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Guideline

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Title:
ASSET MANAGEMENT VALUE FRAMEWORK

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Asset Management Value Framework

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1.0 INTRODUCTION

The Asset Management Value Framework (VF) is used to quantify the value of each asset investment option for potential inclusion in the asset investment portfolio. The asset investment portfolio is optimized based on the VF and business constraints.

This guide defines the Asset Management VF. It also describes how various inputs, calculations, and methodologies are applied. The Asset Management procedures, definitions, roles and accountabilities are documented in **N-PROC-AS-0084, Nuclear Asset Management and Investment Planning**.

2.0 VALUE FRAMEWORK OBJECTIVE AND METHODOLOGY

The objective of using the VF to compare asset investment options is to produce an asset investment portfolio that maximizes asset value within constraints.

Using the Asset Management Tool, the investment cost of an asset investment option is compared against the benefits for determining the option's Asset Investment Net Value. The benefits are comprised of the expected mitigated risks and financial impacts as a result of the investment. See **Figure 1: Asset Investment Net Value**.

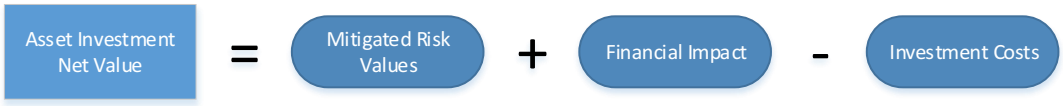

Figure 1: Asset Investment Net Value

The mitigated risks are determined by evaluating each risk area. The risk areas are discussed in **Section 3.1.3** in detail. An expanded graphical illustration of the VF can be found in **Appendix A: Asset Management Value Framework**.

The Asset Investment Net Value is then used to determine an asset investment option's standing among other potential asset investments competing for resources in a constrained optimization process.

3.0 VALUE FRAMEWORK INPUTS AND CALCULATION

Calculation of the Asset Investment Net Value for each investment option requires the following inputs, as applicable:

1. **Mitigated Risk Values:** net risk reduction benefits to OPG by comparing the asset risk profiles before and after investment or implementation of a change in preventative maintenance (PM) strategy

2. **Financial Impact:** net incremental financial impact, either positive or negative, as a result of investment or implementation of a change in PM strategy on the asset

3. **Investment Costs:** cost of implementing the investment option

3.1 Mitigated Risk Value Inputs

As an investment option is intended to reduce the probability and/or impact (to be used interchangeably with the term "consequence" in this document) of an undesirable event (also known as a "risk event") from occurring, the Mitigated Risk Values are determined by:

- Baseline risk over time (also known as a "baseline risk profile") based on the current and expected future condition of the asset if there is no investment or if there is no change to its current PM strategy;

  less

- Residual risk over the same duration of time (also known as a "residual risk profile") as a result of investment or implementation of a change in PM strategy on the asset, starting from the year when the investment or change in PM strategy is expected to go into effect

See **Figure 2** below.

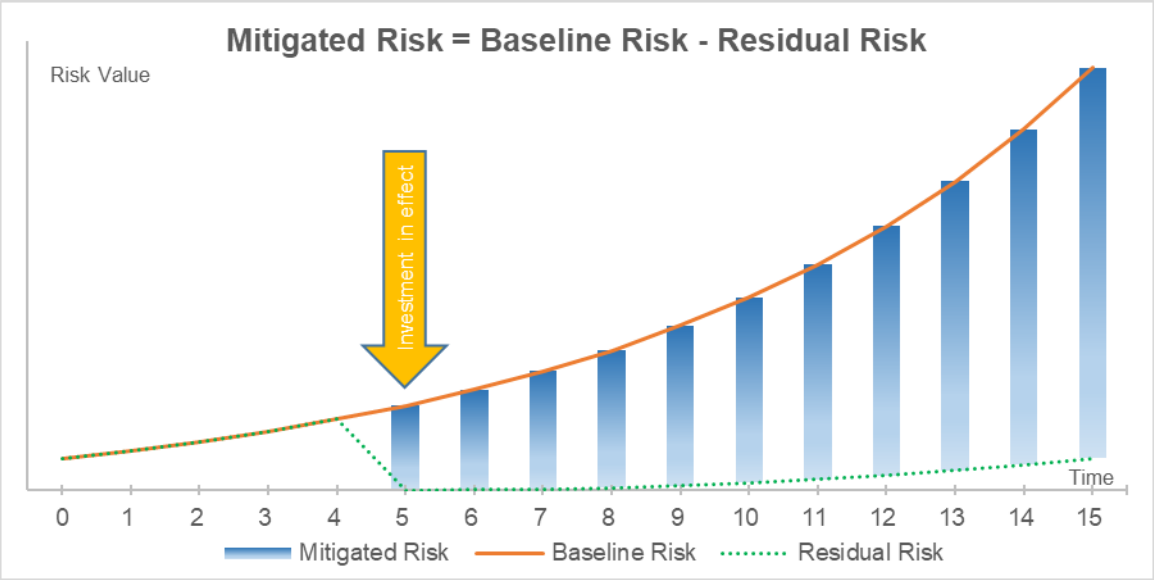

Figure 2: Illustration of Mitigated Risk over time

Mitigated Risk Values should be positive and therefore increase the Asset Investment Net Value for each selected asset investment option.

3.1.1 Risk Value Input Methodology

Each set of Risk Values is a time-series indicating the mitigated risks over time.

Risk is the product of probability and impact. The probability is the likelihood of a risk event occurring. The impact is the consequence of that risk event if it occurs. Risk Values are measured in Value Units.

3.1.2 Probability of Risk Event(s)

When the risk event arises as a result of asset (equipment) failure, the probability of such an event occurring should therefore be characterized by the applicable equipment reliability curve.

A source of acceptable equipment reliability curves includes the EPRI Integrated Life Cycle Management (ILCM) tool. In the absence of an applicable equipment reliability curve or when the equipment reliability curve is deemed not an appropriate measure of the likelihood of the risk event, the probability of the risk event should be assessed in accordance with **Table 1: Probability scale in percent**.

Table 1: Probability scale in percent

PROBABILITY	Almost Impossible	Improbable	Unlikely	Possible	Likely	Probable	Imminent
Range	0% – 0.1%	0.1% – 1%	1% – 5%	5% – 10%	10% – 25%	25% – 50%	50% – 100%
Representative (“midpoint”) Value	0.05%	0.55%	3.0%	7.5%	17.5%	37.5%	75%

The first step of any risk assessment shall be a proper formulation of what the risk event is, and then assign the appropriate probability of such risk event occurring.

After the risk event is properly framed or formulated, the probability of such event occurring should be analyzed, possibly using a combination of probabilities of drivers (different failure modes with potentially separate probability curves).

As there may be more than one failure mode for an asset, the probability and consequence associated with each failure mode should be aligned and distinct from another type of failure mode. For example, a general pump failure probability curve should not be applied towards a specific failure mode such as a complete shaft failure, so as not to significantly overstate the risk. The probability curve used shall be consistent with the probability of the risk event occurring associated with the specific consequence.

As it is impractical to identify all possible failure modes, only the failure modes with the top two highest risk (combination of probability and consequence) should be considered. If there is a single top failure mode that is of significantly higher impact than the others, only the top failure mode should be considered in the VF for simplicity.

Conditional probability

In cases where there is a need to assess multiple probability curves, the recommended approach is to apply a combined probability methodology. The combined probability methodology should consider conditional probability (or Bayes' theorem), as well as the degree of independence between the risk events. **Section 3.1.6** also briefly discusses risk assessment of equipment redundancy.

The need for using a combined probability methodology should be uncommon. If necessary, subject matter experts in equipment reliability and probability theory should be consulted.

3.1.3 Impact (Consequence) and Risk Areas Definitions

The impact (or consequence) of a risk event if it occurs should be assessed and provided as input. The consequence should be translated into the equivalent dollar impact as appropriate and as much as reasonably achievable. It is recommended to consult Finance as necessary.

In cases where a calculated estimate for the consequence is not available, the consequence level of a risk event should be selected between level one (L1) and level seven (L7) in accordance with **Table 2: Consequence scale in Value Units** below, in conjunction with the risk consequence tables in **Appendix B: Risk Area Definition** that corresponds to the applicable risk area(s) identified.

Table 2: Consequence scale in Value Units (thousands)

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Range (Value Units)	< 200	200 – 1,000	1,000 – 10,000	10,000 – 25,000	25,000 – 50,000	50,000 – 100,000	100,000 – 500,000
Representative (midpoint) Value	100	600	5,500	17,500	37,500	75,000	300,000

3.1.4 Risk Areas

In alignment with OPG's strategic imperatives, there are seven major risk areas (ten risk areas altogether including the sub-areas) in the Asset Management VF (see **Appendix A: Asset Management Value Framework** for a graphic illustration):

1. Safety Risks
   (a) Conventional
   (b) Nuclear
   (c) Radiological
2. Regulatory Risk
3. Environmental Risks
   (a) Environmental Risk (Non-Radiological Emissions)
   (b) Radiological Emissions
4. Security Risks*

Either
- Cyber Security Risk for Asset subject to CSA N-290 or NERC CIP

or
- Other Cyber Security Risks

5. Social Licence and Reputation Impact
6. Lost Generation Risk
7. Financial Risk

* Physical Security Risks are also considered by OPG separately. As the details surrounding physical security risk shall only be stored on select secured systems at OPG, it is therefore beyond the scope of the Asset Management VF and not evaluated using the Asset Management Tool.

Note: All ten risk areas/sub-areas are assigned with equal weights.

The consequence of each risk event for each risk area shall be considered and assigned as appropriate and as much as reasonably achievable. Risk areas that do not apply to the identified risk event should be assigned an "N/A" to indicate that the risk area is not omitted, but rather assessed as not applicable.

Similar to the probability input, consequence level inputs shall be provided for both the residual risk and the baseline risk profiles.

3.1.5 Risk Value Calculation

Since risk is probability multiplied by consequence, the resulting risk value can be characterized by a risk heat map illustrated as **Figure 3: Risk Matrix** below, with red indicating high risk and green indicating low risk.

Consequence (000s) / Probability	L1 (0 - 200)	L2 (200 - 1,000)	L3 (1,000 - 10,000)	L4 (10,000 - 25,000)	L5 (25,000 - 50,000)	L6 (50,000 - 100,000)	L7 (100,000 - 500,000)
Imminent (50 - 100%)	75	450	4,125	13,125	28,125	56	00
Probable (25 - 50%)	38	225	2,063	6,563	14,063	28	00
Likely (10 - 25%)	18	105	963	3,063	6,563	13,125	52,500
Possible (5 - 10%)	8	45	413	1,3	5,625		22,500
Unlikely (1 - 5%)	3	18	165	525	1,125	2,250	9,000
Improbable (0.1 - 1%)	1	3	30	96	206	413	1,650
Almost Impossible (0 - 0.1%)	0	0	3	9	19	38	150

500 20,000 20,000 20,000 500 500 500 500 20,000

Mitigate asset risk as soon as practicable

Optimize asset risk mitigation in short-medium term to prevent escalation to Red

Accept asset risk

Figure 3: Risk Matrix

Stacking up all ten risk areas, a Risk Matrix is defined for the asset, as illustrated in **Figure 5: Asset Risk Model** in **Appendix C** and is represented by one number called Risk Value, by summing up the risk values from all ten risk areas.

For high risk items in the Risk Matrix, consider escalating the risk to existing Business Unit and/or Enterprise Risk Management risk registers, if not already present, as described in N-STD-AS-0033 and N-PROC-0094.

As noted above, the Mitigated Risk Value for each asset represents the baseline risk profile less the residual risk profile. Each Mitigated Risk Value reflects future risk values discounted at a nominal discount rate to arrive at its Present Value (PV). The final Mitigated Risk Value is the sum of all the PVs, and is used to compare against the investment cost. For description of the detailed calculation methodology, refer to **Appendix D: Detail Risk Values Calculation Methodology**.

Note: The nominal discount rate is predefined by Finance and should be based on an appropriate weighted average cost of capital.

3.1.6 Impact of Equipment Redundancy

There are instances where the failure of one equipment will not have an immediate impact due to built-in equipment redundancy in certain critical systems. In those situations, the risk should be assessed in the following manner.

The risk event should be formulated as “system unavailability” instead of “equipment failure”. Then the probability of “system unavailability” should be characterized by the conditional probability that given one equipment has failed, what the probability of the redundant equipment will also fail is.

For example, if there is licence or regulatory requirement that the loss of equipment redundancy should never exceed 48 hours, the risk event should be formulated as “loss of equipment redundancy for more than 48 hours”, and the probability and consequence should then be assessed accordingly.

3.2 Financial Impact Inputs

The second input to the VF is the incremental financial impact to the business as a result of the investment. Financial impact should be input when available.

Incremental financial impact is defined as the sum of all forecast changes that will result in a net revenue or expense impact of the business unit. The financial impact shall only be used to determine the asset investment net value if the forecast financial impact is agreed by the business unit and planned to be incorporated into the business plan.

There are three main categories of Financial Impact – Budget Impact, Generation Benefit, and Other Revenue Impact.

Calculation for the financial impact is summarized in the equation below:

Financial Impact = Budget Impact + Generation Benefit + Other Revenue Impact

The annual Financial Impact amounts are discounted at the nominal discount rate to arrive at the PV of the net Financial Impact.

3.2.1 Financial Impact – Budget Impact

Budget impact includes all incremental base and outage OM&A cost savings or increase in budget.

If a potential investment is expected to reduce maintenance requirements but not result in any actual base OM&A savings due to a reallocation of maintenance resources, this would not be considered an incremental financial impact (benefit) and shall not be included in the calculation of the asset investment net value.

If a potential investment is expected to reduce outage costs resulting in net outage OM&A savings to the business unit bottom line (e.g., due to a reduction of contractor use) and the business unit agrees to plan to incorporate the OM&A savings in the business plan, this incremental financial impact (benefit) shall be included in the calculation of the asset investment net value.

If a potential investment is expected to require additional base OM&A cost to maintain such investment (e.g., by hiring additional staff from external) resulting in base OM&A cost incremental to the business unit bottom line and the business unit also agrees to incorporate the additional OM&A cost in the business plan, this incremental financial impact (cost) shall be included in the calculation of the asset investment net value.

3.2.2 Financial Impact – Generation Benefit

Generation benefit includes the financial impact of an incremental net generation increase as a result of the investment.

For example, a net revenue gain due to increase in net electricity production

Note: Net revenue loss due to decrease in net electricity production shall be accounted for under Lost Generation Risk. Refer to **Section 3.1.3 Impact (Consequence) and Risk** Areas Definitions and **Table 12: Definition of Consequences for Lost Generation Risk** in **Appendix B: Risk Area Definition**.

3.2.3 Financial Impact – Other Revenue Impact

Other Revenue impact includes all incremental changes to revenue from other revenue streams as a result of an investment, such as:

- Incremental non-generation revenue (e.g., inspection services, lease revenue, heavy water sales and detritiation services, isotopes sales, or ancillary services, etc.) to external business partners;

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- Any incremental cost incurred to earn said incremental revenue.

3.2.4 Financial Impact – Calculation Guidance: Use of Expected Value

If there is uncertainty associated with the financial impact of a potential investment, Expected Value may be adopted by using probability and the associated impact.

For example, if there is 20% chance that the net financial impact is $5 M, 70% chance that the net financial impact is $10 M, and 10% chance that the net financial impact is $12 M, the Expected Value is $9.2 M (= 20% x $5 M + 70% x $10 M + 10% x $12 M).

3.2.5 Financial Impact – Calculation Guidance: Treatment of Financial Losses

Financial losses due to damage to equipment or company assets (such as clean up and replacement cost) are accounted for in the Financial Risk area (see **Section 3.1.3 Impact (Consequence) and Risk** Areas Definitions and **Table 13: Definition of Consequences for Financial Risk**), instead of accounted for as a Financial Impact as described in this section.

3.2.6 Financial Impact – Guidance: Financial Evaluation Requirement

In cases where the AIOT includes assessment of an investment option that is either Value Enhancing in nature or there are more than one feasible options to address a risk event, financial impact inputs shall be provided with the support of a preliminary financial evaluation, which shall either be prepared or validated by Finance.

3.3 Investment Cost Inputs

The third input to the VF is the investment cost Value represented by the expenditures to execute the investment. Investment cost Values are categorized into accounting classes for budgeting purposes. The three main account types for reporting are Capital, Project OM&A, and Provision.

The investment cost Values are equal to the total spend for each investment option. These investment cost Values are escalated in the Asset Management Tool to take inflation into account. These Values should decrease the Asset Investment Net Value, as these represent cost outflows.

3.3.1 Investment Cost Calculation

In most cases, an investment is planned to be executed at a future time and may also span multiple years. Therefore, the planned annual investment cost is also discounted at the nominal discount rate to arrive at the PV of the investment cost.

4.0 DEFINITIONS AND ACRONYMS

4.1 Definitions

Refer to the equivalent section in **N-PROC-AS-0084, Nuclear Asset Management and Investment Planning**.

4.2 Acronyms

AIOT	Asset Investment Option Template
BR	Baseline Risk Value
EOL	End of life
EPRI	Electric Power Research Institute
ILCM	Integrated Life Cycle Management, from EPRI
MR	Mitigated Risk Value
OM&A	Operations, Maintenance and Administration
PM	Preventative Maintenance
PV	Present Value
RR	Residual Risk Value
VF	Value Framework

Appendix A: Asset Management Value Framework

Figure 4: Illustration of the Asset Management Value Framework (VF)

Appendix B: Risk Area Definitions

The following tables define the consequence levels for each risk area.

Table 3: Definition of Consequences for Safety Risk – Conventional

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Conventional - measures potential conventional safety incidents.							
1. Safety Risk – Conventional	Medically treated injury not resulting in Lost Time	Lost Time Injury OR Permanent Partial Disability	Multiple Lost Time Injuries OR Multiple Permanent Partial Disabilities	Fatality OR Permanent Total Disability	Multiple Fatalities AND/OR Multiple Permanent Total Disabilities (Detailed definitions for L5, L6, and L7 can be found in the Asset Management Tool)		

Table 4: Definition of Consequences for Safety Risk – Nuclear

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Nuclear - measures potential impact on reactivity management, safe shutdown of the reactor and/or maintaining safe-shutdown condition or ensuring barriers to radiation release.							
1. Safety Risk – Nuclear	Minimal adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Minor adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Some adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Moderate adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Major adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Severe adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Inability to control, cool or contain caused by a catastrophic system failure in a SOE (Safe Operating Envelope) System

Table 5: Definition of Consequences for Safety Risk – Radiological

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Radiological - measures potential unplanned radiological exposure or contamination, and lost opportunity for dose savings (refer to N-STD-RA-0018).							
1. Safety Risk – Radiological	• Exposure control level (ECL) exceedance AND/OR • Unplanned exposure	• Administrative dose limit (ADL) exceedance AND • Below CNSC regulatory limit	• Exposure exceeding CNSC regulatory limit AND • Below CNSC Emergency Dose Limits	• Acute Exposure exceeding CNSC Emergency Limit AND • Below LD_{50}	• Multiple Acute Exposures exceeding LD_{50} (Detailed definitions for L5, L6, and L7 can be found in the Asset Management Tool)		
	• Lost opportunity for dose savings of <1 rem/year	• Lost opportunity for dose savings of 1-5 rem/year	• Lost opportunity for dose savings of 5-50 rem/year	• Lost opportunity for dose savings of 50-125 rem/year	• Lost opportunity for dose savings of 125-250 rem/year	• Lost opportunity for dose savings of 250-500 rem/year	• Lost opportunity for dose savings of >500 rem/year

Table 6: Definition of Consequences for Regulatory Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Regulatory Risk - measures potential non-compliance incidents with applicable regulations. - Regulatory risk is used to capture the impact of an event or a failure which would cause the organization to fail to comply with a government or regulatory mandate or internal policy. - Compliance consequences are typically determined by the fines that would be assessed for non-compliance, or the cost to the organization of operating restrictions imposed because of the non-compliance. - The description below is specific to CNSC; however this table should also be used for any other regulatory risks, excluding electricity rate regulation.							
2. Regulatory Risk	• CNSC Action Items OR • Reportable Condition with minimal Regulatory Action	• Reportable Condition requiring minor Regulatory Action	• Event Requiring some Regulatory Action • Increased regulatory inspections or frequency of reporting	• Event Requiring moderate Regulatory Action • Undesirable license condition • Degraded CNSC Ratings • Enhanced regulatory oversight	• Ongoing regulatory oversight • Regulatory enforcement with major impact on business plan • Forced unit derate for a period of < 1 year	• Charges against an OPG officer, director or employee • Forced unit derate for a period of > 1 year	• Permanent shutdown • Facility License Revocation

Table 7: Definition of Consequences for Environmental Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Environmental Risk - measures potential environmental damage, and remediation costs (on and off site). - The Environmental Risk Value Model should not be used for risks including radiological emissions, as such these are captured under Environmental Risk – Radiological Emissions (See **Table 8**)							
3. Environmental Risk	• Impact to on-site environment that can be quickly mitigated • Inability to perform environmental monitoring that can be quickly mitigated • Minimal regulatory impact	• Impact to on-site environment that can be mitigated without legal or permit violations	• Impact to on-site environment resulting in legal or permit violation • Inability to perform environmental monitoring resulting in legal or permit violation	• Detrimental on-site impact, possible to mitigate in the long term • Detrimental off-site short-term impact, possible to mitigate in less than 3 years	• Civil penalties or regulatory violations resulting from detrimental off-site impact, possible to mitigate in the long term (> 3 years)	• Civil penalties, regulatory violations / interventions resulting from catastrophic off-site impact that will be impossible to mitigate • Impact in the range of $50 M – $100 M	• Civil penalties, regulatory violations / interventions resulting from catastrophic off-site impact that will be impossible to mitigate • Impact in the range of $100 M – $500 M

Table 8: Definition of Consequences for Environmental Risk – Radiological Emissions

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Environmental Risk – Radiological Emissions - measures potential environmental damage caused by radiological emissions, and remediation costs (on and off site).							
3. Environmental Risk – Radiological Emissions	Exceeding Internal Investigation Level, but less than an Action Level whether measured or estimated from a non-monitored release	Reaching or exceeding Action Level for the reporting period	Greater than the Derived Release Limit (DRL) for the reporting period (monthly for water, weekly for air)	In excess of the limits that are specified in the licensing documents, possible to mitigate in less than three years	In excess of the limits that are specified in the licensing documents, possible to mitigate in the long term (>3 years)	Emission of radioactive material due to a catastrophic event that is impossible to mitigate, with impact ranging $50 M - $100 M	Emission of radioactive material due to a catastrophic event that is impossible to mitigate, with impact ranging $100 M - $500 M

Table 9: Definition of Consequences for Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP)

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP) - measures potential cyber security breaches, specifically to assets that are subject to CSA N-290 or NERC CIP. - Cyber Security Risk is used to capture cyber security concerns. - But if there is also a potential regulatory risk event arisen from the cyber security breach, it should also be assessed and included separately under Regulatory Risk.							
4. Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP)	Plant equipment disruption OR exposure of Confidential information leading to: • CNSC Action Items, • A Reportable Condition with minimal Regulatory Action, or • A self-report of a potential Non-Compliance to IESO	Plant equipment disruption OR exposure of Confidential information leading to: • A Reportable Condition requiring minor Regulatory Action, or • A minor financial penalty for NERC CIP Non-Compliance	Plant equipment disruption OR exposure of Confidential information leading to: Some Regulatory Action and some impact on plant operation, or • Some financial penalty for NERC CIP Non-Compliance	Plant equipment disruption OR exposure of Confidential information leading to: • Moderate Regulatory Action and moderate impact on plant operation • An Undesirable licence condition	Plant equipment disruption OR exposure of Confidential information leading to: • Ongoing regulatory oversight and major impact on plant operation	Multiple plant equipment disruption OR exposure of Confidential information leading to: • Facility Licence Revocation / Enforced (<1 year)	Multiple plant equipment disruption OR exposure of Confidential information leading to: • Permanent shutdown, or • Persistent breaches of the market rules lead to suspension or termination from the market and disconnection from the IESO-controlled grid

Table 10: Definition of Consequences for Security Risk – Cyber Security (Other)

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Security Risk – Cyber Security (Other) - measures potential cyber security breaches for assets that are not subject to CSA N-290 or NERC CIP. - Cyber Security Risk is used to capture cyber security concerns. - But if there is also a potential regulatory risk event arisen from the cyber security breach, it should also be assessed and included separately under Regulatory Risk.							
4. Security Risk – Cyber Security (Other)	Business systems (All Cyber Assets) vulnerabilities identified and risk mitigated before exposed	Business systems (Priority Three IT or OT) disruption OR alteration of critical information OR exposure of OPG Internal Use Only or OPG Proprietary information	Critical business systems (Priority Two IT or OT) disruption OR alteration of critical information OR exposure of OPG Confidential information	Critical business systems (Priority One IT or OT) disruption OR alteration of critical information OR exposure of OPG Confidential Exclusive information	Critical business systems (Priority One IT or OT) extended disruption OR unrecoverable alteration of critical information	Unrecoverable critical business systems (Priority One IT or OT) disruption, with impact ranging $50 M - $100 M	Unrecoverable critical business systems (Priority One IT or OT) disruption, with impact ranging $100 M - $500 M

Table 11: Definition of Consequences for Social Licence and Reputation Impact

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Social Licence and Reputation Impact - measures potential failure or event that will cause the organization's customers or other external stakeholders to lose confidence in the organization.							
5. Social Licence & Reputation Impact	• Minimal impact on employee engagement • Minimal impact on external stakeholders	• Minor impact on employee engagement • Minor impact on OPG's public reputation (e.g., public escalating legitimate issues to Senior Management, etc.)	• Some impact on employee engagement • Some impact on OPG's public reputation (Individual occurrence of some negative perception by the media, communities of interest and/or the shareholder)	• Potential for labour conflicts • Moderate impact on OPG's reputation (Individual occurrence of moderate negative perception by the media, communities of interest and/or the shareholder)	• Labour conflicts • Major impact on OPG's reputation (e.g., sustained major negative perceptions by media, communities of interest and/or the shareholder)	• Severe impact on OPG's reputation (e.g., sustained severe negative perceptions by media, communities of interest and/or severe loss of confidence by the shareholder)	• Complete loss of confidence by the shareholder resulting in shutdown

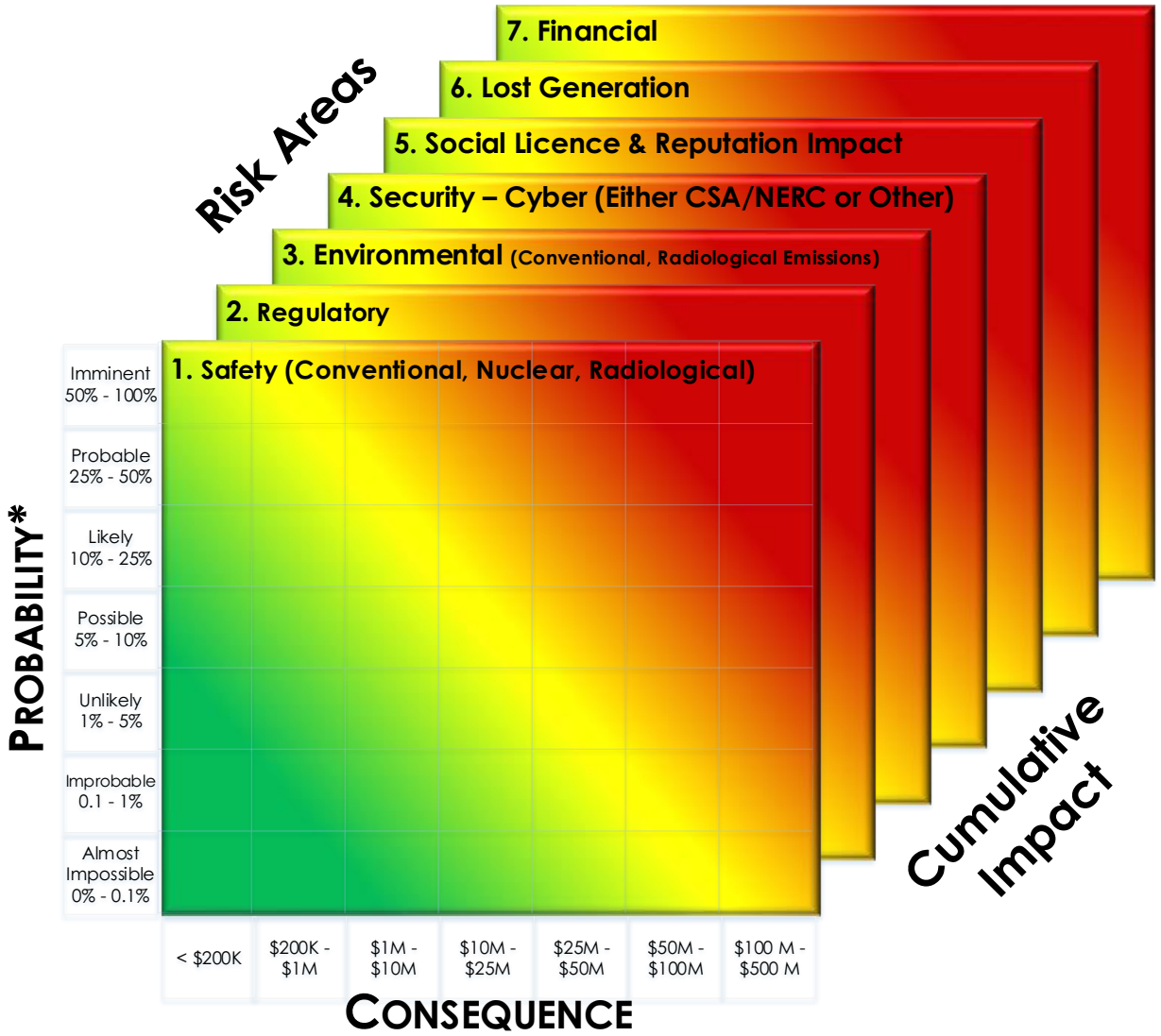
Table 12: Definition of Consequences for Lost Generation Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Lost Generation Risk = Number of additional outage days required x (Daily Lost Net Revenue + Daily Incremental Outage Cost) x *Likelihood of Risk Event occurring that will result in lost generation * Likelihood may be a combination of asset failure probability and other reasonable adjustments due to factors such as system redundancy and spare parts availability							
6. Lost Generation Risk	Lost Generation Revenue <$200 K	Lost Generation Revenue $200 K – $1 M	Lost Generation Revenue $1 M – $10 M	Lost Generation Revenue $10 M – $25 M	Lost Generation Revenue $25 M – $50 M	Lost Generation Revenue $50 M – $100 M	Lost Generation Revenue $100 M – $500 M

Table 13: Definition of Consequences for Financial Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Financial Risk - measures potential financial losses due to damage to equipment or company assets.							
7. Financial Risk	< $200 K	$200 K – $1 M	$1 M – $10 M	$10 M – $25 M	$25 M – $50 M	$50 M – $100 M	$100 M – $500 M

Appendix C: Asset Risk Model



*** Probability is time-dependent, which normally increases as time elapses**

Figure 5: Asset Risk Model

Appendix D: Detail Risk Values Calculation Methodology

The table below shows how the Mitigated Risk Value (MR) is calculated in detail, where:

- MR = Baseline Risk Value (BR) – Residual Risk Value (RR), for a given risk area at a given point of time, symbolized by **$MR_{[risk\ area]}$(time)**
- BR and RR = Probability of risk event occurring at **time = t** multiplied by Consequence of risk event for a given **risk area**
- Time t = 0 should refer to the current year, not the first year the asset is put in service
- E.g., $MR_{1A}(20) = BR_{1A}(20) – RR_{1A}(20)$ is the Mitigated Risk Value for Conventional Safety Risk 20 years from now

For each identified asset investment option:

Risk Areas \ Time (t)	0	1	2	…	n (Site EOL)
1A. Safety – Conventional	$MR_{1A}(0)$	$MR_{1A}(1)$	$MR_{1A}(2)$	$MR_{1A}(…)$	$MR_{1A}(n)$
1B. Safety – Nuclear	$MR_{1B}(0)$	$MR_{1B}(1)$	$MR_{1B}(2)$	$MR_{1B}(…)$	$MR_{1B}(n)$
1C. Safety – Radiological	$MR_{1C}(0)$	$MR_{1C}(1)$	$MR_{1C}(2)$	$MR_{1C}(…)$	$MR_{1C}(n)$
2. Regulatory	$MR_2(0)$	$MR_2(1)$	$MR_2(2)$	$MR_2(…)$	$MR_2(n)$
3A. Environmental – Non-Radiological Emissions	$MR_{3A}(0)$	$MR_{3A}(1)$	$MR_{3A}(2)$	$MR_{3A}(…)$	$MR_{3A}(n)$
3B. Environmental – Radiological Emission	$MR_{3B}(0)$	$MR_{3B}(1)$	$MR_{3B}(2)$	$MR_{3B}(…)$	$MR_{3B}(n)$
4. Cyber Security	$MR_4(0)$	$MR_4(1)$	$MR_4(2)$	$MR_4(…)$	$MR_4(n)$
5. Social Licence and Reputational Impact	$MR_5(0)$	$MR_5(1)$	$MR_5(2)$	$MR_5(…)$	$MR_5(n)$
6. Lost Generation	$MR_6(0)$	$MR_6(1)$	$MR_6(2)$	$MR_6(…)$	$MR_6(n)$
7. Financial	$MR_7(0)$	$MR_7(1)$	$MR_7(2)$	$MR_7(…)$	$MR_7(n)$
Time-series of MRs (sum of all rows for each column)	**MR(0)**	**MR(1)**	**MR(2)**	**MR(…)**	**MR(n)**
x Present Value (PV) Factor (7%)	1.0000	0.9346	0.8734	…	$1 / 1.07^n$
Time-series of PV MRs	**PV of MR(0)**	**PV of MR(1)**	**PV of MR(2)**	**PV of MR(…)**	**PV of MR(n)**
Final Mitigated Risk Value =	**Sum of all PV MRs**				