



Technical Standards and Safety Authority

Annual State of Public Safety Report

2019 Edition



Technical Standards and Safety Authority (TSSA)

delivers public safety services
on behalf of the Government of Ontario in the following key sectors:

- 1) Boilers and Pressure Vessels and Operating Engineers;
- 2) Elevating Devices (Elevators, Escalators and Ski Lifts) and Amusement Devices;
- and 3) Fuels.

TSSA enforces the *Technical Standards and Safety Act, 2000* (the Act)
and its associated regulations.

Refer to www.tssa.org for further information on TSSA.

Refer to www.ontario.ca/laws/statute/00t16 for the Act.

Acknowledgements

TSSA would like to express gratitude to its inspectors and engineers for collecting and documenting valuable pieces of information and data - through their inspections, investigations and engineering services - that has been instrumental in developing this report, as well as its Information Technology team for providing the tools and advice for extracting data.

TSSA would like to especially acknowledge the Public Safety Risk Management team of the Strategic Analytics department for developing this report.

TSSA would also like to acknowledge Chief Safety and Risk Officer, Dr. Daniel Hoornweg, for his ongoing advice and independent review of the report.

Finally, TSSA would like to thank its partners in industry, government, advisory councils and the public, who help keep Ontarians safe.



Enhancements to the *Annual State of Public Safety Report*

In keeping with its commitment to continuous improvement and based on feedback from stakeholders (e.g., feedback obtained from board and advisory council presentations), TSSA continues to enhance the structure and style of its reporting. Based on new information and data, TSSA also enhances its processes and methodologies in analysis and reporting. Changes to this year's *Annual State of Public Safety Report* (ASPR) affecting the results of analysis are discussed below. Structural changes are not identified, as they are considered as enhancements to the readability of the report and do not impact the analysis.

Updates:

1. The top three compliance issues for each program have been summarized in tables using plain English. In addition, tables for the top three external factor device(s) or location type(s) by number of occurrences and observed injury burden have been added to amusement devices, elevators, escalators and ski lifts.
2. For elevators and escalators, the terms “commercial” and “mercantile” with regards to building types have been combined into “commercial”.
3. In response to the report produced by the Auditor General of Ontario, this year's safety numbers in the Fuels Safety Program infographic now include discovery of petroleum products, leaks, liquid petroleum spills and pipeline strikes. In the past, these occurrences were not included since they were of low health impact, without significantly contributing to the risk. These numbers are also now included in the safety numbers in the State of Public Safety in Ontario infographic.
4. TSSA is presently standardizing the classification of equipment data for the Fuels Safety Program, which might impact future analysis. Further review will be carried out in the future to continuously improve data quality.
5. The weights for calculating Disability-Adjusted Life-Years (DALYs) have been updated to values more current with existing public health literature. As an example, one injury type for which the DALY values changed significantly is concussions. Research and awareness in recent years have shown that concussions have much greater long-term health impacts than previously thought and this is now reflected in the DALY weight.
6. Upholstered and Stuffed Articles Safety Program data (all zero values) from fiscal years 2008 and 2009 were deleted from Table A9 in Appendix A, as there was no data available prior to fiscal year 2010.
7. High Profile Root Cause Analysis has been renamed to In-Depth Root Cause Analysis (IDRCA). This better reflects the activities involved in the process. Refer to Appendix F.
8. Safety priority areas have been renamed to “areas of concern”.

New Information:

1. Case studies were added to each program chapter. Details were changed to protect the anonymity of individuals or organizations involved.
2. TSSA is transitioning to a new application to calculate the Risk of Injury or Fatality (RIF). The basic premise remains the same, but some of the assumptions regarding the distributions have changed. This has resulted in some improvements and provides the most accurate estimation of the risk as possible. Refer to Appendix B.
3. Inspection and re-inspection information for all TSSA program areas has been provided in Appendix D.
4. A sample of organizations and groups that collaborate with TSSA on safety issues for Ontarians has been added in Appendix H.



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I. Message on the State of Public Safety in Ontario from Viola Dessanti, Director, Strategic Analytics

The Technical Standards and Safety Authority (TSSA) is pleased to present the 2019 Edition of *the Annual State of Public Safety Report (ASPR)*. The ASPR reports on safety data as collected by TSSA and estimates the level of risk that Ontarians are exposed to through TSSA-regulated technologies, devices, equipment and certified tradespeople. In doing so, it relates critical information about the documented state of safety in the places where Ontarians live, work and play.

The 2019 fiscal year saw TSSA embarking on a landmark transformation to become an outcome-based regulator. The need for this change was reinforced through the report from the Auditor General of Ontario's value for money audit. The shift to an outcome-based regulatory approach will mean that TSSA will proactively identify and assess risk and its causes and develop regulatory approaches that reduce risk in line with modern regulatory standards.

This past fiscal year (May 1, 2018 to April 30, 2019), there were zero fatalities, 48 permanent injuries and 1,746 non-permanent injuries. While TSSA is seeing a 60% decrease in the five-year average of fatalities, there is an increasing trend in the number of non-permanent injuries. Across all inspections conducted by TSSA, 74.4% revealed minor issues and 86.9% of devices and sites inspected by TSSA are considered low risk.

TSSA continues to be vigilant of trends and issues. The following issues were again this year found to be areas of concern for the coming year:

- carbon monoxide (CO) release from fuel-burning equipment in apartments and condominiums;
- elevator incidents involving mainly workers in hospitals;
- fuel-burning equipment in private dwellings;
- elevator incidents involving residents in retirement and long-term care homes; and
- fuel-burning equipment in schools.

There was one issue that is subject to enhanced monitoring:

- fuel-burning equipment in businesses.

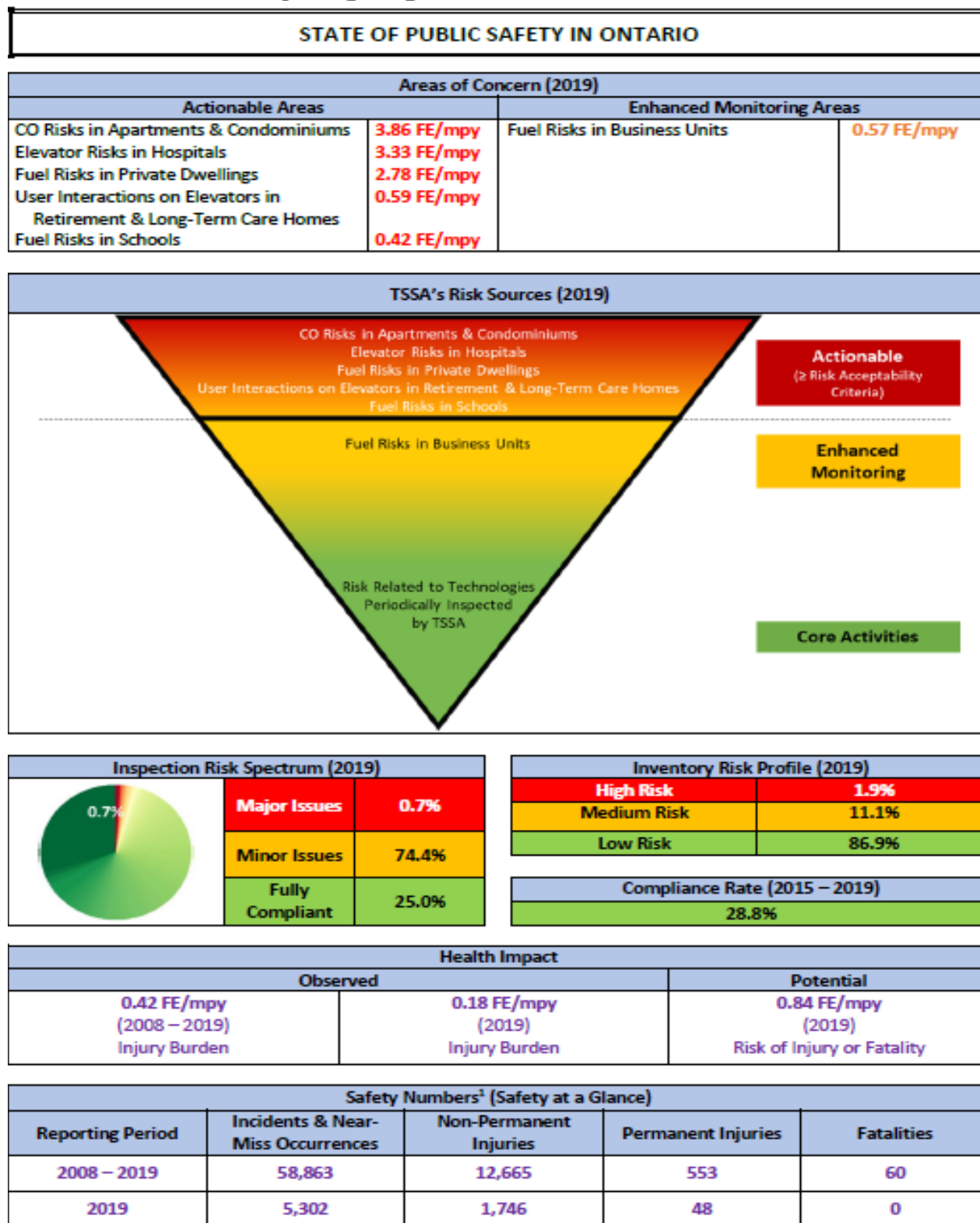
It is noteworthy that two issues now have lowered risk profiles compared to last year's report: namely, fuel risks in retirement and long-term care homes; and fuel-related fire risks in food service locations.

The ASPR is a key strategic document for TSSA and as such is continuously undergoing improvement as TSSA seeks to better measure safety outcomes and communicate them to the public. I invite you to read this report and provide any feedback that you think would be useful as we undertake this important transformation to a modern, outcome-based regulator.

Viola Dessanti
Director, Strategic Analytics



I.1 State of Safety Highlights



¹In this year's ASPR, discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes have been included in these numbers.



Incidents, Injuries and Risk Prediction

TSSA reports on two main measures of public safety and risk: Injury Burden; and the Risk of Injury or Fatality (RIF). The Injury Burden summarizes what has happened in the past and quantifies that in terms of fatalities or equivalents per million people per year (FE/mpy). The RIF is a composite score that uses past data to predict what might happen in the future.

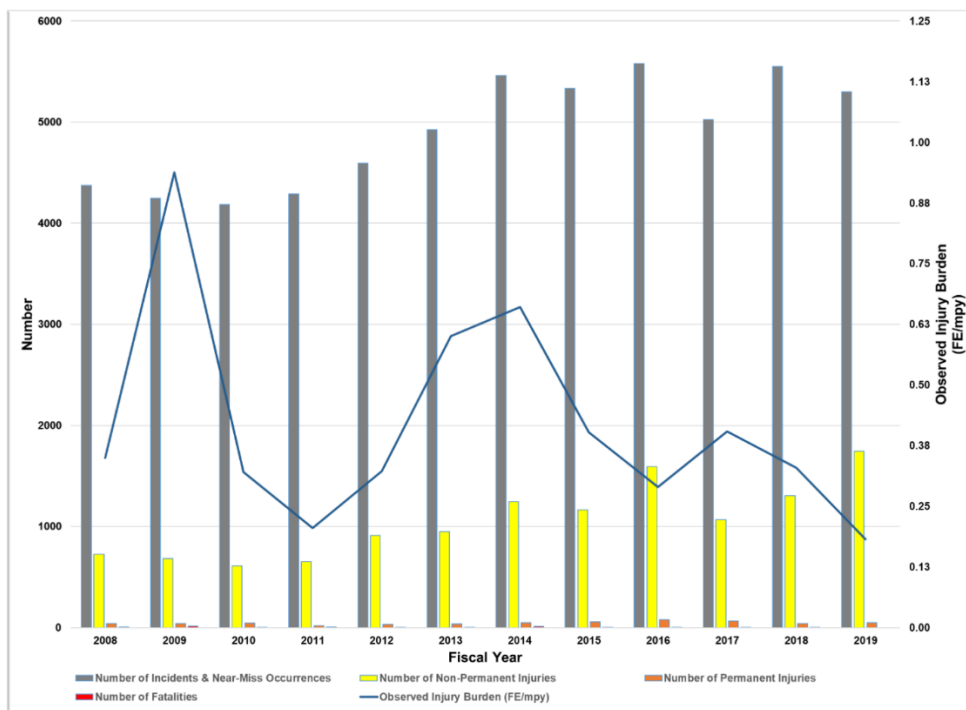
Since fiscal year 2008, there have been 58,863 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 12,665 non-permanent injuries, 553 permanent injuries and 60 fatalities across all TSSA-regulated sectors. This year, occurrences related to low health impact (e.g., discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes) have been included in the safety numbers. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.42 FE/mpy. The observed injury burden for fiscal year 2019 was 0.18 FE/mpy. Injury burden is what has already happened in the past.

Using the predictive approach [1] developed by TSSA, the composite potential RIF to Ontarians¹ over all TSSA-regulated sectors as of fiscal year 2019 was 0.84 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past. Last fiscal year (2018), the RIF was 0.99 FE/mpy. This year's RIF is 15.2% lower than last year.²

The number of occurrences and non-permanent injuries showed increasing trends of 2.9% and 4.1% per year, respectively. There were no demonstrable trends for either permanent injuries or fatalities.

Measures representing the overall state of safety are represented graphically in Figure 1. They are also tabulated in Appendix A.

Figure 1: State of safety of regulated program areas (2008 – 2019).



¹ Readers are cautioned that composite risk of injury or fatality has been established for reporting and benchmarking purposes only. Sections provided for the individual safety programs help gain an understanding of the significant causes, and more importantly, strategies for monitoring and managing risk to Ontarians.

² This is in part due to an improvement in the algorithm employed. Using the previous calculation, the decrease was 5%.

Areas of Concern

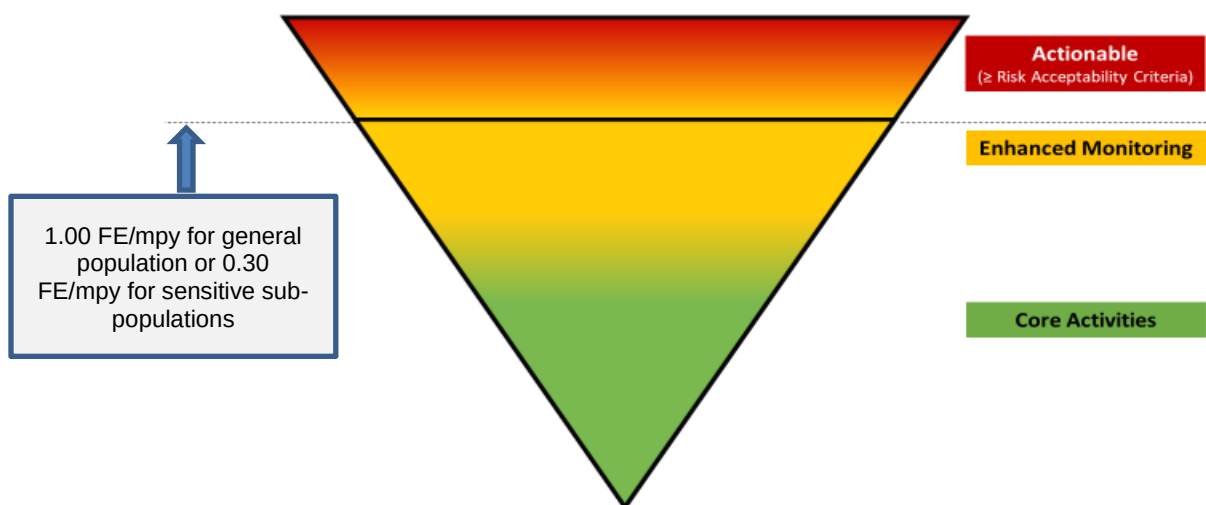
TSSA uses a risk-informed approach to understand the state of safety across its regulated sectors, to identify areas of concern. The state of safety is described using a risk metric, known as the RIF, that is measured in terms of FE/mpy. This measure helps compare against international risk acceptability criteria benchmarks, and to set internal thresholds for decision-making. TSSA has adopted risk acceptability criteria from various international³ and national⁴ best-practice methods. These best-practice methods have been leveraged to provide guidance to decision-makers on:

- situations that warrant mandatory action versus discretionary action; and
- enhancing responses to areas of concern.

Specifically, TSSA uses a criterion of 1.00 FE/mpy for evaluating risk to the general population of Ontario and a criterion of 0.30 FE/mpy for evaluating risks to sensitive sub-populations [2, 3, 4, 5].

Additionally, for the purposes of better understanding the sources of risk, TSSA has adopted the use of “As Low As Reasonably Practicable” (ALARP) principles [5], to assist in classifying risks and identifying areas of concern. As shown in Figure 2, risks can be classified into one of three regions of the triangle: actionable; enhanced monitoring; and core activities.

Figure 2: TSSA adaptation of ALARP principles for classifying risk sources.



Identifying Risks – Risk of Injury or Fatality Approach

As detailed in Appendix B, the RIF relies on historical data (i.e., reported occurrences and injuries since fiscal year 2008) to determine the potential risks that could be observed by certain populations of interest (typically the Ontario population as a whole) when exposed to TSSA-regulated technologies and devices. The approach relies on the use of predictive analytics and multiple simulations. For reporting and decision-making purposes, the 50th percentile value of the simulations is used to avoid over- or under-estimating risks.

Actionable Risks

Risk sources that require mitigating actions (shown in the red zone of Figure 2) exceed the risk acceptability criteria for either the general population (1.00 FE/mpy) or for sensitive sub-populations (0.30 FE/mpy). TSSA identifies these risk sources as safety issues that require risk management strategies. These strategies can include regulatory actions (such as director's orders), as well as advisories and bulletins, collaborative partnerships with stakeholders and public education.

³ Health and Safety Executive [5], US Centers for Disease Control, The National Institute for Occupational Safety and Health [6].

⁴ Major Industrial Accidents Council of Canada [2].



Risks Requiring Enhanced Monitoring

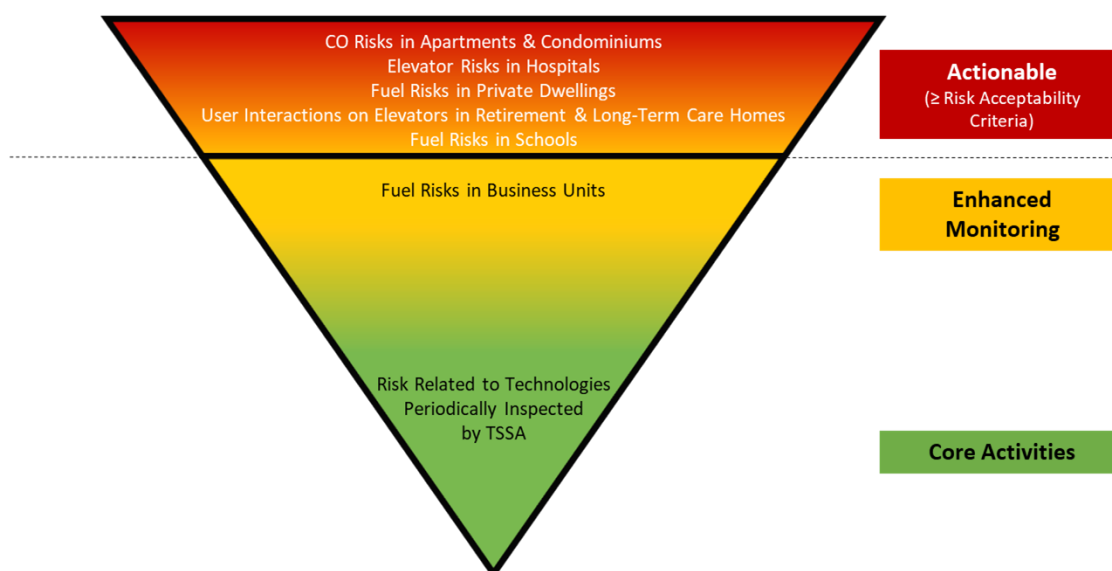
When risk sources approach the risk acceptability criteria, TSSA utilizes enhanced monitoring (shown in the yellow zone of Figure 2). TSSA considers these risk sources to be potentially emerging areas of risk and are monitored (including investigating specific incidents in the affected program area) and/or addressed through mitigation strategies.

Core Activities

Risk sources that are well below the risk acceptability criteria are shown in the green zone of Figure 2. These risk sources are within broadly acceptable levels due to TSSA's preventive/predictive inspection programs. While TSSA considers these risk sources as not being of immediate concern, it continues to monitor and oversee these sources using the various regulatory tools available, such as engineering reviews and periodic inspections.

Figure 3 provides an illustration of the risk sources associated with TSSA-regulated sectors for fiscal year 2019.

Figure 3: TSSA's risk sources (2019).



Observations and significant highlights based on this view of the risk profile are indicated in Table 1. TSSA has identified five actionable areas and one issue requiring enhanced monitoring for fiscal year 2019. Further details on the nature of these risks are given in the Elevators and Fuels sections of this report.

Table 1: TSSA's areas of concern (2019).

Risk Source	Risk of Injury or Fatality (FE/mpy)	Acceptability Criterion (FE/mpy)
CO Risks in Apartments and Condominiums	3.86	1.00
Elevator Risks in Hospitals	3.33	1.00
Fuel Risks ⁵ in Private Dwellings	2.78	1.00
User Interactions on Elevators in Retirement and Long-Term Care Homes	0.59	0.30
Fuel Risks ⁶ in Schools (K-12)	0.42	0.30
Fuel Risks ⁷ in Business Units	0.57	1.00

⁵ Fuel risks include CO release, fire, explosion, and/or vapour release.

⁶ Fuel risks include CO release, fire, explosion, and/or vapour release.

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TSSA remains committed to reducing the risk of injury or fatality in areas identified here. The outcomes-based regulator initiative will transform its regulatory delivery, allowing TSSA to more precisely identify and reduce harms in these areas.

This year's edition of the ASPR, while presenting the current state of safety for a 12-year period ending April 30, 2019, continues to focus on providing a deeper understanding of the causes and behaviours contributing to the overall level of risk. Throughout this report, all references to specific years refer to TSSA's fiscal year, which runs from May 1 to April 30.

Compliance

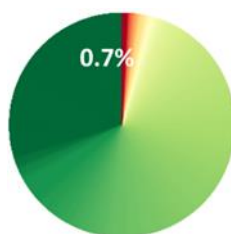
The *State of Public Safety in Ontario* infographic contains details on key metrics that reflect the overall level of compliance across TSSA's regulated sectors and is heavily predicated on the results of periodic inspections.

Using a harmonized approach described in Appendix C, an inventory risk profile has been generated to reflect the level of compliance across TSSA's entire regulated inventory. As indicated by the green bar in the inventory risk profile, 86.9% of regulated devices or facilities demonstrated a low level of risk as of fiscal year 2019⁸.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 28.8% with a decreasing trend of 1.6% per year. TSSA uses a rolling five-year period (2015 – 2019) for measurement and reporting of compliance information for this report. For more details on statistical methods, please refer to Appendix B.

While the compliance rate provides an outcome of the periodic inspections (e.g., pass or fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspections. As indicated by the dark red segment in Figure 4, the spectrum indicates that 0.7% of all inspections conducted in fiscal year 2019 posed unacceptable levels of risk.

Figure 4: Inspection risk spectrum from outcome of periodic inspections conducted in all regulated sectors (2019).



Refer to Appendix D for inspection and re-inspection results.

⁸ The calculation only includes devices for which there is sufficient inspection history to estimate the risk. Certain sectors (i.e., Elevating devices) have a large fraction of new devices for which an assessment cannot yet be made.



II. Risk-Informed Decision-Making at TSSA

Introduction

TSSA statutory directors have general supervisory and administrative responsibility of the Act and its associated regulations to ensure the safety of Ontarians.

The ASPR is a key component of TSSA's Risk-Informed Decision-Making (RIDM) framework and provides information on the state of safety of Ontarians interacting with TSSA-regulated technologies. The ASPR is also a public document that describes the safety strategies established by the statutory directors and those responsible for preventative and educational tools to enhance safety and reduce the risk of injury or fatality to Ontarians.

Initiated in 2007, TSSA's RIDM framework is an evidence-based, scientific approach to identifying, analyzing, measuring and managing the RIF to Ontarians caused through interaction with TSSA-regulated technologies, devices and products. It is a framework to assist in the effective use of available regulatory tools under the Act, through efficient allocation of TSSA's resources, and leveraging partnerships with stakeholders. As a framework, it continues to evolve to align with and lead best practices around the world.

Reducing Risks – Understanding and Managing Causes and Behaviours

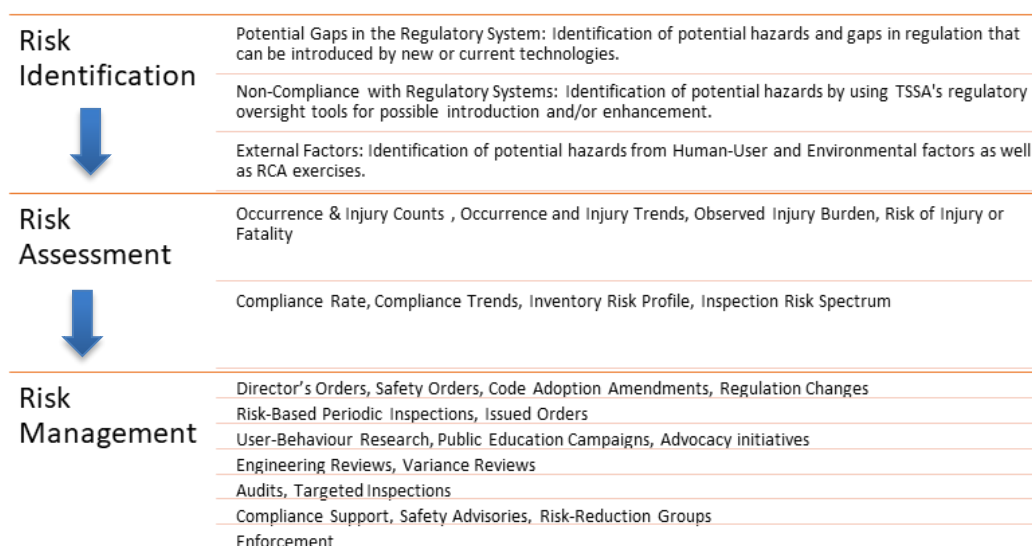
The RIF to Ontarians across the different TSSA-regulated sectors is estimated primarily using information gathered through reported and investigated occurrences (incidents and near-misses) and complemented with information collected through TSSA's inspections and other regulatory oversight tools. The information collected allows TSSA to analyze the primary causes associated with occurrences, and helps statutory directors establish and implement strategies aimed at reducing risks.

The process to address risks to Ontarians is a three-stage process comprised of:

1. risk identification (through cause categorization);
2. risk assessment; and
3. risk management.

This process represents the public safety risk management framework and is illustrated in Figure 5.

Figure 5: Public safety risk management framework⁹.



⁹ Depending upon the nature of the risk, TSSA considers a variety of tools, such as regulation changes, technological solutions, enforcement activities, and public education to help best manage public safety risks.



1. Risk Identification

Risk is identified and then segmented into one of three primary causal categories to aid downstream strategy development and implementation. These causal categories, identified in Figure 5 and as defined in Appendix E, include the following:

Potential Gaps in Regulatory System

Advancements in regulated sectors, including emerging technologies lacking adequate regulatory oversight (including codes and standards), form one aspect of this category. Risks in such cases are typically unknown or may not be estimated due to limited data availability. However, the potential hazards with such technologies may be known or ascertained.

A subset of this category involves safety gaps that are inadequately addressed by the current regulatory system. Examples include technologies designed to older codes and standards that may be prone to fail over time.

In both cases, TSSA may be able to address the gaps through interim tools such as Director's Orders. In certain instances, TSSA may recommend the need to affect changes to regulations.

Non-Compliance with Regulatory System

This category of occurrences results from actions not compliant with the regulatory requirements by those statutorily responsible for the design, manufacture, installation, operation, user interaction and/or maintenance of TSSA-regulated technologies. The level of understanding, education, required skills and training of these regulated stakeholders or responsible parties, such as owners of technologies, installation and maintenance technicians, along with their intent to comply, affects this category of risks.

The level of regulatory oversight varies from program to program. In most instances, the regulatory expectations of TSSA are specified in the Act and its associated regulations. A key oversight function involves TSSA conducting initial and periodic inspections of devices before and during their operation.

Risks falling in this category are identified and reduced through the introduction and/or enhancement of TSSA's existing regulatory oversight tools. Increasing levels of risk in this category may require the introduction, expansion or modification of existing TSSA regulatory oversight powers such as inspections and audits. Another important regulatory tool to manage significant risks involves the use of Director's Orders, and in certain instances, regulatory changes may also be recommended. TSSA may also use advocacy tools and form collaborative partnerships with relevant stakeholders such as other government agencies, like-minded (or focused) safety organizations/associations, regulated sectors and affected parties, to raise awareness and influence behavioral change and compliance.

External Factors

Occurrences can take place despite the presence of an adequate regulatory management system. Risks in this category are typically caused by users' (such as the public) interactions with TSSA-regulated technologies. A comprehensive understanding of human factors helps TSSA set up appropriate public education/safety advocacy tools through collaborative partnerships with stakeholders including consumer advocacy groups, regulated sectors, safety organizations, etc., to reduce risk in this category.

Other reasons include environmental factors, such as weather, deliberate intent or sabotage, occurrences involving TSSA-regulated technologies but due to factors outside of TSSA's jurisdiction, etc. Typically, in such cases, other regulatory agencies may take on primary investigation and management of the risks with TSSA's technical support and expertise. In rare circumstances, changes may be made to regulatory tools to address risk.

In certain circumstances, a formal approach entitled *In-Depth Root Cause Analysis* (IDRCA) is used, which relies on Root Cause Analysis (RCA) principles to determine and document underlying causes related to occurrences under TSSA's regulatory mandate but with additional focus and effort. For additional details on this methodology, refer to Appendix F.



2. Risk Assessment

The RIF across TSSA's regulated sectors is the primary method of estimating risk to Ontarians. The RIF method uses information gathered through reported and investigated occurrences (i.e., both incidents and near-misses) and associated injuries. This information is analyzed quantitatively using an approach that integrates predictive analytics with simulations to estimate the potential risk that would be sustained by Ontarians from exposure to regulated technologies.

TSSA's risk assessment involves the collection of information through inspections conducted on regulated technologies, and other regulatory oversight tools. Non-compliance information from inspections is used to generate compliance metrics, such as the compliance rate, inspection risk spectrum and the inventory risk profile.

The intent of the risk assessment component is to assess the risk of a given source. The quantitative aspect of risk is delivered through measurement using the RIF and supplemented with the observed injury burden and activity counts. Where clean data is available (i.e., validated population counts, statistically-significant data size), specific drilldowns of risk are generated. Greater specificity in identifying risks allows TSSA to target resources specifically to address the largest source of risk and potentially reduce the risk that is intended to be managed.

3. Risk Management

After completing the risk identification and assessment processes, the identified risks in their causal categories undergo a risk management process using TSSA's existing regulatory oversight tools, which aid the statutory directors in establishing and implementing strategies aimed at reducing risks.

To aid decision-makers in selecting controls to manage and mitigate risks, Table 2 captures the hierarchy of controls.

Table 2: Control solutions¹⁰ to manage and/or mitigate risks.

Control Name	Purpose of Control
Elimination	Remove or eliminate hazards altogether
Substitution	Replace hazards (with less hazardous options)
Engineering	Implementation of safeguarding technologies to prevent and/or mitigate hazards and therefore minimize exposure
Administrative	Codes and regulatory changes (new and/or improvements), education, training, procedures, etc.

As indicated in Table 2, elimination is the strongest and most effective control as it physically removes the hazard, and therefore results in the greatest reduction in risk. However, the ability to resort to an elimination control may be restricted due to regulatory purview.

In such cases, the decision-maker would have to move down the hierarchy and evaluate the efficacy of substitution and subsequent controls. Cost-benefit analysis and stakeholder consultation are recommended in evaluating the applicability and efficacy of applying a control, or a set of controls, to a particular risk.

Conclusion

TSSA's RIDM framework is recognized and used for addressing broader public policy issues. It aligns with the recently published guideline UL2984: *Management of Public Risks – Principles and Guidelines*, a vision that was put forward by TSSA and successfully accepted by national and international bodies.

This report acts as a primary source of information for risk-informed decision-making. TSSA's RIDM framework continues to assist statutory directors across all safety programs in making regular day-to-day decisions while helping tackle larger and more complex strategic regulatory decisions. An important element of the framework is continuous improvement and confirmation of decisions as new findings become available. TSSA continues to aggregate data from inspections year over year and there are times that decisions need to be revisited with up-to-date data. This often results in a reinforcement of a prior decision, but there are times that an outcome of updated analysis suggests another option be taken.

¹⁰ Adapted from Hierarchy of Controls from NIOSH, US CDC [6].



III. Program-Specific State of Safety and Compliance and TSSA Strategies

III.1 Boilers and Pressure Vessels

State of Public Safety in Ontario –

BOILERS & PRESSURE VESSELS SAFETY PROGRAM



Program Area Activities	Pressure Vessels Lifecycle
Boilers and pressure vessels include equipment that produce and distribute hot water, steam, compressed air, and other compressed liquids and gases used in commerce and industry. - Regulates all pressure-retaining components manufactured or used in Ontario - Ensures safety of boilers and pressure vessels and piping systems - Conducts periodic inspections on uninsured BPV - Certification of inspectors, including those employed by insurance companies - Engineering services - Quality program audits of manufacturers, insurers, installers, repair and alteration organizations, and safety-valve repair organizations	Design
	Manufacture
	Installation
	Operation
	Maintenance
	Decommissioning

Health Impact ¹		
Observed	Potential	
0.00 FE/mpy (2008 – 2019) Injury Burden	0.00 FE/mpy (2019) Injury Burden	0.02 FE/mpy (2019) Risk of Injury or Fatality

Compliance Rate ¹ (2015 – 2019)	Safety Numbers ¹ (Safety at a Glance)				
	Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
	2008 – 2019	58	3	7	0
98.6%	2019	13	2	0	0

¹ Uninsured boilers and pressure vessels only.

TSSA's Boilers and Pressure Vessels Safety Program ensures the safe design, construction, maintenance, use, operation and repair of pressure-retaining components in Ontario. This includes those that produce and distribute hot water, steam, compressed air and other compressed liquids and gases for industrial, commercial or institutional purposes. See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.



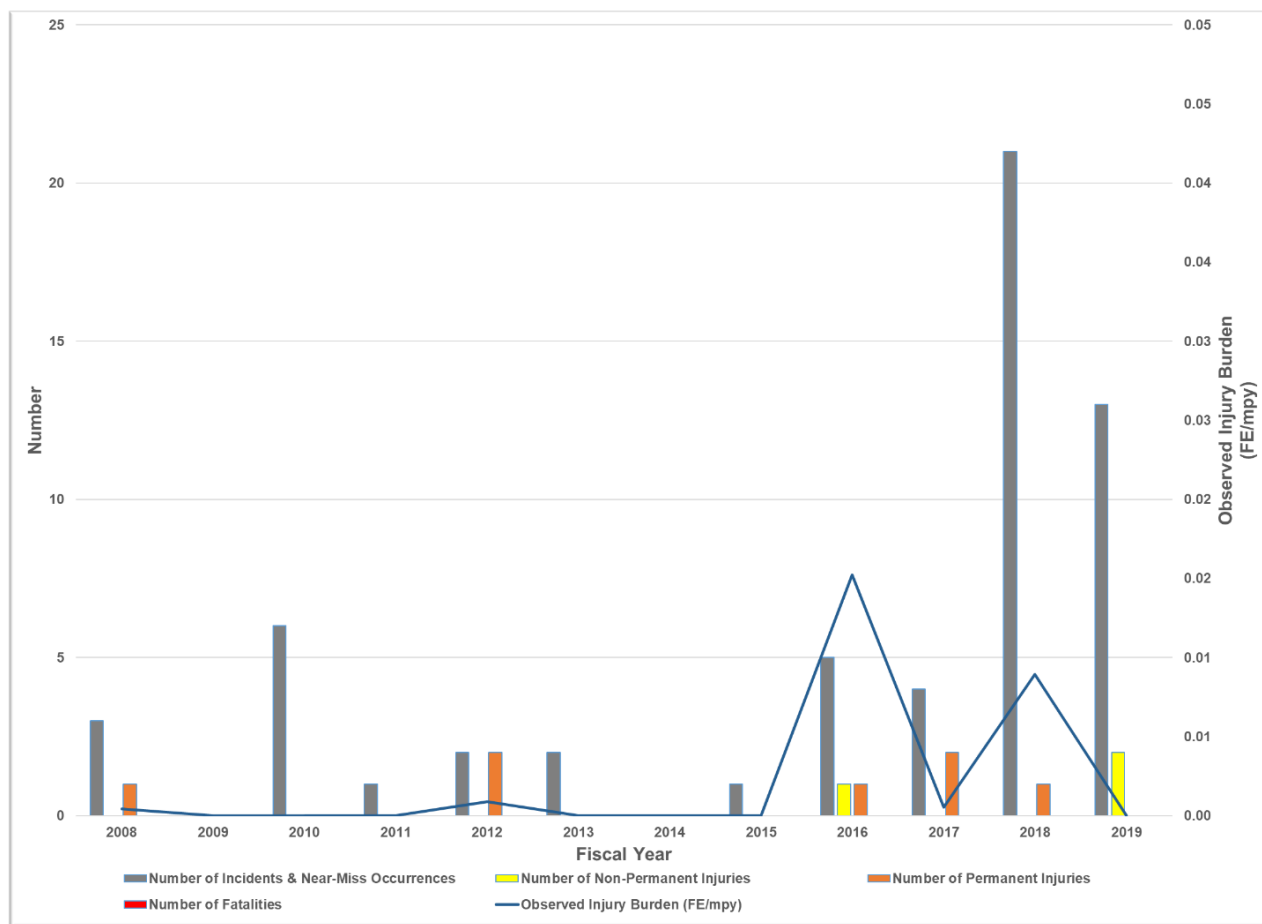
III.1.1 Risk Assessment

Incidents, Injuries and Risk Prediction

Incidents involving these types of equipment could include cracked and corroded vessels or piping, leaks or rupture, resulting in poisonings, suffocations, fires and/or explosions. Failures can be catastrophic and may immediately threaten life and property. The safe design, installation, operation, and maintenance of boilers and pressure vessels, in accordance with appropriate codes and standards, are essential to public safety. TSSA's activities help ensure that safeguards are in place for the lifecycle of this type of equipment.

There have been 58 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in three non-permanent injuries, seven permanent injuries and zero fatalities attributed to regulated boilers, pressure vessels and piping systems in the province over the last twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are shown in Figure BPV-1 and are detailed in Appendix A.

Figure BPV-1: State of safety for uninsured boilers and pressure vessels (2008 – 2019).



Based on the actual injuries observed over the last twelve fiscal years (2008 – 2019), the average rate of injury was 0.06 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of approximately 0.00 FE/mpy. The observed injury burden for fiscal year 2019 was also 0.00 FE/mpy. Injury burden is what has already happened in the past.



Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians as of fiscal year 2019 to be 0.02 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past.

In fiscal year 2019, there were 13 occurrences that were reported and had their investigations completed. This and last year's occurrences (13 and 21 respectively) were more than in previous years, mainly due to increased reporting from owners and contractors via the Ministry of Environment, Conservation and Parks (formerly known as the Ministry of Environment) Spills Action Centre, particularly with regards to refrigeration incidents. Main issues affecting these occurrences included improper or lack of maintenance, failed components and improper installation. Despite increased reporting in fiscal year 2019, the risk of injury or fatality remains low.

Compliance

Ontario Regulation 220/01, Boilers and Pressure Vessels assigns periodic inspection responsibility to both TSSA and insurers who underwrite boiler and machinery insurance. Insurers conduct periodic inspections for the majority of Ontario's fleet of boilers and pressure vessels (98 to 99%), while TSSA inspects the remaining 1 to 2%.

On July 1, 2018, TSSA began issuing certificates of inspection (COI) for boilers and pressure vessels which had undergone periodic inspections.

The frequency of inspections is specified in the Code Adoption Document (CAD) associated with *Ontario Regulation 220/01*. Periodic inspections contribute to the preventative management of risk associated with boilers and pressure vessels. Through the inspection process, any non-conformances are directed to the owner for action within an appropriate time frame.

Uninsured Equipment

The median compliance rate over the last five fiscal years (2015 – 2019) was 98.6%, with no demonstrable trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections by TSSA over the last five fiscal years (2015 – 2019) are shown in Table BPV-1.

Table BPV-1: Top compliance issues by number of orders issued for *uninsured* boilers and pressure vessels (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Equipment not maintained in safe working condition	24.3%
Failure to supply water required for testing	13.5%
Pressure relief devices not properly protected	5.4%

Note that the Boilers and Pressure Vessels Safety Program does not currently use a risk-based inspection system.

Refer to Appendix D for inspection and re-inspection results of *uninsured* equipment.

Insured Equipment

Since TSSA began issuing certificates of inspection (COI) in July 2018, there were 13,129 inspections with 932 non-compliance issues found. The resultant compliance rate was 93.3%. See Table BPV-2 for the top compliance issues found on insured equipment. While the data does not necessarily span the entire fiscal year, it is still possible to report on the data collected thus far and as such these statistics represent preliminary findings from this process.



Table BPV-2: Top compliance issues by number of orders issued for *insured* boilers and pressure vessels (2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Safety relief device inoperable	42.4%
Inspection certificate missing or expired	13.9%
Required documentation/nameplate missing or damaged	12.4%

III.1.2 Risk Management, Message from Roger Neate, Interim Boilers and Pressure Vessels Statutory Director

With the COI program in full swing, TSSA has been able to collect data from insurance companies on insured boilers which represent roughly 98% to 99% of all boilers in Ontario. TSSA is in the preliminary stages of analyzing this data but have already been able to note which are the more prominent safety issues in the province.

The Boilers and Pressure Vessels Safety Program has been comparing TSSA's boilers and pressure vessels periodic inspection compliance results with the National Board of Boilers and Pressure Vessels Violations Tracking Key Performance Indicator. The National Board records periodic inspection results from 34 boiler and pressure vessel jurisdictions in North America. Their compliance rate is over 90%, which indicates that Ontario performance is at similar or better levels.

In addition to periodic inspections, it should be noted that TSSA inspectors completed over 10,000 shop and piping inspections this year, where TSSA inspectors work with manufacturers and installers to ensure that equipment is safe to operate.

With regards to occurrences, the Boilers and Pressure Vessels Safety Program has been reviewing the reporting guidelines, specifically defining incidents and near-misses and clarifying the reporting requirements with stakeholders. It is expected that in the next year, TSSA will be better positioned to understand the number of occurrences involving boilers and pressure vessels.

Case Study: Chiller at a Curling Club

Background

The pressure vessel shell wall of a chiller at a curling club corroded (thinned) from the outside to a point where the vibration during operation initiated a crack where the vessel support was welded to the shell. This resulted in a pressure boundary failure with a release of ammonia to the atmosphere. Fortunately, there were no injuries.

TSSA conducted an investigation and it was determined that the failure was due to Corrosion Under Insulation (CUI).

CUI is a severe form of localized external corrosion that occurs in carbon and low alloy steel equipment that has been insulated. This form of corrosion occurs when water is absorbed by or collected in the insulation. The equipment begins to corrode as it is exposed to water and oxygen.

Outcome

The pressure vessel was scrapped and a new one installed as a replacement. No orders were issued.



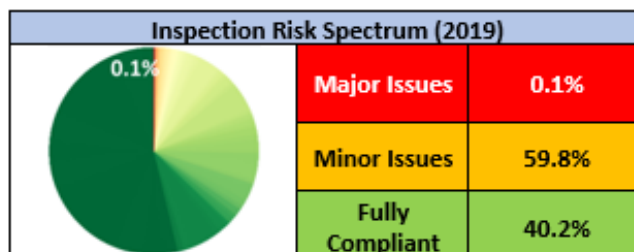
III.2 Operating Engineers

State of Public Safety in Ontario –

OPERATING ENGINEERS SAFETY PROGRAM



Inventory	Program Area Activities
3,280 Plants	- Registers, inspects and regulates the safety of plants in Ontario - Examines and certifies operating engineers - Performs oversight of the management, operation and maintenance of plants to ensure compliance to the regulation and established safety standards
11,742 Operating Engineers	



Inventory Risk Profile (2019)	
High Risk	2.8%
Medium Risk	16.0%
Low Risk	81.2%

Compliance Rate (2015 – 2019)	
	39.7%

Health Impact		
Observed		Potential
0.00 FE/mpy (2008 – 2019) Injury Burden	0.00 FE/mpy (2019) Injury Burden	0.01 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	41	1	3	0
2019	22	0	0	0

TSSA's Operating Engineers Safety Program registers, inspects and regulates plants that power Ontario with electricity, refrigeration, heating and cooling and is also responsible for the examination and certification of operating engineers (also known as power engineers). In addition, TSSA provides oversight of the management, operation and maintenance of plants to ensure compliance to the regulation and established safety standards. See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

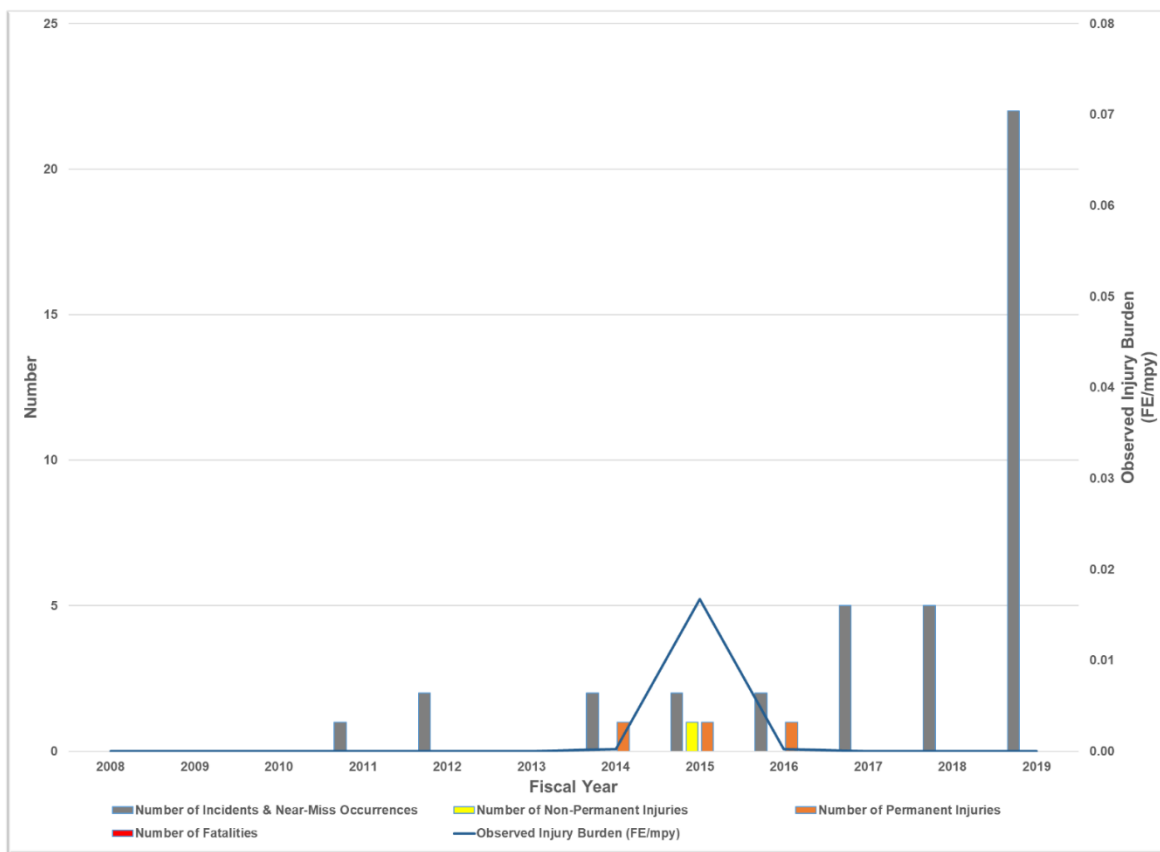


III.2.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 41 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in one non-permanent injury, three permanent injuries and zero fatalities reported over the past twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are represented graphically in Figure OE-1 and are tabulated in Appendix A.

Figure OE-1: State of safety across operating plants (2008 – 2019).



Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 0.02 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of approximately 0.00 FE/mpy. The observed injury burden for fiscal year 2019 was also approximately 0.00 FE/mpy. Injury burden is what has already happened in the past.

Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians as of fiscal year 2019 to be 0.01 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past.

There were no demonstrable trends in the number of occurrences, non-permanent or permanent injuries.

In fiscal year 2019, there were 22 reported occurrences, for which their incident investigations were completed. This year's occurrences were more than in previous years, mainly due to increased reporting from owners and contractors via the Ministry of Environment, Conservation and Parks (formerly known as the Ministry of Environment) Spills Action Centre, particularly with regards to refrigeration incidents. Main issues affecting these occurrences included improper or lack of maintenance, failed components and improper installation. Despite increased reporting in fiscal year 2019, the risk of injury or fatality remains low.



Compliance

TSSA conducts periodic inspections of 3,280 registered operating plants in Ontario. These inspections assist in maintaining a low to negligible risk of injury or fatality to Ontarians that may result from non-compliance with the regulatory requirements. TSSA uses a risk-based inspection scheduling process (RBS) [7] to determine the frequency of inspections of all registered plants. Data collected through these inspections helps prioritize frequency of inspections and to proactively manage risk of injury or fatality. There were 2,746 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 39.7%, with no demonstrable trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table OE-1.

Table OE-1: Top compliance issues by number of orders issued for operating plants (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Equipment not inspected and posted by an Insurance Company or TSSA	10.5%
Safety concerns must be corrected	7.4%
Testing of safety device not recorded	5.8%

The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table OE-2. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table OE-2: Top compliance issues by risk of orders issued for operating plants (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Registered seals missing	82.9%
Safety valves over 5 years old must be recertified or replaced	2.9%
Maintenance not to manufacturer's recommendations	1.6%

Figure OE-2 and Table OE-3 provide information on key indicators associated with the results of periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass or fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 0.0% to 0.1% of all inspections conducted in the past five fiscal years (2015 – 2019) posed unacceptable levels of risk. In fiscal year 2019, nearly 100% of inspections were either fully compliant (40.2%) or had only minor issues (59.8%). Some examples of minor issues included: the plant not being re-registered after changing its name or ownership; missing signage; the registration certificate not being posted in a conspicuous location; missing information from the logbook; and, general housekeeping concerns.

Figure OE-2: Inspection risk spectrums from outcomes of periodic inspections conducted on operating plants (2015 – 2019).

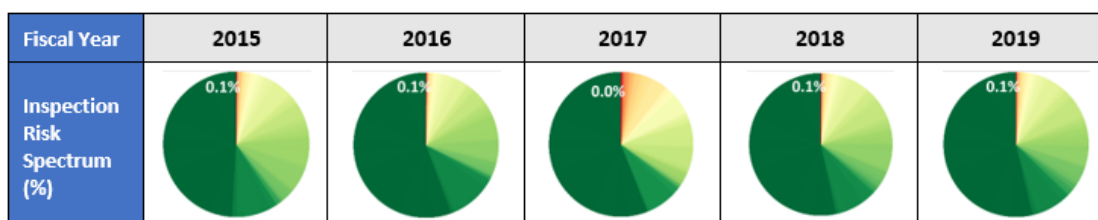




Table OE-3: Inventory risk profiles from outcomes of periodic inspections conducted on operating plants (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	N/A	4.5%	1.7%	1.3%	2.8%
		17.1%	11.1%	10.8%	16.0%
		78.4%	87.1%	88.0%	81.2%

TSSA deals with observed non-compliances by issuing inspection orders to the owner to address these non-compliances within an appropriate timeframe. This process contributes to the preventative management of risk of injury or fatality associated with operating plants.

Using a risk-based approach (i.e., RBS), the entire inventory is inspected at least once over a two-year period. The RBS model, described in Appendix C in detail, is based on a historical profile of the nature and significance of non-compliances found at the plants. As can be seen in Table OE-3, no RBS profiles were estimated for 2015 and therefore that information is not available.

The RBS profile of operating plants in Ontario exhibits no demonstrable trends in the compliance rate as a result of the outcomes of inspections over the past five fiscal years (indicated by the inspection risk spectrum). As of the fiscal year 2019 snapshot, there were 78 high-risk facilities (2.8% of the qualified provincial inventory). Of all the high-risk facilities identified, refrigeration plants accounted for the greatest percentage (24.4%) of these high-risk facilities. See Table OE-4 for further details.

Table OE-4: Top high-risk plant types (2019).

Plant Type	Percentage of Total High-Risk Plants
Refrigeration Plant	24.4%
High-Pressure Power Plant	17.9%
High-Pressure Watertube Low-Water-Volume Power Plant	16.7%

Additionally, public services (such as arenas) made up the greatest percentage (24.4%) of these high-risk facilities. See Table OE-5 for further details.

Table OE-5: Top high-risk plant facility types (2019).

Plant Function Type	Percentage of Total High-Risk Plants
Public Services	24.4%
Food Process	16.7%
Production Industries	14.1%

Refer to Appendix D for inspection and re-inspection results.

III.2.2 Risk Management, Message from Roger Neate, Interim Operating Engineers Statutory Director

In April 2019, the Government of Ontario amended the [Technical Standards and Safety Act, 2000](#), to allow the Minister of Government and Consumer Services (The Minister) authority to approve alternate rules created by TSSA. The purpose of this amendment is to simplify rules and provide flexibility for businesses to achieve compliance with the regulation.



The changes are intended to address the recommendations of the [Operating Engineers Expert Panel Report](#) and allow for adoption of a risk-based regulatory framework developed by the Operating Engineers' Risk Task Group. The framework developed by the task group includes two alternate regulatory paths:

1. Path 1 category-based approach, where plant rating and staffing requirements for operating engineers and operators are determined based on a risk rating; and
2. Path 2 approach, where regulated plants develop and implement site-specific Risk and Safety Management Plans (RSMP).

Under this approach, businesses will have the option to either comply with the alternate rules or continue adhering to requirements in the current regulation. The changes are expected to reduce the regulatory burden on businesses and enhance public safety.

TSSA inspectors remain vigilant in their inspections, working with owners to resolve medium- and low-risk non-compliances. Inspectors find major safety issues in less than one percent of the inspections. As a result, over 80% of plants in Ontario are low risk (this is less than last year because TSSA reassessed some of the low-risk non-compliances and deemed them to be medium risk).

Many of the occurrences the Operating Engineers Safety Program receives are minor leaks. TSSA continues to monitor them to see if further action is required. The initiative in the Boilers and Pressure Vessels Safety Program to clarify reporting requirements and incident/near-miss definitions has been extended to the Operating Engineers Safety Program and it is expected that it will yield insightful data.

Case Study: Refrigeration System at a Food Processing Plant

Background

On a Friday, the refrigeration system that runs the spiral freezer was pumped down manually. The system was shut down after the pump down was completed.

On the following Sunday, the sanitation and maintenance workers started a CIP (clean in place) following the written procedure. The suction pressure to the compressor then rose due to the CIP causing gassing of the ammonia liquid in the evaporator coils. The spiral freezer refrigeration compressor was not in operation at the time. The pressure relief valve prematurely lifted and allowed ammonia gas to vent out of the building through the vent piping.

Some ammonia gas entered the building, possibly through an open roll up door in the shipping area. This entered the engine room and caused the leak detection system to activate and the alarm sounded. The employees evacuated the plant. Some employees exited the building at the exit nearest to the engine room. Due to the rain coming down at the time, the ammonia gas was drawn down and employees were exposed to low levels of ammonia gas and ammonium hydroxide.

These employees walked to the gathering point outside the building. Once there, they sought medical aid.

Outcome

TSSA issued orders to:

- 1) Replace the pressure relief valve
- 2) Establish an evacuation procedure that does not put people in harm's way during a plant evacuation
- 3) Establish a procedure for controlling the ammonia during a CIP to ensure that this type of release can not occur in the future

III.3 Amusement Devices

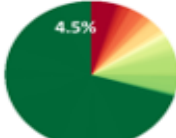
State of Public Safety in Ontario –

AMUSEMENT DEVICES SAFETY PROGRAM



Inventory	Program Area Activities	Regulated Devices
2,824 ¹	- Licenses operators - Reviews and registers rides - Conducts inspections and investigations - Issues permits for rides - Engineering services	- Circular motion rides (e.g., Ferris wheels, merry-go-rounds) - Roller coasters - Water slides, flumes, dry slides - Go-karts, bumper cars - Inflatables (bouncy castles and obstacle courses) - Bungee jumps and bungee-assisted rides - Zip lines (track and cable rides) - Spinning and whirling rides

Top Safety Issues			
Device Type		Occurrence Type	
By Number of Occurrences	By Observed Injury Burden	By Number of Occurrences	By Observed Injury Burden
Water Slides Coaster Rides Zip Lines	Water Slides Coaster Rides Circular Rides	Physical Impacts Sudden Movements Falls from Height	Physical Impacts Falls from Height Burns ²

Inspection Risk Spectrum (2019)		
	Major Issues	4.5%
	Minor Issues	42.8%
	Fully Compliant	52.7%

Inventory Risk Profile (2019)	
High Risk	1.0%
Medium Risk	5.3%
Low Risk	93.6%

Compliance Rate (2015 – 2019)	
53.9%	

Health Impact		
Observed		Potential
0.06 FE/mpy (2008 – 2019) Injury Burden	0.08 FE/mpy (2019) Injury Burden	0.21 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	5,234	4,745	220	0
2019	1,146	1,048	29	0

¹ Permitted devices only.

² Burns were a result of friction, not fire.

TSSA's Amusement Devices Safety Program regulates amusement rides in Ontario to ensure all devices conform to the Act and its associated regulations, codes and standards. As part of the Amusement Devices Safety Program, TSSA: licenses operators; reviews and registers rides; conducts inspections and incident investigations; and, issues a permit for each ride in the current operating season. See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

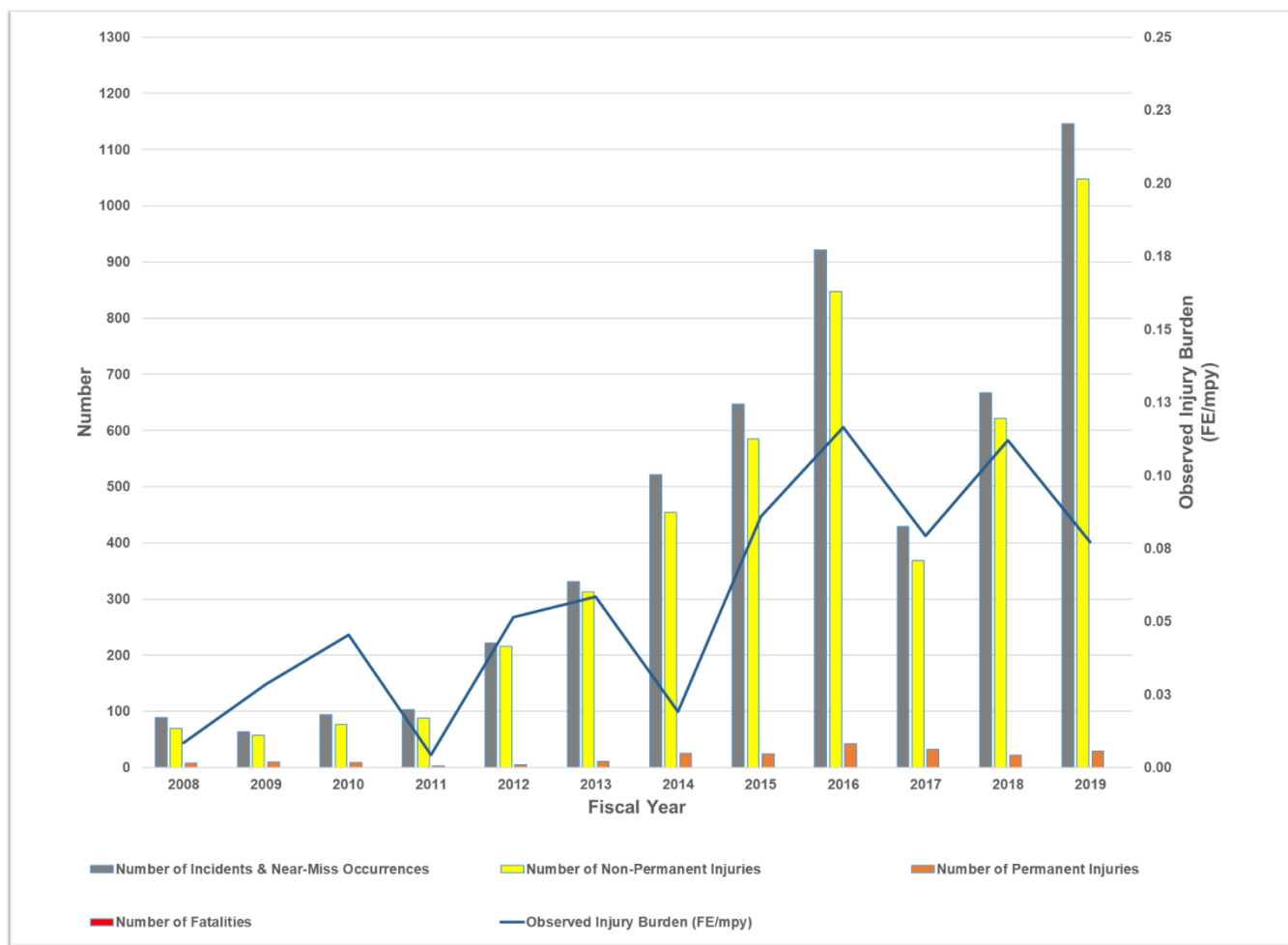
Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

III.3.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 5,234 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 4,745 non-permanent injuries, 220 permanent injuries and zero fatalities reported over the past twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are represented graphically in Figure AD-1 and are tabulated in Appendix A.

Figure AD-1: State of safety across amusement devices (2008 – 2019).



Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 28.64 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.06 FE/mpy. The observed injury burden for fiscal year 2019 was 0.08 FE/mpy. Injury burden is what has already happened in the past.

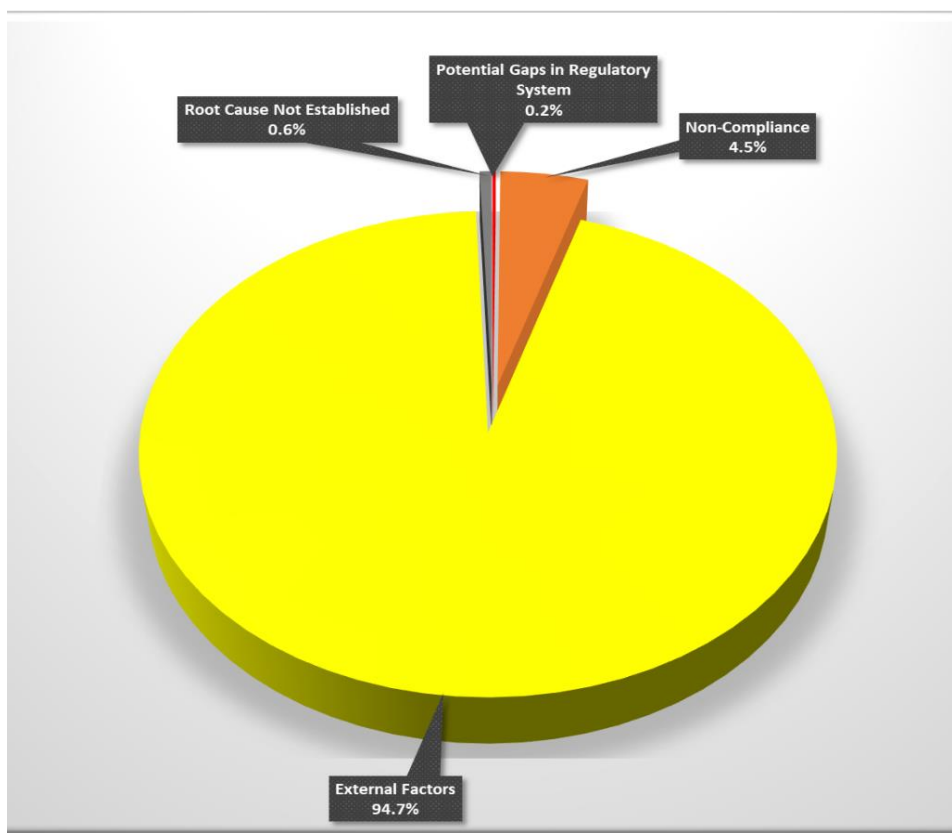
Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using amusement devices as of fiscal year 2019 to be 0.21 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past.

There were increasing trends in the number of occurrences, non-permanent injuries and permanent injuries of 5.5%, 5.1% and 6.2% respectively.



Figure AD-2 illustrates the top issues related to amusement devices in terms of their casual analysis categories. As indicated in the pie chart in Figure AD-2, about 4.5% of the risk over the past twelve fiscal years (2008 – 2019) was due to non-compliances with the regulatory requirements. There were no demonstrable trends in the number of these non-compliance occurrences. Some examples of this included: the operator not obeying the ride height restrictions; a lap bar spring becoming detached, a slip-ring wire coming loose and electrifying the fence; the drive wheel of a Ferris wheel coming loose; and the passenger carrying unit coming loose due to a broken weld. In addition, about 94.7% of the risk was due to factors external to the regulatory environment (see Appendix E for further details on external factors). There was an increasing trend in the number of external-factor occurrences of 5.5% per year.

Figure AD-2: Risk of injury or fatality in amusement devices by casual analysis category (2008 - 2019).



Risk of Injury or Fatality on Amusement Devices due to Human Factors (2008 – 2019)

Human factors accounted for about 99.5% of external-factor incidents and near-miss occurrences.

Water slides had the most occurrences and the largest observed injury burden, as shown in Tables AD-1 and AD-2.

Table AD-1: Top amusement device types by number of human-factor occurrences (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Water Slides	32.9%	5.9%
Coaster Rides	19.5%	2.3%
Zip Lines	14.7%	4.2%



Table AD-2: Top amusement device types by human-factor observed injury burden (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Water Slides	40.7%	5.9%
Coaster Rides	20.9%	2.3%
Circular Rides	10.9%	8.9%

Physical impacts were the most numerous occurrence type and had the largest observed injury burden, as shown in Tables AD-3 and AD-4.

Table AD-3: Top occurrence types by number of human-factor occurrences for amusement devices (2008 – 2019).

Occurrence Type	Percentage of Occurrences	Trend (per year)
Physical Impacts	55.8%	5.2%
Sudden Movements	13.6%	7.1%
Falls from Height	12.5%	7.7%

Table AD-4: Top occurrence types by human-factor observed injury burden for amusement devices (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden	Trend (per year)
Physical Impacts	44.8%	5.2%
Falls from Height	30.5%	7.7%
Burns	10.9%	None

The top occurrence types are discussed below in greater detail.

Physical Impacts

Physical-impact occurrences accounted for 55.8% of human-factor occurrences on amusement devices and 44.8% of the related observed injury burden. There was an increasing trend in the number of physical-impact occurrences of 5.2% per year. A breakdown by amusement device type is shown in Tables AD-5 and AD-6. Water slides had the most occurrences, while coaster rides had the largest observed injury burden.

Table AD-5: Top amusement device types by number of human-factor occurrences for physical impacts (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Water Slides	32.0%	6.3%
Zip Lines	23.9%	4.4%
Coaster Rides	14.7%	2.9%

Table AD-6: Top amusement device types by human-factor observed injury burden for physical impacts (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Coaster Rides	27.4%	2.9%
Circular Rides	22.5%	None
Water Slides	21.0%	6.3%



Sudden Movements

Sudden-movement occurrences of amusement devices accounted for 13.6% of human-factor occurrences on amusement devices and 7.9% of the related observed injury burden. There was an increasing trend in the number of sudden-movement occurrences of 7.1% per year. A breakdown by amusement device type is shown in Tables AD-7 and AD-8. Coaster rides had the most occurrences and the largest observed injury burden.

Table AD-7: Top amusement device types by number of human-factor occurrences for sudden movements (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Coaster Rides	49.4%	None
Water Slides	14.4%	6.6%
Circular Rides	11.8%	None

Table AD-8: Top amusement device types by human-factor observed injury burden for sudden movements (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Coaster Rides	69.0%	None
Inflated Rides	8.2%	None
Go-Karts	5.8%	None

Falls from Height

Fall-from-height occurrences accounted for 12.5% of human-factor occurrences on amusement devices and 30.5% of the related observed injury burden. There was an increasing trend in the number of fall-from-height occurrences of 7.7% per year. A breakdown by amusement device type is shown in Tables AD-9 and AD-10. Water slides had the most occurrences and almost all the observed injury burden.

Table AD-9: Top amusement device types by number of human-factor occurrences for falls from height (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Water Slides	74.2%	8.0%
Circular Rides	9.3%	9.7%
Coaster Rides	3.9%	None

Table AD-10: Top amusement device types by human-factor observed injury burden for falls from height (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Water Slides	97.4%	8.0%
Inflated Rides	1.6%	None
Circular Rides	0.6%	9.7%

Burns

Burns refer to friction burns, and these occurrences accounted for 2.1% of human-factor occurrences on amusement devices and 10.9% of the related observed injury burden. A breakdown by amusement device type is shown in Tables AD-11 and AD-12. Dry slides had the most number of occurrences, while inflated rides had the largest observed injury burden.



Table AD-11: Top amusement device types by number of human-factor occurrences for burns (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Dry Slides	36.9%	None
Water Slides	27.2%	None
Go-Karts	11.7%	None

Table AD-12: Top amusement device types by human-factor observed injury burden for burns (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Inflated Rides	76.5%	None
Dry Slides	9.5%	None
Water Slides	7.8%	None

Compliance

TSSA conducts periodic inspections of all amusement devices at the start of the season to oversee and manage the state of compliance across 2,824 permitted amusement devices in the province of Ontario. Amusement device operations are generally seasonal in nature with a few devices operating all year round. TSSA deals with non-compliances by requiring the owner to address observed failures within an appropriate timeframe through the issuance of inspection orders. This process contributes to the preventative risk management of the inventory. All these devices that had sufficient inspection history were used to calculate a risk score.

For amusement devices, the ride operators perform an important role in ensuring that the users are adhering to the rules for safe riding. Part of TSSA's inspection is to witness the operation of the ride and verify that operating procedures are being followed, thus managing the risk of non-compliance.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 53.9%, with a decreasing trend of 4.7% per year. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table AD-13.

Table AD-13: Top compliance issues by number of orders issued for amusement devices (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
No record of training	2.7%
Hole/tear in inflatable structure	2.6%
Amusement device plate not permanently affixed	2.5%

The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table AD-14. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table AD-14: Top compliance issues by risk of orders issued for amusement devices (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Fencing is required to prevent access	11.0%
Electrical equipment is not guarded	9.6%
Tie downs and anchors are not in place	9.6%



Figure AD-3 and Table AD-15 provide information on key indicators associated with the results of periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass/fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 3.7% to 5.7% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk. In fiscal year 2019, about 95.5% of inspections were either fully compliant (52.7%) or had only minor issues (42.8%). Some examples of minor issues included: missing device information plates; missing signage; records of training not in the logbook; missing information from the technical dossier; and each passenger carrying unit not identified with markers, letters or colours.

Figure AD-3: Inspection risk spectrums from outcomes of periodic inspections conducted on amusement devices (2015 – 2019).

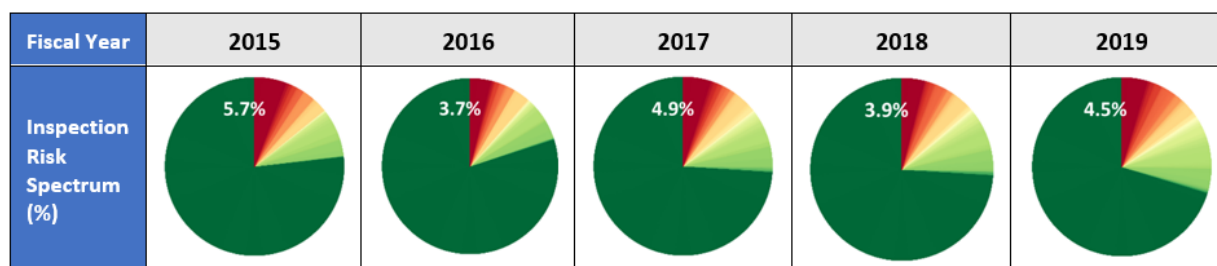


Table AD-15: Inventory risk profiles from outcomes of periodic inspections conducted on amusement devices (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	N/A	0.0%	0.0%	0.0%	1.0%
		6.7%	3.9%	4.2%	5.3%
		93.3%	96.1%	95.7%	93.6%

Using a risk-based approach, an inventory risk profile was generated. As of fiscal year 2019, there were 29 high-risk devices (1.0% of the qualified provincial inventory). Circular rides accounted for the most numerous type of high-risk device (41.4% of all high-risk devices). See Table AD-16 for further details.

Table AD-16: Top high-risk amusement device types (2019).

Device Type	Percentage of Total High-Risk Devices
Circular Rides	41.4%
Revolving or Swinging Rides	13.8%
Water Slides	10.3%

Refer to Appendix D for inspection and re-inspection results.



III.3.2 Risk Management, Message from Dean McLellan, Interim Amusement Devices Statutory Director

Although reported incidents and near-misses continue to be on the rise in amusement devices, the level of safety continues to be good. The observed injury burden and the risk of injury or fatality are well below any threshold for concern. TSSA has been working with owners over the past few years to clarify incident reporting obligations and, as a result, we are now receiving more complete reporting on minor incidents. TSSA will monitor the high prevalence of human factors as a cause of occurrences and more serious injuries such as concussions, to see if some action can mitigate them.

Most amusement devices are fully compliant and are low risk. Currently, periodic inspections are conducted before a device is available for use to the public. Consequently, some owners may wait until a TSSA inspection before preparing their device for the season. TSSA will continue to encourage owners to review their equipment themselves to ensure compliance at the beginning and throughout the season. An owner's ability to ensure compliance without TSSA intervention will become increasingly important if a risk-based inspection program is to be implemented for amusement devices.

Case Study: Water Slide Incident

Background

A youth went down a water slide at an amusement park and hit his head during the ride. Later, he told his mother what had happened because he felt sick. The family went to the hospital where it was determined that he had a concussion. The family reported this to the amusement park. The ride was then shut down and TSSA was called.

The ride was kept shut down until it was inspected by a mechanic and no issues were found.

TSSA conducted an investigation and it was determined that the rider did not stay in the safe riding position during the ride (i.e., human factors).

Outcome

The park staff received additional training in reviewing the park safe operating procedure to ensure all guests ride safely.

III.4 Elevating Devices – Elevators

State of Public Safety in Ontario –

ELEVATING DEVICES SAFETY PROGRAM ELEVATORS



Inventory	Program Area Activities	Regulated Devices
58,682	- Reviews and registers devices - Issues licences - Conducts inspections - Performs incident investigations - Engineering services	- Passenger, freight, hand-powered, observation, sidewalk, temporary, limited use/application elevators - Dumbwaiters, material & freight platform lifts - Lifts for persons with physical disabilities - Man-lifts, construction hoists, incline lifts, stage lifts, and parking garage lifts

Areas of Concern (2019)	
Actionable Areas	
Elevator Risks in Hospitals	3.33 FE/mpy
User Interactions on Elevators in Retirement and Long-Term Care Homes	0.59 FE/mpy

Top Safety Issues			
Location Type		Occurrence Type	
By Number of Occurrences	By Observed Injury Burden	By Number of Occurrences	By Observed Injury Burden
Offices	Student Residences	Door Closings	Entrapments
Rental Apartments	Condominiums	Unintentional Movements	Door Closings
Condominiums	Rental Apartments	Trips/Falls - Levelling	Fires

Inspection Risk Spectrum (2019)		Inventory Risk Profile (2019)	
	Major Issues	0.2%	0.2%
	Minor Issues	81.5%	2.9%
	Fully Compliant	18.4%	96.9%
Compliance Rate (2015 – 2019)			
21.7%			

Health Impact		
Observed		Potential
0.05 FE/mpy (2008 – 2019) Injury Burden	0.02 FE/mpy (2019) Injury Burden	0.61 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	4,880	1,549	83	9
2019	659	99	2	0

The Elevating Devices Safety Program regulates elevating devices in Ontario to ensure all devices conform to the Act and applicable regulations, codes and standards. TSSA reviews and registers elevating devices, issues licences, conducts inspections, performs incident investigations, registers contractors and certifies mechanics. The Elevating Devices Safety Program consists of three areas: 1) elevators; 2) escalators and moving walks; and 3) passenger ropeways (ski lifts). See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

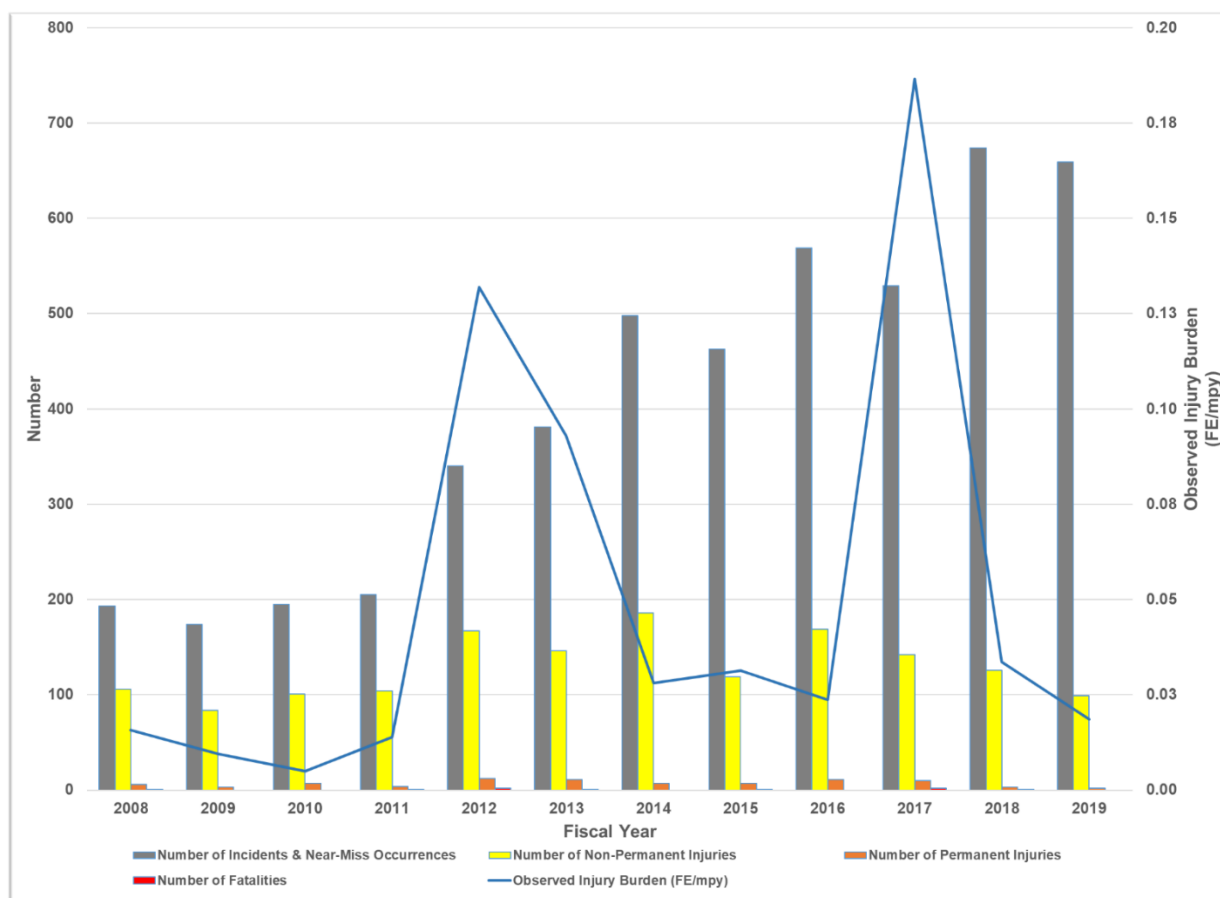


III.4.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 4,880 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 1,549 non-permanent injuries, 83 permanent injuries and nine fatalities reported over the past twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are represented graphically in Figure EL-1 and are tabulated in Appendix A.

Figure EL-1: State of safety across elevators (2008 – 2019).



Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 9.41 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.05 FE/MPY. The observed injury burden for fiscal year 2019 was 0.02 FE/MPY. Injury burden is what has already happened in the past.

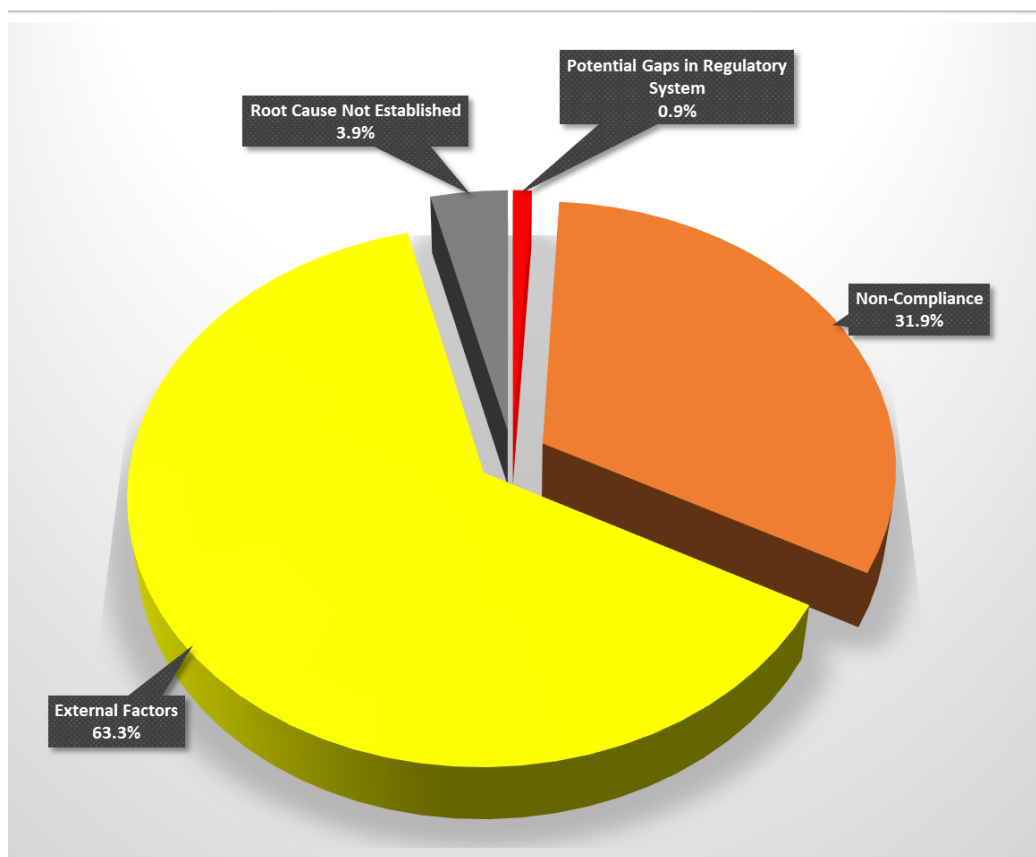
Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using elevators as of fiscal year 2019 to be 0.61 FE/MPY. The RIF is what *might* happen in the future, based on what has happened in the past.

There was an increasing trend in the number of occurrences of 11.9% per year, excluding water-exposure (or flooding) incidents.



Figure EL-2 illustrates the top issues related to elevators in terms of their casual analysis categories. As indicated in this pie chart, about 31.9% of the risk over the past twelve fiscal years (2008 – 2019) was due to non-compliances with the regulatory requirements. There was an increasing trend in the number of these non-compliance occurrences of 7.2% per year. Some examples of this included: a worm shaft sheared at the brake drum coupling; an emergency brake seized in the open position; a hole in the hydraulic cylinder from corrosion; no employee training records; and, a brake replaced by an unauthorized person. In addition, about 63.3% of the risk was due to factors external to the regulatory environment (see Appendix E for further details on external factors). There was an increasing trend in the number of these external-factor occurrences of 12.9% per year, excluding water-exposure incidents.

Figure EL-2: Risk of injury or fatality in elevators by casual analysis category (2008 - 2019).



Risk of Injury or Fatality on Elevators Due to External Factors (2008 – 2019)

Water Exposure

Damage due to water exposure (or flooding) accounted for 42.6% of external-factor elevator incidents and near-miss occurrences. There was an increasing trend in the number of water exposure occurrences of 21.7% per year. It is unclear if this is due to an actual increase in water exposure occurrences or more diligent reporting.

While no health impacts were observed, these occurrences involved water leaking into elevators and elevator shafts, causing damage, and carried the potential of causing injuries due to electrical and physical hazards.

It should be noted that 12.3% of water exposure occurrences were due to inoperative sump pumps. Elevator operators should be encouraged to improve maintenance on their sump pumps to reduce future flooding incidents.



Other External Factors

Human factors were associated with 65.0% of the remaining external-factor elevator incident and near-miss occurrences.

Offices had the most occurrences, while student residences had the largest observed injury burden, as shown in Tables EL-1 and EL-2.

Table EL-1: Top elevator location types by number of external-factor occurrences (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Offices	22.5%	14.7%
Rental Apartment Buildings	21.6%	12.9%
Condominiums	12.6%	14.9%

Table EL-2: Top elevator location types by external-factor observed injury burden (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Student Residences	63.5%	None
Condominiums	13.5%	14.9%
Rental Apartment Buildings	12.0%	12.9%

Door closings were the most numerous occurrence type, while entrapments had the largest observed injury burden, as shown in Tables EL-3 and EL-4.

Table EL-3: Top occurrence types for elevators by number of external-factor occurrences (2008 – 2019).

Occurrence Type	Percentage of Occurrences	Trend (per year)
Door Closings	36.3%	8.4%
Unintentional Movements	18.3%	None
Trips/Falls - Levelling	15.6%	None

Table EL-4: Top occurrence types for elevators by external-factor observed injury burden (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden	Trend (per year)
Entrapments	63.7%	11.2%
Door Closings	16.4%	8.4%
Fires	10.1%	None

The top occurrence types are discussed below in greater detail.

Door Closings

Door-closing occurrences accounted for 36.3% of external-factor occurrences and 16.4% of the associated observed injury burden. There was an increasing trend in the number of door closing occurrences of 8.4% per year. A breakdown by elevator location type is shown in Tables EL-5 and EL-6. Office locations had the most occurrences, while rental apartment buildings had the largest observed injury burden.



Table EL-5: Top elevator location types by number of external-factor occurrences for door closings (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Offices	25.7%	13.4%
Rental Apartment Buildings	16.5%	5.6%
Commercial	15.0%	None

Table EL-6: Top elevator location types by external-factor observed injury burden for door closings (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Rental Apartment Buildings	51.5%	5.6%
Hospitals	28.9%	None
Offices	9.6%	13.4%

Unintentional Movements

Unintentional-movement occurrences of elevators accounted for 18.3% of external-factor occurrences and 1.4% of the associated observed injury burden. A breakdown by elevator location type is shown in Tables EL-7 and EL-8. Office locations had the most occurrences, while rental apartment buildings had the largest observed injury burden.

Table EL-7: Top elevator location types by number of external-factor occurrences for unintentional movements (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Offices	24.9%	None
Rental Apartment Buildings	22.4%	None
Condominiums	19.2%	None

Table EL-8: Top elevator location types by external-factor observed injury burden for unintentional movements (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Rental Apartment Buildings	45.9%	None
Condominiums	34.9%	None
Offices	12.5%	None

Trips/Falls – Levelling

Trip-or-fall occurrences related to elevator levelling accounted for 15.6% of external-factor occurrences and 4.5% of the associated observed injury burden. A breakdown by elevator location type is shown in Tables EL-9 and EL-10. Rental apartment buildings had both the most occurrences and the largest observed injury burden.

Table EL-9: Top elevator location types by number of external-factor occurrences for trips/falls – levelling (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Rental Apartment Buildings	30.5%	None
Offices	26.5%	None
Condominiums	15.1%	None



Table EL-10: Top elevator location types by external-factor observed injury burden for trips/falls – levelling (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Rental Apartment Buildings	38.6%	None
Condominiums	36.3%	None
Offices	19.2%	None

Entrapments

The term “entrapment” when used with elevators refers to the situation where passengers cannot get out of the elevator because the doors do not open.

Entrapment occurrences accounted for 5.9% of external-factor occurrences and 63.7% of the associated observed injury burden. There was an increasing trend in the number of entrapment occurrences of 11.2% per year. A breakdown by elevator location type is shown in Tables EL-11 and EL-12. Rental apartment buildings had the most occurrences, while student residence locations (with only 0.8% of the entrapment occurrences) had almost all the observed injury burden, due to one fatal incident.

Table EL-11 Top elevator location types by number of external-factor occurrences for entrapments (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Rental Apartment Buildings	22.3%	None
Condominiums	19.2%	None
Offices	18.5%	None

Table EL-12: Top elevator location types by external-factor observed injury burden for entrapments (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Student Residences	99.7%	None
Learning Institutions	0.2%	None
Rental Apartment Buildings	0.1%	None

Some examples of learning institutions include schools, colleges and universities.

Entrapment occurrences are typically safe, so long as the passengers remain inside the elevator. Injuries typically occur when passengers try to self-extract themselves from the elevator, e.g., obtaining abrasions or crushing injuries or even falling down the elevator shaft. It is always recommended that entrapped passengers signal for help and wait for properly trained rescue personnel to free them from the elevator.

Fires

Fire occurrences accounted for 3.0% of external-factor occurrences and 10.1% of the associated observed injury burden. A breakdown by elevator location type is shown in Tables EL-13 and EL-14. Rental apartment buildings had the most occurrences, while condominiums had all the observed injury burden.



Table EL-13: Top elevator location types by number of external-factor occurrences for fires (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Rental Apartment Buildings	31.8%	None
Offices	18.2%	None
Condominiums	15.2%	None

Table EL-14: Top elevator location types by external-factor observed injury burden for fires (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Condominiums	100.0%	None

Actionable Areas

Actionable areas are those with RIF values greater than 1.00 FE/mpy for the general population or greater than 0.30 FE/mpy for sensitive sub-populations.

There were two actionable areas identified in the Elevators Safety Program Area this fiscal year:

1. elevator risks in hospitals; and
2. user interactions on elevators in retirement and long-term care homes.

They have been detailed below based on their relative ranking. This ranking is based on the RIF value and/or the deviation of the risk value from the risk acceptability criteria.

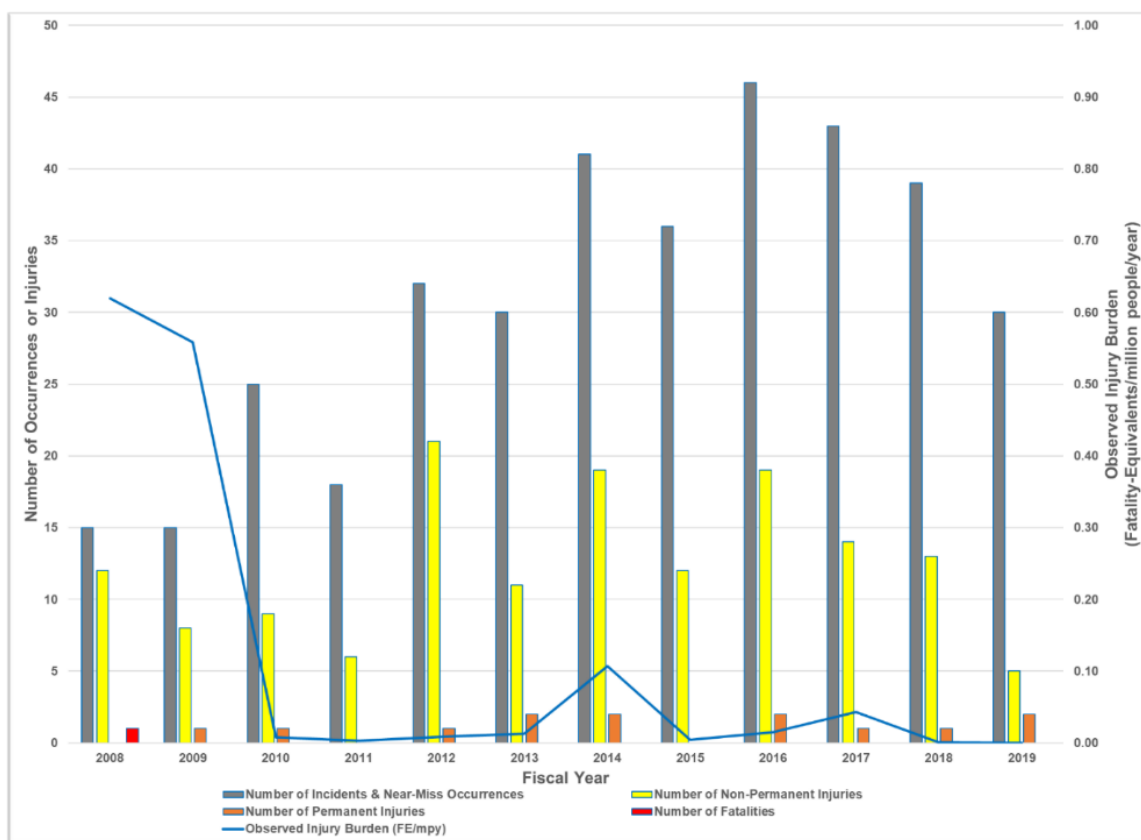
1. Elevator Risks in Hospitals

There have been 370 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 149 non-permanent injuries, 13 permanent injuries and one fatality reported over the past twelve fiscal years (2008 – 2019). Measures representing these historical observations are represented graphically in Figure EL-3 and are tabulated in Appendix A.

Based on available data, there was an actionable level of potential RIF in hospitals as of fiscal year 2019 of 3.33 FE/mpy involving both patient and worker interactions with elevators. Since most of the occurrences involved doors closing on hospital workers wheeling carts or gurneys, the acceptability criterion used was 1.00 FE/mpy. There was an increasing trend in the number of occurrences of 4.5% per year.



Figure EL-3: State of safety of elevator risks in hospitals (2008 – 2019).



Door closings had the most occurrences, while entrapments (with only 5.2% of the occurrences) had the largest observed injury burden, as shown in Tables EL-15 and EL-16.

Table EL-15: Top occurrence types by number of external-factor occurrences for elevators in hospitals (2008 – 2019).

Occurrence Type	Percentage of Occurrences
Door Closings	36.1%
Unintentional Movements	25.1%
Trips/Falls - Levelling	16.5%

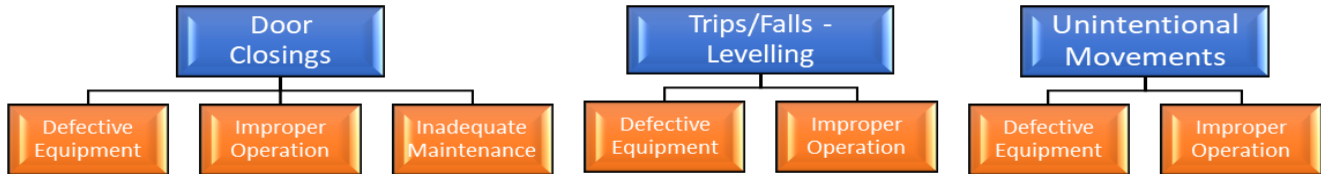
Table EL-16: Top occurrence types by external-factor observed injury burden for elevators in hospitals (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden
Entrapments	48.8%
Door Closings	41.1%
Trips/Falls - Other	3.9%



Figure EL-4 illustrates the contributing causes for elevator safety issues identified in hospitals. It includes occurrences due to door closings, trips/falls due to levelling, and unintentional movements. The primary issue was door closing occurrences which were driven mainly by elevator door speeds that did not provide adequate time for an individual to enter or exit the elevator in a safe manner, particularly when a worker was wheeling a cart or gurney.

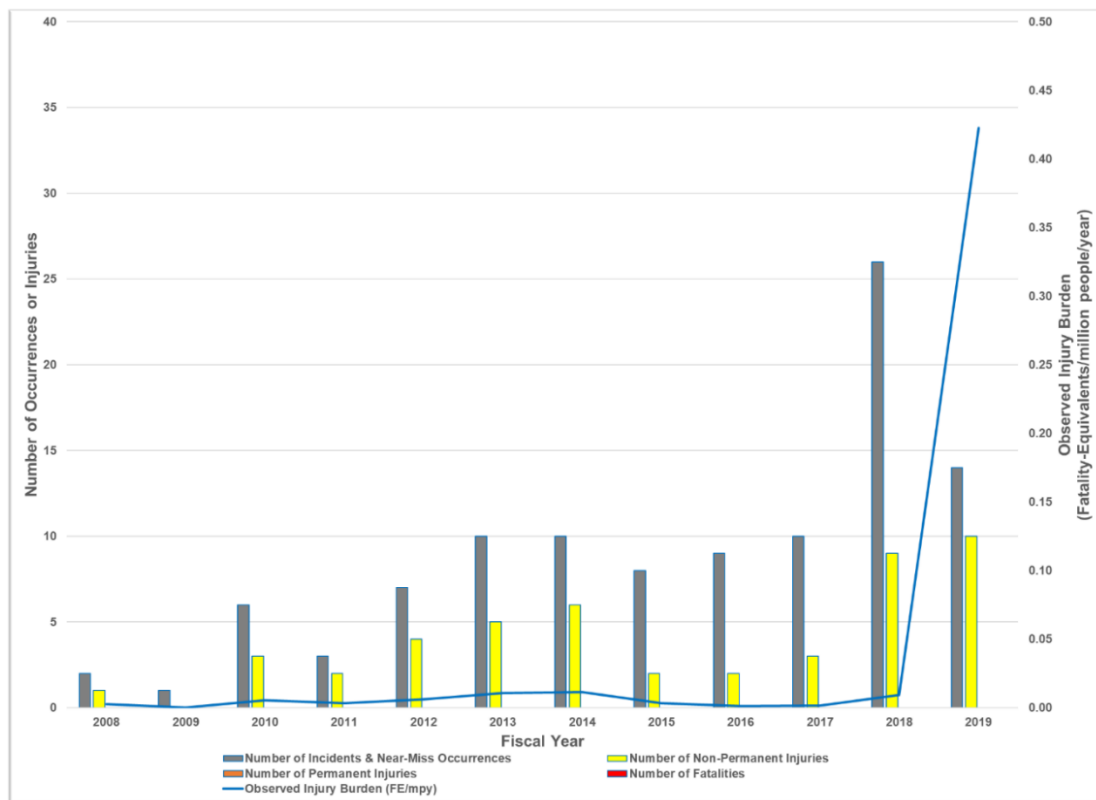
Figure EL-4: Top contributing causes of elevator safety issues in hospitals (2008 – 2019).



2. User Interactions on Elevators in Retirement and Long-Term Care Homes

There have been 106 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 47 non-permanent injuries, zero permanent injuries and zero fatalities reported over the past twelve fiscal years (2008 – 2019). Measures representing these historical observations are represented graphically in Figure EL-5 and are tabulated in Appendix A. Note that the injury burden increased substantially in fiscal year 2019 due to an incident with the victim sustaining a fractured wrist in a door-closing incident.

Figure EL-5: State of safety of user interactions on elevators in retirement and long-term care homes (2008 – 2019).





Based on available data, there was an actionable level of potential RIF in retirement and long-term care homes as of fiscal year 2019 of 0.59 FE/mpy involving resident interaction with elevators. The actionable risk criterion is ≥ 0.30 FE/mpy for this Ontario sensitive sub-population.

Door closings had the most occurrences and the largest observed injury burden, as shown in Tables EL-17 and EL-18.

Table EL-17: Top occurrence types by number of external-factor occurrences for elevators in retirement and long-term care homes (2008 – 2019).

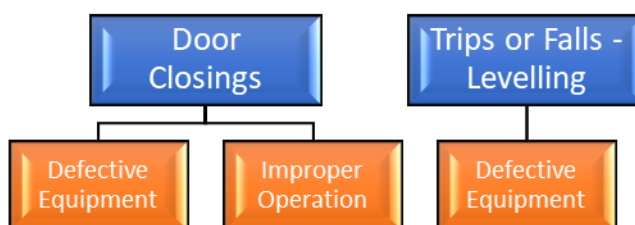
Occurrence Type	Percentage of Occurrences
Door Closings	51.4%
Trips/Falls – Levelling	12.9%
Unintentional Movements	11.4%

Table EL-18: Top occurrence types by external-factor observed injury burden for elevators in retirement and long-term care homes (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden
Door Closings	95.0%
Unintentional Movements	1.6%
Trips/Falls – Levelling	1.5%

There was an increasing trend in the number of occurrences of 12.7% per year. These occurrences were primarily due to elevator car doors closing on passengers. Door closing occurrences were driven mainly by elevator door speeds that did not provide adequate time for the resident to enter or exit the elevator in a safe manner. This risk was further exacerbated when the resident was reliant on a mobility aid. Figure EL-6 illustrates the contributing causes for elevator safety issues identified in retirement and long-term care homes.

Figure EL-6: Top contributing causes of elevator safety issues in retirement and long-term care homes (2008 – 2019).



Compliance

TSSA conducts periodic inspections of all elevators using a risk-based approach to oversee and manage the state of compliance across 58,682 elevators in the province of Ontario. TSSA deals with non-compliances by requiring the owner to address observed failures within an appropriate timeframe through the issuance of inspection orders. This process contributes to the preventative risk management of the inventory. There were 47,001 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 21.7%, with a decreasing trend of 1.6% per year. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders



issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table EL-19.

Table EL-19: Top compliance issues by number of orders issued for elevators (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Late annual periodic task for emergency power and lowering operation	2.3%
Late annual periodic task for firefighter's emergency operation	1.9%
Late annual periodic task for normal and final terminal stopping devices	1.7%

The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table EL-20. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table EL-20: Top compliance issues by risk of orders issued for elevators (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Oily brake liners	7.6%
Drive machine brakes inadequate stopping and holding capacity	7.3%
Low oil level in tank	6.8%

Figure EL-7 and Table EL-21 provide information on key indicators associated with the results of the periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass or fail), the inspection risk spectrum (shown as pie charts) portrays the potential safety risks associated with non-compliances. As indicated by the dark red segments, the spectrums show that 0.1% to 0.3% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk. In fiscal year 2019, about 99.9% of inspections were either fully compliant (18.4%) or had only minor issues (81.5%). Some examples of minor issues included: overdue periodic testing; the car top not being cleaned; missing data plate for counterweight; current licence not posted in a conspicuous location; and, pit lighting being inoperative.

Figure EL-7: Inspection risk spectrums from outcomes of periodic inspections conducted on elevators (2015 – 2019).

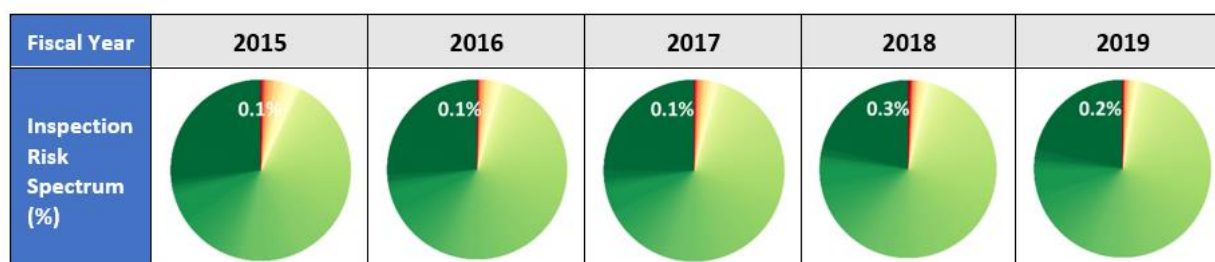


Table EL-21: Inventory risk profiles from outcomes of periodic inspections conducted on elevators (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	1.9%	0.1%	0.0%	0.3%	0.2%
	0.7%	4.8%	2.9%	3.0%	2.9%
	97.4%	95.1%	97.1%	96.7%	96.9%



Using a risk-based approach, an inventory risk profile was generated. As of fiscal year 2019, there were 102 high-risk devices (0.2% of the qualified provincial inventory). The most numerous type location with high-risk devices was offices, which made up 19.6% of locations with high-risk devices. See Table EL-22 for further details.

Table EL-22: Top high-risk elevator location types (2019).

Location Type	Percentage of Total High-Risk Elevators
Offices	19.6%
Industrial	15.7%
Rental Apartment Buildings	14.7%

Refer to Appendix D for inspection and re-inspection results.

Elevator Availability

Ontario Regulation 209/01, Elevating Devices, which governs TSSA's scope of elevator activities, does not include elevator availability. TSSA's focus is elevator *safety*. Hence, TSSA does not have historical data on elevator availability.

However, there is a secondary effect of elevators being unavailable. If an elevator is out of service, then there are accessibility issues for users, particularly for sensitive sub-population individuals, who may not be able to climb the stairs. In addition, first responders would not have the use of an elevator in an emergency.

TSSA has now started recording basic availability information when inspectors are sent out on inspections and will be discussed by the statutory director in his message below.

For further details, refer to the "TSSA Elevator Availability Study Final Report" [8].

III.4.2 Risk Management, Message from Dean McLellan, Interim Elevators Statutory Director

Risks on Elevators in Hospitals

TSSA recognizes that this continues to be an issue, as it first emerged as an area of concern last year. Over the coming year, TSSA will continue to monitor elevator incidents at hospitals and analyze the data to determine what actions may be most beneficial in reducing harm.

Managing Risks on Elevators in Retirement and Long-Term Care Homes

Over the past year, TSSA inspectors have continued to raise awareness among operators of retirement and long-term care homes of the risks associated with elevators. Specifically, inspectors are encouraging owners to make adjustments to elevator door operations that give seniors more time to enter and exit elevator safely. Creating this awareness is consistent with TSSA's corporate strategic goal for 'Safety Awareness and Active Compliance'.

Suspensions of Licences

In response to a recommendation from the Auditor General of Ontario, this past year TSSA implemented a new process when a device is taken out of service by a TSSA inspector due to a major safety issue or when an owner advises TSSA they are shutting down a device.

Reducing Burden on Business

Consistent with our goal of continually seeking opportunities to reduce burden on industry stakeholders, TSSA recently removed the prescriptive code requirement to replace suspension ropes on wind tower turbine elevators after five years of use. In lieu of this prescriptive requirement, TSSA moved to well established practices for determining rope replacement used by the conventional elevator industry, which focuses more on actual physical condition rather than number of years in service.



Educating Elevator Mechanics

Consistent with our corporate strategic goal of 'Safety Awareness, Active Compliance', TSSA undertook an initiative this past year to reach out and educate elevator mechanics on a variety of topics which included: mechanic responsibilities; incident reporting; and, ensuring the safety of devices before returning them to service. This initiative was embraced by several of the larger elevator companies who created opportunities for an inspection group to meet with most of their front-line maintenance mechanics.

Elevator Availability

TSSA inspectors collected data during their regular inspections between October 2018 and February 2019 that has further refined our understanding of the state of availability in Ontario. The data looked at the duration of outage at the time of inspection and factors affecting the duration, such as labour, parts, etc. The key finding is that the data shows an estimated average uptime of 90% for residential elevators, which is significantly worse than was estimated through the Cunningham report which was released last year. TSSA will continue to analyze the collected data to assist the Ministry of Government and Consumer Services with future decision-making.

Case Study: Unintended Movement of an Elevator

Background

When an elevator was called to the upper floor of a condominium, it failed to stop and hold. It then ran with the doors open, ending up at the very top of the elevator shaft. Fortunately, there were no injuries.

TSSA had previously performed a periodic inspection in the previous year, with orders issued for brakes, overdue testing and equipment guarding.

TSSA issued orders to remove the elevator from service until the problem was corrected.

Outcome

Worn brake arms, pins and O-rings were replaced. In addition, TSSA performed an in-depth root cause analysis and determined that improper/negligent work practices were the root cause by failing to maintain the brakes.

III.5 Elevating Devices – Escalators and Moving Walks

State of Public Safety in Ontario –

ELEVATING DEVICES SAFETY PROGRAM ESCALATORS AND MOVING WALKS



Inventory	Program Area Activities
2,282	- Reviews and registers devices - Issues licences - Conducts inspections - Performs incident investigations - Registers contractors and certifies mechanics - Engineering services

Top Safety Issues			
Location Type		Occurrence Type	
By Number of Occurrences	By Observed Injury Burden	By Number of Occurrences	By Observed Injury Burden
Mass Transportation Commercial Offices	Commercial Mass Transportation Assemblies	Trips/Falls Entrapments Falling Objects	Trips/Falls Entrapments Unintentional Movements

Inspection Risk Spectrum (2019)			Inventory Risk Profile (2019)	
	Major Issues	0.6%	High Risk	0.0%
	Minor Issues	88.9%	Medium Risk	2.9%
	Fully Compliant	10.5%	Low Risk	97.1%
			Compliance Rate (2015 – 2019)	
		10.8%		

Health Impact		
Observed		Potential
0.02 FE/mpy (2008 – 2019) Injury Burden	0.00 FE/mpy (2019) Injury Burden	0.05 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	7,291	4,945	44	1
2019	769	513	3	0

The Elevating Devices Safety Program regulates elevating devices in Ontario to ensure all devices conform to the Act and applicable regulations, codes and standards. TSSA reviews and registers elevating devices, issues licences, conducts inspections, performs incident investigations, registers contractors and certifies mechanics. The Elevating Devices Safety Program consists of three areas: 1) elevators; 2) escalators and moving walks; and 3) passenger ropeways (ski lifts). See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

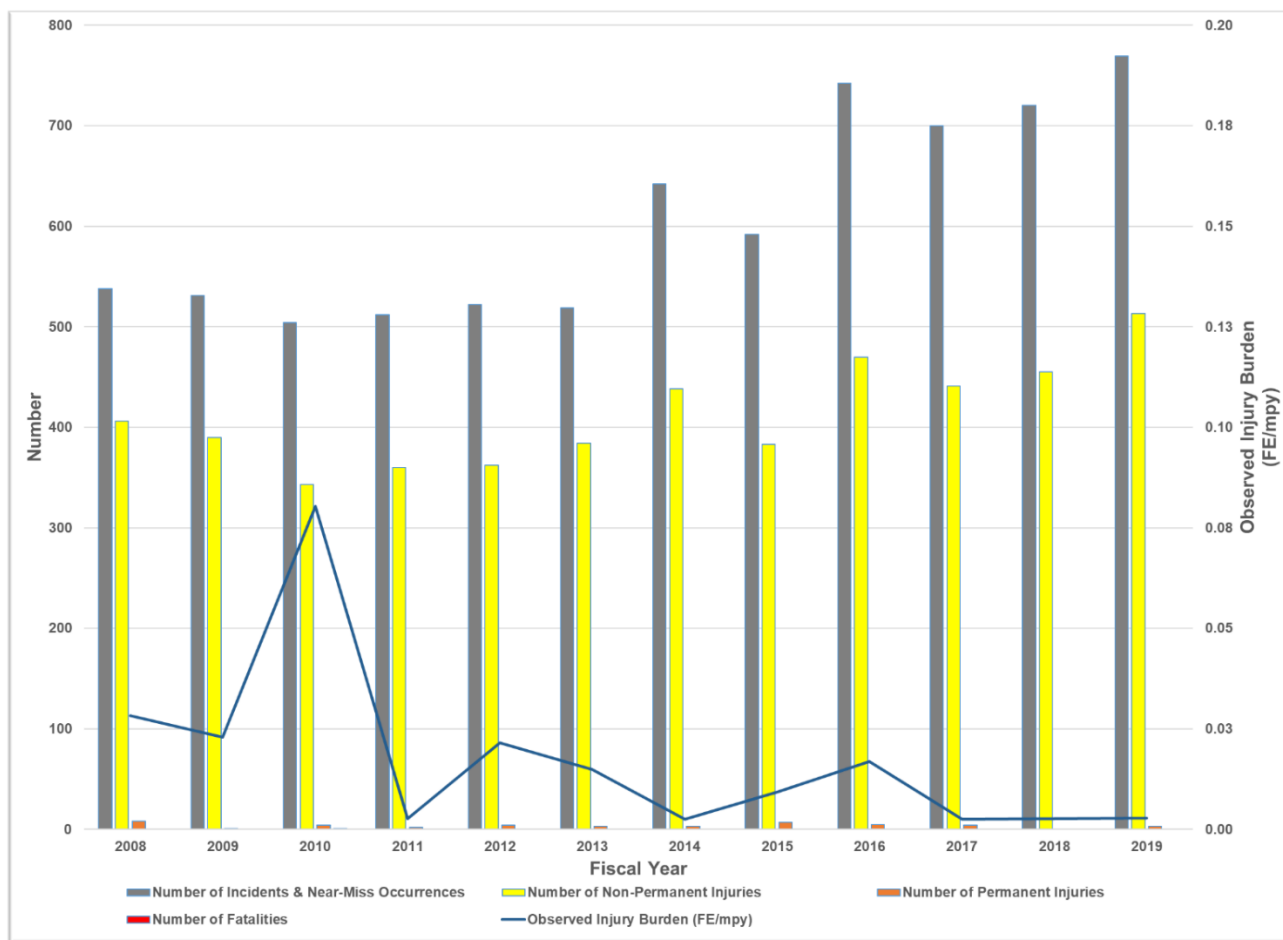


III.5.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 7,291 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 4,945 non-permanent injuries, 44 permanent injuries and one fatality reported over the past twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are represented graphically in Figure EM-1 and tabulated in Appendix A.

Figure EM-1: State of safety across escalators and moving walks (2008 – 2019).



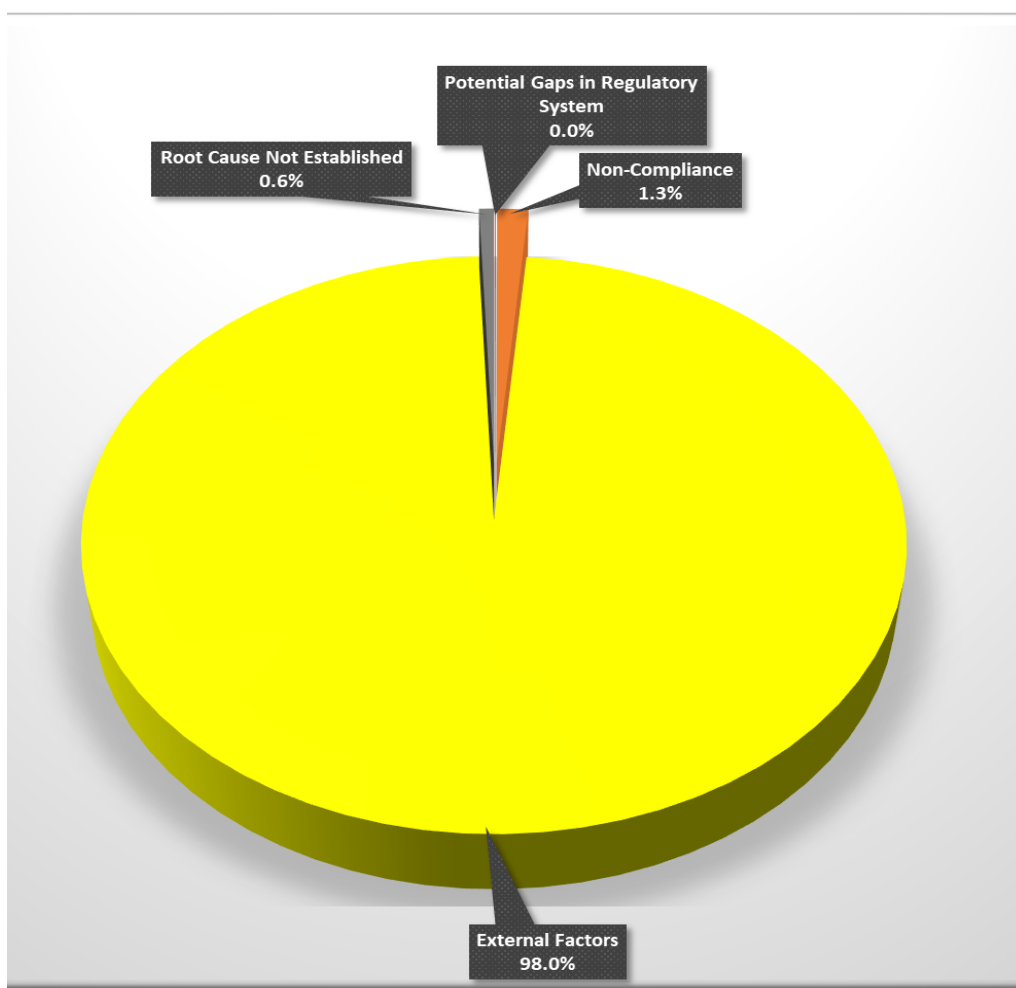
Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 28.78 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.02 FE/imp. The observed injury burden for fiscal year 2019 was approximately 0.00 FE/imp. Injury burden is what has already happened in the past.

Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using escalators and moving walks as of fiscal year 2019 to be 0.05 FE/imp. The RIF is what *might* happen in the future, based on what has happened in the past.

There were increasing trends in the number of occurrences and non-permanent injuries of 4.0% and 2.4% per year, respectively. There was no demonstrable trend in the number of permanent injuries.

Figure EM-2 illustrates the top issues related to escalators and moving walks in terms of their casual analysis categories. As indicated in the pie chart, about 1.3% of the risk over the past twelve fiscal years (2008 – 2019) was due to non-compliances with the regulatory requirements. There were no demonstrable trends in the number of these non-compliance occurrences. Some examples of this included: a relay coil failure in a controller; steps piled up on broken comb plates a handrail stopped; bull gear bolts loosened and sheared; and, a step chain jumped out of the drive sprocket. In addition, about 98.0% of the risk was due to factors external to the regulatory environment (see Appendix E for further details on external factors). There was an increasing trend in the number of these occurrences of 4.4% per year.

Figure EM-2: Risk of injury or fatality in escalators and moving walks by casual analysis category (2008 - 2019).



Risk of Injury or Fatality on Escalators and Moving Walks Due to External Factors (2008 – 2019)

Human factors accounted for about 98.5% of external-factor incident and near-miss occurrences.

Mass transportation locations had the most occurrences of all types, while commercial locations had the largest observed injury burden, as shown in Tables EM-1 and EM-2. Some examples of commercial locations include retail stores and shopping malls. Assemblies are locations where the public can congregate; some examples include libraries, churches, museums, convention centres, community centres, casinos, theatres, concerts, tourist attractions and sporting events/facilities.



Table EM-1: Top escalator and moving walk location types by number of external-factor occurrences (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Mass Transportation	56.8%	6.2%
Commercial	34.7%	None
Offices	4.7%	None

Table EM-2: Top escalator and moving walk location types by external-factor observed injury burden (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Commercial	80.6%	None
Mass Transportation	13.2%	6.2%
Assemblies	4.1%	13.9%

Trips/falls were the most numerous occurrence type and had the largest observed injury burden, as shown in Tables EM-3 and EM-4.

Table EM-3: Top occurrence types for escalators and moving walks by number of external-factor occurrences (2008 – 2019).

Occurrence Type	Percentage of Occurrences	Trend (per year)
Trips/Falls	78.5%	7.2%
Entrapments	10.1%	3.4%
Falling Objects	1.3%	-10.8%

Table EM-4: Top occurrence types for escalators and moving walks by external-factor observed injury burden (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden	Trend (per year)
Trips/Falls	89.0%	7.2%
Entrapments	10.2%	3.4%
Unintentional Movements	0.2%	None

The top occurrence types are discussed below in greater detail.

Trips/Falls

Trip-or-fall occurrences accounted for 78.5% of external-factor occurrences and 89.0% of the associated observed injury burden. There was an increasing trend in the number of trip or fall occurrences of 7.2% per year. A breakdown by escalator and moving walk location type is shown in Tables EM-5 and EM-6. Mass transportation locations had the most occurrences, while commercial locations had the largest observed injury burden.

Table EM-5: Top escalator and moving walk location types by number of external-factor occurrences for trips/falls (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Mass Transportation	59.9%	8.7%
Commercial	32.5%	3.8%
Offices	4.0%	5.8%



Table EM-6: Top escalator and moving walk location types by external-factor observed injury burden for trips/falls (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Commercial	78.7%	3.8%
Mass Transportation	14.5%	8.7%
Assemblies	4.6%	11.4%

Entrapments

Note that the term “entrapment” when used with escalators has a different meaning than when used with elevators. In this case, it refers to the consequence that could result when a user’s body parts, clothing, footwear or accessories becomes physically caught in the moving parts of an escalator or moving walk.

Entrapment occurrences accounted for 10.1% of external-factor occurrences and 10.2% of the associated observed injury burden. There was an increasing trend in the number of entrapment occurrences of 3.4% per year. A breakdown by escalator and moving walk location type is shown in Tables EM-7 and EM-8. Mass transportation locations had the most occurrences, while commercial locations had the largest observed injury burden.

Table EM-7: Top escalator and moving walk location types by number of external-factor occurrences for entrapments (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Mass Transportation	55.1%	5.5%
Commercial	37.6%	None
Offices	4.6%	None

Table EM-8: Top escalator and moving walk location types by external-factor observed injury burden for entrapments (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Commercial	98.0%	None
Mass Transportation	1.6%	5.5%
Offices	0.2%	None

Falling Objects

Falling-object occurrences accounted for 1.3% of external-factor occurrences and 0.1% of the associated observed injury burden. There was a decreasing trend in the number of falling object occurrences of 10.8% per year. A breakdown by escalator and moving walk location type is shown in Tables EM-9 and EM-10. Commercial locations had both the most occurrences and the largest observed injury burden.

Table EM-9: Top escalator and moving walk location types by number of external-factor occurrences for falling objects (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Commercial	90.2%	-9.9%
Mass Transportation	7.6%	None
Offices	1.1%	None



Table EM-10: Top escalator and moving walk location types by external-factor observed injury burden for falling objects (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Commercial	92.0%	-9.9%
Mass Transportation	8.0%	None

Unintentional Movements

Unintentional-movement occurrences of escalators and moving walks accounted for 1.3% of external-factor occurrences and 0.2% of the associated observed injury burden. A breakdown by escalator and moving walk location type is shown in Tables EM-11 and EM-12. Commercial locations had both the most occurrences and the largest observed injury burden.

Table EM-11: Top escalator and moving walk location types by number of external-factor occurrences for unintentional movements (2008 – 2019).

Location Type	Percentage of Occurrences	Trend (per year)
Commercial	46.1%	None
Mass Transportation	37.1%	None
Offices	14.6%	None

Table EM-12: Top escalator and moving walk location types by external-factor observed injury burden for unintentional movements (2008 – 2019).

Location Type	Percentage of Observed Injury Burden	Trend (per year)
Commercial	86.1%	None
Mass Transportation	8.8%	None
Offices	5.0%	None

Compliance

TSSA conducts periodic inspections of all escalators and moving walks to oversee and manage the state of compliance across 2,282 escalators and moving walks in the province of Ontario. TSSA deals with non-compliances by requiring the owner to address observed failures within an appropriate timeframe through the issuance of inspection orders. This process contributes to the preventative risk management of the inventory. There were 1,602 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 10.8%, with no demonstrable trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table EM-13.

Table EM-13: Top compliance issues by number of orders issued for escalators and moving walks (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Late annual periodic task for skirt/step performance index	5.1%
Inspection not allowed to be performed	2.7%
Late maintenance task for escalator cleaning	2.5%



The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table EM-14. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table EM-14: Top compliance issues by risk of orders issued for escalators and moving walks (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Inadequate brake torque	28.5%
Incorrect no-loading stopping distance	12.5%
Oily brake liners	2.3%

Figure EM-3 and Table EM-15 provide information on key indicators associated with the results of periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass or fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 0.0% to 0.6% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels or risk. In fiscal year 2019, about 99.4% of inspections were either fully compliant (10.5%) or had only minor issues (88.9%). Some examples of minor issues included: overdue periodic testing; missing signage; inoperative lighting in the machine space; the brake adjustment procedure not being posted; and, records of authorized trained personnel not available.

Figure EM-3: Inspection risk spectrums from outcomes of periodic inspections conducted on escalators and moving walks (2015 – 2019).

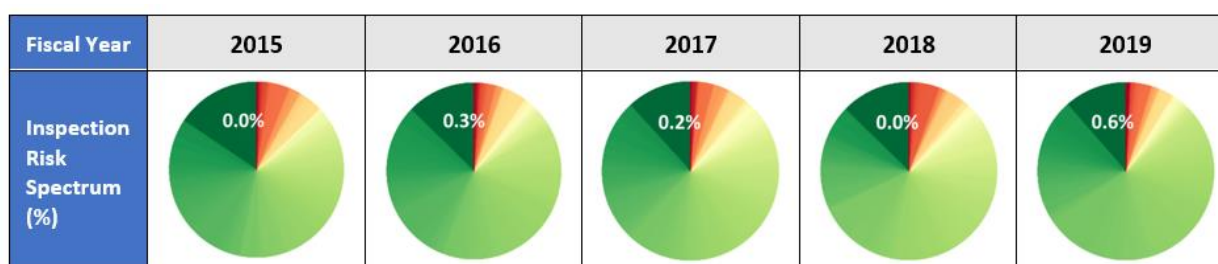


Table EM-15: Inventory risk profiles from outcomes of periodic inspections conducted on escalators and moving walks (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	4.0%	0.0%	0.0%	0.1%	0.0%
	0.2%	7.8%	2.9%	2.6%	2.9%
	95.8%	92.2%	97.1%	97.4%	97.1%

Using a risk-based approach, the inventory profile indicated that as of fiscal year 2019, there were zero high-risk devices and 47 medium-risk devices (2.9% of the qualified provincial inventory). Approximately 57.4% of all medium-risk devices were found in commercial locations. See Table EM-16 for further details.



Table EM-16: Top medium-risk escalator and moving walk location types (2019).

Location Type	Percentage of Total Medium-Risk Escalators and Moving Walks
Commercial	57.4%
Offices	19.1%
Assemblies	12.8%

Refer to Appendix D for inspection and re-inspection results.

III.5.2 Risk Management, Message from Dean McLellan, Interim Escalators Statutory Director

Escalators and moving walks continue to have an excellent safety record, with the observed injury burden and the risk of injury or fatality remaining quite low. Increasing trends in trip/fall occurrences and entrapments underline the need for awareness about escalator safety. Population growth and increased urbanization may be contributing factors to this, but it is nonetheless important to remind escalator users to be mindful when stepping on and off an escalator and to secure loose clothing while riding.

Fortunately, very few major issues are found during inspections. In fact, less than one percent of all periodic inspections this past year found major safety issues and there were no escalators or moving walks deemed to be high risk. TSSA will continue to work with owners and contractors to promote compliance.

Case Study: Trip/Fall on an Escalator

Background

A passenger was riding up an escalator in a supermarket when it suddenly stopped, causing the passenger to trip and fall forward. The victim received some scratches on his shins. The owner immediately shut down the escalator and blocked it off with safety partitions, taking it out of service.

After investigation, it was determined that the handrail drive system was worn and caused the handrail to slip. The unit's handrail sensor had activated and shut the unit down.

Outcome

Repairs included replacing the drive belts and pulleys, adjusting the handrail tension and testing operation. All safety switches were also verified. TSSA reviewed repairs and tests before allowing the escalator to be returned to service.

III.6 Elevating Devices – Passenger Ropeways (Ski Lifts)

State of Public Safety in Ontario –

ELEVATING DEVICES SAFETY PROGRAM PASSENGER ROPEWAYS (SKI LIFTS)



Inventory	Program Area Activities
253	- Regulates bar & chair lifts, outdoor recreational conveyers, rope & tube tows - Reviews and registers lift designs - Conducts inspections and performs incident investigations - Licenses lift devices - Certifies mechanics - Engineering services - Promotes safer ski lift behaviour

Top Safety Issues			
Device Type		Occurrence Type	
By Number of Occurrences	By Observed Injury Burden	By Number of Occurrences	By Observed Injury Burden
Chair Lifts	Chair Lifts	Trips/Falls	Falls from Height
Bar Lifts	Passenger Conveyors	Physical Impacts	Physical Impacts
Passenger Conveyors	Bar Lifts	Falls from Height	Entrapments

Inspection Risk Spectrum (2019)		
	Major Issues	3.9%
	Minor Issues	55.5%
	Fully Compliant	40.6%

Inventory Risk Profile (2019)	
High Risk	8.8%
Medium Risk	2.5%
Low Risk	88.8%

Compliance Rate (2015 – 2019)	
50.2%	

Health Impact		
Observed		Potential
0.02 FE/mpy (2008 – 2019) Injury Burden	0.01 FE/mpy (2019) Injury Burden	0.02 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	1,051	851	27	0
2019	81	65	1	0

The Elevating Devices Safety Program regulates elevating devices in Ontario to ensure all devices conform to the Act and applicable regulations, codes and standards. TSSA reviews and registers elevating devices, issues licences, conducts inspections, performs incident investigations, registers contractors and certifies mechanics. The Elevating Devices Safety Program consists of three areas: 1) elevators; 2) escalators and moving walks; and 3) passenger ropeways (ski lifts). See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

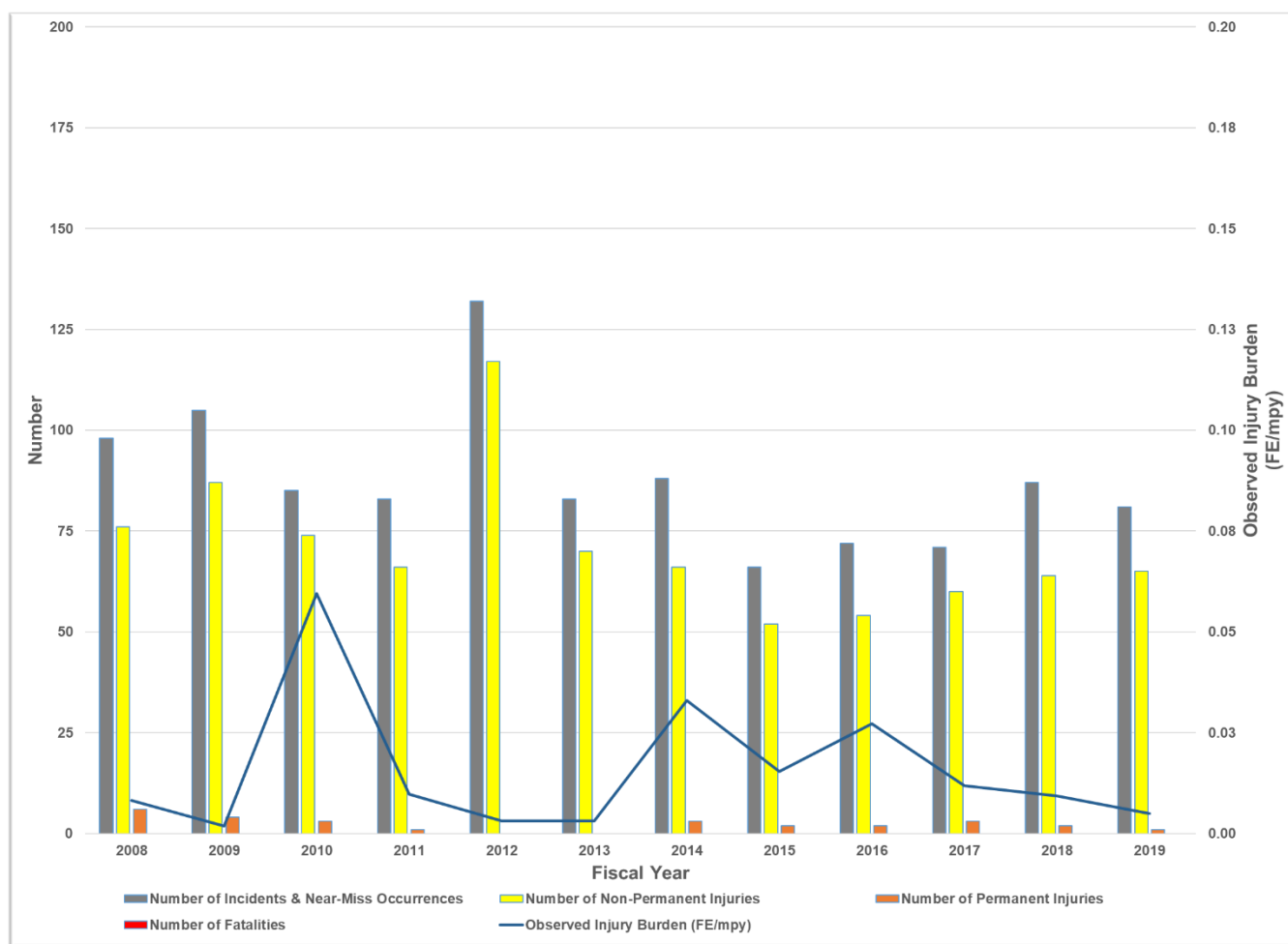


III.6.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 1,051 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 851 non-permanent injuries, 27 permanent injuries and zero fatalities reported over the past twelve fiscal years (2008 – 2019). Measures representing the overall state of safety are represented graphically in Figure SL-1 and tabulated in Appendix A.

Figure SL-1: State of safety across ski lifts (2008 – 2019).



Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 5.06 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.02 FE/mpy. The observed injury burden for fiscal year 2019 was approximately 0.01 FE/mpy. Injury burden is what has already happened in the past.

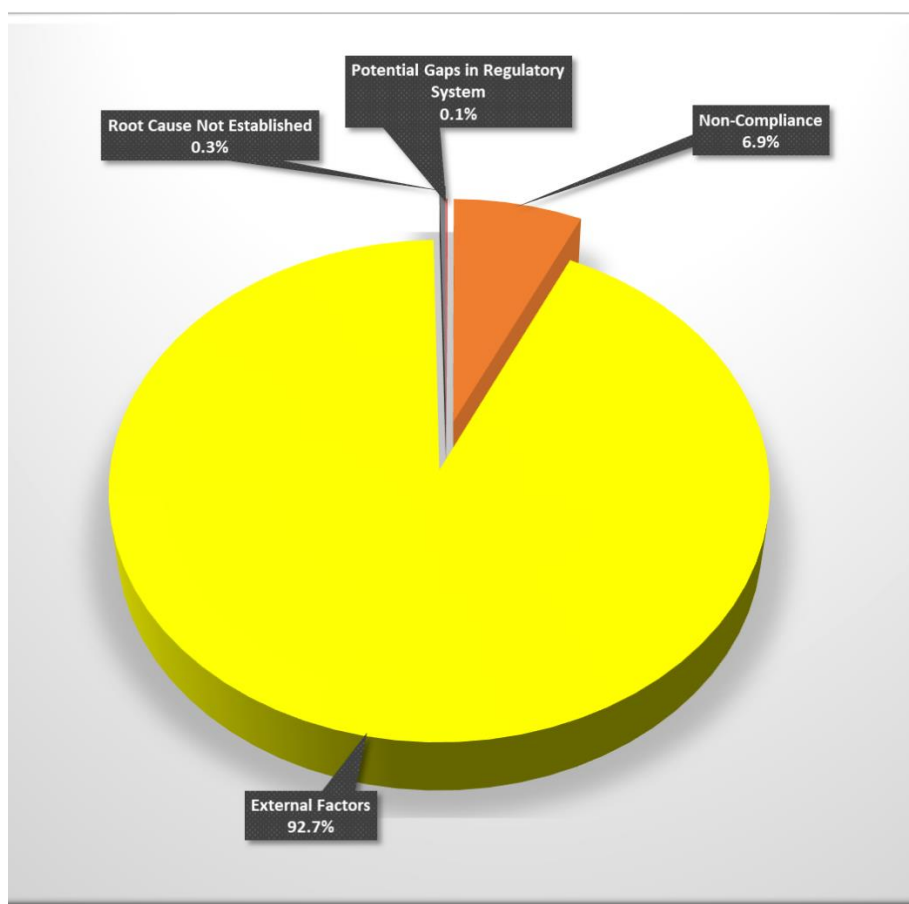
Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using ski lifts as of fiscal year 2019 to be 0.02 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past.

There were no demonstrable trends in the number of occurrences, non-permanent injuries or permanent injuries.



Figure SL-2 illustrates the top issues related to ski lifts in terms of their causal analysis categories. As indicated in the pie chart, about 6.9% of the risk over the past twelve fiscal years (2008 – 2019) was due to non-compliances with the regulatory requirements. Some examples of this included: a cracked seat pivot pin keeper tab; a bull wheel cracked shaft; a broken gearbox pinion shaft; stitching broken at a tow ring; and, a broken heat pad in an electrical panel. In addition, about 92.7% of the risk was due to factors external to the regulatory environment (see Appendix E for further details on external factors). There were no demonstrable trends in risks due to either non-compliances or external factors.

Figure SL-2: Risk of injury or fatality in ski lifts by causal analysis category (2008 - 2019).



Risk of Injury or Fatality on Ski Lifts Due to Human Factors (2008 – 2019)

Human factors accounted for about 99.6% of external-factor incident and near-miss occurrences.

Chair lifts had the most occurrences and the largest observed injury burden, as shown in Tables SL-1 and SL-2.

Table SL-1: Top ski lift types by number of human-factor occurrences (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Chair Lifts	76.3%	None
Bar Lifts	15.6%	None
Passenger Conveyors	4.3%	None



Table SL-2: Top ski lift types by human-factor observed injury burden (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Chair Lifts	87.4%	None
Passenger Conveyors	9.7%	None
Bar Lifts	2.4%	None

Trips/falls were the most numerous occurrence type, while falls from height had the largest observed injury burden, as shown in Tables SL-3 and SL-4.

Table SL-3: Top occurrence types for ski lifts by number of human-factor occurrences (2008 – 2019).

Occurrence Type	Percentage of Occurrences	Trend (per year)
Trips/Falls	40.6%	None
Physical Impacts	34.3%	None
Falls from Height	14.4%	None

Table SL-4: Top occurrence types for ski lifts by human-factor observed injury burden (2008 – 2019).

Occurrence Type	Percentage of Observed Injury Burden	Trend (per year)
Falls from Height	70.9%	None
Physical Impacts	12.7%	None
Entrapments	9.6%	None

The top occurrence types are discussed below in greater detail.

Trips/Falls

Trip-or-fall occurrences accounted for 40.6% of human-factor occurrences and 3.0% of the associated observed injury burden. A breakdown by ski lift type is shown in Tables SL-5 and SL-6. Chair lifts had the most occurrences and the largest observed injury burden.

Table SL-5: Top ski lift types by number of human-factor occurrences for trips/falls (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Chair Lifts	80.7%	None
Passenger Conveyors	7.2%	None
Bar Lifts	6.4%	None

Table SL-6: Top ski lift types by human-factor observed injury burden for trips/falls (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Chair Lifts	91.5%	None
Rope Tows	4.2%	None
Bar Lifts	2.4%	None



Physical Impacts

Physical-impact occurrences accounted for 34.3% of human-factor occurrences and 12.7% of the associated observed injury burden. A breakdown by ski lift type is shown in Tables SL-7 and SL-8. Chair lifts had the most occurrences and the largest observed injury burden.

Table SL-7: Top ski lift types by number of human-factor occurrences for physical impacts (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Chair Lifts	60.8%	None
Bar Lifts	34.8%	None
Rope Tows	2.0%	None

Table SL-8: Top ski lift types by human-factor observed injury burden for physical impacts (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Chair Lifts	82.0%	None
Bar Lifts	17.9%	None
Rope Tows	0.1%	None

Falls from Height

Fall-from-height occurrences accounted for 14.4% of human-factor occurrences and 70.9% of the associated observed injury burden. A breakdown by ski lift type is shown in Tables SL-9 and SL-10. Chair lifts had the most occurrences and most of the observed injury burden.

Table SL-9: Top ski lift types by number of human-factor occurrences for falls from height (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Chair Lifts	95.8%	None
Bar Lifts	2.1%	None
Rope Tows	1.4%	None

Table SL-10: Top ski lift types by human-factor observed injury burden for falls from height (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Chair Lifts	100.0%	None

Entrapments

Note that the term “entrapment” when used with ski lifts refers to the consequence that could result when a user’s body parts, clothing, footwear or accessories becomes physically caught in the moving parts of a ski lift.

Entrapment occurrences accounted for 2.5% of human-factor occurrences and 9.6% of the associated observed injury burden. A breakdown by ski lift type is shown in Tables SL-11 and SL-12. Chair lifts had the most occurrences, while passenger conveyors had the largest observed injury burden.



Table SL-11: Top ski lift types by number of human-factor occurrences for entrapments (2008 – 2019).

Device Type	Percentage of Occurrences	Trend (per year)
Chair Lifts	60.0%	None
Passenger Conveyors	28.0%	None
Rope Tows	8.0%	None

Table SL-12: Top ski lift types by human-factor observed injury burden for entrapments (2008 – 2019).

Device Type	Percentage of Observed Injury Burden	Trend (per year)
Passenger Conveyors	99.7%	None
Chair Lifts	0.2%	None

Compliance

TSSA conducts periodic inspections of all ski lifts using a risk-based approach to oversee and manage the state of compliance across 253 ski lifts in the province of Ontario. TSSA deals with non-compliances by requiring the owner to address observed failures within an appropriate timeframe through the issuance of inspection orders. This process contributes to the preventative management of risk associated with ski lifts. There were 240 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 50.2%, with an 8.4% decreasing trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table SL-13.

Table SL-13: Top compliance issues by number of orders issued for ski lifts (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Sheave assembly misalignment	2.4%
Overhanging tree limbs	2.4%
Gap between belt guides too wide	2.1%

The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table SL-14. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table SL-14: Top compliance issues by risk of orders issued for ski lifts (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Conveyor rigid skirting required	11.4%
Inadequate clearance where people are not permitted	11.3%
Inadequate clearance where people are permitted	10.8%



Figure SL-3 and Table SL-15 provide information on key indicators associated with the results of the periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass or fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 2.8% to 8.5% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk. In fiscal year 2019, about 96.1% of inspections were either fully compliant (40.6%) or had only minor issues (55.5%). Some examples of minor issues included: the machine room lighting not being guarded; missing signage; general housekeeping requirements not being met; towers not being identified with successive numbers; and, start, run, stop and speed control switches not being permanently marked.

Figure SL-3: Inspection risk spectrums from outcomes of periodic inspections conducted on ski lifts (2015 – 2019).

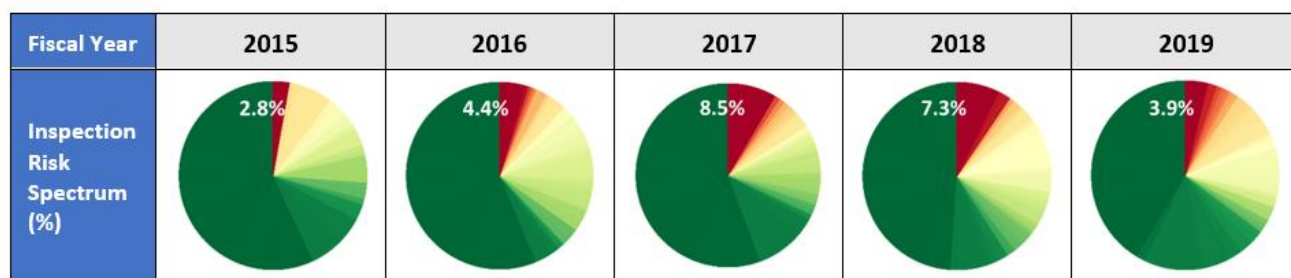


Table SL-15: Inventory risk profiles from outcomes of periodic inspections conducted on ski lifts (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	0.4%	7.8%	0.0%	0.0%	8.8%
	0.4%	31.6%	5.8%	2.5%	2.5%
	99.2%	60.6%	94.2%	97.5%	88.8%

TSSA continues to use a risk-based approach to schedule ski inspections with the inspection frequency ranging from as often as twice a season to once every two years. Using this approach, the inventory risk profile indicated that as of fiscal year 2019, there were 21 high-risk devices (8.8% of the qualified provincial inventory). Chair lifts represented 76.2% of high-risk devices. See Table SL-16 for further details.

Table SL-16: Top high-risk ski lift types (2019).

Device Type	Percentage of Total High-Risk Ski Lifts
Chair Lifts	76.2%
Passenger Conveyors	14.3%
Bar Lifts	4.8%

Refer to Appendix D for inspection and re-inspection results.



III.6.2 Risk Management, Message from Dean McLellan, Interim Ski Lifts Statutory Director

This past year, in partnership with the Ontario Snow Resorts Association, TSSA modernized its public awareness signage that is routinely posted in around ski resorts across Ontario. The signs were redesigned with a more modern feel with a hope that they would be more appealing and resonate with today's skiers. The signs have garnered interest from other industry associations and jurisdictions across Canada who have followed suit and are now using the same signs.

Case Study: Fall from Height on a Ski Lift

Background

A child was loading onto a chair lift with its older sibling. However, the passenger did not sit properly and started to slip out of the chair. The older sibling grabbed the child, but could not hold on, eventually letting go. The victim fell approximately 10 metres and received a fracture.

The ski lift was unloaded and taken out of service. TSSA was then notified.

After investigation, TSSA determined that the accident was a result of employees failing to follow operating procedures (i.e., human factors).

Outcome

The owner reviewed procedures with all staff on a daily basis for loading children onto chair lifts and encouraged them to remain vigilant throughout the day.

III.7 Fuels

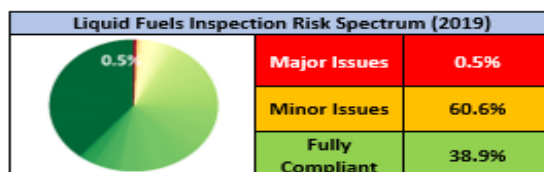
State of Public Safety in Ontario –

FUELS SAFETY PROGRAM



Facilities	Program Area Activities	Fuels Lifecycle	Regulated Fuels
4,207 Liquid Fuels 1,343 Propane	- Licenses fuel facilities - Registers contractors - Certifies tradespersons who install & service equipment - Reviews and approves facility plans for licensed sites - Custom equipment approval - Conducts inspection services - Engineering services	Transmission, Distribution and Transportation Storage and Dispensing Utilization (burning)	- Natural gas - Propane - Butane - Hydrogen - Digester gas - Landfill gas - Liquid fuels (fuel oil, gasoline, diesel)

Areas of Concern ¹ (2019)			
Actionable Areas		Enhanced Monitoring Areas	
CO Risks in Apartments & Condominiums	3.86 FE/mpy	Fuel Risks in Business Units	0.57 FE/mpy
Fuel Risks in Private Dwellings	2.78 FE/mpy		
Fuel Risks in Schools	0.42 FE/mpy		

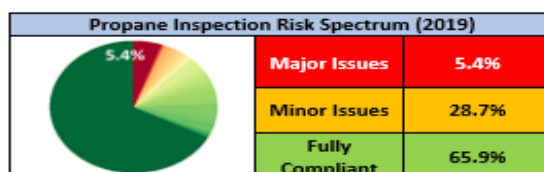


Liquid Fuels Inventory Risk Profile (2019)

Risk Category	Percentage
High Risk	2.1%
Medium Risk	17.1%
Low Risk	80.9%

Liquid Fuels Compliance Rate (2015 – 2019)

42.3%



Propane Inventory Risk Profile (2019)

Risk Category	Percentage
High Risk	4.6%
Medium Risk	5.8%
Low Risk	89.6%

Propane Compliance Rate (2015 – 2019)

72.2%

Health Impact ¹		
Observed		Potential
0.27 FE/mpy (2008 – 2019) Injury Burden	0.08 FE/mpy (2019) Injury Burden	1.41 FE/mpy (2019) Risk of Injury or Fatality

Safety Numbers ¹ (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2019	40,270	565	169	50
2019	2,612	19	13	0

¹ In this year's ASPR, discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes have been included in these numbers.

TSSA's Fuels Safety Program regulates the transportation, storage, handling and use of fuels in Ontario. Fuels under this program include: natural gas; propane; butane; hydrogen; digester gas; landfill gas; fuel oil; gasoline; and, diesel. TSSA licenses fuel facilities, registers contractors and certifies tradespeople who install and service equipment. TSSA also reviews and approves facility plans for sites licensed by TSSA and perform custom equipment approvals and inspection services to ensure safe handling and usage of fuel. See Appendix G for a listing of current legislation and regulatory information. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

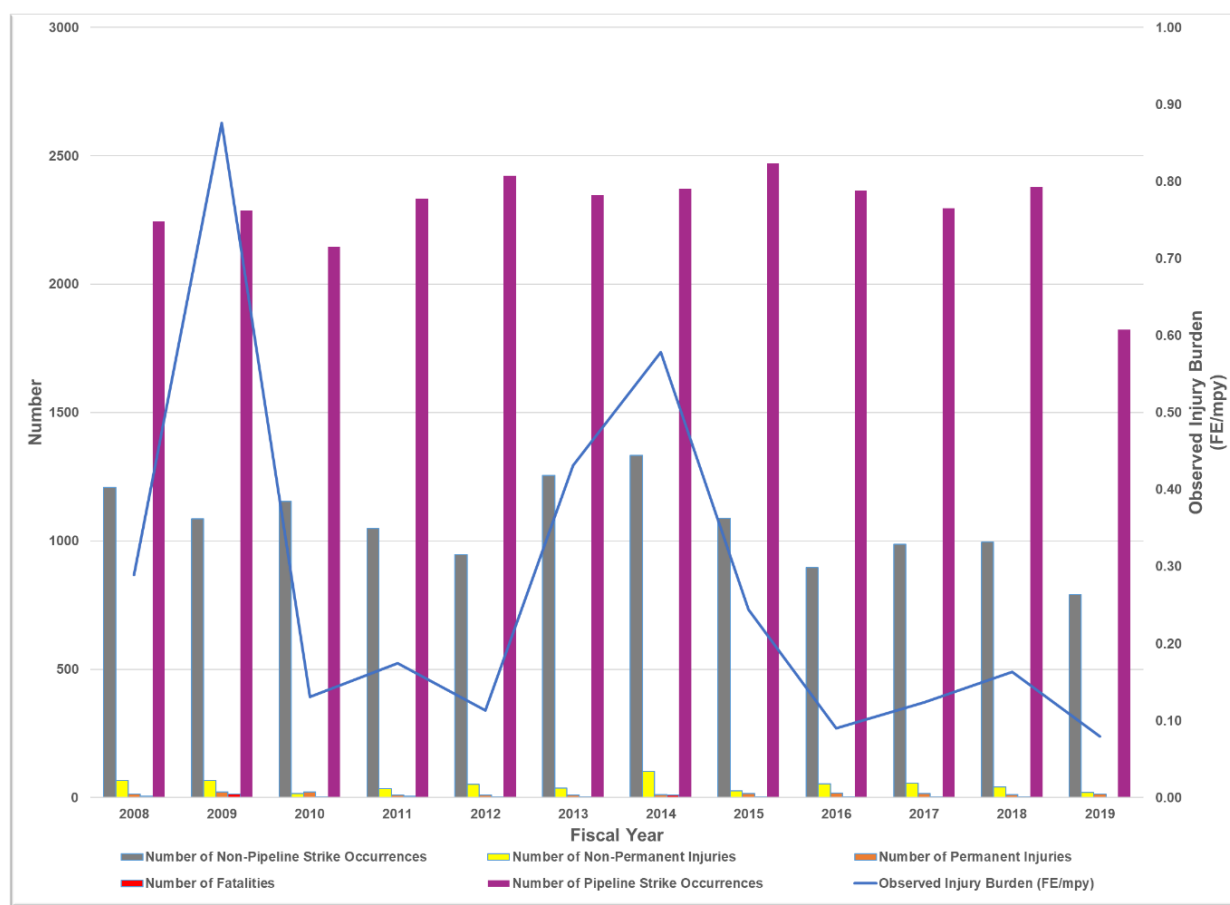
Note that numbers may not add up fully or may exceed the 100th percentile due to rounding off.

III.7.1 Risk Assessment

Incidents, Injuries and Risk Prediction

There have been 40,270 incidents and near-miss occurrences that were reported and had their investigations completed (27,485 pipeline strikes and 12,785 all others), resulting in 565 non-permanent injuries, 169 permanent injuries and 50 fatalities reported over the past twelve fiscal years (2008 – 2019). This year, occurrences related to low health impact, such as discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes, have been included in the totals. Measures representing the overall state of safety are represented graphically in Figure FS-1 and tabulated in Appendix A. This year, the non-pipeline strike incident and near-miss occurrence columns in Figure FS-1 include the addition of discovery of petroleum products, liquid petroleum spills, and leaks, while pipeline strikes are shown in separate columns.

Figure FS-1: State of safety across fuels (2008 – 2019).



Based on the actual injuries observed over the past twelve fiscal years (2008 – 2019), the average rate of injury was 4.23 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 12-year average injury burden of 0.27 FE/MPY. The observed injury burden for fiscal year 2019 was 0.08 FE/MPY. Injury burden is what has already happened in the past.

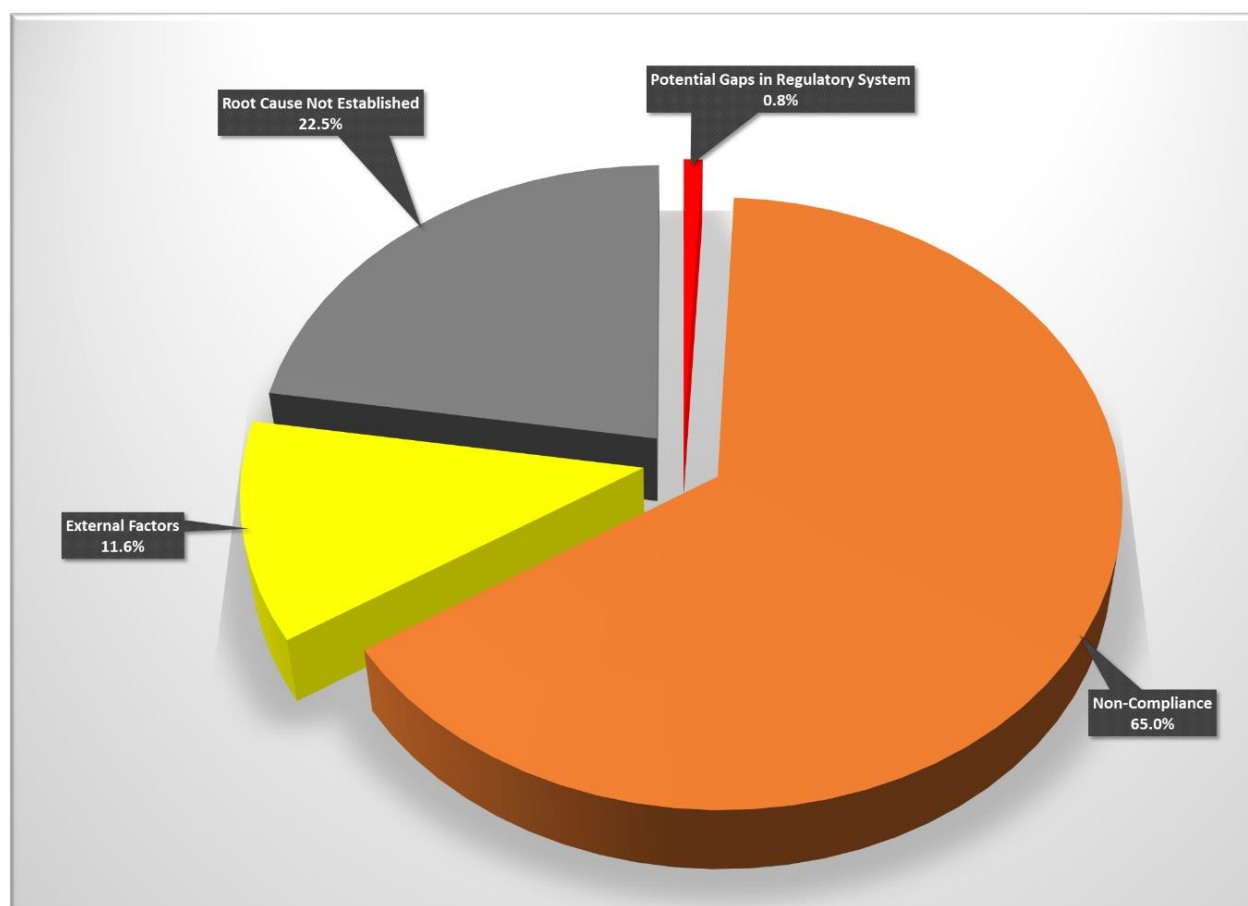
Based on all the occurrences over the past twelve fiscal years (2008 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using fuel-fired appliances as of fiscal year 2019 to be 1.41 FE/MPY. Note that this year, the RIF also includes occurrences and health impacts resulting from discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes. The RIF is what *might* happen in the future, based on what has happened in the past.



There were no demonstrable trends in the number of occurrences, non-permanent or permanent injuries or fatalities.

Figure FS-2 illustrates the top issues related to fuels in terms of their causal analysis categories. As indicated in the pie chart in Figure FS-2, about 65.0% of the risk over the past twelve fiscal years (2008 – 2019) was due to non-compliances with the regulatory requirements. Some examples of this included: fittings on a stove gas connection not being gas tight leading to a vapour release; corroded pool heaters leading to CO release; a cracked furnace heat exchanger leading to CO release; a stove pilot light safety valve stuck in the open position leading to an explosion; and, work on a boiler by uncertified personnel. In addition, about 11.6% of the risk was due to factors external to the regulatory environment (see Appendix E for further details on external factors). There were no demonstrable trends in risks due to either non-compliances or external factors.

Figure FS-2: Risk of injury or fatality in fuels by casual analysis category (2008 - 2019).



Pipeline Strikes

A pipeline strike is a reportable pipeline incident (or near-miss) involving damage to a pipeline, or its protective coating, including gouges, scrapes, dents or creases, resulting in, or having the potential to, damage a pipeline, even if there is no release/spillage of products or substances from the pipeline. Even small disturbances to a pipeline's integrity may cause a future leak due to subsequent corrosion. A pipeline strike can also involve the rupture of an underground natural gas pipeline during an excavation that results in the release of natural gas.

There was a total of 27,485 pipeline strike occurrences reported over the past twelve fiscal years (2008 - 2019), with no demonstrable trend. There were 1,822 pipeline strikes in fiscal year 2019. Historical data is tabulated in Appendix A.



Actionable Areas

Actionable areas are those with RIF values greater than 1.00 FE/mpy for the general population or greater than 0.30 FE/mpy for sensitive sub-populations.

There were three actionable areas identified in the Fuels Safety Program this fiscal year:

1. CO risks in apartments and condominiums;
2. fuel risks in private dwellings; and
3. fuel risks in schools.

They have been detailed below based on their relative ranking. This ranking is based on the RIF value and/or the deviation of the risk value from the risk acceptability criteria.

1. CO Risks in Apartments and Condominiums

This is inclusive of high rises, both rental apartment buildings and condominiums.

There have been 195 reported CO incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 13 non-permanent injuries, zero permanent injuries and one fatality reported over the past twelve fiscal years (2008 - 2019). Measures representing these historical observations are represented graphically in Figure FS-3 and is tabulated in Appendix A.

TSSA's predictive model estimated the potential RIF to Ontarians as of fiscal year 2019 to be 3.86 FE/mpy, or an actionable level of risk. There was no demonstrable trend in the number of related occurrences.

Figure FS-3: State of safety of CO risks in apartments and condominiums (2008 – 2019).

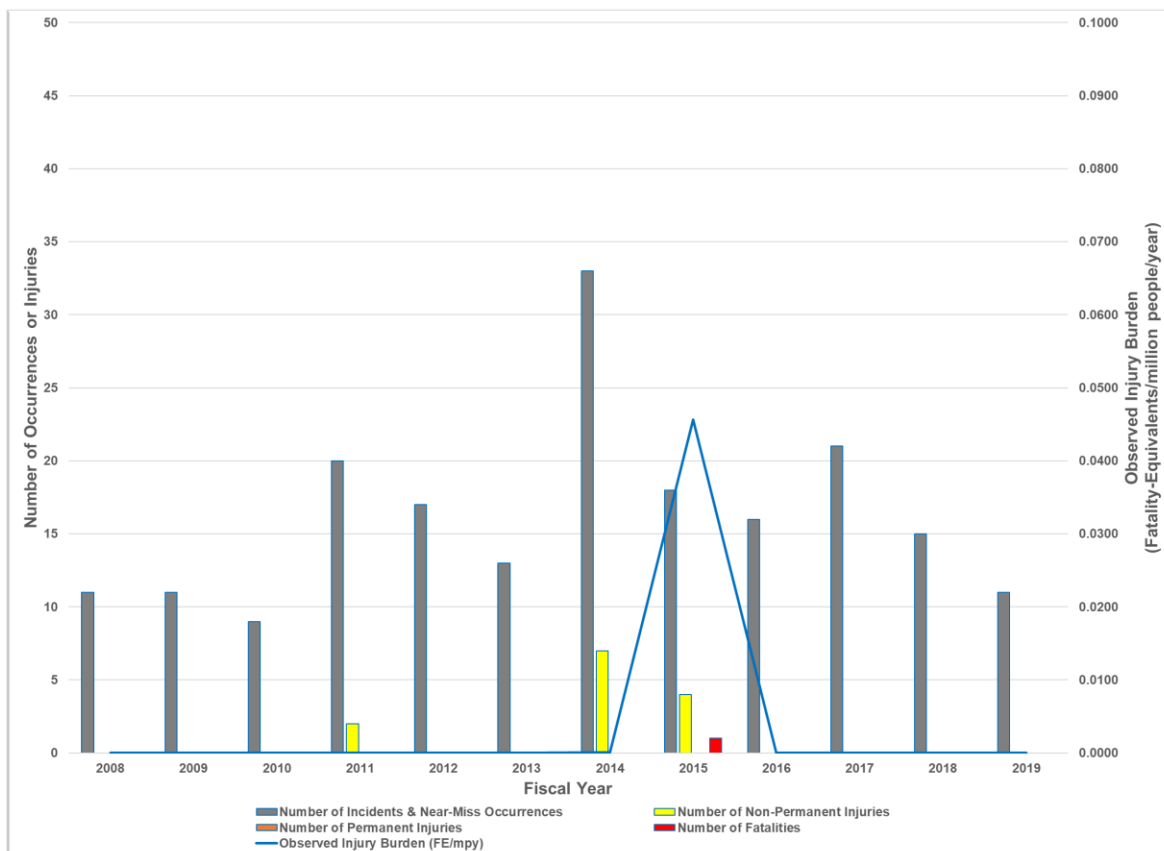
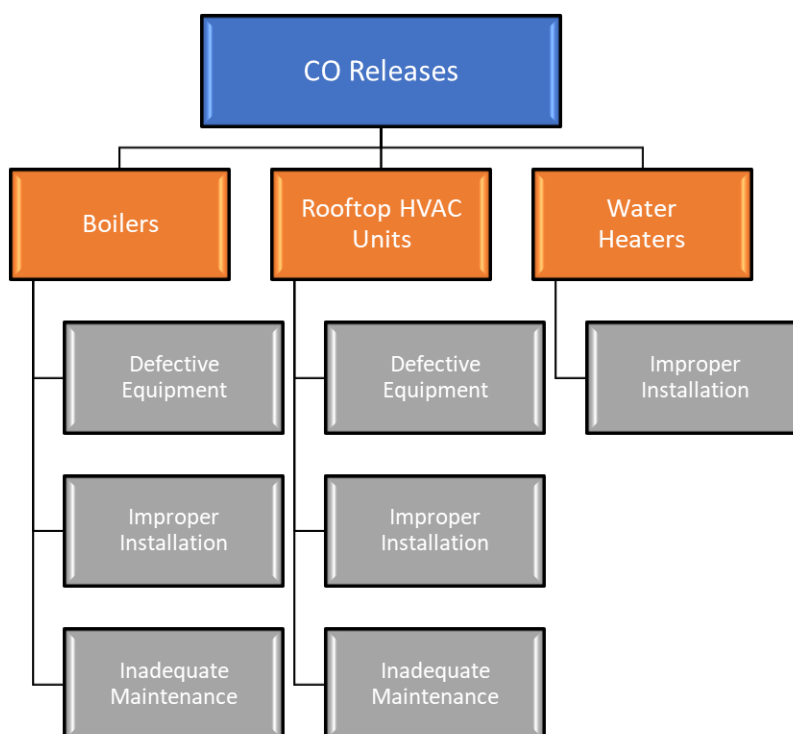


Figure FS-4 illustrates the contributing causes related to CO releases in apartments and condominiums. Occurrences involving boilers, rooftop heating ventilation and air conditioning (HVAC) units, and water heaters represented 38.1%, 30.2% and 11.1% of CO occurrences in apartments respectively.

- Occurrences involving boiler and rooftop HVAC units were mainly due to defective equipment, improper installation and inadequate maintenance.
- Occurrences involving water heaters were mainly due to improper installation.

Figure FS-4: Top contributing causes of CO release safety issues in apartments and condominiums (2008 – 2019).



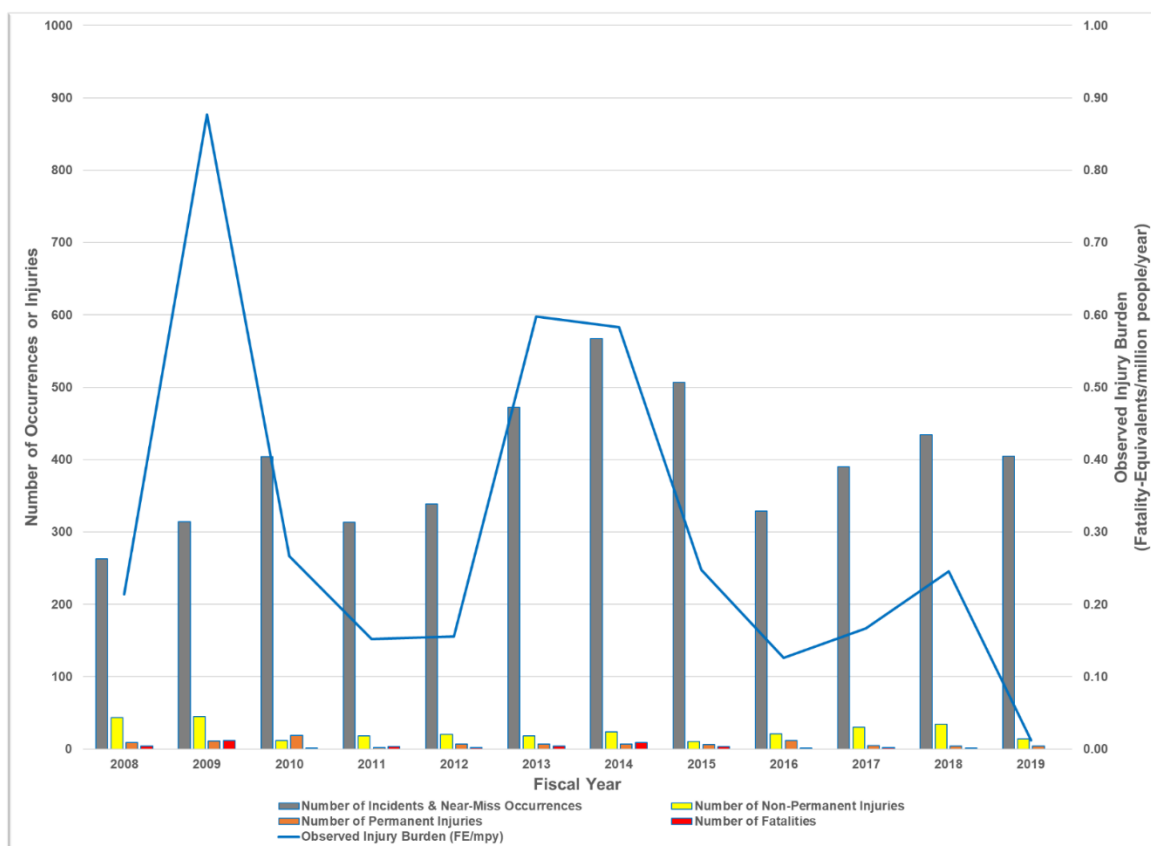
2. Fuel Risks in Private Dwellings

Private dwellings are residential locations which, for the purposes of this report, include detached and semi-detached houses, duplexes and townhouses. In addition, TSSA is monitoring other configurations of residences to better understand their fuel-related risks.

There have been 4,737 incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 289 non-permanent injuries, 93 permanent injuries and 42 fatalities reported over the past twelve fiscal years (2008 – 2019). These occurrences resulted in CO releases, fires, explosions, and/or vapour releases. There was no demonstrable trend in the number of these occurrences. Measures representing these historical observations are represented graphically in Figure FS-5 and tabulated in Appendix A.

TSSA's predictive model estimated the potential RIF to Ontarians as of fiscal year 2019 to be 2.78 FE/mpy. Fuel risks at private dwellings continue to demonstrate an actionable level of risk.

Figure FS-5: State of safety of fuel risks in private dwellings (2008 – 2019).



Comprehensive drilldowns have been provided for CO release, fires, explosions and vapour release, as these areas all demonstrate elevated levels of risk in private dwellings (see Figure FS-6).

CO Releases

The largest source of risk at private dwellings continues to be related to CO releases and was estimated to be 7.09 FE/MPY. The associated risk continued to be well above the TSSA acceptance criterion of 1.00 FE/MPY. Additionally, CO release occurrences accounted for 50.6% of all private dwelling occurrences over the last twelve fiscal years (2008 – 2019) and have resulted in 21 fatalities and 264 injuries during this period. There was no demonstrable trend in the number of these occurrences.

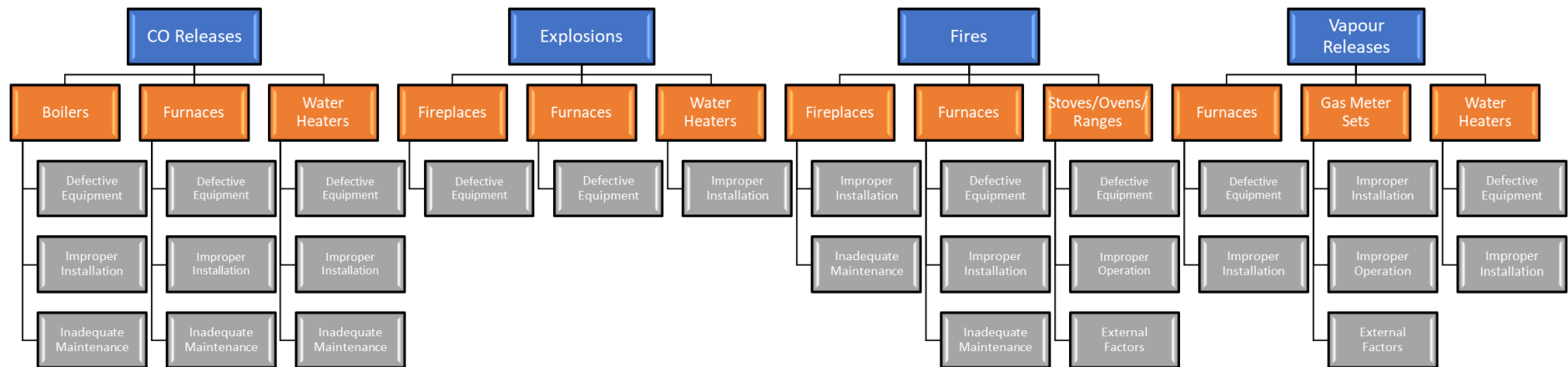
Figure FS-6 illustrates the top issues related to CO releases in private dwellings in terms of their contributing causes. As indicated, these occurrences involved boilers, furnaces, and water heaters.

- Occurrences involving boilers (particularly natural-gas-fired natural-draft boilers) were mainly due to defective equipment, improper installation, and inadequate maintenance.
- Occurrences involving furnaces were mainly due to defective equipment, improper installation, and inadequate maintenance. Examples included blocked, cracked or failed heat exchangers in furnaces.
- Occurrences involving water heaters were mainly due to defective equipment, improper installation, and inadequate maintenance. Several of these occurrences involved venting and/or chimneys.

In Ontario, over 65% of all injuries and deaths due to CO have occurred in homes.



Figure FS-6: Top contributing causes of fuel-related safety issues in private dwellings (2008 - 2019).





Explosions

The risk at private dwellings due to explosions was 1.16 FE/mpy. The associated risk continued to exceed the TSSA acceptance criterion of 1.00 FE/mpy. Additionally, explosions in private dwellings accounted for 4.7% of all occurrences and resulted in seven fatalities and 70 injuries over the last twelve fiscal years (2008 – 2019). There was no demonstrable trend in the number of these occurrences.

Figure FS-6 illustrates the top issues related to explosions in private dwellings involving fuel-burning appliances in terms of their contributing causes. As indicated, these occurrences involved fireplaces, furnaces, and water heaters.

- Occurrences involving fireplaces were mainly due to defective equipment. Some of these occurrences involved shattered glass.
- Occurrences involving furnaces were mainly due to defective equipment. Occurrences involving water heaters were mainly due to improper installation.

Fires

The risk at private dwellings due to fuel-related fires was 2.17 FE/mpy. The associated risk continued to exceed the TSSA acceptance criterion of 1.00 FE/mpy. Additionally, fires in private dwellings accounted for 19.3% of all occurrences, resulting in 11 fatalities and 41 injuries over the last twelve fiscal years (2008 – 2019). There was no demonstrable trend in the number of these occurrences.

Figure FS-6 illustrates the top issues related to fires in private dwellings in terms of their contributing causes. As indicated, occurrences in private dwellings resulting in a fire involved fireplaces, furnaces, as well as stoves, ovens, and ranges.

- Occurrences involving fireplaces were mainly due to improper installation and inadequate maintenance. Examples included damaged venting or chimneys.
- Occurrences involving furnaces were mainly due to defective equipment, improper installation, and inadequate maintenance. Examples included circuit or control board components and fires inside the furnace.
- Occurrences involving stoves, ovens and ranges were mainly due to defective equipment, improper operation, and external factors. Examples included grease fires in ovens and unattended cooking equipment.

Vapour Releases

The risk at private dwellings due to vapour releases was 0.68 FE/mpy, which is slightly below the TSSA acceptance criterion of 1.00 FE/mpy. Vapour releases in private dwellings accounted for 25.3% of all occurrences and resulted in three fatalities and seven injuries over the last twelve fiscal years (2008 – 2019). There was no demonstrable trend in the number of these occurrences.

Figure FS-6 illustrates the top vapour release issues for private dwellings in terms of their contributing causes. As indicated, these occurrences included furnaces, gas meter sets, and water heaters.

Occurrences involving furnaces were mainly due to defective equipment and improper installation. Occurrences involving gas meter sets were mainly due to improper installation, improper operation, and external factors. Occurrences involving water heaters were mainly due to defective equipment and improper installation.

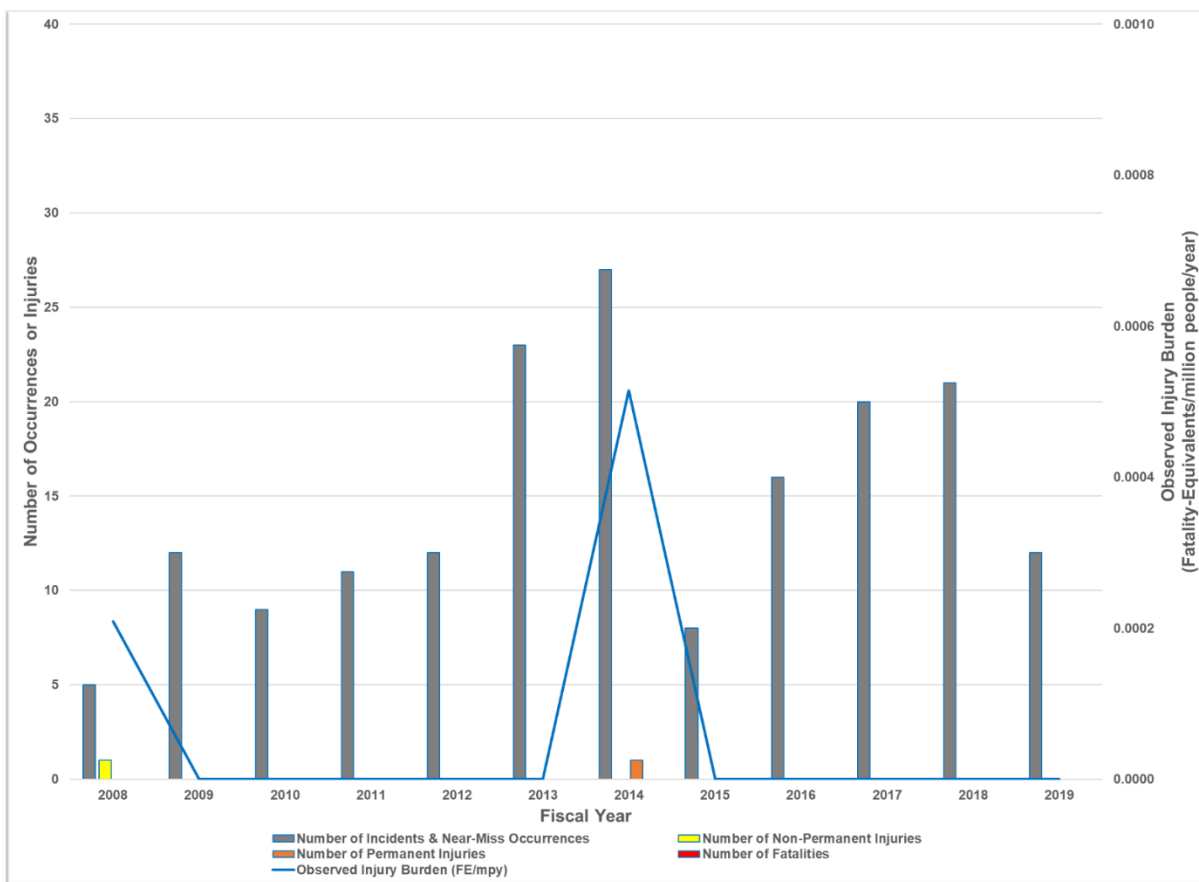
3. Fuel Risks in Schools

Schools in this section include kindergarten through grade 12, both public and private. They exclude nursery schools, universities and colleges.



There have been 176 reported incidents and near-miss occurrences that were reported and had their investigations completed, resulting in one non-permanent injury, one permanent injury and zero fatalities reported over the past twelve fiscal years (2008 – 2019). There is no demonstrable trend in the number of occurrences at these locations. Measures representing these observations are represented in Figure FS-7 and are tabulated in Appendix A.

Figure FS-7: State of safety of fuel risks in schools (2008 – 2019).



TSSA's predictive model estimated the potential RIF to Ontarians as of fiscal year 2019 to be 0.42 FE/MPY. This was above the acceptability threshold of 0.30 FE/MPY at these locations, which is understandably much lower than other exposed populations due to the type of population and the ability of their occupants to escape in the event of an emergency.

Though vapour release occurrences were observed most often, making up 56.5% of all occurrences at schools, the primary safety concern and largest source of risk at these locations involved CO release. As indicated in Figure FS-8, occurrences resulting in CO releases in schools involved boilers, and were primarily caused due to defective equipment and improper operation. Historical occurrences and similar issues with boilers in other locations (i.e., residences, commercial locations, etc.) also substantiate this finding.

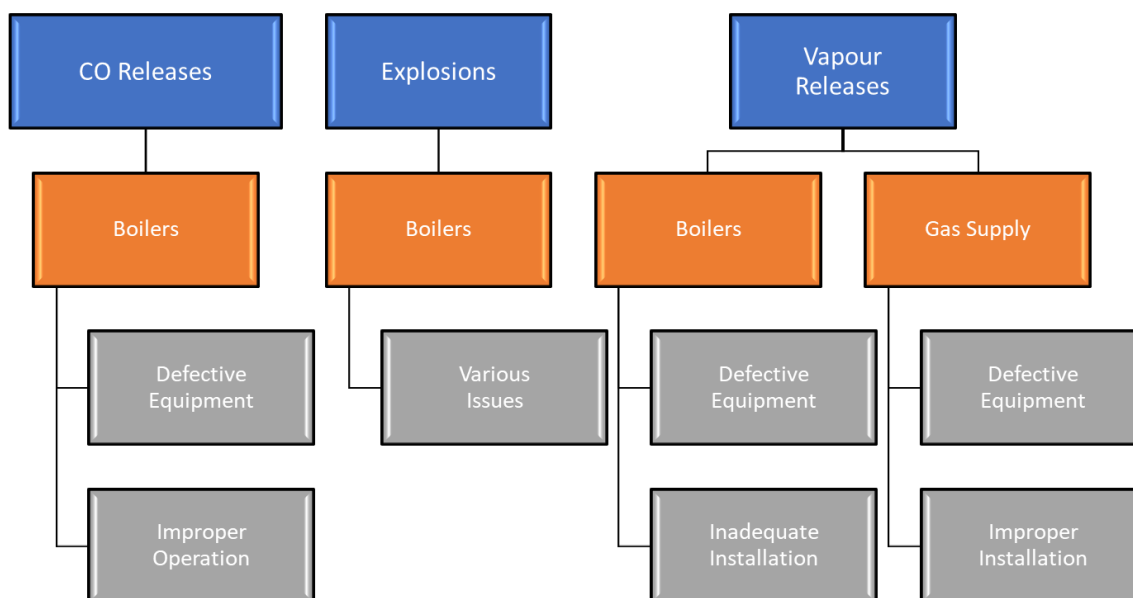
As indicated in Figure FS-8, occurrences resulting in explosions involved boiler technology failing due to various issues, but with no dominating cause. Most of these occurrences involved delayed ignitions.

As indicated in Figure FS-8, occurrences resulting in vapour releases in schools involved boilers and gas supply equipment. Boiler and gas supply issues were mainly due to defective equipment and improper installation.

There have been two factors that have contributed to an increase in the risk at schools. There has been an increase in the annual occurrence rate (i.e., the number of occurrences per year). In particular, there has been

increased reporting from schools over the last few years, particularly with CO release occurrences. Moreover, a CO release occurrence in a school could lead to many impacted people, thereby resulting in more exposed students per occurrence. These factors in conjunction contributed to the increase in risk.

Figure FS-8: Top contributing causes of fuel-related safety issues in schools (2008 – 2019).



Enhanced Monitoring Area

There was only one enhanced monitoring area identified in the Fuels Safety Program this fiscal year:

- fuel risks in business units.

Fuel Risks in Business Units

Business units include commercial plazas and various retail, service, supply and office locations. They exclude food service locations, manufacturing facilities and warehouses.

There have been 583 reported incidents and near-miss occurrences that were reported and had their investigations completed, resulting in 39 non-permanent injuries, nine permanent injuries and zero fatalities reported over the past twelve fiscal years (2008 – 2019). There was a 6.0% increasing trend in the number of occurrences at these locations. Measures representing these historical observations are shown in Figure FS-9 and have been detailed in Appendix A.

TSSA's predictive model estimated the potential RIF to Ontarians to be 0.57 FE/mpy, thus representing an issue that requires enhanced monitoring.

Upstream occurrences (i.e., outside of the commercial establishment on fuel distributor meters and service lines) accounted for 33.5% of fuel-related occurrences at business units. These occurrences involved gas supply equipment, such as piping, pipelines and regulators, and resulted in vapour release.

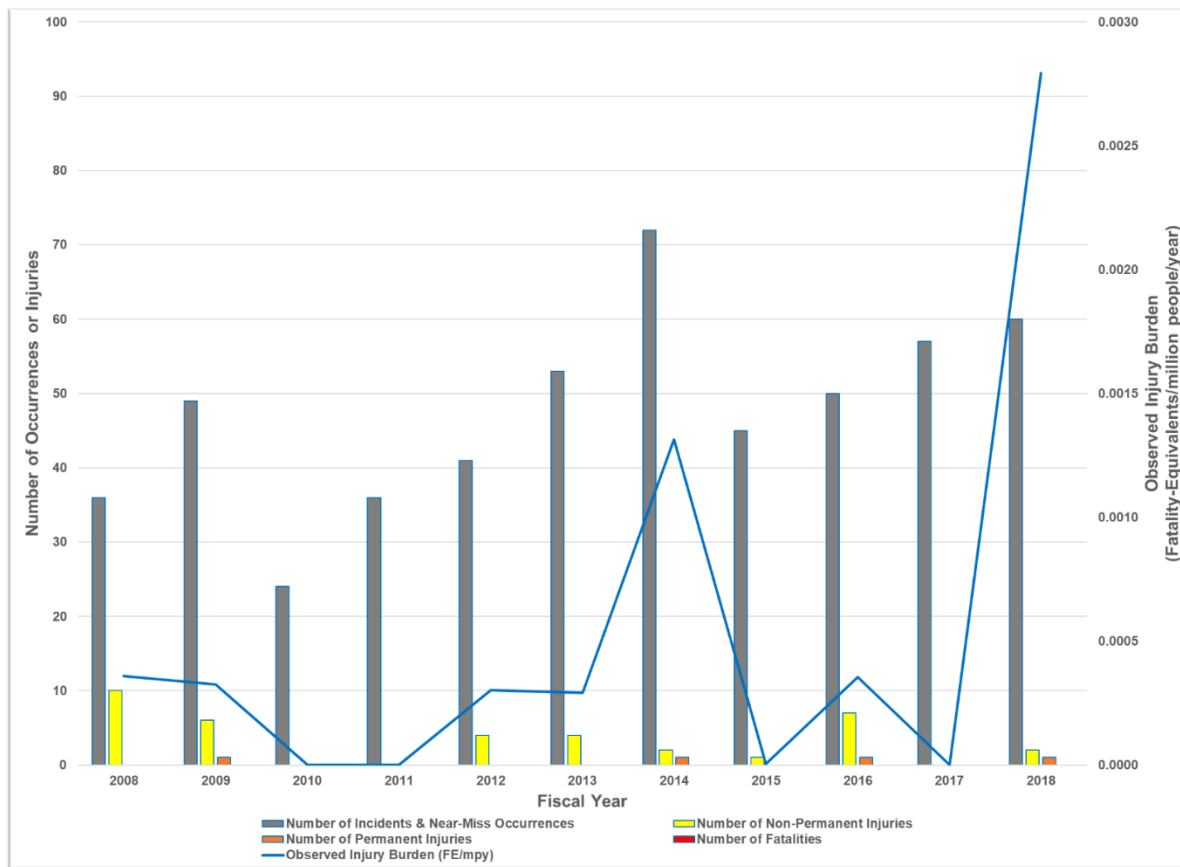
As indicated in Figure FS-10, non-vehicle upstream occurrences mainly occurred due to defective equipment and improper installation.

Vehicles colliding with gas supply equipment accounted for 75.0% of upstream occurrences. These vehicles typically included passenger motor vehicles, snow removal equipment, construction equipment, and forklifts. As



indicated in Figure FS-10, these upstream occurrences primarily occurred due to improper installation, improper operation, and external factors.

Figure FS-9: State of safety of fuel risks in business units (2008 – 2019).



Downstream occurrences accounted for 66.5% of fuel-related occurrences at business units. The main issue was CO releases. As indicated in Figure FS-10, these occurrences involved boilers, furnaces, and rooftop HVAC units.

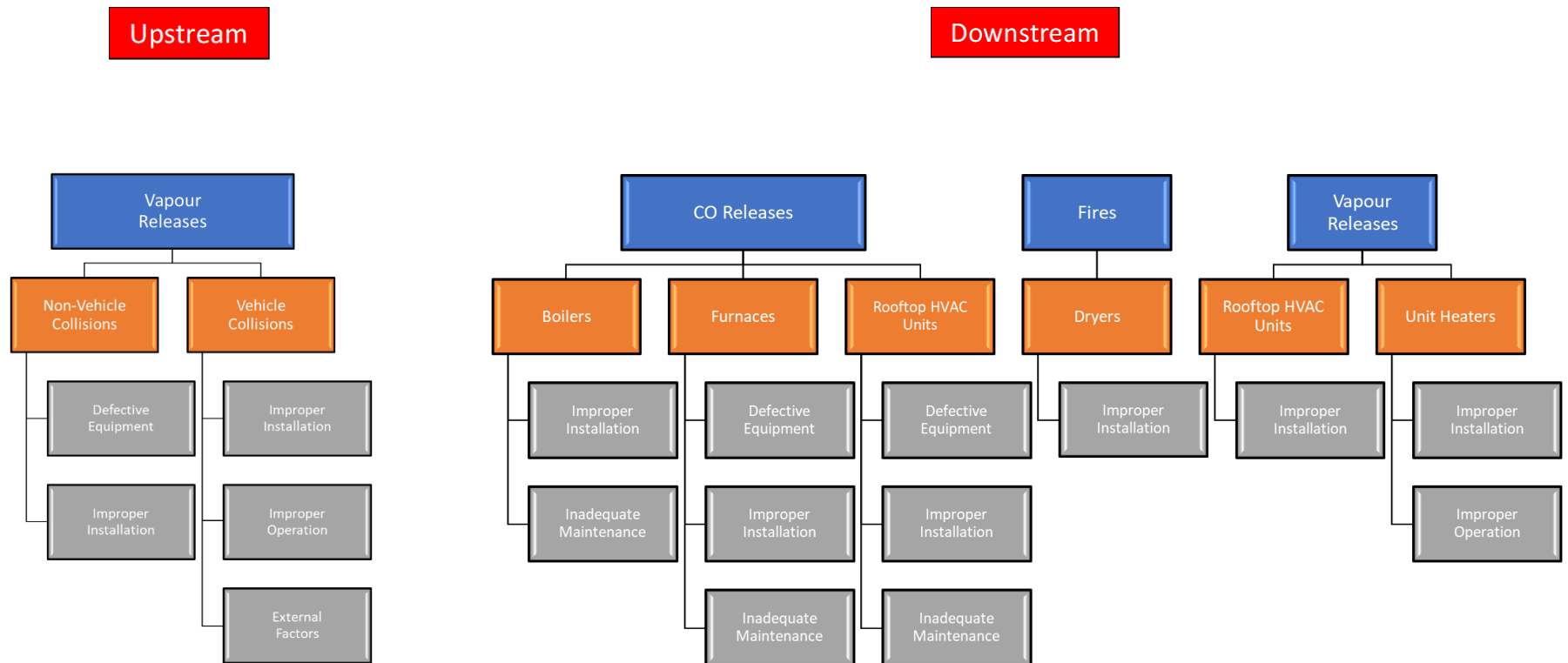
- Occurrences involving boilers were mainly due to improper installation and inadequate maintenance.
- Occurrences involving furnaces were mainly caused by defective equipment, improper installation, and inadequate maintenance.
- Occurrences of CO release involving rooftop HVAC units were mainly due to defective equipment, improper installation, and inadequate maintenance.

As indicated in Figure FS-10, downstream fire occurrences in business units primarily involved dryers, mainly due to improper installation.

Downstream vapour-release occurrences in business units primarily involved rooftop HVAC units and unit heaters. As indicated in Figure FS-10, occurrences involving rooftop HVAC units were mainly due to improper installation. Occurrences involving unit heaters were mainly due to improper installation and improper operation.



Figure FS-10: Top contributing causes of fuel-related safety issues in business units (2008 – 2019).





Compliance

Refer to Appendix D for overall Fuels Safety Program inspection and re-inspection results.

Licensed Liquid Fuels Sites

TSSA conducts periodic inspections of liquid fuels storage and dispensing facilities at least once every three years to oversee and manage the state of compliance across 4,207 licensed sites in Ontario. There were 3,553 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 42.3%, with no demonstrable trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table FS-1.

Table FS-1: Top compliance issues by number of orders issued for liquid fuels licensed sites (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Defective equipment needs to be repaired or replaced	18.4%
Equipment not maintained and tested at least once per year	7.9%
Leak testing not being performed	6.6%

The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table FS-2. Although the total risk of these orders is large, the actual numbers of these orders is usually small. Note that propane orders show up in liquid fuels licensed sites because these locations are gas stations that also sell propane. Thus, the propane-related orders show up under liquid fuels periodic inspections.

Table FS-2: Top compliance issues by risk of orders issued for liquid fuels licensed sites (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Liquid Fuels Regulation 217/01 Section 5(1) not being followed	45.5%
Cylinder in storage with valve not closed	20.9%
Employee is not trained and there is no record of training	1.6%

Figure FS-11 and Table FS-3 provide information on key indicators associated with the results of the periodic inspections. The inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 0.1% to 0.5% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk.

In fiscal year 2019, about 99.5% of inspections were either fully compliant (38.9%) or had only minor issues (60.6%). Some examples of minor issues included: above ground storage tanks not being permanently marked; missing signage; testing not being performed; licence not being displayed; and, underground storage tanks not removed after being out of service for two years.



Figure FS-11: Inspection risk spectrums from outcomes of periodic inspections conducted at liquid fuels licenced sites (2015 – 2019).

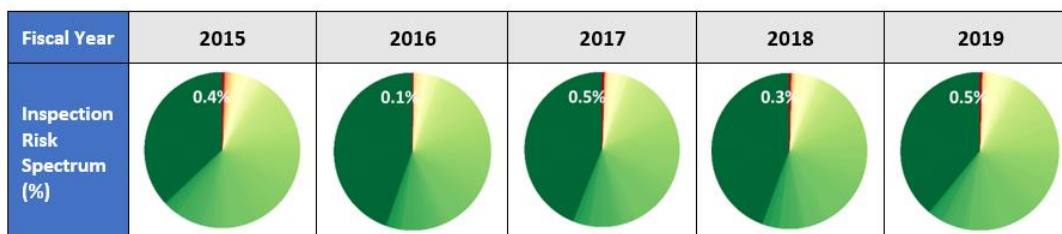


Table FS-3: Inventory risk profiles from outcomes of periodic inspections conducted at liquid fuels licenced sites (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile	N/A	14.3%	2.5%	2.0%	2.1%
		12.1%	15.3%	14.0%	17.1%
		73.7%	82.2%	84.0%	80.9%

Using a risk-based approach, an inventory risk profile was generated. As of fiscal year 2019, there were 74 high-risk liquid fuel sites (2.1% of the qualified provincial inventory). Gas stations accounted for the greatest proportion of these high-risk sites (74.3% of all high-risk sites). See Table FS-4 for further details.

Table FS-4: Top high-risk liquid fuels licensed site types (2019).

Site Type	Percentage of Total High-Risk Sites
Gas Stations	74.3%
Marinas	23.0%
Bulk Plants	2.7%

Licensed Propane Sites

TSSA conducts periodic inspections of propane facilities to oversee and manage the state of compliance across 1,343 licensed sites in the province of Ontario. There were 1,077 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 72.2%, with a decreasing trend of 1.3% per year. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table FS-5.

Table FS-5: Top compliance issues by number of orders issued for propane licenced sites (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Readily ignitable materials around container	9.6%
Piping and tubing without either painting or coating protection	5.5%
Portable fire extinguisher not installed	5.0%



The top compliance issues by risk of orders issued that were identified through periodic inspections are shown in Table FS-6. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

Table FS-6: Top compliance issues by risk of orders issued for propane licenced sites (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Match, candle or flame used to check for propane leak	27.9%
No notification to inspector after occurrence	25.4%
Employee handling propane without certificate	23.1%

Figure FS-12 and Table FS-7 provide information on key indicators associated with the results of the periodic inspections. While the compliance rate provides an outcome of the periodic inspection (e.g., pass or fail), the inspection risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the inspection. As indicated by the dark red segments, the spectrums show that 1.3% to 5.4% of all inspections conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk.

In fiscal year 2019, about 94.6% of inspections were either fully compliant (65.9%) or had only minor issues (28.7%). Some examples of minor issues included: missing signage; steel tanks not being kept painted; and, readily ignitable materials including vegetation being too close to containers, inadequate fencing, and the licence not being displayed.

In the spirit of continuous improvement of TSSA's risk-based inspection scheduling, TSSA is heeding the advice of the Auditor General of Ontario, which noted that the information used in the Risk and Safety Management Plans (RSMPs) could be used to inform inspection frequencies. For example, the RSMPs list the land usage surrounding propane facilities. As such, the risk threshold for facilities in high density residential zones is 10% of that in remote/industrial locations and the threshold near sensitive receptors is 3% of the industrial threshold. In this way, TSSA can target inspection resources to facilities with the greatest potential for harm.

Figure FS-12: Inspection risk spectrum from outcomes of periodic inspections conducted at propane licenced sites (2015 – 2019).

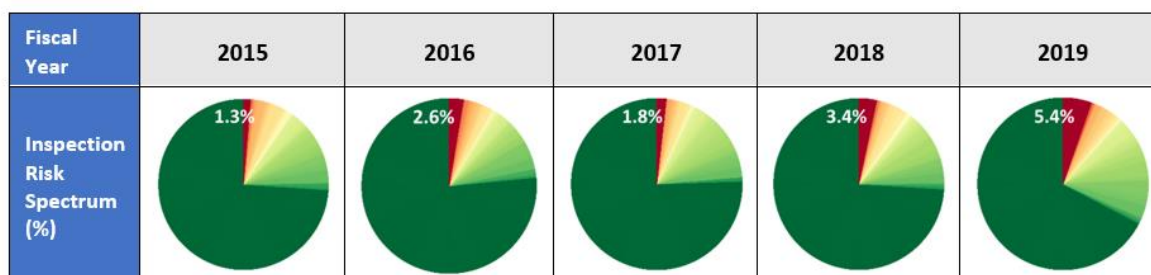


Table FS-7: Inventory risk profiles from outcomes of periodic inspections conducted at propane licenced sites (2015 – 2019).

Fiscal Year	2015	2016	2017	2018	2019
Inventory Risk Profile ⁸⁰	12.4%	5.1%	8.1%	5.5%	4.6%
	7.6%	17.0%	12.5%	12.4%	5.8%
	80.1%	77.9%	79.4%	82.1%	89.6%



Using a risk-based approach, an inventory risk profile was generated. As of fiscal year 2019, there were 50 high-risk propane sites (4.6% of the qualified provincial inventory). Cylinder refill centres accounted for the most predominant locations (86.0% of all high-risk sites). See Table FS-8 for further details.

Table FS-8: Top high-risk propane licensed site types (2019).

Site Type	Percentage of Total High-Risk Sites
Cylinder Refill Centres	86.0%
Propane Filling Plants > 5000 USWG	14.0%

Fuels Contractors

Heating Contractors

TSSA conducts periodic audits on heating contractors in the province of Ontario to oversee and manage their state of compliance. The median compliance rate observed was 55.3% over the last five fiscal years (2015 – 2019), with a decreasing trend of 2.3% per year. The compliance rate is defined as the percentage of heating contractor audits with no orders issued compared to the total number of heating contractor audits. The top compliance issues by number of orders issued that were identified in these periodic audits over the last five fiscal years (2015 – 2019) are shown in Table FS-9.

Table FS-9: Top compliance issues by number of orders issued for heating contractors (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Unacceptable condition - no immediate hazard	24.6%
Equipment not installed per manufacturer's certified instructions	9.0%
Did not comply with Act and Regulation	7.1%

The top compliance issues by risk of orders issued that were identified through heating contractor audits are shown in Table FS-10. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

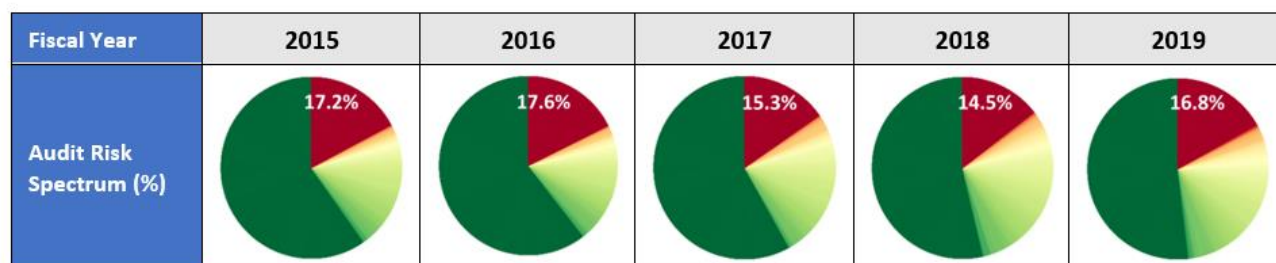
Table FS-10: Top compliance issues by risk of orders issued for heating contractors (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Equipment not installed per manufacturer's certified instructions	0.7%
Unacceptable condition – immediate hazard	0.3%
Did not comply with Act and Regulation	0.3%

Figure FS-13 provides information on key indicators associated with the results of heating contractor audits. While the compliance rate provides an outcome of the heating contractor audit (e.g., pass or fail), the audit risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the audits. As indicated by the dark red segments, the spectrums show that 14.5% to 17.6% of all heating contractor audits conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk.

In fiscal year 2019, about 83.2% of these audits were either fully compliant (50.6%) or had only minor issues (32.6%). Some examples of minor issues included: the registration not being displayed in a conspicuous location; equipment not being installed per manufacturer's instructions; use of unapproved equipment; drip or dirt pockets not readily accessible for cleaning; and the installer not leaving the manufacturer's instructions with the user.

Figure FS-13: Audit risk spectrum from outcomes of audits conducted on heating contractors (2015 – 2019).



Petroleum Contractors

TSSA conducts periodic audits on petroleum contractors in the province of Ontario to oversee and manage their state of compliance. The median compliance rate observed was 91.0% over the last five fiscal years (2015 – 2019), with a decreasing trend of 2.7% per year. The compliance rate is defined as the percentage of petroleum contractor audits with no orders issued compared to the total number of petroleum contractor audits. The top compliance issues by number of orders issued that were identified in these periodic audits over the last five fiscal years (2015 – 2019) are shown in Table FS-11.

Table FS-11: Top compliance issues by number of orders issued for petroleum contractors (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Above ground storage tank not protected from vehicular impact	7.9%
Vehicle not clearly marked	7.3%
Above ground storage tank not permanently marked	6.2%

The top compliance issues by risk of orders issued that were identified through petroleum contractor audits are shown in Table FS-12. Although the total risk of these orders is large, the actual numbers of these orders is usually small.

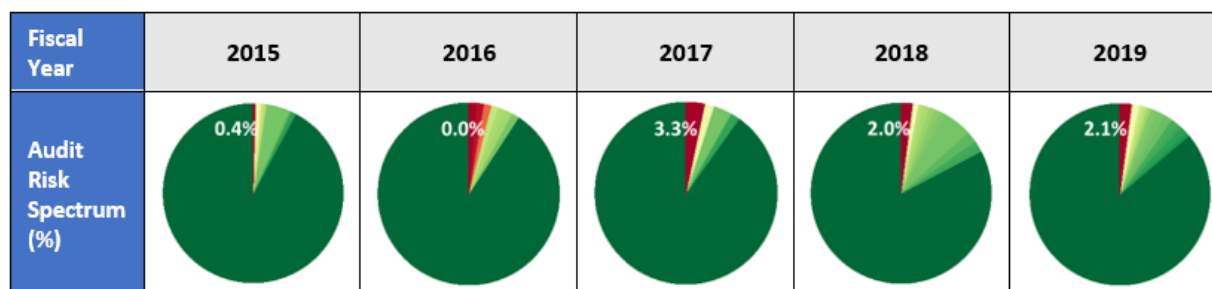
Table FS-12: Top compliance issues by risk of orders issued for petroleum contractors (2015 – 2019).

Compliance Issue	Percentage of Total Risk of Orders Issued
Employees not being instructed to comply with Act and Regulation	42.4%
No notification of unacceptable condition	22.7%
Liquid Fuels Regulation 217/01 not being followed	14.1%

Figure FS-14 provides information on key indicators associated with the results of petroleum contractor audits. While the compliance rate provides an outcome of the petroleum contractor audit (e.g., pass or fail), the audit risk spectrum (shown as a pie chart) portrays the potential safety risks associated with non-compliances found during the audits. As indicated by the dark red segments, the spectrums show that 0.0% to 3.3% of all petroleum contractor audits conducted in each of the past five fiscal years (2015 – 2019) posed unacceptable levels of risk.

In fiscal year 2019, about 97.9% of these audits were either fully compliant (86.1%) or had only minor issues (11.8%). Some examples of minor issues included: aboveground storage tanks not being permanently marked; aboveground storage tanks not being protected against vehicular impact; contractor vehicles not being marked with the name and registration number; missing signage; and, the application for licence renewal being made after it had already expired.

Figure FS-14: Audit risk spectrum from outcomes of audits conducted on petroleum contractors (2015 – 2019).



III.7.2 Risk Management, Message from John Marshall, Fuels Statutory Director

Areas of Concern

This year's ASPR identifies the following areas of concern for the Fuels Safety Program: CO Risks in Apartments and Condominiums; Fuel-Related Risks in Private Dwellings; and, Fuel-Related Risks in Schools. In addition, Fuel-Related Risks in Business Units continues to be an area of enhanced monitoring. In these areas, the Fuels Safety Program will continue to look for opportunities to work with key stakeholders and other safety partners to provide compliance safety information, compliance support and educational material to assist them in reducing the RIFs in their sectors. Specifically, providing fuels industry stakeholders with root cause information and top orders cited during inspections to reduce contributing causes of fuels-related issues.

There were two issues which no longer qualify for enhanced monitoring: Fuel-related risks in retirement and long-term care homes and fuel-related fires in food service locations. TSSA had implemented targeted programs for both of these issues in recent years.

It is expected that through the course of TSSA's transition toward becoming an outcome-based regulator, these concerns will be addressed more effectively. Enhancements to the contractor audit program, compliance support, and inspections more targeted at harm are just a few initiatives from this transformation that should result in a decrease of the RIFs in the areas of concern.

Pipeline Strikes

Statistically, there is no demonstrable trend in pipeline strike occurrences. However, there is a reduction over the same period in the damage ratio (a measure of damage prevention performance by the volume of damages per thousand notifications)¹¹.

Pipeline strikes and damage prevention to pipelines will continue to be an area of focus. The Fuels Safety Program will work with damage prevention partners, such as Ontario Regional Common Ground Alliance and Ontario One Call, to promote public awareness campaigns for "Call or Click Before you Dig".

In addition, in response to the Auditor General's 2018 Audit, TSSA has committed to reviewing its existing oversight processes for fuel oil tanks, and based on the outcome of this review, will determine appropriate annual licensing condition requirements for fuel oil distributors. TSSA will also develop and advance the specifics of an action plan with the Ministry of Government and Consumer Services to improve the safety of oil tanks.

¹¹ Source: Ontario Regional Common Ground Alliance 2018 DIRT Report.



Case Study: Fire at a Pizzeria

Background

A pizza oven had a pilot light that would not light. When an employee tried to light the oven, a fire blew back at the employee, resulting in burns to the employee's arms and face. The oven was then turned off because of the incident and TSSA was notified.

Outcome

TSSA inspector performed a site inspection and found the following safety issues:

1. The pizza oven had no rating plate.
2. The natural gas supply line was not sealed where it passes through the exterior wall.
3. No evidence of relighting instructions.
4. Fryer with no protection from open flame.
5. Range with no serial number.
6. Rooftop HVAC unit with unsupported gas supply piping.

Orders were issued to comply with Code.

It was determined that the root cause of the accident was failure to follow maintenance procedures.

III.8 Upholstered and Stuffed Articles

State of Public Safety in Ontario –

UPHOLSTERED & STUFFED ARTICLES SAFETY PROGRAM



Program Area Activities	Stakeholders
Upholstered and stuffed articles include toys, sporting goods, pet items, furniture, mattresses/box springs, apparel, bedding items, handbags, luggage and seasonal ornaments. - Protect the public from potential hazards associated with unclean or unsafe filling materials in upholstered and stuffed articles in Ontario - Protect against fraud, misrepresentation of materials and to provide a level playing field for industry - Ensure upholstered and stuffed articles contain only new clean filling materials - Enforce through inspections at point of sale and manufacturing level	Retailer
	Manufacturer
	Importer/Distributor
	Renovator
	Home Hobby/Craft Operator
	Supplier

Health Impact		
Observed	Potential	
0.00 FE/mpy (2010 – 2019) Injury Burden	0.00 FE/mpy (2019) Injury Burden	0.00 FE/mpy (2019) Risk of Injury or Fatality

Compliance Rate (2015 – 2019)	Safety Numbers (Safety at a Glance)				
	Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
	2010 – 2019	38	6	0	0
73.1%	2019	0	0	0	0

Ontario Regulation 218/01, *Upholstered and Stuffed Articles*, which was revoked as of July 1, 2019 stipulated that only new clean filling materials were allowed in upholstered and stuffed articles, and all articles were required to be labelled, identifying the registration number and indicating all filling materials. Such articles included toys, sporting goods, pet items, furniture, mattresses/box springs, apparel, bedding items, handbags, luggage and seasonal ornaments. The requirements for new and clean filling materials were enforced through inspections at point-of-sale and at the manufacturing level.



During the reporting period, the following stakeholders fell under TSSA's jurisdiction:

- retailers;
- manufacturers;
- importers/distributors;
- renovators;
- home hobby/craft operators; and
- suppliers.

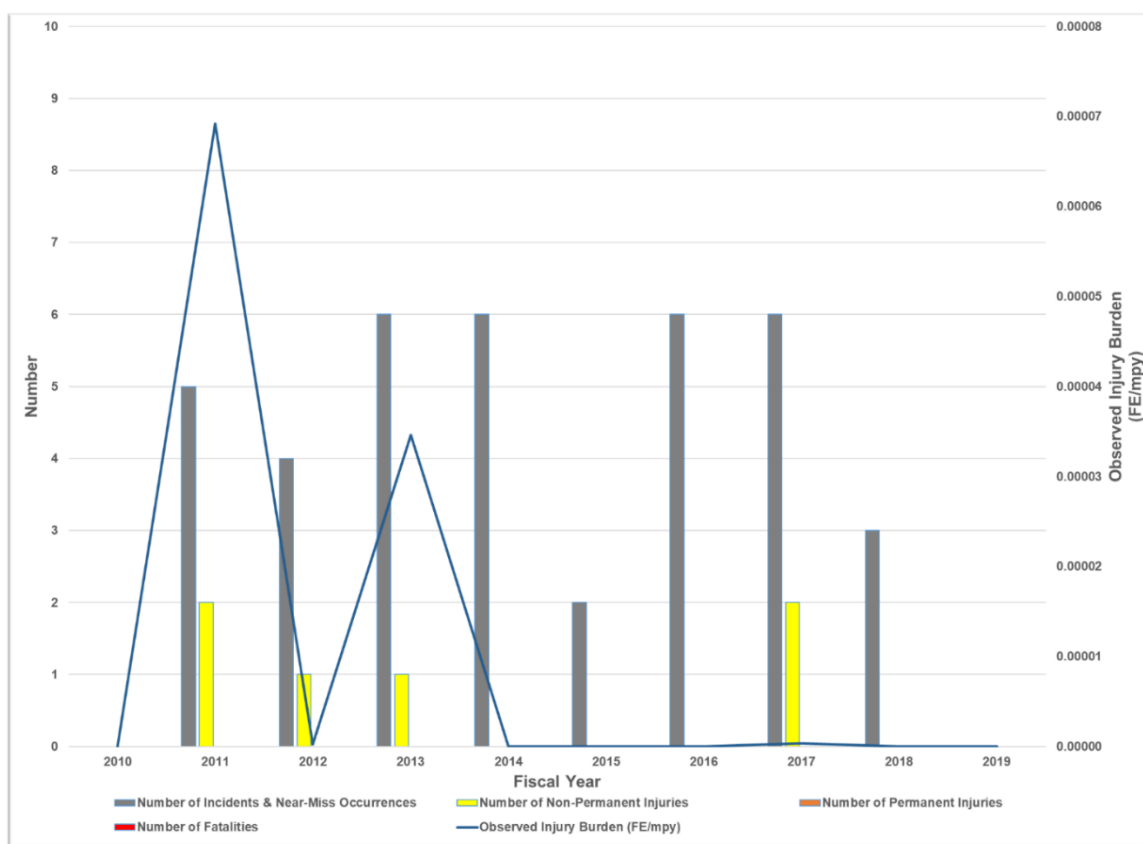
See Appendix G for a listing of legislation and regulatory information before revocation. See Appendix H for a list of organizations and groups that TSSA has worked with to help keep Ontarians safe.

III.8.1 Risk Assessment

Incidents, Injuries and Risk Prediction

TSSA received reports of actual health impacts resulting from reportable occurrences. Over the period of fiscal years 2010 – 2019, there were 38 incidents and near-miss occurrences that were reported and had their investigations completed. Measures representing these historical observations are represented graphically in Figure USA-1 and tabulated in Appendix A. All these occurrences took place due to non-compliance with regulatory requirements and have been described below.

Figure USA-1: State of safety of upholstered and stuffed articles (2010 – 2019).



Incidents

There were five incidents reported with six victims over the past ten fiscal years (2010 – 2019). Of these incidents, the victims sustained respiratory infection irritations or lacerations with superficial cuts. The incidents pertained to sofa sets and bedding materials, which were contaminated by either mould, fungus



or vermin. The root cause attributed to all these occurrences was contamination of equipment, material or component.

Near-Misses

There were 33 near-miss occurrences reported to TSSA over the past ten fiscal years (2010 – 2019), of which 19 were reported through complaint inspections and 14 were reported via TSSA's incident reporting framework. These occurrences demonstrated instances of elevated exposure to risk. However, they did not result in consequences to people or property. Most of these occurrences related to used materials and incorrect labels. The root cause attributed to these occurrences was defective or failed material.

Based on the actual injuries observed over the past ten fiscal years (2010 – 2019), the average rate of injury was 0.04 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to a 10-year average injury burden of approximately 0.00 FE/mpy. The observed injury burden for fiscal year 2019 was approximately 0.00 FE/mpy. Injury burden is what has already happened in the past.

Based on all the occurrences over the past ten fiscal years (2010 – 2019), TSSA's predictive model estimated the potential RIF to Ontarians using upholstered and stuffed articles as of fiscal year 2019 to be approximately 0.00 FE/mpy. The RIF is what *might* happen in the future, based on what has happened in the past.

Compliance

In fiscal year 2019, TSSA's Upholstered and Stuffed Articles Safety Program conducted 1,099 inspections and issued 1,359 orders, focusing mainly on retailers. Table USA-1 lists inspections and orders for the top inspection types over the last five fiscal years (2015 – 2019) and for the current fiscal year (2019). The number of inspections and orders issued in fiscal year 2019 were less than in previous years as resources were re-allocated due to the Upholstered and Stuffed Articles Safety Program being wound down in the latter half of the fiscal year. Refer to Appendix D for inspection and re-inspection results.

Table USA-1: Top inspections and orders for upholstered and stuffed articles (2015 – 2019).

Reporting Period	2015 – 2019		2019	
Inspection Type	Number of Inspections Conducted	Number of Issued Orders	Number of Inspections Conducted	Number of Issued Orders
Retailer	2,376	40,235	181	803
Seasonal	1,208	16,581	60	100
Manufacturer	947	1,234	249	134

The median compliance rate observed over the past five fiscal years (2015 – 2019) was 73.1%, with a 4.3% increasing trend. The compliance rate is defined as the percentage of periodic inspections with no orders issued compared to the total number of periodic inspections. The top compliance issues by number of orders issued that were identified through periodic inspections over the last five fiscal years (2015 – 2019) are shown in Table USA-2.

Table USA-2: Top compliance issues by number of orders issued for upholstered and stuffed articles (2015 – 2019).

Compliance Issue	Percentage of Total Number of Orders Issued
Manufacturer not registered in Ontario	29.1%
No provincial label	23.6%
No contents declared	6.5%

Note that the Upholstered and Stuffed Articles Safety Program did not use a risk-based inspection system.



Upholstered and Stuffed Articles Regulation Revocation

As of July 1, 2019, the Government of Ontario approved the revocation of *Ontario Regulation 218/01: Upholstered and Stuffed Articles* under the Act. This eliminated all Ontario-specific requirements for upholstered and stuffed articles imposed on business and removed the oversight and enforcement role of TSSA. This will be the final year an Upholstered and Stuffed Articles section appears in the ASPR.

III.8.2 Risk Management, Message from Peter Wong, Acting Upholstered and Stuffed Articles Statutory Director

On December 6, 2018, the Government of Ontario announced its decision to revoke *Ontario Regulation 218/01: Upholstered and Stuffed Articles*.

As of July 1, 2019, provincial licensing, labelling, processing, cleanliness and sterilization requirements set out in the regulation will no longer apply to manufacturers, renovators, home hobby/craft operators and other persons currently subject to the regulation in the province of Ontario.

In the lead-up to revocation, TSSA concentrated its regulatory delivery on follow-up inspections for high-risk orders which were completed by February 2019. These orders were identified as high-risk due to the potential hazards to public safety. High-risk orders typically included mold, pellets, degradation of wooden furniture frames, etc. The high-risk orders requiring resolution included non-compliances in the following areas:

- rusted springs; and
- unclean polyurethane foam.

Additionally, TSSA rescinded orders for low-risk non-compliances where the impact of compliance would not be felt until after the revocation of the regulation, imposing an unnecessary burden on business. TSSA rescinded orders dating back to October 2018.

Examples of these low-risk non-compliances typically involve labelling, such as:

- incorrect label format;
- filling materials not listed in order of predominance;
- filling materials not listed by generic name; and
- labels not securely affixed to the article.

The Upholstered and Stuffed Articles Safety Program continued to address complaints and undertake investigations enforcement until revocation on July 1, 2019.

The TSSA Upholstered and Stuffed Articles Advisory Council was dissolved, with the last meeting held on February 25, 2019.

Case Study: Counterfeit Mattresses

Background

A customer bought two mattresses from a furniture store that were claimed to be brand name mattresses. When the customer checked with the alleged manufacturer, it was discovered they were not genuine. They did not even have the tag that should be there as a regulatory requirement.

A complaint by the customer was made to TSSA.

Outcome

TSSA issued orders to register the manufacturer, affix the approved provincial label and to declare the correct contents.





IV. References

- [1] Veeramany A and Mangalam S. "Application of disability-adjusted life years to predict the burden of injuries and fatalities due to public exposure to engineering technologies." *Population Health Metrics* 12 (2014): 1-9.
- [2] PSM Division, CSChE. Major Industrial Accidents Council of Canada (MIACC) Criteria for land-use planning (2008).
- [3] Vatn J. "A discussion of the acceptable risk problem." *Reliability Engineering & System Safety* 61 (1998): 11-19.
- [4] Aven T. "Reliability & Risk Analysis." North Holland, 1992.
- [5] Health and Safety Executive. "ALARP 'at a glance'." Retrieved May 1, 2015 from <http://www.hse.gov.uk/risk/theory/alarpglance.htm>.
- [6] US Centers for Disease Control (CDC), The National Institute for Occupational Safety and Health (NIOSH), Hierarchy of Controls. Retrieved on April 12, 2017 from <https://www.cdc.gov/niosh/topics/hierarchy/default.html>.
- [7] Mangalam S, Mulamootil LA, Veeramany A, Witt D, and Karavas R. "System and method for inspecting and assessing risk of mechanical equipment and facilities." U.S. Patent No. 13/894,812, May 15, 2013.
- [8] "TSSA Elevator Availability Study Final Report." Retrieved April 25, 2019 from: https://icreate.tssa.org/230002_iCreate_NewsV2/Management/Attachment/Download/c8cd11c8-9de8-4a6e-80e3-43b41c9b7f15.
- [9] Begg S, Vos T, Barker B, Stevenson C, Stanley L and Lopez A. "The burden of disease and injury in Australia." (2003). Cat. No. PHE 82. Canberra: AIHW 2007.



V. Appendices

Appendix A – Overall State of Safety Measures (2008 – 2019)

Table A1: Cross-program state of safety measures (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences ¹²	4,374	4,247	4,184	4,291	4,593	4,923	5,461	5,332	5,580	5,026	5,550	5,302
Non-Permanent Injuries	724	685	610	654	914	951	1,246	1,167	1,594	1,068	1,306	1,746
Permanent Injuries	42	40	45	19	32	35	51	56	80	66	39	48
Fatalities	7	14	2	6	4	5	10	5	1	4	2	0
Observed Injury Burden (FE/mpy)	0.35	0.94	0.32	0.21	0.32	0.60	0.66	0.40	0.29	0.40	0.33	0.18

Table A2: State of safety measures for boilers & pressure vessels¹³ (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	3	0	6	1	2	2	0	1	5	4	21	13
Non-Permanent Injuries	0	0	0	0	0	0	0	0	1	0	0	2
Permanent Injuries	1	0	0	0	2	0	0	0	1	2	1	0
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00

¹² In this year's ASPR, discovery of petroleum products, liquid petroleum spills, leaks and pipeline strikes have been included in these numbers.

¹³ Uninsured equipment only.



Table A3: State of safety measures for operating plants (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	0	0	0	1	2	0	2	2	2	5	5	22
Non-Permanent Injuries	0	0	0	0	0	0	0	1	0	0	0	0
Permanent Injuries	0	0	0	0	0	0	1	1	1	0	0	0
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00

Table A4: State of safety measures for amusement devices (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	89	64	94	103	222	331	521	647	921	429	667	1,146
Non-Permanent Injuries	70	58	77	88	216	313	454	585	847	368	621	1,048
Permanent Injuries	8	10	9	3	5	11	25	24	42	32	22	29
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.01	0.03	0.05	0.00	0.05	0.06	0.02	0.09	0.12	0.08	0.11	0.08

Table A5: State of safety measures for elevators (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	193	174	195	205	340	381	498	463	569	529	674	659
Non-Permanent Injuries	106	84	101	104	167	146	186	119	169	142	126	99
Permanent Injuries	6	3	7	4	12	11	7	7	11	10	3	2
Fatalities	1	0	0	1	2	1	0	1	0	2	1	0
Observed Injury Burden (FE/mpy)	0.02	0.01	0.00	0.01	0.13	0.09	0.03	0.03	0.02	0.19	0.03	0.02



Table A6: State of safety measures for escalators & moving walks (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	538	531	504	512	522	519	642	592	742	700	720	769
Non-Permanent Injuries	406	390	343	360	362	384	438	383	470	441	455	513
Permanent Injuries	8	1	4	2	4	3	3	7	5	4	0	3
Fatalities	0	0	1	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.03	0.02	0.08	0.00	0.02	0.01	0.00	0.01	0.02	0.00	0.00	0.00

Table A7: State of safety measures for ski lifts (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	98	105	85	83	132	83	88	66	72	71	87	81
Non-Permanent Injuries	76	87	74	66	117	70	66	52	54	60	64	65
Permanent Injuries	6	4	3	1	0	0	3	2	2	3	2	1
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.01	0.00	0.06	0.01	0.00	0.00	0.03	0.02	0.03	0.01	0.01	0.01



Table A8: State of safety measures for fuels (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents & Near-Miss Occurrences ¹⁴	1,209	1,085	1,154	1,048	946	1,254	1,332	1,088	897	986	996	790
Non-Permanent Injuries	66	66	15	34	51	37	102	27	53	55	40	19
Permanent Injuries	13	22	22	9	9	10	12	15	18	15	11	13
Fatalities	6	14	1	5	2	4	10	4	1	2	1	0
Observed Injury Burden (FE/mpy)	0.29	0.88	0.13	0.17	0.11	0.43	0.58	0.24	0.09	0.12	0.16	0.08
Pipeline Strike Occurrences ¹⁵	2,244	2,288	2,146	2,333	2,423	2,347	2,372	2,471	2,366	2,296	2,377	1,822

Table A9: State of safety measures for upholstered and stuffed articles (2010 – 2019).

Measure	Fiscal Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	0	5	4	6	6	2	6	6	3	0
Non-Permanent Injuries	0	2	1	1	0	0	0	2	0	0
Permanent Injuries	0	0	0	0	0	0	0	0	0	0
Fatalities	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

¹⁴ In this year's ASPR, discovery of petroleum products, liquid petroleum spills, and leaks have been included in these numbers. The numbers in this row exclude pipeline strikes.

¹⁵ Includes occurrences resulting from pipeline strikes only. Data not included in Incidents & Near-Miss Occurrences row above.



Actionable (Red) Areas (2019)

Table A10: State of safety measures for CO risks in apartments and condominiums (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	11	11	9	20	17	13	33	18	16	21	15	11
Non-Permanent Injuries	0	0	0	2	0	0	7	4	0	0	0	0
Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0	0
Fatalities	0	0	0	0	0	0	0	1	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00

Table A11: State of safety measures for elevator risks in hospitals (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	15	15	25	18	32	30	41	36	46	43	39	30
Non-Permanent Injuries	12	8	9	6	21	11	19	12	19	14	13	5
Permanent Injuries	0	1	1	0	1	2	2	0	2	1	1	2
Fatalities	1	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.62	0.56	0.01	0.00	0.01	0.01	0.11	0.00	0.02	0.04	0.00	0.00

Table A12: State of safety measures for fuel risks¹⁶ in private dwellings (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	263	314	404	313	339	472	567	507	329	390	434	405
Non-Permanent Injuries	43	45	12	18	20	18	24	10	21	30	34	14
Permanent Injuries	9	11	19	2	7	7	7	6	12	5	4	4
Fatalities	4	12	1	3	2	4	9	3	1	2	1	0
Observed Injury Burden (FE/mpy)	0.21	0.88	0.27	0.15	0.16	0.60	0.58	0.25	0.13	0.17	0.25	0.01

¹⁶ Includes occurrences and injuries resulting from CO release, fire, explosion, and/or vapour release.



Table A13: State of safety measures for user interactions on elevators in retirement and long-term care homes (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	2	1	6	3	7	10	10	8	9	10	26	14
Non-Permanent Injuries	1	0	3	2	4	5	6	2	2	3	9	10
Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0	0
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.42

Table A14: State of safety measures for fuel risks¹⁷ in schools (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	5	12	9	11	12	23	27	8	16	20	21	12
Non-Permanent Injuries	1	0	0	0	0	0	0	0	0	0	0	0
Permanent Injuries	0	0	0	0	0	0	1	0	0	0	0	0
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Enhanced Monitoring (Yellow) Areas (2019)

Table A15: State of safety measures for fuels risks¹⁸ in business units (2008 – 2019).

Measure	Fiscal Year											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Incidents and Near-Miss Occurrences	36	49	24	36	41	53	72	45	50	57	60	60
Non-Permanent Injuries	10	6	0	0	4	4	2	1	7	0	2	3
Permanent Injuries	0	1	0	0	0	0	1	0	1	0	1	5
Fatalities	0	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21

¹⁷ Includes occurrences and injuries resulting from CO release, fire, explosion, and/or vapour release.

¹⁸ Includes occurrences and injuries resulting from CO release, fire, explosion, and/or vapour release.



Appendix B – Metrics

Disability-Adjusted Life Year (DALY)

The Risk of Injury or Fatality (RIF) metric is determined using the Disability-Adjusted Life Year (DALY) metric. The DALY is a universal health impact metric, introduced by the World Health Organization as a single measure to quantify the burden of diseases and injuries. The DALY can be thought of as equivalent years of “healthy” life lost by virtue of being in states of poor health or disability and/or due to premature fatality.

A DALY of 1.0 is the loss of one year of healthy life of a single person due to an injury. For example, a DALY of 28.1 means that 28.1 years of “healthy” life were lost due to injuries arising from all the sectors that TSSA regulates.

The expected health impact for a fatality is calculated based on the standard life expectancy at age of death in years and is based on age and sex (e.g., fatality of a male child aged 5 would translate to 70 DALY assuming an average life expectancy of 75 years). The expected health impact for an injury is calculated by multiplying the average duration of the injury by a weight factor that reflects the severity of the injury on a scale from 0 (being in perfect health) to 1 (being fatal).

Health loss is characterized by three dominant aspects of public health:

- quality of life;
- quantity of life; and
- social magnitude.

The quality of life is measured by duration of injury and life expectancy of a victim. The quantity of life lost is expressed through disability weights, and the social magnitude is characterized by the number of people affected.

The expected health impact in units of DALY can be calculated by the following equation:

$$(\text{Short-term Weight} * \text{Short-term Duration}) + \\ (\text{Fraction Long-term}) * (\text{Long-term Weight} * \text{Long-term Duration})$$

There are four injury types categorized in the TSSA database:

- i) fatality;
- ii) permanent injury;
- iii) non-permanent injury; and
- iv) no injury.

The permanent and non-permanent injuries are further characterized by 28 specific types of injury descriptions. In the above equation, disability weights, fraction long-term and short-term durations, associated with the various injury descriptions, have been adopted and/or modified from the Australian Burden of Disease and Injury Study [9]. The long-term duration is the expected life expectancy at the time of injury and is applicable in the case of a permanent injury.

Consider the following hypothetical example to better understand the evaluation of expected health impact. Assume a male victim sustains a spinal injury at the age of 30 years due to the malfunctioning of a regulated technology. Using the cohort life expectancy of 48.1 years for males aged 25 to 34, the equivalent healthy years lost due to the spinal injury can be calculated as 21.31 DALYs by using the above equation. In this calculation, the short-term weight of 0 and duration of 0 years were used respectively, and the fraction long-term and long-term duration parameters were taken to be 1 and 0.443 respectively.

Injury Burden

The observed health impact is quantified based on each victim’s age and injury type in denominations of DALY and is then scaled by the time period under study, the median life expectancy and the exposed population to determine the injury burden in units of fatality-equivalents per exposed population per year. Note that the scaling



factors are dynamic and subject to change year-over-year or once every five years during a nation-wide census update.

This edition of the ASPR includes the observed injury burden expressed using actual DALYs, as well as the risk of injury or fatality. The former reflects the health impact experienced in a given year, while the latter is a prediction of the injury burden expected in the future based on historical data.

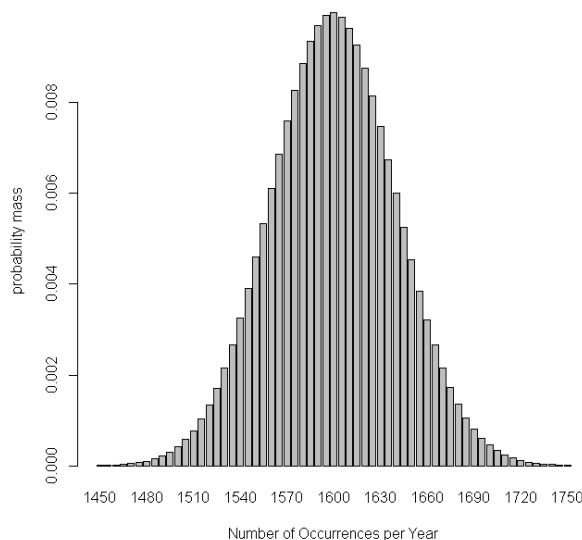
Risk of Injury or Fatality

The Risk of Injury or Fatality (RIF) approach determines predicted injury burden by accounting for historical occurrences while taking into consideration the uncertainties and variability inherent in the involved parameters and predicts the future state of safety in terms of fatality-equivalents per exposed population per year. The rationale behind this approach is that there is a potential for some of the occurrences without health impacts to manifest themselves as incidents with injuries and fatalities in the future. A simulation approach is used to conduct the predictions based on actual observations. Parametric uncertainties are taken as probability distributions which are then input into the prediction model:

- (a) One major uncertainty is in the actual number of occurrences. This attribute is subject to reporting bias which means that an unknown fraction of incidents goes unreported to TSSA. The randomness is assumed to follow a Poisson distribution¹⁹ with the observed occurrence rate as the input parameter.

Figure B1 illustrates the breadth of uncertainty in the occurrence rate when, for example, 1,600 occurrences a year are observed on average.

Figure B1: Probability mass distribution of the occurrence rate (example).

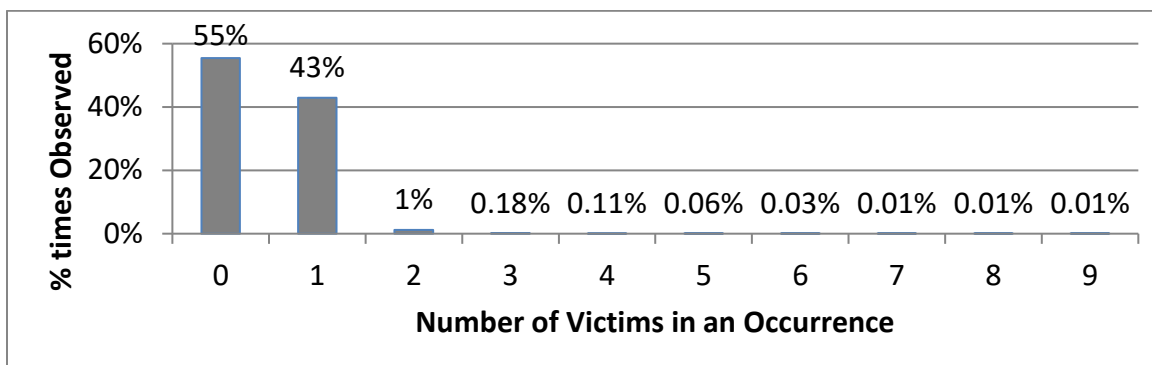


- (b) The number of victims involved in an occurrence is assumed to be a discrete empirical probability distribution constructed from historical observations. This scheme ensures that extreme tail events are assigned a minimal probability, instead of assuming that they are equally likely compared to the most representative estimate.

Figure B2 illustrates the victim count distribution for a typical composite TSSA State of Safety prediction. The example shows that there are no victims involved in 55% of the cases, one victim involved in 43% of the occurrences and as high as nine victims in less than 0.01% of the occurrences.

¹⁹ https://en.wikipedia.org/wiki/Poisson_distribution

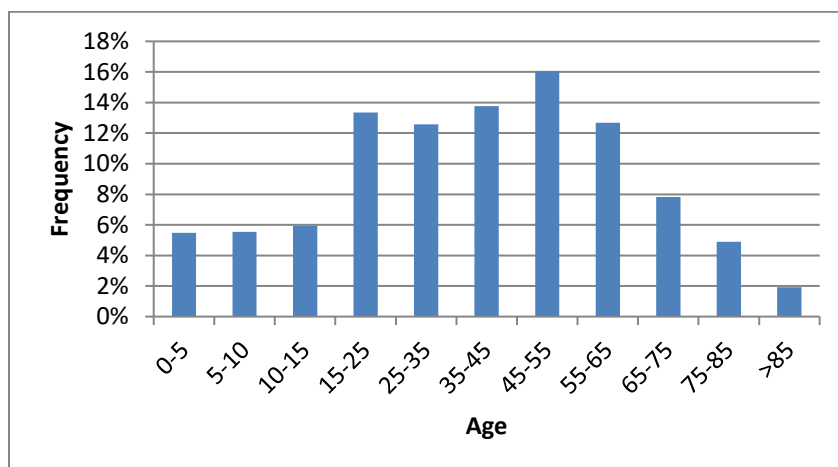
Figure B2: Frequency of the number of victims in an occurrence (example).



- (c) The age of a victim is also uncertain, and the range is between that of being an infant and an elderly person. It is sampled from an age-based population census estimate from Statistics Canada.

Ontarians aged 15 – 65 constitute about 70% of the population as seen in Figure B3 and are more likely to be victims of an occurrence than otherwise.

Figure B3: Age distribution for predicted risk simulation (example).

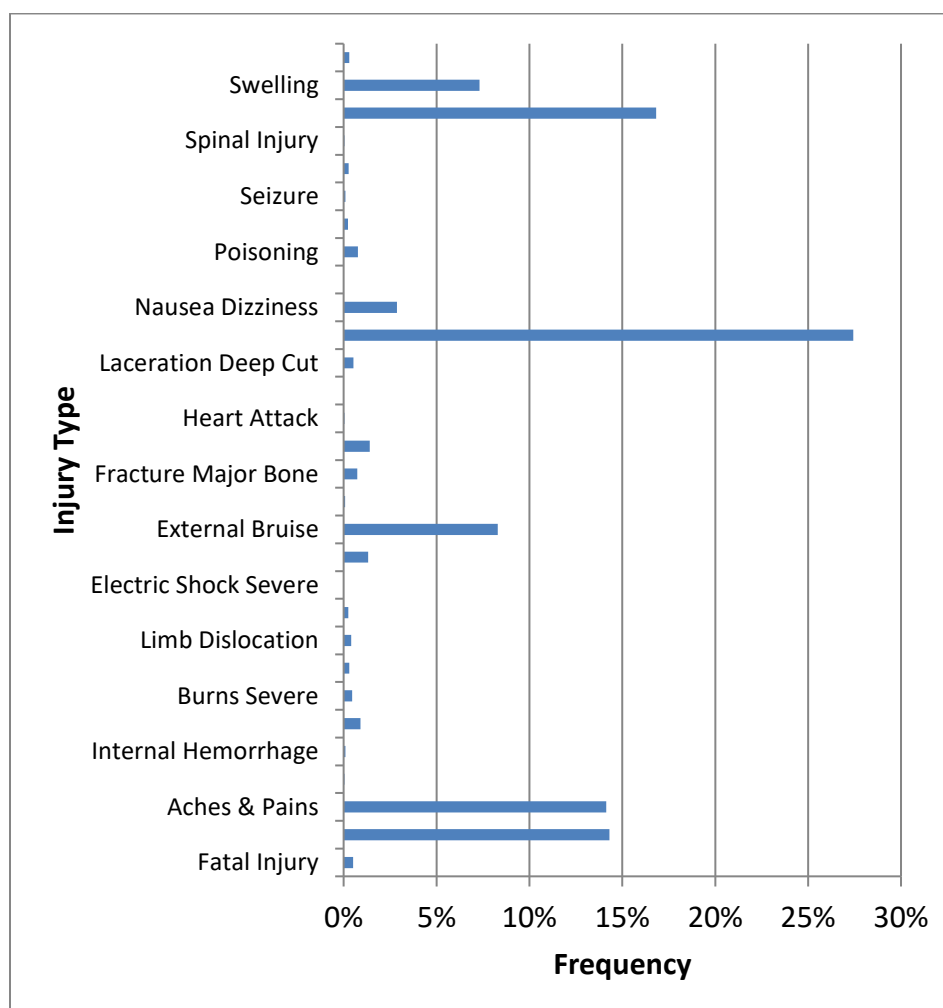


- (d) The number and type of injuries is sampled from a distribution constructed out of observations. This distribution is dependent on the program and the specific occurrence type under consideration.

An injured victim is likely to sustain superficial cuts, sprains, aches and pains or no injury at all more often than a fatal injury as seen in Figure B4. The distribution is for illustrative purposes only and varies depending on the regulated sector under study.



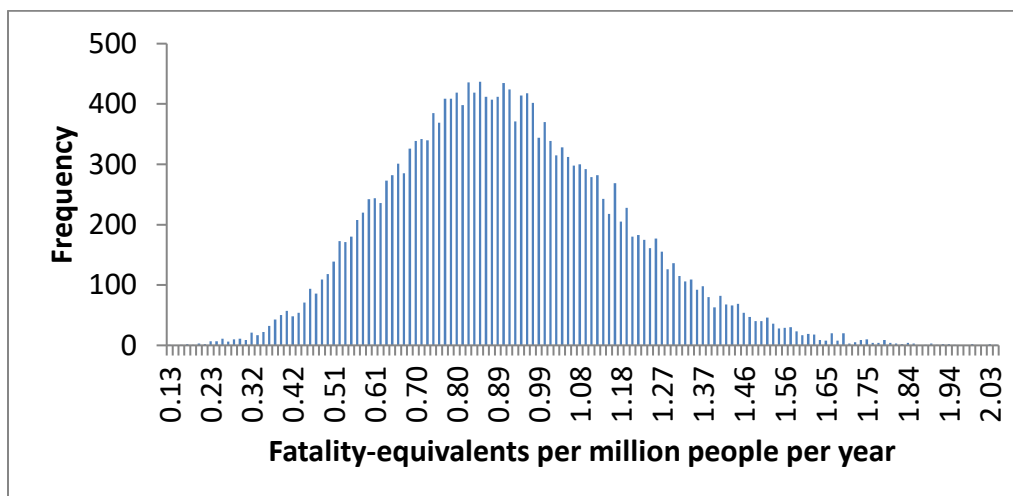
Figure B4: Injury distribution for the composite risk of injury or fatality (example).



In fiscal year 2019, the calculation was updated to improve accuracy and reduce numerical instabilities. In particular, the victim and number of injury distributions now rely on empirical distributions rather than uniform distributions.

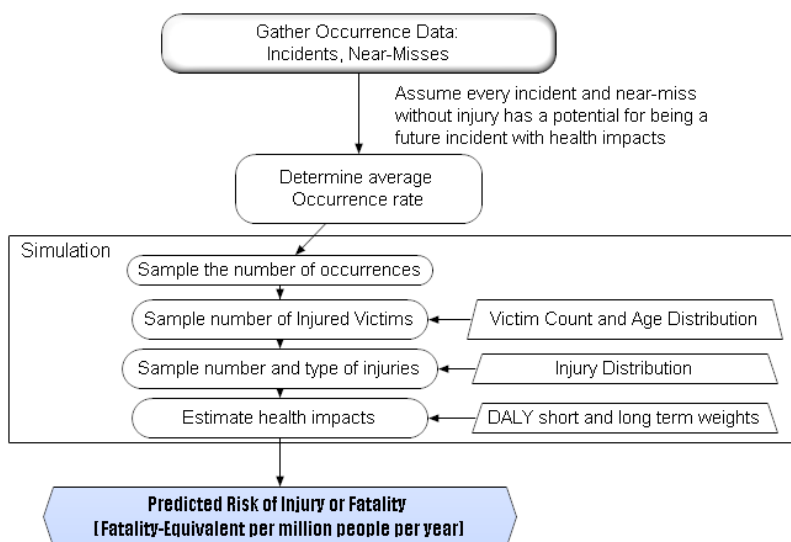
The end result of a risk simulation is a frequency distribution of predicted health impacts as exemplified in Figure B5. The mean value is used for reporting purposes in the report. In Figure B5, the respective estimate is 0.91 fatality-equivalents/million/year. Note that the risk of injury or fatality is expected to be somewhat larger than the corresponding observed risk. This is a result of the model design to consider near-misses as potential incidents and to ensure that a larger set of uncertainties are incorporated into the model that are not exhaustively captured in the actual observations.

Figure B5: Risk of injury or fatality distribution (example).



The procedure followed to determine the anticipated health impacts is shown in Figure B6.

Figure B6: Flowchart to predict future health impacts.



Statistical Methods

The statistical analysis of the time-series data in this report includes data analysis and trend tests.

When presenting data, it is often desirable to know whether the measured indicator is increasing or decreasing over time. While time-series plots tempt the reader to make visual assumptions on the behaviour of variables over time, trend tests allow for rigorous statistical hypotheses testing. This has three additional advantages over graphical data analysis:

- it ensures a systematic, consistent method of data analysis;
- it yields a measure of the increase or decrease over time; and
- it presents a measure of the strength of the evidence (the p-value).



The current format of the ASPR does not include the p-value explicitly, but it is used as a step in the trend analysis.

The Mann-Kendall test²⁰ is a non-parametric trend test and does not require any assumption of normality or canonical distributions in the data. This test is robust and allows missing data to be present in the analysis.

The trend analysis presented in this report considers the predominantly seasonal nature of the operation of devices (i.e., amusement devices and ski lifts). The trend analysis confirms and takes into account seasonality while establishing historical patterns of safety and compliance performance.

There are many instances where seasonality is the source of variation in the response variable. As such, this report uses Kruskal-Wallis²¹ statistics for testing seasonality in the time series, which was done using Minitab 17[®] software. The assertions of any of these tests are made with 95% confidence and if evidence is found for seasonality, then the Seasonal Mann-Kendall trend test is used instead of the Mann-Kendall test.

While the trend tests are performed on the quarterly data, this data is aggregated annually for communication purposes.

Assumptions and Sources of Uncertainty

The analysis of compliance trends is provided over a rolling five-year period, which aligns with TSSA's Strategic Planning process. This approach allows for appropriate measurement and reporting on the effectiveness of these strategies. Trend analysis on incidents and near-miss occurrences is based on an indefinite period, limited by the nature and quality of information available in TSSA's database. This will help in better understanding the changing risk profile over extended periods of time.

In producing this report, TSSA's Public Safety Risk Management (PSRM) team of the Strategic Analytics department has made every effort to ensure a high level of quality control over its calculations and methodologies. To this effect, TSSA takes every precaution to ensure the accuracy and quality of data presented in the ASPR. Intrinsically, PSRM developed a Quality Management System in 2012 to ensure accurate presentation of public safety information. Occasionally, it is necessary to make restatements to results reported in previous years, typically a result of timeframe factors, such as information received subsequently to the issuance of the report, localized reporting lags for periodic data, investigations completed, and other issues.

Analysis involving reported and inspected incidents and near-miss occurrences may be impacted by reporting biases. Due to the varied nature of reporting across the different regulated sectors, TSSA is currently unable to quantify the level of reporting bias and is therefore not currently in a position to account for this uncertainty.

Some figures were created using numbers that have been rounded off for ease of display and as such some totals may not add up fully or may exceed the 100th percentile.

The average rate of injury and the observed injury burden figures are assumed on a fixed Ontario population size of 14,446,515²² in the calculation, resulting in some degree of uncertainty. However, it is not considered to be significant.

Occasionally, data records can be misclassified. For example, an amusement device occurrence might be mistakenly entered into the database as an elevating device occurrence. This would not affect the overall RIF calculation, but would be filtered out for the program RIF calculation. Misclassified data such as this would be followed up with the relevant program so the data can be corrected for future editions of the ASPR. In addition, data records may have missing or inaccurate information, such as a victim's age being unknown in an occurrence report. When a victim's age is unknown, the risk software assumes an average age. If age information is later found to be inaccurate, then this would again be followed up with the relevant program to modify the database, so

²⁰ https://en.wikipedia.org/wiki/Trend_analysis

²¹ https://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance

²² The population of Ontario in Q1 2019 was 14,446,515 per Statistics Canada (ref: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1710000901>).



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it could be corrected for future editions of the ASPR. Assumptions can also be made while entering data. For example, a decision will need to be made on whether an injury should be described as a “minor” or a “severe” burn, which requires some degree of interpretation. TSSA makes every effort to minimize these sources of uncertainty and makes corrections, if applicable, when they are discovered.

This report contains occurrences that were reported and had their investigations completed, and had their data entered into TSSA’s information system. It does not include ongoing inspections or investigations. Accordingly, this may result in a slight underreporting in some numbers. Since TSSA aims for a prompt turn-around time, it is expected that the impact is largely isolated to the results for the most recent year (in this case, fiscal year 2019).



Appendix C – Risk-Based Inspection Scheduling

Introduction

TSSA conducts periodic inspections of devices and facilities administered under the Act, based on prescribed intervals set in regulations or at the discretion of the statutory director responsible for the specific regulations using the Director's powers laid out in the Act and/or the regulations. As part of TSSA's RIDM framework, TSSA has adopted to use a risk-informed approach to schedule the frequency of inspections when not prescribed. This scientific and evidence-based approach helps TSSA to focus its resource allocation efforts on the basis of safety risk to Ontarians while ensuring objectivity, consistency, fairness and transparency.

TSSA's patented approach for risk-based scheduling (RBS) of devices and facilities is based on the non-compliances observed (hereafter "orders issued") during inspections, as well as occurrences caused by non-compliance with regulations. Devices or facilities that have had no occurrences caused by non-compliance with regulatory requirements, and/or relatively small number of low-risk non-compliances found during inspections are likely to be inspected at longer intervals. Short inspection intervals would be recommended for devices or facilities that have many high-risk orders issued against them and/or have occurrences caused by non-compliance with regulations.

Not only can the RBS method inform inspection scheduling, it gives an indication as to the estimated risk profile in a particular area of concern. In cases where the regulations specify intervals, RBS profiles can be generated exclusively for reporting purposes (e.g., Amusement Devices, Liquid Fuels). Since not all programs use RBS for scheduling, it is reported instead as the *Inventory Risk Profile*.

The RBS 2.5 Model

TSSA initially developed and obtained a patent for the model (RBS 2.0) in 2013. However, since that time TSSA has been making enhancements to the model based on implementation in the field and new information and this appendix describes the most up-to-date version (v. 2.5).

The conceptual basis for the model involves a mathematical aggregation of orders issued during inspections and enforcement actions. Risk scores are determined for all orders, drawing primarily on the standard orders risk assessment (see Appendix I); the key difference being when determining the recommended time to compliance (TTC), the risk is defined as *frequency x consequence* while for the RBS the risk is defined as *probability x consequence*. In the case of the determination of the TTC, the objective is to determine the time by when the aggregated consequences of potential occurrences due to an observed non-compliance (if left unaddressed) could reach a threshold. However, the objective of RBS is to determine the time by when the probable accumulation of non-compliances would result in a cumulative consequence. For orders where no risk score is currently available or not determined (e.g. non-standard orders), the issued TTC is used as a surrogate to derive a risk score based on the median risk score of all standard orders with a similar TTC.

The RBS calculation considers all orders issued over the past three periodic inspections and any other applicable inspection activities in that time interval. For instance, if Device A has periodic inspections conducted in 2012, 2014, and 2016, then any additional inspections, such as enforcement actions and ad-hoc inspections, since 2012 will be included. These order scores are then summed to arrive at an inspection risk score. Devices with occurrences caused by non-compliance with regulations are additionally penalized by assigning each occurrence a DALY value based on the most likely significant consequence (or the 99.5th percentile of all injury-carrying occurrences) and added to the inspection risk score. A time weighted average of the inspection risk scores and the time duration between inspections is calculated to arrive at a device or facility risk score.

It is assumed that the risk at a facility/device is close to zero immediately after a periodic inspection. It is also assumed that, in the absence of inspections, the perceived risk gradually accumulates over time due to unobserved non-compliances at a rate specific to a facility/device based on historical observations. The rate is determined based on the following factors:



1. Probable Occurrence Rate for Facility/Device - This is determined by dividing the Facility/Device Risk Score with the average health impacts (measured in fatality-equivalents) per occurrence based on incident history across all facilities/devices and all occurrences with known health impacts.
2. Shape Factor (p) – This provides the shape of the curve that helps determine the rate of accumulation of the perceived risk over time. It is determined by fitting an appropriate statistical distribution to observed time to occurrence since the last inspection. The shape factor is applied to all facilities/devices.

A cumulative risk curve is constructed for each facility/device based on the facility/device specific occurrence rate (described above) and the shape factor. The recommended periodic inspection interval is obtained from the curve as the time to chance of a fraction of one fatality-equivalent as determined by the statutory director. A tolerability interval is obtained from the curve as the time to chance of one fatality-equivalent.

For operational reasons and to address uncertainty in the risk estimates the statutory director sets the maximum and minimum inspection intervals (for example, statutory director for the Elevators Safety Program Area has set the minimum and maximum intervals at 6 months and 5 years respectively). In this year's ASPR, the inspection intervals of high-, medium-, and low-risk devices/facilities have been fixed as per Table C1.

Table C1: Inspection intervals of high/medium/low risk facilities.

Risk Bin	Inspection interval (months)
High	6
Medium	6 – 24
Low	24

In addition to harmonizing the risk bin definitions, the acceptability thresholds have been harmonized for reporting purposes. This value represents the acceptable level of risk; the calculation determines the inspection interval based on inspecting a device/facility before that risk is accumulated. Historically this level is set by the statutory director, but this year it has been made constant for all applications.

This year's calculation features a significant enhancement for propane licensed sites. TSSA is heeding the Auditor General of Ontario's recommendation to incorporate the information stored in Risk and Safety Management Plans (RSMs) into the RBS calculation. To this end, TSSA has implemented a variable risk threshold for propane facilities such that the acceptable level of risk is dependant on surrounding land use. For example, a facility with sensitive receptors in its hazard radius has a risk threshold 3% of that which is used in a remote/industrial area. Similarly, a facility in a high-density residential area has a risk threshold 10% of that which is used in a remote/industrial area. If TSSA can gather this sort of information on other types of sites, it would consider extending this approach to other technologies.



Appendix D – Inspection and Re-Inspection Results

The tables below contain number and type of inspections, as well as re-inspection results, for fiscal year 2019. “Pass” or “Fail” was based on the outcome status of an inspection. “Other” was a group of inspection outcomes that included either non-mandated outcomes, outcomes that were neither pass or fail (such as validating installed base statuses or occurrence inspections), and various other miscellaneous statuses. “Other” outcomes were not included in the pass rate. There are subtle differences between the pass rate used in this appendix and the compliance rate used in the main body of the report, which can result in small differences between the two numbers.

Table D1: All programs combined inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	2,056	2,244	6	4,306	47.8%
Alteration Inspections	96	5	0	101	95.0%
Complaint Inspections	536	55	0	591	90.7%
Initial Inspections	7,707	3,301	44	11,052	70.0%
Inspections for Certification	2,679	83	0	2,762	97.0%
Minor Alteration Inspections	1,686	1,477	0	3,163	53.3%
Non-Mandated/Non-Regulated Inspections	1,645	529	771	2,945	75.7%
Occurrence Inspections	59	120	3,337	3,516	33.0%
Operational Inspections	258	42	0	300	86.0%
Other Inspections	12,023	4,936	818	17,777	70.9%
Periodic Inspections	8,506	19,110	18	27,634	30.8%
Re-Inspections	12,378	25,379	307	38,064	32.8%
Repair Inspections	634	3	0	637	99.5%
All Programs Total	50,263	57,284	5,301	112,848	46.7%

Table D2: Boilers and pressure vessels²³ safety program inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Alteration Inspections	76	0	0	76	100.0%
Initial Inspections	2,455	18	0	2,473	99.3%
Inspections for Certification	2,679	83	0	2,762	97.0%
Non-Mandated/Non-Regulated Inspections	1,508	0	7	1,515	100.0%
Occurrence Inspections	0	0	16	16	N/A
Other Inspections	11,040	511	0	11,551	95.6%
Periodic Inspections	288	5	0	293	98.3%
Re-Inspections	72	15	0	87	82.8%
Repair Inspections	634	3	0	637	99.5%
Boilers and Pressure Vessels Total	18,752	635	23	19410	96.7%

Table D3: Operating engineers safety program inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Initial Inspections	13	72	0	85	15.3%
Occurrence Inspections	0	0	12	12	N/A
Other Inspections	69	60	92	221	53.5%
Periodic Inspections	752	1,003	0	1,755	42.8%
Re-Inspections	436	388	42	866	52.9%
Operating Engineers Total	1,270	1,523	146	2,939	45.5%

²³ Uninsured equipment only.



Table D4: Amusement devices safety program inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	5	19	0	24	20.8%
Initial Inspections	106	144	0	250	42.4%
Occurrence Inspections	9	7	0	16	56.3%
Operational Inspections	201	9	0	210	95.7%
Other Inspections	12	8	0	20	60.0%
Periodic Inspections	1,238	938	0	2,176	56.9%
Re-Inspections	197	192	1	390	50.6%
Amusement Devices Total	1,768	1,317	1	3,086	57.3%

Table D5: Elevating devices safety program – elevators inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	358	1,281	1	1,640	21.8%
Initial Inspections	792	2,370	0	3,162	25.0%
Minor Alteration Inspections	1,626	1,454	0	3,080	52.8%
Non-Mandated/Non-Regulated Inspections	130	520	1	651	20.0%
Occurrence Inspections	32	100	0	132	24.2%
Other Inspections	40	1,387	624	2,051	2.8%
Periodic Inspections	3,481	14,976	0	18,457	18.9%
Re-Inspections	8,685	21,451	182	30,318	28.8%
Elevators Total	15,144	43,539	808	59,491	25.8%

Table D6: Elevating devices safety program – escalators and moving walks inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	0	35	0	35	0.0%
Initial Inspections	6	84	0	90	6.7%
Minor Alteration Inspections	60	23	0	83	72.3%
Non-Mandated/Non-Regulated Inspections	7	7	0	14	50.0%
Occurrence Inspections	3	6	0	9	33.3%
Other Inspections	0	69	41	110	0.0%
Periodic Inspections	83	568	0	651	12.7%
Re-Inspections	496	825	9	1,330	37.5%
Escalators and Moving Walks Total	655	1,617	50	2,322	28.8%

Table D7: Elevating devices safety program – passenger ropeways (ski lifts) inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	2	8	0	10	20.0%
Alteration Inspections	8	3	0	11	72.7%
Initial Inspections	7	5	0	12	58.3%
Non-Mandated/Non-Regulated Inspections	0	2	2	4	0.0%
Occurrence Inspections	1	7	0	8	12.5%
Operational Inspections	57	33	0	90	63.3%
Periodic Inspections	47	81	0	128	36.7%
Re-Inspections	50	31	0	81	61.7%
Ski Lifts Total	172	170	2	344	50.3%



Table D8: Fuels safety program inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	1,596	791	5	2,392	66.9%
Alteration Inspections	12	2	0	14	85.7%
Complaint Inspections	531	55	0	586	90.6%
Initial Inspections	4,038	529	44	4,611	88.4%
Non-Mandated/Non-Regulated Inspections	0	0	761	761	N/A
Occurrence Inspections	0	0	3,309	3,309	N/A
Other Inspections	862	2,901	61	3,824	22.9%
Periodic Inspections	2,227	1,409	18	3,654	61.2%
Re-Inspections	2,039	2,340	73	4,452	46.6%
Fuels Total	11,305	8,027	4,271	23,603	58.5%

Table D9: Upholstered and stuffed articles safety program inspection and re-inspection results (2019).

Inspection Type	Pass	Fail	Other	Grand Total	Pass Rate (%)
Ad Hoc/Unscheduled Inspections	95	110	0	205	46.3%
Complaint Inspections	5	0	0	5	100.0%
Initial Inspections	290	79	0	369	78.6%
Occurrence Inspections	14	0	0	14	100.0%
Periodic Inspections	390	130	0	520	75.0%
Re-Inspections	403	137	0	540	74.6%
Upholstered and Stuffed Articles Total	1,197	456	0	1,653	72.4%



Appendix E – Causal Analysis Categories

TSSA designates occurrences with a root cause into three categories. The description of each category and the associated mapping of root cause information are listed below. Occurrences that do not have an established root cause after inspection are contained in a fourth category: root cause not established.

Potential Gaps in Regulatory System

Occurrences in this causal category indicate potential areas in need of regulatory change or improvement. They are consistent with the regulatory gap and impact analysis currently used by the Ministry of Government and Consumer Services to effectively improve the regulatory system without imposing unnecessary additional regulatory burden.

Table E1: Causes contained in the potential gaps in regulatory system category.

Category	Definition	Sub-Categories
Design	Factors related to the engineering outline and physical make-up of a device for its intended purpose.	• Defective or inadequate design. • Defective/inadequate safety features, or devices.
Management	Factors related to the levels of responsibility that are accountable for specific activities, programs and systems of operation.	• Gaps in the regulatory management system.

Non-compliance with Regulatory System

Occurrences in this causal category most appropriately reflect TSSA's effectiveness in administering the safety system and obtaining compliance. They allow TSSA to allocate enforcement resources to areas of greatest risk.

Table E2: Causes contained in the non-compliance with regulatory system category.

Category	Definition	Sub-Categories
Design	Factors related to the engineering outline and physical make-up of a device for its intended purpose.	• Inappropriate equipment or material selection. • Inappropriate drawing, specification or data.
Equipment/ Material/ Component	Factors related to a device (machinery), the physical constituents of a device (material used or make-up) or a specific unit of an overall device of machinery.	• Defective, failed, or malfunctioning equipment. • Defective or failed component, including safety devices. • Defective or failed material. • Defective assembly. • Electrical or instrument noise or malfunction. • Contamination of material, component or equipment.



Category	Definition	Sub-Categories
Human Factors	Factors related to actions or inactions of humans in the execution of activities in the operation of equipment or in the general work environment.	• Inadequate or unsafe operating environment. • Failure to follow maintenance procedures. • Failure to follow operating procedures. • Failure to follow installation procedures. • Inappropriate plant operator attendance. • Incomplete or inadequate internal communication. • Incomplete or inadequate external communication.
Maintenance Procedures	Factors related to repair and upkeep activities required for the preservation of a device during its useful lifecycle.	• Defective or inadequate maintenance procedures. • Lack of maintenance procedures.
Management	Factors related to the levels of responsibility that are accountable for specific activities, programs and systems of operation.	• Inadequate or defective management systems. • Lack of management systems. • Improper or negligent work practices.
Procedures	Factors related to guidelines that outline how specific activities should be executed.	• Defective or inadequate operating procedures. • Lack of operating procedures. • Lack of or inadequate safety procedures. • Defective or inadequate installation procedures. • Lack of installation procedures.
Training	Factors related to documented programs that prepare employees for the proper execution of specific work activities as required.	• Lack of training programs. • Defective or inadequate training programs.

External Factors

Occurrences in this causal category indicate those outside the control or influence of TSSA. This category prevents misrepresentation of TSSA's performance with respect to compliance or the effectiveness of provincial regulations and allows for the identification of other mitigation measures.

Table E3: Causes contained in the external factors category.

Category	Definition	Sub-Categories
External Events	Events representing occurrences beyond human control or TSSA regulatory control.	• Weather or other environment conditions. • Utilities disruption or failure. • External incidents. • Sabotage, terrorism, vandalism or theft. • Non-compliance with non-TSSA regulations.



Category	Definition	Sub-Categories
Human Factors	Refers to the use of regulated technology by a user in a manner that TSSA cannot reasonably know or anticipate and may result in occurrence.	• Special conditions. • Failure to follow user instructions. • Deliberate intent or sabotage.



Appendix F – In-Depth Root Cause Analysis

“A director shall order such investigation as he or she considers necessary on being notified of an accident or incident.”

Technical Standard and Safety Act; 2000, c. 16, s. 25.

Introduction

TSSA administers this requirement in accordance with its risk-informed incident management policy and the associated Incident Management System that facilitates a decision-making process applicable to all types of occurrences (i.e., incidents or near-misses). The Incident Management System deals with all stages, starting from the time an occurrence is reported, an inspector dispatching decision is made, all the way to the determination of cause for the occurrence and any future actions, including prosecutions. Information is collected and documented through the entire process using TSSA's unique Incident Management Information System.

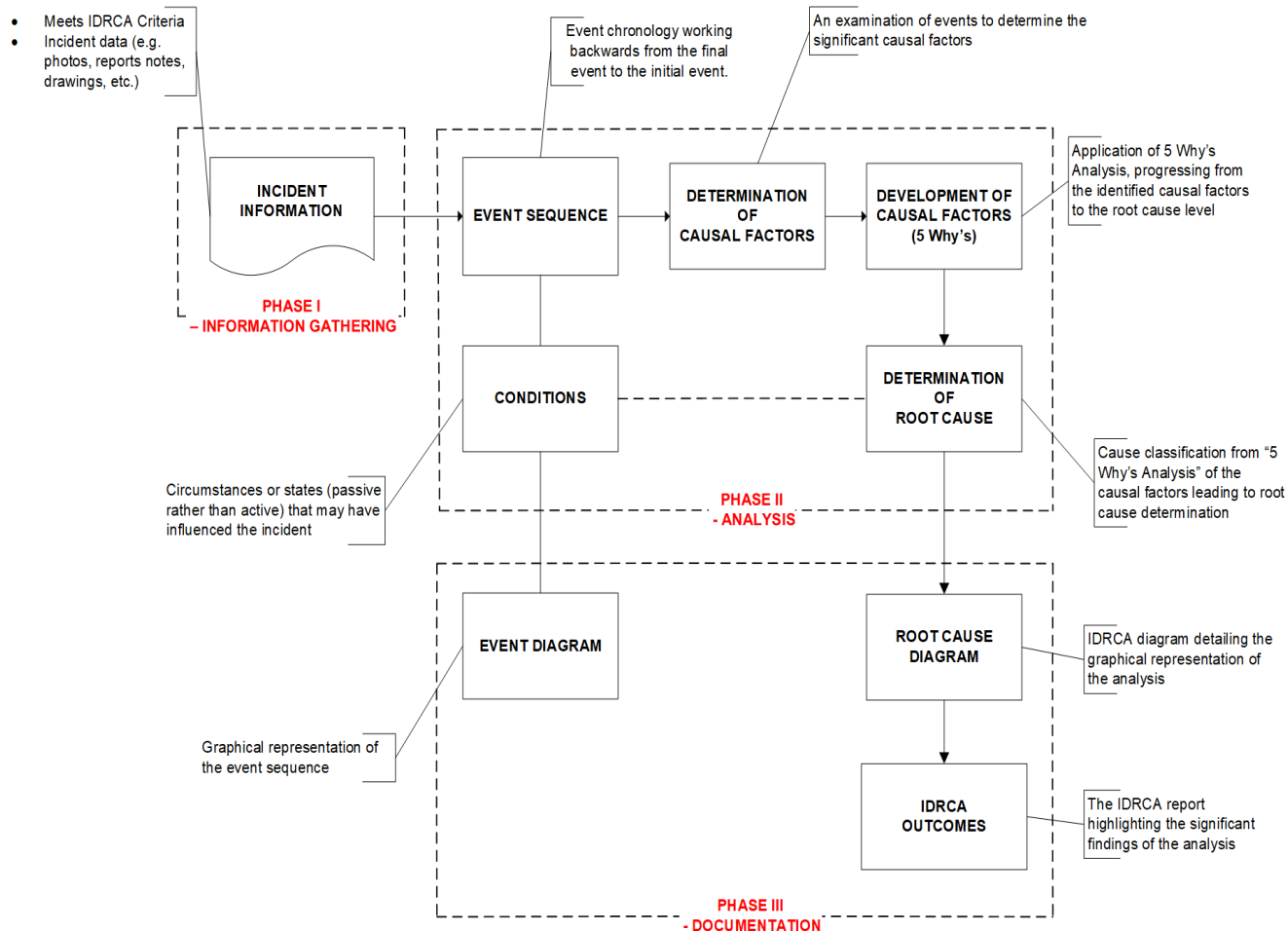
A key aspect of the Incident Management System is the determination of cause(s) for occurrences, as this helps TSSA in addressing any potential gaps in the safety system and reducing risk to Ontarians. Investigations, due to the nature of most occurrences, tend to be completed by inspectors' basic analyses to determine cause(s). However, where a root cause cannot be determined by an inspector alone, and also depending on the nature of the reported occurrences, their level of complexity, the effort in determining cause varies. In recognition of this variability and its associated importance, TSSA has developed a best-practice investigation methodology for occurrences that meet the in-depth criteria. This formal approach, *In-Depth Root Cause Analysis (IDRCA)*, uses Root Cause Analysis (RCA) principles to determine and document underlying causes related to occurrences under the TSSA regulatory mandate but with additional focus and effort (see Figure F1). To this effect, TSSA has internally developed a formal process that has significantly improved the efficiency and quality of the RCA exercise. This analysis allows for the development of strategies to prevent and/or mitigate re-occurrence of such incidents by providing useful data to assist in informing further safety decision-making.

The ultimate objective of the IDRCA process is to determine all causal factors and not to identify blame. An additional benefit of the IDRCA is that it has provided useful information to other processes (e.g., risk assessments, Director's Orders, etc.) to enhance safety decision-making.

For an occurrence to be classified as requiring an IDRCA, it has to meet the following criteria:

1. Fatality (i.e. where the health impact from an occurrence included death of a victim); and/or
2. Where regulatory non-compliance and the root cause could not be determined by the inspector alone (i.e., complex scenarios); and/or
3. Where the inspector and/or those involved in the occurrence inspection believes that there is a high potential for re-occurrence in the future involving similar equipment/circumstances.
4. Other reasons as determined to be appropriate by TSSA investigators including nature and magnitude of consequences associated with the occurrence (e.g., multiple permanent injuries, disruptions, extensive media/political coverage etc.).

Figure F1: In-depth root cause analysis flowchart.



The IDRC Process

The IDRC tool, developed by TSSA, is used to document the entire analysis exercise where occurrence information is recorded in a logical manner to assist in the validation and accuracy of incident data.

The IDRC is conducted in three phases:

- incident information documentation;
- root cause analysis; and
- report preparation.

(a) Incident Information Documentation – TSSA inspectors are trained to and follow standard operating procedures while collecting necessary incident information. This phase consists of gathering and documenting all possible data/details the inspector is able to collect from the occurrence. An illustration of this phase is shown in Figures F2 – F4 below:

Figure F2: Relevant conditions (at the time of the occurrence).

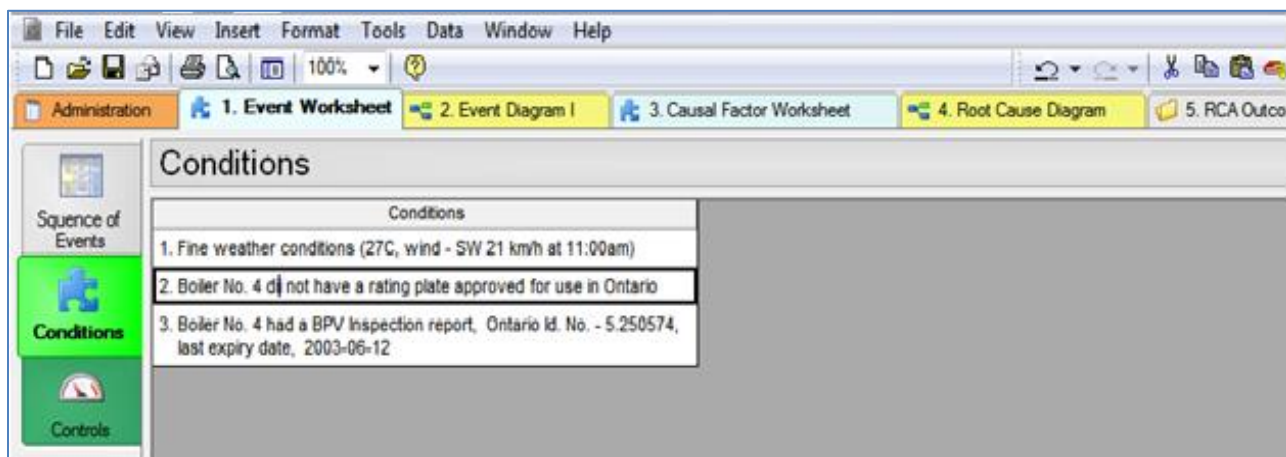


Figure F3: Incident information – data collection.

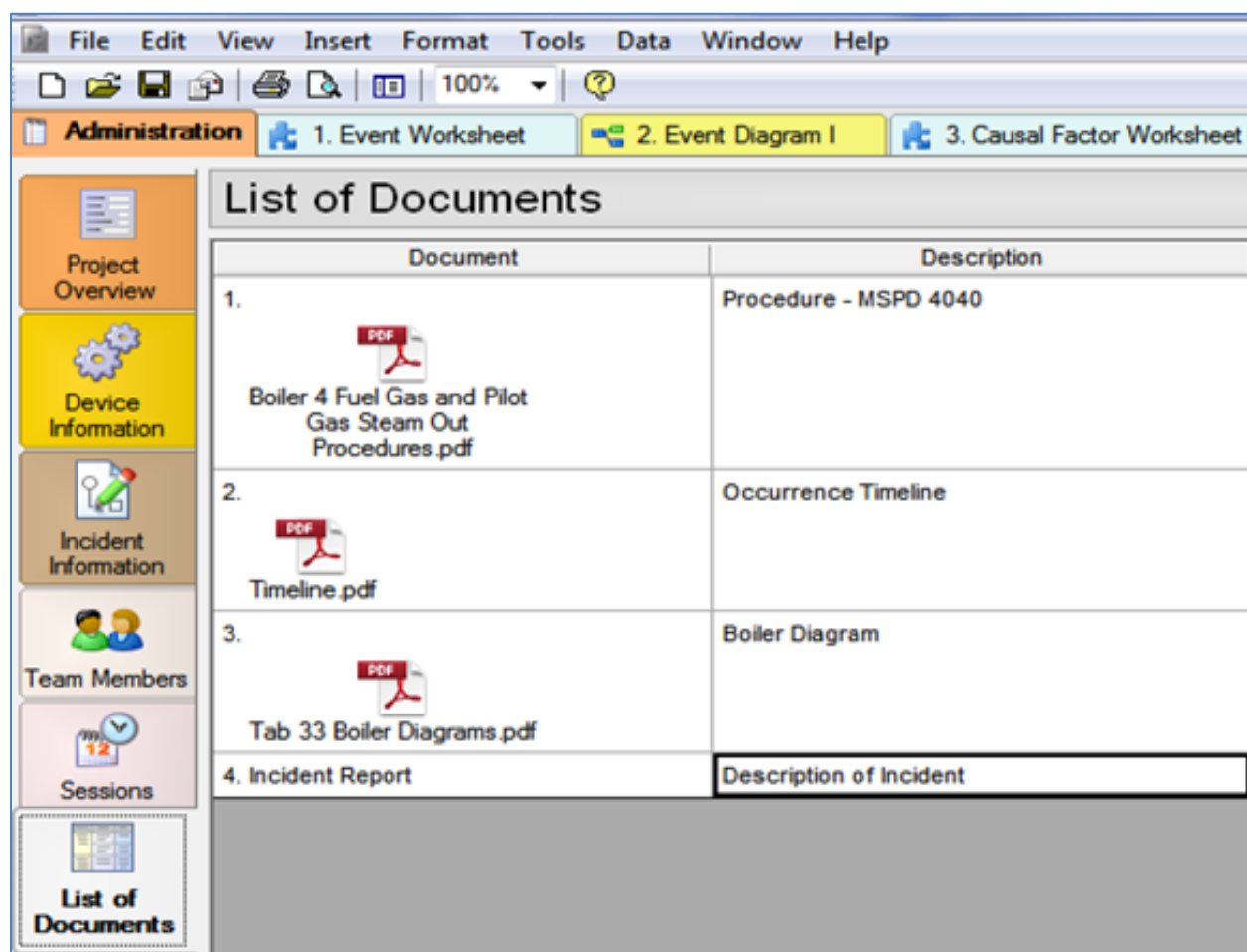
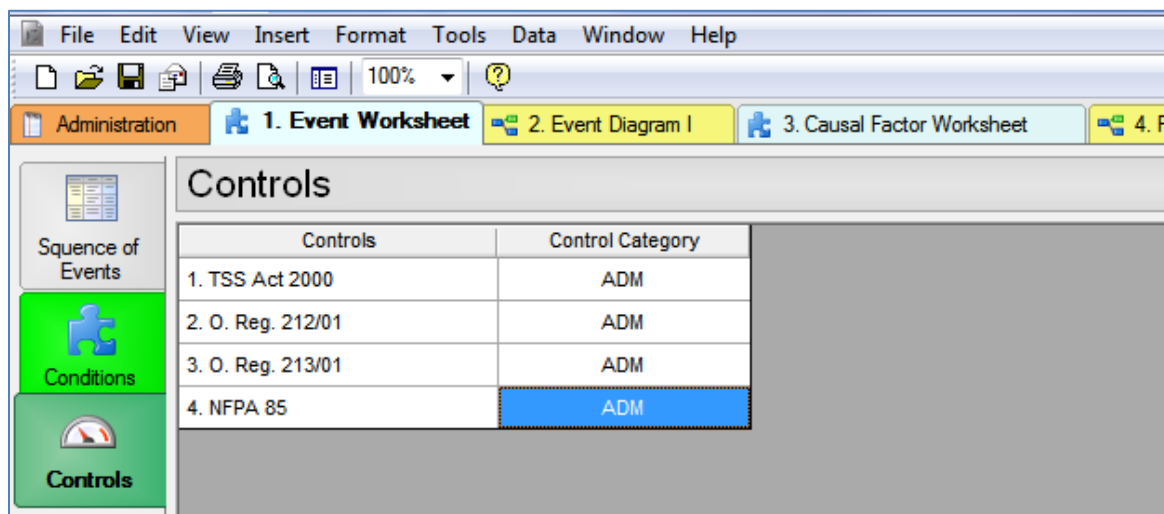


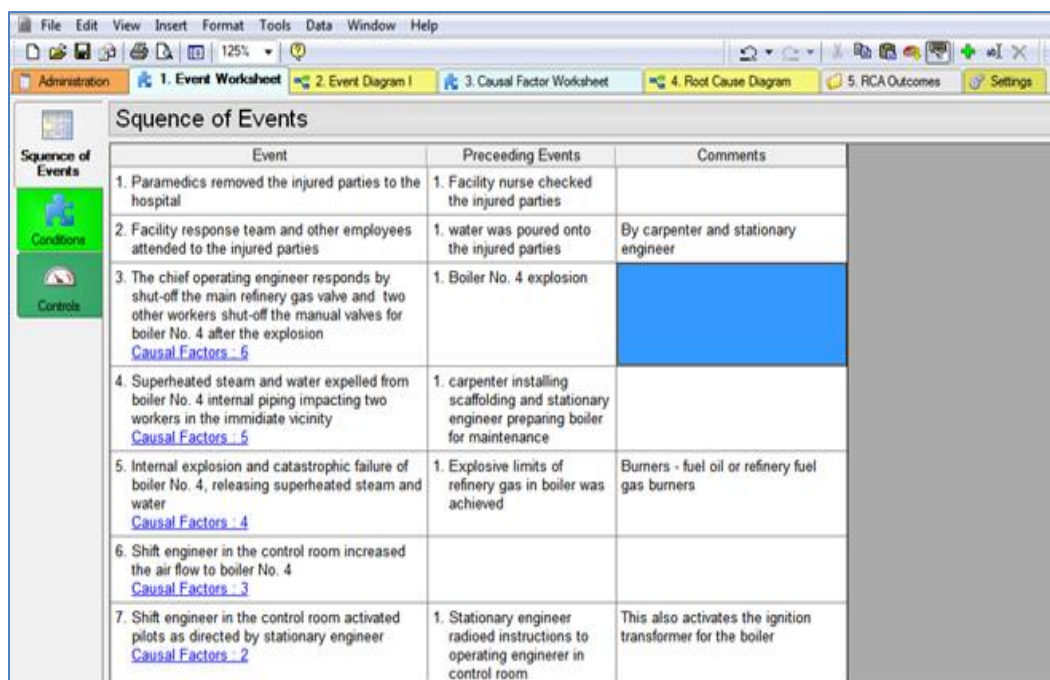
Figure F4: Relevant controls (regulatory or other controls).



Controls	Control Category
1. TSS Act 2000	ADM
2. O. Reg. 212/01	ADM
3. O. Reg. 213/01	ADM
4. NFPA 85	ADM

(b) Root Cause Analysis – This phase involves the application of a best practice analysis approach to determine and evaluate significant events, conditions and causal factors. These findings are documented in a structured manner for the determination of cause based on the evidence by determining the sequence of events (i.e., in chronological order) by working sequentially and visually documenting the combination of events leading to the final event (see Figures F5 and F6). The analysis of each occurrence/final event is achieved by the evaluation of identified causal factors to determine the Direct Cause and followed by application of the “5 Whys Principle?” (see Figure F7 - e.g. asking why or how this could happen?) to determine the Root Cause. This procedure is followed for each causal factor chain identified until all the Contributing Causes are identified, and the team is satisfied it has captured all related scenarios. The TSSA’s root cause analysis policy requires that a single root cause be established, if possible, for each occurrence.

Figure F5: Sequence of events (chronological order).



Event	Preceding Events	Comments
1. Paramedics removed the injured parties to the hospital	1. Facility nurse checked the injured parties	
2. Facility response team and other employees attended to the injured parties	1. water was poured onto the injured parties	By carpenter and stationary engineer
3. The chief operating engineer responds by shut-off the main refinery gas valve and two other workers shut-off the manual valves for boiler No. 4 after the explosion Causal Factors - 6	1. Boiler No. 4 explosion	
4. Superheated steam and water expelled from boiler No. 4 internal piping impacting two workers in the immediate vicinity Causal Factors - 5	1. carpenter installing scaffolding and stationary engineer preparing boiler for maintenance	
5. Internal explosion and catastrophic failure of boiler No. 4, releasing superheated steam and water Causal Factors - 4	1. Explosive limits of refinery gas in boiler was achieved	Burners - fuel oil or refinery fuel gas burners
6. Shift engineer in the control room increased the air flow to boiler No. 4 Causal Factors - 3		
7. Shift engineer in the control room activated pilots as directed by stationary engineer Causal Factors - 2	1. Stationary engineer radioed instructions to operating engineer in control room	This also activates the ignition transformer for the boiler

Figure F6: Sequence of events – event diagram.

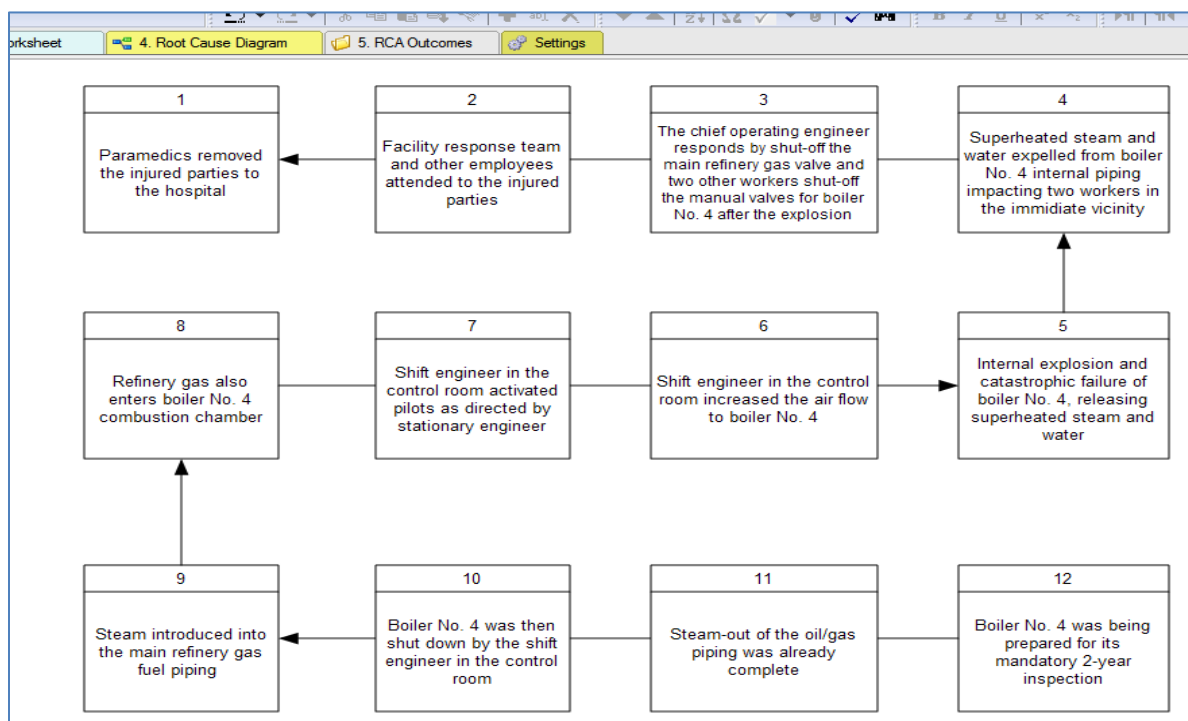


Figure F7: Analysis of causal factors - 5 Whys approach.

Causal Factors	CF Category	1. Why this happened?	Cause Category	Comments	2. Why this happened?	Cause Category	Comment	3. Why this happened?	Cause Category	Comment	4. Why this happened?	Cause Category	Comment	5. Why this happened?	Cause Category	Comment
1. Steam introduced into the main refinery gas fuel piping Sequence of Events - Event 9	Equipment	1. To clean out the refinery gas line - but refinery gas is also introduced as well as steam RCA Outcomes 3	CONTRIBUTING CAUSE	steam used as per procedure (Shell - MSPD 4040)	1. To clean piping of hydrocarbon residue - but refinery gas fills the combustion chamber RCA Outcomes 4	CONTRIBUTING CAUSE	The main refinery gas valve should have been closed/blanked-off as per procedure (Shell - MSPD 4040)	1. The main refinery fuel gas valve was in the open position RCA Outcomes 6	CONTRIBUTING CAUSE	The main refinery gas valve was not closed or blanked-off (Shell - MSPD 4040)	1. The main refinery gas valve was not closed as per procedure RCA Outcomes 7	CONTRIBUTING CAUSE	No documentation for verification of lock-out-tag-out as required by procedures	1. The stationary engineer did not shut-off and lock-out the main refinery gas valve RCA Outcome 5.1	ROOT CAUSE	The stationary engineer was trained and qualified (see training records) Other valves had Lock and Tag the keys were left (not found)
2. Shift engineer in the control room activated pilots as directed by stationary engineer Sequence of Events - Event 7	Personnel	1. To vent off residual refinery gas from the pilot line piping		The ignition transformer continuously sparks when activated	1. To clean piping of hydrocarbon residue			1. To return the boiler to "zero energy" state for maintenance			1. For mandatory inspection of Boiler					
3. Shift engineer in the control room	Personnel	1. To expell unburnt refinery	CONTRIBUTING CAUSE		1. To ensure unburnt gas will not		To eliminate the									



(c) Report Preparation – The final phase the IDRCA process involves preparing a report that documents the findings, provides conclusions and recommendations. The tool itself can summarize the entire exercise including, all administrative details and the documentation of evidence, analysis deliberations, graphical representation of all causal findings in the process (see Figures F8 – F10). A summary report is developed when all phases are completed by the IDRCA facilitator and submitted to the program statutory director including relevant recommendations and conclusions.

Figure F8: IDRCA diagram.

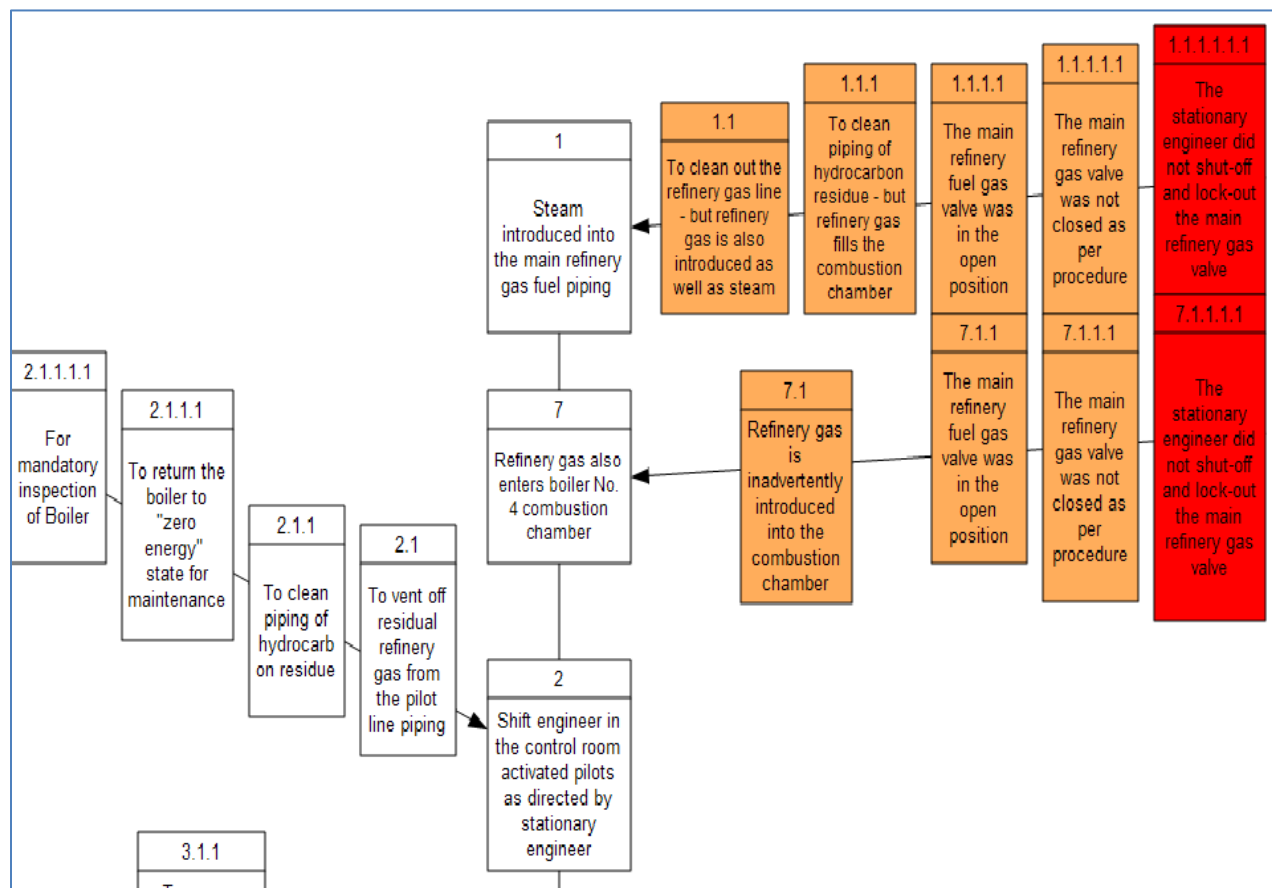
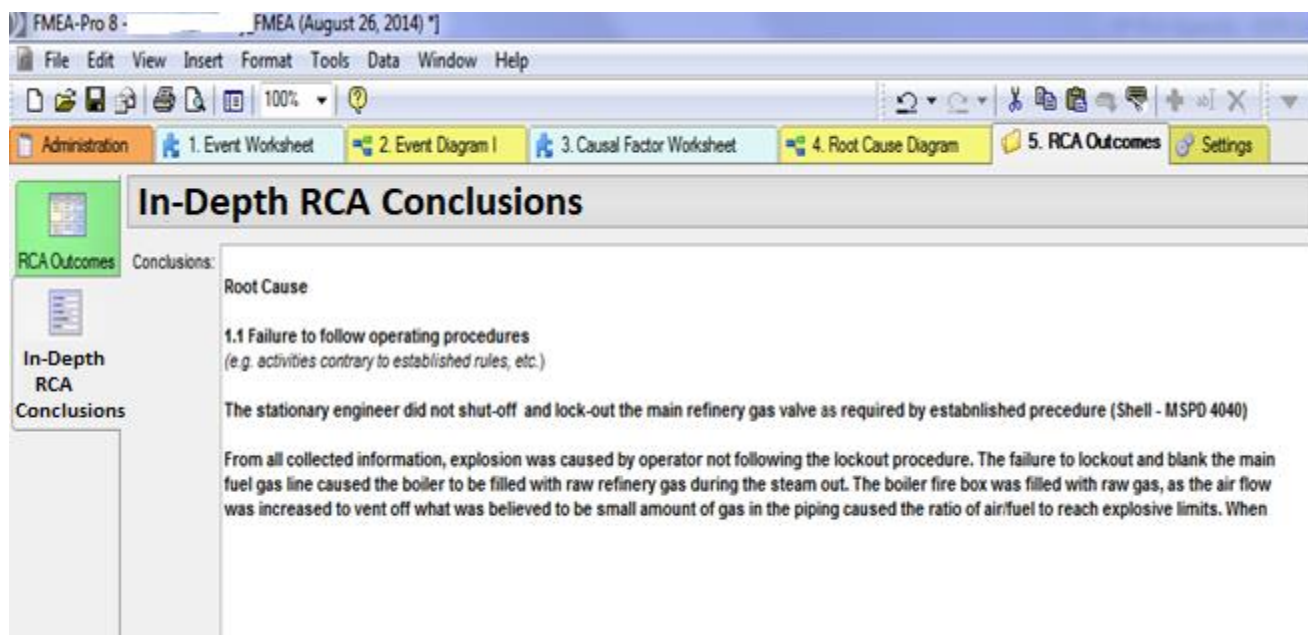




Figure F9: IDRCA outcomes.

RCA Outcomes		
RCA Outcomes	Cause Category	Violations
1. The stationary engineer did not shut-off and lock-out the main refinery gas valve Causal Factors - 5. Why this happened?: 1.1.1.1.1	ROOT CAUSE	1. 1. TSSA Act Section 41. Every person who employs a person to carry out any activity referred to in subsection (1) shall take every precaution that is reasonable in the circumstances to ensure that the person's employees comply with the Act and this Regulation. Note: The stationary engineer did not comply with procedure MSPD 4040: Failure to verify blank is in place of block valve #1. It was confirmed that the main gas valve was not blanked as per procedure and was left in the open position allowing raw refinery fuel gas to enter the combustion chamber the entire duration of the steam out process. 2. ONTARIO REGULATION 212/01. (GASEOUS FUELS) 11 (1). Every person who operates, installs, removes, repairs, alters or services appliances or works shall instruct the person's employees to comply with the Act and this Regulation. Note: The stationary engineer began the shutdown of #4 Boiler without following Procedure MSPD 4040. 3. ONTARIO REGULATION 212/01. (GASEOUS FUELS) 11 (2). Every person who employs a person to carry out any activity referred to in subsection (1) shall take every precaution that is reasonable in the circumstances to ensure that the person's employees comply with the Act and this Regulation. Note: Procedure MSPD 4040 continued with critical lockout and blanking of gas valve # not performed nor verified. 4. ONTARIO REGULATION 212/01. (GASEOUS FUELS) 3 (1). Every person engaged in an activity, use of equipment, process or procedure to which the Act and this Regulation apply shall comply with the Act and this Regulation. Note: The stationary engineer began the shutdown of #4 Boiler without following Procedure MSPD 4040. 5. Ontario Regulation 212/01. (GASEOUS FUELS) 3 (2). For the purposes of subsection (1), the reference to an activity, use of equipment, process or procedure includes, but is not limited to, design, installation, alteration, repair, service, removal, purging, activation, storing, handling, modifying and using. Note: During the entire purging process the boiler filled with raw refinery fuel gas as main gas valve was not blanked as per procedure MSPD 4040 and was left in open position.
2. The pilot ignition transformer was activated igniting the refinery gas/air mixture in the combustion chamber Causal Factors - 1. Why this happened?: 4.1	DIRECT CAUSE	1. 1. Ontario Regulation 212/01. (GASEOUS FUELS) 3 (2). For the purposes of subsection (1), the reference to an activity, use of equipment, process or procedure includes, but is not limited to, design, installation, alteration, repair, service, removal, purging, activation, storing, handling, modifying and using. Note: As procedure MSPD 4040 was not followed. The boiler was filled with raw fuel gas. Stationary engineer contacted the control room manned by operator Ian Snedden and asked for the pilot lines to be opened. Operator Snedden complied by activating the pilots. The pilot solenoid valves as well as the ignition transformers energized. The fuel gas/air mixture was within the explosive limits and the ignition transformers provided the spark that resulted in the explosion.
3. To clean out the refinery gas line - but refinery gas is also introduced as well as steam Causal Factors - 1. Why this happened?: 1.1	CONTRIBUTING CAUSE	1. 1. Ontario Regulation 212/01. (GASEOUS FUELS) 3 (2). For the purposes of subsection (1), the reference to an activity, use of equipment, process or procedure includes, but is not limited to, design, installation, alteration, repair, service, removal, purging, activation, storing, handling, modifying and using. Note: At approx. 1015 hrs. The steam out procedure MSPD 4040 began. Failure to verify main gas valve was closed and blanked resulted in raw fuel gas to enter the combustion chamber the duration of the steam out.

Figure F10: IDRCA conclusions.



The IDRCA Team - Roles and responsibilities

The IDRCA team works independently of any outside influence to ensure findings determined and evaluated purely based on the evidence collected and is made up of the following roles and responsibilities:

Facilitator

The PSRM team at TSSA provides facilitation for the IDRCA process to ensure the consistent application of the methodology and the elimination of gaps by continuously focusing the group's attention and technical expertise on the facts and relevant issues. This also includes challenging the safety program experts on the incident details and analysis outcomes, the elimination of personal assumptions of causes and overall IDRCA management. The facilitator develops the summary report with the significant findings of the IDRCA for reporting purposes.

Safety Program Experts

The safety program provides the resources required (i.e., IDRCA team – engineers, inspectors, etc.) for the execution of the IDRCA exercise. This ensures all information related to event sequencing and causal chains are determined in a systematic and consistent manner for the determination of cause.

- investigator – safety program lead for the analysis of the incident information collected.
- inspector – assigned to the occurrence inspection and is responsible for the collection and reporting of all related incident information, including the responsibility of appropriately completing and documenting the IDRCA results.
- engineer - technical support as technology expert (e.g., design lifecycle and operational functions, etc.) pertaining to the system/equipment/component associated with the occurrence.
- safety program technical specialist – additional safety program subject matter experts.



IDRCA – Examples at TSSA

Below are a few examples of completed IDRCA on incidents that have provided useful information to safety programs for further safety issue management.

1. Elevator (IDRCA Criteria – Fatality)

Entrapment and then self-extraction from an elevator car stopped between floors. Victim jumped from elevator onto floor landing and fell into the elevator shaft, falling six floors to the pit.

Root Cause

Gaps in the regulatory management system (No means of restricting the possibility or potential for passengers to self-extract from an elevator car, stopped away from the unlocking zone).

Conclusions

It was determined that the elevator motor was operating in an overload condition at the time of the occurrence, which caused the car to stop between floors (i.e., within design specifications). The actions of the passengers could have been prevented if a physical safeguard was in place on the elevator car to prevent the passengers from opening the doors to a position where self-extraction was possible.

Recommendations

TSSA completed a risk assessment to determine if there is a broader safety issue requiring attention related to the hazards of elevator self-extraction as a next step to estimate the associated risks. The focus was on older design technology, where entrapment is an acceptable feature for an elevator car stopping between floors due to the detection of an abnormal condition.

Risk Assessment Outcomes

The estimated risk was found to be unacceptable if both the door restrictor and apron are either absent or inadequately fitted. It was determined that door restrictors are quite effective at reducing the frequency of successful self-extractions in an elevator; therefore, it would be best to mandate the proper functionality of either or both of door restrictors and aprons.

As a result, a Director's Order (see Figure F11) was issued on April 15, 2015 to address this issue.

Figure F11: Director's order – car platform apron requirements for existing passenger elevators (260/14 r1, 04/15/2015).

	Elevating and Amusement Devices Safety Division	Ref. No.: 260 / 14	Rev. No.: 1
	DIRECTOR'S SAFETY ORDER	Date: March 17, 2014	Date: April 15, 2015

IN THE MATTER OF:

THE *TECHNICAL STANDARDS AND SAFETY ACT*, 2000, S.O. 2000, c. 16 (the "Act")

- and -

ONTARIO REGULATION 209/01 (Elevating Devices) made under the Act

Subject: Car Platform Apron Requirements for Existing Passenger Elevators
Applicable to: All Owners of Existing Passenger Elevators and All Elevator Contractors

The Director, Elevating Devices Regulation (O.Reg. 209/01) pursuant to his authority under section 14 of the *Technical Standards & Safety Act*, 2000 hereby orders the following:

1. PLATFORM APRON REQUIREMENTS

- 1.1. Per the provisions of the Elevating Devices Code Adoption Document (CAD), section 3.10 establishes requirements for car platform aprons on existing passenger elevators for a given occupancy class.

3.10 Platform Apron Requirements (166/01)

3.10.1 Every passenger elevator installed before the 1st day of May, 1981 and currently operated in an apartment building, condominium apartment building or educational institution and every passenger elevator installed after that date in any building, shall be provided at the entrance side with a smooth apron made of metal not less than 1.5 millimetres thick, or made of material of equivalent strength and stiffness, reinforced and braced to the car platform such that:

- It does not extend less than the full width of the widest hoistway door opening;
- It has a straight vertical face, extending below the floor surface of the car-platform, of not less than 1,200 millimetres, except that for an existing elevator this may be reduced where the hoistway pit is not deep enough to accommodate a larger vertical face;



2. **Elevator Serious Injury** (IDRCA Criteria - Where regulatory non-compliance and the root cause could not be determined by the inspector alone)

An elderly man entered the fifth-floor lobby, to descend on the elevator parked with its doors open. As he attempted to step into the elevator, the car moved away and descended with the doors open. The victim fell into the elevator shaft and was trapped between the car door header and the hoistway enclosure as the car descended to the first floor. He sustained serious injuries to his head, arms, and legs as result of this incident. An elevator mechanic was working on the elevator at the time of the incident.

Root Cause

Display of unsafe working practices (i.e., failure to follow maintenance procedures - *activities contrary to established rules*).

Conclusion

It was determined that the elevator mechanic did not demonstrate proper understanding of established safety procedures and standards applicable to the device on which he undertook to perform work. This included non-compliance with the various Director's Orders issued related to the use of jumpers on elevating devices during maintenance, inspection, testing and repair. Also identified were multiple violations of the Field Employee Safety Handbook, the B44/07 codes and Ontario's Regulations for Elevating Devices.

TSSA applied appropriate regulatory sanctions against the mechanic for this incident. No additional recommendations were made for this occurrence.

3. **Motor Vehicle Fire** (IDRCA Criteria - Where the inspector and/or those involved in the occurrence inspection believes that there is a potential for re-occurrence in the future involving similar equipment/circumstances)

Customer at a gas station refueling a car overfilled the tank causing a fuel spill. The spilled fuel was ignited resulting in a fire at the car as well as the fuel pump. No injuries were incurred by the customer, but the car was burnt out and the pump damaged by the fire.

Root Cause

Inadequate or defective management systems (*e.g., hazard identification, monitoring, etc.*).

- Lack of proper maintenance of gas dispensing components at pump.

Conclusion

It was determined that the owner of the gas station ignored previous complaints about the nozzle at the pump before the incident happened.

Recommendations

TSSA will continue to monitor similar incidents and complete a risk assessment as a next step to determine if there is a broader safety issue requiring attention and to estimate the risks related to gas pump nozzle failures as a component of the fuel dispensing system.



Appendix G – Legislation and Regulatory Information

The tables below contain legislation and regulatory information in addition to the Act, including a list of director's orders issued in fiscal year 2019. See www.tssa.org for a comprehensive listing of legislation and regulatory information.

1.0 Boilers and Pressure Vessels Safety Program

Current TSSA legislation and regulatory information for the Boilers and Pressure Vessels Safety Program is shown in Table G1. The Boilers and Pressure Vessels CAD was amended on July 1, 2018 to reflect the changes incorporated in O. Reg. 220/01 that were put in place on July 1, 2018.

Table G1: TSSA boilers and pressure vessels legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 220/01: Boilers and Pressure Vessels Regulation	2018
Summary of Key Changes for the Regulation of Pressure Equipment	2001
Minister's Exemption for Agriculture	2001
Boilers and Pressure Vessels CAD Amendment BPV-18-01	2018

During fiscal year 2019, there were no Boilers and Pressure Vessels director's orders or guidelines issued, but the following were issued:

- one Boilers and Pressure Vessels advisory:
 - Boilers and Pressure Vessels Safety and Fuels Safety Programs Involvement in Piping Systems in Fuel Services BPV-18-02
- one Boilers and Pressure Vessels bulletin:
 - Hot Tap and Line Stopping for Pressure Equipment SB05-02

2.0 Operating Engineers Safety Program

Current TSSA legislation and regulatory information for the Operating Engineers Safety Program is shown in Table G2.

Table G2: TSSA operating engineers legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 219/01: Operating Engineers Regulation	2001
Ontario Regulation 219/01: Director's Order	2003

During fiscal year 2019, there were no Operating Engineers director's orders, advisories bulletins or guidelines issued.

3.0 Amusement Devices Safety Program

Current TSSA legislation and regulatory information for the Amusement Devices Safety Program is shown in Table G3.

Table G3: TSSA amusement devices legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 221/01: Amusement Devices Regulation	2009
Ontario Regulation 187/03: Certification and Training of Amusement Device Mechanics	2013
Amusement Devices CAD Amendment 535-18	2018
Canadian Bungee Safe Code of Practice	2000



During fiscal year 2019, there were no Amusement Devices director's orders, bulletins or guidelines issued, but the following were issued:

- three Amusement Devices advisories:
 - Pre-Examination Checklist for Amusement Devices 538/19
 - Retroactive Amusement Devices CAD Amendment 535-18 Requirements 539/19
 - Drop off Practice for Inflatable Devices Rentals 540/19

4.0 Elevating Devices Safety Program – Elevators

Current TSSA legislation and regulatory information for the Elevators Safety Program Area is shown in Table G4.

Table G4: TSSA elevators legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2009
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2009
Elevating Devices CAD Amendment 277-19	2019

During fiscal year 2019, there were no Elevators bulletins or guidelines issued, but the following were issued:

- one Elevators director's order:
 - Requirements for B355 Vertical Platform Lifts that utilize Magnetic Reed Switches in Leveling and/or Anti-creep Circuits 271/18
- four Elevators advisories:
 - Brake Marking Plates on Elevator Driving Machine 273/18
 - Deep Pit Access 274/18
 - Emergency Brake - Brake Lining Replacement 275/18
 - Category 1 Testing of Emergency Power (8.6.4.19.7) 276/18

5.0 Elevating Devices Safety Program – Escalators and Moving Walks

Current TSSA legislation and regulatory information for the Escalators and Moving Walks Safety Program Area is shown in Table G5.

Table G5: TSSA escalators and moving walks legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2009
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2009
Elevating Devices CAD Amendment 277-19	2019

During fiscal year 2019, there were no Escalators and Moving Walks director's orders, advisories, bulletins or guidelines issued.

6.0 Elevating Devices Safety Program – Passenger Ropeways (Ski Lifts)

Current TSSA legislation and regulatory information for the Ski Lifts Safety Program Area is shown in Table G6.

Table G6: TSSA ski lifts legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2009
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2009
Elevating Devices CAD Amendment 277-19	2019



There were no Ski Lifts advisories, bulletins or guidelines issued during fiscal year 2019, but the following was issued:

- one Ski Lifts director's order:
 - Ski Lift Mechanic Continuing Education Requirements ED-272-18

7.0 Fuels Safety Program

Current TSSA legislation and regulatory information for the Fuels Safety Program is shown in Table G7.

Table G7: TSSA fuels legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Oil and Gas Pipeline Systems	
Ontario Regulation 210/01: Oil and Gas Pipeline Systems	2001
Ontario Regulation 210/01: Director's Order	2001
Oil and Gas Pipeline Systems CAD Amendment FS-238-18	2018
Propane Storage and Handling	
Ontario Regulation 211/01: Propane Storage and Handling	2015
Ontario Regulation 197/14: Liability Insurance Requirements for Propane Operators	2016
Propane CAD Amendment FS-224-17	2017
Gaseous Fuels	
Ontario Regulation 212/01: Gaseous Fuels	2015
Ontario Regulation 212/01: Director's Order	2001
Gaseous Fuels CAD Amendment FS-225-17	2017
Mobile Food Service Equipment Code TSSA-MFSE-2014	2014
Field Approval Code TSSA-FA-2016	2016
Digester, Landfill and Bio-Gas Code TSSA-DLB-2016	2016
Fuel Oil	
Ontario Regulation 213/01: Fuel Oil	2001
Ontario Regulation 213/01: Director's Order	2001
Fuel Oil CAD Amendment FS-219-16	2016
Compressed Gas	
Ontario Regulation 214/01: Compressed Gas	2007
Compressed Gas CAD Amendment FS-143-09	2009
Liquid Fuels	
Ontario Regulation 217/01: Liquid Fuels	2001
Ontario Regulation 217/01: Director's Order	2001
Liquid Fuels CAD Amendment FS-235-18	2019
Requirements for Contractors	
Ontario Regulation 216/01: Certification of Petroleum Equipment Mechanics	2008
Ontario Regulation 215/01: Fuel Industry Certificates	2015
Amendment to Ontario Regulation 215/01 - CDT Activation (Ontario Regulation 184/03)	2003



During fiscal year 2019, there were no Fuels director's orders, bulletins or guidelines issued, but the following were issued:

- eight Fuels advisories:
 - Protection Against Vehicular Traffic FS-114-07
 - Appliances Connected Butane Cylinders with a Capacity of 250 g or less FS-231-18
 - Refueling Propane Vehicles at Licensed Propane Refuelling Stations in Ontario FS-236-18
 - Certificate Holder Requirements to Refuel and Work on Propane Vehicles FS-237-18
 - Boilers and Pressure Vessels Safety and Fuels Safety Programs Involvement in Piping Systems in Fuel Services FS-241-18
 - Safety Assurance Responsibilities of Fuel Oil Distributors FS-242-18
 - Cell Phone Use at Gas Station Dispensers FS-243-19
 - Procedure for the Handling of Fuel on Construction Sites

8.0 Upholstered and Stuffed Articles Safety Program

TSSA legislation and regulatory information before revocation for the Upholstered and Stuffed Articles Safety Program is shown in Table G8.

Table G8: TSSA upholstered and stuffed articles legislation and regulatory information.

Legislation and Regulatory Information as of 2019	Latest Revision
Ontario Regulation 218/01: Upholstered and Stuffed Articles	2001
Ontario Regulation 218/01: Minister's Exemption	2018

There were no Upholstered and Stuffed Articles director's orders, advisories, bulletins or guidelines issued during fiscal year 2019.



Appendix H – Collaborators in Safety

TSSA has worked with many organizations and groups to help keep Ontarians safe. This includes, but is not limited to:

Regulatory

- Electrical Safety Authority
- Ministry of Government and Consumer Services
- Ministry of Labour
- Ministry of Long-Term Care
- Ministry of the Environment, Conservation and Parks
- Ministry of Training, Colleges and Universities
- Office of the Fire Marshal and Emergency Management
- Ontario One Call
- Ontario Regional Common Ground Alliance
- Retirement Homes Regulatory Authority

Industry

- Advisory Councils:
 - Boilers & Pressure Vessels Advisory Council
 - Operating Engineers Advisory Council
 - Amusement Devices Advisory Council
 - Elevating Devices Advisory Council
 - Ski Lifts Advisory Council
 - Liquid Fuels Advisory Council
 - Natural Gas Advisory Council
 - Propane Advisory Council
 - Consumers Advisory Council
- Training and Certification Advisory Boards
- Risk Reduction Groups
- Field Advisory Committees



Appendix I – Risk-Informed Inspection Order Management

1.0 Introduction

Section 17 of the Act provides powers to TSSA inspectors to conduct inspections to ensure that “things” regulated under the Act are used, operated, installed, made, manufactured, repaired, renovated or offered for sale are in compliance with this Act and its associated regulations.

During an inspection, Section 21 of the Act requires inspectors to issue inspection orders against non-compliances that are observed. The Act also requires inspectors to specify the time period in which the non-compliance should be addressed. This “Time to Compliance” (TTC) is an essential component of the inspection process.

Consistent with RIDM principles, TSSA has established a risk-informed inspection order policy, which provides guidance for establishing:

- the requirements or necessary preconditions or circumstances for issuing an order pursuant to Section 21 of the Act;
- risk-informed criteria for deeming a thing under the Act as unsafe, as posing an immediate hazard or a demonstrable threat to public safety (Section 21.1 and Section 21.2 of the Act);
- risk-informed criteria for determining time for compliance with terms of inspection order (Section 21.1(a) and Section 21.2 of the Act); and
- minimum criteria for type and content of an inspection order issued to a contravener (Section 21.4 of the Act).

In implementing this policy, TSSA has established standardized inspection orders for the various safety program areas. Using its risk assessment methodology, TSSA has also established the TTCs associated with these standardized inspection orders. Currently, inspectors from only the elevating and amusement devices and the operating engineers’ programs have the standardized inspection orders and associated TTCs available to choose from electronically during inspections. Inspectors from other programs continue to rely on pre-existing tools including manual entry processes while TSSA is working towards creating new and enhanced tools. For the purposes of analysis and reporting, TSSA is currently providing interim equivalent approaches to characterize documented inspection orders including the use of actual TTCs issued by inspectors.

2.0 Elements of Standardized Inspection Orders

2.1 Standard Order Master List

The most basic element of the standardized inspection orders framework is a list of inspection orders themselves. An inspection order master list is developed and maintained by each safety program, based on the Act, applicable regulations and codes, using a program-specific standardized format structure. An example of a standard order is the following in the case of escalators in Table I1.

Table I1: Escalators and moving walks standard order example.

Order ID	Directive Text	Code Reference
XE0414	Repair/replace the damaged skirt panel.	CSA B44-10 (8.6.8.5) “The exposed surface of the skirt panels adjacent to the steps, if not made from, shall be treated with, a friction-reducing material. Damaged skirt or dynamic skirt panels shall be replaced or repaired.”

Program areas may have multiple lists, divided into the various types for things they inspect. For instance, elevating devices may have a list for dumbwaiters and a separate list for construction hoists.

The final implementation of this step is completed when they are uploaded to TSSA’s computer system and are available for use to the inspectors.



2.2 Risk Characterization – Determination of Time to Compliance

Risk Assessment

Once there is an established list of orders available for an inspector, the next step to assess how much risk each order carries to determine the TTC that the inspectors are recommended to issue. Recall that risk is defined by the combination of frequency of harm and the severity of that harm. The technique to determine the TTC is a three-step process. In the first step, frequency and severity of possible consequences (occurrences) if an inspector observed non-compliance were allowed to persist, is determined. In the second step, risk threshold is determined for each occurrence type so as to analyze the time at which the occurrence type intersects the threshold. Given the time of possible occurrence of each occurrence type posing maximum risk, the third step entails determining the TTC by choosing the time that corresponds to an occurrence type that could potentially occur at the earliest time.

TSSA assesses orders using an expert panel of inspectors, engineers, and public safety risk specialists. Initial groundwork is laid out by developing a risk assessment template, which helps guide the thinking of the panel through the process. The template, developed internally by TSSA and shown in Figure I1, guides the expert panel in determining the possible outcome(s) of non-compliance, the likelihood of the outcomes, and severity of the health impacts associated with the outcomes. Evidence including past incident history is used to guide the process, if available, and to help ascertain the severity of health impacts associated with the outcomes.

Figure I1: TTC tool depicting failure scenarios.

The screenshot shows the Microsoft Access interface for the 'TTC Tool'. The title bar indicates the file path: 'TTC Tool: Database: P:\Standard Orders Risk Characterization\SOWA\Development\notes\TTC Tool.accdb (Access 2010)'. The ribbon includes 'FILE', 'HOME', 'CREATE', 'EXTERNAL DATA', 'DATABASE TOOLS', 'HELPS', and 'TABLE'. The 'TABLE' ribbon is active, showing options like 'New', 'Save', 'Refresh All', 'Delete', 'Records', 'Find', 'Replace', 'Go To', and 'Text Formatting'. Below the ribbon, there are two tabs: 'Standard Orders' and 'Failure Scenarios'. The 'Failure Scenarios' tab is selected, displaying a table with the following data:

ID	Failure Scenario	Click to Add
291	Elevator moves with doors open	
292	Limb and/or clothing caught between doors	
293	Door strength inadequate	
294	Governor does not operate	
295	Slip/trip/fall	
296	Leveling	
297	Inadequate/no light	
298	Limb and/or body part caught in escalator component	
299	Step and complete interaction	
300	Improper escalator stop	
301	Improper escalator start up	
302	Person loses balance and experiences impact	
303	Undesired movement of component/device	
304	Failure/breakage of component	
305	Contact with or between various components	
306	Unauthorized access	



This process is vetted with external stakeholders and experts as appropriate and relevant. The conceptual approach has also been presented at several conferences and is patent pending the US and Canada.

Orders with no conceivable health impacts are deemed to be “administrative” orders with a risk score of zero.

Once the likelihoods and severities are established, a mathematical prediction model developed by TSSA combines these quantities, in addition to observed occurrence data to derive two outputs; the risk score for each standardized inspection order, and the associated TTC. Additionally, this process also provides the basic inputs required for establishing inspection intervals for devices that are currently on a risk-informed periodic inspection schedule.

The predicted TTC is made available for implementation and use including for analysis purposes using risk bins and referred to throughout this report. Table I2 provides an illustration of a risk bin for each TTC range (note that zero risk, administrative orders are low risk regardless of their TTC).

Table I2: Risk bins and corresponding TTC ranges across program areas.

Risk Bin	TTC Range (Operating Engineers)	TTC Range (all other programs)
High	0 – 10 days	0 – 10 days
Medium	11 – 29 days	11 – 60 days
Low	More than 29 days	More than 60 days

As mentioned earlier, TSSA will continue to implement this process electronically as part of a major strategic information system upgrade initiative. In the interim, TSSA has developed an equivalent approach to determine the risk scores for issued inspection orders using a combination of fuzzy logic²⁴ searches for clause IDs and inspector issued TTCs. This interim approach helps TSSA for analysis, reporting and inspection scheduling purposes.

²⁴ https://en.wikipedia.org/wiki/Fuzzy_logic



Appendix J – List of Acronyms

ASPR	Annual State of Public Safety Report
CAD	Code Adoption Document
CO	Carbon Monoxide
DALY	Disability-Adjusted Life Year
FE/mpy	Fatality-Equivalent(s)/million people/year
IDRCA	In-Depth Root Cause Analysis
PSRM	Public Safety Risk Management
RBS	Risk-Based Scheduling
RCA	Root Cause Analysis
RIDM	Risk-Informed Decision-Making
RIF	Risk of Injury or Fatality
RSMP	Risk and Safety Management Plan
TTC	Time to Compliance



Appendix K – Glossary of Terms

Actionable Area	This is a risk source that requires mitigating actions because it exceeds the risk acceptability criteria for either the general population (1.00 FE/mpy) or for sensitive sub-populations (0.30 FE/mpy). TSSA identifies these risk sources as safety issues that require risk management strategies. These strategies can include regulatory actions (such as director's orders), as well as advisories and bulletins, collaborative partnerships with stakeholders and public education.
Code Adoption Document (CAD)	The default regulatory instrument for mandatory requirements of general application, such as the adoption of codes and standards. This instrument is used to identify and communicate changes to TSSA-specific requirements.
Compliance Rate	The percentage of periodic inspections compliant with the <i>Technical Standards and Safety Act, 2000</i> (the Act) and its associated regulations.
Director's Order	A regulatory decision made by a Statutory Director under the powers given to him/her as per the Act. Director's Order, Limited Use (s. 27) Places limits on the operation of a thing that is found to be defective or to not comply with the conditions of its authorization after the thing is fabricated or installed. <i>27. A director may,</i> <i>(a) establish the limits of operation and use of things that are found to be defective or do not conform with its authorization after fabrication or installation;</i> <i>(b) permit the operation and use of such thing within such limits as are prescribed, or if there are no such limits, as the director considers safe.</i> Director's Order, Public Safety (s. 31) Used only where there is or may be a demonstrable threat to public safety and the subject matter has not otherwise been provided for in the Act or its associated regulations. It can require regulation, use or disuse of specified things. <i>31. In cases where there is or may be a demonstrable threat to public safety, a director may make an order with respect to the following matters if they have not otherwise been provided for in this Act, the regulations or a Minister's order:</i> <i>1. Requiring and establishing the form and location of notices, markings or other forms of identification to be used in conjunction with equipment or other things that are prescribed.</i> <i>2. Regulating, governing and providing for the authorization of the design, fabrication, processing, handling, installation, operation, access, use, repair, maintenance, inspection, location, construction, removing, alteration, service, testing, filling, replacement, blocking, dismantling, destruction, removal from service and transportation of any thing, whether new or used, or a part of a thing and any equipment or attachment used in connection with it.</i>



Disability-Adjusted Life Year (DALY)	A DALY of 1.0 is the loss of one year of healthy life of a single person due to an injury. Please see Appendix B for a full description. Injury Burden Quantified health impact determined by integrating injuries and fatalities observed across the population exposed to TSSA-regulated devices/technologies over a period of time. The DALY metric is used to combine injuries and fatalities into a single metric. The injury burden is expressed in the units of fatality-equivalents per exposed population per year. Refer to Appendix B for additional details.
Enhanced Monitoring Area	When a risk source approaches the risk acceptability criteria, TSSA utilizes enhanced monitoring. TSSA considers these risk sources to be potentially emerging areas of risk and are monitored (including investigating specific incidents in the affected program area) and/or addressed through mitigation strategies.
External Factors	Safety impact related to failures associated with factors outside the direct control of TSSA's safety system (e.g. behaviour of users/consumers of technologies and devices in lieu of their intended use, environmental/weather conditions, utility failures, etc.). Refer to Appendix E for additional details.
Fatality-Equivalent (FE)	A unit of measure obtained by integrating quantified health impacts into a single count of equivalent fatalities for benchmarking and decision-making purposes. Injury burden and Risk of Injury or Fatality are expressed in terms of Fatality-Equivalents (FEs). Fatality-equivalent/million people/year (FE/mpy) is a unit of measure obtained by integrating quantified health impacts into a single count of equivalent fatalities for benchmarking and decision-making purposes. Refer to Appendix B for additional details.
Fiscal Year	Represents TSSA's fiscal year (May 1 – April 30), e.g., 2019 represents fiscal year 2019 (May 1, 2018 – April 30, 2019)
Health Impact	Refers qualitatively to injuries or fatalities sustained by the public exposed to TSSA-regulated devices/technologies. A health impact could be one of fatal, permanent or non-permanent injuries. Permanent Injury An injury sustained by an individual that partially or totally impairs the normal abilities of that individual for the rest of his/her expected remaining life. Non-Permanent Injury The consequence of an incident occurrence wherein there was an observed health impact that was estimated to be non-permanent based on the nature of the injury and its associated severity using a methodology developed by the World Health Organization (WHO). A non-permanent injury has no significant impact on the individual's life expectancy at the time of injury.
In-Depth Root Cause Analysis (IDRCA)	This formal approach, <i>In-Depth Root Cause Analysis (IDRCA)</i>, uses Root Cause Analysis (RCA) principles to determine and document underlying causes related to occurrences under the TSSA regulatory mandate but with additional focus and effort. Root Cause Analysis (RCA) A method of problem solving using a specified range of approaches, tools and techniques to uncover the most basic reason (underlying cause) for an occurrence that can be reasonably identified. Refer to Appendix F for further details.



Incident Management System	A structured framework that translates the legislated regulatory responsibilities of TSSA, specifically as it pertains to incident investigations into a management system. This management system contains policies, procedures, roles and responsibilities and associated processes that enable the receipt, investigation and analysis of reported incidents and near-miss occurrences.
Incident Management Information System	A public safety decision-support information tool that enables TSSA to document the receipt, dispatch, investigation and analysis of reported incidents and near-miss occurrences and forms a component of the Incident Management System.
Inspection	An official examination of a device, system or procedure conducted by an inspector under the Act in accordance with Section 17 of the Act.
Inspection Order	The authority to issue an order comes from Section 21 of the Act and is served by an inspector to one who contravenes and/or who corrects a contravention to the Act or its associated regulations. Under this section, an inspector may also seal any thing with respect to amusement devices, boilers and pressure vessels, elevating devices, fuels, operating engineers and upholstered or stuffed articles, as referred to in the regulations. Where there is or may be a demonstrable threat to public safety, whether or not the thing is subject to an authorization, an inspection order includes the specific nature of identified contravention, the conditions and actions to be taken to correct the contravention and the allowable time to comply for each identified contravention. Orders can be classified into high-, medium-, and low-risk categories, which statutory directors can define to suit the needs of their program area. With the exception of Operating Engineers, the classifications are defined below. Please see Appendix I for additional details. High-Risk Inspection Order Issued where non-compliance is identified and warrants an inspection order for immediate action within 0 to 10 days, for time to compliance to regulatory requirements. Medium-Risk Inspection Order Issued where non-compliance is identified and warrants an inspection order for action within 11 to 60 days, for time to compliance to regulatory requirements. Low-Risk Inspection Order Issued where a non-compliance is identified and warrants an inspection order for action within 90 days, for time to compliance to regulatory requirements.
Non-Compliance with the Regulatory System	Safety impact associated with the violation of established regulatory controls (e.g., TSSA-enforced regulations). Refer to Appendix E for additional details.
Occurrence	The realization of a hazard which results in, or has the potential to result in, a consequence to people or property. Incident An occurrence involving a system/device/component/tradesperson under TSSA's jurisdiction, whereby a hazard is exposed resulting in a consequence to people or property. Near-Miss An occurrence involving a system/device/component/tradesperson under TSSA's jurisdiction, whereby a hazard is exposed demonstrating an instance of elevated exposure to risk, while in this particular instance resulting in no consequence to people or property.



Occurrence Involving...	Door Closing - A consequence that could result when elevator doors close and impact a user who is entering or exiting an elevator or attempting to prevent the doors from closing. Entanglement - A consequence that could result when a user's ski equipment becomes crossed, causing them to lose balance. Applies only to ski lifts. Entrapment – This depends on context. A consequence that could result when a user's clothing, footwear or accessories becomes caught in the moving parts of a device. Applies to amusement devices, elevators, escalators and moving walks and ski lifts. Can also refer to being stranded in an elevator. Levelling - A consequence that could result when an elevator does not level at the floor landing thereby creating a tripping hazard. Physical Impact - A consequence that could result when a user of a device comes into contact with the device (e.g. falling roof tiles on an elevator car). Applies to amusement devices, elevators, escalators and moving walks and ski lifts. Trips or Falls - A consequence that could result when a user of a device stumbles or falls upon entry into or exit from a device. Applies to amusement devices, elevators, escalators and moving walks and ski lifts. Water Exposure - A consequence that could result when a device is impacted by water damage. Applies mainly to elevators.
Operational Risk	Potential risk of injury or fatality associated with the operation and maintenance of things or class of things regulated under the Act and does not account for sources of risks manifested during the design and installation stages. Operational Risk considers only those risks that can be observed during an inspection and can be addressed through the issuance of inspection orders. High, Medium, Low Operational Risk High-, medium-, and low-risk devices/facilities are those with inspection intervals of 6 months, 6 to 24 months and greater than or equal to 24 months respectively.
Pass Rate	The percentage of inspections which do not require additional inspection or follow-up activity.
Periodic Inspection	An inspection conducted at such intervals as may be determined by the statutory director, risk-based scheduling (where applicable), or required by code or regulation for the purpose of ensuring the safe operation of the device/facility.
Potential Gaps in Regulatory System	Safety impact associated with gaps in the regulatory system or where no regulatory control exists. Refer to Appendix E for additional details.
Risk	The combination of the probability of occurrence of harm from a thing or a class of things under Section 2 of the Act and the severity of that harm.
Risk-Informed Decision-Making	An approach to regulatory decision-making, in which insights from probabilistic risk assessments are considered with other engineering insights. The risk-informed approach has been a key element in our regulatory success, allowing TSSA to: • understand the nature of public safety risks; • quickly develop preventative strategies to address safety hazards; • target activity where it will have the greatest impact on risk; and • improve safety outcomes generally. Refer to Section II of this report for more information.



Risk of Injury or Fatality (RIF)	The injury burden predicted using a simulation model to combine the probability of occurrence of harm (estimated as occurrence rates) to someone interacting or exposed to TSSA-regulated devices/technologies and severity of that harm. The Risk of Injury or Fatality (RIF) metric is expressed in fatality-equivalents per exposed population (expressed in millions) per year (FE/mpy). This measure of risk accounts for historical occurrences while taking into consideration the uncertainties and variability inherent in the involved parameters such as the occurrence rate, number of victims, age of each victim and types of injuries sustained. Refer to Appendix B for additional details. Composite Risk of Injury or Fatality A single quantified measure of risk of injury or fatality across TSSA-regulated sectors in Ontario. The estimate is only for reporting purposes and may be used for benchmarking.
Sensitive Sub-populations	Populations with persons more at risk than the general population because they are less able to respond to an occurrence (e.g., in schools, retirement and long-term care homes, etc.).
Time to Compliance (TTC)	The time required for a client to have the work completed as specified in a TSSA inspector's order due to a deficiency found during an inspection. Also known as time to comply.
Trend	A statistically representative measure for the noticeable tendency or movement toward, or in, a particular direction over a measured period of time (e.g. positive trend, negative trend and no significant quarterly trend). Refer to Appendix B for additional details.