PRIVATE & CONFIDENTIAL

Performance Audit of Technical Safety BC

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Abbreviations and Definitions

Abbreviation	Details
Agreement	The Administrative Agreement sets out TSBC's obligations to the Province to administer the Safety Standards Act.
ERM	Enterprise Risk Management
GRC	Governance Risk and Control
KPI	Key Performance Indicator
LEO	Lead Executive Officer (Chief Executive Officer)
Ministry	Ministry of Attorney General and Ministry responsible for Housing
ML	Machine Learning
MOU	Memoranda of Understanding
RACI	Responsible, Accountable, Consulted, Informed Matrix
RAM	Risk Assessment Model
RAP	Risk Assessment Program
SMART	Specific, Measurable, Attainable, Realistic and Time-limited
SOP	Standard Operating Procedure
SRA	Structured Resource Allocation
TSASK	Technical Safety Authority of Saskatchewan
TSBC	Technical Safety BC
TSSA	Technical Standards and Safety Authority

Executive Summary

Key insights and summary of findings

Introduction

In 2004, the Province of British Columbia delegated authority to administer the Province's Safety Standards Act to Technical Safety BC ("TSBC"), an independent, not-for-profit corporation. TSBC is established by the Safety Authority Act and is responsible for delivering safety services, including assessment, licensing and certifications, compliance and enforcement, and incident investigation for the following technologies:

- Amusement rides;
- Boilers, pressure vessels, and refrigeration systems;
- Electrical equipment and services;
- Elevators;
- Gas appliances and systems, including hydrogen;
- Passenger ropeways such as aerial trams and ski lifts; and
- Railways, including rapid transit (by agreement with the Ministry of Transportation and Infrastructure).

The Province has also delegated authority to 10 local governments under the Administration Delegation Regulation. These local governments have limited electrical and/or gas safety oversight authority, enabling them to issue electrical and/or gas installation and operating permits and perform inspections.

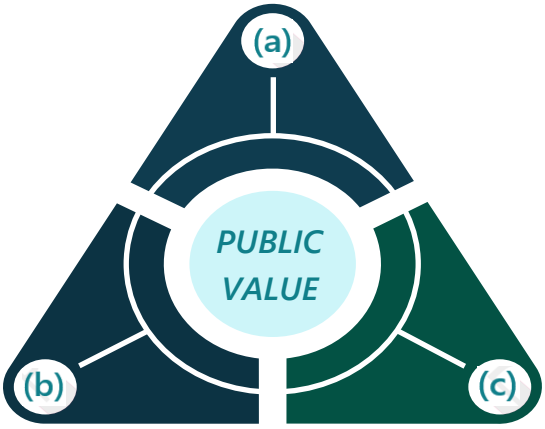
To ensure provincial interest in the safety sphere, the Province has retained the following authorities and responsibilities concerning the safety system:

- Set legislation, regulation, and policy;
- Adopt safety codes and standards substantially based on national standards;
- Manage the inter-provincial codes and standards relationships;
- Oversee participation of ten grand-parented municipalities as implementation partners in the safety system;
- Oversee the appeal system as delegated to the Safety Standards Appeals Board;
- Liaise with TSBC, monitor operations and report on results of the safety system; and
- Delegate administrative powers to TSBC and collaborate on a communication protocol.

The Safety Authority Act is the founding legislation that depicts the existence, governance framework and alignment for a common cause to achieve a safer British Columbia. To maintain, align and ensure provincial interest in safety, the Province has retained the responsibility for policy directives, delegation, monitoring, and alignment to the Safety Standards Act and derived safety system.

To enable the seamless implementation and operationalization of the Safety Authority Act, TSBC has been delegated the responsibility for administering the Safety Standards Act through an Administrative Agreement with the Province of British Columbia, which defines the delegation's terms and conditions.

TSBC's organizational classification enables its Lead Executive Officer, management, and staff resources to prepare strategic plans, operational plans and budgets with direction and approval from the Board of Directors.



(a) The Safety Authority Act
(b) Administrative Agreement
(c) Delegated Authority (TSBC)

Figure 1

The TSBC's Board and leadership are highly experienced in corporate governance and safety culture. The organization's leaders are preparing to transform their organization and lead the industry with innovative risk management philosophy and technology.

During our jurisdictional scan, we had discussions with the Technical Standards and Safety Authority (TSSA) in Ontario. It was highlighted during these discussions that TSBC is deemed as one of the benchmark standards with its peers for comparative, innovative and leading practices in the safety field.

TSBC has undergone several changes since its inception in 2004. For example, it implemented an accident prevention model in 2010, including education and outreach, compliance and enforcement, and research. More recently, TSBC developed and deployed a risk assessment program that utilizes predictive algorithms, machine learning, safety officer discretion, sample plans, and policy rules to help inform decisions on whether to conduct physical inspections. Also, in response to the COVID-19 pandemic, TSBC has reduced its number of regional offices and recently started performing remote inspections and assessments.

The Ministry engaged MNP to conduct a performance audit of the BC Safety Authority, now doing business as Technical Safety BC. The focus of this audit relates to the Administrative Agreement between the Province and TSBC, the effectiveness of its financial model, governance model, and risk assessment program, and alignment with its commitment to continuous improvement in the technical safety system within British Columbia.

This audit was a two-part performance audit which comprised of the following:

Part I – TSBC's Overall Performance

The first area of work focused on conducting an overall performance audit of TSBC, including how it performed in the following key areas: 1) Governance model, 2) Performance objectives and 3) Value for money.

Part II – Risk Assessment Program

The second area of work was to determine the effectiveness of TSBC's assessment and inspection activities, including its use of risk-based decision-making. This included reviewing its Structured Resource Allocation Program.

Summary of Observations

TSBC has a professional and experienced executive team and the Board of Directors that supervises the activities of the TSBC. Our recommendations highlight that there exist opportunities for the Ministry to provide greater oversight of the integrated safety system in the Province, which includes TSBC and the local governments that have gas and/or electrical safety oversight. TSBC requires greater transparency for performance and outcomes that can be measured and communicated with stakeholders. At present, performance measures identified and tracked by TSBC are not adequate for monitoring TSBC's efficiency, economy, and effectiveness.

Based on our interviews with stakeholders[1], there is a perception of a lack of value provided by TSBC. There is a general belief that TSBC has moved to a model focused on reduced inspections, combined with a strong reliance on TSBC's Structured Resource Allocation (SRA) Risk Management process. In reviewing the SRA in detail, our audit has several recommendations to improve the reliance on the SRA as a basis to determine which samples to investigate. We also faced challenges receiving certain SRA documentation, linking artifacts, and completing our analysis. Overall, TSBC's financial metrics are in alignment with other jurisdictions. However, further improvement with regard to performance management and monitoring is required.

To enhance the safety system and reduce risk to the Province and the public, we also recommend improved data sharing, communication, and collaboration between the Province, TSBC and the local governments. Governance, communication, and data-sharing protocols can be documented in the agreements with local governments and TSBC.

[1] Stakeholders consulted include two contractor associations that represent strong points of interaction with TSBC for permitting and other matters. These stakeholders represent sectors that comprise approximately 65% and 62% of total TSBC revenue in 2021 and 2020, respectively.

The summary recommendations below are organized by the two parts of the audit.

Part I - TSBC's Overall Performance

The formal agreement between TSBC and the Province, the Administrative Agreement ("the Agreement"), was last updated In June 2019. Supporting the Agreement is the Administrative Agreement Protocol ("the Protocol") which was last updated in 2017.

The objectives and targets per Performance Objectives and Targets listed in Schedule B of the Agreement are high-level. See *Appendix A(a)*. They do not correlate to reducing safety risks through assessment, education and outreach, enforcement, and research. As performance measures, more specific, measurable, achievable, relevant, and time-based (SMART) goals would allow for greater insight into and oversight of the safety system. The Agreement does not provide guidelines on how to derive performance measures and indicators acceptable to the Ministry. TSBC and the Ministry should address this in the near future to establish expectations and set quantitative thresholds for achieving desired outcomes and driving accountability.

The Chair of the TSBC Board, its Lead Executive Officer (LEO), the Attorney-General, Deputy Attorney General, or Associate Deputy Minister can enhance clarity between the organizations with regular scheduled and more frequent meetings. Currently, meetings with these executives are occurring ad hoc, without essential resources to support TSBC and the Ministry. Enhancing this governance process will improve communication between TSBC and the Ministry, allow the Ministry to have more formal and direct oversight of TSBC and enhance the line of sight into TSBC, achieving safety and performance objectives.

The existing right to audit within the Agreement should be exercised regularly to review TSBC's performance and compliance with the terms of the Agreement. This will allow the province to track accountability of timely actioning of recommendations from this audit and to continue to assess TSBC's ability to effectively manage safety system risks. Targeted audits should also be completed annually.

Although no significant outliers are noted from the financial analysis and comparison with similar organizations, there is a perceived lack of or misalignment in value when assessed against stakeholders' [2] expectations. To better serve TSBC's mission and vision, we suggest that additional methods be used to ensure stakeholder value management, including the implementation of robust and well-defined performance and outcome measures which have been agreed to by the Province and communicated to TSBC's stakeholders to strengthen transparency and trust.

Part II - Risk Assessment Program

There are three primary methods by which TSBC selects the inspections it performs: Option 1) Inspect all possible sites based on submitted permits, Option 2) Select a sample of sites based on the professional experience and judgement of TSBC safety officers, and Option 3) Use a model based on Artificial Intelligence and Machine Learning whereby a system selects the sites to inspect.

[2] Stakeholders consulted include two contractor associations that represent strong points of interaction with TSBC for permitting and other matters. These stakeholders represent sectors that comprise approximately 65% and 62% of total TSBC revenue in 2021 and 2020, respectively.

We understand there are 5 inputs for prioritization of inspection as provided by TSBC and listed below:

1. Hazard Elimination (eliminating hazards by following up on notifications received from the general public)
2. Predictive Modelling (identifying sites where high hazards are most likely to exist, using machine learning and other analytical tools)
3. Sample Plans (seeking insights into specific client and technology segments, using both random and hypothesis driven sample plans)
4. Policy Rules (focussing on segments where TSBC has low risk tolerance, using policy rules that mandate certain types of inspections)
5. Safety Officer Expertise (leveraging the knowledge of our safety officers to inform which inspections to additionally conduct).

For the 5 areas above, we noted a varying degree of formality and documentation. In particular, the policy rules were the least formally documented input. Other parts of this report have addressed the documentation gaps related to the other input areas.

TSBC's Structured Resource Allocation (SRA) [3] aims to increasingly use the third option to determine a sample of inspections to perform and where the professional judgement of the safety officers (option 2) is the final mitigating control. TSBC believes the SRA will optimize inspection effectiveness with more efficient use of its resources.

The following areas were addressed in our audit in determining the degree to which the SRA selection may be relied upon as a basis to determine which permits to select for inspection. The areas are arranged in priority order and summarize the challenges we faced in obtaining documentation, linking artifacts, and completing our analysis:

1. SRA Validation Framework – A well-structured Governance and Artificial Intelligence Analytical framework is essential to the integrity of data and related decision-making based on a model such as the SRA. Our fieldwork confirmed that such a framework had not been established. MNP developed a candidate framework which was then shared with TSBC prior to being used to assess the SRA. Both the Ministry and TSBC approved using this framework for this purpose without modification.

2. Backtesting ML with Real Word Data – We requested TSBC provide us with examples of how it backtests the performance of the SRA (thus demonstrating that the SRA performs as expected to real-world outcomes and therefore helping to select samples more effectively).

3 "Structured Resource Allocation" is a data-driven program that provides for a balanced use of safety officer time – focused on finding high hazard sites using predictive models, random sampling to understand market segments, rules to cover policy priorities, and local safety officer insight on how to maximize overall impact. (From the TSBC website: https://www.technicalsafetybc.ca/glossary/structured-resource-allocation-program)

We were informed that TSBC has 2 stages that TSBC feels is aligned to backtesting:

1. As part of the development of the algorithms by splitting historical real-world data into training and testing data sets; the latter used for backtesting.
2. As part of operations reporting, the percentage of high hazards found is empirically determined from real world data and reported on a quarterly basis to the Executive team.

What we were expecting to see is a formal and structured approach that validates the model in the following ways subsequent to the development and implementation of the model:

1. false positives predicted by the model,
2. false negatives predicted by the model,
3. true positives predicted by the model, and
4. true negatives predicted by the model

Only true positives and false positives are identified and addressed. We did not see structured periodic backtesting plan. There is no regular validation using real world evidence to confirm the validity of the ML model.

It is important to validate the real-world congruence of the AI/ML model to inspection outcomes periodically (e.g., quarterly or annually). During interviews with senior resources within TSBC familiar with the rigour of the model, it was agreed that the formality and rigour of backtesting would be required to improve stakeholders' ability to rely on the SRA. Currently, it is believed that the ML component performs no worse than the professional judgement of TSBC safety officers. However, it was noted that safety officers could override the results and recommendations of the SRA inspection selection.

3. Primary SRA stakeholders not fully documented or addressed – A complete and updated SRA stakeholder analysis of consumers of SRA outputs was not readily available. The SRA Policy, last approved on December 2, 2020, covers primary and secondary consumers in the Responsibilities Section while also addressing internal TSBC stakeholders such as managers, IT, leadership roles, and safety officers. The SRA Policy is missing the ML component of the SRA. The SRA Standard Operating Procedure (SOP) does list the Role and Responsibilities associated with the ML component of the SRA and similar responsibilities, such as validating and approving the model. However, validating the integrity of the input data is not explicitly discussed.

4. SRA Control documentation was lacking – Generally, there was a lack of, or issues with, the documentation available for the SRA. We were not able to obtain a complete list of policy decision rules. A complete description of roles and responsibilities for the development and deployment of the ML model was also not available. There was also a lack of standards and process documentation with respect to ML model training, data validation, independent verification, and validation of both the ML component of the SRA and the entire SRA process itself.

5. Responsible, Accountable, Consulted, Informed (RACI) not defined – A RACI Matrix including accountabilities and stakeholder engagement (a complete list of who needs to be informed and consulted) was unavailable when requested by our team.

Scope and Approach

The Ministry engaged MNP to conduct a performance review at TSBC. We have grouped the scope and approach below:

Part I – Overall TSBC Performance

The first area of our performance audit is an assessment of how TSBC is performing in the following key areas:

- Governance model: The effectiveness of TSBC's governance model in governing the safety system and ensuring TSBC acts in the best interest of British Columbians.
- Performance objectives: How well TSBC is meeting its performance objectives as set out in the Administrative Agreement.
- Value for money: Analyzing TSBC's financial model to determine its effectiveness and sustainability and how the model affects the delivery of safety services.

Part II – Risk Assessment Program

In this section of our audit, the TSBC's risk assessment program was evaluated to understand the effectiveness of assessment and inspection activities, including the use of risk-based decision-making tools and processes. More specifically, the focus was placed on evaluating the effectiveness of the Structured Resource Allocation Program used to prioritize electrical and gas inspection activities, including:

- Risk-based decision-making in identifying high-hazard sites
- Review of predictive models, random sampling to understand industry segments, rules to cover policy priorities, and local safety officer insight on how to maximize the overall impact of algorithms and machine learning
- Assessment of activities for other technologies that do not use the Structured Resource Allocation Program

Workplan Methodology

MNP completed the performance audit of TSBC in the Summer of 2022. The following phases and key activities were completed during this audit:

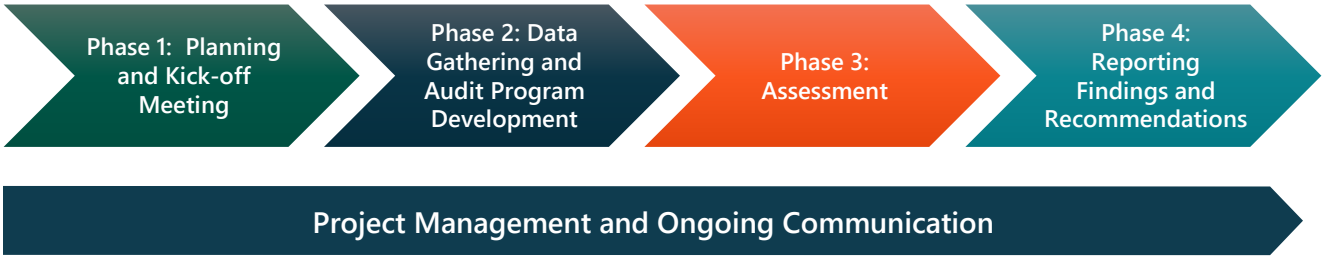


Figure 2

Each phase of our methodology above is further segmented into two parts, as highlighted in the prior section (Scope and approach).

Phase 1: Planning and Kick-off, Parts I and II

During this phase, we aimed to form a working relationship with the Ministry, TSBC and MNP to ensure we were aligned with the expectations and requirements. Our project began with a kick-off meeting involving all key stakeholders from the teams. The essential tasks included:

1. Introductions and roles;
2. Detailing the documentation required that was to be reviewed; and
3. Identified key stakeholders that were to be interviewed.

Additional activities performed during this phase included the following:

- Identifying key data sets, including performance metrics across the organization;
- Confirmation of the initial deliverable listing; and
- Defining the expectations regarding the communication and engagement strategy.

Phase 2: Data gathering and audit program development, Parts I and II

Our focus during this phase was to identify points of focus for the audit and develop relevant criteria to conduct our fieldwork and analyses. It began with understanding TSBC's performance objectives, obligations, business/financial operations, governance models, risk assessment programs and processes, resource allocation and decision-making mechanisms, and relevant processes and activities designed to support the contents mentioned above. Based on the information collected, a comprehensive audit program was developed and confirmed with the Ministry and TSBC.

The key activities included:

Part I – Overall TSBC Performance

Based on the objectives, scope, criteria, and activities agreed upon in the planning phase, the following activities were undertaken:

- Studied the Administrative Agreement between the Ministry and TSBC, including Schedules A - D, to identify the key performance objectives and obligations.
- Interviewed relevant TSBC staff and other stakeholders from the Ministry to understand both parties' expectations of performance and interpretations of the objectives/obligations.
- Interviewed relevant TSBC staff and reviewed relevant documentation to understand if relevant performance indicators or measurements had been established. We also examined whether TSBC had implemented relevant processes/frameworks to achieve its objectives and fulfill its obligations, e.g., what information/data is collected and used by TSBC to support meeting its performance objectives/obligations.
- Reviewed TSBC's audited financial statements and other financial-related documentation and interviewed relevant TSBC staff.
- Interviewed relevant TSBC staff and reviewed relevant documentation such as TSBC incorporation legislation, corporate organization chart, job descriptions, management mandate, policies, procedures, etc., to understand TSBC's Governance Model.
- Interviewed relevant TSBC staff/Ministry representatives to understand the relationship between the Province and TSBC, including:
    - Governance;
    - Operational; and
    - Performance Measures and Reporting Expectations/Requirements.

Part II – Risk Assessment Program

To determine the effectiveness of TSBC's risk assessment program, we conducted the following activities before the assessment:

- Interviewed TSBC staff and reviewed relevant documentation such as policies and procedures, risk register, the script of risk assessment algorithms, etc., to build a thorough understanding of the TSBC's Structured Resource Allocation Program, e.g., AI strategy, data management (e.g., source, storage, quality, integrity, and stakeholders), risk identification process, risk assessment criteria, tools and technologies, approach and algorithms, human intervention and discretion, program governance, IT general controls, etc.
- Interviewed TSBC staff and reviewed relevant documents, such as assessment reports to understand the risk assessment process for the technologies that do not use the Structured Resource Allocation Program.
- Based on the information/data obtained from the above steps, we developed an audit program that was used to evaluate the effectiveness of TSBC's risk assessment program. Specifically, we

reviewed and analyzed the algorithms of TSBC's Machine Learning model and assessed its correctness and efficiency; then validated the results of TSBC's Structured Resource Allocation Program based on the algorithms and assessed the correctness of the program.

- Based on our previous assessments of TSBC and knowledge gained from other AI/ML projects, our points of focus included the following:
  - Data integrity – source, completeness, accuracy
  - Data governance
  - Assumptions used to build and refine the algorithms
  - Input and output controls
  - Deployment of tools into the field
  - Use of human judgment/override

Phase 3: Assessment

Phase 3 focused on the execution of the agreed-on audit programs/procedures. Based on the execution results, we provided an overall assessment of TSBC's performance and the effectiveness of TSBC's risk assessment program. In addition, throughout this phase, we worked to identify opportunities to improve existing processes and make recommendations regarding implementing these improvements.

Part I – Overall TSBC Performance

- Assessed if TSBC met its performance objectives and obligations as outlined in the Administrative Agreement;
- Assessed if appropriate and reasonable performance indicators have been set up in accordance with Schedule B (Performance Objectives and Targets) of the Administrative Agreement and if additional performance indicators should be included;
- Assessed TSBC's data collection and management (such as storage, safeguard, security, integrity) process, and if TSBC adequately collected the right data to support meeting its performance objectives and obligations;
- Based on the understanding of TSBC's financial model and evidence from annual financial audits as well as other data sources such as management reports, determined if the financial model is effective and sustainable;
- Assessed how the fee-for-service model is affecting the delivery of safety services;
- Interviewed a selection of certificate holders and licensed contractors to determine whether safety system participants are getting value for the services delivered by TSBC;
- Reviewed incident and hazard trends in the regulated sectors to determine the public safety benefit of the services delivered by TSBC;
- Evaluated TSBC's fees in comparison to fees for similar services in other provinces, considering factors that impact costs of doing business in different jurisdictions, such as cost of labour, cost of raw materials, etc.;

- Evaluated TSBC's costs compared to other similar organizations in other provinces or other BC provincial government agencies of similar size and complexity (where the information is available);
- Reviewed TSBC reporting to government and the public (e.g., the State of Safety annual report) and how it aligns with the requirements of the Safety Authority Act and expectations of the Ministry and public and industry stakeholders;
- Evaluated the governance model as outlined within the Safety Authority Act and compared this with leading governance practices from within the public sector or peer groups with similar size and complexity;
- Assessed the composition and skills mix of the Board of Directors; and,
- Assessed adherence to the Safety Authority Act and Administrative Agreement.

Part II – Risk Assessment Program

- Based on the assessment results from Part 1 (i.e., TSBC data management process), assess the completeness and integrity of the data used by TSBC's risk assessment program
- Assessed the appropriateness of the standards criteria used in TSBC's risk assessment program
- Assessed the process, system, and people competency within TSBC's risk assessment program
- Gained understanding and assessed processes around how the AI/ML algorithm(s) are developed, tested, maintained, deployed, and refined. Test relevant controls around the integrity and security of the algorithm(s)
- Reviewed the algorithm(s) used in TSBC's Structured Resource Allocation Program and assessed effectiveness, validity, and efficiency by sample testing;
- Assessed practices to ensure/enhance data integrity and governance;
- Sampled and tested criteria and assumptions used in building/refining algorithm;
- Sampled test input/output controls;
- Sampled test deployment and use in the field (including the application of human judgement/override); and,
- Assessed the effectiveness of TSBC's assessment activities of the technologies that do not use the Structure Resource Allocation Program and the effectiveness of this risk assessment model.

Phase 4 – Reporting Findings and Recommendations

Using the information gathered and the deliverables generated from the previous phases, MNP prepared a draft and final report and supported the Attorney General and Minister Responsible for Housing in understanding and communicating the results to other Government parties.

- We developed a draft report for the Attorney General and Minister Responsible for Housing to validate, including:
  - Scope and Objectives of work; and,
  - Findings, recommendations, and conclusions were identified during the previous phases of this work.

- The draft report and findings were then provided to TSBC. TSBC was provided with the opportunity to:
  - Review the draft report and findings to outline any substantial factual errors to be corrected before finalizing a formal draft report; and,
  - Once the formal draft report is finalized, respond to the recommendations for inclusion in the report's final version.
- A presentation of summary findings and recommendations that our senior team presented to the Attorney General and Minister Responsible for Housing and Ministry staff, as well as to staff from TSBC, as required.

Limitations

Our work and findings do not in any way constitute an audit as defined under Canadian Audit Standards, and we offer no assurance as defined under these same standards. We did not subject the information contained in the report to checking or verification procedures except to the extent expressly stated. We accept no liability in relation to any commercial decisions taken as a result of our advice or recommendations.

Our work was not designed to identify and cannot necessarily be expected to disclose defalcations, fraud, and other irregularities. As a result, this report does not necessarily include all those matters, which a more extensive or special examination might develop. The discovery of irregularities might, of course, have resulted from our audit and, if so, any significant findings would be reported to the Ministry.

In no circumstances shall we be responsible for any loss or damage of whatsoever nature arising from information material to our work being withheld or concealed from us or misrepresented to us by management and employees of TSBC or the Ministry or any other person of whom we may make enquiries.

This report is intended solely for the information and use of the Ministry. This report should not be distributed to third parties, excluding the agency under review, without MNP LLP's prior written consent. Any use that a third party makes of this report, and any reliance or decisions made based on it, are the responsibility of such third party. MNP LLP accepts no liability or responsibility for any loss or damages suffered by any third party as a result of decisions made or actions taken based on this report.

Detailed Report

Detailed reporting on observations for Part I, and II.

Detailed Report: Part I – Overall TSBC Performance

Part 1 of the audit focused on the overall performance audit of TSBC programs and approaches to assess its efficiency and effectiveness in the following key areas:

- Governance model – The effectiveness of TSBC's governance model in governing the safety system.
- Performance objectives – Assess how well TSBC is meeting its performance objectives as set out in the Administrative Agreement between the Province and TSBC.
- Value for money – Assessing its effectiveness and sustainability and how the current Model affects the delivery of safety services.

1.0 Governance Model

1.1	Updating the Administrative Agreement and Administrative Agreement Protocol to allow for effective oversight of TSBC and the provincial safety system

The formal agreement between TSBC and the province, the Agreement, was last updated In June 2019. Supporting the Agreement is the Protocol which was last updated in 2017. The Agreement documents the high-level outcomes TSBC strives towards and addresses other administrative items such as financial terms, communication, litigation, dispute resolution and indemnity. The safety outcomes described in the Agreement are at a high level. It includes achieving operational excellence, promoting activities which enhance public safety, reducing risks from hazards, and being responsive to the education and communication needs of the public who use the equipment that TSBC regulates and to the clients that pay for TSBC services. Other outcomes include promoting and encouraging the harmonization of technical safety standards and establishing a leadership role for British Columbia at national safety forums.

The Performance Objectives and Targets are listed in Schedule B of the Agreement[4] to provide oversight of TSBC. At a high level, these include:

- An adjusted working capital determines operational Excellence (i.e., current assets over current liabilities greater than or equal to 1;
- Promoting activities to enhance safety and reduce the risk that includes conducting an independent review of TSBC's technical risk assessment process and producing the State of Safety report with Specified information;

4 See Appendix A for a full list of the performance measures

- Responsive to equipment users and clients' education and communication needs as evidenced in the Annual Report, State of Safety Report, or a separate report.
- Promoting harmonization of technical safety standards and establishing a role in national safety forums demonstrated by participation and leadership on national committees and inter-provincial working groups.

The above objectives and targets are high-level and do not correlate to reducing safety risk through assessment, education and outreach, enforcement, and research. More specific, measurable, achievable, relevant, and time-based (SMART) goals as performance measures would allow for greater oversight of the safety system. Specific measures could include financial metrics, safety-related outcomes, education, and stakeholder satisfaction. We also reviewed TSBC's internal KPIs used for measuring management and executive performance. However, these measures were not SMART, and revising them is recommended.

We gathered measures used by peers and compared that to TSBC's. For reference and comparison, *Appendix A (b and c)* includes Ontario's TSSA current measures. It is worth noting that TSSA's measures may change soon as they strive to be more outcome-focused.

The State of Safety Report is TSBC's Confirmation Document for achieving the Performance Objectives of Information Analysis and Incident Investigation. These objectives include an analysis of incident and injury trends across all TSBC regulated sectors, explanations for trends and deviations, responding to information gathered from investigations, understanding causes, and taking action to resolve problems. Very little data is shared or received from the ten local governments who administer either electrical and/or gas, so the State of Safety Report is not complete for these areas. Improved data sharing would enhance the information on incidents, injuries and trends and help reduce the safety risk in these two sectors.

Section 4.4 Joint Planning and Prioritization of the Agreement outlines how the parties will work together to "foster a transparent and collaborative relationship and to ensure that future collaborative work is appropriately resourced." Section 4.41 outlines that the ADM of the Ministry and the Vice President, Regulatory Leadership, will "strive" to meet at least one per quarter. Other areas of the Agreement include Priority Planning Session and Semi-Annual Policy Team Meetings and supporting Technical team liaisons. In discussions with the Ministry and TSBC, feedback indicates that some of these meetings are happening and are effective, and others are happening on a more ad hoc basis. This section also lacks clarity on the involvement of the Board Chair and Lead Executive Officer (LEO) of TSBC and the Attorney General, Deputy Attorney General, or Associate Deputy Minister of the Ministry. Meetings with these executives are happening but more on an ad hoc basis, without involving key supporting TSBC and Ministry resources. Enhancing the section of the Agreement as a formal governance process will improve communication between TSBC and the Ministry and improve the Ministry's formal oversight of TSBC and the line of sight into achieving safety objectives.

In 2004, TSBC was established by the Province as an independent, not-for-profit corporation. The "Agreement" was established at that time and included a right to audit clause in Section 6.03 (c). This audit, conducted in 2022, was the first time this clause was actioned. In comparison, TSSA has been under regular audits, and follow-up audits from the Ontario Office of the Auditor General. During discussions with TSSA, they stated the value received from independent audits. Audits are a tool to help organizations continuously improve and can be scoped to focus widely on many areas or specific areas.

Recommendations:

1.1.1. To effectively monitor the outcomes of TSBC, we recommend that SMART performance measures be developed and monitored. If the performance measures remain in the Agreement, they should be reviewed annually, with the performance measures adjusted as required. Currently, the Agreement is to be reviewed every three years. Alternatively, the performance measures could reside in the Protocol agreement or form part of a Ministerial Letter of Expectations. These performance measures should be made available on the TSBC website for transparency and accountability.

1.1.2. Performance objectives for Information Analysis and Incident Investigation in Schedule B reference the State of Safety Report as a confirmation document. The Province should work with TSBC and the local governments to improve data sharing, so the State of Safety Report can include data on electrical and gas from local governments.

1.1.3. Section 4.4 Joint Planning and Prioritizing of the Agreement Protocol should be redrafted as a formal governance model section. It should document how all levels of the Ministry interact with TSBC. It includes how the Minister and the Board Chair and CEO (now LEO) of TSBC interact down to the technical resources. Formal governance should include meeting objectives, cadence, attendees, outcome reporting and meeting minutes. This section should also include an escalation process throughout the levels of governance.

1.1.4. The Province should conduct regular audits of TSBC as permitted in the Agreement. We recommend these audits could include annual follow-up audits and can be scoped to include specific areas of focus.

1.2	**The TSBC 2022-2024 Business plan document does not detail the performance measures as required by the Administrative Agreement.**

Section 6.04(m) of the Administrative Agreement states, "make available to the public a three-year business plan prior to January 1 of each year," which is in line with the Safety Authority Act. This business plan must be aligned to schedule "A" of the Administrative Agreement, which requires the plan to include:

- Corporate Overview
- Vision and Values
- Planning Context and Key Strategic Issues
- Goals, Objectives, Strategies and Performance Measures
- Expenditure and Revenue Requirements

A review of TSBC's 2022-2024 Business plan indicates the performance measures are currently assessed at a project level in TSBC's dashboard, which includes annual targets, to translate TSBC's strategic priorities into measurable outcomes. Furthermore, the Administrative Agreement does not provide guidelines on deriving these performance measures. This performance dashboard is an internal document and is thus not available to the public as required by the Administrative Agreement. Furthermore, these measures are not comprehensive as would be expected from a safety regulator, nor are they SMART (Specific, Measurable, Attainable, Realistic and Time-limited).

Recommendation:

1.2.1. TSBC should include performance measures within the annual business plan as required by the Administrative Agreement so that visibility on the organization's performance measures and intended targets are made transparent. These could be the same performance measures discussed in Recommendation 1.1.

2.0 Value-for-Money Assessment

2.1	**Although no significant outliers are noted from financial analysis and comparison with similar organizations, there is a perceived lack of / misalignment in value when assessed against stakeholders' expectations.**

Financial Analysis

TSBC has a robust financial structure to ensure proper allocation and utilization of resources. Regular analysis of the financial state is performed and presented to the Board at regular intervals. Financial ratios are monitored and tracked toward the planned strategic position defined by management.

Based on high-level benchmarking, the percentage of TSBC expenses to the total expenses incurred is comparable to similar organizations responsible for safety.

TSBC's financial ratios compared to Technical Standards and Safety Authority (TSSA) and Technical Safety Authority of Saskatchewan (TSASK) are shown below:

Current ratio:

Table 1

	TSBC				TSSA				TSASK			
	2020	2019	2018	3yrs Avg	2020	2019	2018	3yrs Avg	2020	2019	2018	3yrs Avg
Current ratio[5]	2.66	2.19	2.06	2.30	2.39	3.04	2.51	2.64	12.46	20.81	15.74	16.34
Debt Ratio	0.50	0.50	0.51	0.50	0.44	0.42	0.45	0.44	0.48	0.45	0.51	0.48

The current ratio measures TSBC's liquidity position and ability to pay short-term obligations within one year. The debt ratio shows the percentage of TSBC's assets funded by debt.

The summary financial ratios show that:

1. TSBC's liquidity position is higher than one (1) as required in the Administrative Agreement and comparable to TSSA's, averaging 2.30 over three years. TSASK shows a much higher liquidity position.

[5] $Current\ Ratio = \frac{Curret\ Assets}{Current\ Liabilities - Deferred\ Revenue}$

2. Though slightly higher, TSBC's debt ratio is comparable to TSSA and TSASK.

Analysis and trend of TSBC's expenses and revenue compared to TSSA and TSASK is shown below, with no apparent outliers noted.

Expenses as a percentage (%) of Revenue

Table 2

	TSBC			TSSA			TSASK		
Expenses as % of Revenue	2020	2019	2018	2020	2019	2018	2020	2019	2018
Salaries and benefits	71%	68%	68%	71%	71%	70%	77%	69%	64%
General, operating and administration	9%	8%	11%	22%	23%	30%	11%	9%	8%
Amortization and write-down of tangible capital assets and intangible assets	7%	7%	7%	2%	2%	2%	3%	4%	5%
Building occupancy	5%	5%	8%	-	-	-	10%	9%	8%
Communications and information services	6%	6%	5%	-	-	-	-	-	-
Transportation	1%	3%	4%	-	-	-	6%	5%	5%
Corporate governance	1%	1%	1%	-	-	-	1%	1%	1%
Non-regulatory business expenses	-	-	-	7%	7%	5%	-	-	-

Expenses as a percentage (%) of Total Expenses

Table 3

	TSBC			TSSA			TSASK		
Expenses as % of Revenue	2020	2019	2018	2020	2019	2018	2020	2019	2018
Salaries and benefits	71%	70%	65%	70%	69%	65%	71%	71%	71%
General, operating and administration	9%	9%	11%	22%	22%	28%	10%	9%	8%
Amortization and write-down of tangible capital assets and intangible assets	7%	7%	6%	2%	2%	2%	3%	5%	5%
Building occupancy	5%	5%	7%	-	-	-	9%	9%	9%
Communications and information services	6%	6%	5%	-	-	-	-	-	-
Transportation	1%	3%	4%	-	-	-	5%	6%	6%
Corporate governance	1%	1%	1%	-	-	-	1%	1%	1%
Non-regulatory Business Expenses	-	-	-	7%	7%	5%	-	-	-
Total Expenses	100%	100%	100%	100%	100%	100%	100%[6]	100%	100%

[6] Total TSASK Expenses as a percentage (%) of Total Expenses for 2020 do not sum up to 100% due to rounding.

Table 4

TSBC Revenue vs Salaries	2020	2019	2018	2017	2016	2015
Revenue ($) (services and related fees)	66,955,215	68,478,408	64,723,925	60,227,584	56,204,845	51,472,509
Salaries and Benefits ($)	49,123,092	48,195,055	44,332,073	39,885,474	36,601,361	34,011,124
Revenue % Change	-2.2%	5.8%	7.5%	7.2%	9.2%	-
Salaries & Benefits % Change	1.9%	8.7%	11.1%	9.0%	7.6%	-

TSBC Revenue and Salaries and Benefit Trends

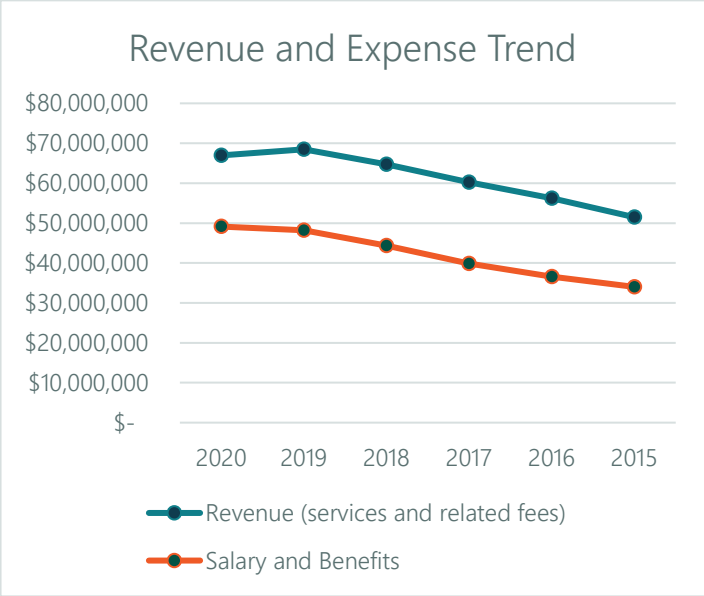


Figure 3: Revenue and Expense Trend

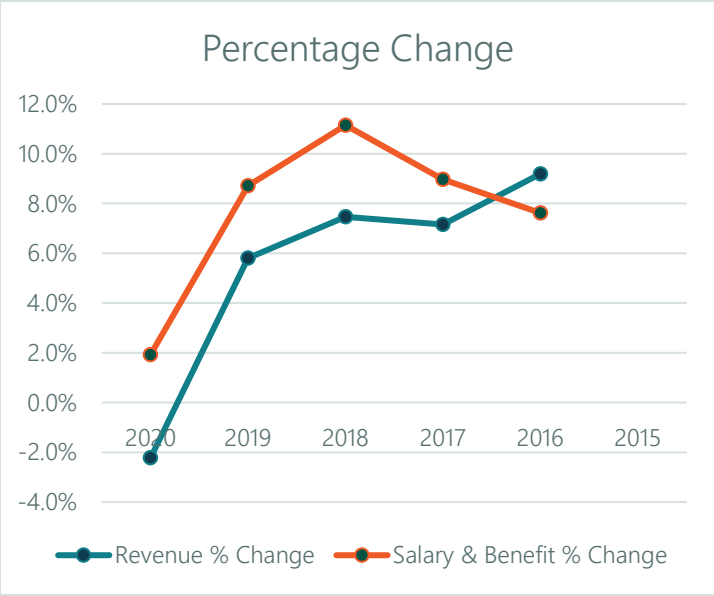


Figure 4: Percentage of change

The trend above shows that salaries and benefits continue to grow as revenue from services and related fees grows. The percentage change trend in revenue, year-over-year, is similar to the trend in salaries and benefits. This correlation indicates that portions of the increased fees charged by TSBC on services have been used to fund the increase in staff strength within the organization, supporting investments in the risk-based approach adopted.

Also, an analysis showing TSBC's average revenue, cost and contribution margin (CM) per transaction based on quarter four (Q4) financial information is shown below.

Table 5

	Boilers and Pressure Vessels	Electrical	Gas	Passenger Ropeways, Amusement & Elevating Device	Railway	Alternative Safety Approaches	Totals
Average Contribution Margin per transaction (2020)	13	174	63	110	1,003	2,239	9,044
Average Contribution Margin per transaction (2019)	9.83	145.57	67.96	94.46	500.95	842.28	10,786
Average Contribution Margin per transaction (2018)	12.09	161.78	67.69	67.95	613.64	1,130.22	7,873

These tables show a consistent positive average contribution per transaction by technology, indicating that each technology or group of technologies (i.e., passenger ropeways, amusement, and elevating device) assessed together can cover their share of the direct costs.

Safety Trends

TSBC monitors and reports on the state of safety within BC and publishes the trend across technology on its website. These trends include, but are not limited to, the number of permits issued year-over-year, the number of inspections, and the total reported incidents. TSBC also identifies initiatives adopted to manage further the safety risk reported over the year to reduce the risk in these technology areas.

MNP reviewed the State of Safety reports and compared TSBC's inspection rate and incident rate to peers in the safety system.

Total inspections and incidents [7]

Table 6

Description	Total # of Inspection[8]	Total # of Incidents	% Incident to Inspection
TSBC 2020	45,121	246	0.55%
TSSA 2020	107,939	5,732	5.31%

Though TSSA's incident rate to inspection is higher than TSBC's, some factors might influence the completeness of the data, for example, the nature of the incidence required to be reported, the diligence of reporting, etc.

[7] Analysis did not include inspection time, comprehensiveness and prioritization.

[8] TSSA's Inspections include pass inspections, fail inspections and other inspections – non-mandatory outcomes or neither pass nor fail outcomes.

Inspection Rates (2020) per permits issued [9]

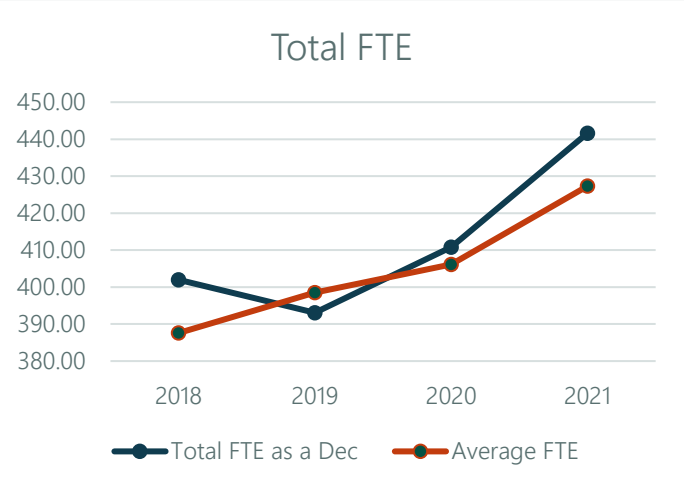
Table 7

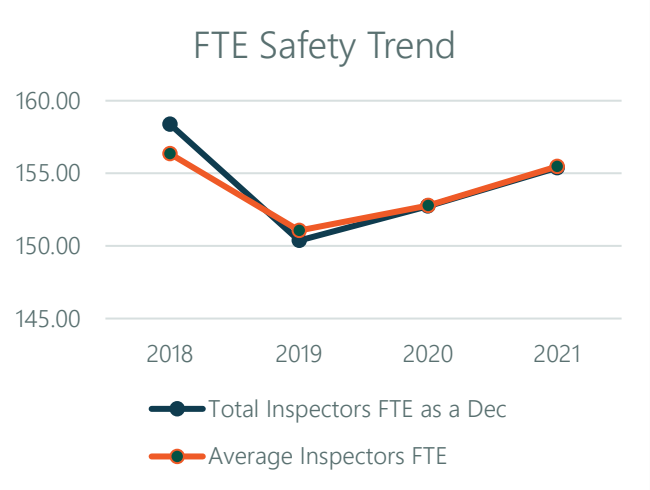
Description	TSBC	TSASK	Local Governments
Electrical	29.1%	55.5%	40-100%[10]
Elevators	10.3%	61.2%	N.A.
Gas	17.2%	79.2%	40-100%

Trends in Staff Strength

TSBC's total full-time employees have increased over the years, as shown in the graphs below. The graphs show a decline in the number of safety related positions[11] in 2019, increasing afterward in 2020 and 2021. The total safety related positions is yet to reach the 2018 average.

Value Assessment





TSBC's financial information shows a strong liquidity position, comparable debt ratio, comparable contribution across technology and comparable to other safety authorities. Incident trends indicate increased safety, hence resulting in a reduction in incidents. However, based on our observations from the interviews with stakeholders [12] (i.e., local governments and associations), there is a perceived lack of value and recurring concerns raised. Some of which include a significant reduction in safety officer's site visits, inadequate customer service or access to safety officers, and permits being followed up on by safety officers long after project completion. One contractor association interviewed also expressed concerns

[9] Analysis did not include inspection time, comprehensiveness and prioritization.

[10] Of the five local governments interviewed, two reported they inspect at a rate of 40% and 70%, respectively. They perform initial inspections followed by declarations and random inspections, complete with final inspections for larger projects such as condominium buildings.

[11] The FTE Safety Trend includes Safety Officers, Safety System Officers, Safety System Risk, Manager Safety System Risk, and Safety Managers.

[12] Stakeholders consulted include two contractor associations that represent strong points of interaction with TSBC for permitting and other matters. These stakeholders represent sectors that comprise approximately 65% and 62% of total TSBC revenue in 2021 and 2020, respectively.

with open action items from their joint meetings with TSBC. Another contractor association indicated they do not have formal meetings with TSBC and are in the process of requesting these meetings take place.

TSBC has adopted a risk-based approach, using the SRA to identify inspections and is considered a value add to TSBC as it implies efficient use of the available resources. There is the recurring theme of a lack of understanding of the risk-based approach TSBC has adopted in determining which permits should be inspected. There is a perception that TSBC relies on the SRA and therefore does not need to inspect at high rates. There is also the perception that if TSBC is inspecting at low rates and this data goes into the SRA system, how can this data be used to make risk-based decisions? Although TSBC has lower inspection rates when compared to other jurisdictions for certain technologies, there was no evidence to link the inspection rates to the SRA[13].

Recommendations:

2.1.1. We recommend that TSBC review its client service strategy and increase its' stakeholder engagement initiatives and focus, i.e., regular formalized stakeholder meetings, to obtain input and update stakeholders on its initiatives. Stakeholder groups indicated an interest in more formal contact with TSBC to better understand TSBC's risk assessment process and be more actively involved in other activities.

2.1.2. We recommend that TSBC enhance its stakeholder surveys, including contractors, associations, etc., focusing on safety management (inspections, permits, etc.) to better understand and implement stakeholder needs. This may help to change the perception of the lack of value.

2.2	**Financial modelling is completed for certifications and licensing to assess the impact of rising licensing and certification costs and the need for fee increases. However, modelling for key safety services was not completed at our audit time.**

TSBC operates a fee-for-service approach and currently charges fees for the following services:

1. Certificates and Licenses,
2. Permits (operating, new installation),
3. Learning Centre
4. Alternative Safety Approaches
5. Inspections
6. Design Registration
7. Equipment Approval

TSBC has a structured fee impact analysis model for assessing the impact of changes to certification fees, including examination and evaluation fees. The analysis is based on reviewing the current fee schedule, the average annual volume over three years, and weighted average gross margins. Assumptions are documented and reviewed.

[13] See Table 7 for inspection rates

From our review and inquiries, however, we noted that TSBC does not have a detailed fee model similar to the fee impact model for certification. Based on the fee-setting approach adopted by TSBC, the impact of increased fees on technologies is assessed after the proposed fees are set.

We also performed a jurisdictional scan to assess how TSBC's approach compared to peers. Areas reviewed and compared include the fee-setting process and fee structure. Key highlights from the jurisdictional search are summarized below.

Appendix B - Fee Structure and Governance Jurisdictional Search of this report includes a detailed summary of our findings.

- TSBC's fees for electrical and gas are based on amps and the number of appliances, while TSSA charges a flat fee, and TSASK's fee is based on the type of dwelling, amps (for temporary services) and cost of building.
- TSBC increased its fees by 3% for 2022, TSSA increased by 2.6% effective 2022, and TSASK had a fee restructuring in 2021.
- Specific local governments adopt TSBC's fee structure for gas or electrical permits, while others have different structures in place. The fees are not directly comparable; however, TSBC's gas installation permit fees appear to be more than the local governments except one. See
- Appendix B - Fee Structure and Governance Jurisdictional Search for details.
- Contractor association feedback has indicated concerns with the lack of physical inspections performed by TSBC, potentially leading to lower contractor quality and higher risk in TSBC-regulated industries. They have also indicated concerns with trying to reach out directly to TSBC to close permits (examples were related to boilers and pressure vessels). They indicated there is an appetite to increase fees if it corresponds with higher levels of service.

Recommendation:

2.2.1. A fee impact model should be designed for all significant technologies within TSBC, e.g., Permits and Inspections. Assumptions should also be documented appropriately by TSBC and stress tested.

2.3 Financial information required to determine the level of cross-subsidization across technologies is not available. TSBC is not able to meet its obligations as stated in Article 8 of the Administrative Agreement requiring TSBC to report the extent of cross-subsidization to the Province.

TSBC currently subsidizes costs incurred in the following technology areas; amusement, compliance and enforcement, boiler and pressure vessels, and railways. Based on the Financial Terms (Article 8) in the Administrative Agreement between the Province and TSBC,

- TSBC should ensure it has adequate financial and other resources to carry out its obligations
- Maintain a fee-setting process following the requirements of the Safety Authority Act.
- Maintain a fee schedule developed according to principles in the Safety Authority Act that strives to:

- Minimize cross-industry subsidization
- Reduce service line subsidization
- Reflects risk, and
- Encourage safe behaviours.

- To the extent that cross-industry subsidization occurs, TSBC will report on that cross-industry subsidization as required by the Province from time to time.

TSBC combines the smaller technologies for financial reporting and indicates they are not self-supporting if reported individually. We noted that TSBC does not capture the financial information for elevating, amusement devices and passenger ropeway in a manner to be able to report on cross-subsidization and is not performing the necessary analyses to understand the extent of cross-subsidization across technologies. Hence, as required by the Agreement, TSBC does not have the information required to report to the Province on industry/technology cross-subsidization.

Recommendation:

2.3.1. TSBC should track the level of cross-subsidization across all technologies and provide this information to the Province as required in the Administrative Agreement. This will also ensure TSBC has the information required to make informed decisions in relation to cross-subsidization.

Detailed Report: Part II – Risk Assessment Program

This part of our review focused on gaining an understanding of the Risk Assessment Model (RAM) employed by TSBC. We reviewed documentation and conducted interviews to assess the governance and evaluation processes of the Structured Resource Allocation (SRA) project and its Machine Learning (ML) component. We also gathered information on the methods used by TSBC to address conflicts of interest and allegations of fraud.

An explanation of how the ML model works is available in *Appendix C*.

1. Assurance Statement

Overall, when reviewing the SRA governance, we noted that a governance risk and control assessment framework was not defined and readily available for our review. We employed two assessment frameworks developed by the audit team and shared with TSBC and the Ministry. The first framework focused on SRA Governance and the second on specific ML Controls. While areas of improvement were identified, nothing came to our attention that suggests material and significant governance, risk, or control gaps would lead to an inability to promote activities associated with regulated work-regulated products. However, before the SRA can be relied on as an impactful consideration and reliable for inspections, more rigour and formality in the SRA processes for governance, risk, and control should be implemented. The primary mitigating control we understand is that it is at the TSBC safety officer's discretion.

The relatively small proportion of inspections conducted by TSBC raises the question of whether enough information is collected to create an effective automated prioritization tool. Despite the small proportion of inspections conducted by TSBC each year, the cardinal numbers are still high. According to TSBC's documentation, 41,060 inspections were conducted for Gas and Electrical technologies in 2021. TSBC's machine learning model is built using historical data, meaning in some cases, more than a decade of data has informed the model. Based on research in the biomedical field using the same type of machine learning model as that currently employed by TSBC, we can expect the accuracy of their model to be very high, given the amount of data used to train it.

TSBC mitigates the risks associated with an ineffective automated process by relying on the knowledge of their safety officers. The SRA is a tiered system that makes less than half of all inspections mandatory, including work types classified as low-risk tolerance, random sampling for research, and high machine learning scores, while leaving most assessments to the discretion of the safety officer. The information gathered by inspections driven from all these sources is used to improve each successive version of the machine learning model.

2. Leading Risk Assessment Practices

The following leading risk assessment practices have been observed in TSBC's implementation of the SRA and safety risk assessment practices, *Appendix D*.

- **Anti-Fraud Controls and Policies** – TSBC's Standard Operating Procedure (SOP) for Reporting and Investigating Allegations of Misconduct states the procedures to follow when allegations of suspected fraudulent activity or misconduct are reported internally. It lists the responsibilities of executive leadership and states the involvement of the TSBC legal services department.
- **Anti-fraud Training** – The SOP states that all leaders are responsible for ensuring that members of their team have read and understood the Standards of Conduct policy and the requirement to report untoward activity or behaviour that contravenes the values and expectations of Technical Safety BC policies. This suggests the material is circulated among employees, and TSBC leadership is accountable for communication, monitoring, and enforcement. Please see the "Anti-fraud Training" section below for additional improvements.
- **Conflicts of Interest (COI)** – Internal stakeholders are informed of the policies and expectations surrounding conflict of interest and fraudulent activity. All TSBC employees sign the Standards of Conduct Policy at the beginning of their employment, and all employees must review the policy annually. The Standards of Conduct Policy covers conflict of interest and fraudulent activity, among other standards of conduct.
- **SRA Model Approval Process** – The SRA model is reviewed regularly and has a consistent approval process that has been demonstrated. The Action Item Summary for the Strategic Advisory Committee of the Board of Directors notes the SRA is to be reviewed annually. The presentation to operations leadership demonstrates quantitative analysis done in the review. TSBC provided an example of the approval process, including assessments and validation, for the ML model, although we have noted that more rigorous backtesting and a well-defined assessment framework should be defined, employed, and reported on.
- **Legal Consultation** – A legal representative is part of the SRA working group that provides recommendations to the SAC.
- **ML Model input data protection** – The policy documentation and responses provided by TSBC indicate mature standards for ensuring the protection of data from unauthorized manipulation by third parties. The Information Security Leader is responsible for annual information security assessments, including performing comprehensive information security risk assessments and penetration testing. Other documentation provided describes additional safeguards in place to protect data ingested into the system from public, or semi-public sources, like the contractor portal.
- **ML model approval and validation** – TSBC has processes in place to validate and approve model deployment. Requirements for a model are documented in a standard format and approved by the VP, Operations and VP, Data Analytics and Decision Science, before development. Before deploying the ML model to production, an online test is run with documented criteria and timelines for measuring the success of the model.
- **Standardized inspection criteria –** To minimize bias introduced in inspections, safety officers used standardized hazard maps to help address consistent safety score among different safety officers.

3. Assessment Criteria

As noted above, when we started our audit of Part II, the SRA assessment, we asked both the Province and TSBC if they employed a governance risk and control (GRC) framework to confirm the completeness and accuracy of the SRA and confirm how the objectives for the SRA are met. In both cases, a comprehensive GRC framework did not exist, and we, therefore, developed one for the purposes of this report. The GRC framework allows for a structured, repeatable, and defensible review of the SRA model and any dependent organization, process or technology that supports this model. Accordingly, to address the completeness and accuracy of the criteria used for our audit of the SRA, we developed and employed the following framework:

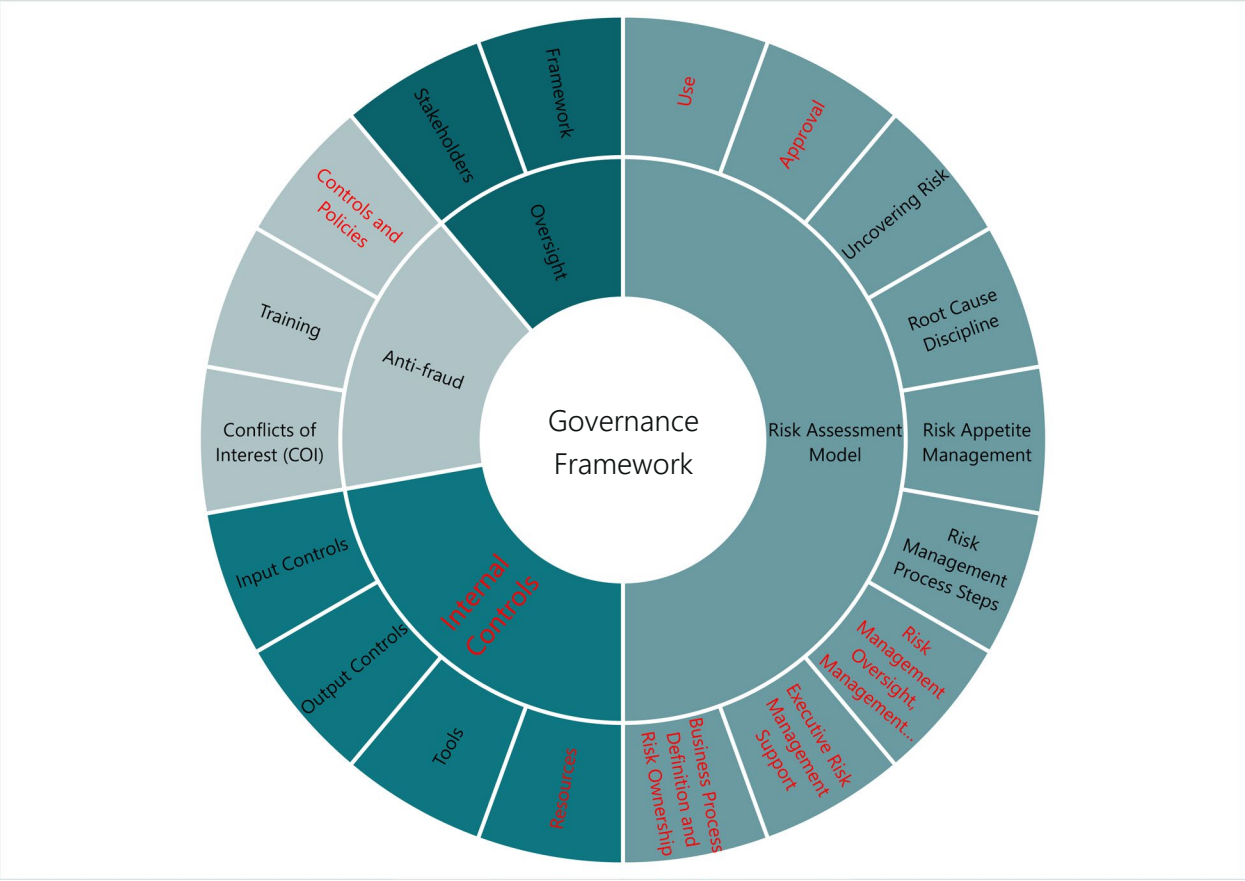


Figure 8

Please note that the items in the red text were chosen to focus our review based on risk.

Similarly, we developed a more technical AI framework. We focussed our review on the following risks noted in red text in Figure 9.

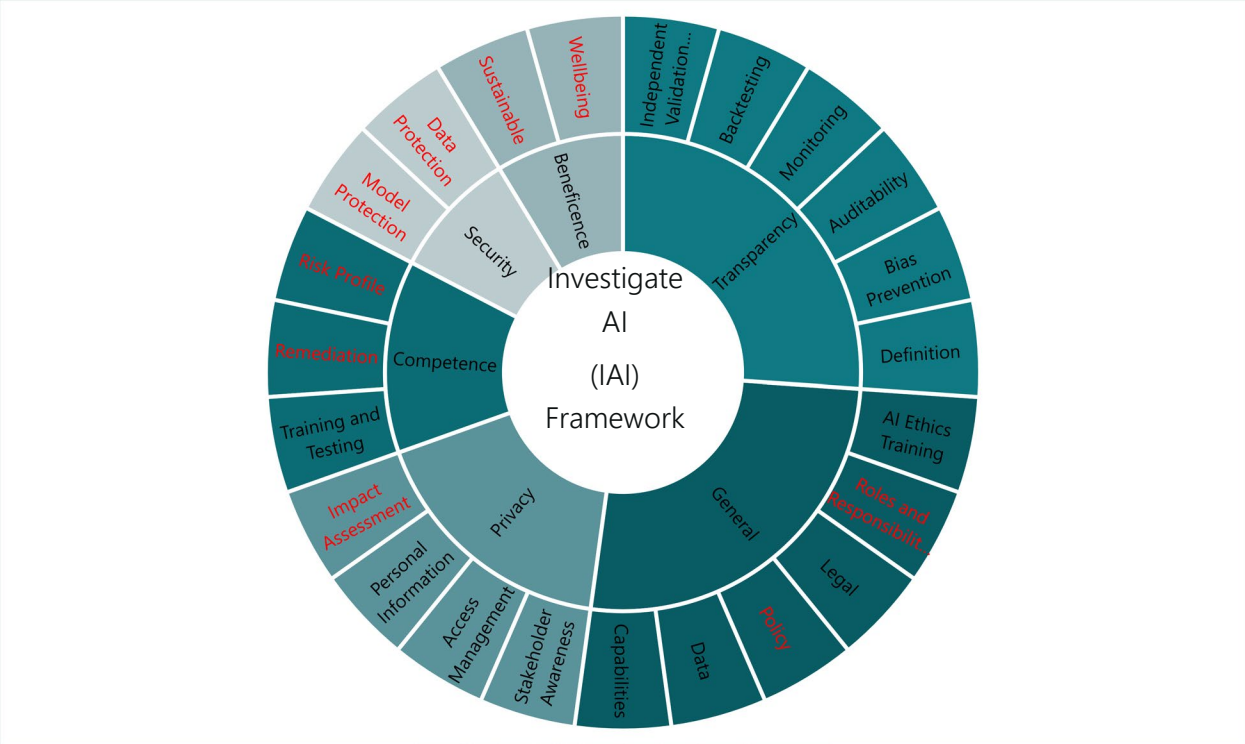


Figure 9

Part II focused on the following key questions:

A. Can we establish that the SRA program is more effective and efficient at reducing system-wide safety risk?

B. Is the policy framework for the SRA well documented, communicated, monitored and enforced?

C. What are key technical discussions and details that would help formalize the SRA?

These three fundamental questions are addressed in the sections that follow, and our findings and recommendations are grouped accordingly in a logical structure

A. Can we establish that the SRA program is more effective and efficient at reducing system-wide safety risk?

There are three primary methods by which TSBC selects the inspections they perform: 1) Inspect all possible sites based on submitted permits, 2) Select a sample of sites based on the professional experience and judgement of TSBC safety officers and 3) Use a model based on Artificial Intelligence and Machine

Learning where a system selects the sites based on an algorithm. The SRA uses a combination of options 2 and 3 to select a sample of inspections. TSBC believes this results in higher inspection performance with more efficient use of resources.
As stated previously in the "Value Assessment" section, we understand that the SRA implies efficient use of the available resources because TSBC believes that the SRA provides a better selection of which inspections to perform on a sample basis. We faced challenges in obtaining documentation, artifacts, and analysis. We requested the following in determining the degree to which the SRA selection may be relied upon:

SRA Validation Framework – The SRA model's integrity, effectiveness and efficiency should be measurable and tracked using a well-structured formal Governance and Artificial Intelligence Analytical framework. While we requested such a framework be provided to us by TSBC so that we could use it to confirm the SRA performs as expected, we were informed such a framework was not available for our review. MNP developed a candidate framework which was then shared with TSBC prior to it being used to assess the SRA, and both the Ministry and TSBC approved this framework without modification.

Related findings and observations are as follows:

- The SRA program is reviewed regularly and has a consistent approval process. The review does not employ an assessment framework. The Deetken Management Review Report ("the Review") from October 2019 was provided as an example. A framework was not included as part of the Deetken Management Review, and the report alerted TSBC to non-conformance of mandatory inspection criteria ranging from 20 to 30%.
- Definitions, key terminology, and the parameters that define responsibilities, accountabilities and specific policy requirements remain unclear. As an example, there is no clear definition for what "Mandatory" inspections are or guidance on when it is acceptable to waive mandatory inspections. While we understand operations leadership performs spot checks particularly related to occupational health and safety, as well as other concerns, not all mandatory inspections that have been waived have been reviewed and actions taken. Well understood exceptions to the mandatory inspections, such as lack of physical ability to access, have not been well documented.
- Much of the analysis performed by TSBC and related processes are not documented. It is not possible to validate management decision processes, including how Risk Assessment Program (RAP) risk scores are determined, risk tolerance thresholds are established, Hazard Eliminations are categorized, and Policy Decision Rules are formed.
- With respect to independent validation and verification of the ML models, these engagements are done on an ad-hoc basis. There are no set standards that call for when or if an independent review should happen and the assessment framework employed, making it difficult to track progress and compare and share results with primary stakeholders.

Recommendation:

TSBC should establish or adopt a formal effectiveness and efficiency framework that can help confirm the accuracy, completeness, cohesiveness, consistency, and coherence of the SRA predictive models, algorithms and AI/ML components that can be backtested and independently and objectively verified.

Backtesting SRA with Real Word Data – One of the essential controls when managing any model is establishing the "real-world" application and evidence that the model's predictions can be confirmed to be relevant and predictive of actual real-world events. In the pharmaceutical industry, "*Real-world data (RWD) are data relating to patient health status and/or the delivery of health care routinely collected from a variety of sources,*" and *"Real-world evidence (RWE) is the clinical evidence about the usage and potential benefits, or risks of a medical product derived from analysis of RWD*." There are also similar requirements in financial services where financial models are required to be "backtested" where "*backtesting is the general method for seeing how well that strategy or model would have done ex-post…*". Backtesting models are important since it helps establish the credibility, validity, sensitivity and applicability of the model to real-world situations.

We expected a formal backtesting strategy that considers the following:

a. Testing population completeness accuracy and whether the population needs to be stratified for relevant and common elements (populations are ultimately valid such as the full population of permits for a given technology).
b. Testing both false positive and false negative (confirming that the AI/ML model identifies investigations that should have been performed and that the AI/ML model doesn't omit situations where the investigation should have been done).
c. Confirming boundary conditions, tolerances and acceptable errors are identified, well understood, and fully disclosed to stakeholders.
d. The backtesting strategy is documented, communicated, and shared with key stakeholders so that there is open discussion, scrutiny, and validation.
e. The backtesting strategy is independently validated and confirmed for applicability, accuracy, completion and shared among stakeholders.

We requested TSBC provide us with examples of how they backtested the performance of the SRA, demonstrating that the SRA performs as expected to real-world outcomes and helps to select samples more effectively. We were not provided with a formal backtesting plan, generalized strategy or the results of an analysis that validates the real-world congruence of the AI/ML model to inspection outcomes on a periodic basis (quarterly or annual). During interviews with senior resources within the organization that are familiar with the rigour of financial modelling, it was agreed that this formality and rigour would be required for stakeholders to rely on the SRA.

Other related findings and observations are as follows:

- While backtesting is conducted on hazards detected during inspections and incident data is used to form policy decisions, incident data is not mapped to related permit data to investigate opportunities for improvement of the ML model.
- As mentioned, the recent Deetken Management Review Report also did not perform any backtesting of the SRA with real-world evidence.
- In addition, there is concern from local governments and contractor associations that the SRA ML Model uses insufficient data to accurately predict risk levels. This partly stems from the relatively small percentage of inspections conducted by TSBC, along with concerns that the SRA does not account for considerations like engineering drawings, risk of lack of training, and risk of mistakes.

MNP found that because safety officer discretion is the largest inspection driver of the SRA, these may be accounted for; however, safety officer discretion is based on personal knowledge, not aggregated data, and may be driven by inconsistent decision factors.

- MNP was not provided with formal documentation tracing the lineage of data used in the SRA to its source tables and columns. Similarly, MNP was not provided with a mapping of the inputs to those same source tables and columns.
- We were not provided with set standards, policies, or codified procedures that members of the Data Analytics and Decision Science or Operations team would follow to perform model drift testing. It should be noted that this testing occurs; however, there is a lack of documentation on how and when this testing occurs and who conducts it.

We cannot currently establish the use of the SRA in selecting inspection to perform results is a more efficient and effective use of resources (versus, for example, using the safety officer's professional judgement) as we were not able to ascertain if the SRA better analyzes and focuses on risk indicators denoting the need for less inspections.

Recommendations:

1) TSBC establish a formal backtest strategy that confirms SRA effectiveness and how the SRA improves expected efficiency when selecting inspections to be performed (or at least matches the efficiency to safety officers who use their experience and professional judgement) on a periodic basis such as annually or quarterly based on the degree to which there is reliance that the AI/ML and SRA.

2) Additionally, we would recommend that TBSC formally map the data lineage from its original and precise source to its point of use as part of the SRA in its entirety so it can be shared with primary and secondary stakeholders.

B. Is the policy framework for the SRA well documented, communicated, monitored and enforced?

A governance, risk and compliance framework including an assessment framework for the AI/ML models is a key control and we have already stated that this control has yet to be formalized and implemented. Similarly, we have addressed "backtesting" as another key control yet to be formalized and consistently assessed on a periodic basis. Generally, a governance, risk, and control framework are established through a "Policy Suite". By Policy Suite we mean a well-structured set of documents that establish acceptable behavior, standards/procedures to be followed and the specific mechanisms to communicate and enforce the policy with well-defined terms and definitions and guidelines to help operational staff comply. Finally, establishing clear responsibilities and accountabilities is important and should be readily available and communicated to key internal and external stakeholders. A matrix establishing a Responsibility, Accountably, Consulted, and Informed (RACI) stakeholder list is a key tool to confirm there are no gaps in how people govern, control, and manage risk.

In terms of the policy framework and related communication mechanisms and controls the following are key issues to be addressed:

1. Primary SRA stakeholders are not fully identified and engaged – A complete and updated SRA stakeholder analysis of consumers of SRA outputs was not readily available. The SRA Policy, last approved on December 2, 2020, covers primary and secondary consumers in the Responsibilities section while also addressing internal TSBC stakeholders such as Managers, IT, leadership roles, and safety officers. While the SRA Policy refers to using the "the best tool to predict higher hazard levels", it does not explicitly discuss the ML component of the SRA, nor why one would be lead to believe ML is the best tool. The SRA SOP does list the Roles and Responsibilities associated with the ML component of the SRA, however responsibilities, such as validating and approving the model, and validating the integrity of the input data, are not explicitly discussed.

2. SRA Control documentation was lacking – Generally, there was a lack of, or issues with, the documentation available for the SRA. We were not able to obtain a complete list of policy decision rules. A complete breakdown of roles and responsibilities for the development and deployment of the ML model was not available. There was also a lack of standards and process documentation with respect to ML model training, data validation, and independent verification and validation of both the ML and SRA models. Several examples of documentation gaps include the following:
    - In the risk management framework, section 2 categorizes the Safety System. There is no specific section to address the ML components, or a list of risks related to the SRA process, data used in SRA or use of the resulting reports.
    - As input controls, while a general data quality policy exists, the policy-specific application to the SRA process and specific accountabilities for each of the following data quality processes were not readily available for review: 1) SRA data collection - correction, validation, and reconciliation at source; 2) SRA processing - calculations, transformations, and translations in SRA subsystems; 3) Outcomes and output validation.

- Section 6 of the Risk Management Framework has a subsection titled "Accountability" that maps roles to responsibilities but does not specify the roles for SRA Governance or Implementation. A separate SRA Policy exists, which provides much of the SRA Governance and oversight Roles and Responsibilities but does not include those responsible for implementing the Machine Learning facet (i.e., the Research Analytics Team), which are outlined in the SRA SOP. The Risk Management Framework does not reference the SRA Policy or SRA SOP.
- TSBC has provided a documented outline of planned improvements to the Data Governance Policy and AI Governance. As a point-in-time assessment, the following were informal or are currently not specifically detailed for SRA data quality: Model validation; Model Independent verification and validation process using third parties (frequency, selection, independence, and objectivity such as a SOC report); Oversight and approval of model changes; Tolerance within which data quality impacts model validity.
- Documentation indicates that experimentation is required as part of model development. There was no identified framework that outlines the ML training process and guidance on leading practices. Management indicated that it uses various methods to train ML models but lacks the codified versions of the process and procedures they would use to train a new model. Training is included as part of the outlined items planned to be improved in the AI Governance documentation.
- Since the SRA model includes and relies on safety officer discretion to determine whether inspections are to be conducted, there may be a few instances where the model may not be used; however, we were not provided with documented guidance on the acceptable use of the SRA, and how to determine whether the model could not be used. In the context of the SRA model, this means that mandatory inspections may not be waived where it would be appropriate to do so, impacting safety officer efficiency and effectiveness.

3. Responsible, Accountable, Consulted, Informed (RACI) not defined – Responsible, Accountable, Consulted, Informed (RACI) Matrix including accountabilities, stakeholder engagement (a complete list of who needs to be informed and consulted) was not available when requested by our team. Key responsibilities, accountabilities, and engagement (consultation and information provision) for the following were not readily evident:
   - The Enterprise Risk Management (ERM) framework provides responsibilities under the accountability section.
   - ERM provides a description of the RAP under “all employees” but does not provide SRA or RAP specific coverage for assignment, or prioritization responsibilities.
   - Appendix E of the ERM grants that the Director, Internal Audit will provide consulting advice on the design of internal controls. Appendix D of the ERM refers to consultations with respect to risk level. No other consultation provisions are made with respect to the SRA, including those related to assignment, prioritization, or conduction of inspections.
   - Schedule A of the Data Governance Policy provides accountability for key data sets but does not clearly provide accountability for the storage of transformed data used by the ML model.
   - The Data Governance Policy does not provide for who must be consulted with respect to the use or modification of data in the SRA.
   - It is unclear from existing documentation what the reporting requirements for the SRA are and where accountability lies for them.

Overall, we did not see a full and complete list of internal and external stakeholders of the SRA model, a complete policy suite or a RACI matrix establishing who needs to be involved in what manner. We were not able to confirm that data capacity and the resources to manage/store and use the data are in place to support the continual optimization of the AI/ML and the growth of the model, and how it impacts the selection of inspections based on permit population. These are key elements and essential to helping formalize the SRA as a basis to drive efficiencies and effectiveness of the Safety System.

Recommendation:

1) TSBC develop a complete list of internal and external stakeholders of the SRA. This can help establish who should be included when developing policy, process, and practice documentation and who can help improve the SRA predictive models, algorithms, and AI/ML components.

2) TSBC formalize the risk, control, and governance documentation to guide, manage, measure and track performance of the SRA including a RACI matrix to establish clear responsibilities and accountabilities.

3) TSBC to document standards related to model validation, IVV processes, oversight with approvals of model changes and measuring/managing tolerance within which data quality impacts model validity.

C. What are key technical discussion and details that would help formalize the SRA?

Further to our analysis above, there were technical issues that were identified during our audit of the SRA AI/ML program. Addressing technical issues early in the development of a model such as those employed as part of the SRA can help improve the overall performance. During our audit we noted the following:

1. Some assessments result in high ML scores qualifying them as "mandatory inspections", but the safety officer can override these decisions. The documentation provided states that the impact is whether a safety officer goes to a site to conduct an assessment or not, and that the duration of the impact is short. While where a safety officer goes to a site or not is a direct impact, we would expect to see further analysis identifying and measuring the results of those impacts. i.e., what is the impact if a safety officer goes to a site with no hazards or low-hazards, what is the impact if a safety officer does not go to a site with high-hazards, etc. Along with an understanding of how these impacts look aggregated across the landscape of work assessed by the ML Model. There is no clear evidence that inspections are reviewed before being used to further train the model.
2. There is a potential for safety officer discretion to introduce a selection bias into the ML model. Also from the walkthrough, we know the source data for training the ML model is inspection data. From the documentation provided, we know that safety officer discretion is the largest driver of inspections at over 50%. Because safety officer discretion constitutes the largest inspection driver, the decision to inspect or waive assessments has a considerable impact on the decision factors made by the model.
3. Standardization is missing around testing for potential areas of bias during the development and deployment stages of the model.
4. The auditability of the ML model, including but not limited to the ability to easily reproduce results, is considered by management. However, there is a need to increase documentation regarding standards relating to data validation, and other data transformations. Notably, this is included in the outline provided for updates to Data Governance and Artificial Intelligence (AI) governance that is currently being drafted and not reviewed by us.

Recommendation:
TSBC to implement standardized, automated testing to reduce potential bias areas at the development/deployment stages for ML development.

Hazard Trends And Safety Indicators

The Ministry engaged us to assess how the change in the rate of hazards detected indicates the effectiveness of the RAM. The number of hazards detected is not a true measure of the effectiveness of the RAM because, without ground truth knowledge of the total number of hazards, it may simply be an indication of an external factor.

In machine learning, test sets contain both real positive and real negative. These results are used to determine the effectiveness of a model by measuring the precision, which is true positives divided by the

total positives the model predicted, and the recall, which is the true positives divided by the total number of positive results in the test set. The precision and recall are then combined into an f1-score to measure the model's effectiveness concisely.

Hazard trends can measure true and false positives, effectively determining the precision for certain aspects of the RAM that are more associated with hazard prediction, such as the machine learning function and safety officer discretion. Because there is no knowledge of the actual number of hazards that exist in the population, the recall cannot be determined.

Hazard trends are a less effective measure of performance for aspects of the RAM that are more directed at fact-finding, low-tolerance areas, or legislated inspections. These areas are inspected regardless of what a risk assessment predicts; therefore, they are more likely to have fewer hazards. For this reason, overall hazard trends should not be considered an indicator of the effectiveness for all parts the SRA.

Previous IT Reviews

The Ministry engaged us to review any Information Technology (IT), or Operational Technology (OT) assessments performed in the past 24 months. TSBC has provided no evidence that any interviews have been conducted since the Deetken Management Review from October 2019.

The Review examined TSBC's data science practices and the effectiveness of their machine learning models.

The Review found that TSBC has strong fundamentals, processes, tools, and techniques in analytics and well-defined measures and targets for the decision-making process. The Review also found they rely on ad-hoc processes to detect anomalous inputs and behaviour. There were inconsistent documentation and coding standards, with a reliance on individuals for deployment governance, and data science platform assets were inconsistently curated and upgraded.

The Review also found that the SRA Model performance outperformed targets in high hazard predictions and in safety officer confidence. They found no measurable bias, though note a stronger conclusion could have been reached with a longer measurement period.

Table 4: Recommendations from "Ref#33 - Deetken SRA_Recommendations Update.pptx"

Recommendations	Noted status	MNP Notes
Risk – Investigate options for improving Compliance & Enforcement data consistency or implementing more sophisticated matching	Planning	TSBC is preparing updates to the Data Governance and AI Governance; however, compliance and enforcement of data matching within the data sets are not outlined in the table of contents provided[14]
Risk – Implement anomaly detection	On-going	No documentation provided

[14] Ref#F1 - List of Items for AI Governance.docx

algorithms for source and output data to detect trends and flag deviations		
Risk – Design and implement a random sampling plan to mitigate bias reinforcement and improve model performance measurement	On-going	This refers to random sampling plans collected to: 1. better measure Model Recall; and 2. supplement the training data set with physical inspections that are not biased by the ML model. No documentation provided
Risk – Develop an implementation plan to migrate from Python 2 to Python 3 (goal is Jan 1, 2020)	Completed	
Explore modifications to Gas ML Model to a) improve performance and b) increase understanding of model behaviours	On-going	The documentation provided shows improvements in Gas ML hit-rate performance since 2019. Implementation of Shapley Additive Explanation shows attempts to increase understanding of model behaviours.
Implement additional metrics for Accuracy, Bias, Reliability and Transparency	On-going	As discussed in the Deetken Management Review, hit rate and f1 scores are presently the only metrics monitored.
Establish standards, processes, and roles & responsibilities for Coding & Documentation practices	Completed	TSBC has an SRA SOP that outlines roles and responsibilities, however, as discussed in the stakeholder's section below, lacks definition of responsibilities important to governance.
Replicate Model Performance analysis & review on SRA Electrical ML Model	Completed	
Increase visibility/accessibility of model performance and especially trends	Completed	
Evaluate options to mitigate risks of data science infrastructure being single machine, single site	Completed	

Acknowledgement

We wish to thank the Ministry for the opportunity to assist in completing this audit. We want to express our appreciation for the cooperation and efforts made by TSBC's management and staff throughout the audit process.

Appendix

List of Appendices

Appendix A - Performance

a. TSBC's Performance Measured as Defined in the Administrative Agreement with the Province

Table 5

SCHEDULE "B"

Performance Objectives and Targets

Safety Outcome (article 3.01 of the Agreement)	Performance Objectives	Targets
(a) to achieve operational excellence in the administration of the Act	Technical Safety BC is a non-profit organization; however they must maintain an operating reserve to protect the organisation from an economic downturn. Technical Safety BC should ensure they have sufficient liquid assets to cover short-term demands for cash.	To maintain an adjusted working capital >=1 (current assets are equal to or exceed current liabilities excluding deferred revenue liability)
(b) to promote activities which will enhance public safety and reduce the risk of the hazards associated with regulated work and regulated products	Risk management: o Technical Safety BC will arrange for an independent review of its risk control processes for each technology in relation to Technical Safety BC's performance during each three-year period under this Agreement. The cost of the review will be borne by Technical Safety BC. o Confirmation Document: Review report. Information Analysis: o Analysis of incident and injury trends in all sectors regulated by Technical Safety BC. o Provide explanations for trends, particularly significant deviations, and explain the measures implemented by Technical Safety BC to manage the trends. o Work towards comparing trends in BC to other jurisdictions where possible. o Confirmation Document: State of Safety Report Incident investigation: o Responding to information gathered from investigations, including understanding causes and taking necessary action to resolve systemic problems (e.g., directives, public safety alerts, safety initiatives, etc.). o Confirmation Document: State of Safety Report.	Risk management: o The review report demonstrates that Technical Safety BC has an effective process in place in each technology for the identification of major risks and the development of appropriate risk control plans with respect to those risks. Information analysis: o Information is gathered, sorted into trends and published. o Findings are used to direct Technical Safety BC resources in their accident prevention activities. Investigation response: o Demonstrate that Technical Safety BC is taking action to resolve issues that are discovered during investigations.
(c) to be responsive to the education and communication needs of people in British Columbia including the general public who use the equipment which Technical Safety BC regulates, the clients who pay for Technical Safety BC services (both	Responsiveness to customer needs: o To engage in education and communication initiatives that focus on risks, as defined by Technical Safety BC, within the technologies regulated by Technical Safety BC. o Confirmation Document: Annual Report, State of Safety Report or a separate report.	Responsiveness to customer needs: o Demonstrate that Technical Safety BC is engaged in educational and communication activities based on risk.
technical and non-technical) and stakeholders who have a role to play in the safety system		
(d) to promote and encourage harmonization of technical safety standards and establish a leadership role for British Columbia in	Technical Safety BC should take a leadership role in inter-provincial and national safety committees o Confirmation Document: State of Safety Report or a separate report	o Demonstrated participation and leadership on national committees and inter-provincial working groups.

b. TSSA's Key Performance Indicators (KPI)

TSSA's KPI's and targets for each fiscal year (FY) have been approved by the Minister of Government and Consumer Services.

Table 6

Objective	Performance Measure	FY 2021 Target	FY 2021 Actual	FY 2022 Target	FY 2022 Actual
Active Regulatory Compliance	Percent High Risk inventory	0.5% decrease based on a 5-year rolling average (2.68%)	20 >	1.0% decrease based on a 5-year rolling average (2.67%)	
Reduced Health Impacts	Number of Permanent Injuries and Fatalities combined per million people	5% decrease over five years based on 5-year rolling average (4.31 by FY25)	3.44	5% decrease over five years based on 5-year rolling average (4.31 by FY25)	
Efficiency of Safety Service Delivery	Cost per Regulated Entity	Per cent increase no more than rate of inflation ($399)	$337	% increase no more than rate of inflation ($404.98)	
Customer Service	Number of External Processes and Services Digitized	One new process digitized in fiscal year 2021	1 new service (BPV portal for owners)	One new process digitized in fiscal year 2022	
	Customer Service Standard Attainment	Defined standards attained to 95%	0.67	0.95	
Safety Services	Auditor General Recommended Actions Fully Implemented	0.67	0.67	0.71	
	Implementation of Safety Risk Officer (SRO) Recommendations	Percent of SRO accepted recommendations planned for implementation 100%	100% 1 Recommendation completed as planned	Percent of SRO accepted recommendations planned for implementation 100%	

c - TSSA's Roles and Responsibilities (As per Schedule M)

Table 7

Description	Responsibility	
	Ministry	Corporation
Establishing and amending performance measures	The ministry may direct the Corporation to develop or amend performance measures from time to time but shall not do so more frequently than on an annual basis. Such development or changes to the performance measures is subject to the approval of the Minister.	The Corporation shall supply the ministry with proposed newly established or amended performance measures for the Ministers approval as requested. The Corporation shall provide the ministry with calculations used to establish or amend performance measures. No development or amendments to the performance measures will be implemented until it has been reviewed and approved by the Minister.
Target Setting	The ministry may direct the Corporation from time to time to develop targets to be used to assess the relevant performance measures from the Corporation.	The Corporation shall supply the ministry with targets as it relates to the applicable performance measures for the Ministers approval as requested. Each fiscal year, the Corporation shall set targets that drive strong performance for each of the Corporation's performance measures. The Corporation shall provide the ministry with its proposed annual targets. along with rationale. no more than 60 days

Description	Responsibility	
	Ministry	Corporation
		following the commencement of the Corporation's fiscal year. For all other requests made to the Corporation relating to establishing targets, the Corporation shall provide the ministry with its proposed targets, along with a rationale, no more than 60 days after receiving the request.
Assessing the Corporation's performance against performance measure targets	The ministry will request the Corporation to undertake an assessment of performance measures against applicable targets and to provide the ministry a report of this assessment on a quarterly basis. in accordance with the Corporation's fiscal calendar.	The Corporation shall supply the ministry with an assessment of performance measures against applicable targets on a quarterly basis in accordance with the Corporation's fiscal calendar. This information shall be provided: • no more than 45 days following the end of each quarter per the Corporation's fiscal calendar. • no more than 90 days following the end of the Corporation's fiscal year.
Assessment Follow-up and Corrective Actions	Upon reviewing the Corporation's quarterly performance measure assessment and in situations where it's determined that the Corporation may not meet its annual performance measure targets, the ministry may request additional information from the Corporation, including to determine the cause and develop a plan so that the Corporation is better able to achieve its annual performance measure targets.	The Corporation shall supply the ministry with an analysis and action plan to address situations where the Ministry has determined that the Corporation may not meet its annual performance measure targets. This information shall be provided within 60 days of the Corporation receiving the request.

Appendix B - Fee Structure and Governance Jurisdictional Search

Governance

Table 12

Description	TSSA (Ontario)	TSASK (Saskatchewan)
Accountability	TSSA is accountable to its Board of Directors and the Ministry of Government and Consumer Services to demonstrate that it is most effectively and efficiently using its resources. Costs per regulated entity have been declining year over year.	"TSASK operates at arms-length from the provincial government, under the terms of a Safety Standards Act.
Executive Leadership	• CEO, • Vice President, • CFO, • Vice President of Comms, • VP HR, • VP Ops, and • CIO, plus 6 Statutory appointed Directors	• CEO, • Chief Inspector, • Director & Chief Electrical Inspector, • Chief Gas & Plumbing Inspector, and • VP Corporate Services

Fee Structure

MNP gathered fee-setting approaches across jurisdictions and assessed that against TSBCs for benchmarking purposes. The peers included in the search are:

1. Technical Standards & Safety Authority Ontario (TSSA)
2. Technical Safety Authority of Saskatchewan (TSASK)

Table 13

Jurisdiction	Population
Ontario	14,789,778[15]
Saskatchewan	1,180,314[16]

Also included in the permit fee scan are the following local governments:

1. The City of Burnaby
2. The City of Kelowna
3. The City of North Vancouver
4. The City of Richmond
5. The City of Surrey
6. The City of Vancouver
7. The City of Victoria
8. The District of North Vancouver
9. The District of West Vancouver
10. The City of Maple Ridge

[15] Ontario Demographic Quarterly: Highlights of first quarter

[16] https://dashboard.saskatchewan.ca/people-community/people/population

Safety Authority Fee Setting Approach

Table 14

Description	TSSA (Ontario)	TSASK (Saskatchewan)
Fee Structure	A fixed annual fee for licenses, permits and registrations is charged, including all periodic inspections, follow-up inspections, and engineering reviews. Customers who require multiple follow-ups needed due to non-compliance will be billed. This structure rewards compliance by minimizing fees. A flat fee structure is intended to eliminate concerns about billing surprises, help businesses budget with certainty and price requested services more accurately.	TSASK's registration, inspection, certification and licensing programs and services operate fee-for-service. These fees are charged to the sectors that design, manufacture, install, operate, and own potentially hazardous equipment in the industries TSASK regulates. TSSA's fees are based on cost-recovery, adjusted to reflect the service's value.
Fee increase	Inflationary fee increase for Boilers and fuels of 2.6% effective May 1, 2022. https://www.tssa.org/en/Fees.aspx	July 1, 2021, fee change/restructuring for gas & electrical licensing
Sustainability Approach	Cost recovery basis: • Recover all direct and indirect service delivery costs associated with the delegated authority mandate • Generate a net revenue margin of up to 5% • Reflect three-year cost trends • Reasonably reflect sector and service activity, such as engineering and inspection, within each program • Reflects safety infrastructure costs such as standards and codes work, investigations, prosecutions, regulatory	The core base of stable and dependable revenues is generated from licensing. TSASK looks to balance fees to be cost-effective for the industry while ensuring they can recover expenses and generate sufficient earnings to fund future needs.

Description	TSSA (Ontario)	TSASK (Saskatchewan)
	enhancements, and re-investments in public safety	
Full-Time Employee	Approximately 400[17]	64.9[18] in 2020 jumped to 158.6[19] in 2021 (incl plumbing)
Cross-subsidization	Eliminate cross-subsidization between safety programs	N/A

Fee Comparison

MNP collated the fee charged across local governments for gas and electricity permits. Where fees are comparable, the Fee Comparison table shows the comparison. Key highlights notes include:

1. Two cities in BC use TSBC's fee structure for electrical permits and have been excluded from the comparison table. They are:
    a. The City of Kelowna, and
    b. The City of Richmond
2. Three cities in BC also use TSBC's fee structure for gas permits and have been excluded from the comparison table. They are:
    a. The City of Surrey,
    b. The City of Victoria, and
    c. The District of West Vancouver
3. For the other cities, fees are based on the building permit cost, equipment cost or electrical installation value.

[17] https://www.tssa.org/en/about-tssa/career-opportunities.aspx

[18] https://www.tsask.ca/public/images/TSASK_Annual_Report_2020.pdf

[19] https://www.tsask.ca/public/images/TSASK_Annual_Report_2021.pdf

Fee Comparison Table

Table 15

Description	TSBC	City of Burnaby	City of North Vancouver	City of Vancouver	District of North Vancouver	Maple Ridge
GAS INSTALLATION PERMITS						
Installation or replacement of 1 or 2 appliances, including vent and gas piping	$138	$61.75	$100	$229	$81.70	$100
Installation or replacement of each additional appliance, including vent and gas piping	$67	$33.70	$27.85	$72.50	$34.40	
installation or alteration of venting without appliances	$67	$61.75	-	-	-	-
Installation or alteration of gas piping without appliances	$55	$58.15	-	-	-	-
Connection of gas piping to a new or used certified mobile building with existing appliances	$104	-	-	-	-	-
Other ways cities charge their gas fees						
Vents, furnace plenums and piping only	-	-	-	-	-	$87.50
Complete house piping - single family & Duplex	-	-	-	-	-	$87.50
Other than single-family dwellings - the first 30 meters	-	-	-	-	-	$70
Re-inspection fee	-	-	-	-	-	$175+Tax
ELECTRICAL INSTALLATION PERMITS						
Installation of each residential service of less than or equal to 125A	$783	-	-	-	-	-
Installation of each residential service of 126A-200A	$1,138	-	-	-	-	-
Upgrade of each residential service up to and including 200A	$525	-	-	-	-	-

Description	TSBC	City of Burnaby	City of North Vancouver	City of Vancouver	District of North Vancouver	Maple Ridge
Other electrical work	-	-	-	-	-	-
Addition of one new circuit or modification of an existing circuit	$115	-	-	-	-	-
Alteration to the electrical installation, not including service work, for each existing residential service of less than or equal to 125A	$337	-	-	-	-	-
Alteration to the electrical installation, not including service work, for each existing residential service of 126-200A	$516	-	-	-	-	-
Permit Value Amendment						
Homeowner Expiry Amendment	$71	-	-	-	-	-
Permit Amendment Review	$249	-	-	-	-	-
Homeowner Temporary Construction Service	$177	-	-	-	-	-
Other Ways Cities charge their electrical fees.						
power permit for single and two-family dwellings	-	-	-	$467	-	-
When the cost of work does not exceed $250	-	-	-	$85.80	-	-
When the cost of work exceeds $250 but not $500	-	-	-	$115.70	-	-
Electrical system for a dwelling including service connection and Temporary Current Permit	-	18% of BPF[20]	-	-	-	-
Value of Electrical Installation (as approved by Electrical Inspector): $100 or less	-	$50.55	-	-	-	-
Value of Electrical Installation (as approved by Electrical Inspector): $100.01 - $250	-	$67.30	-	-	-	-
Value of Electrical Installation (as approved by Electrical Inspector): $250.01 - $350	-	$83.90	-	-	-	-

[20] Building Permit Fees

Description	TSBC	City of Burnaby	City of North Vancouver	City of Vancouver	District of North Vancouver	Maple Ridge
Value of $0 - $1000	-	-	$100.00	-	-	$150.00
Value of $1,001 - $2,000	-	-	$153.04	-	-	$173.00
Value of $2,001 - $3000	-	-	$206.08	-	-	$196.00
Value of installation up to a maximum of $500	-	-	-	-	$81.70	-
Value of installation exceeds $500 up to a maximum of $750	-	-	-	-	$115.70	-
Value of installation exceeds $750	-	-	-	-	$148.00	-

Appendix C - Machine Learning Explanation

MNP was tasked with describing the functionality of the Machine Learning Model that is part of the SRA.

This explanation is based on the Gas and Electrical deployment checklists provided ("Ref#75 - Gas Operating Model Deployment Checklist.pdf" and "Ref#75 - Electrical Operating Model Deployment Checklist.pdf"). Both documents are dated October 10, 2021. Both models are described as version 4.1.0.

The Gas Operating and Electrical Operating both use models built on an algorithm called XGBoost (eXtreme Gradient Boost). XGBoost is a set of rules and mathematical formulas for building decision trees for predicting values or classes. As pictured below, decision trees have "nodes", depicted as squares, which represent decision points based on the inputs to the model, commonly called "features". The "root" node is the one at the top. Each node will have "branches" that lead to the next decision point based on the result of the current one. A node with no branches is called a "leaf" and represents the result.

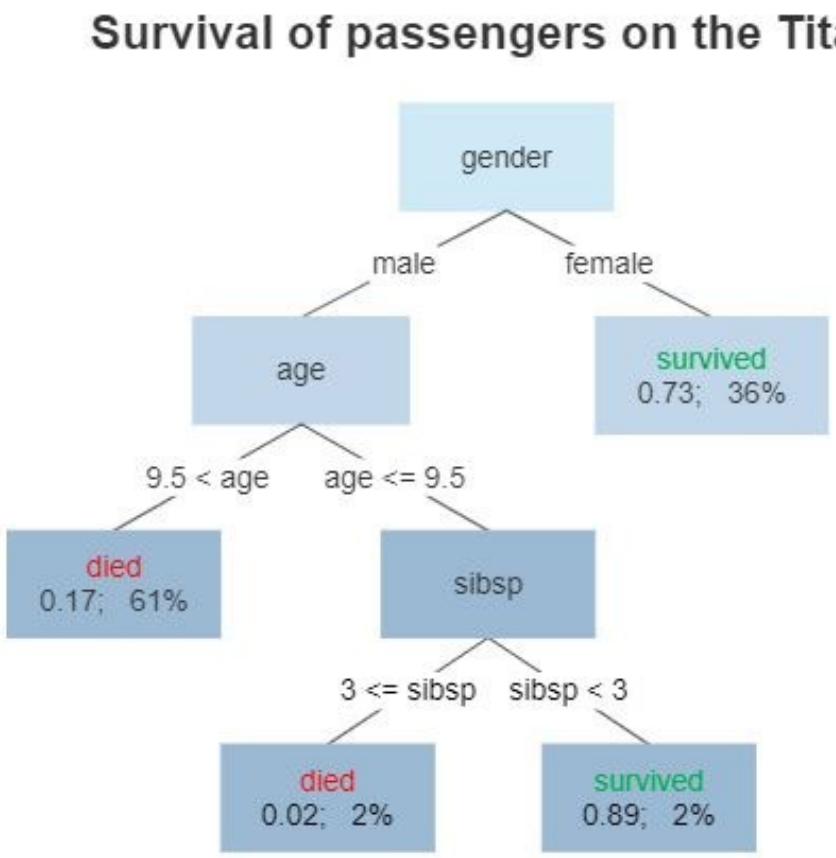


Figure 10 Example Decision Tree diagram (https://commons.wikimedia.org/wiki/File:Decision_Tree.jpg)

Decision trees can be used to predict a numerical value, or to categorize an item. TSBC uses their models to categorize, or "classify", permits as likely to have high hazard scores, or not likely to have high hazard scores.

The XGBoost method of machine learning creates a model by building and chaining together a series of small decision trees that do not repeat features along the different levels of the tree, such that the results of one tree feed into the next. Intuitively, the goal is to minimize the number of erroneous predictions, thus, each tree added will reduce the number of erroneous predictions. Because each tree starts from a different result, the features may be repeated among different the trees. Trees are added, until a maximum number, set by the developer is reached, or a threshold is reached where the number of erroneous predictions within a training data set is sufficiently small.

Once a model has been constructed by establishing the features and value thresholds it is comprised of, it is used to predict the high hazard rating. Every evening, permits are evaluated against the model by applying the values of the permits along the path that corresponds to the features of the decision trees. This path concludes with a predictive result. The confidence of the model, or likelihood that the prediction is correct, is used to determine whether and inspection for the permitted work should be mandatory. In February 2021, the confidence threshold that drives

mandatory inspections was set to 20%.[21]

TSBC uses 24 features in the Gas Operating model and 36 in the Electrical Operating model to make their predictions.

Table 16

Feature	Gas Operating Model	Electrical Operating Model
Age of permit	Yes	Yes
Number of non-compliances in the last 1-5 years, grouped by the owner	4 features	
Average hazard score in the last 2-5 years, grouped by permit	3 features	3 features
Time since last inspection, grouped by permit	Yes	Yes
Number of physical inspections in the last 1-5 years, grouped by the permit	4 features	4 features
Number of non-compliances in the last 1-5 years, grouped by permit	4 features	4 features
Permit class	Yes	Yes
Cylinder filling class	Yes	
Equipment class	Yes	
Propane bulk plant class	Yes	
Vehicle convenience shop class	Yes	
Vehicle filling class	Yes	
Occupancy type	Yes	Yes
Average hazard score in the last 2-5 years, grouped by Field Service Representative (FSR)		4 features
Number of physical inspections in the last 1-5 years, grouped by FSR		4 features

[21] *Structured Resource Allocation For Operations Leadership Meeting - July 13, 2021*, "Ref#47 - SRA_ppt_ops_Leaders 2021.pptx", slide 9

Number of non-compliances in the last 1-5 years, grouped by the FSR		4 features
Number of physical inspections in the last 1-5 years, grouped by the main contractor		4 features
Amps		Yes
Line to line volts		Yes
Loader 12-month demand		Noted as "???"
Phase		Yes
Volts		Yes

NOTE: A Field Service Representative (FSR) is defined by TSBC as a person who is certified to make declarations that the work described in an electrical installation or operating permit complies with the Safety Standards Act and Electrical Safety Regulation. An FSR can make these declarations on behalf of a contractor. (https://www.technicalsafetybc.ca/certification/electrical-fsr)

Based on the 2021 Q4 evaluation results the effectiveness of the Gas Operating Model is considerably less than the Electrical Operating model. We did not examine any documentation that described the model in sufficient depth to see the impact that the additional features have on the effectiveness. If it has not been explored as part of the Gas Operating Model, integrating the features like those grouped by the individuals who make declarations, as implemented in the Electrical Operating Model, may improve observed performance.

Appendix D - Key Policy Files (Part II)

Table 17

Data Governance Policy	Ref#46 - Data Governance Policy 20201130.pdf
Enterprise Risk Management Framework	Ref#44 - Enterprise Risk Management Framework.pdf
	Ref#66 - ERM-AppendixA-RiskCategories.pdf
	Ref#66 - ERM-AppendixB-GlossaryofKeyTerms.pdf
	Ref#66 - ERM-AppendixC-RiskManagementPolicy.pdf
	Ref#66 - ERM-AppendixD-BoardofDirectorsRiskOversight.pdf
	Ref#66 - ERM-AppendixE-Strategic Issues+Risk Mgmt Committee.pdf
	Ref#66 - ERM-AppendixF-RiskMatrix.pdf
	Ref#66 - ERM-AppendixG-EscalationandReportingRequirements.pdf
	Ref#66 - ERM-AppendixH-RiskAppetiteStatementandParameters.pdf
Enterprise Risk Register	Ref#87 - TSBC Enterprise Risk Register.pdf
Governance Manual	Document 8.a and 10.a_Governance Manual - TSBC May 2021.pdf
Hazard Elimination User Guides	Ref#F3 - HE User Guide - Energy.pdf
	Ref#F3 - HE User Guide - Transportation.pdf
Hazard Map Quality Standards Policy	F37 - As Found Hazards - Hazard Map Quality Standard POL-3080-00.pdf
Hazard Maps Update Project Charter	F37 - SSRM-HazardMapsUpdateProjectCharter-170622-1034-42.pdf
Incident Investigation Policy	Ref#51 - Incident Investigations Policy.pdf
Incident Investigation Process	Ref#51 - Incident Investigation Process.pdf
Information Security Policy	Ref#65 - Information+Security+Policy+(POL-3123).doc
Inspection Process	Ref#68 - Inspection Process SOP-2009-03.pdf
Privacy Policy	Ref#F8 - SOP-58359526-020622-1256-50.pdf

Public Interest Disclosure Policy	Ref#71 - Public Interest Disclosure Act POL-3141.pdf
Reporting and Investigation of Misconduct Process	Ref#71 - Reporting and Investigations of Misconduct SOP-2095.pdf
Remote Assessment Procedure	Ref#F4 - Remote Assessments.pdf
Risk Assessment Program Rules	Ref#F10 - BPV, EL, GA RAP Rules.xlsx
Risk Assessment Program Summaries	Ref#F10 - ED RAP Summary.pdf
	Ref#F10 - PR RAP Summary.pdf
Reporting Allegations of Misconduct Process	F42 - reporting+allegations+of+misconduct+(sop-2095).docx
Policy Decision Rules For Inspections	F30 - EL Policy Mandatory.pdf
SRA SOP	F22 - SRA SOP Document Control.pdf
SRA Policy	Ref#84 - SRA Policy (POL-3109).pdf
Standards of Conduct Policy	Ref#70 - Standards of Conduct POL -3004.pdf
Safety Hazard Maps	Ref#F10 - BP Hazard Map (POL-3081-04).pdf
	Ref#F10 - PR Hazard Map.pdf
	F37 - Electrical Hazard Map.pdf

Appendix E – Additional Financial Analysis

TSBC, TSSA and TSASK Comparative Information, where available.

Simple average salaries per employee (2020)

Table 18

	Salaries ($)	# of Employees	Salaries/Employees
BC	49,123,092	411	119,521
Ontario	51,057,000	400	127,643
Saskatchewan	6,820,921	65	104,937

From this analysis, TSBC is the mid-point between Saskatchewan and Ontario regarding the average employee salary.

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