intended. It should start with a testing plan covering all aspects of the Model. Model Development testing should also cover the following, all of which should be discussed with stakeholders as part of the interactive Model development process (e.g. Tollgate meetings) and included in Model development documents:

1. **Model accuracy.** Provide the testing evidence to demonstrate the accuracy of the developed Model. This should include, but not be limited to, verification of the derivation of the logic and mathematical equations, and various statistical tests and analyses. Evaluate the impact of the Model results when they rely on the outputs of other Model(s) as inputs, as well as the Model's uncertainty.
2. **Robustness and stability.** Where appropriate to the Model, provide the testing evidence to demonstrate the effectiveness of the developed Model under its normal range of use. Evaluate the Model behaviour over a range of Model input values, and detect the boundaries of the Model inputs and outputs where the Model performs poorly or is unreliable in serving its intended purposes. This should include, but not be limited to, back-testing (in-sample and out of sample), sensitivity testing and scenario analysis. Sensitivity testing helps to understand the sensitivity/weight of individual input variables to the Model outcomes individually and in combination. Scenario analysis helps to identify where the Model may fail to perform as intended under boundary conditions. Scenario analysis can also cover the stress testing which helps to identify the Effective Range of Model Use as well as potential Trigger events. Testing results should also ensure that the final Model is not subject to concerns around over-fitting.
3. **Outcomes Analysis.** For stressed scenario forecasting clearly document the comparison between the actual historical outcomes and the forecasted outcomes conditioned on the scenarios to see if the outcomes are similar to those witnessed in the prior down periods under similar scenarios.
4. **Fit-For-Use Test.** Model Developers, with input from the Model Owner / Users will provide evidence that the Model performs as intended under actual circumstances within representative scenarios and in a variety of market conditions including those extreme scenarios beyond the range of ordinary expectations. The Fit-For-Use Test will also help to validate certain assumptions and detect undesirable Model behavior such as counter-intuitiveness related to business application.
5. **Comparison to Alternative Approaches.** The selected Model should be compared to alternative approaches whenever possible. In choosing an alternative approach, the strength of the

alternatives in offsetting the weaknesses of the selected Model, as well as a comparison of Model outcomes should be taken into account. The potential impact of the alternative approach should be assessed as best as possible and documented as appropriate. This will help to identify the strengths and weaknesses of the selected Model.

4.3.5. Model Developer Assessments

The Model Developer, with the input from the Model Owner, will conduct and document an assessment of the Model and its Risk, and include it as part of its submission to MV for validation. The assessment should include the following:

4.3.5.1. Model Materiality Assessment

The Model Developer with the input of the Model Owner will assess the materiality of each new or modified Model based on its purpose. See quantitative and qualitative criteria the Model Materiality table in Appendix 2 of the Standard for guidance. The Model Developer will arrive at a comprehensive materiality assessment by considering the following:

- retrieving data and information related to the scope and purpose of the Model (such as capital impact, percentage of asset class covered by the Model, VaR or specific risk impact, MVE and assets under management) and the role the Model plays in the decision-making process
- based on the quantitative criteria in the Model Materiality table (Appendix 2 to the Standard) rate the Model materiality as High, Medium, Low or Non-Material
- based on qualitative factors such as Model purpose, the importance of the Model in the decision-making process, and characteristics of the portfolio being covered by the Model, adjust or confirm the materiality rating derived from the quantitative factors
- review the economic and strategic aspects of the business impact of the Model.

4.3.5.2. Model Risk Uncertainty

Model Risk Uncertainty has two dimensions: identification of the sources of the uncertainty and their impact. The Model Developer will identify and document the key sources of Model Risk Uncertainty including:

- flaws in the Model framework, design, methodology, logic and validity of assumptions
- deficiencies in data (e.g. small sample size, biased data, missing data or data proxies, errors in either development or Model use, or unrepresentativeness of data)
- unjustified key assumptions and lack of understanding of the impact of the assumptions on Model output
- inconsistency between the assumptions about Model inputs and the actual application of the Model
- inaccurate calibration of Model inputs and parameters, or lack of sufficient out-of-sample back-testing
- weaknesses or limitations due to the over-complexity of the Model or overly complex Model usage/application

4.3.5.3. Effective Range of Use

The Model Developer must specify and document the Effective Range of Use for each Model as part of their Validation Submission including the following three dimensions:

- i. the specific purpose of the model;
- ii. the product/portfolio for which the Model was designed; and
- iii. the natural range of the Model, i.e. the range within which the input parameters can be used to produce valid output for the intended purpose, given the assumptions upon which they are based

4.3.6. Model Performance Monitoring Plan

All Models within the enterprise should have a clearly documented ongoing Model performance monitoring plan (See Section 4.7). This Model performance monitoring plan should include at least one Key Performance Indicator (KPI) or trigger, if appropriate. Each KPI description should be accurate, complete and informative. KPIs can vary by Model type and should be appropriate for the type of Model being used and the purpose for which it is used. For specific events, Model Triggers should be identified in the plan that captures instances where the Model may need to be reviewed. Where performance monitoring procedures already exist, they should be referenced

- **Key Performance Indicator (KPI)** – Quarterly KPIs are required for all Models with High MRI and High or Medium MEP, and any regulatory required Models in accordance to the Policy. In addition, for all High and Medium risk Models (see Section 3.2.2) the Model Developer must develop (if none exists), discuss with stakeholders (e.g. at the appropriate Tollgate or equivalent) and document a plan for the Ongoing Monitoring of the Model which should be at least Quarterly for High Risk Models and semi-annually for Medium Risk Models.

Model Monitoring Frequency		MRI Rating		
		High	Medium	Low
MEP Rating	High	Quarterly KPI	Quarterly	Annual
	Medium	Quarterly KPI	Semi-Annual	Annual
	Low	Semi-Annual	Semi-Annual	Annual
Legend: Model Risk Rating		High	Medium	Low

- KPI monitoring may be less frequent for certain Models where the cadence of execution is less regular. For example, High Risk Models which are executed only semi-annually would not be required to adhere to the minimum requirements of executing monitoring quarterly. KPI's can be defined using the following types of tests:
 - **Stability** – where appropriate, monitoring should include evaluating the stability of the population

- **Performance metrics** – Metrics that include measures of separation lift, R-squared, expected vs actual comparisons, rank ordering etc., should be captured for each Model. These measures can be compared to an absolute standard or relative to a Model baseline to help assess Model performance
- **Back-testing** – involves comparing actual outcomes with Model forecasts, at an observation frequency that matches the forecast horizon and performance window of the Model. The Model forecasts should have expected tolerance ranges established around them that are considers acceptable variances.
- **Sensitivity analysis** – and other check for robustness and stability can be useful during ongoing Model monitoring as they are during Model development. If Models work well for only certain ranges of input values, market conditions, or other factors, they should be monitored to identify situations where these constraints are approached or exceeded.
- **Overrides** – are defined as cases where Model output is added to, adjusted, or reversed based on expert judgement of Model users or on supplemental analysis. Such overrides may be an indication that the Model is not performing as intended or has limitations. Model Owners should evaluate the reasons for overrides, and should track and analyze override performance. If the rate of overrides is high, or if the override process consistently improves Model performance, the underlying Model may need revision or redevelopment.
- **Management Overlays** – For Scenario Analysis Models used in the CCAR/DFAST process and for other Model uses identified by Model Owners or MG (e.g. IFRS9), the Model Developer will not use In-Model adjustments (e.g. MOC), but will work with the Model Owner and other key stakeholders to put forward appropriate post-Model overlays to account for any known Model or data limitations. (See Section 5 for Capital Planning)
- **Benchmarking** – is the comparison of a given Models inputs and outputs to estimates from alternative internal or external data or Models. It can be incorporated in Model development as well as in ongoing Model monitoring. Whatever the source, benchmark Models should be rigorous enough to serve their purpose, and benchmark data should be reliable enough to ensure reasonable comparison.
- **Model Triggers** – The Model Developer should, after consulting with the Model Owner and/or Tollgate review, if appropriate, set Model-specific Triggers with regard to the effective use of the Model. The Triggers should complement the performance monitoring metrics for high & medium Risk Models and reflect the parameters and/or boundaries linked to the Effective Range of Use and Model performance or specific events whereby the Model may not be perform as designed or effectively, thereby triggering the need for a specific review. Specific trigger metrics should be identified, along with the Model's trigger sensitivity (See Section 4.7.2.4), and submitted to MV as part of the Model documentation package.

Note: Significant findings from CAD or Regulators may trigger a review of all applicable Models. This should be a component of Model Developer trigger monitoring Operating Procedures but as it applies potentially to all Models, they need not be proposed in the trigger documentation for each Model.

In some instances it may not be possible to explicitly define traditional KPI metrics for a given Model when there is no observable actual data against which to compare the output from the Model. In such cases, the Model Owner/ Developer should document the appropriate rationale as to why KPIs cannot be defined and submit the rationale to MV for review and challenge. In line with current policy requirements, any of these instances where the Model has High MRI and High or Medium MEP, or is a regulatory requirement, requires a CRO approval for exception from the KPI performance monitoring process.

The Model monitoring plan should also provide a high level description of the process to be followed for monitoring the Model including the following key elements:

- Management of data risk including verifying that internal and external data inputs continue to be accurate, complete, consistent with Model purpose and design, and of the highest quality available.
- Management of implementation risk including routines for ensuring that all Model components are functioning as designed and that access to change calculations or code is controlled.
- Methods of verifying that Models are used in accordance with the Model documentation and within the Range of Effective Use.

4.3.6.1. Model Performance Rating

A holistic Model performance assessment rating must be recorded in MRIS (under the data attribute “*Model Performance Status*”), to reflect the overall conclusion on the performance on the Model for each performance period. (See Section 4.7)

A three-level scale must be used as follows:

- **GREEN** (“Continue Use”) indicates that the Model performance is adequate and presents no substantive performance issues
- **YELLOW** (“Watch”) indicates that the Model exhibits some performance issues, but those issues are either minor or do not present a conclusive pattern of performance that require action to be taken at that time
- **RED** (“Action required”) indicates that the Model exhibits substantive performance issues (i.e. breached threshold limits), and some action must be taken regarding the Models performance, or that a monitoring program has not been established or performance metrics have not been produced and evaluated.

The holistic Model performance rating approach used should be documented in the Model performance monitoring plan by the Model developer

4.3.7. Model Developer & Model Owner Agreement

It is expected that the Model Developer and the Model Owner executives will agree and approve that the Model that has been developed effectively serves its intended purpose, in order for the Model to be submitted to MV for validation. Evidence of such agreement and approval should be documented and included as part of the submission for validation.

If an agreement can't be reached before submitting the Model for validation, the matter will be escalated as per the Escalation process (see Section 7). A resolution will result in either an agreement to revise the Model prior to submission or an approval to proceed with the submission for validation. Any disagreement will be documented and included in the Model documentation.

4.3.8. Procuring Vendor Models

Vendor products such as complete Models, data and parameter values used for Model development or use, are subject to the same principles of Model Risk Management and the same requirements of validation and oversight as Models that are developed in-house. For vendor Models, the Model Owner or its delegate (i.e. an internal Model Developer) will act as the Model Developer to fulfill the Model Development roles and responsibilities. This will include performing and documenting the appropriate due diligence to ensure the Model Owner has confidence in the Model and its ability to meet the objectives of the intended use. Stakeholder engagement (i.e., the Tollgate process) should be adapted to apply appropriately to cover Vendor Models.

When a vendor Model or data for Model development is required, a selection process will be in place to ensure the alternative choices available are identified, that business and quantitative expertise are employed to arrive at a determination, and that the Model selected will comply with the Model Risk Management Framework including being subject to MV's independent validation and approval.

The Model Owner and internal Developer (if any), will prepare, or require vendors to provide Model documentation, including development evidence as well as Model performance test results that show the Model works as expected. Additionally, where feasible, the vendor should be required to clearly indicate the Model's limitations and assumptions and where the product's use may be problematic.

4.3.8.1. Vendor Model Requirements

The Model Owner / Developer (with input from any identified User) must define and document the Model requirements, including details of:

- the purpose of the Model
- the business requirements the Model will meet (e.g. support capture of business opportunity, enable business process)
- any BMO specific customization and appropriate justification
- user requirements
- the business context including the business strategy and the role the Model plays in business decision-making
- the rationale for selection of the Model as opposed to alternatives
- the required outputs
- important Model functions.

4.3.8.2. Vendor Model Framework

The Model Owner / Developer must identify and provide the following information for a vendor Model selected for use:

- developmental evidence explaining the product's components and design

- the Model's pre-requisites and limitations in addition to the Model fit for the specific use within BMO
- key assumptions used in specifying the Model framework, design, methodologies and processes
- any BMO specific customization and appropriate justification
- the business context for the Model, including the proposed Model application, the market or area in which it will be used, the size of the portfolio, the percentage of the asset class, the business or function the Model will cover or support and the cost of the Model
- the rationale for selecting the Model, based on the defined user requirements, business context, analysis of benchmarks and industry best practice, and an examination of multiple Models to determine the best fit based on the requirements
- vendor white papers and technical specifications for the Model.

4.3.8.3. Vendor Model Methodology, Theory and Logic

The Model Owner or Model Developer on the Owner's behalf will assess and provide the vendor's documentation of the Model's methodology, theory and logic, including:

- a description of the theory behind the methodology
- test results supporting the methodology
- Model parameters and configuration for the business specific use
- pros and cons of the methodology.

4.3.8.4. Vendor Model Data

The Model Owner or Model Developer on the Owner's behalf will assess and provide the vendor's documentation of the Model data, including:

- data assumptions
- vendor in- and out-sample data and calibration
- evidence the sample data is suitable for the Model and is consistent with the Model theory and methodology
- evidence the sample data represents the Bank's business and evidence that the population can be represented by the sample
- Identification of data proxies, manipulations and outliers.

4.3.8.5. Vendor Model Tests

The Model Owner or Model Developer on the Owner's behalf will provide documentary evidence of Model soundness, including but not limited to:

- vendor or Developer test results, including stress testing, sensitivity testing and scenario analysis

- The Fit for Use Test results demonstrate the effectiveness of the Model for the business-specific use within BMO, including the applicability of the inputs and the effectiveness of the outputs in the decision-making process
- when possible benchmark, sensitivity testing and/or scenario analysis
- test reports that demonstrate the product works as expected
- vendor Model performance monitoring and outcome analysis of the vendor Model using BMO's own outcomes.

4.3.8.6. Model Assessment of Vendor Models

Once a vendor Model has been purchased, to the extent possible, the Model Owner, or a Developer on the Model Owner's behalf, must provide its own risk assessment of the Model as is required for in-house Models (See Section 4.3.5), including its assessment of the Model, Model materiality and the identification of any Model weaknesses or limitations, with explicit rationale. In addition, a performance monitoring plan for the Model, including Key Performance metrics, traffic lights and any Model triggers must be included as part of its Validation Submission.

Vendor Models used exclusively as benchmarks in the Model development process do not require an assessment of Model materiality or a specified Model monitoring program.

4.3.9. Model Documentation Requirements

4.3.9.1. In-House Models

Strong Model documentation is a critical component of Model risk management. Model Owners and Model Developers are responsible for ensuring that documentation provides both:

- A comprehensive description of the development of the Model, including the logical foundation of the Model; and
- All operational evidence needed to manage the key Model risks

Model development documentation should include all aspects of the Modeling process, both quantitative evaluation and qualitative judgments, and clarify all the rules and criteria surrounding the Model. Furthermore, the documentation should include explanation of Model results, including interpretations and assessments, of relevant statistical testing, sensitivity analysis, stress testing, back-testing, and benchmarks. When a Model is subject to a specific regulatory requirement, the documentation should include all required compliance assessments.

Model documentation must be sufficiently detailed so that parties unfamiliar with the Model can understand how the Model operates, its limitations and key assumptions. Additionally, Model documentation and developmental evidence should be easily traceable so that a third party can easily understand the linkage between documents for a particular Model.

To ensure documentation is as complete, consistent and comprehensive as possible, the Head of each Model Development group is required to develop a *Model Development Documentation Template* when feasible, or for groups with limited number of Models, use a generic Model development documentation template, and require its mandatory use for all Models developed within the group. These templates should be reviewed and agreed to by Model Governance that

they are in compliance with the Framework. Approved documentation templates become governance documents and will be used by MG to verify consistent use within the Model development group. At a minimum, Model Development Documentation should cover the topics detailed in Table 4.2-1:

The Model Developer is responsible for ensuring that all Model documentation with the appropriate version control is stored in the MRIS and kept current and accurate as ongoing changes are made to the Model.

For Model updates, the Model documentation should clearly reference all key steps relied upon during development. For Models developed before the implementation of revised framework in December 2015, the documentation should be evaluated based on current requirements and any updates required to bring the documentation up to the current standards should be undertaken as part of the next Scheduled Review or Model Change. For example, if a variable reduction process was documented in previous Model document and is relied upon in the redevelopment, it should be clearly referenced or summarized in the updated document to ensure an independent third party can clearly and easily follow the key aspects of the Model development process.

Full Model documentation must be provided to MV for Models developed in-house. A Model submitted to MV for Validation that is missing essential components of documentation will be rejected by MV. Such rejection will be documented. Non-essential Model documentation that is missing may be identified as an Observation in the resulting Validation Report. Table 4.2-1 provides Model documentation requirements, as determined by Model Materiality.

Table 4.2-1: Model documentation requirements, as determined by Model Materiality

Model Documentation Required for Validation	Model Materiality			
	High	Medium	Low	Non-Material ¹
Documentation Checklist	Y	Y	Y	Y
Model Materiality Assessment	Y	Y	Y	Y
Model Purpose (including Model User Requirements)	Y	Y	Y	Y
Data for calibration, development, and validation, with related documentation	Y	Y	Y	Y
Data Description (including source, integrity, accuracy and representativeness of data)	Y	Y	Y	N/A
Data Assessment	Y	Y	Y	N/A
Framework design, logic and theory, all key assumptions and their rationale and methodology	Y	Y	Y	N/A
Identification and ranking of Model weaknesses and limitations	Y	Y	Y	N/A
Model Developer Test Results and Analysis	Y	Y	Y	Proxy
Actual Outcome Compared with Forecasted Outcome	Y	Y	N/A	N/A
Impact Analysis	Y	Y	Proxy	N/A
How Model (direct) outputs will be transformed and used in production/decision making	Y	Y	Y	N/A
Fit-For-Use Test (see Section 4,4-4)	Y	Y	Y	Y
UAT (see Section 6.1.3)	Y	Y	Y	N/A
Model User Support Material	Y	Y	N/A	N/A
Ongoing Performance Monitoring Metrics	Y	Y	Y	Y
Trigger Metrics and Sensitivities	Y	Y	Y	Y
Effective Range of Use	Y	Y	Y	Y
Basel AIRB Compliance Assessment Template or assessment of regulatory compliance, where applicable	Y	Y	Y	N/A
Model Owner Approval/Model User Recommendation	Y	Y	Y	N/A
Legend				
Y	Required for Validation Scope			
N/A	Not required for Validation Scope			

4.3.9.2. Vendor Models

Documentation is also required for Models from Vendors/third parties. The level and rigor of the documentation should follow the same requirements, to the extent possible for in-house Models and include all the requirements in S. 4.3.8 above. While proprietary information may prevent all documentation being available, the Model Owners and Developers should make every reasonable effort to ensure the vendor maintains and provides sufficient information and complete documentation to meet the requirements for validation, on-going monitoring and sound Model risk management. This will include the Model Owner/ Developer performing and documenting the appropriate due diligence to ensure the Model Owner has confidence in the Model and its ability to meet the objectives of the intended use.

Model Documentation should be provided by the vendor, depth of documentation may vary due to vendor proprietor issues, or, when unavailable, the Model Owner / Developer based on their best knowledge should include the following:

1. If Model Documentation is available, the Model Owner / Developer will provide information on the Model, including any white papers and access to the vendor's subject matter experts. The Model Owner /Developer will help MV contact the vendor when necessary to answer questions that arise during initial or subsequent Model Validations.
2. If Model documentation is not accessible, the Model Owner/ Developer will provide MV with a user manual or Model instructions, or instructions on Model inputs/outputs, key Model assumptions and information on the key role the Model plays in the business.
3. If there is no access to the Model and/or system, the Model Owner/ Developer is responsible for:
 - documenting key Model information such as assumptions and key inputs to determine outputs for decision-making
 - taking MV's input scenarios to the vendor to have scenario testing performed, and delivering the output to MV. Any cost incurred will be borne by the Model Owner / Developer.

Model Owner/Developer overall assessment as to the adequacy of the Model to meet the objective and intended use. For Models governed by regulatory requirements or external audit, such as Basel Models, the Model Owner / Developer is required to provide documentation that meets the minimum requirements prescribed by the regulator or auditor.

4.3.10. Model, System and Data Access

In conjunction with the Model submission, Model Developers will provide MV with access to the test or production system and Model input data including:

- **Model and System Access**
 - a copy of the Model as a stand-alone or access to the testing environment in which the Model has been built
 - Model access for a vendor Model. Any related costs, such as license fees, should be covered by the Model Developer for First-Time and Ongoing Validation

- Executable code and Executable access to the production or pre-production environment (once available) for duration of the validation, at a minimum, to test the Model Risk impact level.

If a Model (in-house or vendor) can only be accessed from an external vendor system, the Model Developer must gain system access for MV from the vendor, and cover any related costs.

▪ **Data Access**

- The development data sample and Model input data and the source of the data or access to that used in the Model Development process
- data definition and specification as well as documented data collection process
- documentation of any special data treatment such as missing data, proxies, data errors, data outliers, data manipulation, etc.

4.3.11. Requests for Validation

Model Developers, must submit a request for Validation to MV for all newly-developed or purchased Models as well as for Models in production that have been redeveloped and constitute a Model Change. All validation requests must be initiated in the MRIS.

Workflows submitted to MV through the MRIS must be approved by the Model Developer executive or assigned delegate², and must provide all the Model-related attributes required in all the mandatory fields on the Validation Request input form in the MRIS. The Model developer is responsible for the completeness and accuracy of the data entered in the MRIS [Ref 11].

² All Delegate authorities must be obtained from the LOB executive and submitted to the Model Governance Group for the record.

4.4. Model Validation

Model validation activities assess the appropriateness and adequacy of a Model for its intended purpose. These activities include Validation and Annual Review.

4.4.1. Model Validation General Approach

The depth and level of independent validation should be commensurate with the risk the Model poses to the organization. It ensures that risks have been properly identified and addressed, the Model has been properly developed and tested, and the implementation decision is free from potential management bias. Given that all Models are an imperfect representation of reality, the independent Model Validation should also provide critical analyses of Models capabilities and limitations.

In order to validate a Model effectively, the person performing the validation must be familiar with the requirements and standards associated with developing and operating a Model.

4.4.1.1. Independence in the Model Validation Process

Independence is a key element in the validation process, as it ensures that someone independent from Model Development, and with the appropriate technical expertise, provides a critical assessment of the Model and its acceptability for use. This allows for an unbiased view of the Model from someone who has not been involved in making decision about its design, development, and implementation. Validation should conduct critical reviews of development activities (e.g. Model testing monitoring, etc.) performed by Model Developers and clearly document the separate activities as to evidence Validation's independence.

4.4.1.2. Effective Challenge

Effective Challenge is a set of processes of critical assessment performed by an independent party with requisite competence, appropriate incentives and authority, performed with clarity of purpose on a timely basis, and leading to a decisive conclusion and the enforcement of established requirements. Effective Challenge is defined in Section 2.1 of the Policy. The principles of Effective Challenge, as applied during the independent validation process, are outlined in Table 4.4-1.

Table 4.4-1: Principles of Effective Challenge

Principle	Description
Clarity of Purpose	MV has clearly defined processes and procedures to analyse and assess Models and to report validation findings.
Competence	MV personnel possess the technical knowledge and Modelling skills, experience, training and judgement to provide Effective Challenge.
Independence	MV validates Models independently of the Model Development process.
Proactivity	MV performs Effective Challenge by directly engaging Model Owners and Users to ensure the validated Models indeed serve for their intended purposes.
Timing	MV conducts validation of newly-developed Models before they are put into production, and of in-production Models on an ongoing basis.
Transparency	MV fully documents the validation procedure and the technical information

Principle	Description
	of the validation, and makes the documentation available to all parties via the Model Risk Inventory System.
Review Criteria	The MV Validation Review process specifies criteria for assessing the adequacy of the challenge actions and responses.
Roles and Responsibilities	MV independently validates Models with the conclusion of approval/rejection for use. As part of the validation, Model Risk is assessed and communicated to Model Owners and Developers through comprehensive Validation Reports.
Consistency	The MV Validation process is applied to all Models without bias.

4.4.1.3. Receiving Validation Requests

MV will return any incomplete Validation Submission package and issue a formal rejection notice to the Model Owner / Developer, identifying what required information/documentation is missing.

The Validation process will begin once MV confirms its receipt of the complete validation request package and allocates the appropriate validation resources.

Once a submission is complete, to kick off the Model Validation, the Model Developer, as agent for the Model Owner, will ensure that MV has an overview of the Model and its use. The overview can include information provided during tollgate (or early engagement) meetings and should include business purpose and requirements; Model framework, methodology and key assumptions; input and output data; summary of test results; uncertainties and deficiencies; Model Owner & User feedback; and ongoing monitoring plan.

MV will determine whether a Model can be validated based on the documentation submitted. If it is determined that the Model can be validated, MV will prioritize the validation based on input from Model Developers and Model Owners.

If a Model is material but MV determines it cannot be validated, the Model Owner/ Developer are responsible for monitoring and mitigating any Model Risk. MV will determine whether there is sufficient information available for the validation of such Models.

Once all Model documentation is received and validation priorities have been determined, the approximate duration of the validation will be based on the Model's materiality and complexity and MV's participation in Tollgate or other early-engagement meetings. MV will develop a project plan with estimated timing to complete the validation based on MV internal processes. These estimates will be used for tracking purposes.

4.4.2. Model Validation Activities

Model validation activities include the following:

- Model Validation
- Quality Assurance Review

Additionally, as per Section 4.1.2, MV is responsible for reviewing the Model Owners assessment of the tool as a Model as outlined in Section 2.2 of the Policy.

If MV confirms the opinion of the Owner/Model Developer:

- that the tool in question does not meet the definition of Model under the Framework - then MV will so inform the Owner/Developer and no Model Validation will be required. However, the Owner / Model Developer must specify to MV and MG the governance framework under which the tool is being controlled.
- that the tool is a Model, it will proceed with the Model Validation process outlined below

If MV's determination differs from that of the Model Developer / Owner of the tool, the issue will be escalated for final determination as per escalation protocol between the first and second lines.

4.4.2.1. Model Validation

Validation involves routines to thoroughly assess Model risk in order to confirm Model appropriateness and capability, effectively challenge Model development, and communicate decisions regarding Model use to the business. All Models require independent validation. The purpose of the Model validation is to:

- Assess whether a Model is appropriate for its intended use
- Provide critical analysis so that decision makers can better understand a Model's capabilities, stress points and limitations
- Assess the associated Model Risk and the controls in place to mitigate that risk
- Identify flaws in the logic or errors in the data, Model Development, or Model Implementation

Model Validation can vary in accordance with the complexity and degree of risk inherent in a Model, as well as by Model type and techniques used to develop the Model.

Model Validation should be an ongoing activity that occurs throughout the Model lifecycle and is required at specific points in time based on specific events. If one of these events occurs (see Section 4.4.2.2), MV should be consulted to determine the scope and rigor of Validation activities. The extent and type of the event will determine the scope and timing of the Validation required: this could mean a pre-implementation validation, Revalidation (fka Scheduled Review), or targeted scope revalidation as described below:

- i. Pre-Implementation Validation
- ii. Validation of an Existing Model (Revalidation)
- iii. Targeted Scope Validation

4.4.2.1.1. Pre-Implementation Validation

A full scope validation must be completed for all new or acquired Models, or for a Model that has undergone a substantive Model change prior to use. This validation type is triggered by the LOB's creation or re-development of a Model and involves a comprehensive review of conceptual soundness, Model use, and outcome analyses. This type of review always requires and independent testing of Model outcomes.

4.4.2.1.2. Revalidation - Validation of an Existing Model

Models that have been previously validated and approved for use are subject to periodic Revalidation. A Revalidation requires a deeper probe into the Model, and greater analysis of the Model itself, than an Annual Review.

A Revalidation should be initiated for any of the following reasons:

- Based on the conclusion of an Annual Review that a re-validation is needed
- Under required timeframes outlined in MRM framework as follows:

Table 4.4-2: Revalidation Frequency

		Model Error Potential		
		High	Medium	Low
Model Risk Impact	High	1 year	2 years	3 years
	Medium	2 years	3 years	4 years
	Low	4 years	4 years	5 years
	Non-Material	5 years	5 years	5 years

Note:

1. In the year in which a Model is subject to Revalidation based on the above schedule, an Annual Review is not required
2. For Basel AIRB Models, revalidation should be synchronised with the AIRB Annual Assessment and Validation (See section 4.7.3)
3. Fiduciary Models with High-High, High-Medium and Medium-High Risk Rating will have a review frequency of every three years. For fiduciary Models with all other Risk Ratings, the review frequency will be every five years.
4. Special systems with multiple Model components may require a different approval and review frequency for each Model component.

The purpose of the revalidation is to provide a new effective challenge of the Model given the passage of time, and assess the ongoing validity of the Model under the prevailing market/economic conditions, current portfolio structure or data availability. The revalidation uses the same framework as the pre-implementation validation, but will likely have a somewhat different scope and focus, reflecting the maturity of the Model and its usage experience. The scope of the revalidation should be commensurate with the risk rating of the Model.

The pre-implementation Validation report and subsequent ongoing monitoring, annual reviews, and Validation can be used as resources in the revalidation process.

The revalidation provides an opportunity to re-challenge certain underperforming components of the Model, or areas that were difficult to analyze fully during the pre-implementation validation. For example, decisions may have been made during the initial development of the Model based on limitations in the data or data quality. Those issues may no longer exist in the current environment, which may change the conclusion regarding the adequacy of the current Model. Therefore, it is critical to use appropriate judgement when determining the scope of the revalidation, and to challenge those aspects of the Model that warrant a fresh independent review. The revalidation also challenges those aspects of the Model that may be subject to risk or performance degradation, rather than simply focusing on what has or has not changed.

Some key areas that can be addressed as part of the revalidation process include (but are not limited to) the following:

- Assumptions made in the original development of the Model
- Current inputs and assumptions that are being fed into the Model
- Input assumptions included in the Model to improve the overall performance and ability to achieve business purpose
- Limitations or restriction imposed during the original development process that are no longer valid, including impact on performance of the Model
- Data quality improvements, stability or declination since the last validation, and potential risk
- Theoretical or design issues identified in the validation, resolution, and potential risk
- Changes made to the Model since last validation and status of implementation
- Model's change control process
- Output of the Model being quantified and accuracy
- Output of the Model and appropriateness of new use
- Changes in the external environment or business that may affect the performance of the Model and its ability to fulfill its business purpose
- Continued compliance with applicable regulations
- Operational issues with the running of the Model

The revalidation can include detailed independent testing and analysis to examine the areas above and support the validation conclusions. With a mature Model that has been in use for some time since its initial implementation, there is typically a wealth of performance data to determine the ongoing adequacy of the Model. The revalidation will take a deep dive into the Model performance information, including stress tests, scenario analysis, and other performance measures that provide an expanded view of the Model's current adequacy and capabilities. Model degradation over time can be a sign of poor Model design or development, stale Model assumptions, changing environment or business factors not reflected in the Model, or errors introduced into the Model through inappropriate or inaccurate changes to the Model.

For revalidations, the Model Developer, in consultation with Model Owners and key Model Users, should provide updated documentation assessing the Model, based on the above. This documentation will be reviewed and challenged by the Model Validation group along with any additionally testing or analysis performed by MV to ensure effective challenge of the Model.

4.4.2.1.3. Targeted Scope Validation

A target scope validation is required when triggering events occur that are more targeted or less impactful than those requiring a full revalidation. This validation of an existing Model is focused primarily on the aspects of the Model affected by the proposed Model change or remediation and may not require independent testing of Model outcomes.

4.4.2.1.4. Triggering Events

A Triggering Event is any event which may trigger a full-scope or targeted validation.

Validation is required when a new Model is developed or acquired or if one of the following events occurs for an existing Model:

- A material change is made to the Model inputs, theory or code
- A Model is applied to a significantly different population, product or process
- Material changes in Model performance, especially breaches identified in back-testing, occur, beyond those expected at the time of validation
- Significant changes occur in the environment within which the Model is being used
- There are significant annual review, regulatory, audit or other oversight findings related to the Model that were not previously identified or considered by MV as part of the previous Model validation activity

4.4.2.2. Quality Assurance Review

If a Model is not currently being used or if the tool has been determined not to be a Model under the Framework, then the Owner / Developer may still request that MV perform a Quality Assurance (QA) Review and issue a QA memo that provides its risk assessment with recommendations, but which requires no follow-up action. These tools are not part of the Model inventory and neither the tool nor any QA memo needs to be recorded in the MRIS.

4.4.2.3. Timing of Validation Activities

At the time of a Model's initial validation, the validator should establish an anniversary date. The anniversary date should drive the timing of subsequent validation and annual review activities. The initial anniversary date should be within three (3) months of the one-year anniversary of (whichever of these is later):

- The Model's implementation date (If Model implementation is delayed it is the responsibility of the Model Developer to ensure the implementation date is recorded in the MRIS as the anniversary date when determined)
- The initial validation Approval date

This will provide some flexibility in subsequent scheduling efforts, reducing situations where many Models must be validated at the same time or conflicts with timeframes related to the Model's use. Once the anniversary date is established, this date is used to schedule all subsequent Model validation activities. The next annual review date will be on the anniversary date. The next validation date will be determined based on the timeframes outlines in the MRM framework, using the anniversary date as the due date. For example, assuming a High Risk Model:

The scope of first-time validation follows a risk-return approach based on the Model Materiality of each Model and is outline in Table 4.4-3 below.

For the ongoing Model validation reviews (e.g. Revalidation, Trigger Review, Performance Monitoring Review or Annual Review), the validation review scope is to be based on the assessed Model risk rating, Model type as well as overall model performance observed.

Table 4.4-3: Scope of First-Time Model Validation

Scope of Model Validation					
Model Materiality Rating		High	Medium	Low	Non-Material
Validation Requirements					
Evaluate	Model Documentation	Y	Y	Y	Y
	Model Materiality	Y	Y	Y	Y
	Model Choices	Y	Y	Y (high level)	N
	Theoretical Construction	Y	Y	Y	N
	Assumptions	Y	Y	Y	N
	Data	Y	Y	Y	N
	Mathematical/ Statistical Calculations	Y	Y	Y	N
	Replication	Y	Y	Y	N
	Model Output Against Reality (when applicable)	Y	Y	Y	N
	MOC/Overlay	Y	Y	Y (if applied)	N
	Benchmarking Against Industry (when applicable)	Y	Y	N	N
AIRB	Quantitative component of compliance assessment	Y	Y	Y	N
RC/ICAAP/CCAR / DFAST/ Additional Testing and Analysis	Sensitivity Testing	Y	Y	Y (when needed)	Y (when needed)
	Scenario Analysis	Y	Y	Y (when needed)	Y (when needed)
	System Robustness	Y	Y	Y	Y
	Stress Testing	Y	Y	N	N
Model Risk Uncertainty		Y	Y	Y	N
Conclusion (Approve/Reject)		Y	Y	Y	Y
Output	Material Deficiency	Y	Y	Y	N
	Observation	Y	Y	Y	N
	Effective Range of Use	Y	Y	Y	N
	Triggers	Y	Y	Y	Y

Legend	
Y	In Validation Scope
N	Out of Validation Scope
Exceptions: Some Model types, i.e., MFL applications, may receive distinct treatment. See Appendix 3 for treatment of MFL applications.	

Note: 1. MV will validate the quantitative component of the Model Developer's compliance assessment for all Basel AIRB Models.

4.4.4. Model Validation Process

4.4.4.1. Model Validation Kick-off

Once the Model Development package is deemed complete in the MRIS, MV or MD will, as appropriate, convene a kick-off meeting before commencing the actual validation or combine it with a Tollgate meeting. This meeting will provide an opportunity for the Model Developer, Model Owner and key Model Users to describe the business context, the role the Model plays in decision-making and any additional details that may assist the Validation Analyst in performing the validation in the context of use. The Model Owner / Developer will provide an overview of the Model to MV in the kick-off meeting as part of their required submission.

4.4.4.2. Non-Parallel and Parallel Validation

All Models must be independently validated prior to use. Traditionally, Model validation has been conducted in a "non-Parallel" fashion where the validation is completed post-Model development. This approach is appropriate for many situations. However, there are situations, like CCAR, where a "Parallel Validation" approach is more suitable. As outlined in Section 4.3, a tollgate process should be used to facilitate this parallel validation and the independence of the validator should be maintained. Issues identified during the tollgates should be clearly documented to ensure a tracking of the effective challenge and these should be included in the final Model Validation report.

4.4.4.3. Model Validation Procedures

Model validation procedures are intended to provide effective assurance of the reliability of the Model. The nature and extent of the procedure will depend on the type of Model, the level of risk of the Model, and the availability of the data, effective benchmarks, etc. The Model Validation group should maintain validation procedures to ensure consistency in the approach and documentation of the validation process. The following provides a general view of types of validation procedures, and the level of independent testing that is required.

4.4.4.3.1. Data Input

Data quality is integral to the effectiveness of a Model. The validation process must ensure that the data used for Modelling is appropriate and representative for the intended purpose. The validation process should also ensure that adequate data quality analysis has been performed and data quality issues have been adequately documented and addressed.

In many Models, specific procedures are necessary for invalid or missing data in order to omit the data or transform it to an acceptable value. Procedures applied to raw data must be analyzed as part of the validation process.

Data that comes from outside sources or data proxies should also be assessed for reasonableness, representativeness, and the appropriateness of the external sources themselves should be assessed as well (e.g. the data may reconcile to an external source, but the sources may not be providing the type of information that is relevant to the Model).

4.4.4.3.2. Assumptions

Most Models typically require the acceptance of certain assumptions in order for the Model to derive an estimate or prediction of behaviour. (The term “assumption” in this case includes, broadly, any subjective inputs required of the developer in creating the Model). These may include assumptions on the mathematical relationships between variables or user-determined parameter settings. These assumptions are often judgemental – based on theory, history, or anecdotal evidence which may or may not be relevant to future predictions and significant to the output of the Model.

Such assumptions can create considerable risk to the Model’s ability to fulfil its intended business use; the validation process should assess the assumptions in light of these risks. The validation must include the following:

- A review of the Models assumptions for reasonableness (including management’s justification for using particular assumptions);
- A review of the process established to update and analyze (or back-test) assumptions on a regular basis, as well as a review of the results of this process;
- A review of the change control process, to ensure that assumptions are changed appropriately;
- A discussion on the sensitivity of the Model output to changes in assumptions, particularly those that cannot be readily verified.

4.4.4.3.3. Theory and Operating Accuracy

Assessing the conceptual soundness of the Model theory is an essential part of the Model validation process. Model theory is often complex and requires an appropriate level of knowledge and skill, on the part of both the Model developer and the Model validator. The theory of the Model must be appropriate for the intended use of the Model and should be adequately supported by either academic or professional journals or by other means that provide adequate support for the reliability of the conceptual design of the Model for its intended use.

The objective of validating the Model is to provide reasonable assurance that it is fit for use, operating as intended and is free of any material errors. This is a necessary complement to the theoretical review that establishes the appropriateness of the Model’s design.

The types of tests performed to ensure the accuracy of the Model math or code will depend greatly on the type of Model. The types of validation procedures that can be applied include, but are not limited to:

- Reviewing the development and user acceptance testing performed during Model development, possibly including independent verification of the results;
- Reviewing the Model Developer’s independent in-sample and out-of-sample test or independent performing the test, where appropriate

- Reviewing key accessible portions of the Model code where appropriate (often used with more complex Models that cannot be replicated or simply validated)
- Reviewing intermediate results where appropriate
- Independently creating the Model or key calculations and reconciling the results to those of the Model being validated
- Conducting benchmarking, where appropriate, to an alternative method or analytical approach that addresses known weaknesses and limitations of the primary Model, where appropriate. Benchmarking may be performed using external sources, independent creation of an alternative specification of the Model, or by comparing the performance of the Model to a known alternative.
- Testing the Model in specific cases where results are known or analytically tractable
- Sensitivity analysis that tests the impact changes in the key Model inputs would have on Model outputs
- Stress testing that considers the full range of possible inputs that may be used with the Model, including those that may be used as part of reported stress test or scenario analysis (e.g. CCAR/DFAST)
- Operational stress testing that attempts to ascertain the conditions or to determine the applicable range of the input.

The choice of procedures to ensure the Model's operating accuracy shall be based on MV's professional judgement based on the level of risk embedded in the Model processing component, as well as the most efficient way to test the Model. When completed, the validation must provide reasonable assurance that the Model is materially free of errors and is operating as intended. The final validation result and conclusion should have analytical support.

4.4.4.3.4. Model Outputs

The validation process must assess the validity of each Model's output. It is critical to understand what outputs are used, for what purposes, and to assess the possible impact if the Model results are flawed.

In some cases, information that comes directly out the Model may be transformed or otherwise manipulated outside of the core Model before it is used to make a business decision. The Model validation process must assess the validity of the actual information used in the decision making process – not just the output generated from the specific Model code. In some cases, information may pass through multiple transformation processes and be used in multiple ways for decision making, analysis, etc. Judgement must be used to determine the most appropriate cut-off point for the scope of the Model validation, which includes considering the risks inherent in the subsequent transformation processes, the controls in place to mitigate those risks, and other oversight processes that may perform secondary controls similar to independent validation.

Validation of the Model outputs can often be combined with testing of the other components described above. These procedures may include code review, independent testing of the Model, benchmarking, stress testing, or reviews of Model back-testing.

4.4.4.3.5. Model Adjustments

Model algorithms are occasionally adjusted to align a Model to the current production environment or population and improve Model performance. The use of adjustment factors may

delay the need for full recalibration or redevelopment or may be part of a robust, ongoing calibration protocol. Whether the Model uses in-Model or out-of-Model adjustments, it is critical that the methodology, use, and impact of these factors be transparent throughout the Model lifecycle

- ***In-Model Adjustment*** (Margins of Conservatism) – are defined as scalars, indices, dummy variables, or other factors applied as part of the Model calculation. In-Model adjustments are not estimable parameters; they are factors that may be applied once or adjusted each use to improve Model performance; but are not part of a clearly defined calibration approach.
- ***Justification of Adjustments*** – any Model adjustments must not be used to mask poor Model performance or apply conservatism that is not grounded in sound economic practice. All Model adjustments must have appropriate root-cause justifications documented as part of the Model development documentation. Model Adjustments, like any Model component, must meet core development and validation principles of conceptual soundness, outcome analysis, and ongoing monitoring, and must be appropriately justified and documented.

4.4.4.4. Assessing the Ongoing Monitoring Plan

- Assess the key performance metrics identified by the Model Developer and identify any gaps requiring additional metrics if appropriate
- Review and assess the proposed frequency of the monitoring
- Review and challenge the Model Triggers proposed by the Model Developer. Ensure the metrics are appropriate and can be monitored. Identify any gaps not covered by the proposed triggers
- Review (as required) the Model's triggers, Model Trigger Sensitivity rating and the trigger sensitivity

4.4.4.5. Assessing Vendor Models

As all vendor Models will be validated, to the extent possible, to the same standards as in-house Models, Model Owner / Developer will provide MV with the required access to and documentation of a vendor Model.

Degrees of Access to Model-related Information:

- Where the necessary information is available – MV will perform a normal validation.
- Where Model Information is Restricted – MV will validate the Model on a best effort basis
- When MV has no access to the system and/or Model:

Model Owner / Developer will:

- Provide MV with key Model information such as assumptions, and key inputs to determine outputs for decision-making
- Deliver MV's input scenarios to the vendor to perform scenario testing and then deliver the output to MV for analysis. Any cost incurred will be borne by the Model Owner

- Provide back-testing results to MV to validate the effectiveness of the Model.

Due to the nature of the constraints, in this case where there is insufficient information, an initial Validation Report will be replaced by a Quality Assurance memo.

When constraints prevent a meaningful analysis of a Model, MV may deem such a Model as unable to be validated. In this case, the Model cannot be fully subject to the Framework, will require an exception to the Policy and the Model Owner/Developer will have to make explicit appropriate controls.

4.4.5. Model Validation Conclusions and Documentation

MV will document its conclusions using a Validation Report template based on the Model's materiality:

- Medium-High Validation Report template
- Low Materiality- Non-Material Validation Report template

MV will develop and use Validation templates designed for specific Model types as required.

4.4.5.1. Classification of Findings

Based on its independent review of the Model Developer's identified and classified Model weaknesses and MV's own testing, MV will independently assess the Model Developer's identified weaknesses and identify any additional findings, and classify, explicitly justify and document these weaknesses/findings as follows:

- Critical Deficiency (Results in Rejection of Model); or
- Material Deficiency; or an
- Observation

The process for classification of Model weaknesses and findings is outlined in Appendix 4. MV will indicate, with supporting evidence, why a deficiency is classified as a Critical Deficiency, Material Deficiency or an Observation. Material Deficiencies will not pertain to Models assessed as non-material.

4.4.5.1.1. Agreement on Classification of Findings

MV will share its findings and conclusions with the Model Developer and Model Owner either through formal Toll Gate sessions, where they take place, or through regular stakeholder project update meetings after it completes its preliminary Model assessment. The Model Developer and Model Owner will have an opportunity to review the findings and provide feedback.

If the Model Developer does not agree with MV as to the classification of one or more Material Deficiencies, or MV does not agree with the Model Developers Remediation Plan or time frame for resolution, MG will be notified. MG will review the issue and attempt to resolve, if unable to resolve MG will facilitate mediation by the Head, ER. If no agreement is forthcoming from mediation the matter will be escalated as per the Escalation process (see S.12 of these Guidelines)

In all cases where MV either proposes to approve a Model with Material Deficiencies requiring a mitigation or remediation plan, or reject the Model due to Critical Deficiencies, or approve a

Model with or without Observations, the findings of the draft Validation Report will be reviewed with the Model Owner /Developer prior to sign-off (See Section 4.4.5.1.1).

4.4.5.1.2. Material Deficiencies

MV will indicate, with supporting evidence, why a deficiency is classified as a Critical Deficiency, Material Deficiency or an Observation. Material Deficiencies will not pertain to Models assessed as non-material.

For Material Deficiencies a remediation plan, which may set out remediation and/or mitigation measures, is required to address the Deficiency. MV will specify what needs to be remediated/mitigated and why, and when a Remediation Plan is provided by the Model Developer, assess whether the Remediation Plan provided is sufficient. The Model Validation report will specify a Submission Date for when the Model Developer is required to provide evidence of the completed remediation/mitigation work and a Fulfillment Date, by which MV should complete its review of the remediation/mitigation work.

(For potential sources of Model deficiencies and their ranking, refer to Appendix 4)

4.4.5.1.2.1. Remediation of Material Deficiencies

The Model Developer must submit the solution in the agreed upon remediation plan to MV by the agreed upon Submission due date. If the solution is not submitted by the Submission date, and no Extension of the date has been granted, the Model approval will be revoked. (See Section 6.6)

4.4.5.1.2.2. Material Deficiency Remediation Approval Authority

Remediation of material deficiencies submitted to MV may be approved by the appropriate Validation team director.

The identification of any new Material Deficiency resulting from the assessment of the remediation of a previously-existing Deficiency is subject to the same requirement for a Remediation Plan and appropriate due dates.

4.4.5.2. Approving or Rejecting a Model

The conclusion of the Model Validation will result in one of the below outcomes:

- Approved for Use
- Approved for Use with Material Deficiency (pending completion of remediation plan) or Observation
- Not Approved (the Model has been rejected or may be rescinded by the Model owner in anticipation of it being rejected)

A Model can be approved if there are no Critical Deficiencies and if Material Deficiencies that have been identified can be effectively remediated through a remediation plan or a mitigation agreed to by the Model Developer and MV in the MRIS, by specified dates. As part of determining the conclusion for approval, if there are multiple findings MV will consider the aggregate impact of all findings.

A Model will be rejected if MV concludes a Critical Deficiency exists after considering all mitigating factors, including any business overrides, described by the Model Owner / Developer.

4.4.5.2.1. Criteria for Approving a Model with Material Deficiencies

If, during the course of validation, MV identifies Critical Deficiencies, and the Model Developer agrees to revise the Model, the validation will be stopped (through the MRIS). Similarly, if, during validation, MV identifies Model deficiencies that would not result in rejection but nonetheless the Model Developer, agreeing with MV's assessment, wishes to re-develop the Model and subsequently re-submit it for validation, the validation activity along with the workflow will be stopped in the MRIS. In both cases the plan will be adjusted, and resources will be re-allocated. Similarly, The Model Developer will re-submit the Model for validation at a later date, based on a revised timeline agreed-upon between the Model Developer and MV.

If a Model is assigned an MEP/MRI rating of High/High, the Model Owner / Developer will be required to provide a written description of existing or planned mitigation or an action plan for controlling the risks identified in the Validation Report until the remediation of the deficiencies is fully implemented. If a Model is assigned a High/High Risk Rating due to a Material Deficiency, an acceptable Remediation Plan will be required to address the material Model Deficiencies in order to reduce the Model Risk within the time provided in the Remediation Plan.

If a Model is rejected due to a Critical Deficiency, the Model Owner can re-develop the Model, discontinue planned Model use or escalate the matter to the accountable Model Owner / Developer's executive.

If a Model has a Material Deficiency, but actions identified in a Remediation Plan and taken by the Model Developer, including risk mitigation and control processes, reduce the Model residual risk to an acceptable level, MV will approve the Model based on the actions identified in the Remediation Plan. If there are multiple Material Deficiencies, MV will consider all findings in their collective entirety to determine overall conclusion.

If a previously approved in-production Model is subsequently rejected as a result of MV's reassessment, the Model Developer, on behalf of the Model Owner, will be provided with a reasonable timeframe within which to deliver an acceptable solution. In the interim, the Model may continue to be used provided the Model Developer procures an approved Exception (see Section 6.4).

4.4.5.2.2. Model Approval Authority for Pre-implementation Validation and Re-Validation

All Models require the approval of Head, MV or designee prior to use.

Table 4.4-4: Model Approval Authority

		Model Error Potential		
		High	Medium	Low
Model Risk Impact	High	Head, MV	Head, MV	Head, MV
	Medium	Head, MV	Head, MV or Designee	Head, MV or Designee
	Low	Head, MV or Designee	Head, MV or Designee	Head, MV or Designee
	Non-Material	Head, MV or Designee	Head, MV or Designee	Head, MV or Designee

Note: For MFL utilities, where MEP is High, Approval Authority is Head, Model Validation. Otherwise approval authority is Head, Model Validation or Designee.

After a Model has been approved, for approval of any addenda added to capture certain aspects not covered in the original Validation report, i.e., UAT review and approval, overlay review or approval, ongoing performance monitoring, or a clarification, the Head, MV can delegate approval.

4.4.5.3. Sharing Findings with Model Developer/Owner

MV will share its findings and conclusions with the Model Developer and Model Owner either through formal Toll Gate sessions, where they take place, or through regular stakeholder project update meetings after it completes its preliminary Model assessment. The Model Developer, Model Owner, and where appropriate key Model Users will have an opportunity to review the findings and provide formal feedback in the MRIS.

4.4.5.4. Model Validation Documentation

The result of the validation process is a written report detailing the overall conclusion, validation steps, risks, issues, recommendations, and Model risk rating of the Model.

To ensure documentation is as complete, consistent and comprehensive as possible, the Head of the Model Validation group is required to establish appropriate *Model Validation Documentation Template(s)* and require their mandatory use for all Models validated within the group. These templates should be reviewed by Model Governance and once approved they become governance documents and will be used by MG to verify consistent use within MV.

The Model Validation report for first time model validation and model change validation should at a minimum contain the following:

- Executive Summary – Overall summary of the validation and conclusions with explicit rationale

- Effective range of Use
- Assessment of Model
- Model Validation Approach
- Model Validation Findings, including Remediation plans, and Observations (which don't require any remediation)
- Model Risk Rating
- Ongoing Performance Monitoring
- the documented assessment of the Model and Model Risk
- the results of all tests and analysis conducted
- Next Review Schedule

4.4.5.4.1. Effective Range of Use

MV will assess the Effective Range of Use specified in the Model documentation and then set out the Effective Range of Use in each Validation Report.

4.4.5.4.2. Model Risk Rating

For each validated and approved Model, based on its review of the Model Owner and Model Developer's proposed risk rating, test results, and MV's independent analysis, MV will provide and justify a Model Risk Rating for the Model comprising MEP & MRI based on the ranges in tables 3-4 and 3-5 (see Policy Sections 2.5 & 2.12, respectively).

The Risk Rating will determine the review frequency of the Model and the approval authority (refer to Section 3.1).

4.4.5.4.3. Ongoing Model Performance Monitoring

The Validation Report will specify the specific performance indicators that will be part of the performance monitoring for the Model. If a Model already has a performance monitoring procedure in place, it should be referenced. Where there are specific regulatory requirements for performance monitoring, these will be included. It will also specify each trigger, its sensitivity along with the overall Model trigger sensitivity and monitoring/reporting frequency.

4.4.5.4.4. Next Revalidation Schedule

The Validation Report will specify the Next Review Submission and Fulfillment Dates based on the Model's Risk Rating for the Revalidation of the Model (fka Scheduled Review as per Section 5.11 of the Policy). (See Section 4.4.2.1.2)

4.4.5.4.5. Draft Validation Reports

MV will submit the draft report through the MRIS to the Model Developer and, where appropriate, the Model Owner, for review. Unless otherwise agreed upon by MV, the feedback on the draft report must be provided to MV within one week of MV issuing the draft in the MRIS.

Whether MV either proposes to reject the Model due to a Critical Deficiency, to approve a Model with Material deficiencies that require remediation or mitigation, or approve a Model

with or without Observations, the findings of the draft Validation Report will be reviewed with the Model Owner /Developer prior to sign-off.

4.4.5.4.6. Final Validation Report

MV will finalize the report after taking key stakeholder feedback on the draft into account and obtain the appropriate approvals. Each validation report, and resulting issues and recommendations, MV will publish the final report and share it with the appropriate levels of the First Line of Defence management and other Model stakeholders. It is the responsibility of the Model Owner to track the issues identified as part of the validation process and to address those issue in a timely manner as agreed in the Validation process.

Additionally, MV will record all mandatory validation data attributes in the report and ensure they are kept current in MRIS.

4.5. Model Implementation

After the Model has been developed and validated it is migrated into a production environment to be run on an ongoing basis (the “Implementation” process). In some cases, (for example, with a Model using Microsoft Excel) the implementation process may be very basic and limited. In other cases the implementation process may involve re-coding the development Model into “production code” and integrating that code into a technology production system, which can be an extensive effort. The following Model implementation principles should be considered for all Models:

- There must be proper procedures and controls in place to ensure that the Model being implemented appropriately resembles the Model that was developed and tested;
- Proper testing must be performed to ensure that the Model will operate accurately and efficiently in the production environment, consistent with the Model version approved by MV;
- Data sources for the production process must be adequately understood and data integrity tested and addressed properly

Model implementation is the bridge between an effective Model development process and an effective production Model. A well-developed Model does not necessarily ensure that the Model will work effectively on an ongoing basis in a live production environment. Production data feeds may not work as intended, data integrity or availability may be different on current data than the data used to develop the Model, the production code may be different from the development code and produce a different result than expected, etc. As a result, the Model must be appropriately tested to ensure it will work as intended in a production environment. The type and rigor of the testing will depend on the complexity of the integration process.

All aspects of Model Implementation are the responsibility of the Model Developer*, with assistance of Model Owners and Users, and with the support of relevant stakeholders such as T&O. The Model Developer, in those Model areas where appropriate, is responsible to identify and engage the appropriate stakeholders such as the Model Owners and User (or proxy), and T&O in Model implementation. For all other situations, such as vendor Models, the Model Owner shall fulfill this role.

* In those areas where another relevant stakeholder has responsibility for implementation in lieu of or in conjunction with the Model Developer, they are responsible for all aspects of Model implementation that would otherwise be ascribed the Model Developer.

Model Developers will work with relevant stakeholders to ensure the system on which the Model is implemented is robust and flexible. The system should be:

- capable of adapting to change
- expandable/scalable and designed to accommodate growth
- sustainable
- reliable and stable.

The Model Developer should identify any manual processes associated with the Model and work with T&O, when appropriate, to ensure there are effective controls to reduce process errors.

4.5.1. Implementation Documentation

Model implementation must be confirmed with documentation by the Model Developer or Model Owner/relevant stakeholder with primary responsibility for Model implementation. Documentation may take the form of a separate implementation document or be contained wholly in the development document.

The documentation must include a Model description if the implementation is covered in a standalone document apart from the development documentation. This should be a summary only, sufficient to inform readers of the general characteristics of the Model. If appropriate, references to Model development documentation may be provided so that interested readers can request additional details.

In addition to a description, the implementation documentation must include at least the following information:

- Model Functions assessed by the implementation
- Data Sources, taken as inputs to analytics functions
- Configuration, such as hard-coded or user defined settings or flags
- Date and Version history including description of change control mechanism and sources control system
- Implementation or production platforms including implementation languages and identification of any supporting libraries or architectural layers (including specific versions where appropriate)
- Known gaps in implementation, including a statement of anticipated severity and any applicable mitigation plans.

4.5.2. Data Mapping

The Model Developer will work with relevant stakeholders such as T&O to map variables in the input data set to variables in the output data set to ensure that Model output is accurate and complete.

The Model output must support the Model Owner /User's defined business, business decision-making and reporting requirements.

4.5.3. Model Testing

In general all Models should be subject to multiple tests to ensure the Model is robust and stable, limitations are properly assessed, Model behaviour over a range of inputs and assumption values is understood, situations where the Model performs poorly or unreliably are understood, and the different uses of the Model are adequately analysed.

Implementation testing and process verification must be completed prior to Model use.

Model Developers, with the participation of tactical or operational key stakeholders and Model Owner / Users, will execute implementation testing with the support of T&O to ensure:

- the approved version of the Model is the one that has been coded/implemented
- the production Model is coded and implemented correctly and yields the expected output for a given input
- data flows are mapped correctly from a Model Owner / User perspective.
- During implementation testing, the Model Developer will work with the Model Owner / User and other stakeholders such as T&O to address any material findings or deficiencies related to implementation testing. The user interface for the Model will be tested and evaluated to ensure it is working correctly.
- The Model reporting functionality will be tested and the resulting reports will be evaluated for accuracy, completeness and relevance to the stated business requirements. The report contents must be informed by the key assumptions and Model weaknesses identified by the Model Owner / Developer and MV.

4.5.3.1. User Acceptance Testing

Implementation testing ensures that the production process will yield the same output as the development process. In situation where production code is separate from development code, this generally involves a comparison of the two and testing using the same inputs and assumptions. The following types of tests should be considered, as applicable:

- **Unit testing** – tests the accuracy of the processing component of the Model
- **System Testing** – tests that the Model performs as expected under simulated conditions and across system interfaces
- **System Integration testing** – where certain Models output can impact the input and/or the output of downstream Models.
- **End-User testing** – tests the Model performs as expected under normal operating conditions and that no systems or processes are adversely (unexpectedly) impacted
- **Stress Testing** – tests that the Model performs under adverse conditions, such as situations when economic or other assumptions are outside of normal expected values or levels
- **Pilot testing** – is performed in an actual production environment on real-time data, limited to a small population, in order to test a live use of the Model. Pilot testing can vary in size and duration depending on the business impact.

- **Champion / Challenger Testing** – involves running a newly developed Model parallel to the existing Model and comparing results – to determine the “lift”, benefit, or gained accuracy of the new Model over the exiting Model.

4.5.4. Model Rollout

When the Model is ready to be put into production use, the Model Owner / Developer will implement the Model access and the change and version controls. They will provide Model Owner / Users with the following information:

- full disclosure of the Model Risk
- assumptions about Model inputs, outputs and uncertainties
- Model input parameters
- Model outputs that will inform Model Owner / Users for decision-making or reporting purposes.

The Model Developer will provide guidance to the Model Owner / User through a User Manual or documentation, *and provide the Model Owner / User with training on the effective use of a Model and the mitigation of the Model Risk*. The scope of the instructions and training to be provided will be determined by the Model Materiality. See table 4.5-1 for further details.

Table 4.5-1: Model Manual Content

Model Type	Manual/Guidelines Content
High and Medium Materiality Models	<ul style="list-style-type: none"> • Instruction on Model usage • key assumptions about the Model and its effectiveness • key assumptions to the Model inputs • key Model deficiencies, key sources of uncertainty • key uncertainties of the Model output and guidance to mitigate the risk such as overrides • the Effective Range of Use • Triggers and their monitoring
Low and Non-Materiality Models	<ul style="list-style-type: none"> • Instruction on Model usage • inputs to and outputs from the Model and their key assumptions • key sources of uncertainty and mitigation guidance • Effective Range of Use • Triggers and their monitoring

Model Owner / Users must participate in user training and follow the User Manual or guidelines provided by the Model Developer to ensure proper use of the Model. Model Owners / Model Users must ensure they understand the assumptions about the inputs and the interpretation of the outputs and take them into consideration when they are used for decision-making and reporting.

4.5.5. Approvals and version Control

The Model Owner, or where appropriate the Developer as agent of the Owner, will ensure that the approved version of the Model is implemented into the production environment and provide documented evidence of proper implementation to relevant stakeholders including MV.

Once the Model has passed UAT, the Model Owner / Developer must submit the test results to all key stakeholders required to review and approve them, including MV.

4.6. Model Use & Ongoing Maintenance

An adequately built Model can still lead to bad business decisions if used improperly. The use of the Model is as critical as the development process itself, and appropriate use can lead to reduced Model risk. Because of this, each Model Owner is expected to establish appropriate Model controls to ensure the Model and its ongoing use are adequately managed and subject to ongoing monitoring.

Once the Model is put in production, the Model must have clear access control. MG will conduct sample testing to ensure such control is in place.

4.6.1. Model Change Control

All changes made to a Model should be detailed in a change control log by the Model Developer, Model Owner or appropriate stakeholder (i.e., T&O). Changes should be made in an environment that ensures the existing production system is not compromised, subject to adequate security to ensure that only qualified individuals make changes. All changes should be adequately tested, and the results reviewed and accepted by management before the change is implemented. Any material Model modifications or material Model changes (see Model change definition in Appendix 1) resulting from any of the triggering events outlined in Section 4.4.2.2 should be reviewed and approved by Model Validation.

Changes resulting from Model calibrations may not be subject to validation if the Model calibration procedure has been previously approved by Model validation. Calibrations that fall outside of an approved calibration procedure will be subject to validation and approval.

4.6.2. Model Security

Security involves protecting not only the physical Model itself, but also the intellectual property that relates to the Model. The Model code, program, or file should be secured in a manner consistent with the BMO Information Security Corporate Standard [Ref 5]. Once a Model is completed, it should be “locked” as a version and access should be limited to the Model owner, developer and other individuals on an as-need basis only. Changes to existing, implemented Models should not be performed on the production Model, but on a controlled copy of the Model (development code or file). Access to the development code or file should also be appropriately limited.

In addition to security for the code or file, there should be proper security for all Model documentation and Model output (both hard and electronic copies) under the BMO information security standards.

4.6.3. Model Monitoring

Sound Model development is the first stage in an effective Model monitoring program. Detailed requirements and responsibilities for Model monitoring are described in Section 4.7.

4.6.4. Updates to Model Assumptions

Assumptions should be reviewed on a periodic basis as part of ongoing monitoring and updated as necessary if the assumption is found to have changed from the original development. Any change to Model assumptions should be made with the same care and control as a Model code change, including appropriate management and MV approval for key assumption changes. Support for assumptions

made, and any subsequent changes, should be properly documented such that an independent reviewer can assess the validity and reasonableness of all key assumptions.

4.6.5. Model Backup and Recovery

Models are critical business decision making tools and must be available as needed to make ongoing business decisions. Appropriate backup and recovery process should exist to ensure system availability. To the extent applicable, Model Owners are expected to follow BMO Business Continuity Planning Management Corporate Standard [Ref 6].

4.6.6. Model Retention

Models contain critical business information that may be subject to requirements associated with record retention. To the extent applicable, Model Owners are expected to follow BMO Information Management Corporate Standard [Ref 7].

4.7. Ongoing Model Monitoring and Validation

Ongoing Model monitoring and validation is essential throughout the Model lifecycle in order to evaluate whether changes in products, exposures, activities, business practices or market conditions necessitate adjustments, redevelopment, or replacement of the Model, as well as to verify the validity of any significant extensions of the Model beyond its original scope. The scope and depth of monitoring should be commensurate with the risk rating of the Model.

Once a Model is put into production it is subject to ongoing performance monitoring and review in order to ensure the Model continues to be fit for the intended purpose, perform as expected and with the passage of time and the availability of additional information, the initial assessments made concerning the Model's materiality, risk rating, etc. remain valid. The ongoing monitoring & validation process has the following components:

- Model Performance Monitoring
- Model Triggers
- AIRB Annual Model Validation
- Annual Review

Section 4.3.6 above outlined the specific expectation for how the Model Owner/ Developer should develop a plan for ongoing performance monitoring and specify triggers as part of the development of the Model. Once the Model is in use, the following minimum expectations for ongoing monitoring should be met:

Table 4.7.1: Frequency of Model Performance Monitoring

Model Risk Rating	Frequency of Performance Monitoring (KPIs)	Trigger Review Frequency	Annual Review	MV Role
High	Quarterly	As defined below in S.4.7.2	Roll-up of quarterly monitoring and trigger monitoring into an annual assessment of the Model	Review and Challenge Quarterly KPI & Trigger Monitoring and Annual Review
Medium	Semi-Annual		Roll-up of semi-annual monitoring and trigger monitoring into an annual assessment of the Model	Review and Challenge Performance & Trigger Monitoring and Annual Review
Low	N/A		Annual assessment of Model performance including triggers and overall Model performance which should consider KPIs when possible.	Review and Challenge through Annual Review
N/A	Performance assessment is to be conducted as part of Annual Review for MFL or as specified in the approved first-time validation report			

All Models with High MRI and High or Medium MEP, or those that are required by regulations should follow the same requirements as High risk Models. As stated in Section 4.3.6, the performance assessment for every Model should be included in the MRIS to allow for centralized tracking and reporting of aggregate Model risk.

4.7.1. Model Performance Monitoring

All Models should have an approved Model performance monitoring program prior to Model implementation as described in Section 4.3.6. For specific Models where it is not possible to define appropriate tests to monitor the Model performance using KPIs, the relevant exception should be sought. However, these Models are still subject to performance monitoring through trigger monitoring, tripped trigger review and annual review.

4.7.2. Model Triggers

Model Trigger Monitoring is a component of a Model's performance monitoring plan and compliments the KPI performance monitoring. Model triggers are proposed by the Model

Developer/Owner and are subject to review and challenge by MV as part of Model validation (see Enterprise Model Trigger Monitoring Process).

Each Model will have a Model Trigger classification that will determine the monitoring and reporting frequency following the initial validation of each Model and prior to use. The Model Trigger classification is based on two dimensions: i) the sensitivity of each trigger for a particular Model as determined by the Model Developer; and ii) the materiality of the Model. The Model Trigger classification of the most sensitive trigger coupled with the Model Materiality will determine the required frequency of trigger monitoring as follows:

Trigger Sensitivity (Dimension 1):

- **High Sensitivity:** triggers that are highly time sensitive to changes in market and/or economic conditions, operating environment, customer behaviour, and/or other idiosyncratic factors such as business strategies, etc. in the use of a Model. Typically, HS Triggers will be measurable, Model-specific and quantifiable. High Sensitivity Triggers include relevant change events that have the potential to significantly impact a Model's effectiveness, accuracy and performance within a short period of time.
- **Medium Sensitivity (MST):** triggers moderately sensitive to changes in market conditions, economic environment, customer behaviour, and/or other idiosyncratic factors such as business strategies, or regulatory requirements in the use of a Model. Medium Sensitivity Triggers also include a change event with potentially significant impact on the Model's effectiveness, accuracy and performance but with less time sensitivity and in a more prolonged fashion than for HSTs. MSTs have a moderate impact on the business and accordingly are classified as medium. Triggers for Credit Risk Rating, Scenario Analysis Models typically have medium sensitivity.
- **Low Sensitivity (LST):** triggers with low sensitivity to changes in market conditions, economic environment, customer behaviour, and/or other idiosyncratic factors such as business strategies, in the use of the Model. LSTs include events that potentially affect the Model's effectiveness, accuracy and/or performance on a cumulative basis, with less time severity, i.e., triggers for Insurance liability, valuation Models or fiduciary Models.

Model Trigger Classification and Monitoring & Reporting Frequency

Model Triggers are classified using the following two dimensions (see Table 4.7-1):

1. Model Trigger Sensitivity; and
2. Model Materiality

Table 4.7-2: Model Trigger Classification and Monitoring Frequency

		Model Materiality			
		High	Medium	Low	Non Material
Trigger Sensitivity	High Sensitivity Triggers (HST)	Monthly HST Models	Monthly HST Models	Annual LST Models	Annual LST Models
	Medium Sensitivity Triggers (MST)	Quarterly MST Models	Quarterly MST Models	Annual LST Models	Annual LST Models
	Low Sensitivity Triggers (LST)	Annual LST Models	Annual LST Models	Annual LST Models	Annual LST Models

Notes:

- 1) For Models used in CCAR/DFAST/ICAAP process, the trigger review frequency will be semi-annually. Benchmark Models used in the CCAR/DFAST stress scenario Model development process do not have triggers.
- 2) MFL utilities do not have triggers set and are not subject to trigger monitoring.
- 3) Where appropriate, specific triggers for the same Model may be monitored at different frequencies based on rationale provided by the Model Developer and accepted by MV.

Triggers will be monitored, reported on and, when a trigger is tripped, its impact will be assessed and documented by the Model Developer and MV will validate and approve through the Trigger Review process and proposed remediation (see [Ref 8] and Section 6.7.4.).

4.7.3. Model Performance Reviews

Monitoring reports should be produced by the Model Owners (either directly or through Model Developer as its agent) in alignment with the frequency outlined in the Model monitoring program for High and Medium risk Models and in alignment with the annual review schedule for Low risk Models. The frequency of performance reviews must be reflected in the Model monitoring program.

General Requirements for Performance Reviews

The purpose of the performance review process is to determine whether the Model should continue to be used for its approved business purpose. Stakeholders should review the KPIs and triggers contained in the Model monitoring and provide input as to whether the Model is performing acceptably or action should be taken. The Model monitoring results should be a

combination of quantitative assessment and qualitative analysis. Documentation of Model performance should include monitoring reports containing the KPIs, Triggers and the overall performance rating and commentary on the results.

The Model Owner (either directly or through Model Developer as its agent), must complete the first-line performance review of all Models on a recurring basis as outlined in the frequency of monitoring table 4.7.1 above. A second line review must be completed, by MV, for all High and Medium Risk Models and for Low Risk Models used for CCAR or Basel. For Low risk Models other than CCAR or Basel, only the first-line rating and commentary is required.

For the second-line review MV should conduct meetings to review the Model performance monitoring when reports are available. The purpose is for both the first and second-line to look at each Model holistically. MV should obtain any necessary clarifications and provide effective challenge where necessary with regard to triggers tripped in the previous quarter, overrides or any other aspect of Model performance identified in the Model Developer's reporting.

A summary of the discussion, which should include reference to specific Models and related rationale and Model monitoring results will serve as evidence of MV challenge, and should be uploaded to the MRIS through the Performance monitoring workflow with an email notification to Model Governance once the summary is uploaded into the MRIS.

4.7.4. Basel AIRB Models "Annual Assessment and Validation" (OSFI Requirement)

For Basel AIRB Models an Annual Validation is an OSFI requirement and is carried out within the context of the Credit Risk Measures Corporate Standard which outlines the overarching Enterprise-wide validation requirements for AIRB Models. Annual Validation of AIRB Models consists of Model Developer assessment of the Model and of regulatory compliance, according to procedures laid out in approved Guidelines as per Section 7.8.2 of the Risk Rating Systems Corporate Standard and the effective challenge and approval of that assessment by MV.

The Annual Assessment and Validation of Basel AIRB Models refers to the process of ensuring that the Model performance is in line with expectations and is a responsibility of the Model Owner/ Developer. This performance assessment is subject to review and challenge from Model Validation.

Annual Reviews are not required for Models subject to Basel AIRB Annual Assessment and Validation.

a) Basel AIRB Annual Model Validation Guidelines

Basel AIRB Model Developer Assessment Guidelines should be developed by the Model Developer for all Basel AIRB Models that require Annual Assessment and submitted to MV for review and approval.

MV will develop its own Basel AIRB Validation Guidelines for all Models that require Annual Validation.

All Guidelines related to Basel AIRB Model Annual Assessment and Validation will be reviewed and updated biennially.

b) Performing the Basel AIRB Annual Model Assessment

Model Developers, working with Model Owners, Users, and all other relevant stakeholders, will perform their Basel AIRB Annual Assessment based on the approved guidelines and submit their assessment and conclusions to MV for review and approval through the MRIS.

c) MV Basel AIRB Annual Model Validation

MV will review and assess the Annual Validation Report submitted by the Model Developer based on its AIRB Validation guidelines.

MV will present its results in a report that should include:

- Any proposed change in the Model's Risk Rating
- The need for redevelopment of the Model or the identification of any new material Model deficiencies that require remediation
- Any Observations including reassessment of KPIs, triggers, or the need for other mitigation

The report will be shared with the Model Owner / Developer and follow the same protocol as per the issuing of an initial Validation Report in terms remediation of Material Deficiencies (see Section 4.4.5.4.5)

Model Owner/ Developers will take the Annual Validation Report and MV's review report into consideration in their Model performance enhancement and the assessment of their SAP.

4.7.5. Annual Reviews

The primary purpose of an annual review is to determine whether a Model is working as intended and if the existing validation activities are sufficient or if revalidation or redevelopment is needed and identify any issues related to the ongoing use of the Model. The annual review is a critical component of the ongoing monitoring and validation process and is a summary of the Model performance assessment encompassing the KPI performance monitoring, triggers, and any other pertinent information impacting Model performance covering the previous 12 months.

The Annual review is not a revalidation. A revalidation requires a deeper probe into the Model, and greater analysis of the Model itself. The annual review focuses on the Model's use, known factors that may affect the Model's ongoing validity, including changes to the Model or environment in which it is used, and the performance of the Model.

For the Model Development/ Owner, the primary result of the annual review is an assessment of the Model performance consistent with the "Green", "Yellow", and "Red" ratings used for performance monitoring – however a more formal documented conclusion on the performance would be required.

For MV, the primary outputs of the annual review are a determination as to whether the existing validation is sufficient or a full or targeted scope revalidation or redevelopment of the Model is warranted, and identification of any issues that are related to the ongoing use of the Model or were not previously identified in earlier validations. The result of the annual review should be summarized in an annual review report using a prescribed template and the overall conclusion of the annual review should be a determination of one of the following:

- Existing validation is still appropriate
- Targeted Scope Validation needed
- Full Validation needed
- Model Redevelopment needed

For Annual Reviews the Model Developer, in consultation with Model Owners and key Model Users, should provide documentation assessing the Model, based on the above. This documentation will be submitted to Model Validation in the MRIS using the Annual Validation workflow. It will be reviewed and challenged by the Model Validation group along with any additional testing or analysis performed by MV to ensure effective challenge of the Model. Model Validation's assessment will be approved by Head, MV or delegate.

In addition, Model Owner documentation should re-assess Model materiality, the Model risk rating, and mandatory inventory information. MV should review these items, re-assess the MRI and MEP if necessary, review the Model's change log for potential triggering events, and the status of Material Deficiencies. It is possible that an annual review could result in the conclusion that a Model should be re-developed, or even decommissioned without performing a revalidation of the Model. This could happen in cases where a weakness is blatant or already known and the appropriate action does not require additional analysis to support it.

Note: 1. For Basel AIRB Models, as required by regulation, Annual Assessment and Validation will be performed instead of Annual Review.

2. Annual Review is not required for Models that are subject to revalidation in that year.

4.8. Model Decommission

Models will be decommissioned in the following instances:

- If any tool recorded in the MRIS as a Model, upon review does not meet the definition of the Model, such that it is not otherwise specified as being part of the Framework
- A Model is specifically developed for a one-time use and will no longer be valid after that use is completed.
- A Model is replaced by an updated version and the version of the Model being replaced will no longer be valid (i.e. linking old Model to the new in the MRIS).
- A Model is developed for a specific product, the product is discontinued and there are no more on the books.
- Where use of a Model has been discontinued for one year but the Model has not been decommissioned and there is no specific date by which Model use will recommence.

Models that are no longer needed for use will be removed from production. The appropriate Model Owner / Model Developer must notify MG and MV, and initiate a Decommission request through the MRIS. All Model Decommission requests must be approved by MV.

In the event that a Model Owner or User identifies a need to use a Model that has already been retired, they must re-submit the Model to MV for validation and approval prior to use. If appropriate, an Exception must be requested and approved by MV if the Model needs to be used before Validation can be completed.

Models that are decommissioned are recorded in the Model Risk Inventory System as retired. Model Owners should capture any newly Decommissioned Models in the Quarterly Inventory Attestation immediately after the Model is decommissioned.

In the case where a Model is to be replaced by or merged with another Model, the Model Owner / Developer must apprise MV and MG about the status change of the Model as soon as the Model is replaced or merged. MV will issue a memo to document the termination, and update the MRIS to change the status of the Model to "Terminated". The Model Owner should capture this change in next Model Inventory Attestation.

5. CAPITAL PLANNING

The Bank increasingly relies on Models in the capital planning process, including stress testing. It is important to ensure Model Risk uncertainties associated with the use of these Models in the capital planning process are properly identified, measured, and efficiently managed through implementing remediation controls.

Development: As per Section 4.2 above, all Models to be used for the CCAR process must follow a Tollgate process.

Validation: All Models used for the Internal Capital Adequacy Assessment Process (ICAAP), or Comprehensive Capital Analysis and Review (CCAR) and Dodd-Frank Act Stress Tests (DFAST) must be validated and approved prior to use. The remediation/mitigation of all Material Deficiencies for Models used in the CCAR process will be completed by the Model Developer and assessed and approved by MV prior to the use of a Model for CCAR.

Review: All previously-validated and approved Models that will be used in the upcoming CCAR process must be re-evaluated as part of the Annual Review, in the context of ICAAP/CCAR to ensure each Model remains fit for its intended purpose. The Model Developer /Owner will assess each Model. The Model Developer will fully document its assessment and rationale and submit it to MV for effective challenge and approval. MV will communicate its conclusion to all relevant stakeholders.

If MV determines that a Model is not fit for use in the CCAR process, the Model will be removed from the list of CCAR Models to be used in the upcoming submission. If the Model Developer disagrees with MV's conclusion, the matter will be escalation, facilitated by MG, to the US CRO for final determination. If the US CRO confirms that the Model is not fit for use in the upcoming CCAR submission, the Model will be removed from the CCAR list of Models to be used.

Overlays: As per Section 4.3.3.2 of these Guidelines, for Scenario Analysis Models used in the CCAR/DFAST process, the Model Developer will not use Model adjustments (e.g. MOC), but will work with the Model Owner and other key stakeholders to put forward appropriate post-Model overlays to account for any known Model or data limitations. These post Model overlays must be subject to effective challenge by appropriate parties including Model Validation and the Model Owner has the responsibility to ensure an appropriate process is in place to provide this effective challenge. (See Section 10)

A proposed overlay will be included as part of the Model development documentation submitted to MV. When a proposed overlay is quantitative, MV will review and approve the methodology to determine the overlay. MV's assessment and approval will be documented in its Validation report.

The overlay recommendation will be presented by the Model Owner at the Challenge Session that is part of the CCAR process. The Model Developer and MV will attend and participate in the session. Through the challenge process the overlay recommendation will be challenged and approved. On the basis of what is approved, the Model Owner and key Users are responsible for applying the required overlays to the Model output. The results are then approved through the CCAR governance process.

6. MODEL RISK GOVERNANCE & REPORTING

Strong Model Risk Governance is fundamental to the effectiveness of the Model Risk Management Framework.

Model Owners (directly or through Model Developers), as the First Line of Defense and MV, as the second line of defense, are responsible for managing Model Risk with oversight provided by Model Governance. See Section 3.1 for details of Model risk governance and oversight. All stakeholders are responsible for ensuring their own compliance with the MRM Framework, including any and all due dates regarding remediation plans, revalidations, annual reviews and ongoing monitoring. MG is responsible for providing oversight across the Model lifecycle through monitoring, testing, reporting and escalating to ensure compliance with the MRMF.

6.1. Oversight Reporting of Model Risk

As outlined in Section 3.1, the Model Governance group provides enterprise-wide oversight of Model risk across the Model lifecycle. To facilitate these responsibilities, MG will produce regular reporting at both the Enterprise and the US levels, to the Model Risk Management Committee (MRMC), the Risk Management Committee (RMC) and the Risk Review Committee (RRC) and the Risk Oversight Committee (ROC) of the Board of Directors [Ref 13]:

- On a quarterly basis, MG will provide both the RMC and the ROC with Model Risk Appetite reporting and any other information MG believes is needed to support their respective understanding of Model risk or ensure both the RMC and ROC are informed of critical Model issues and the status of resolving those issues;
- At least semi-annually, MG will provide the RRC with Model risk appetite reporting and any other information MG believes is needed to support the Board's understanding of Model risk or ensure the Board is informed of critical Model issues and the status of resolving those issues;
- The MRMC will receive detailed Model risk reporting, at least quarterly, on various metrics including the Model inventory, Model issues, policy exceptions, and status of any project initiatives associated with managing Model risk.

6.1.1. Model Risk Aggregation

Aggregate Model risk is affected by the interaction and dependencies among Models; reliance on common assumptions, data, or methodologies; and any other factors that could adversely affect several Models and their outputs at the same time. As required by Section 6.0 of the Standard, Model risk will be reported at the individual and aggregate levels. See [Ref 19] for details of the Model risk aggregation approach.

6.2. Governance Control of the Framework

MG will monitor and perform a range of Model-related activities across the Model life-cycle at the Enterprise level, such as regular monitoring of compliance with all due dates (Remediation, Exceptions and Extensions), Limit Structure (Tables 3-3 & 3-4) and Tolerance Ranges (Tables 3-5 & 3-6), and the Quarterly Assurance and Model Inventory Attestation process, reporting and escalation of non-compliance.

MG will send status notifications to the relevant stakeholders prior to relevant due dates as specified in the relevant SOPs (add **references**). Model Risk will be monitored, reported and controlled against the approved Tolerance Ranges, metrics, and limits.

Table 6.1-1 provides an overview of controls that will be employed to manage Model risk across the Model life cycle, [Ref 10].

Table 6.1-1: Overview of Model Lifecycle Controls

	Model Lifecycle	Control
1	Model Initiation, Identification	<ul style="list-style-type: none"> ▪ Business case for new Model, including purpose and objective of Model (IAAP & SEMS) ▪ Quarterly Model Inventory Attestation ▪ Model Risk Tiering
2	Data	<ul style="list-style-type: none"> ▪ Data Requirements & Specification
3	Model Development	<ul style="list-style-type: none"> ▪ Model Development Operating Procedures ▪ Model Development Documentation Template ▪ Model Development Tollgates ▪ Model Owner, Model Developer Approvals ▪ Model Change Control
4	Model Validation	<ul style="list-style-type: none"> ▪ Model Documentation Checklist ▪ Model Validation Operating Procedures ▪ Model Validation Documentation Template ▪ Model Validation Approvals
5	Implementation	<ul style="list-style-type: none"> ▪ Implementation Documentation ▪ UAT Testing ▪ Model User Training ▪ Implementation Approvals
6	Model Use & Maintenance	<ul style="list-style-type: none"> ▪ Model Change control ▪ Model Access Control ▪ Model Overlay Approvals ▪ Model Revocation Confirmation
7	Ongoing Monitoring & Validation	<ul style="list-style-type: none"> ▪ Model Performance Monitoring Program ▪ Model Performance Monitoring Reports ▪ Completion of Revalidations ▪ AIRB Annual Validation Model Developer Model Assessment Guidelines ▪ AIRB Annual Validation MV Validation Guidelines ▪ Completion of Annual Reviews
8	Model Decommission	<ul style="list-style-type: none"> ▪ Model Decommission Documentation & Process

6.3. Compliance with the MRM Framework

All stakeholders are responsible for ensuring their own compliance with the MRM Framework. In order to ensure compliance, the Policy & Standard require Model Owners, Developers, Users and MV to develop operating procedures and templates around managing Model risk. Each stakeholder group should make available to MG, and MG should review any guidelines, operating procedures or templates, to provide feedback as to whether these documents are aligned with the MRMF. Once MG's feedback is incorporated and a document is approved, the process or template will become a Model governance document, placed in a central repository and be subject to formal change control with explicit notification to MG by the owner of the process or documentation of each subsequent version. MG will periodically perform sample testing of compliance with these documents.

For those operating procedures that Model Owner or Developer groups plan to use in lieu of these Guidelines pursuant to Section 1.1, and for area-specific Stakeholder RACI Charts that better reflect stakeholder roles than the generic Chart in Appendix 6, once MG is satisfied that the operating procedure is compliant with the Policy and the Standard, the Head, MG will issue an email to that effect the Model Developer or Model Owner executive. This email acknowledgement will permit the Model Developer or Model Owner to use this specific operating procedure as per Section 1.1 and to the extent set forth in such email in place of these Guidelines.

MG will work with key stakeholders to provide guidance or make necessary changes to the framework so that all governance and process-related findings or observations issued by the second-line of defence (MV, MG or Independent Review), third line of defence (CAD) or regulators, are remediated and brought into compliance with the MRMF and/or regulatory expectations by the agreed upon dates by either drafting enterprise-wide Model governance process or providing feedback on those remediation processes drafted by individual stakeholder groups.

6.4. Model Validation Policy Exceptions

According to the Policy (Section 4.4), all Models must be validated and approved prior to use. If an unvalidated Model is discovered to be in use or Model(s) are part of an acquisition that requires time to align with the MRM framework, the MD/MO may apply and MV may grant a Validation Exception, if within the approved Limits Structure, to permit the use of the Model prior to its Validation and Approval. These exceptions, within the Limit Structure, are typically valid for up to two years and may not be extended, unless approved by CRO. All Model Validation Exceptions will have a specified expiration date which cannot be extended without CRO approval. The Exception expiration dates will be closely monitored and reported on an ongoing basis by MG.

If the request for a Model validation exception will breach the Limit Structure, it must be recommended for Exception by the Head of MV on notice to Head, MG and must be approved by the CRO.

If the Model is not validated and approved for use by the expiration date of the Exception, it will be subject to revocation (See Section 6.6 & [Ref 9]).

6.4.1. **Validation Exception Requests**

The Model Developer will verify that there is room for an Exception within the Limit Structure and prepare the Exception Request and submit it, along with Executive approval, to MV. The request must include:

- a business justification for the Exception
- evidence of the Model's effectiveness for its intended purpose
- demonstrable support of relevant stakeholders through the approval of the Model Owner executive and explicit support of relevant control stakeholders such as Market Risk Oversight
- an acceptable action plan to bring the Model into compliance with the Corporate Policy within a specified timeframe. This should specify a submission date by which the MD must submit the relevant material to MV and a final date by which time the Exception will expire.
- Outline any risk mitigation actions that will be taken to limit Model risk during the Exception period

6.4.2. Exception Approvals

Upon receiving a request for an Exception, MV will review the request within 30 days. MV will examine the rationale behind the request and the evidence provided; conduct tests and high-level analyses to ensure no significant Model Risk has been overlooked and that the Model Risk will be controlled before the expiry date of the Exception.

If MV has no significant concerns and the request does not breach the Limit Structure, the Head, MV will approve the Exception Request.

If MV has significant concerns or is unable to provide a proper assessment, MV may request that the Model Developer and Model Owner present further background and justification to enable MV to understand the objectives and business role of the Model, the Model content or the Model's effectiveness in order to make an assessment.

If the Exception request is rejected by the Head, MV, the Model cannot be used. However, the Model Owner / Developer executives can escalate the disagreement to the CRO through the escalation process and on notice to Head, MG.

A Model Validation Exception will not be issued when issuance would result in the immediate breach of a limit. Rather, the request for approval must be escalated to the CRO for approval.

6.4.3. Exceptions for new Models acquired as part of M&A

Models that are acquired as part of the Merger & Acquisition (M&A) process require a period of time in order to be transitioned into the Framework. A complete list of all Models and their associated Model documentation should be requested as part of the initial due diligence in the pre-acquisition phase. Where possible, this documentation should be reviewed as early as possible in the due diligence phase by the potential BMO Model Owner and Model Developer to develop a plan to transition them into the BMO MRM framework.

If required, the BMO Model Owners of these newly acquired Models, or Developers as their delegates, should apply to the Head, MV for an Exception Approval to continue using these Models prior to Day 1. If this is not possible, the BMO Model Owner should apply for an exception in the following stages:

- Stage 1: Day 1 – Model Owner should apply for a blanket Exception covering all Models for a period of 90 days. The request should identify a list of all Models and risk mitigation actions to be taken to ensure Model risk is controlled.

- Stage 2: Day 1 +90Days – Model Owner should apply for specific Model exceptions with detailed plans to mitigate Model risk for the Model during the Exception period.

Where the portfolio of newly acquired Models is sufficiently large so that it breaches the applicable limit, or the time required to transition the portfolio of Models exceeds the two years allotted for Exception Approvals, the Model Owner will apply an exception to the Policy to the CRO. The Model Owner should include in its application a path to normalization for each Model along with a specified time line and an assessment and approval by MV.

6.5. Extensions

Where a submission date for a Remediation of a Material Deficiency, Revalidation or Annual Review cannot be met, the Model Owner, (either directly or through the Model Developer) must apply to the Head, MV for an Extension of the Submission Date prior to 30 days before the Submission date as per s.

6.6. If a Material Deficiency, Revalidation or Annual Review is not completed by the Fulfillment date and does not have an approved extension, the Model will be subject to revocation. (See Revocation Operating Procedure)

An application for an Extension must include:

- justification by the Model Owner / Developer and, where applicable, the business, for the Extension
- approval by Model Developer and Owner executives
- an acceptable action plan to complete the activity and submit it by the new date.
- If an extension is granted, the Extension due date will become the new submission date. The Extension must be closed by the new fulfillment date or the Model approval for use will be revoked (see Section 6.6).
- One Extension is allowed for up to 2 years for a material deficiency remediation and one Extension is allowed for up to 2 years, but for no more than 50% of the review cycle for a fixed term revalidation. Exceptions will not be extended.

6.6. Revocation of Models

As per Section 4.4 of the Standard, compliance with specified and previously agreed upon due dates is a core principle of the MRMF. Failure to do so, where no extension has been applied for and approved, will result in the revocation of the approval of a Model, [Ref 9].

Governance of compliance with due dates for the closure of an approved Validation Exception, Remediation of a Material Deficiency or Submission of a Model Revalidation will be as follows:

- **Exceptions** - Each Exception should contain an expiry date by which time MV should complete its initial validation and approve the Model for use, thereby closing the Exception. Unless specifically agreed to otherwise in the Exception approval, MD is required to submit all documentation to MV 90 days ahead of the Validation Exception Fulfillment date.
- **Material Deficiency Remediation Plans** - The date by which Model Developers are required to submit all completed actions to remediate Material Deficiencies is specified in the most recent validation

report. Unless stated otherwise in the validation report, MD is required to submit the fully documented remediation solution to MV 60 days ahead of the Material Deficiency Fulfillment Date – by which MV must complete its assessment of the Model Developer’s Submission (which is also specified the validation report).

- **Revalidations** - The Revalidation Submission date, specified in the most recent validation report, is the date by which the Model Developer is required to submit its fully-documented re-assessment of the Model to MV for validation and approval for fixed term Revalidations. The Revalidation fulfillment date is the date by which MV must complete its assessment of the Model Developer’s Submission. Unless otherwise specified, this date is 90 days after the Model developer’s submission date.

Model Revocation proceedings will commence, if no approved Extension is in place 30 days before the fulfillment date, by the Head, MG convening a revocation meeting with the heads of MD, MV and Model Owner Executive (or delegate) to determine the Revocation action to be implemented the day after fulfillment is due.

If a revocation decision is made it will be documented along with any remediation requirements and provided to all participants, impacted stakeholders, Model Owner Accountable Executive and the Head, Enterprise Risk.

One the day after the Fulfillment date, if an extension is not in place the Model revocation will be in effect as per the decision reached at the revocation meeting. All revocations will be reported to Head ER, the CRO, the Model Risk Management Committee (MRMC) and the Risk Management Committee (RMC). Revocations are also reported in the Monthly Monitoring Report until the Model is reinstated and approved by MV.

Within five (5) days of the Model revocation effective date, the MO /MD will be required to provide MG with an attestation that the Model is no longer in use or the required restrictions are in place. The evidence will be reviewed by MG. MG will confirm to the Head ER and the CRO that they are satisfied that the Model revocation is in place. The CRO will be notified immediately of any non-compliance of revocation.

6.7. Governance of Key Model Risk Measures

MG will closely monitor and report on the following key measures of Model risk:

- Model Risk Appetite Metrics
- Model Risk Limits
- Policy Exceptions
- Remediation of Material Deficiencies
- On-Going Monitoring

6.7.1. Model Risk Appetite Metrics

The Key Risk Metrics, as per the approved Model Risk Appetite Statement and included in the Standard, will be tracked and reported a monthly and quarterly basis, as appropriate using the following simplified traffic light system:

- **Red** - Any limit in the red zone will be escalated by MG to the Model Developer Accountable executive (and inform the Model Owner executive) within two weeks of the breach being identified. An action plan will have to be developed immediately by the Model Developer/Owner and the exposure must be brought under the limit within one quarter. The action plan must be agreed upon by the Head, MG. If no agreement can be reached between the Head, MG with the Model Owner / Developer accountable executive, the issue will be further escalated by the Head, MG to the Head, ER for mediation. If there is no resolution after mediation by the Head, ER, the issue will be escalated to the CRO for final resolution.
- **Yellow** - For all limits reported as yellow, the Model Owner/Developer must develop an action plan to reduce the number back into the green zone to avoid having to apply to the CRO.

Model Owners/Developers are responsible for knowing the status of their respective limits through the review of the Monthly Monitor Report and/or through their own tracking mechanism.

6.7.2. Model Risk Limits

The Limits for the number of outstanding Validation Exceptions and Extensions permitted at any one time for each identified Model Risk type is related to the Enterprise Model Risk Appetite and is specified at the aggregate level in Appendix 4 of the Standard (Table 1 and 2 for the particulars of the Enterprise and U.S. Limit Structures). The limits are reviewed and approved at least every two years and/or as required through local jurisdictions.

The Model Owners and Developers are responsible for monitoring and ensuring the number of Exceptions and Extensions does not exceed the approved limit. MG will report on limit breaches to all key stakeholders, Senior Management and various committees including RMC, MPMC, US MPMC and the CRO on a regular basis.

6.7.3. Remediation of Material Deficiencies

The Action Plan to remediate any Material Deficiency contained in an approved Validation or Review report will specify two due dates (See Section 4.4.5.1.2), i.e., A Submission and Fulfillment date.

The Model Developer and MG will monitor both of these dates. MG will notify each key stakeholder of the impending due date through the MRIS system and indicate in the Monthly reporting, all remediation, Revalidations or extensions due dates coming due in the next 30 days and that may result in Model revocation if not completed or extended.

The Model Developer must submit the remediation package to MV through the MRIS System by the submission date and:

- If MV confirms that the package is sufficiently comprehensive to allow for an assessment, the Model owner /developer will be deemed to have met their submission date. If the due dates are met and the Material Deficiency is closed, MV will update the MRIS as per the MRIS Operating Procedure, verified by the MD, and MG will report the closure in the next monthly report to reflect the change in status;
- If MV determines that the solution submitted by the Model Developer does not adequately address the deficiency, MV will reject the solution in the MRIS. MV will set out its decision in a memorandum with rationale and supporting evidence. If MV rejects the submitted remediation,

MV may specify a period of time within which the Model Developer can re-submit their remediation to MV, subject to communication of this date to the Model Owner, other key Model Users and MG. Upon MV's update of the new due date in MRIS, MG will monitor and report on this new due date.

- If no new due date is agreed upon the matter should be escalated to arrive at a conclusion. Otherwise, in the absence of a date the Model approval will be revoked unless an Exception approval is requested and approved.

6.7.4. On-Going Monitoring

The Model Developer will, as agent of the Model Owner, track on-going performance monitoring programs; including monitoring of any Model triggers [Ref 8].

The Model Developer will maintain a documented on-going Model performance monitoring process, including trigger monitoring, that has been submitted to MG for review and ensure its Model performance monitoring status and trigger inventory are up-to-date through the Quarterly Inventory Attestation.

MD will conduct, document and report Model performance monitoring, including trigger monitoring, as per the defined frequency. MD will identify the overall Model performance rating (see Section 4.3.6.1) as well as the status of each trigger, including tripped triggers and initiate a performance monitoring workflow in the MRIS.

For any Model for which a traffic light is reported as red, the Model Developer will submit, in the performance monitoring workflow, a root cause analysis and proposed action plan to MV for challenge and approval.

Once a tripped trigger has been reviewed by the Model Developer, the Model developer will initiate a trigger review workflow in the MRIS, submitting its analysis and any proposed action plan to MV for challenge and approval.

MV will review MD analysis of Model performance and the reasons any triggers tripped along with their proposed action items, and provide its independent assessment and approval in a Model Monitoring / Trigger review Report. The outcome of the report is subject to the same Model escalation process as for all other validation activities. MV's approval decision on Model performance and tripped triggers should be documented and reported.

MV's approval authority for ongoing performance monitoring results is as follows:

Table 6.7-1: Model Performance Monitoring Approval Authority

Risk Rating	Required Approval
High	Head, Model Validation
Medium	Head, Model Validation (for Medium MRI & Medium MEP Head, Model Validation or Designee)
Low	Head, Model Validation <u>or</u> Designee
Basel AIRB	Head, Model Validation

6.8. Model Risk Attestations

Attestations are required to ensure that stakeholder groups own, develop and/or use Models are keeping track of the Models they are using and have acknowledged the risks associated with using. They also provide high level assurance to senior management that stakeholders are in compliance with the requirements of the MRMF.

There are two types of attestations performed;

- Quarterly Model Inventory (see section 3.2.5.1); and the
- Quarterly Assurance on Model Risk provided by the Head of MG to the Head, Enterprise Risk.

6.8.1. Quarterly Risk Attestations

At the beginning of the last month of every quarter, Head, MG, MV and heads of key Model Developer groups will provide Quarterly Risk Attestations to the Head, Enterprise Risk by assigning ratings for the specific metrics pertaining to their respective areas, as per the requirements of the Enterprise Guideline for Quarterly Risk Attestation [Reference link].

6.9. Corporate Support Area Activities

MG is the Model Risk Corporate Support Area (CSA) and further controls Model Risk by performing the CSA responsibilities as delineated in the Operational Risk framework [Ref 14], including participation in the supplier governance & IAAP processes, Risk Control Assessments (RCA), and reporting on Model Risk KRI, [Ref 15] as well as performing Quality Assurance of the predefined key MRM processes, [Ref 16].

7. ESCALATION

In accordance with Section 8.2 of the Policy, all unresolved issues related to substantive Model matters, may be escalated to the CRO for final resolution. Section 8.3 of the Policy indicates when a matter is in breach of the Governance provisions of the Model Risk Corporate Policy or key stakeholders cannot agree on the resolution of an outstanding issue, the matter will reviewed by MG and if unresolved after mediation by the Head, ER, will be escalated to the CRO for resolution.

7.1. Escalation for Governance Breach

MG, as part of the second-line of defence, will escalate any breach of the Governance provisions of the Policy, including the failure to meet all due dates and breaches of Limits, to the accountable Model Developer and/or Model Owner executive within two weeks from when the breach is detected.

7.2. Escalation for Stakeholder Resolution

When key stakeholder agreement is required but it is not possible for the stakeholders to reach agreement in a timely manner on an issue after both parties, having shared evidence of their respective positions and attempted to resolve their disagreement, or where both parties agree on an issue but cannot agree on a solution, the matter will be escalated for resolution within two weeks from when the disagreement arises.

When one party wishes to escalate an issue, that party will inform the other of their intention to escalate. Both sides will then document their respective positions and send it to their accountable executive. The escalation document will include a detailed description of the articulated issues, information about previous discussions of the issue, including meeting dates, and what the party expects from the Escalation.

Escalations will be conducted in the following circumstances:

- **Data Validation Escalation** – If a Model Owner / Developer and MV, or a Model Developer/MV and Model Owner cannot agree on a significant matter related to data validation, Model Developers or Model Owner will escalate to the next level executive with accountability for the Model in question for resolution with the Head, Model Validation.
- **Model Developer - Model Owner Development Escalation** – If Model Developers and Model Owners cannot agree whether to submit a Model for validation, the matter will be escalated to their respective next level executives and MG for final resolution.
- **Validation Escalation** – During initial Model Validation or any other Validation activity for which MV issues a report with an approval, if it is not possible for the Model Owner / Developer/User and MV to agree on whether or not a Model should be rejected, a Remediation Plan, Performance Monitoring, or any action plan, the Model Owner / Developers or Users may escalate to the next level executive with accountability for the Model in question while MV may escalate from the MV Director to Head, MV or from Head MV to Head MG for resolution.
- **Vendor Model Escalation** – If there is disagreement about the assessment or validation of vendor Models between the Model Developer/Owner and MV, and no agreement can be reached with the

next level executive with accountability for the Model in question, MV may escalate from the MV Director to Head, MV or from Head MV to Head MG for resolution.

Where the next level Model Developer/Model Owner Executive and the Head, MV does not have sufficient information to reach an agreement, they may seek guidance from knowledgeable internal or external bodies. When, the next level Model Developer/Model Owner Executive and/or Head, MV cannot resolve an issue, they will ask the Head MG to make a recommendation to settle the disagreement in a timely manner. If the Head MG recommendation is not accepted by a party, they may ask the Head, ER to mediate any substantial/technical matters to attempt to resolve them, following which the parties should go to the CRO for final resolution and may ask the Head, ER to resolve any process matters. For U.S. Model issues the escalation will be to the U.S. CRO prior to the escalation to Head, ER.

8. REFERENCES

1. [Model Risk Corporate Policy, September 2015](#)
2. [Model Risk Corporate Standard, December 2015](#)
3. BMO Model Risk Appetite Statement (see Appendix 3, Model Risk Corporate Standard)
4. Quarterly Attestation Operating Procedure
5. [BMO Information Security Corporate Standard](#)
6. [BMO Business Continuity Planning Management Corporate Standard](#)
7. [BMO Information Management Corporate Standard](#)
8. Enterprise Model Trigger Management Operating Procedure
9. Model Revocation Operating Procedure
10. Model Governance Monitoring & Testing Operating Procedure
11. Model Inventory Data Integrity Operating Procedure
12. MV SOP Exceptions, Extensions and Decommissioning
13. MG Reporting Operating Procedure
14. Integrated Operational Risk Management (ORMF) Guideline, Corporate Operational Risk Management
15. [Key Risk Indicator Handbook](#), Operational Risk Management
16. Corporate Support Area (CSA) QA Guidelines, Corporate Operational Risk Management
17. [Business Managed Application Management Standard](#), Global Information and Technology Risk Management
18. [Technology Asset Inventory Governance](#), Enterprise Directive, Global Information and Technology Risk Management
19. Model Risk Aggregation Operating Procedure (In Development – to be referenced when approved)

APPENDIX 1: GLOSSARY OF TERMS

All terms of reference used in these Guidelines, other than those defined below, are either defined in the Policy, Standard or in the Corporate Operational Risk Management (CORM) Risk Reference Library.

Term	Description
Fulfillment Date	<p>The Fulfillment date is the agreed upon date by which MV must complete its assessment and approve or reject the Model Developer's submission related to Exception approvals, deficiency Remediation's and Revalidations (Scheduled Review) and represents the expiration date of the exception or final due date of remediation work or revalidations. Fulfillment dates will be the final due date specified in MV's validation report or its Exception Approval Memo. (For governance of due dates see Model Revocation s. 11.3 below)</p> <p>Fulfillment dates are recorded in the Model Risk Management System (MRIS) and monitored, reported and escalated by MG.</p>
In-Model Overlay or Margin of Conservatism (MOC)	<p>An In-Model Overlay/MOC is an adjustment by the Model Developer that adds conservatism within a Model to mitigate the Model Risk from identified key sources of uncertainty. It should be noted that for Stress Test (CCAR/DFAST) Models only, the use of In-Model MOC is discontinued, and the scope of Post-Model Overlays, including adjustments to account for known Model or data limitations, will be expanded.</p>
Model Change	<p>Significant Changes to Existing Models – When changes are such that the resulting Model essentially represents a new Model, all key aspects of the Model should be validated. An example of a significant change would be a code change that structurally affects the majority of the Model and has a significant impact on the output of the Model.</p> <p>Less Significant Changes to Existing Models – when changes made to a Model represent any of the following events but are not significant enough to warrant treating the Models as a new Model, the Model should be subject to an independent validation that ensures the changes being made are appropriate, well controlled, and accurately implemented. An example of this would be code change that is structurally isolated to one component of the Model, but still has significant impact on the output of the Model.</p> <ul style="list-style-type: none"> • A material change is made to the Model inputs, theory, or code • A new use of a Model is established that has significant impact on the business • The Model is applied to a significantly different population, product or process • Material changes in Model performance occur, beyond those expected at the time of validation • Significant changes occur in the environment within which the Model is being used • There are significant annual review, regulatory, audit or other oversight findings related to the Model that were not previously identified or considered by the validator as part of the previous validation activity. <p>Use Changes – Model are validated and approved for a specific effective range of use. If the output of a Model is being used in a new way, or involves a new process significant to the business that has been introduced since the most recent validation, then this situation requires that the Model (or specific components of the Model) be validated for the new use.</p> <p>Minor Changes to Existing Models – If the changes made to a Model do not represent any of the events described above and independent validation is not required prior to implementation. Minor changes include those that have little impact on Model output and structurally represent a low risk to the Model.</p> <p>Assumption Changes - Changes to inputs or assumptions do not necessarily constitute a change to the Model. Many Models are routinely subject to changed inputs and assumptions as new data becomes available. Good business judgement must be used to determine whether an input or assumption change represents an event that requires independent validation.</p> <p>Where there is no change to the underlying Model but a Model is being submitted to MV for revalidation due to data recalibration, this does not constitute a Model change however MV should perform verification and approve for High and Medium materiality Models; for Low and non-material Models, review can be done in the first-line by an independent group.</p>

Model Implementation	The logical deployment of the developed Model in the production environment.
Material Model Modification	For AIRB Models: A Material Model Modification is one that is deemed to be material based on the Board-approved definition of materiality to assess modifications to regulatory capital Models. Material Model modifications must be approved by OSFI prior to use for regulatory capital purposes as per OSFI Implementation Note: <i>Approval of Regulatory Capital Models for Deposit-Taking Institutions</i> . [Reference Regulatory Capital Model Modification Process & Materiality Definition for Regulatory Capital Model Modifications]
Mathematical Finance Library (MFL) Utilities	Mathematical Finance Library (MFL) is a unified Model library built to accurately calculate trade valuations and risks. See Appendix 3 for specific requirements for MFL Utilities
Model Developer	See Section 2.4 of Enterprise Model Risk Corporate Policy
Model Owner	See Section 2.9 of Enterprise Model Risk Corporate Policy. See Appendix 6 for a sample RACI chart for a high-level break down of overall Model Risk Management accountabilities and responsibilities.
Model Risk Mitigation	See Section 2.4 of Enterprise Model Risk Corporate Standard
Non-Model Tools	Are tools that use a quantitative approach based on subject-matter expert judgment; produce non-quantitative estimates as outputs; do not use statistical, economic, financial or mathematical theories or approaches; do not contain any assumptions that are considered not to be a Model; or where all assumptions are made based on expert judgment. The MRMF does not apply to Non-Model tools unless explicitly specified. The Model versus non-Model filtering criteria in Appendix 5 to these guidelines will assist Model Owners to determine whether or not a tool they are using, or assist MV to determine whether a tool submitted for validation is: a Model subject to this Framework; a non-Model tool subject to a different governance framework (e.g. Business Managed or Technology Managed Application if the tool is systems implemented); or requires further assessment to make the determination. If a tool is classified as non-Model, the Model Owner / Model Developer must specify to MG the framework or control process under which the tool is governed.
Operating Groups	Operating Groups are Canadian Personal and Commercial Banking (Canadian P&C), U.S. Personal and Commercial Banking (U.S. P&C), Wealth Management, BMO Capital Markets (BMO CM), and Corporate Services, which includes Technology & Operations (T&O). Operating Groups can be further organized into sub-groups, commonly referred to as Lines of Business (LOBs) or Business Units (BUs), or within Corporate Services, as functional units.
Post-Model Overlay/Management Overlay	A Post-Model Overlay/Management Overlay (PMO) is an adjustment by the Model Owner or User outside of the Model. PMO can account for other uncertainties such as business initiatives (Business Initiative Overlay – BIO) and/or Model limitations (Out of Model Limitation – OML).
Remediation Plan	An action plan to remediate Material Deficiencies, including former Conditions, identified by MV that has not been determined to be Observations. The remediation plan should provide timelines with specific due date for submission of the remediation by the Model Developer to MV and a final fulfillment date by which MV must assess and approve/reject the remediation and disposition the Material deficiency.
Sensitivity Analysis	Sensitivity analysis is defined as the study of how uncertainty in the output of a Model can be attributed to different sources of uncertainty in the Model input
Submission Date	The Submission date is a specific agreed upon date by which Model Developers are required to submit to MV, all completed actions to remediate Model Risk issues requiring action

	<ul style="list-style-type: none"> • For material Deficiencies, the submission date is the date specified in MV's validation or review report. • For Revalidations (fka Scheduled Reviews), the submission date is the number of years from the date the report is approved or implemented (whichever is later) indicated in the review frequency table in Section 4.4.2.4.2 of these Guidelines. <p>Model Developer's submission will be deemed to be completed once MV has determined that there is sufficient information to proceed with its assessment. If the package submitted to MV for assessment is incomplete, MV will request a resubmission and indicate what material is missing. Any subsequent disagreement as to the completeness of the package submitted to MV should be escalated by MV and or MD to MG for resolution.</p>
Vendor Model	<p>A Vendor Model is a Model developed, tested and distributed by an independent third party. Vendor Models, to the extent possible, are subject to the requirements of Model owner/Developer assessment and documentation of the Model and the same validation principles as Models developed in-house.</p>

APPENDIX 2: MODEL RISK TIERING FOR BANK SECRECY ACT (BSA) / AML – FINANCIAL CRIMES (IN PROCESS DOCUMENT TO BE UPDATED BY AML WITH MV & MG AGREEMENT)

	Metric	High	Medium	Low
1	Geography: AML risk of geographic footprint covered by the model	Includes exclusively high risk jurisdictions	Includes some high risk jurisdictions	Includes many jurisdictions across the risk spectrum
2	Customers: AML risk characterization of monitored customers	Includes high risk and broadly profiled population	Includes high risk and targeted population profile	Includes only low risk and broadly profiled population
3	Complexity: Use of combination of various approaches such as sequentially, mathematical /statistical complexity, business logic rules, customer characterisation information, etc.	Use of a combination of approaches, including multiple high level or sequential mathematical /statistical concepts, customer characterisations, and business logic rules	Use of some business logic rules, customer characterisations, and at most one or two high level mathematical /statistical concepts	Use of a combination of business logic rules, customer characterisations, and simple and non-sequential mathematical concepts such as averages
4	Coverage Type: AML coverage of the model's population by other systems	Includes population(s) with only single coverage through this model	N/A	Entire population has coverage from front line controls or other systems, as well as this model
5	Weight or Influence of Model Results: AML division reliance on the results from the model for subsequent actions	AML uses results as a primary input for actions	AML uses the results but not the primary input for actions for any one of them	AML uses the results but not the primary input for actions for any one of them
6	Change Frequency: changes to the model and their frequency	Changes necessitated to address performance issues prior to subsequent scheduled review following a complete validation or revalidation	Changes necessitated to address performance issues prior to subsequent planned revalidation	Changes to the model based on revalidation findings
7	Control Environment: How the model is used as part of controls to mitigate risk	Model does not include auditable user controls, separation of duties or disaster recovery	Model includes at least two of the following: auditable user controls, separation of duties and disaster recovery	Model includes auditable user controls, separation of duties and disaster recovery
	Based on the responses to the above questions, the contributing values for the overall risk rank are:	Final, overall risk ranking is determined by scoring 3 for every high materiality metric, 2 for every medium materiality metric, and 1 for every low materiality metric. The scores are summed and averaged, and the total model materiality is determined by the following scale:		

		<ul style="list-style-type: none"> • Low: Less than 1.5 • Medium: 1.5 – 2.5 • High: Greater than 2.5 <p>If applicable, the Model Owner can override the overall risk ranking.</p>
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APPENDIX 3: MATHEMATICAL FINANCE LIBRARY (MFL) - VALIDATION

Mathematical Finance Library (MFL) is a unified Model library built to accurately calculate trade valuations and risks.

MFL utility functions are available within the library, as general tools to application developers throughout the Bank. These utility functions are subject to a two-phased validation approach.

Phase 1 - Initial Model validation and approval by MV, is to verify the accuracy of the implementation of the mathematical concept. Since at this point these utilities are not used to estimate or book risk, the validation involves evaluating the accuracy of the analytics without any specific business context. As a result, at this point, the MFL utility functions are:

- assigned a Model Materiality rating of N/A; and
- not assigned an MRI as this metric is associated with Model use.

An MFL Utility is re-validated at this level any time a material change is made in the utility. The validation provides a baseline of the MFL utility's functionality so that whenever the MFL utility is updated, each validated function can be regression tested to demonstrate consistency with the previous release version. Oversight and approval of modifications to these MFL utilities follows the same governance as outlined in the Model Change section of Appendix 1. As these MFL utilities are incorporated in to Applications/Models to estimate and book risk (see Phase 2 below), the MFL utility will have already been validated and will not require the application/ Model to be validated each time the MFL utility is updated in the MFL library.

Proper controls should be established by the MFL utility library owner to inform MV and the Model Owner of material changes in new releases of an MFL utility and track where these MFL utilities are being used within applications/Models within the bank. These MFL utilities should be subject to an Annual Review.

Phase 2 - Occurs when any of these utilities are incorporated into an application that will be used to book risk. This second phase of Model Validation consists of a full validation of the overall application/Model as outlined in the Framework for all Models. As part of this phase a Model materiality rating will be assigned and the MRI and MEP will be fully assessed.

APPENDIX 4: MODEL DEFICIENCIES – QUALITATIVE MATERIALITY MATRIX

(For guidance only as there are many other considerations for issue classification, such as size of portfolio, type of Models etc.)

Category	Critical Deficiency	Material Deficiency	Observation
Model	Model design is not conceptually sound, does not achieve the key business objectives, or does not satisfy regulatory requirements	Model design is conceptually sound, meets essential regulatory requirements, but key business objectives are not fully met, potentially due to data or framework issues which are actionable in the near term	Model design is conceptually sound, meets business objectives, is an improvement over existing alternatives and meets applicable regulatory requirements, but the Model design could be improved in the future
Assumptions	Key assumptions are counter-intuitive, contradict empirical evidence, are inconsistent with the primary use for which the Model was developed, or are inconsistent with both published well-accepted theory and sound industry practice	Key assumptions do not consistently hold during the primary use for which the Model was developed or are not well supported by published well-accepted theory, sound industry practice or empirical evidence	A non-key assumption does not hold well, or a key assumption may not hold reliably under plausible but unexpected circumstances, during the primary use for which the Model was developed but, in either case, the impact on the outcome is likely not material. A key assumption is not fully supported by published well-accepted theory, sound industry practice and empirical evidence
Data	Data contains significant errors, or data is significantly incomplete, mistreated or lacks basic representativeness	Data contains errors or gaps or mistreatments that could materially affect Model accuracy and effectiveness but, after considering mitigation and other existing alternatives, is sufficient for the Model's key business objectives and better than existing alternatives	Data is satisfactory but contains errors or data gaps or mistreatments that should not materially affect the Model accuracy and effectiveness but should be considered when using this Model or developing a new Model
Model Construction (e.g. Model specification or calibration)	Model specification contains counter-intuitive drivers, is missing significant available drivers or is inferior to other existing alternatives	Model specification fails to identify potentially important risk drivers, uses non-intuitive drivers or intuitive but volatile drivers, or has potentially material calibration errors, but the impact	Model specification captures identified key drivers and is reasonably calibrated but may be unnecessarily complicated, have other unidentified drivers or otherwise be less than

Category	Critical Deficiency	Material Deficiency	Observation
	(e.g. current Model suite)	therefrom is mitigated or can be remediated and the Model is better than existing alternatives.	optimal
Model Performance	Model output demonstrates a pattern of significantly different than actual results/experience, demonstrates significant bias, lack of stability or convergence or materially and consistently performs in an inferior manner to existing alternatives	Model performance is within an acceptable range but could materially underperform without mitigation or remediation involving achievable alternatives	Model performance is satisfactory but could be improved in the future by acting on achievable alternatives
Model Documentation	Critical development evidence is missing so that validation cannot complete its Model assessment.	Material development evidence is incomplete but can be improved by timely re-submission showing additional work (e.g. the work was done but not documented).	Model documentation may not be comprehensive or consistent but contains key elements necessary for independent validation and review.
Mode Implementation	Model implementation is significantly flawed and this prevents the Model from meeting its intended use	Model implementation is not fully aligned with how the Model was designed for use but the misalignment can be remediated and/or mitigated.	Model implementation may have some immaterial misalignment for use or complicated manual processes which could be streamlined in the future.

APPENDIX 5: MODEL VERSUS NON-MODEL FILTERING CRITERIA

Input		Processing		Output	
Does the tool or process use historical data sourced from an internal database?		Does the tool apply mathematical or statistical techniques to the historical data or assumptions identified?		Is the output of the tool or process used as a key input to drive decision making by management?	
Does the tool or process use data that is procured from an outside source or vendor?		Is judgment exercised in the creation of the tool or process such that there is ambiguity in developing the final process or tool?		Is the output of the tool or process used repeatedly over time?	
Are analytical techniques used to sample from historical data, or to create samples used in analysis?		Does the tool or process create a forecast or estimate of future events?		Is the output from the tool or process automated to provide information for frontline decision making such as loan underwriting?	
Is historical data manipulated in any way, such as, making inferences where data may be missing or incomplete?		Is the process or tool used to generate reports on key metrics or historical insight into trends in financial or portfolio performance?		Is the output used to provide information to management on key performance metrics for a Line of Business or function?	
Are assumptions used as part of the tool or process that are derived partially or wholly from empirical data analysis?		Does the process or tool provide a recommendation or propose a course of action?		Is the output of the tool or process used to satisfy specific regulatory requirements?	
Does the process or tool use only judgmentally derived assumptions without any reference to external data or analysis?		Is the tool or process provided by an external vendor?			

[Click Here to Assess Tool/ Process Against Model Definition](#)

Note: Please contact model governance to access the above mentioned tool.

APPENDIX 6: GENERIC MODEL STAKEHOLDER RACI CHART

	1 st line of defence				2 nd line of defence	
Life Cycle Activity Process	Model Owner	MO Activity/Output	MD	Other Model Users	Model Validation	Model Governance
Identify business need for Model, define objectives, regulatory requirements, ensure key stakeholders provide input	A & R		C	R	I	I & C
Data definition & data requirements	A		R		C	
Model Design, Development/ Redevelopment	A	Provide agreement with MD on Model	R	C	C	C
Pre-Validation Materiality Risk Rating/ Materiality Assessment	A	MO should be aligned with MD	R	I	C	
Pre-validation of assessment of Model deficiencies	A		R			
Compliance with Regulatory Requirements	A	Ensure that the Model in compliance	R	C	R	
Model package for submission to Validation	A	MD puts package together but MO sign-off required	R	I	I	I
Model Validation & Approval	R	MO needs to ensure that the Models it owns are validated and approved	C	C/I	A & R MV owns the validation process	I
Deficiency Remediation	A	Ensure timelines are met and framework complied with	R (remediate)	I	R (validate and approve)	I
Model Implementation & Training (including UAT)	A	Before Model goes into production, MO should be satisfied process followed, approvals obtained and comfortable there is compliance with framework	R	C/I	R (review and UAT)	

	1 st line of defence				2 nd line of defence	
Life Cycle Activity Process	Model Owner	MO Activity/Output	MD	Other Model Users	Model Validation	Model Governance
Ongoing Performance Monitoring including Trigger Monitoring	A	Ensure MD performs the testing as required by framework and keeps MO apprised of Model performance	R	C/I	R (validate trigger reviews)	I
Annual Review	A	Ensure that Models subject to review are reviewed annually in compliance with framework	R	C / I	R	I
AIRB Annual Validation	A	MD owns AIRB annual validation process. MO to ensure requirements are complied with	A & R	C/I	R (approve validation guidelines and review and approve MD assessment)	
Maintenance of source data inputs	A	Work with the data owner to influence getting problems fixed	C	A & R Business (Business will own data and accountable for ensuring integrity and fixing identified problems) C (Credit)		
Quarterly Inventory Attestation	A & R	Accountable only to ensure the attestation gets done and for its attestation	R	R	R	A & R (accountable for attestation process)

	1 st line of defence				2 nd line of defence	
Life Cycle Activity Process	Model Owner	MO Activity/Output	MD	Other Model Users	Model Validation	Model Governance
Revalidation (Schedules Reviews)	A	Ensure frequency and timelines are abided by	R	C	R	I
Model Change Management	A	Satisfy themselves that appropriate changes made	R (managing any change in the Model)	R (manage any change in use of the Model)	C	I
Model Decommission	A	Ensure Models they own that are no longer used are decommissioned	R	C/I	R (approve)	I

Legend:

R	Responsible	The individual(s) who actually complete the task
A	Accountable	The accountable person is the individual who is ultimately answerable for the activity or decision
C	Consult	The consult role is individual(s) (typically subject matter experts) to be consulted prior to a final decision or action
I	Inform	This is individual (s) who needs to be informed after a decision or action is taken.