



Technical Standards and Safety Authority

Annual State of Public Safety Report

2018 Edition



Technical Standards and Safety Authority (TSSA)

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

- 1) Boilers and Pressure Vessels and Operating Engineers;
- 2) Elevating Devices, Amusement Devices and Ski Lifts;
- 3) Fuels; and
- 4) Upholstered and Stuffed Articles.

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 and investigations that have been used to develop 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 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.



List of Acronyms

AD	Amusement Devices
ALARP	As Low As Reasonably Practicable
ASPR	Annual State of Public Safety Report
BPV	Boilers and Pressure Vessels
CAD	Code Adoption Document
CO	Carbon Monoxide
DALY	Disability-Adjusted Life Year
ED	Elevators
EM	Escalators and Moving Walks
FE/mpy	Fatality-Equivalent(s)/million people/year
FS	Fuels Safety
HPRCA	High Profile Root Cause Analysis
IMS	Incident Management System
IMIS	Incident Management Information System
MGCS	Ministry of Government and Consumer Services
MIACC	Major Industrial Accidents Council of Canada
OE	Operating Engineers
PCU	Passenger Carrying Unit
PSRM	Public Safety Risk Management
QMS	Quality Management System
RBS	Risk-Based Scheduling
RCA	Root Cause Analysis
RIDM	Risk-Informed Decision-Making
RIF	Risk of Injury or Fatality
SL	Ski Lifts
TTC	Time to Compliance
USA	Upholstered and Stuffed Articles



Enhancements to the *Annual State of Public Safety Report*

In line with its commitment to continuous improvement and based on feedback from stakeholders, TSSA continues to enhance the structure and style of 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 herewith. 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. State of Public Safety in Ontario on page 2 – Category Titles Updated
 - Compliance-Risk Spectrum – converted to Inspection Risk Spectrum.
 - Risk of Injury or Fatality – converted to Health Impact.
 - The presentation was also reorganized to improve readability.
2. TSSA's Risk Sources "Triangle" in Figure 2 on page 4 – Legend Updated
 - Red Zone – Actionable.
 - Yellow Zone – Enhanced Monitoring.
 - Green Zone – Core Activities.
3. Information on **Risk of Injury or Fatality Metric** and **Statistical Methods** have been consolidated into one document, namely **Metrics** (see Appendix B).
4. Observed injury burden figures are only given in main program areas and not in safety priority areas.

New Information:

1. Safety program legislation and regulatory information, including a list of director's orders issued in 2018 – List of Title and date of issue. These are found in Appendix F, along with safety program advisories, bulletins and guidelines issued during 2018. For a comprehensive listing of legislation and regulatory information, refer to www.tssa.org.
2. Pipeline strike incident and near-miss occurrences and trending information, along with fuel contractor audit results, were added to the Fuels Safety section.



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 incident 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 makes every effort to ensure a high level of data integrity and continuously works toward improving the integrity of all data collected for the purposes of reporting. To this effect, TSSA takes every precaution to ensure the accuracy and quality of data presented in the ASPR. Intrinsically, TSSA's Public Safety Risk Management (PSRM) department developed a Quality Management System (QMS) in 2012 to ensure accurate presentation of public safety information. This QMS is to ensure transparency, data integrity and quality of the information in the report. Occasionally, it is necessary to make restatements to results reported in previous years, typically a result of timeframe factors, such as information received subsequent to the issuance of the report, localized reporting lags for periodic data, and other issues.

Analysis involving prediction of health impacts and conducted as part of safety risk assessments has identified and quantitatively accounted for additional sources of uncertainties. Explicitly stated predictions in this report typically represent expected values after accounting for such known sources of uncertainties. In line with its commitment to transparency, TSSA has been reporting on the range of expected values associated with these measures to give readers a better idea on the uncertainty surrounding these estimates.

Analysis involving reported and inspected incident and near-miss occurrences may be significantly impacted by reporting biases, as defined in Appendix B. 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 so some totals may not quite add up to 100%.

The average rate of injury and the observed injury burden figures are assumed on a fixed Ontario population size of 13,500,000¹ in the calculation, resulting in some degree of uncertainty. However, it is not considered to be significant.

The median compliance rate is determined from the median compliance over a rolling five-year period. The use of average instead of median is currently being reviewed by PSRM as a potentially better metric. However, this review is still underway and so the median is retained here for this report.

¹ The population of Ontario in 2016 was 13,448,494 per Statistics Canada (ref: <https://www12.statcan.gc.ca/census-recensement/2016/as-sa/fogs-spg/Facts-pr-eng.cfm?Lang=Eng&GK=PR&GC=35&TOPIC=1>).



Glossary of Terms

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 change or modify TSSA-specific requirements.
Compliance Rate	The percentage of periodic inspections compliant with 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.



Annual State of Public Safety Report

2018 Edition

External Factors	Safety impact related to failures associated with factors outside the direct control of the 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 D for additional details.
Fatality-Equivalent	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. Fatality-equivalent/million people/year 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., 2018 represents fiscal year 2018 (May 1, 2017 – April 30, 2018)
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.
High Profile Root Cause Analysis (HPRCA)	This formal approach, <i>High Profile Root Cause Analysis</i> (HPRCA), 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 wide 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 E for further details.
Incident Management System (IMS)	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 incident and near-miss occurrences.



Annual State of Public Safety Report

2018 Edition

Incident Management Information System (IMIS)	A public safety decision-support information tool that enables TSSA to document the receipt, dispatch, investigation and analysis of reported incident 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 bins, 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 G 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 D 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 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 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. Entrapment – This depends on context. A consequence that could result when a user's clothing, footwear or other 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 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.
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 D 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.



Annual State of Public Safety Report

2018 Edition

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	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 metric is expressed in fatality-equivalents per exposed population per year. 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., found in schools, retirement and long-term care homes, etc.).
Time to Compliance (TTC)	Also known as time to comply, is 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.
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.



Table of Contents

I.	Message on the State of Public Safety in Ontario from Robert Wiersma, Manager, Public Safety Risk Management	1
I.1	State of Safety Highlights	2
II.	Risk-Informed Decision-Making at TSSA	7
III.	Program-Specific State of Safety and Compliance and TSSA Strategies	11
III.1	Boilers and Pressure Vessels	11
III.1.1	Risk Assessment	12
III.1.2	Risk Management, Message from Mike Adams, Statutory Director of BPV Safety Program	13
III.2	Operating Engineers	15
III.2.1	Risk Assessment	16
III.2.2	Risk Management, Message from Mike Adams, Statutory Director of OE Safety Program	18
III.3	Amusement Devices.....	19
III.3.1	Risk Assessment	20
III.3.2	Risk Management, Message from Roger Neate, Statutory Director of AD Safety Program	23
III.4	Elevators.....	24
III.4.1	Risk Assessment	25
III.4.2	Risk Management, Message from Roger Neate, Statutory Director of ED Safety Program	31
III.5	Escalators and Moving Walks	32
III.5.1	Risk Assessment	33
III.5.2	Risk Management, Message from Roger Neate, Statutory Director of EM Safety Program	36
III.6	Passenger Ropeways (Ski Lifts)	37
III.6.1	Risk Assessment	38
III.6.2	Risk Management, Message from Roger Neate, Statutory Director of SL Safety Program	41
III.7	Fuels Safety.....	42
III.7.1	Risk Assessment	43
III.7.2	Risk Management, Message from John Marshall, Statutory Director of Fuels Safety Program	61
III.8	Upholstered and Stuffed Articles.....	62
III.8.1	Risk Assessment	63
III.8.2	Risk Management, Message from Peter Wong, Acting Statutory Director of USA Safety Program	64
IV.	References	65
V.	Appendices	66
	Appendix A – Overall State of Safety Measures (2008 – 2018)	66
	Appendix B – Metrics.....	72
	Appendix C – Risk-Based Inspection Scheduling.....	78
	Appendix D – Causal Analysis Categories.....	80
	Appendix E – High Profile Root Cause Analysis	82
	Appendix F – Legislation and Regulatory Information	92
	Appendix G – Risk-Informed Inspection Order Management.....	95



I. Message on the State of Public Safety in Ontario from Robert Wiersma, Manager, Public Safety Risk Management

The Technical Standards and Safety Authority (TSSA) is pleased to present the 2018 Edition of the *Annual State of Public Safety Report* (ASPR). This is the 18th Edition of an annual safety report and the 5th version in its current name and format. The ASPR aggregates and reports on safety data as collected by TSSA and estimates the level of risk that Ontarians are exposed to through TSSA-regulated technologies. In doing so, this report draws heavily on what is observed by TSSA inspectors in the form of inspections, as well as incidents and near-misses. It aligns with TSSA's strategic plan by indicating the technical safety risks where the public lives, works, and plays.

This past fiscal year (May 1, 2017 – April 30, 2018) has seen the continued positive pattern from previous years for strong safety numbers:

- The five-year average of fatalities is down over 40% from 2012; and
- The observed injury burden – which combines injuries and fatalities into a single number – is the lowest observed since the metric has been in use.

These findings are complemented by similar findings by inspectors – almost 90% of all periodically inspected devices and facilities are low risk; slightly better than last year.

The composite risk of injury or fatality (RIF) over all programs is 0.99 fatality-equivalents/million people/year (FE/mpy), marginally below TSSA's benchmark of 1.00 FE/mpy. This number remains high in part due to increased number of individuals exposed to harm in a single incident. For example, in 2018, nine people were exposed to carbon monoxide in a private dwelling at one time. Thankfully, they all emerged with only minor injuries, but history tells us all too somberly of the deadliness of this odourless gas.

TSSA attempts to define issues as specifically as possible, calculate their RIF values, and then compare with an acceptability threshold. The following issues exceed the acceptability threshold and therefore require action:

- Carbon monoxide (CO) risks in apartments and condominiums;
- Fuel risks in private dwellings;
- Elevator risks in hospitals (**new this year**);
- User interactions on elevators in retirement and long-term care homes; and
- Fuel risks in schools.

Issues that approach the threshold but do not exceed it are subject to enhanced monitoring:

- Fuel risks in retirement and long-term care homes;
- Fuel risks in business units; and
- Fuel-related fire risks in food service locations.

TSSA will continue to focus on reducing these risks this year.

The ASPR is continually 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.

Robert Wiersma,
Manager, Public Safety Risk Management



I.1 State of Safety Highlights

STATE OF PUBLIC SAFETY IN ONTARIO

Top Safety Issues (2018)

Actionable Areas		Enhanced Monitoring Areas	
CO Risks in Apartments & Condominiums	5.32 FE/mpy	Fuel Risks in Retirement and Long-Term Care Homes	0.26 FE/mpy
Fuel Risks in Private Dwellings	3.73 FE/mpy	Fuel Risks in Business Units	0.73 FE/mpy
Elevator Risks in Hospitals	3.49 FE/mpy	Fuel-related Fire Risks in Food Service Locations	0.61 FE/mpy
User Interactions on Elevators in Retirement & Long-Term Care Homes	0.70 FE/mpy		
Fuel Risks in Schools	0.56 FE/mpy		

TSSA's Risk Sources (2018)



Inspection Risk Spectrum (2018)



Inventory Risk Profile (2018)

High Risk	1%
Medium Risk	9%
Low Risk	89%

Compliance Rate (2014 – 2018)

32%

Health Impact

Observed		Potential
0.46 FE/mpy (2008 – 2018) Injury Burden	0.14 FE/mpy (2018) Injury Burden	0.99 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)

Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	27,457	10,821	499	57
2018	2,827	1,236	35	1



Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

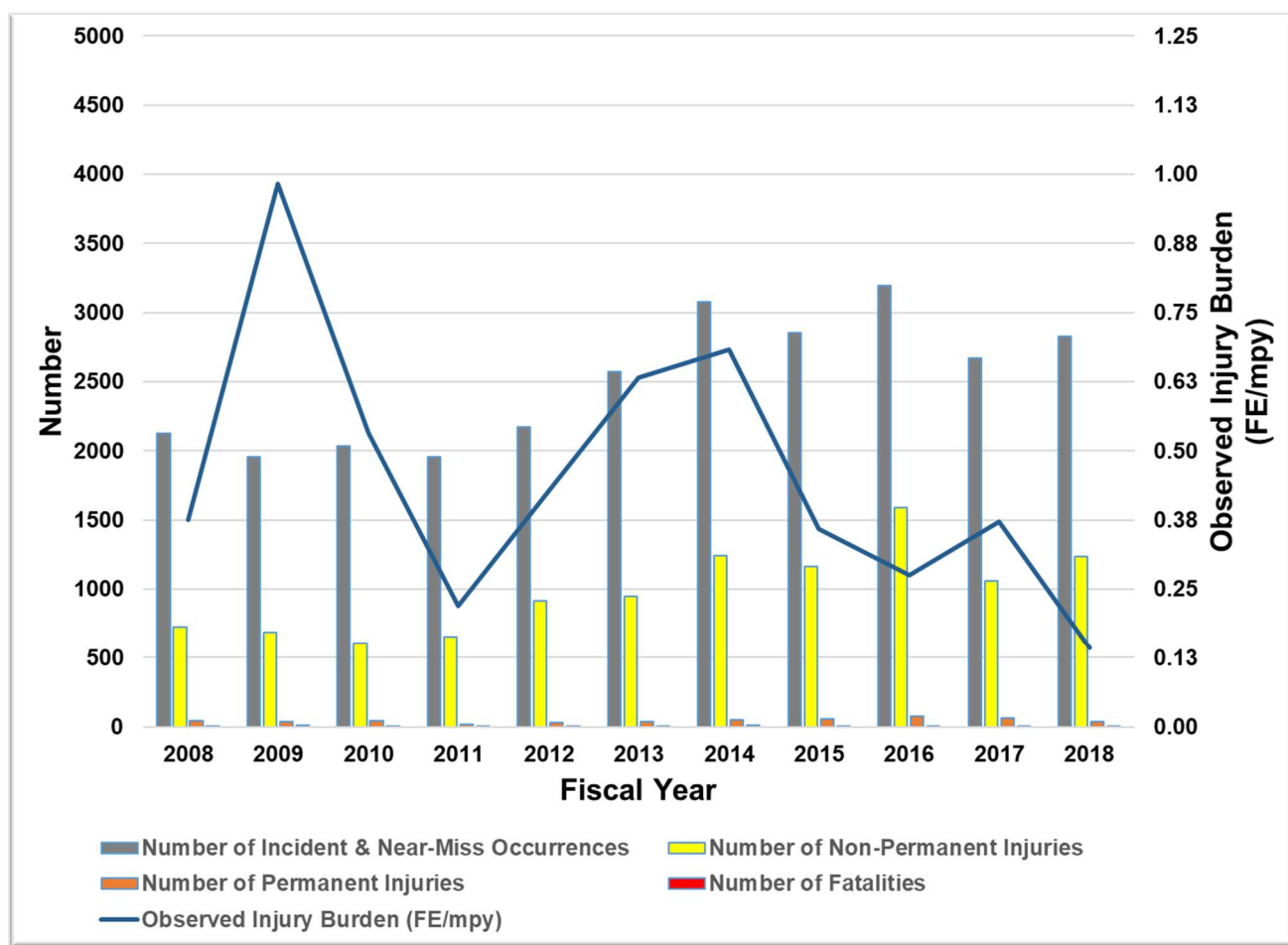
Since 2008, there have been 27,457 incidents and near-miss occurrences, resulting in 10,821 non-permanent injuries, 499 permanent injuries and 57 fatalities. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.46 FE/mpy. The observed injury burden for 2018 was 0.14 FE/mpy.

Using the predictive approach [1] developed by TSSA, the composite potential RIF to Ontarians² over all TSSA-regulated programs was 0.99 FE/mpy³.

The number of occurrences showed an increasing trend of 5% per year and the number of non-permanent injuries showed an increasing trend of 4% per year. 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 – 2018).



² 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.

³ Represents expected estimate of a simulated distribution, 5th and 95th percentiles are 0.59 and 1.45 FE/mpy respectively.



Priority Safety Issues

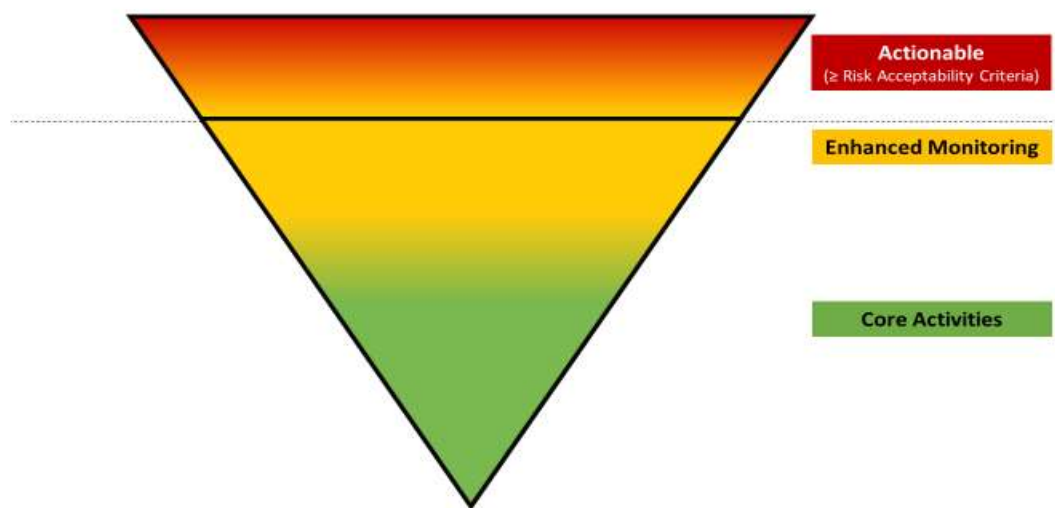
TSSA uses a risk-informed approach to understand the state of safety across its regulated sectors, to identify safety issues and to establish priorities. The state of safety is described using a risk metric, known as the RIF that is measured in terms of FE/mpy. This measure helps compare against international risk acceptability criteria benchmarks, and to set internal thresholds for decision-making. TSSA has adopted risk acceptability criteria from various international⁴ and national⁵ 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 priority safety areas.

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 [2-4].

Additionally, for the purposes of better understanding the sources of risk and establishing priorities, TSSA has adopted the use of ALARP (As Low As Reasonably Practicable) principles [5], to assist in classifying risks and identifying priority safety areas. 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 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. 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.

⁴ Health and Safety Executive [5], US Centers for Disease Control (CDC), The National Institute for Occupational Safety and Health (NIOSH) [6].

⁵ Major Industrial Accidents Council of Canada (MIACC) [2].



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 priority 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.

Risks Requiring Enhanced Monitoring

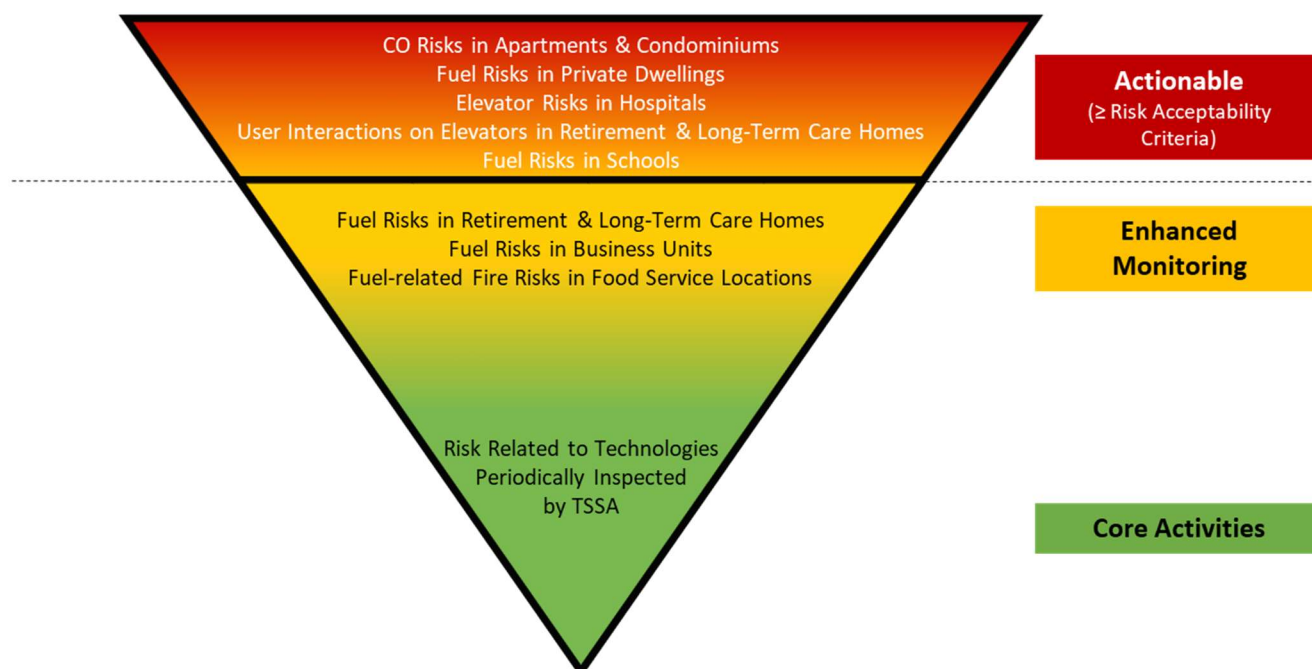
When risk sources approach the risk acceptability criteria, TSSA utilizes enhanced monitoring (shown in the yellow zone of Figure 2). TSSA considers these risk sources to be potentially emerging areas of risk and are monitored (including investigating specific incidents in the affected program area) 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 technologies for 2018.

Figure 3: TSSA's risk sources (2018).



Observations and significant highlights based on this view of the risk profile are indicated in Table 1. TSSA has identified five actionable areas and three issues requiring enhanced monitoring for 2018. Further details on the nature of these risks are given in the Elevator and Fuels Safety sections of this report.



Table 1: TSSA's risk sources (2018).

Risk Source	Risk of Injury or Fatality (FE/mpy)	Acceptability Criterion (FE/mpy)	Risk Region
CO Risks in Apartments and Condominiums	5.32	1.00	Actionable
Fuel Risks ⁶ in Private Dwellings	3.73	1.00	Actionable
Elevator Risks in Hospitals	3.49	1.00	Actionable
User Interactions on Elevators in Retirement and Long-Term Care Homes	0.70	0.30	Actionable
Fuel Risks ⁶ in Schools	0.56	0.30	Actionable
Fuel Risks ⁶ in Retirement and Long-Term Care Homes	0.26	0.30	Enhanced Monitoring
Fuel Risks ⁶ in Business Units	0.73	1.00	Enhanced Monitoring
Fuel-Related Fire Risks in Food Service Locations	0.61	1.00	Enhanced Monitoring

This year's edition of the ASPR, while presenting the current state of safety for an 11-year period ending April 30, 2018, 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* on page 2 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, 89% of regulated devices or facilities demonstrated a low level of risk as of 2018 (note that only uninsured boilers are included for BPV).

The median compliance rate observed over the past five years (2014 – 2018) was 32% with no demonstrable trend. TSSA uses a rolling five-year period (2014 – 2018) 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, the spectrum indicates that 1% of all inspections conducted in 2018 posed unacceptable levels of risk.

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



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 4.

Figure 4: Public safety risk management framework.



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 4 and as defined in Appendix D, 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 and devices. 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, regulated sectors and affected parties, to raise awareness and influence organizational behavioral change and compliance.

External Factors

Occurrences take place despite the presence of an adequate regulatory management system. Risks in this category are typically caused due to the use of technologies and devices by users, such as members of the public in lieu of their intended purpose. A comprehensive understanding of human factors helps TSSA set up appropriate public education tools through collaborative partnerships with stakeholders including consumer advocacy groups, regulated sectors, public education 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 *High Profile Root Cause Analysis* (HPRCA, see Appendix E), is used which relies on 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. For additional details on this methodology, refer to Appendix D.

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 a novel 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 various types of controls, with varying degrees of efficacy. Table 2 is adapted from *NIOSH's Hierarchy of Controls*.

Table 2: Control solutions⁷ to manage and/or mitigate risks.

Control Name	Purpose of Control
Elimination	Physically remove hazard
Substitution	Replace hazard (with less hazardous option)
Engineering	Minimize the exposure to people from hazard
Administrative	Change the way people work
Personal Protective Equipment	Safeguards design to protect people from hazards

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. Work is underway towards the development of a national guideline on *Managing Risks in the Public Interest*, 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.

⁷ 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. • Certification of boiler inspections • Regulates all pressure-retaining components manufactured or used in Ontario • Ensures safety of BPV and piping systems • Conducts periodic inspections on uninsured BPV • Certification of inspectors employed by insurance companies	Design
	Manufacture
	Installation
	Operation
	Maintenance
	Decommissioning

Health Impact		
Observed	Potential	
0.00 FE/mpy (2008 – 2018) Injury Burden	0.02 FE/mpy (2018) Injury Burden	0.02 FE/mpy (2018) Risk of Injury or Fatality

Compliance Rate (2014 – 2018)	Safety Numbers (Safety at a Glance)				
	Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
	2008 – 2018	41	1	7	0
98%*	2018	18	0	1	0

* Uninsured boilers only.

TSSA's Boilers and Pressure Vessels (BPV) safety program ensures the safe design, construction, maintenance, use, operation and repair of all uninsured 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 F for a listing of current legislation and regulatory information.



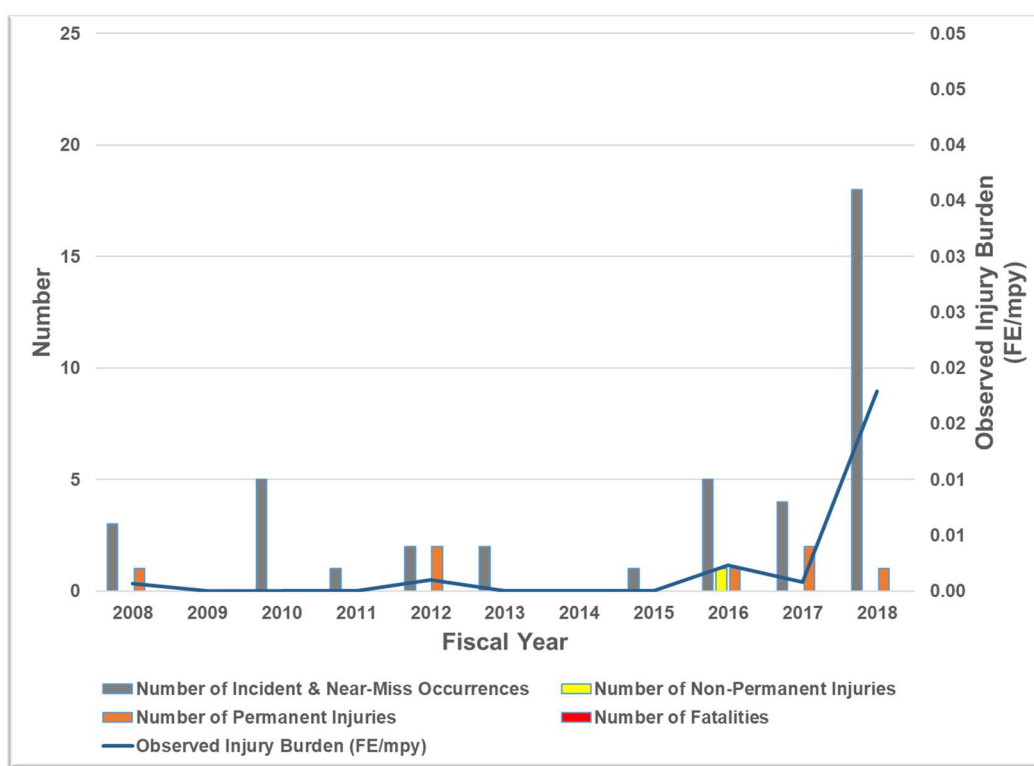
III.1.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

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 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 41 incident and near-miss occurrences, resulting in one non-permanent injury, seven permanent injuries and zero fatalities attributed to regulated boilers, pressure vessels and piping systems in the province over the last eleven years (2008 – 2018). 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 boilers and pressure vessels (2008 – 2018).



Based on the actual injuries observed over the last eleven years (2008 – 2018), the average rate of injury was 0.05 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of approximately 0.00 FE/mpy. The observed injury burden for 2018 was 0.02 FE/mpy.

Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians to be 0.02 FE/mpy⁸.

In 2018, there were 18 occurrences that were reported and/or had their inspection investigations completed. This was more than in previous years, mainly due to increased reporting from the Ministry of Environment, Conservation and Parks (formerly known as the Ministry of Environment) Spills Action Centre, particularly with

⁸ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 0.11 FE/mpy respectively.



regards to refrigeration incidents. Main issues affecting these occurrences included improper or lack of maintenance, failed components, improper installation and expired components. Despite increased reporting in 2018, the risk of injury or fatality remains low.

Compliance

The regulation 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%. The compliance data in this report does not include data from insurers and only represents the devices that TSSA inspects.

The frequency of those inspections is specified in the Code Adoption Document (CAD) associated with *Ontario Regulation 220/01: Boilers and Pressure Vessels*. TSSA deals with non-compliance by requiring the owners/operators to address observed non-conformances within an appropriate timeframe through the issuance of inspection orders. This periodic inspection process contributes to the preventative management of risk associated with boilers and pressure vessels.

The median compliance rate over the last five years (2014 – 2018) was 98%, with an increasing trend of 1% per year. The top compliance issues that were identified through periodic inspections are shown in Table BPV-1.

Table BPV-1: Top compliance issues for boilers and pressure vessels (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Owner to ensure that equipment is maintained in a safe working condition and operated safely, including pressure vessel supports to be repaired or replaced and maintained in good condition.	29%
Owner or any other party to do what is necessary for an inspector to conduct a proper inspection.	23%
Owner or any other party to do what is necessary for an inspector to conduct a proper inspection, including pressure relief devices to be properly set and protected against unauthorized adjustment.	19%
Owner or any other party to do what is necessary for an inspector to conduct a proper inspection, including to prepare equipment for and to assist with testing.	10%
Equipment to have adequate pressure relief device set to relieve at or below its maximum allowable working pressure.	4%

III.1.2 Risk Management, Message from Mike Adams, Statutory Director of BPV Safety Program

With the goal of improving the means for managing risks on boilers and pressure vessels, the Ministry of Government and Consumer Services and TSSA embarked on a review of *Ontario Regulation 220/01: Boilers and Pressure Vessels*. A regulatory proposal and public consultation have been completed; and the amended BPV Regulation received Cabinet approval in November 2017. The amended BPV Regulation came into effect on July 1, 2018, and the associated Code Adoption Document was also amended accordingly.

A major component of the amended regulation was the introduction of the certificate of inspection (COI) for insured BPVs. Not only does this allow TSSA to collect data on the results of the inspections on insured BPVs, TSSA will be able to have a better understanding of the installed equipment currently at BPV sites. Over the next year, the BPV program will continue to work with insurers to ensure all of the appropriate data is collected and processed.



In discussions with stakeholders regarding incidents, an opportunity to clarify near-miss reporting was identified. Given that there are historically few incidents in this sector, near-miss reporting plays an enhanced role in identifying emerging risks. As a result, during the fiscal year, BPV will engage stakeholders to ensure a common understanding of incident reporting is achieved.

Serious ammonia leaks have led to fatalities in other jurisdictions, which is why TSSA is now tracking more low-level releases. The BPV program recently requested that the Ministry of the Environment, Conservation and Parks (formerly known as the Ministry of Environment and Climate Change) Spills Action Centre (SAC) increase their reporting on low-level refrigeration releases by lowering their threshold. This has resulted in an increase in reported occurrences this year. Most of the increase represents minor – both in terms of volume and/or toxicity - refrigerant leaks that would have more of an environmental impact than a safety impact. The BPV program will continue to monitor such environmental releases to determine if any action is warranted.

Regarding safety-related performance targets, BPV now compares the TSSA boilers and pressure vessels periodic inspection compliance results (representing 1% of devices in Ontario – these are uninsured devices) with the National Board's Violations Tracking KPI (Key Performance Indicator). The National Board records periodic inspection results from 34 boiler and pressure vessel jurisdictions in North America, representing 643,448 periodic inspections over the period: April 1, 2017 to March 31, 2018, with a 91% compliance rate. The median compliance rate in Ontario of the 1% that TSSA inspects over the last five years (2014 – 2018) for BPV is 98%. Under the new regulation which was in effect on July 1, 2018, TSSA has also started collecting compliance rates for insured devices from Ontario insurers, representing the remaining 99% of devices in Ontario. From July 1, 2018 to September 29, 2018, the insurer compliance rate is 95%. TSSA will continue to provide these compliance results in future reports.

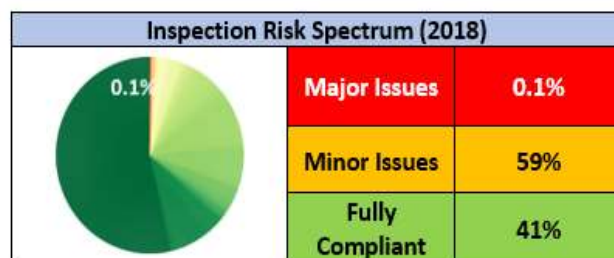
III.2 Operating Engineers

State of Public Safety in Ontario –

OPERATING ENGINEERS SAFETY PROGRAM



Inventory	Program Area Activities
3,280 Plants 12,571 Operating Engineers	- Registers 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



Inventory Risk Profile (2018)	
High Risk	1%
Medium Risk	11%
Low Risk	88%

Compliance Rate (2014 – 2018)
41%

Health Impact		
Observed	Potential	
0.00 FE/mpy (2008 – 2018) Injury Burden	0.00 FE/mpy (2018) Injury Burden	0.01 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	16	1	2	0
2018	4	0	0	0

TSSA's Operating Engineers (OE) Safety Program registers plants that power Ontario with electricity, refrigeration, heating and cooling in Ontario 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 F for a listing of current legislation and regulatory information.

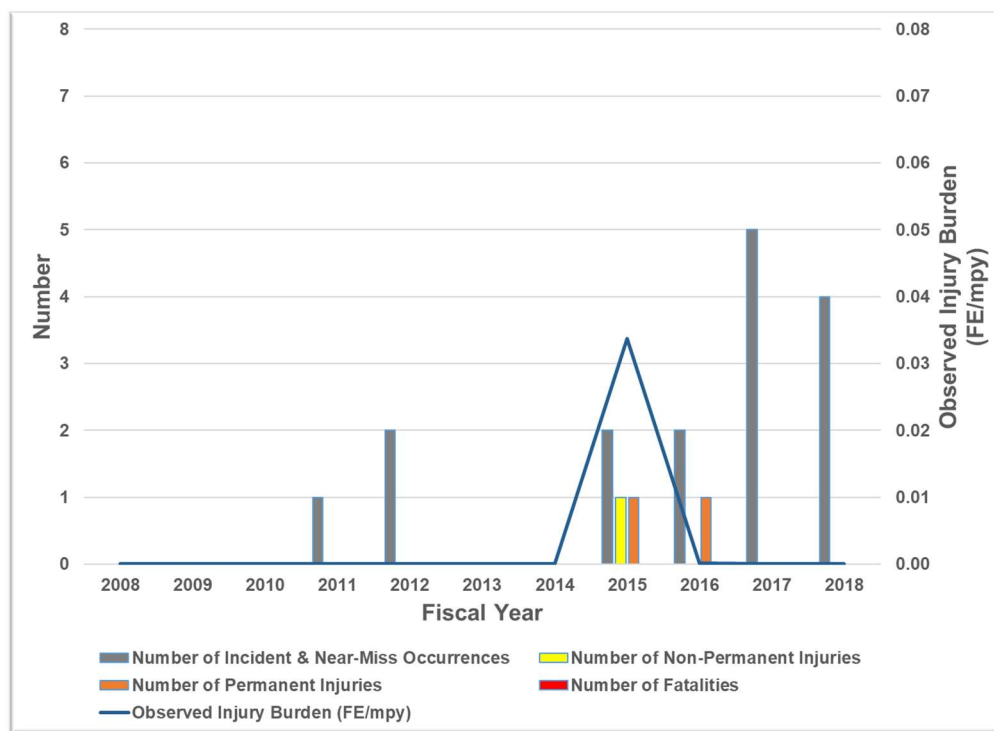


III.2.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 16 incident and near-miss occurrences, resulting in one non-permanent injury, two permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). 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 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 0.02 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of approximately 0.00 FE/mpy. The observed injury burden for 2018 was also approximately 0.00 FE/mpy.

Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians to be 0.01 FE/mpy⁹.

In 2018, there were four reported occurrences, for which their incident investigations were completed. The occurrence details have been included below:

- An occurrence involved an ammonia leak in a refrigeration plant at a recreation complex. The cause of the occurrence was attributed to lack of management systems;
- An occurrence involved an ammonia leak in a refrigeration plant at a food distribution centre. While performing an oil drainage from an ammonia receiver, a worker slipped and accidentally opened the valve fully. The cause of the occurrence was attributed to failure to follow operating procedures;
- An occurrence involved at a high-pressure power plant. A worker accidentally stepped into a pit filled with hot water while inspecting a portable sump pump. The cause of the occurrence was attributed to defective or inadequate maintenance procedures; and
- An occurrence involved an ammonia leak in a refrigeration plant at an arena from a welded pipe joint and the facility was evacuated. The root cause of the occurrence was not ascertained.

⁹ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 0.03 FE/mpy respectively.



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 2,706 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 41%, with no demonstrable trend. The top compliance issues that were identified through periodic inspections are shown in Table OE-1.

Table OE-1: Top compliance issues for operating plants (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Equipment to be internally/externally inspected by an insurance company or TSSA inspector.	9%
The following safety concerns shall be corrected as noted below.	7%
Testing of safety devices has not been recorded.	5%
All safety limiting devices to be tested, logged and tagged at least once per year.	4%
Refrigerant gas detector, ventilation system and alarm to be tested, tagged and logged once per year.	4%

Figures OE-2 and 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 less than 1% (0 – 0.1%) of all inspections conducted in the past five years (2014 – 2018) posed unacceptable levels of risk.

Figure OE-2: Inspection risk spectrums from outcomes of periodic inspections conducted on operating plants (2014 – 2018).

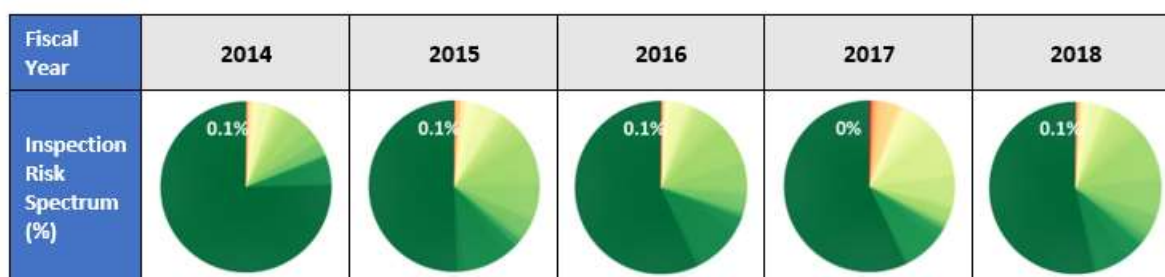


Figure OE-3: Inventory risk profiles from outcomes of periodic inspections conducted on operating plants (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	6%	N/A	5%	2%	1%
	41%		17%	11%	11%
	54%		78%	87%	88%



TSSA deals with observed non-compliances by issuing inspection orders to the owner/operator 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 Figure 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 years (indicated by the inspection risk spectrum). As of the 2018 snapshot, there were 34 high-risk facilities. The most numerous type of plant of all the high-risk facilities was high-pressure water tube low-water-volume power plants, which accounted for 26% of the high-risk facilities. These types of locations represent 10% of the total provincial inventory of assessed operating plants. Additionally, the most numerous plant function of all the high-risk facilities was food processing facilities, which made up 21% of the high-risk facilities. These types of locations represent 11% of the total provincial inventory of assessed operating plants.

III.2.2 Risk Management, Message from Mike Adams, Statutory Director of OE Safety Program

Similar to BPV, a review to modernize *Ontario Regulation 219/01 Operating Engineers* was undertaken by the Ministry with TSSA and stakeholder engagement. Over the past year, an expert panel review was completed with 23 recommendations made. The report underwent public consultation during the year. this review is currently on hold pending government direction.

While, the compliance rate of 41% for operating plants from 2013 – 2018 is lower than ideal, the majority of those non-compliances are low risk in nature. These non-compliances are typically related to logbooks, housekeeping, or registration details. Over the same timeframe, the number of high-risk plants has reduced from 13% in 2013 to 1% in 2018. Also, less than 1% (0 – 0.1%) of all inspections conducted in all the past five years found unacceptable levels of risk. As a result, The OE Program will continue to work with customers to help them understand the source of their non-compliances.

III.3 Amusement Devices

State of Public Safety in Ontario –

AMUSEMENT DEVICES SAFETY PROGRAM AREA



Inventory	Program Area Activities	Regulated Devices
2,468*	- Licenses operators - Reviews and files rides - Conducts inspections and investigations - Issues permits for rides - Delivers public awareness campaigns	- Circular motion rides (e.g., roller coasters, Ferris wheels, merry-go-rounds) - 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	
Equipment	Issues
Water Slides Coaster Rides Circular Rides Ziplines	Physical Impacts Trips or Falls



Inventory Risk Profile (2018)	
High Risk	0%
Medium Risk	4%
Low Risk	96%

Compliance Rate (2014 – 2018)	
63%	

Health Impact		
Observed		Potential
0.03 FE/mpy (2008 – 2018) Injury Burden	0.01 FE/mpy (2018) Injury Burden	0.14 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	4,028	3,644	188	0
2018	614	575	19	0

* Permitted devices only.

TSSA's Amusement Devices (AD) Safety Program Area regulates amusement rides in Ontario to ensure all devices conform to the Act and its associated regulations, codes and standards. As part of the AD safety program area, the TSSA: licenses operators; reviews and files rides; conducts inspections and incident investigations; issues permit for each ride in the current operating season; and delivers public awareness campaigns throughout the province. See Appendix F for a listing of current legislation and regulatory information.

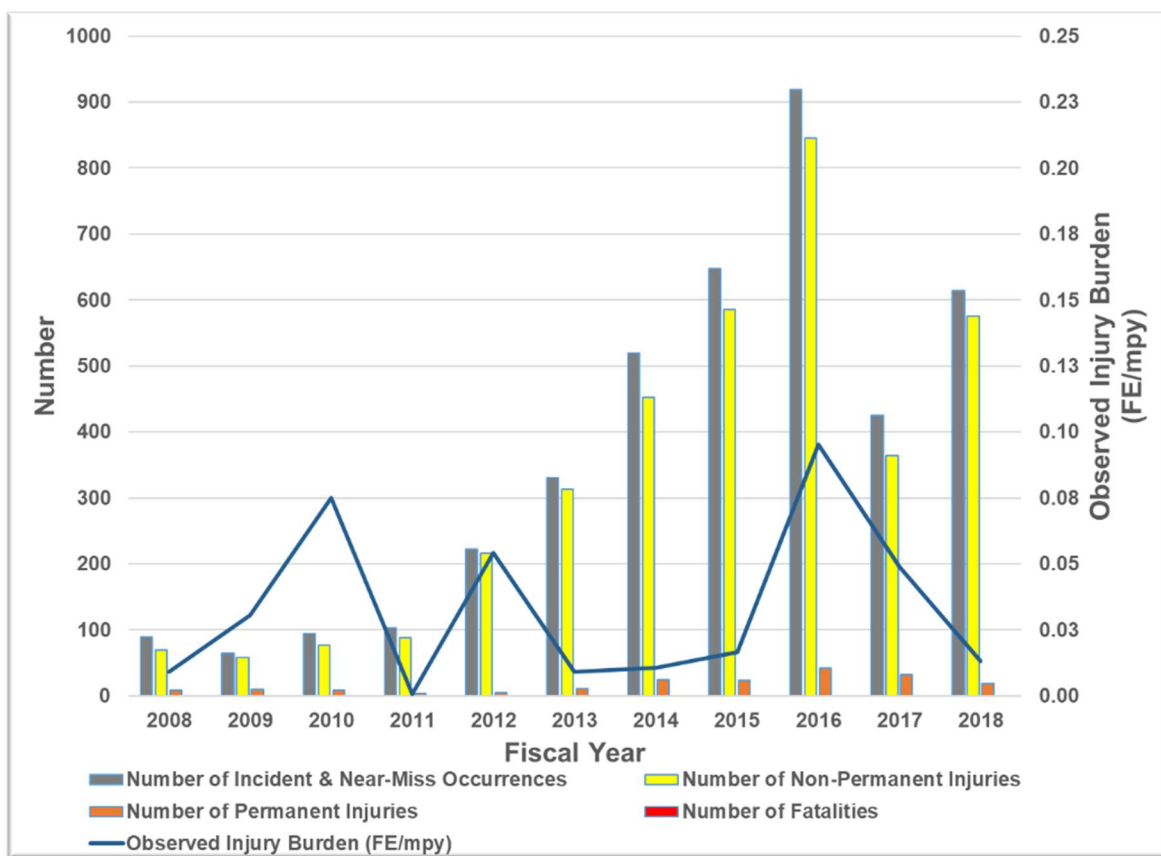


III.3.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 4,028 incident and near-miss occurrences, resulting in 3,644 non-permanent injuries, 188 permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). 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 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 25.80 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.03 FE/mpy. The observed injury burden for 2018 was 0.01 FE/mpy.

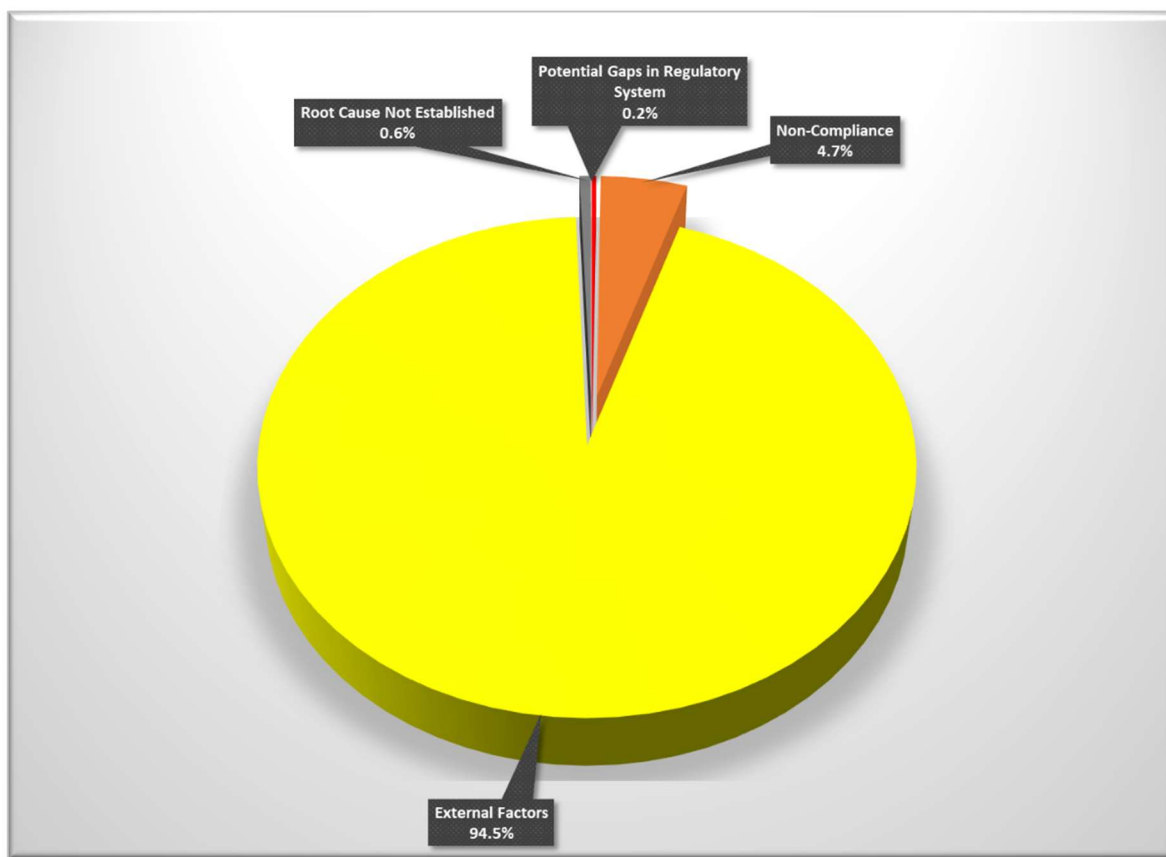
Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians using amusement devices to be 0.14 FE/mpy¹⁰.

There were increasing trends in the number of occurrences, non-permanent injuries and permanent injuries of 6%, 6% and 7% 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, approximately 95% of the risk caused over the past eleven years (2008 – 2018) was due to factors external to the regulatory environment. There was an increasing trend in the number of external-factor occurrences of 6% per year.

¹⁰ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.04 and 0.29 FE/mpy respectively.

Figure AD-2: Risk of injury or fatality in amusement devices by casual analysis category (2008 - 2018).



Risk of Injury or Fatality on Amusement Devices due to Human Factors (2010 – 2018)¹¹

Based on available data, approximately 95% of all amusement device incident and near-miss occurrences were due to human factors (approximately 99% of external factors). The most predominant of these occurrences were physical impacts, and trips or falls sustained by riders and are summarized below.

Physical Impacts

Physical impact occurrences accounted for 43% of human factor occurrences on amusement devices and 13% of the related observed injury burden.

Waterslides accounted for 29% of the physical impact occurrences, and 22% of the related observed injury burden. These occurrences primarily took place in the flume and passenger carrying unit (PCU) areas of the waterslide. Head injuries were predominant and resulted in 52% of these occurrences and nearly 56% of the associated observed injury burden.

Ziplines accounted for 22% of the physical impact occurrences, and 23% of the related observed injury burden. These occurrences primarily took place in the landing area of the zipline or involved pulleys. Hand and leg injuries were predominant and resulted in nearly 44% and 30% of the zipline occurrences respectively. Though head injuries accounted for 12% of these occurrences, they accounted for 72% of the observed injury burden.

¹¹ The information is not available for 2008 – 2009. Hence, the analysis only reflects the period of 2010 – 2018.



Coaster rides accounted for 14% of the physical impact occurrences, and 31% of the related observed injury burden. These occurrences primarily took place in the PCU area of the device. Head injuries were sustained by patrons in 62% of these occurrences.

Circular rides accounted for 11% of the physical impact occurrences, and 2% of the related observed injury burden. These occurrences primarily took place in the PCU area of the device. Head injuries were sustained by patrons in 51% of these occurrences.

Trips or Falls

Trip or fall occurrences accounted for 19% of human factor occurrences on amusement devices and 47% of the related observed injury burden.

Waterslides accounted for 46% of the trip or fall occurrences, and 95% of the observed injury burden. These occurrences primarily took place in the flume area of the waterslide. Head injuries accounted for 63% of occurrences on waterslides, and 44% of the related observed injury burden.

Circular rides accounted for 17% of the trip or fall occurrences, and 0.2% of the observed injury burden. These occurrences primarily took place in the loading or unloading areas of the circular ride. Head injuries accounted for 42% of the circular ride occurrences, and 44% of the related observed injury burden.

Coaster rides accounted for 11% of the trip or fall occurrences, and 2% of the observed injury burden. These occurrences primarily took place in the loading or unloading areas of the coaster ride. Head injuries accounted for 35% of the coaster ride occurrences, and 94% of the related observed injury burden.

Compliance

TSSA conducts periodic inspections of all amusement devices at the start of the season to oversee and manage the state of compliance across 2,468 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/operator 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 2,468 devices that had sufficient inspection history 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 years (2014 – 2018) was 63%, with a decreasing trend of 5% per year. The top compliance issues that were identified through periodic inspections are shown in Table AD-1.

Table AD-1: Top compliance issues for amusement devices (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
AD plate to be permanently fixed to device.	2%
Training records to be kept in log book.	2%
Repair hole/tear in inflatable device.	2%
PCU surface to be kept smooth and free of sharp edges.	2%
Daily inspection record to be kept in log book.	1%



Figures AD-3 and AD-4 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 2% to 6% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

Figure AD-3: Inspection risk spectrums from outcomes of periodic inspections conducted on amusement devices (2014 – 2018).

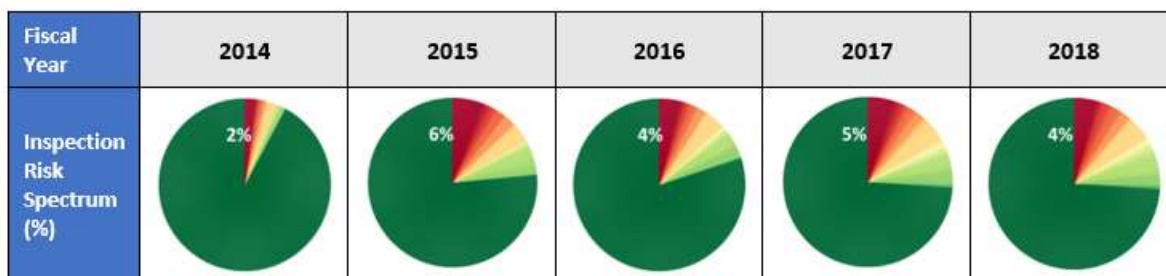


Figure AD-4: Inventory risk profiles from outcomes of periodic inspections conducted on amusement devices (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	N/A	N/A	0%	0%	0%
			7%	4%	4%
			93%	96%	96%

Using a risk-based approach, an inventory risk profile was generated. As of 2018, there was only one high-risk device (a waterslide). The most numerous type of medium-risk devices was circular rides, which make up 36% of all medium-risk devices. Circular rides comprise nearly 14% of the entire qualified inventory.

III.3.2 Risk Management, Message from Roger Neate, Statutory Director of AD Safety Program

With an observed average injury burden of approximately 0.03 FE/mpy and a predictive risk of injury of 0.14 FE/mpy, we are confident with the relative safety of amusement devices. That is not to say that they are completely risk-free, for we are still seeing incidents and our analysis shows that a majority of these are related to human factors. The dilemma before us is to determine how many of these incidents are related to the inherent risks of experiencing amusement devices and how many can be reasonably eliminated without being prohibitively expensive or potentially sanitizing the ride to such an extent that all the amusement or thrill is removed from the ride in a quest to make it absolutely safe.

III.4 Elevators

State of Public Safety in Ontario –

ELEVATORS SAFETY PROGRAM AREA



Inventory	Program Area Activities	Regulated Devices
55,812	- Reviews and registers devices - Issues licences - Conducts inspections - Performs incident investigations	- 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

Actionable Areas (2018)	
Elevator Risks in Hospitals	3.49 FE/mpy
User Interactions on Elevators in Retirement and Long-Term Care Homes	0.70 FE/mpy



Inventory Risk Profile (2018)	
High Risk	0.3%
Medium Risk	3%
Low Risk	97%

Compliance Rate (2014 – 2018)
23%

Health Impact		
Observed		Potential
0.05 FE/mpy (2008 – 2018) Injury Burden	0.04 FE/mpy (2018) Injury Burden	0.70 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	4,199	1,445	81	8
2018	661	123	3	1

The Elevators (ED) Safety Program Area 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 and performs incident investigations. See Appendix F for a listing of current legislation and regulatory information.

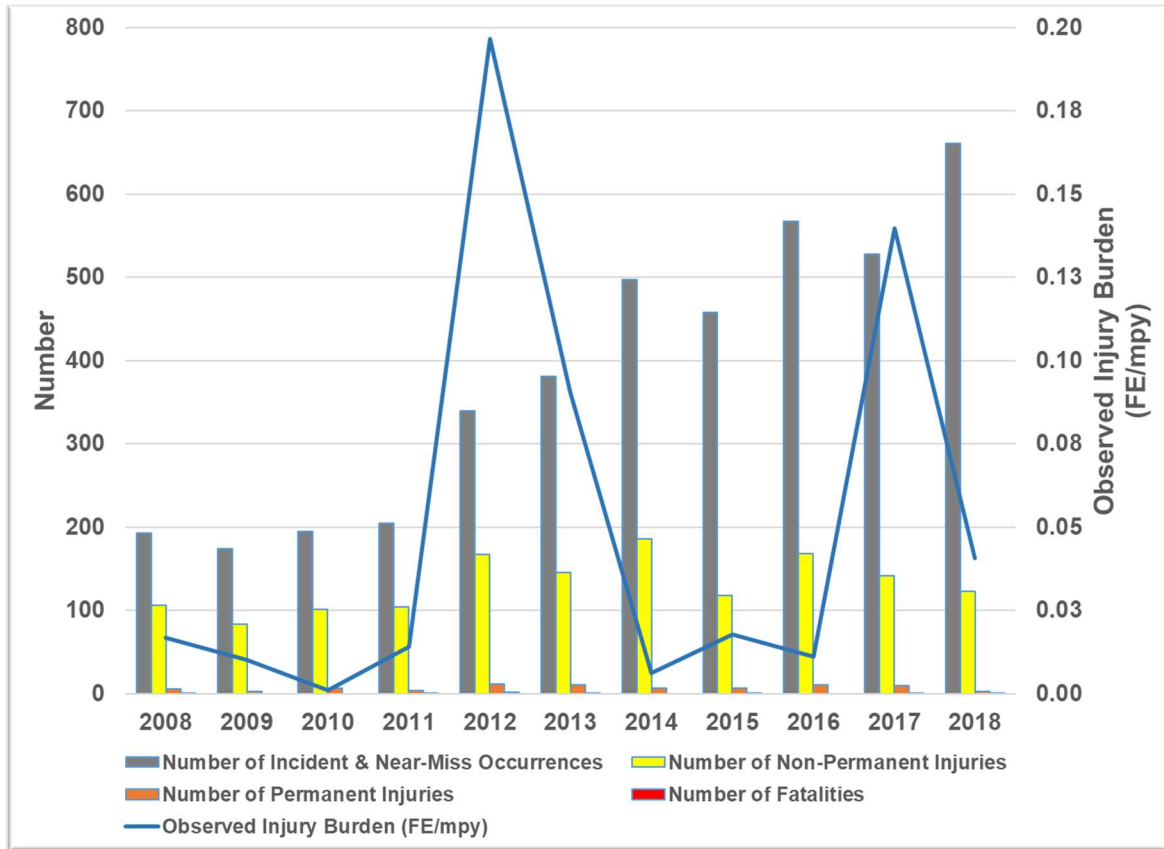


III.4.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 4,199 incident and near-miss occurrences, resulting in 1,445 non-permanent injuries, 81 permanent injuries and eight fatalities reported over the past eleven years (2008 – 2018). Measures representing the overall state of safety are represented graphically in Figure ED-1 and are tabulated in Appendix A.

Figure ED-1: State of safety across elevators (2008 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 10.28 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.05 FE/mpy. The observed injury burden for 2018 was 0.04 FE/mpy.

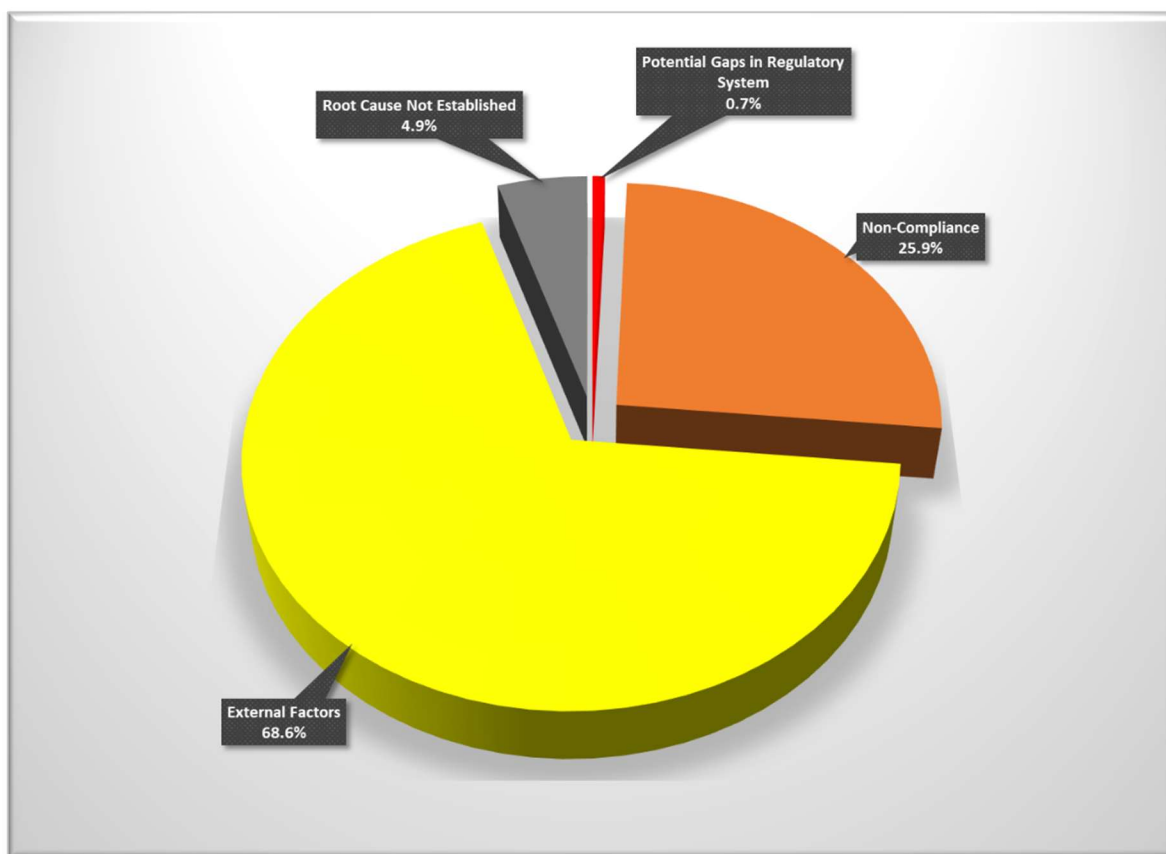
Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians using elevators to be 0.70 FE/mpy¹².

There was an increasing trend in the number of occurrences of 7% per year, excluding water-exposure (or flooding) incidents. The trend would be higher (13%) if water-exposure incidents were included. However, water-exposure incidents have resulted in zero injury burden over the 11 years TSSA has been analyzing data, which is why they were not included in the RIF calculation (i.e., water exposure is more of a maintenance issue than a safety issue).

¹² Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.34 and 1.13 FE/mpy respectively.

Figure ED-2 illustrates the top issues related to elevators in terms of their casual analysis categories. As indicated in this pie chart, approximately 69% of the risk caused over the past eleven years (2008 – 2018) was due to factors external to the regulatory environment (see Appendix D for further details on external factors). There was an increasing trend in the number of these external-factor occurrences of 6% per year, excluding water-exposure incidents¹³.

Figure ED-2: Risk of injury or fatality in elevators by casual analysis category (2008 - 2018).



Risk of Injury or Fatality on Elevators Due to External Factors (2010 – 2018)¹⁴

Water Exposure

Damage due to water exposure (or flooding) accounted for 36% of external-factor elevator incident and near-miss occurrences. 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.

Human Factors

Human factors were associated with 65% of the remaining external-factor elevator incident and near-miss occurrences (excluding water exposure). Based on available data, the most predominant consequences of these occurrences were due to elevator car doors closing on passengers and levelling, including trips or falls.

¹³ The trend would be increasing at 14% per year if water-exposure incidents were included.

¹⁴ The information is not available for 2008 – 2009. Hence, the analysis only reflects the period of 2010 – 2018.



Elevator Doors Closing on Passengers

Door closing occurrences accounted for 49% of human factor occurrences and 51% of the associated observed injury burden.

Office locations accounted for 27% of these occurrences, and 4% of the associated observed injury burden. There was an increasing trend in the number of these occurrences of 10% per year.

Despite accounting for only 16% of these occurrences, 82% of the associated observed injury burden took place in rental locations.

Mercantile locations accounted for 15% of these occurrences, and 6% of the associated observed injury burden.

Hospitals accounted for 10% of these occurrences, and 1% of the associated observed injury burden. Door closing occurrences were the most predominant consequence of unsafe user-related elevator occurrences in hospitals and represented approximately one third of the related occurrences in hospitals. Note that although both occurrences and the observed injury burden for hospitals are relatively low, the predicted risk (or RIF value) is relatively high due to the limited population size, making this an actionable area in the TSSA risk sources triangle (as seen in Figure 3 on page 5).

Hotels made up only 6% of these occurrences and represented negligible injury burden. However, there was an increasing trend in the number of these occurrences of 21% per year.

Levelling and Trips or Falls

Levelling occurrences accounted for 32% of human factor occurrences and 23% of the associated observed injury burden.

Rental locations accounted for nearly 29% of these occurrences, and 22% of the associated observed injury burden.

Office locations accounted for 23% of these occurrences, and 21% of the associated observed injury burden.

Despite accounting for only 16% of these occurrences, 37% of the observed injury burden relating to human factor levelling occurrences took place in condominiums.

Actionable Areas

There were two actionable areas identified in ED:

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 338 incident and near-miss occurrences, resulting in 143 non-permanent injuries, 10 permanent injuries and one fatality reported over the past eleven years (2008 – 2018). Measures representing these historical observations are represented graphically in Figure ED-3 and are tabulated in Appendix A.



Based on available data, there was an actionable level of potential RIF in hospitals of 3.49 FE/mpy¹⁵ 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.

Figure ED-3: State of safety of elevator risks in hospitals (2008 – 2018).

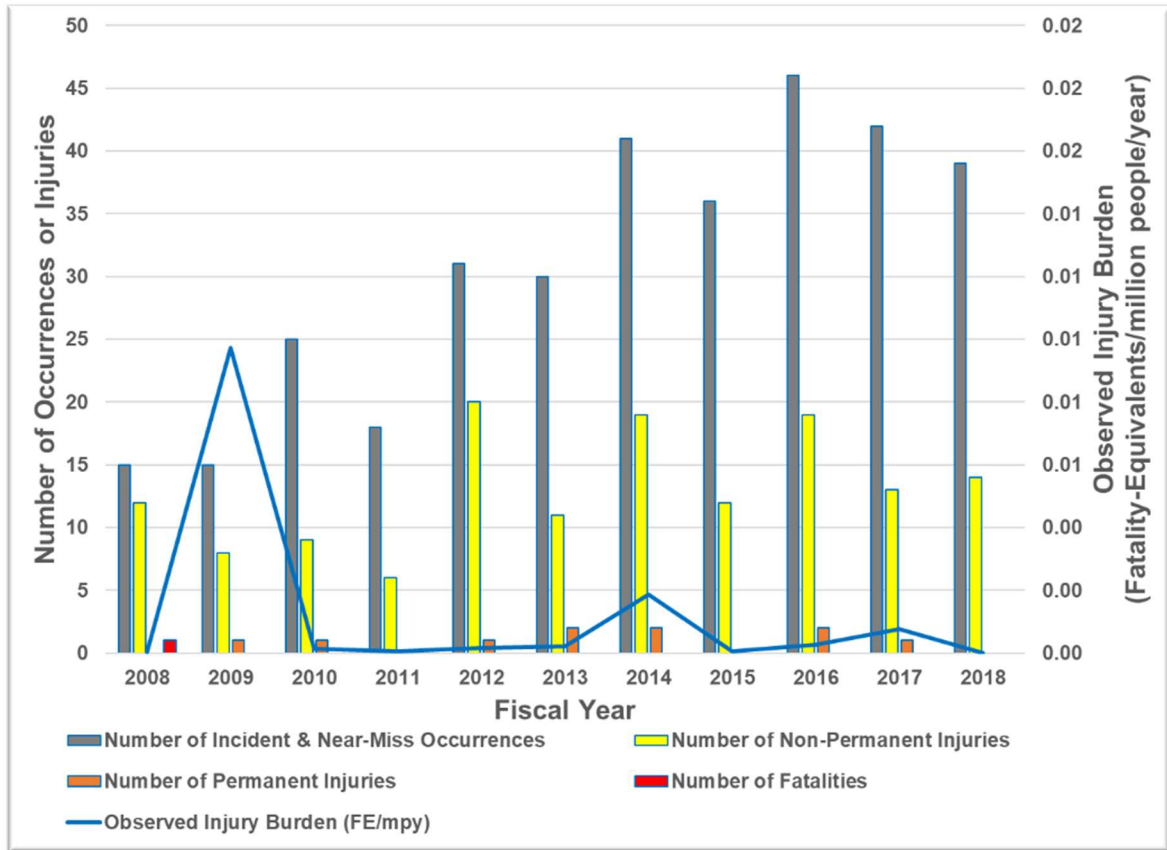
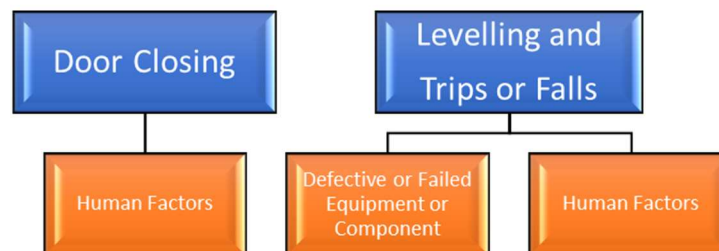


Figure ED-4 illustrates the contributing causes for elevator safety issues identified in hospitals. It includes both door closing and levelling and trip or fall occurrences, mainly due to human factor issues. Door closing occurrences are driven mainly by elevator door speeds that do not provide adequate time for an individual to enter or exit the elevator in a safe manner, particularly when a worker is wheeling a cart or gurney.

Figure ED-4: Contributing causes of elevator safety issues in hospitals (2008 – 2018).

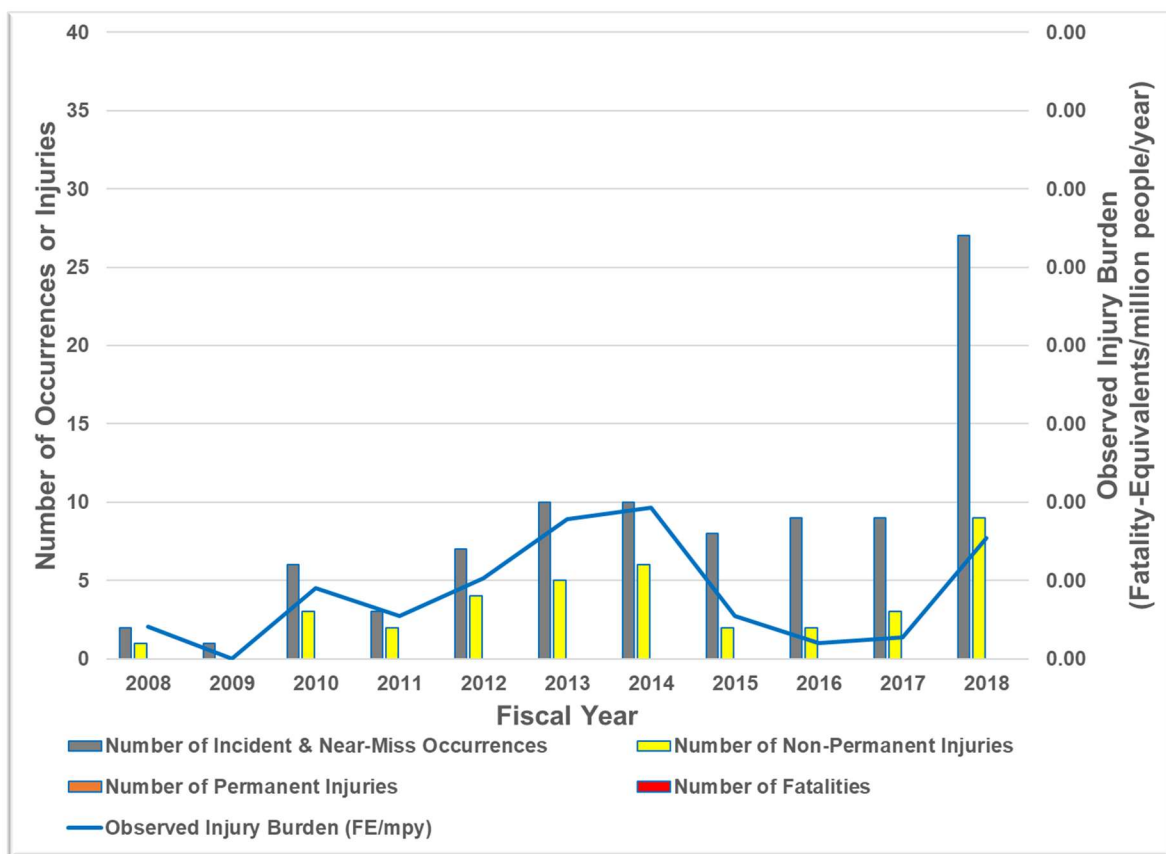


¹⁵ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.05 and 11.45 FE/MPY respectively.

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

There have been 92 incident and near-miss occurrences, resulting in 37 non-permanent injuries, zero permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). Measures representing these historical observations are represented graphically in Figure ED-5 and are tabulated in Appendix A.

Figure ED-5: State of safety of user interactions on elevators in retirement and long-term care homes (2008 – 2018).



Based on available data, there was an actionable level of potential RIF in retirement and long-term care homes of 0.70 FE/mpy¹⁶ involving resident interaction with elevators. The actionable risk criterion is ≥ 0.3 fatalities/million people/year for this Ontario sensitive sub-population [2-4].

These occurrences were primarily due to elevator car doors closing on passengers and levelling and trips or falls. Door closing occurrences are driven mainly by elevator door speeds that do not provide adequate time for the resident to enter or exit the elevator in a safe manner. This risk is further exacerbated when the resident is reliant on a mobility aid. Figure ED-6 illustrates the contributing causes for elevator safety issues identified in retirement and long-term care homes.

¹⁶ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 6.22 FE/mpy respectively.

Figure ED-6: Contributing causes of elevator safety issues in retirement and long-term care homes (2008 – 2018).



Compliance

TSSA conducts periodic inspections of all elevators using a risk-based approach to oversee and manage the state of compliance across 55,812 elevators in the province of Ontario. TSSA deals with non-compliances by requiring the owner/operator 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 45,472 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 23%, with a decreasing trend of 2% per year. The top compliance issues that were identified through periodic inspections are shown in Table ED-1.

Table ED-1: Top compliance issues for elevators (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Late annual periodic task for standby or emergency power and emergency lowering operation.	2%
Late annual periodic task for firefighter's emergency operation.	2%
Late annual periodic task for power operation of door system.	2%
Late annual periodic task for normal and final terminal stopping devices.	2%
Late annual periodic task for emergency communications.	1%

Figures ED-7 and ED-8 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 years (2014 – 2018) posed unacceptable levels of risk.

Figure ED-7: Inspection risk spectrums from outcomes of periodic inspections conducted on elevators (2014 – 2018).

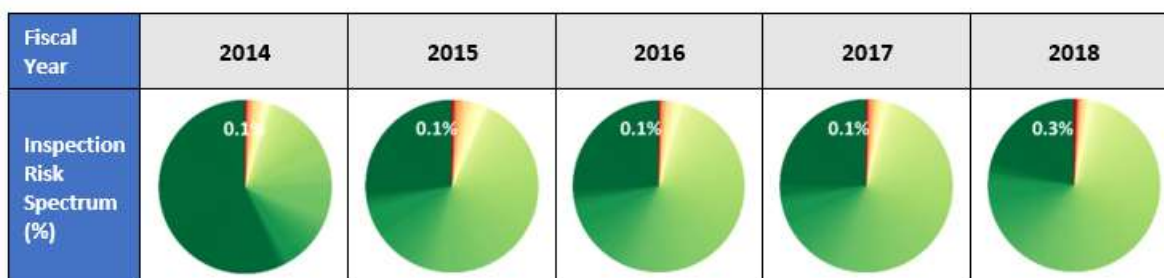




Figure ED-8: Inventory risk profiles from outcomes of periodic inspections conducted on elevators (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	2%	2%	0.14%	0.01%	0.30%
	1%	1%	5%	3%	3%
	98%	97%	95%	97%	97%

Using a risk-based approach, the inventory risk profile indicated that as of 2018, rental locations continued to have the largest number of high- and medium-risk devices, followed by offices and hospitals. In proportion with the number of devices, hospitals and hotels had the greatest number of high- and medium-risk devices.

III.4.2 Risk Management, Message from Roger Neate, Statutory Director of ED Safety Program

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

Over the past year, we have focused on creating greater awareness among operators of retirement and long-term care homes of the risks associated with elevators in these facilities and the steps that operators can take to help mitigate some of these risks. The primary message has been about making adjustments to elevator door operations that give seniors more time to enter and exit elevator safely. Over the coming years, we will leverage these relationships and the advocacy materials we have developed to educate owners, operators and the elevator industry about this risk via social media and through direct engagement by our inspectors during our regular periodic inspections.

Managing Risks on Elevators in Hospitals

Through additional analysis of incidents and trends, we have identified an unacceptable level of risk primarily involving hospital workers. Much like risks in retirement and long-term care homes, it comes down to user interactions with the elevator doors. Over the coming year, TSSA will be working with hospital operators, other regulatory bodies/agencies and the elevator industry to develop strategies to address these risks.

Compliance

As noted in the previous edition of the ASPR, I am concerned about the continuing trend of decreasing compliance. This past year, our team implemented an initiative to work closely with those elevator contractors who displayed the lowest levels of compliance. The purpose of this initiative is to help contractors understand the types and numbers of non-compliances we were seeing through our inspections and then provide education and guidance that will assist them to develop strategies for improvement. One of the major learnings from these meetings and the sharing of our data was that the senior executives of these organizations were largely unaware of the extent to which their organizations were non-compliant.

With this new understanding of compliance requirements, these executives have responded positively and put in place plans for improvement. As of the time of this report's publication, we have yet to see significant improvement in the data. We attribute this to the size of the problem and the time needed to make the operational changes and culture changes within their organizations. It is my belief that the cooperative approach we are taking to address this problem with contractors is working. We are seeing the required commitment to change and anticipate that it may take at least two more quarters to start seeing improvements in data trends

III.5 Escalators and Moving Walks

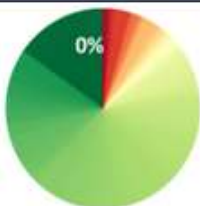
State of Public Safety in Ontario –

ESCALATORS AND MOVING WALKS SAFETY PROGRAM AREA



Inventory	Program Area Activities
2,117	- Reviews and registers devices - Issues licences - Conducts inspections - Performs incident investigations

Top Safety Issues	
Locations	Issues
Mass Transportation Mercantile	Physical Impacts Trips or Falls

Inspection Risk Spectrum (2018)		Inventory Risk Profile (2018)	
	Major Issues	0%	0%
	Minor Issues	89%	3%
	Fully Compliant	11%	97%
Compliance Rate (2014 – 2018)			
10%			

Health Impact		
Observed		Potential
0.02 FE/mpy (2008 – 2018) Injury Burden	0.00 FE/mpy (2018) Injury Burden	0.07 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	6,503	4,424	41	1
2018	704	448	0	0

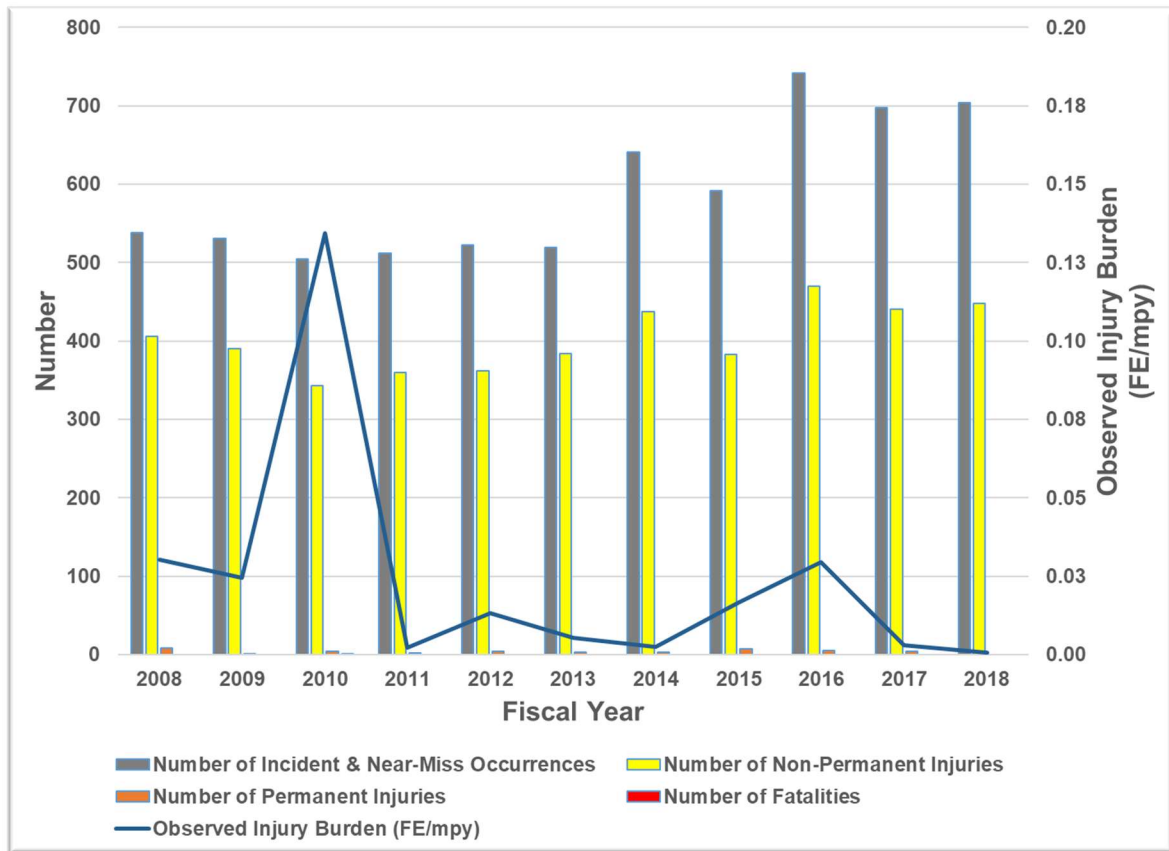
The Escalators and Moving Walks (EM) Safety Program Area regulates escalators and moving walks in Ontario to ensure all devices conform to the Act and applicable regulations, codes and standards. TSSA reviews and registers escalators and moving walks, issues licences, conducts inspections and performs incident investigations. See Appendix F for a listing of current legislation and regulatory information.

III.5.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 6,503 incident and near-miss occurrences, resulting in 4,424 non-permanent injuries, 41 permanent injuries and one fatality reported over the past eleven years (2008 – 2018). 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 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 30.07 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.02 FE/mpy. The observed injury burden for 2018 was approximately 0.00 FE/mpy.

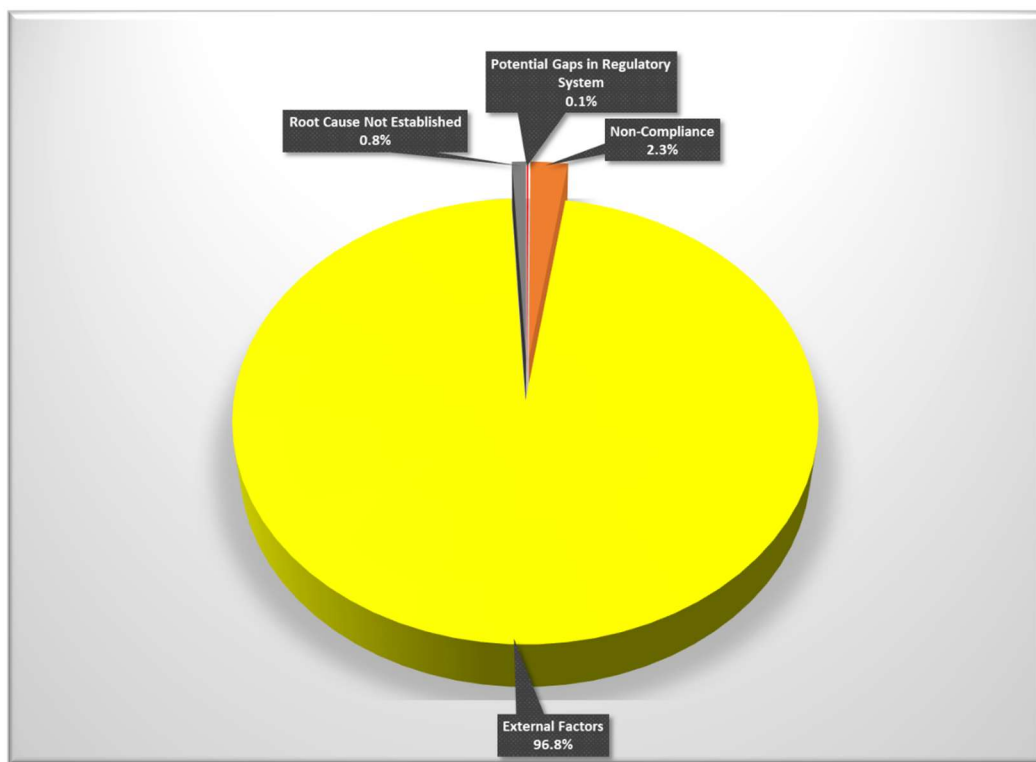
Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians using escalators and moving walks to be 0.07 FE/mpy¹⁷.

There was an increasing trend in the number of occurrences of 4% per year. There were no demonstrable trends in the number of non-permanent or 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, approximately 97% of the risk caused over the past eleven years (2008 – 2018) was due to factors external to the regulatory environment. There was an increasing trend in the number of these occurrences of 4% per year.

¹⁷ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.01 and 0.19 FE/mpy respectively.

Figure EM-2: Risk of injury or fatality in escalators and moving walks by casual analysis category (2008 - 2018).



Risk of Injury or Fatality on Escalators and Moving Walks Due to Human factors (2010 – 2018)¹⁸

Human factors accounted for 88% of external-factor incident and near-miss occurrences. The most significant issues with escalators and moving walks have been summarized below. There was an increasing trend in the number of these occurrences of 4% per year.

Trips or Falls

Trip or fall occurrences accounted for 90% of human factor occurrences and almost 100% of the associated observed injury burden. There was an increasing trend in the number of occurrences of 6% per year.

Mass transportation locations accounted for 60% of these occurrences and 13% of the associated observed injury burden. There was an increasing trend in the number of these occurrences of 6% per year.

Mercantile locations accounted for 33% of these occurrences and 85% of the associated observed injury burden.

Entrapments

Entrapment occurrences accounted for 9% of human factor occurrences and 0.3% of the associated observed injury burden. There was an increasing trend in the number of occurrences of 10% per year.

Mass transportation locations accounted for 58% of these occurrences and also 58% of the associated observed injury burden. There was an increasing trend in the number of occurrences of 13% per year. In particular, 28% of these occurrences involved patrons' clothing getting caught in the escalator.

Mercantile locations accounted for 35% of these occurrences, and 27% of the associated observed injury burden. There was an increasing trend in the number of occurrences of 7% per year.

¹⁸ The information is not available for 2008 – 2009. Hence, the analysis only reflects the period of 2010 – 2018.



Compliance

TSSA conducts periodic inspections of all escalators and moving walks to oversee and manage the state of compliance across 2,117 escalators and moving walks in the province of Ontario. TSSA deals with non-compliances by requiring the owner/operator 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 1,598 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 10%, with no demonstrable trend. The top compliance issues that were identified through periodic inspections are shown in Table EM-1.

Table EM-1: Top compliance issues for escalators and moving walks (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Late annual periodic task for escalator skirt/step performance index.	5%
Late scheduled maintenance task for escalator cleaning.	2%
Elevating device to be removed from service.	2%
Late scheduled maintenance task for escalator step/skirt performance index.	2%
Owner to make arrangements for an inspection of the device.	2%

Figures EM-3 and EM-4 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% to 0.5% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels or risk.

Using a risk-based approach, the inventory profile indicated that as of 2018, there was only one high-risk device (at a mass transportation location). Over 51% of all medium-risk devices were found in mercantile locations. Mercantile devices comprised 39% of the entire qualified provincial inventory.

Figure EM-3: Inspection risk spectrums from outcomes of periodic inspections conducted on escalators & moving walks (2014 – 2018).

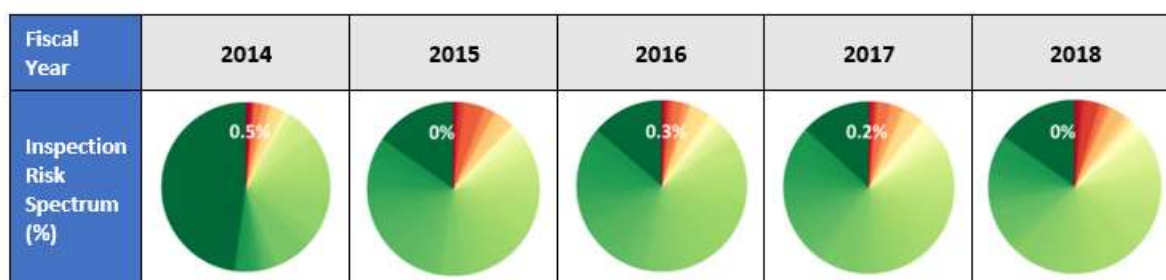


Figure EM-4: Inventory risk profiles from outcomes of periodic inspections conducted on escalators & moving walks (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	4%	4%	0%	0%	0%
	0%	0%	8%	3%	3%
	96%	96%	92%	97%	97%



III.5.2 Risk Management, Message from Roger Neate, Statutory Director of EM Safety Program

While we continue to see incidents on escalators and moving walks, they are for the most part not serious, as indicated by TSSA's predictive model of 0.07 FE/mpy. Regardless, there are incidents and TSSA will continue to promote safe behaviour on escalators through the distribution of the public safety videos we produced last year.

Compliance related to escalators and moving walks continues to be an issue. The work described earlier in the elevator section of this report also applies to escalators and moving walks.

III.6 Passenger Ropeways (Ski Lifts)

State of Public Safety in Ontario –

SKI LIFTS SAFETY PROGRAM AREA



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

Top Safety Issues	
Equipment	Issues
Chairlifts Bar Lifts	Falls Physical Impacts Entanglements



Inventory Risk Profile (2018)	
High Risk	0%
Medium Risk	3%
Low Risk	97%

Compliance Rate (2014 – 2018)	
	51%

Health Impact		
Observed		Potential
0.01 FE/mpy (2008 – 2018) Injury Burden	0.00 FE/mpy (2018) Injury Burden	0.02 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incident & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	958	776	26	0
2018	87	64	2	0

The TSSA Passenger Ropeways (Ski Lifts or SL) Safety Program Area regulates the following devices: chair lifts, bar lifts, recreational conveyors, gondola lifts, reversible ropeways, passenger ropeways, rope tows, tube tows, belt tows, and aerial tramways. TSSA also reviews and registers lift designs, licenses lift devices, conducts inspections, performs incident investigations and delivers public awareness campaigns throughout Ontario. See Appendix F for a listing of current legislation and regulatory information.

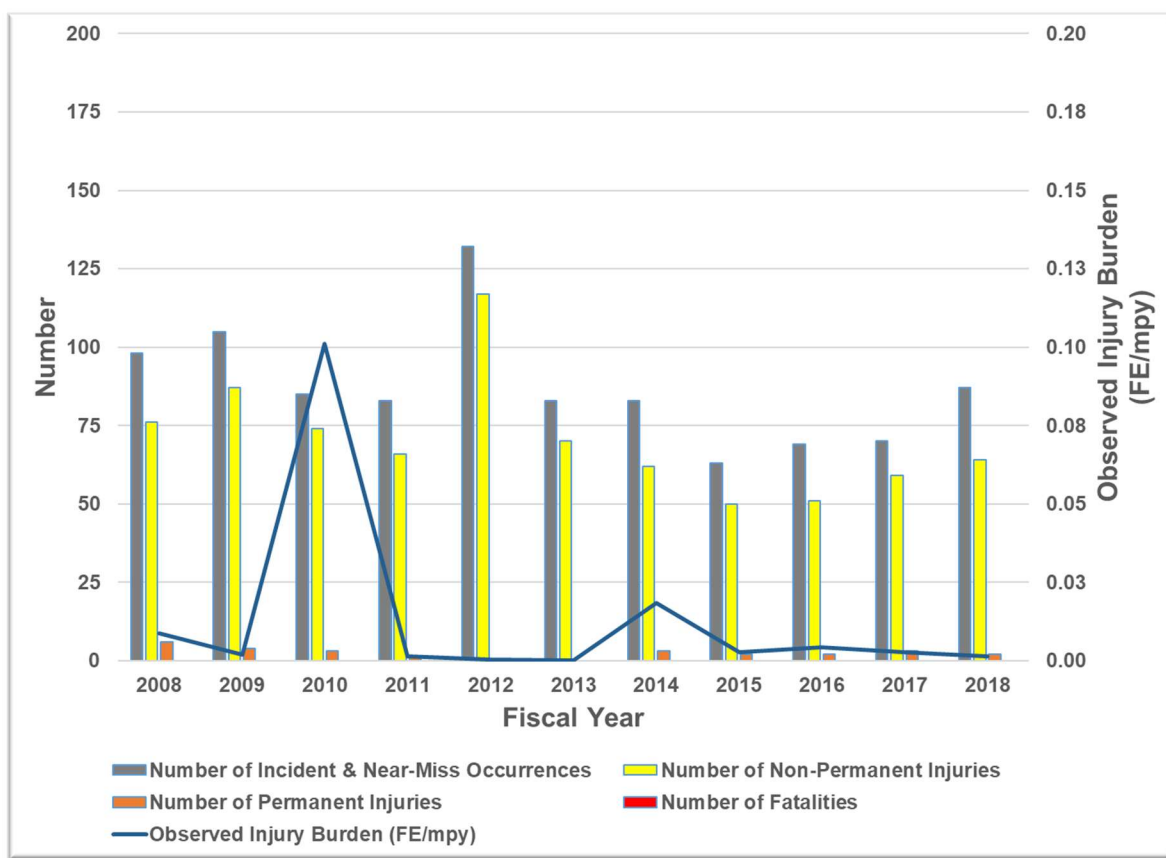


III.6.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 958 incident and near-miss occurrences, resulting in 776 non-permanent injuries, 26 permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). 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 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 5.40 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.01 FE/mpy. The observed injury burden for 2018 was approximately 0.00 FE/mpy.

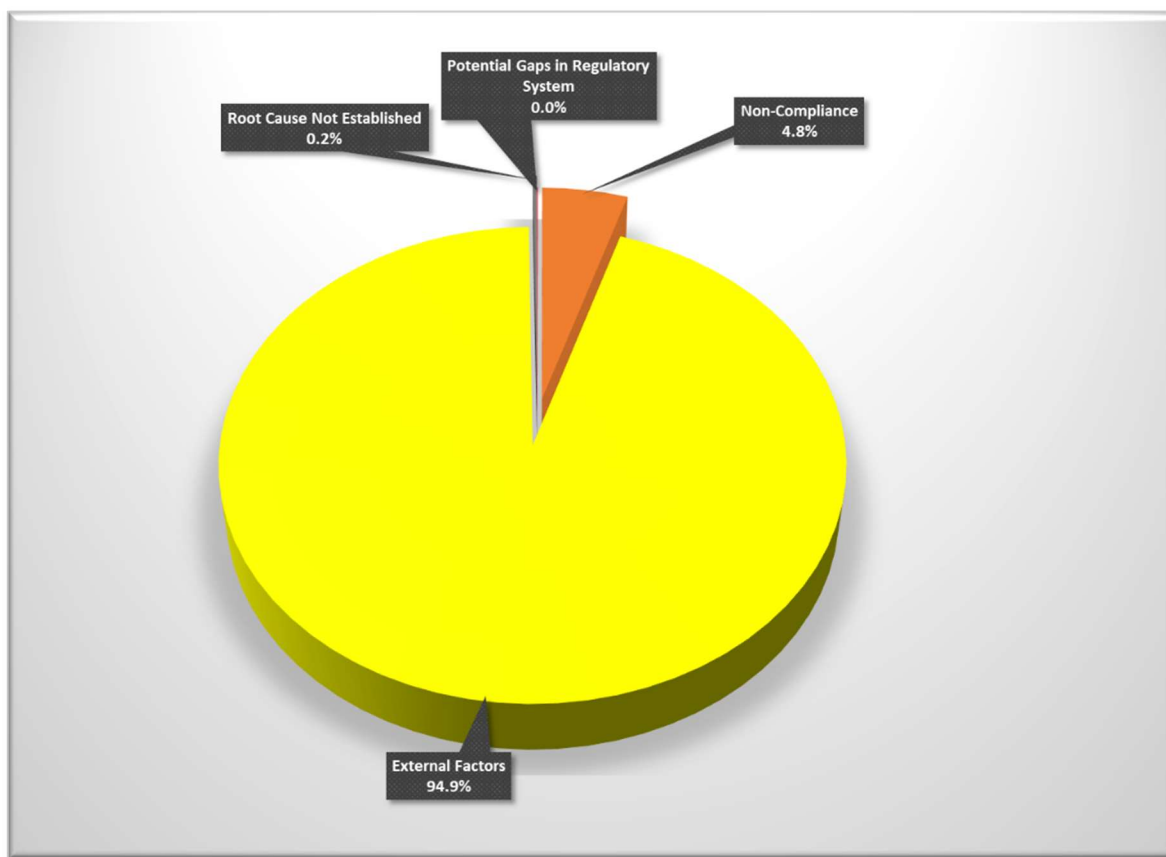
Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians using ski lifts to be 0.02 FE/mpy¹⁹.

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 casual analysis categories. As indicated in the pie chart, approximately 95% of the risk caused over the past eleven years (2008 – 2018) was due to factors external to the regulatory environment.

¹⁹ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 0.09 FE/mpy respectively.

Figure SL-2: Risk of injury or fatality in ski lifts by causal analysis category (2008 - 2018).



Risk of Injury or Fatality on Ski Lifts Due to Human Factors (2010 – 2018)²⁰

Human factors accounted for 99.7% of external-factor incident and near-miss occurrences. The most significant issues on ski lifts have been summarized below.

Falls

Falls accounted for 48% of human factor occurrences and 79% of the associated observed health impact.

Chairlifts accounted for 79% of fall occurrences and almost 100% of the associated observed health impact. Nearly 70% of chairlift occurrences took place in the loading or unloading area of the chairlift. Though 17% of the occurrences that took place on chairlifts involved falling from the chair while in transit, they represented 97% of the associated observed health impact. Riders experienced leg injuries in 31% of chairlift occurrences and head injuries in 17% of chairlift occurrences.

Bar lifts accounted for 11% of fall occurrences, and 0.1% of the associated observed health impact. Of these, 42% of fall occurrences on bar lifts took place on the bar area of the bar lift and 34% of the associated observed health impact. Riders experienced head injuries in 63% of bar lift occurrences.

Physical Impacts

Physical impact occurrences accounted for 30% of human factor occurrences and 6% of the associated observed health impact.

²⁰ The information is not available for 2008 – 2009. Hence, the analysis only reflects the period of 2010 – 2018.



Chairlifts accounted for 70% of these occurrences, and 98% of the associated observed health impact. Additionally, 60% of physical impact occurrences on chairlifts took place on the loading and/or the unloading areas of the chairlift ride and represented 52% of the associated observed health impact on chairlifts. Moreover, 22% involved impact with the restraining bar, representing 30% of the associated observed health impact on chairlifts. Riders experienced head injuries in 41% of chairlift occurrences, and leg injuries in 20% of chairlift occurrences.

Bar lifts accounted for 24% of these occurrences, and 1% of the associated observed health impact. Moreover, 75% of occurrences on bar lifts involved impact with the bar itself and represented 68% of the associated observed health impact. Riders experienced head injuries in 76% of related bar lift occurrences.

Entanglements

Entanglement occurrences accounted for 9% of human factor occurrences and 4% of the associated observed health impact.

Chairlifts accounted for 87% of these occurrences and 89% of the associated observed health impact. Furthermore, 56% of occurrences on chairlifts took place on the loading and/or the unloading areas of the chairlift ride, representing 53% of the observed health impact on chairlifts. Riders experienced leg injuries in 69% of these occurrences.

Compliance

TSSA conducts periodic inspections of all ski lifts using a risk-based approach to oversee and manage the state of compliance across 254 ski lifts in the province of Ontario. TSSA deals with non-compliances by requiring the owner/operator 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 239 devices that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 51%, with no demonstrable trend. The top compliance issues that were identified through periodic inspections are shown in Table SL-1.

Table SL-1: Top compliance issues for ski lifts (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Sheave assembly alignment to be corrected.	2%
Elevating device to be removed from service.	2%
Log book required for each elevating device and to be kept up to date.	2%
Gap between belt guides to be reduced to avoid pinching or catching hazards.	2%
All applicable signs to be posted.	1%

Figures SL-3 and SL-4 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 3% to 8% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

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 2018, there were no high-risk devices in the qualified provincial inventory and only six medium-risk devices, consisting of chairlifts and bar lifts. Chairlifts represented 49% while bar lifts represented 15% of the qualified provincial inventory respectively.



Figure SL-3: Inspection risk spectrums from outcomes of periodic inspections conducted on ski lifts (2014 – 2018).

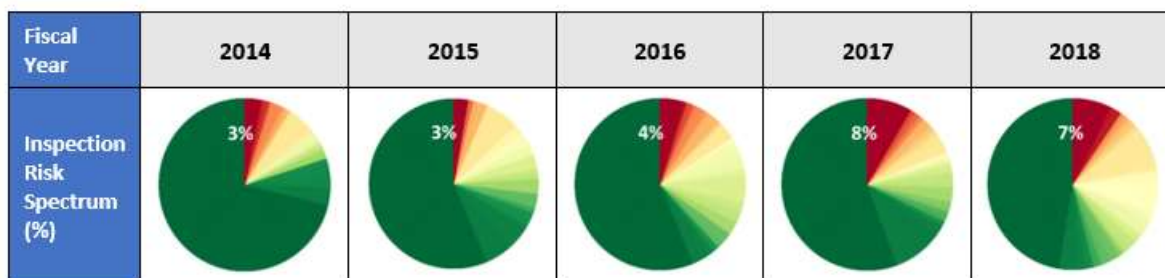


Figure SL-4: Inventory risk profiles from outcomes of periodic inspections conducted on ski lifts (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	0.4%	0.4%	8%	0%	0%
	6%	0.4%	32%	6%	3%
	94%	99%	61%	94%	97%

III.6.2 Risk Management, Message from Roger Neate, Statutory Director of SL Safety Program

The overall state of safety related to passenger ropeways continues to be positive with a risk of injury or fatality of only 0.02 FE/mpy. Historically incidents that have occurred are related to human factors. As such this past year, we worked in partnership with both the Canadian Ski Instructors Alliance and Parachute Canada to produce two videos to educate skiers and snowboarders on how to safely ride passenger ropeways.

Over the coming year, we will continue to leverage the materials we produced with both organizations and the ski industry broadly to get the messages out to new and experienced passenger ropeways users. This ski season we will be rolling out updated passenger ropeways signage which were prepared in partnership with the Ontario Snow Resorts Association this past year. This signage will have a more modern and appealing look that we hope will resonate with today's skiers.

III.7 Fuels Safety

State of Public Safety in Ontario –

FUELS SAFETY PROGRAM



Facilities	Program Area Activities	Fuels Lifecycle	Regulated Fuels
4,220 Liquid Fuels	- 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	Transmission, Distribution and Transportation	- Natural gas - Propane - Butane - Hydrogen - Digester gas - Landfill gas - Liquid fuels (fuel oil, gasoline, diesel)
1,346 Propane		Storage and Dispensing	
		Utilization (burning)	

Top Safety Issues (2018)			
Actionable Areas		Enhanced Monitoring Areas	
CO Risks in Apartments & Condominiums	5.32 FE/mpy	Fuel Risks in Retirement and Long-Term Care Homes	0.26 FE/mpy
Fuel Risks in Private Dwellings	3.73 FE/mpy	Fuel Risks in Business Units	0.73 FE/mpy
Fuel Risks in Schools	0.56 FE/mpy	Fuel-related Fire Risks in Food Service Locations	0.61 FE/mpy



Propane Inventory Risk Profile (2018)	
High Risk	5%
Medium Risk	12%
Low Risk	82%

Propane Compliance Rate (2014 – 2018)	
	74%



Liquid Fuels Inventory Risk Profile (2018)	
High Risk	2%
Medium Risk	14%
Low Risk	84%

Liquid Fuels Compliance Rate (2014 – 2018)	
	42%

Health Impact		
Observed	Potential	
0.33 FE/mpy (2008 – 2018) Injury Burden	0.07 FE/mpy (2018) Injury Burden	1.89 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2008 – 2018	7,880*	521	152	48
2018	589*	26	10	0

* Excludes occurrences related to low-health impact (ie, pipeline strikes, leaks and spills); a complete tabulation is contained in Appendix A.

TSSA's Fuels Safety (FS) 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. We also review and approve 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 F for a listing of current legislation and regulatory information.

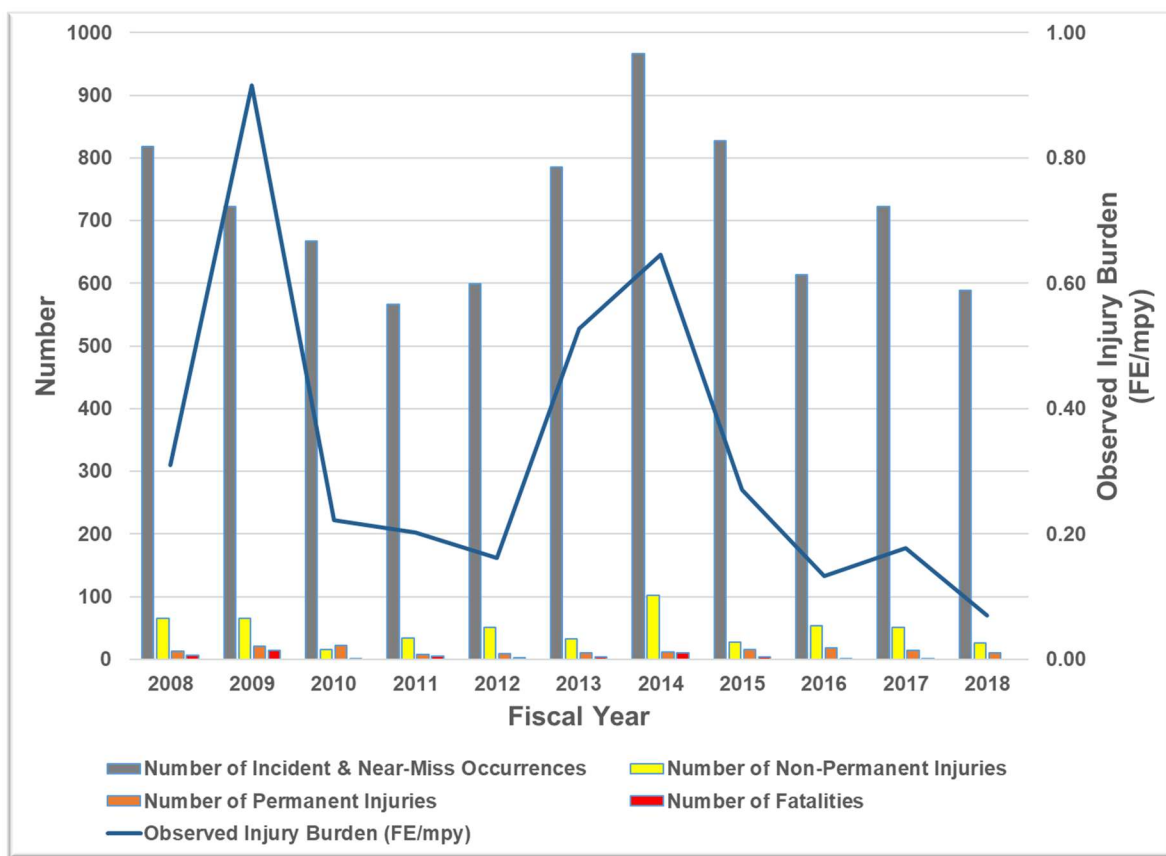


III.7.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

There have been 7,880 incident and near-miss occurrences, resulting in 521 non-permanent injuries, 152 permanent injuries and 48 fatalities reported over the past eleven years (2008 – 2018). Measures representing the overall state of safety are represented graphically in Figure FS-1 and tabulated in Appendix A.

Figure FS-1: State of safety across fuels safety (2008 – 2018).



Based on the actual injuries observed over the past eleven years (2008 – 2018), the average rate of injury was 4.53 injuries/million people/year. Using TSSA's approach of integrating injuries and fatalities, this corresponded to an 11-year average injury burden of 0.33 FE/mpy. The observed injury burden for 2018 was 0.07 FE/mpy.

Based on all the occurrences over the past eleven years (2008 – 2018), TSSA's predictive model estimated the potential RIF to Ontarians using fuel-fired appliances to be 1.89 FE/mpy²¹.

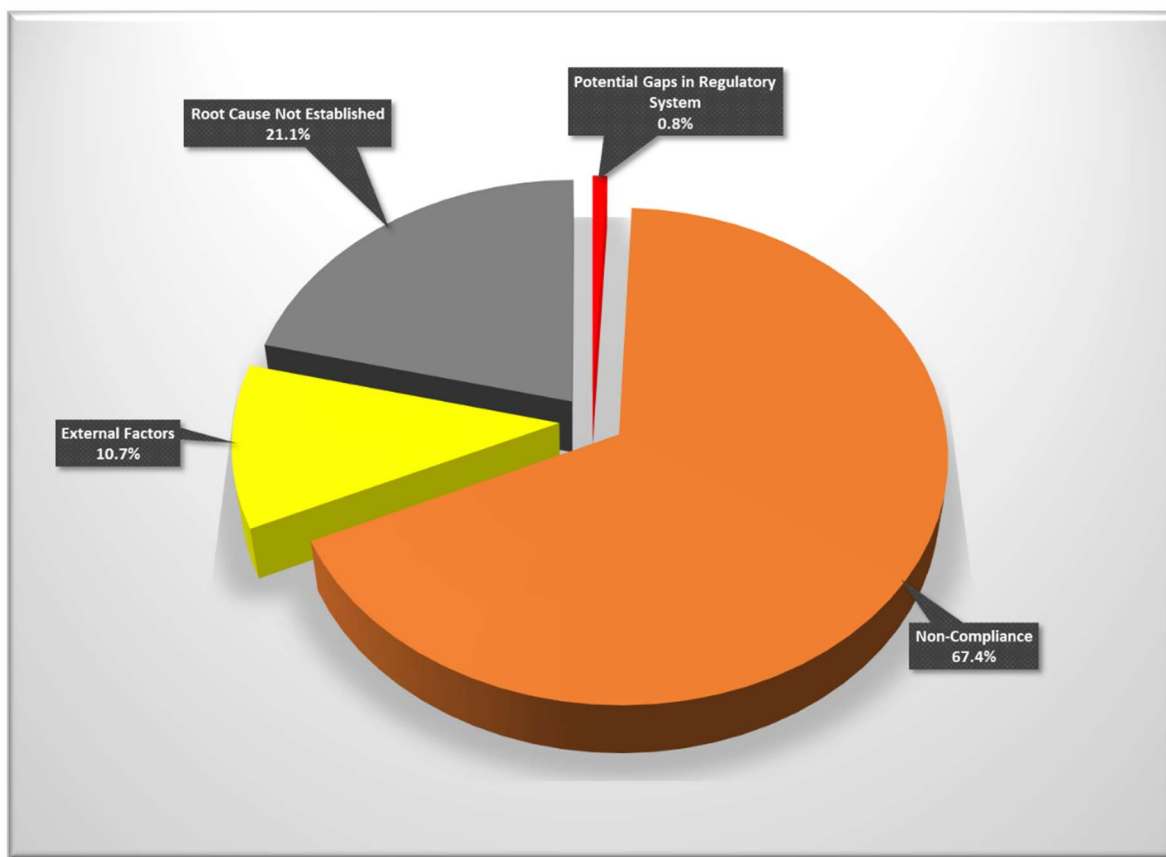
There were no demonstrable trends in the number of occurrences, non-permanent injuries or permanent injuries.

As indicated in the pie chart in Figure FS-2, the risk of injury or fatality attributed to non-compliance with regulatory requirements accounted for approximately 67% of the overall level of risk in the Fuels program. There was no demonstrable trend in the number of related occurrences.

²¹ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 10.82 FE/mpy respectively.



**Figure FS-2: Risk of injury or fatality in fuels
by casual analysis category (2008 - 2018).**



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 25,356 pipeline strike occurrences reported over the past eleven years (2008 - 2018), with no demonstrable trend. Historical data is tabulated in Appendix A.

Actionable Areas

There were three actionable areas identified in FS:

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 179 CO incident and near-miss occurrences, resulting in 13 non-permanent injuries, zero permanent injuries and one fatality reported over the past eleven years (2008 - 2018). 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 to be 5.32 FE/mpy²², 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 – 2018).

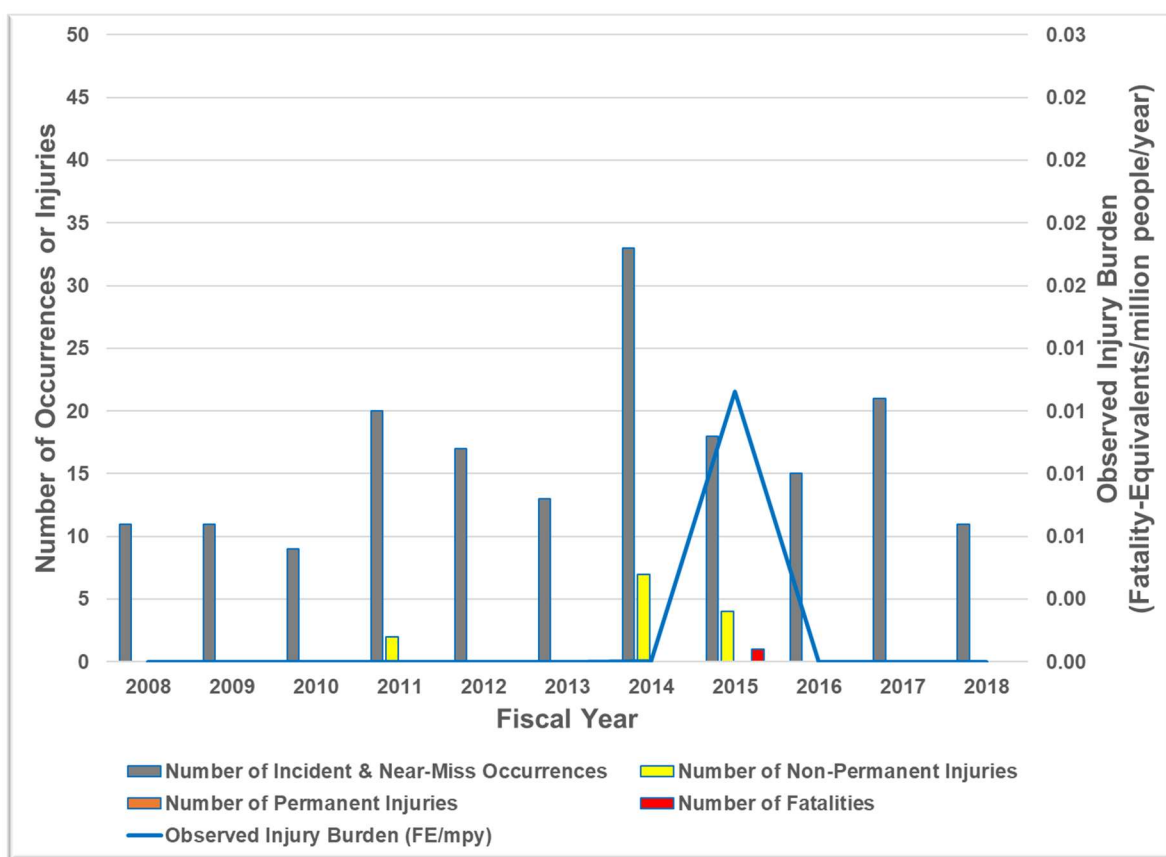


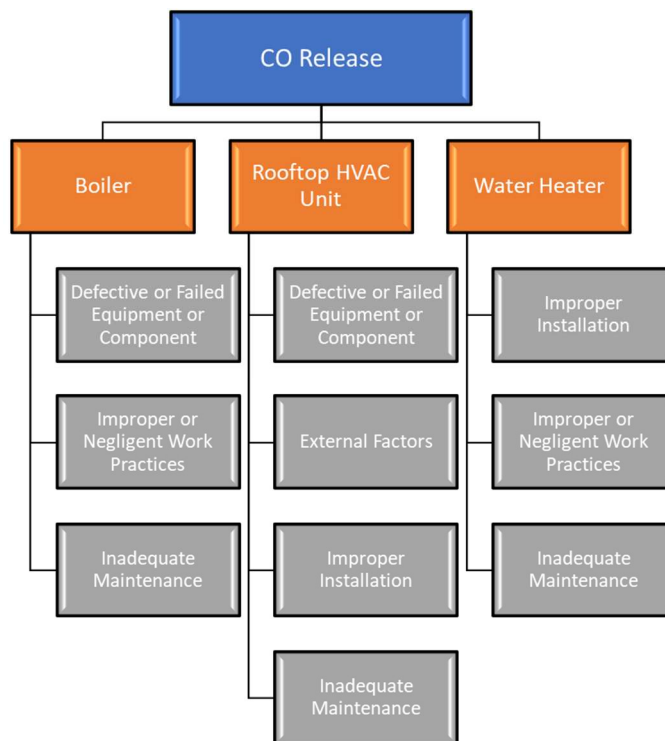
Figure FS-4 illustrates the contributing causes related to CO release in apartments and condominiums. Occurrences involving boilers, rooftop heating ventilation and air conditioning (HVAC) units and water heaters represented 42%, 15% and 9% of CO occurrences in apartments respectively.

Boiler occurrences were due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Rooftop HVAC unit occurrences were due to defective or failed equipment or component, external factors, improper installation, and inadequate maintenance. Water heater occurrences were due to improper installation, improper or negligent work practices, and inadequate maintenance.

There continue to be reports of incidents mainly associated with natural gas-fired natural draft boilers in residences, which accounted for 46% of boiler occurrences.

²² Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 1.66 and 9.80 FE/mpy respectively.

Figure FS-4: Contributing causes of CO release safety issues in apartments and condominiums (2008 – 2018).



2. Fuel Risks in Private Dwellings

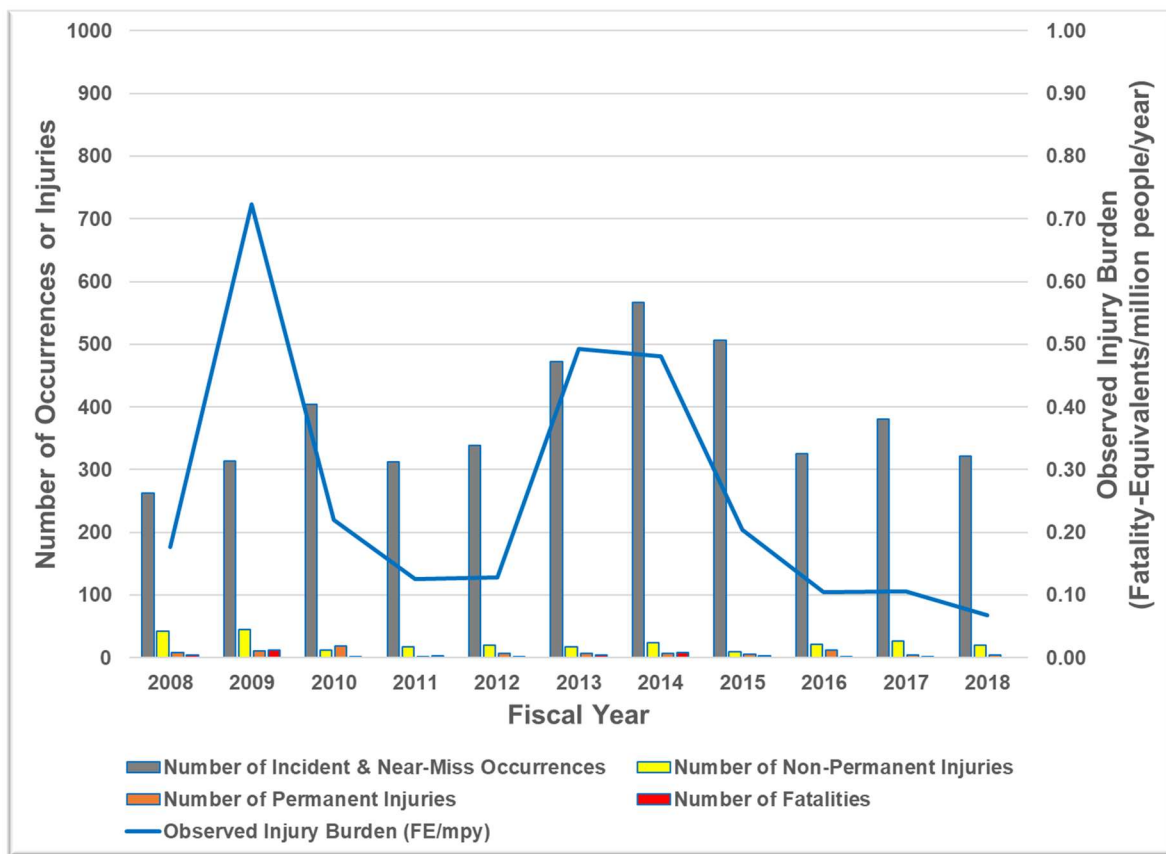
Private dwellings are residential locations which, for the purposes of this report, include detached and semi-detached houses, duplexes and townhouses. In addition, TSSA is monitoring other configurations of residences to better understand their fuel-related risks.

There have been 4,206 incident and near-miss occurrences, resulting in 258 non-permanent injuries, 88 permanent injuries and 40 fatalities reported over the past eleven years (2008 – 2018). These occurrences resulted in CO release, fire, explosion and/or vapour release. 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 to be 3.73 FE/mpy²³. Fuel risks at private dwellings continue to demonstrate an actionable level of risk.

²³ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.71 and 10.29 FE/mpy respectively.

Figure FS-5: State of safety of fuel risks in private dwellings (2008 – 2018).



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 Release

The largest source of risk at private dwellings continues to be related to CO release and was estimated to be 9.21 FE/mpy²⁴. The associated risk continued to be well above the TSSA acceptance criterion of 1.00 FE/mpy. Additionally, CO release occurrences accounted for 45% of all private dwelling occurrences over the last eleven years (2008 – 2018) and have resulted in 20 fatalities and 235 injuries during this period. There was a 4% per year increasing trend in the number of these occurrences.

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

Boiler (particularly natural gas-fired natural draft boilers) occurrences were due to improper or negligent work practices, and inadequate maintenance.

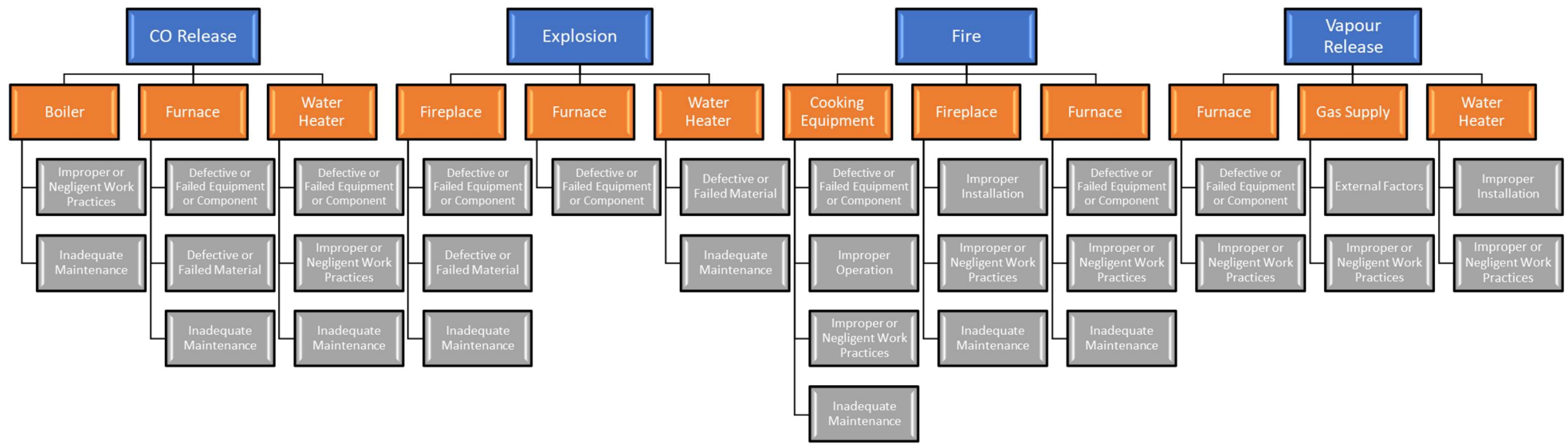
Furnace occurrences were due to defective or failed equipment or component, defective or failed material, and inadequate maintenance. Examples included blocked, cracked or failed heat exchangers in furnaces.

Water heater occurrences were due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Several of these occurrences involved venting and/or chimneys.

²⁴ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 7.15 and 11.37 FE/mpy respectively.



Figure FS-6: Contributing causes of fuel-related safety issues in private dwellings (2008 - 2018).





Fires

The risk at private dwellings due to fuel-related fire was 2.97 FE/mpy²⁵. The associated risk continued to exceed the TSSA acceptance criterion of 1.00 FE/mpy. Additionally, fires in private dwellings accounted for 21% of all occurrences, resulting in 10 fatalities and 41 injuries over the last eleven years (2008 – 2018). 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 cooking equipment, fireplaces and furnaces.

Cooking equipment occurrences included BBQs and stoves and were due to defective or failed component or equipment, improper operation, improper or negligent work practices, and inadequate maintenance. Examples included BBQ fires, grease fires in ovens, and unattended cooking equipment.

Fireplace occurrences were due to improper installation, improper or negligent work practices, and inadequate maintenance. An example of occurrences involving improper or negligent work practices was damaged venting or chimneys.

Furnace occurrences were due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Examples included circuit or control board components and fires inside the furnace.

Explosions

The risk at private dwellings due to explosions was 1.76 FE/mpy²⁶. The associated risk continued to exceed the TSSA acceptance criterion of 1.00 FE/mpy. Additionally, explosions in private dwellings accounted for 5% of all occurrences and resulted in 63 injuries and seven fatalities over the last eleven years (2008 – 2018). There is 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 due to defective or failed equipment or component, defective or failed material, and inadequate maintenance. Some of these occurrences involved shattered glass. Occurrences involving furnaces were due to defective or failed equipment or component. Occurrences involving water heaters were due to defective or failed material, and inadequate maintenance.

Vapour Release

The risk at private dwellings due to vapour release was 0.99 FE/mpy²⁷, which is slightly below the TSSA acceptance criterion of 1.00 FE/mpy. Vapour releases in private dwellings accounted for 28% of all occurrences and resulted in seven injuries and three fatalities over the last eleven years (2008 – 2018). 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 supply and water heaters.

Occurrences involving furnaces were due to defective or failed equipment or component, and improper or negligent work practices. Occurrences involving the gas supply were due to external factors, and improper or negligent work practices. Occurrences involving water heaters were due to improper installation, and improper or negligent work practices.

²⁵ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 2.04 and 4.02 FE/mpy respectively.

²⁶ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.89 and 2.78 FE/mpy respectively.

²⁷ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.53 and 1.51 FE/mpy respectively.

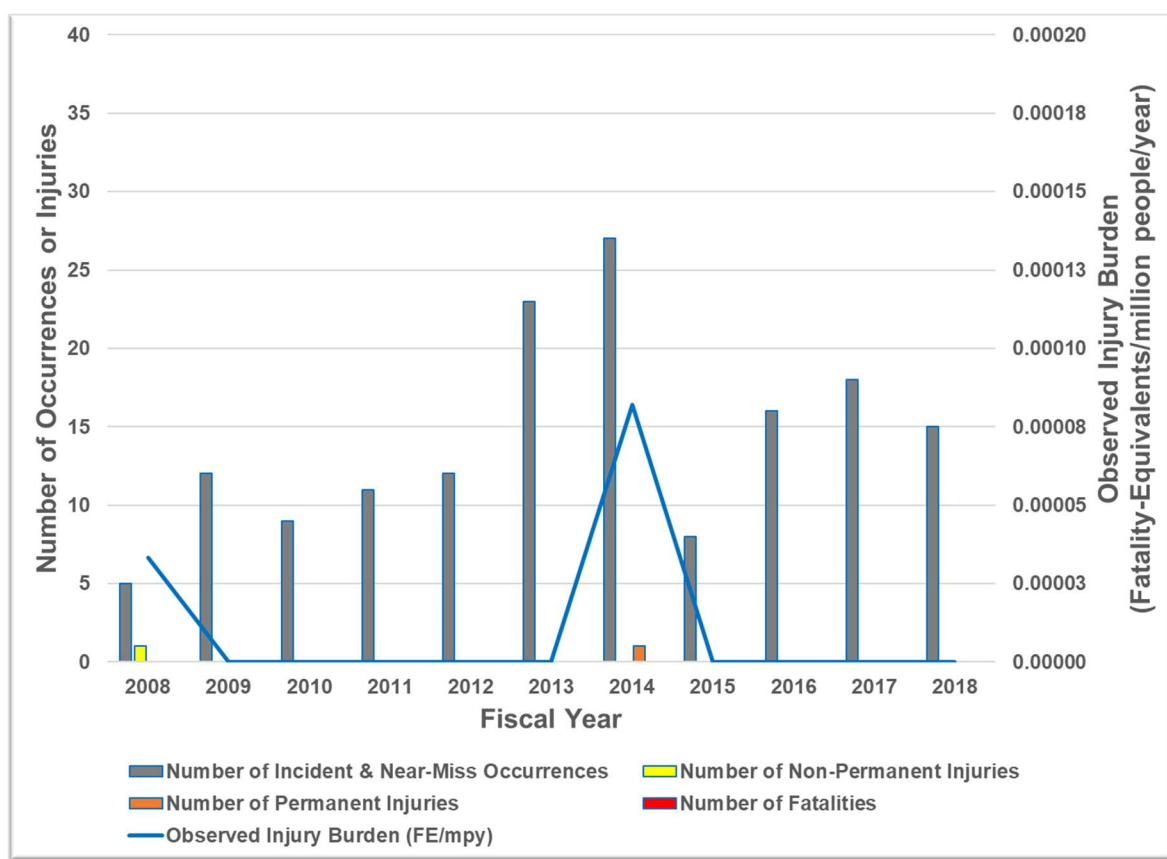


3. Fuel Risks in Schools

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

There have been 156 incident and near-miss occurrences, resulting in one non-permanent injury, one permanent injury and zero fatalities reported over the past eleven years (2008 – 2018). There is an 6% increasing trend in the number of occurrences in 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 – 2018).



TSSA's predictive model estimated the potential RIF to Ontarians to be 0.56 FE/mpy²⁸. 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 given an emergency.

Though vapour release occurrences were observed most often, making up 56% 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 release in schools involved boilers, and were primarily caused due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Historical occurrences and similar issues with boilers in other locations (i.e., residences, commercial locations, etc.) also substantiate this finding.

²⁸ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 2.09 FE/mpy respectively.



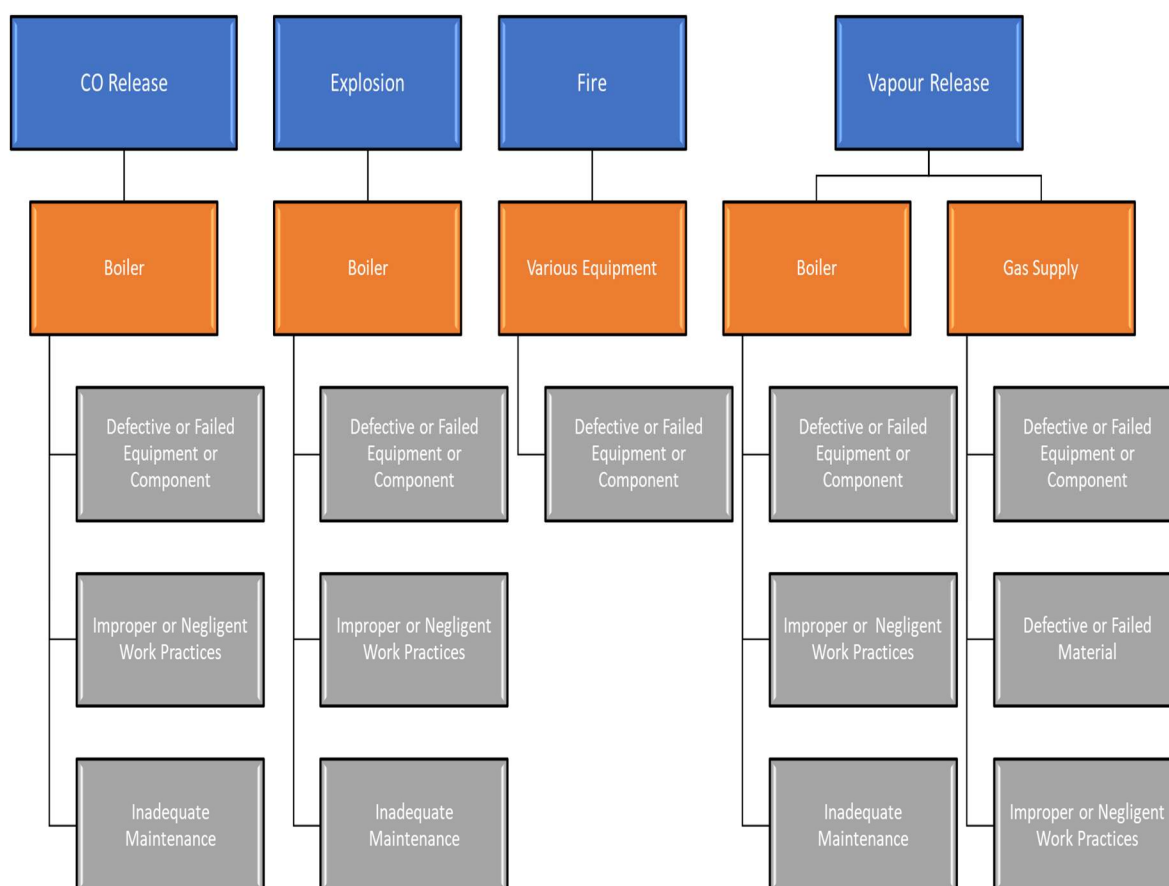
As indicated in Figure FS-8, occurrences resulting in vapour release in schools involved boilers and gas supply equipment. Boiler issues were due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Gas supply issues were due to defective or failed equipment or component, defective or failed material, and improper or negligent work practices.

As indicated in Figure FS-8, occurrences resulting in fire involved a wide variety of defective or failed equipment or component.

As indicated in Figure FS-8, occurrences resulting in explosions involved boiler technology failing due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance. Most of these occurrences involved delayed ignitions.

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: Contributing causes of fuel-related safety issues in schools (2008 – 2018).



Enhanced Monitoring Areas

There were three enhanced monitoring areas identified in FS:

1. Fuel Risks in Retirement and Long-Term Care Homes;
2. Fuel Risks in Business Units; and
3. Fuel-Related Fire Risks in Food Service Locations.



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.

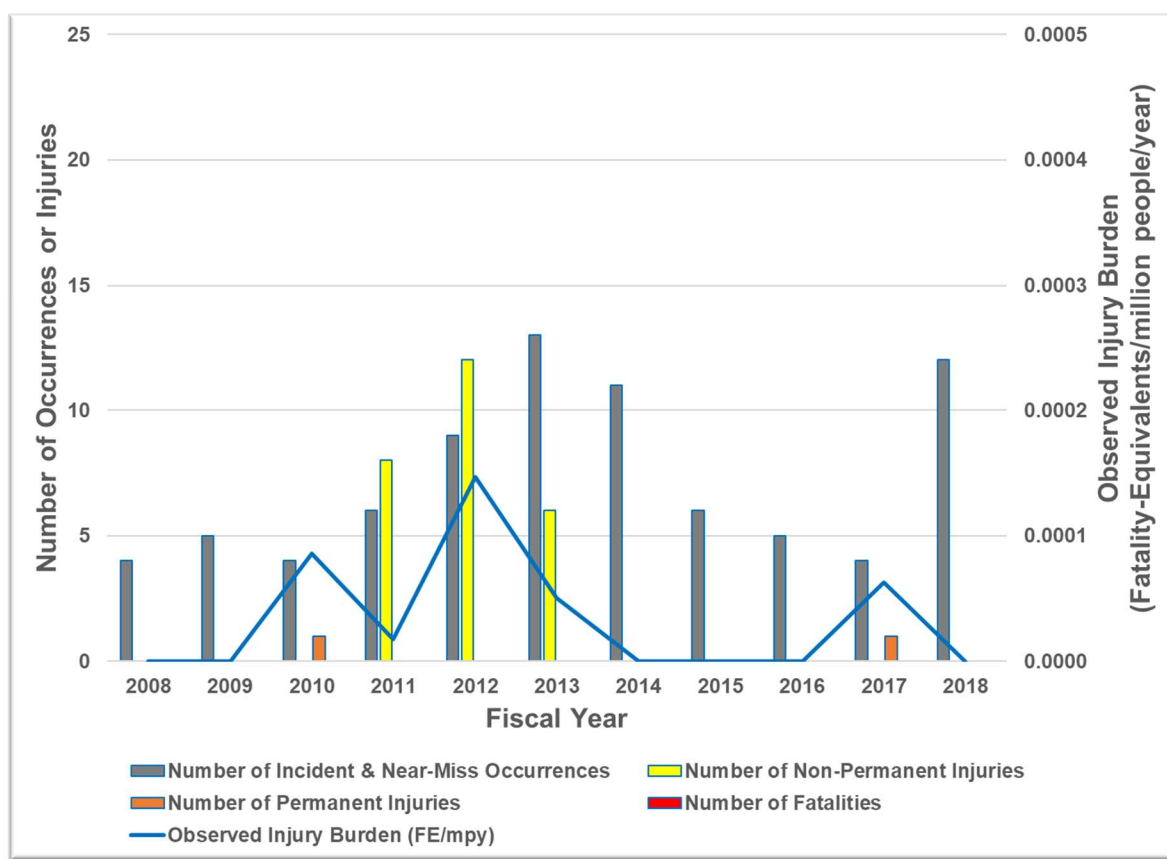
1. Fuel Risks in Retirement and Long-Term Care Homes

These locations include retirement homes and long-term care (or nursing) homes. They exclude hospitals.

There have been 79 incident and near-miss occurrences, resulting in 26 non-permanent injuries, 2 permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). There was no demonstrable trend in the number of occurrences in these locations. Measures representing these observations are represented in Figure FS-9 and are tabulated in Appendix A.

TSSA's predictive model estimated the potential RIF to Ontarians to be 0.26 FE/mpy²⁹. This was close to the acceptability criterion of 0.30 FE/mpy for sensitive sub-populations, thus it is an issue that requires monitoring.

Figure FS-9: State of safety of fuel risks in retirement and long-term care homes (2008 – 2018).

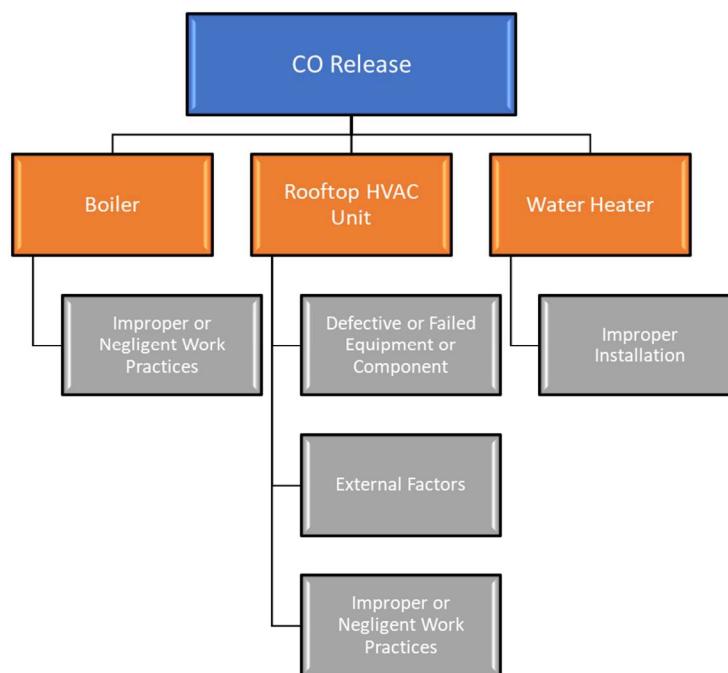


CO release occurrences accounted for 54% of occurrences at these locations, representing a risk of injury or fatality of 0.69 FE/mpy³⁰. As shown in Figure FS-10, these occurrences were primarily caused by boilers, rooftop HVAC units and water heaters. Boiler issues were mainly due to improper or negligent work practices. Rooftop HVAC unit issues were due to defective or failed equipment or component, external factors, and improper or negligent work practices. Water heater issues were mainly due to improper installation.

²⁹ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 1.23 FE/mpy respectively.

³⁰ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 1.97 FE/mpy respectively.

Figure FS-10: Contributing causes of CO release safety issues in retirement and long-term care homes (2008 – 2018).



2. 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 509 incident and near-miss occurrences, resulting in 36 non-permanent injuries, four permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). There was a 3% increasing trend in the number of occurrences at these locations. Measures representing these historical observations are shown in Figure FS-11 and have been detailed in Appendix A.

TSSA's predictive model estimated the potential RIF to Ontarians to be 0.73 FE/mpy³¹, thus representing an issue that requires monitoring.

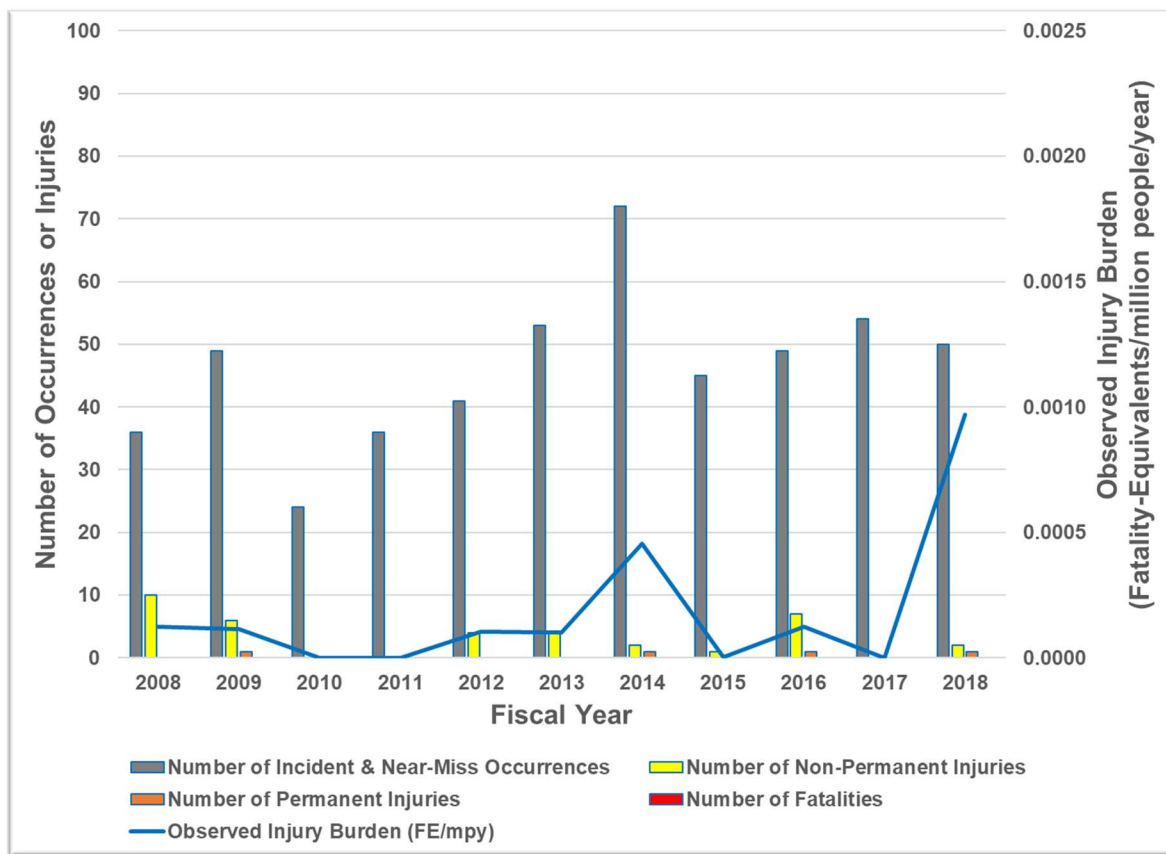
Upstream occurrences (i.e., outside of the commercial establishment on fuel distributor meters and service lines) accounted for 48% of fuel-related occurrences at business units. There was an increasing trend in the number of these occurrences of 7% per year. These occurrences involved gas supply equipment, such as piping, pipelines and regulators and resulted in vapour release. As indicated in Figure FS-12, non-vehicle upstream occurrences occurred due to defective or failed material, and improper or negligent work practices.

Vehicles colliding with gas supply equipment accounted for 52% of upstream occurrences. There was an increasing trend in the number of these occurrences of 15% per year. These vehicles typically included passenger motor vehicles, snow removal equipment, construction equipment fork lifts and tow motors. As indicated in Figure FS-12, these upstream occurrences primarily occurred due to improper or negligent work practices.

³¹ Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.00 and 2.17 FE/mpy respectively.



Figure FS-11: State of safety of fuel risks in business units (2008 – 2018).



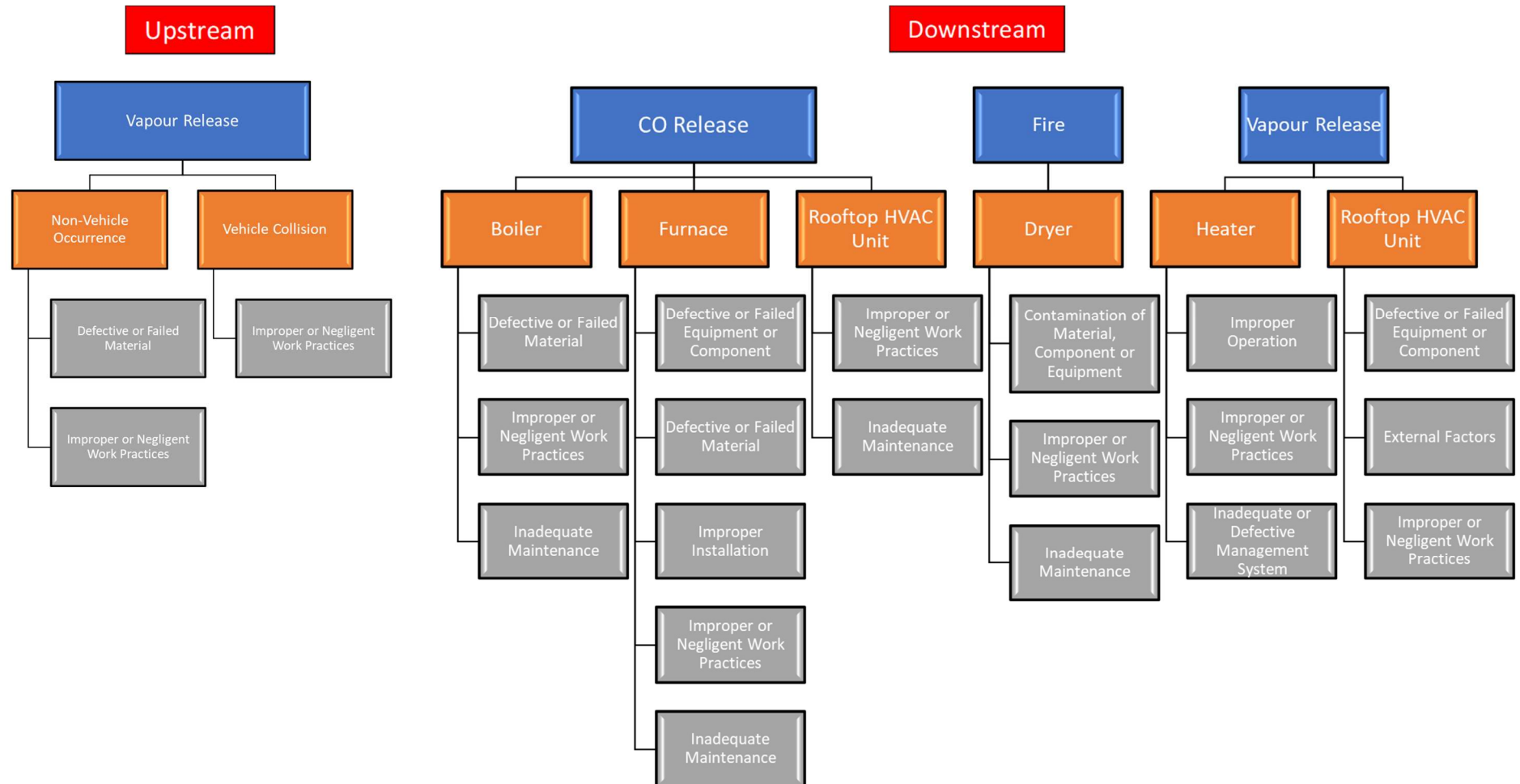
Downstream occurrences accounted for 52% of fuel-related occurrences at business units. The main issue was CO release. As indicated in Figure FS-12, these occurrences involved boilers, furnaces and rooftop HVAC units. Occurrences involving CO release from boilers were due to defective or failed material, improper or negligent work practices, and inadequate maintenance. Occurrences involving furnaces were caused by defective or failed equipment or component, defective or failed material, improper installation, improper or negligent work practices, and inadequate maintenance. Occurrences involving rooftop HVAC units were due to improper or negligent work practices, and inadequate maintenance.

As indicated in Figure FS-12, downstream fire occurrences in business units primarily involved dryers, due to contamination of material, component or equipment, improper or negligent work practices, and inadequate maintenance.

Downstream vapour release occurrences in business units primarily involved heaters and rooftop HVAC units. As indicated in Figure FS-12, occurrences involving heaters were due to improper operation, improper or negligent work practices, and inadequate or defective management systems. Occurrences involving rooftop HVAC units were due to defective or failed equipment or component, external factors, and improper or negligent work practices.



Figure FS-12: Contributing causes of fuel-related safety issues in business units (2008 – 2018).



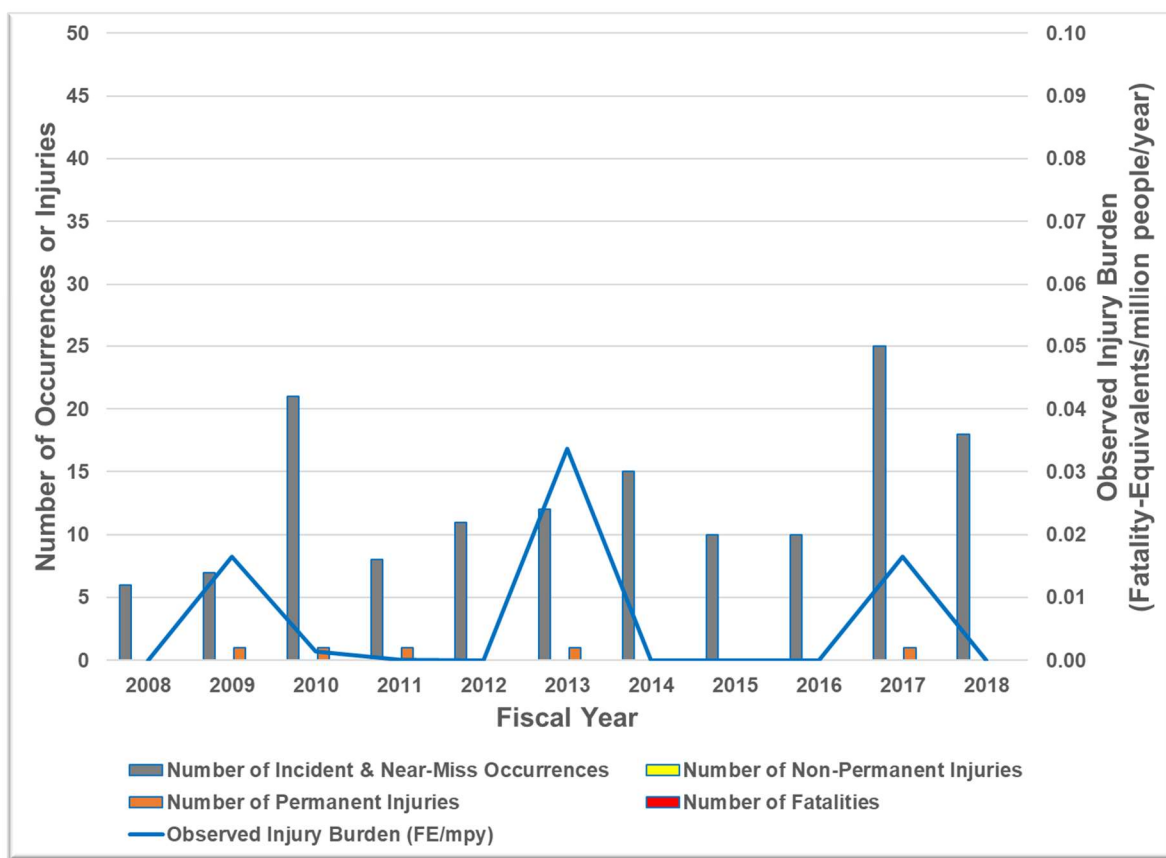


3. Fuel-Related Fire Risks in Food Service Locations

Food service locations include bakeries, pizzerias and restaurants.

There have been 143 incident and near-miss occurrences, resulting in zero non-permanent injuries, five permanent injuries and zero fatalities reported over the past eleven years (2008 – 2018). There was an increasing trend in the number of occurrences of 7% per year. Measures representing these historical observations are represented graphically in Figure FS-13 and tabulated in Appendix A.

Figure FS-13: State of safety of fuel-related fire risks in food service locations (2008 – 2018).



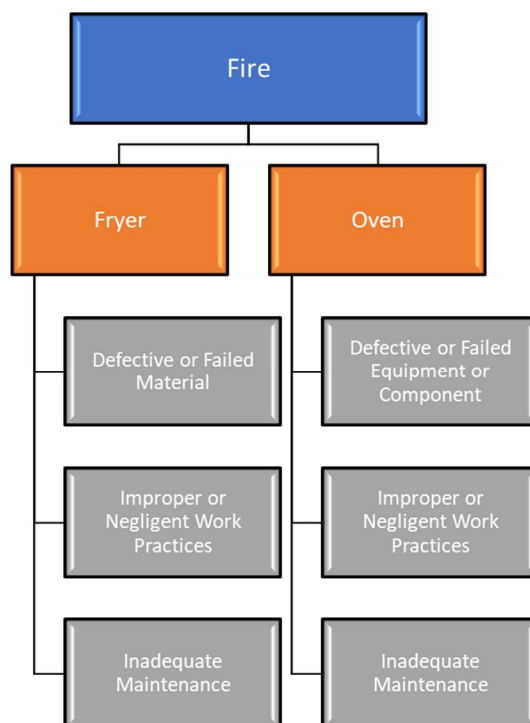
TSSA's predictive model estimated the potential RIF to Ontarians to be 0.61 FE/mpy³², thus representing an issue that requires monitoring.

Figure FS-14 illustrates the top issues related to fires involving fuel-burning appliances in food service locations in terms of their contributing causes.

Occurrences involving fryers and ovens respectively accounted for 20% and 13% of occurrences resulting in fires in food service locations. As indicated in Figure FS-14, fires from fryers were due to defective or failed material, improper or negligent work practices, and inadequate maintenance. Oven fires were mainly due to defective or failed equipment or component, improper or negligent work practices, and inadequate maintenance.

³² Represents expected estimate of a simulated distribution; 5th and 95th percentiles are 0.17 and 1.15 FE/mpy respectively.

Figure FS-14: Contributing causes of fuel-related fire safety issues in food service locations (2008 – 2018).



Compliance

Liquid Fuels Licensed 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 4,220 licensed sites in Ontario. There were 3,444 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 42%, with an increasing trend of 3% per year. The top compliance issues that were identified through periodic inspections are shown in Table FS-1.

Table FS-1: Top compliance issues for liquid fuels licenced sites (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Location to be maintained in a safe operating condition. Any defective equipment to be repaired or replaced.	17%
Equipment to be tested and monitored for leaks.	6%
Shear valves and leak detection systems to be maintained and tested at least once per year.	5%
Corrosion protection system for underground storage tank system to be tested at least every two years.	5%
Equipment to be installed per this Code and manufacturer's instructions and be appropriate for intended service.	4%



Figures FS-15 and FS-16 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 1% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

Figure FS-15: Inspection risk spectrums from outcomes of periodic inspections conducted at liquid fuels licenced sites (2014 – 2018).

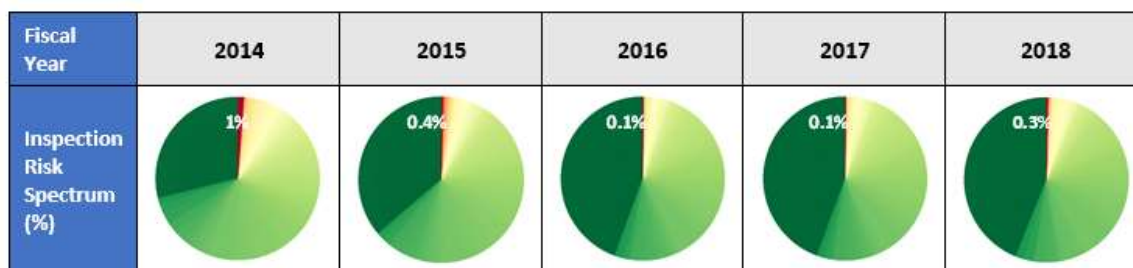


Figure FS-16: Inventory risk profiles from outcomes of periodic inspections conducted at liquid fuels licenced sites (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	N/A	N/A	14%	3%	2%
			12%	15%	14%
			74%	82%	84%

Using a risk-based approach, the inventory risk profile indicated that as of 2018, high-risk facilities accounted for 2% of the qualified provincial inventory. Out of high-risk facilities, 39% and 28% were self-serve and full-serve gas stations respectively. Self-serve and full-serve gas stations comprised 54% and 20% respectively of the entire qualified inventory.

Propane Licensed Sites

TSSA conducts periodic inspections of propane facilities to oversee and manage the state of compliance across 1,346 licensed sites in the province of Ontario. There were 1,078 facilities that had sufficient inspection history to calculate a risk score.

The median compliance rate observed over the past five years (2014 – 2018) was 74%, with no demonstrable trend. The top compliance issues that were identified through periodic inspections are shown in Table FS-2.

Table FS-2: Top compliance issues for propane licenced sites (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Readily ignitable materials to be removed.	10%
Piping and tubing exposed to corrosive atmospheres to be protected by either painting or coating.	6%
At least one portable fire extinguisher to be readily accessible.	5%
Every steel tank to be kept painted.	4%
Equipment to be maintained in safe operating condition.	4%



Figures FS-17 and FS-18 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% to 3% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

A regulatory change made in 2014 removed annual inspection requirements for these facilities. These facilities are now inspected using a risk-based approach. TSSA successfully implemented a risk-based inspection scheduling process for propane storage and dispensing facilities that has received broad stakeholder support and acceptance. This process has helped TSSA focus its inspection efforts based on risk, while providing incentives to industry with better compliance records.

Figure FS-17: Inspection risk spectrum from outcomes of periodic inspections conducted at propane licenced sites (2014 – 2018).

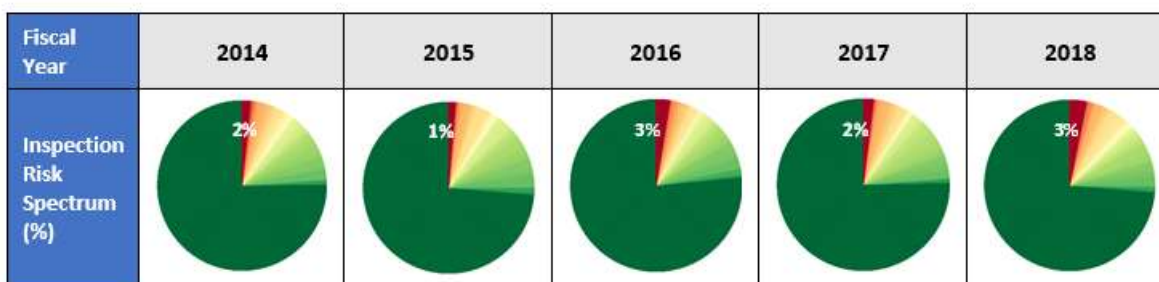


Figure FS-18: Inventory risk profiles from outcomes of periodic inspections conducted at propane licenced sites (2014 – 2018).

Fiscal Year	2014	2015	2016	2017	2018
Inventory Risk Profile	15%	12%	5%	8%	5%
	5%	8%	17%	13%	12%
	80%	80%	78%	79%	82%

Using a risk-based approach, the RBS profile indicated that as of 2018, high-risk facilities accounted for 5% of the qualified provincial inventory. Nearly 83% of all high-risk facilities were cylinder filling stations. Cylinder filling stations comprised 82% of the entire qualified provincial inventory.

Fuels Contractors

Heating Contractors

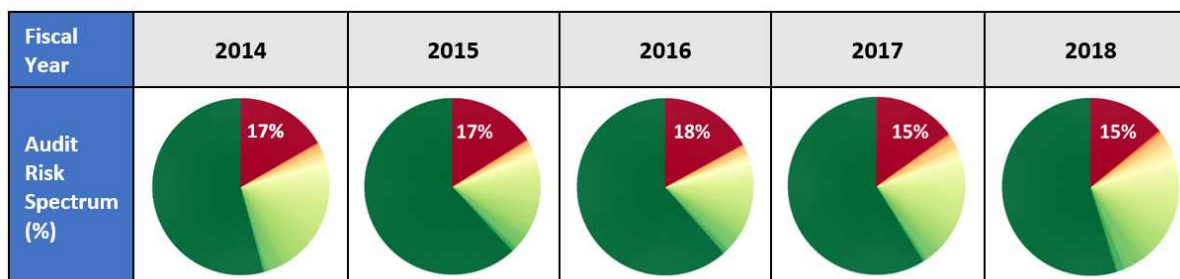
TSSA conducts periodic audits on heating contractors in the province of Ontario to oversee and manage their state of compliance. The median compliance rate observed was 55% over the last five years (2014 – 2018), with no demonstrable trend. The top compliance issues that were identified in these periodic audits are shown in Table FS-3.

Table FS-3: Top compliance issues for heating contractors (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Unacceptable condition - no immediate hazard.	21%
Equipment to be installed per manufacturer's instructions and this Code.	9%
Every person to comply with the Act and Regulation.	8%
All interior metal gas piping and tubing to be made electrically continuous and bonded.	4%
Tag to be attached to equipment after pressure or leak test.	4%

Figure FS-19 provides information on key indicators associated with the results of periodic audits. While the compliance rate provides an outcome of the periodic 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 15% to 18% of all audits conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

Figure FS-19: Audit risk spectrum from outcomes of periodic audits conducted on heating contractors (2014 – 2018).



Petroleum Contractors

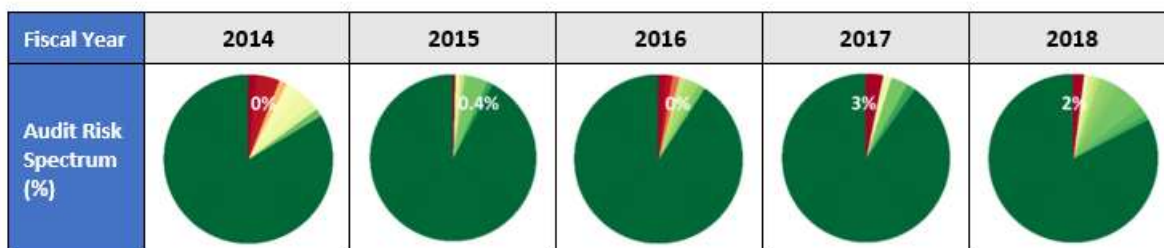
TSSA conducts periodic audits on petroleum contractors in the province of Ontario to oversee and manage their state of compliance. The median compliance rate observed was 93% over the last five years (2014 – 2018), with no demonstrable trend. The top compliance issues that were identified in these periodic audits are shown in Table FS-4.

Table FS-4: Top compliance issues for petroleum contractors (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
All vehicles to be clearly marked with name and registration number from contractor's registration certificate.	12%
Tank to be supported on supports or concrete pad to allow for bottom to be inspected.	8%
Equipment to be installed per this Code, manufacturer's instructions and to be appropriate for intended service.	7%
Installed signage to be visible.	6%
Tank supports to be non-combustible.	5%

Figure FS-20 provides information on key indicators associated with the results of periodic audits. While the compliance rate provides an outcome of the periodic 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% to 3% of all inspections conducted in each of the past five years (2014 – 2018) posed unacceptable levels of risk.

Figure FS-20: Audit risk spectrum from outcomes of periodic audits conducted on petroleum contractors (2014 – 2018).



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

Carbon monoxide (CO) continues to be a key area of focus as the predictive modelling indicates an elevated risk of injury as manifested in priority safety areas identified below.

CO Risks in Apartments and Condominiums

TSSA's 2018 activities to tackle this priority have provided some excellent learnings. We began conducting inspections at these types of buildings and have been able to work with owners and property managers to help them understand the importance of proper installation and maintenance. In 2019, we will assess the learnings from these inspections and in consultation with our partners assess a plan forward to address this safety risk.

Fuel-related Risks in Private Dwellings

Fuel-related risks at private dwellings have long been identified as a priority safety issue. TSSA has formed partnerships with public health organizations who we hope will support our position that CO is a public health issue. In 2019, we will continue to support our partners in raising awareness and promoting regular maintenance and the use of CO detectors as two-pronged defense against this deadly gas.

Fuel-related Risks in Schools

Over the last few years, TSSA has been worked collaboratively with school boards and cross-province maintenance organizations to underline the importance of proper installation and maintenance of fuel-burning equipment. In collaboration with its safety partners, TSSA will conduct a detailed evaluation of all data regarding this matter in order to better understand the source of this risk and potential mitigating actions.

Enhanced Monitoring Risks

Fuel-related risks in retirement and long-term care homes, fuel-related risks in business units, and (fuel-related) fire risks at food service locations continue to be worthy of enhanced monitoring because of an elevated level of risk. We will continue to leverage any existing advocacy material while tracking these issues carefully. It is noteworthy that while in previous years fire risks at food service locations was a priority, this year the level of risk has decreased significantly, possibly in part due to TSSA advocacy.

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 – 2018) Injury Burden	0.00 FE/mpy (2018) Injury Burden	0.00 FE/mpy (2018) Risk of Injury or Fatality

Safety Numbers (Safety at a Glance)				
Reporting Period	Incidents & Near-Miss Occurrences	Non-Permanent Injuries	Permanent Injuries	Fatalities
2010 – 2018	35	6	0	0
2018	1	0	0	0

The role of the Upholstered and Stuffed Articles Safety Program (USA) is to protect the public from potential hazards associated with the use of unclean or unsafe filling materials in upholstered and stuffed articles in Ontario. In addition to promoting safety, TSSA's aim is to protect consumers against fraud, misrepresentation of filling materials in upholstered and stuffed articles, and to provide a level playing field for industry.

Under *Ontario Regulation 218/01, Upholstered and Stuffed Articles*³³, only new clean filling materials are allowed in upholstered and stuffed articles, and all articles are required to be labelled, identifying the registration number and indicating all filling materials. Such articles include 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 are enforced through inspections at point-of-sale and the manufacturing level.

³³ This regulation is presently under governmental review, which may affect jurisdictional materials.



The following stakeholders fall under TSSA's jurisdiction:

- Retailers;
- Manufacturers;
- Importers/Distributors;
- Renovators;
- Home Hobby/Craft Operators; and
- Suppliers.

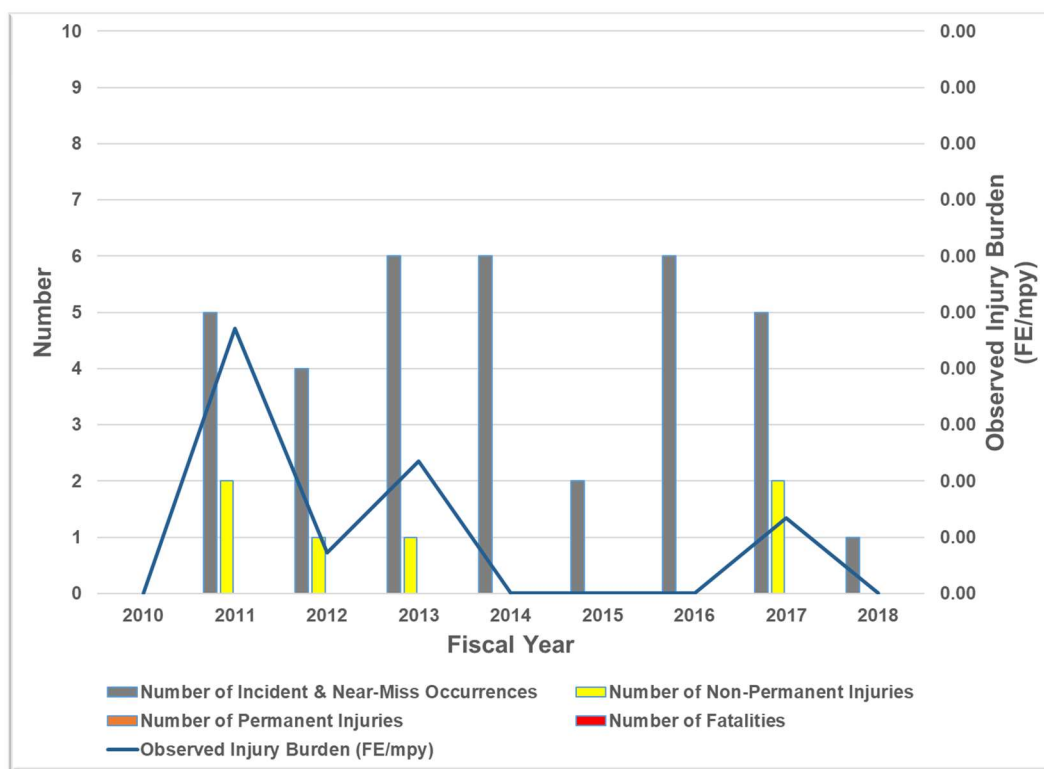
See Appendix F for a listing of current legislation and regulatory information.

III.8.1 Risk Assessment

Incident and Near-Miss Occurrences Associated with TSSA-Regulated Technologies and Devices

TSSA has received reports of actual health impacts resulting from reportable occurrences. Over the period of 2010 – 2018, there have been 35 incident and near-miss occurrences reported to TSSA. Measures representing these historical observations are represented graphically in Figure USA-1 and tabulated in Appendix A. 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 – 2018).



Incidents

There have been five incidents reported with six victims. In 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 have been 30 near-miss occurrences reported to TSSA, of which 16 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.

Compliance

In 2018, TSSA's Upholstered and Stuffed Articles program conducted 1,808 inspections and issued 13,740 orders, focusing mainly on retailers. Table USA-1 lists inspections and orders for the top inspection types over the last five years (2014 – 2018) and for the current fiscal year (2018).

Table USA-1: Top inspections and orders for upholstered and stuffed articles (2014 – 2018).

Reporting Period	2014	2018	2018	2018
Inspection Type	Number of Inspections Conducted	Number of Issued Orders	Number of Inspections Conducted	Number of Issued Orders
Retailer	2,936	55,373	424	8,801
Seasonal	1,157	17,539	160	3,165
Manufacturer	832	1,249	168	168
Importer/Distributor	731	13,127	135	1,468
Renovator	563	381	95	51

The top compliance issues that were identified through periodic inspections over the last five years (2014 – 2018) are shown in Table USA-2.

Table USA-2: Top compliance issues for upholstered and stuffed articles (2014 – 2018).

Compliance Issue	Percentage of Total Number of Orders Issued
Manufacturer not registered in Ontario	34%
Other. See notes for this infraction	25%
No provincial label	22%
No contents declared	9%
Non-approved label format	2%

III.8.2 Risk Management, Message from Peter Wong, Acting Statutory Director of USA Safety Program

The Ministry with TSSA support had targeted July 1, 2018 as the in-force date for revisions to the Upholstered and Stuffed Articles regulation. This initiative was not completed before the recent Provincial election.

The current government is assessing the review of this regulation. TSSA will support government efforts if it revisits plans to modernize the regulation and will undertake preparatory work in anticipation of proposed changes so that we are in a position to administer a modernized regulation.

In the meantime, Ontario's existing Upholstered and Stuffed Articles regulation remains in force and TSSA continues to administer the existing regulation.



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/hiosh/topics/hierarchy/>
- [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] 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 – 2018)

Table A1: Cross-program state of safety measures (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	2,130	1,959	2,037	1,958	2,170	2,574	3,079	2,852	3,197	2,674	2,827
Non-Permanent Injuries	724	685	610	654	914	946	1,240	1,164	1,588	1,060	1,236
Permanent Injuries	42	40	45	19	32	35	50	56	80	65	35
Fatalities	7	14	2	6	4	5	10	5	1	2	1
Observed Injury Burden (FE/mpy)	0.37	0.98	0.53	0.22	0.43	0.63	0.68	0.36	0.28	0.37	0.14

Table A2: State of safety measures for boilers & pressure vessels (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	3	0	5	1	2	2	0	1	5	4	18
Non-Permanent Injuries	0	0	0	0	0	0	0	0	1	0	0
Permanent Injuries	1	0	0	0	2	0	0	0	1	2	1
Fatalities	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	0.02

Table A3: State of safety measures for operating plants (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	0	0	0	1	2	0	0	2	2	5	4
Non-Permanent Injuries	0	0	0	0	0	0	0	1	0	0	0
Permanent Injuries	0	0	0	0	0	0	0	1	1	0	0
Fatalities	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	0.03	0.00	0.00	0.00



Table A4: State of safety measures for amusement devices (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	89	64	94	103	222	331	520	647	919	425	614
Non-Permanent Injuries	70	58	77	88	216	313	453	585	845	364	575
Permanent Injuries	8	10	9	3	5	11	25	24	42	32	19
Fatalities	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.01	0.03	0.07	0.00	0.05	0.01	0.01	0.02	0.10	0.05	0.01

Table A5: State of safety measures for elevators (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	193	174	195	205	340	381	497	458	567	528	661
Non-Permanent Injuries	106	84	101	104	167	146	186	118	168	142	123
Permanent Injuries	6	3	7	4	12	11	7	7	11	10	3
Fatalities	1	0	0	1	2	1	0	1	0	1	1
Observed Injury Burden (FE/mpy)	0.02	0.01	0.00	0.01	0.20	0.09	0.01	0.02	0.01	0.14	0.04

Table A6: State of safety measures for escalators & moving walks (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	538	531	504	512	522	519	641	592	742	698	704
Non-Permanent Injuries	406	390	343	360	362	384	437	383	470	441	448
Permanent Injuries	8	1	4	2	4	3	3	7	5	4	0
Fatalities	0	0	1	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.03	0.02	0.13	0.00	0.01	0.01	0.00	0.02	0.03	0.00	0.00



Table A7: State of safety measures for ski lifts (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	98	105	85	83	132	83	83	63	69	70	87
Non-Permanent Injuries	76	87	74	66	117	70	62	50	51	59	64
Permanent Injuries	6	4	3	1	0	0	3	2	2	3	2
Fatalities	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.01	0.00	0.10	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00

Table A8: State of safety measures for fuels (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total Incident and Near-Miss Occurrences ³⁴	1,209	1,085	1,154	1,048	946	1,252	1,332	1,087	887	939	738
Leak/Discovery/Spill Incident & Near-Miss Occurrences ³⁵	391	362	486	481	347	466	366	259	274	216	149
Incident & Near-Miss Occurrences (used for RIF calc.) ³⁶	818	723	668	567	599	786	966	828	613	723	589
Non-Permanent Injuries ³⁶	65	65	15	34	51	32	102	27	53	51	26
Permanent Injuries ³⁶	13	21	22	8	9	10	12	15	18	14	10
Fatalities ³⁶	6	14	1	5	2	4	10	4	1	1	0
Observed Injury Burden (FE/mpy) ³⁷	0.31	0.92	0.22	0.20	0.16	0.53	0.65	0.27	0.13	0.18	0.07
Pipeline Strike Occurrences ³⁸	2,244	2,288	2,145	2,333	2,423	2,347	2,372	2,471	2,363	2,289	2,081

³⁴ Includes occurrences resulting from leaks, discovery of petroleum products and liquid petroleum spills. Excludes occurrences resulting from pipeline strikes.

³⁵ Includes occurrences resulting from leaks, discovery of petroleum products and liquid petroleum spills only.

³⁶ Excludes occurrences and injuries resulting from leaks, discovery of petroleum products, liquid petroleum spills and pipeline strikes. Used for RIF calculation.

³⁷ Excludes occurrences and injuries resulting from leaks, discovery of petroleum products, liquid petroleum spills and pipeline strikes.

³⁸ Includes occurrences resulting from pipeline strikes only. Data not included in Total Occurrences.



Table A9: State of safety measures for upholstered and stuffed articles (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	0	0	0	5	4	6	6	2	6	5	1
Non-Permanent Injuries	0	0	0	2	1	1	0	0	0	2	0
Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0
Fatalities	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

Actionable (Red) Areas (2018)

Table A10: State of safety measures for CO risks in apartments and condominiums (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	11	11	9	20	17	13	33	18	15	21	11
Non-Permanent Injuries	0	0	0	2	0	0	7	4	0	0	0
Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0
Fatalities	0	0	0	0	0	0	0	1	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00

Table A11: State of safety measures for fuel risks³⁹ in private dwellings (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	263	314	404	313	339	472	567	507	325	381	321
Non-Permanent Injuries	43	45	12	18	20	18	24	10	21	27	20
Permanent Injuries	9	11	19	2	7	7	7	6	12	4	4
Fatalities	4	12	1	3	2	4	9	3	1	1	0
Observed Injury Burden (FE/mpy)	0.18	0.72	0.22	0.13	0.13	0.49	0.48	0.20	0.10	0.11	0.07

³⁹ Includes occurrences and injuries resulting from CO release, fire, explosion and/or vapour release.



Table A12: State of safety measures for elevator risks in hospitals (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	15	15	25	18	31	30	41	36	46	42	39
Non-Permanent Injuries	12	8	9	6	20	11	19	12	19	13	14
Permanent Injuries	0	1	1	0	1	2	2	0	2	1	0
Fatalities	1	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A13: State of safety measures for user interactions on elevators in retirement and long-term care homes (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	2	1	6	3	7	10	10	8	9	9	27
Non-Permanent Injuries	1	0	3	2	4	5	6	2	2	3	9
Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0
Fatalities	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

Table A14: State of safety measures for fuel risks⁴⁰ in schools (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	5	12	9	11	12	23	27	8	16	18	15
Non-Permanent Injuries	1	0	0	0	0	0	0	0	0	0	0
Permanent Injuries	0	0	0	0	0	0	1	0	0	0	0
Fatalities	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

⁴⁰ Includes occurrences and injuries resulting from CO release, fire, explosion and/or vapour release.



Enhanced Monitoring (Yellow) Areas (2018)

Table A15: State of safety measures for fuel risks⁴¹ in retirement and long-term care homes (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	4	5	4	6	9	13	11	6	5	4	12
Non-Permanent Injuries	0	0	0	8	12	6	0	0	0	0	0
Permanent Injuries	0	0	1	0	0	0	0	0	0	1	0
Fatalities	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

Table A16: State of safety measures for fuels risks⁴² in business units (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	36	49	24	36	41	53	72	45	49	54	50
Non-Permanent Injuries	10	6	0	0	4	4	2	1	7	0	2
Permanent Injuries	0	1	0	0	0	0	1	0	1	0	1
Fatalities	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

Table A17: State of safety measures for fuel-related fire risks in food service locations (2008 – 2018).

Measure	Fiscal Year										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Incident and Near-Miss Occurrences	6	7	21	8	11	12	15	10	10	25	18
Non-Permanent Injuries	0	0	0	0	0	0	0	0	0	0	0
Permanent Injuries	0	1	1	1	0	1	0	0	0	1	0
Fatalities	0	0	0	0	0	0	0	0	0	0	0
Observed Injury Burden (FE/mpy)	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.02	0.00

⁴¹ Includes occurrences and injuries resulting from CO release, fire, explosion and/or vapour release.

⁴² 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:

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

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 [8]. 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 34.87 DALY by using the above equation. In this calculation, the short-term weight of 0.725 and duration of 0 years were used respectively, and the fraction long-term and long-term duration parameters were taken to be 1 and 0.725 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.

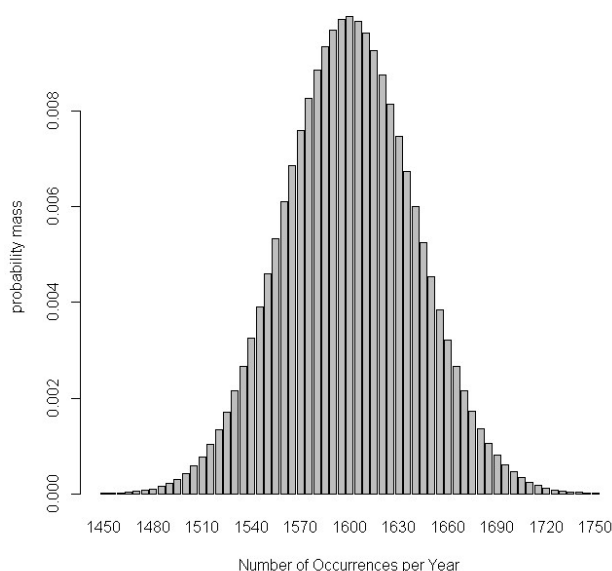
Risk of Injury or Fatality

The Risk of Injury or Fatality 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 distribution⁴³ 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 probability distribution based on historical observations. In cases where there is adequate evidence, a categorical distribution is used. An example is the determination of the TSSA composite prediction.

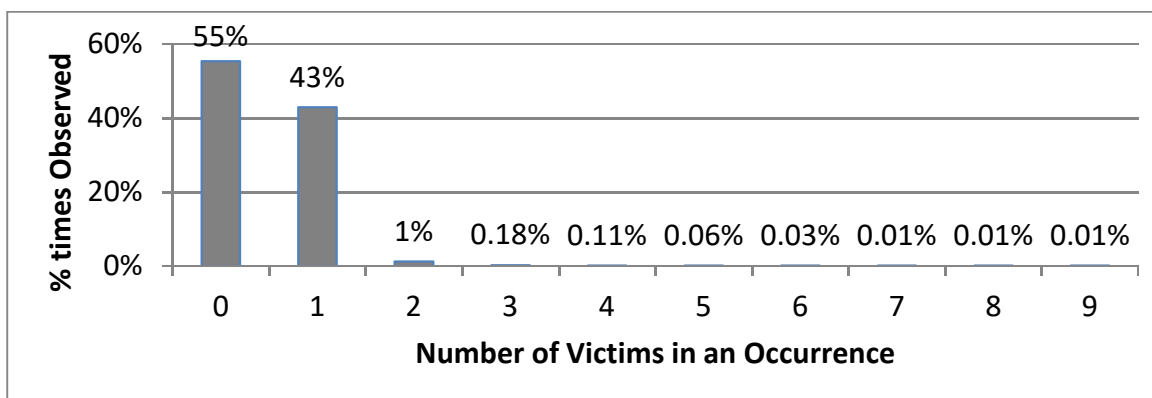
The TSSA Composite Risk of Injury or Fatality assumes that the number of victims per occurrence follows a discrete empirical probability distribution constructed from historical observations. This scheme ensures that extreme tail events are assigned a minimal probability, instead of assuming that they are equally likely compared to the most representative estimate. In the case of granular drilldowns where there is inadequate evidence, the number of occurrences is assumed to be equally likely between zero and the 99.9th percentile

⁴³ https://en.wikipedia.org/wiki/Poisson_distribution

of historically observed number of victims. This ensures that unexpected or misreported events occurring as extreme outliers with large impact, are excluded from the analysis.

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.

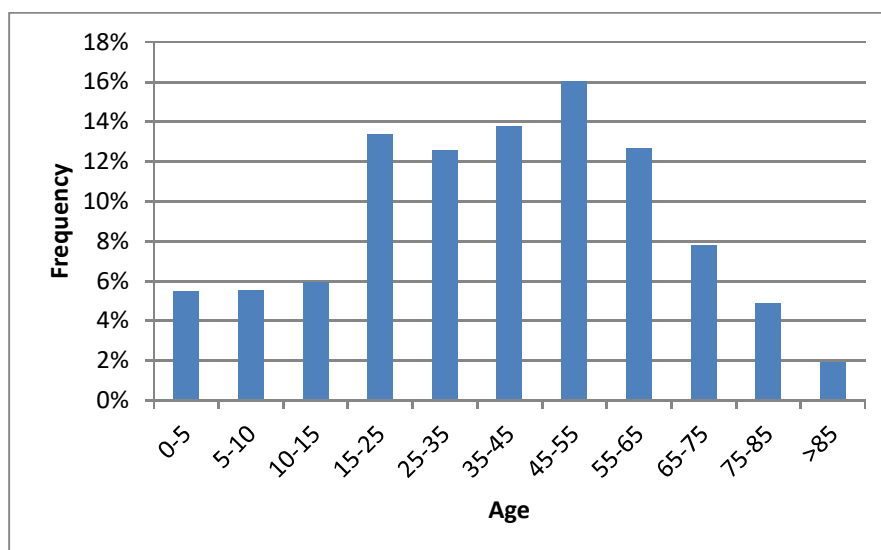
Figure B2: Frequency of the number of victims in an occurrence (example).



- (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).

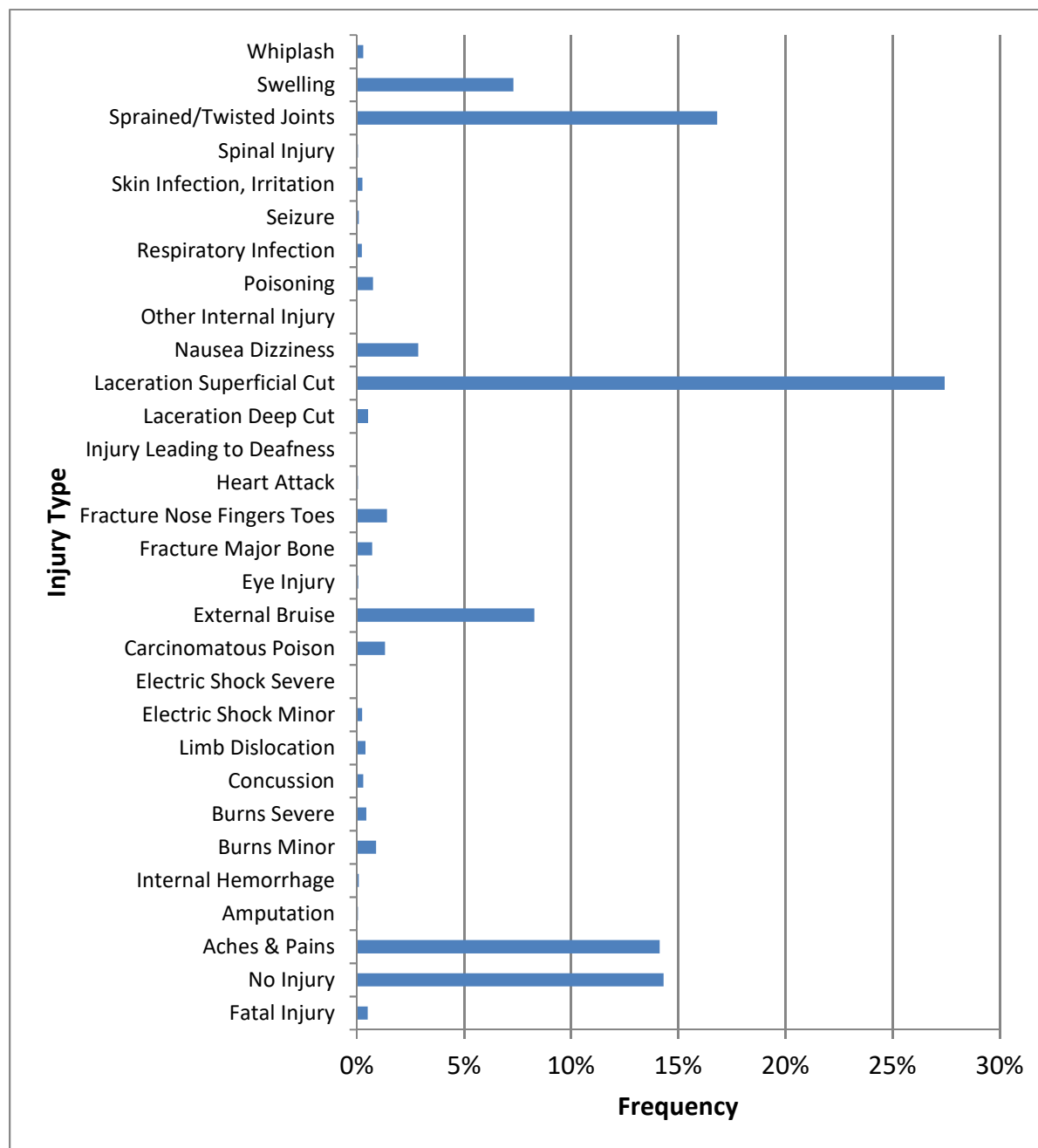


- (d) The number and type of injuries is sampled from a distribution constructed out of observations. This distribution is dependent on the program and the specific occurrence type under consideration.

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.

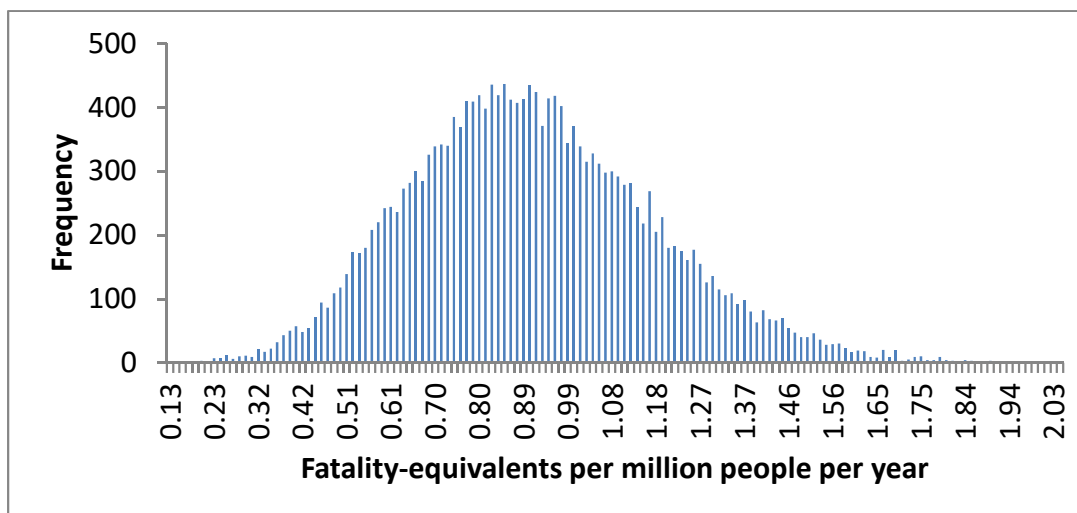


Figure B4: Injury distribution for the composite risk of injury or fatality (example).



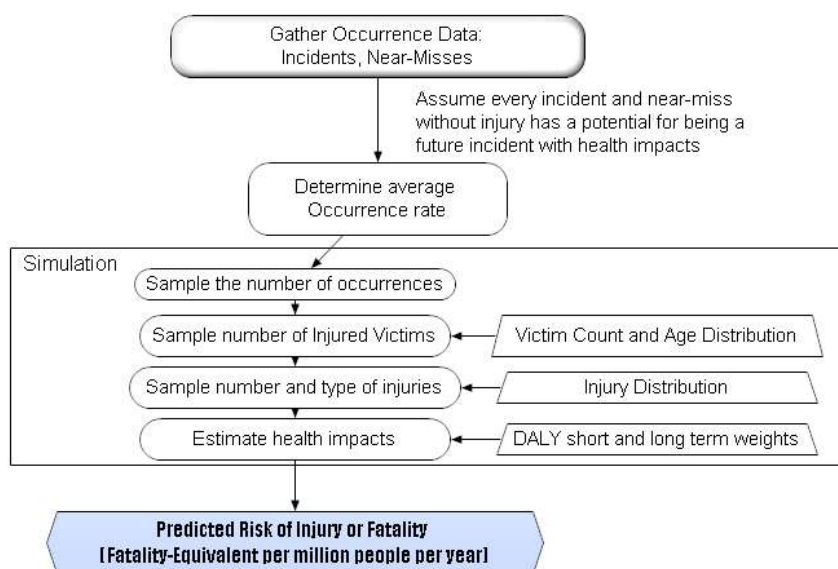
The end result of a risk simulation is a frequency distribution of predicted health impacts as exemplified in Figure B5. The mean value, fifth and 95th percentiles of the distribution are used for reporting purposes in the report. In Figure B5, the respective estimates are 0.51, 0.91 and 1.37 fatality-equivalents/million/year. 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 test⁴⁴ 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-Wallis⁴⁵ 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.

⁴⁴ https://en.wikipedia.org/wiki/Trend_analysis

⁴⁵ https://en.wikipedia.org/wiki/Kruskal%E2%80%93Wallis_one-way_analysis_of_variance



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 G); 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 ED 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 (and indeed for scheduling it will remain as such), but to compare across programs, it has been made constant for all applications. Accordingly, significant differences from historical values are seen in OE, AD, and FS licensed sites.



Appendix D – 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 (MGCS) to effectively improve the regulatory system without imposing unnecessary additional regulatory burden.

Table D1: 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 D2: 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.
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.



Category	Definition	Sub Categories
		• 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 D3: 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.
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 E – High Profile 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 (IMS) that facilitates a decision-making process applicable through the life cycle of an occurrence (incident or near-miss). The IMS 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 (IMIS).

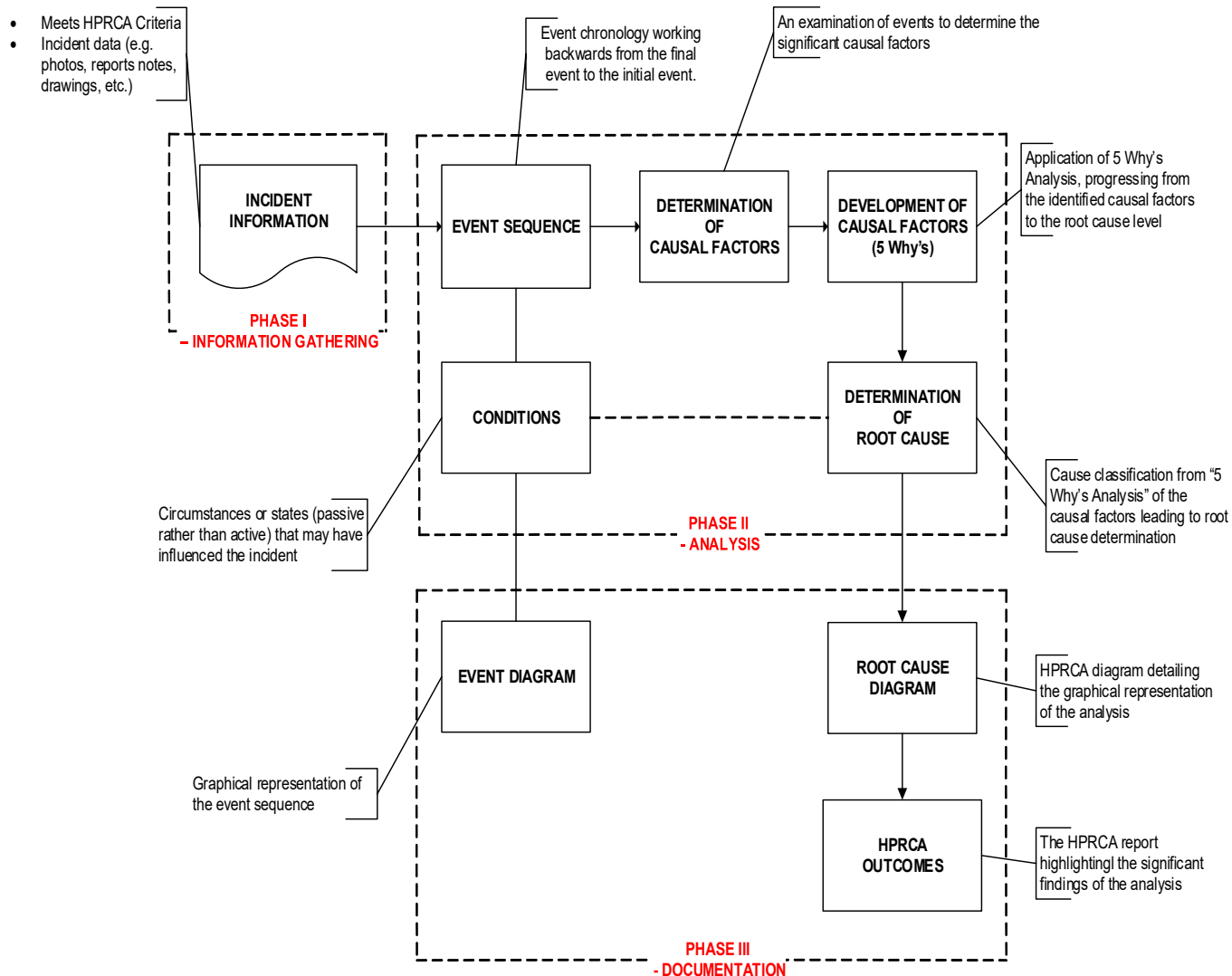
A key aspect of the IMS is the determination of cause(s) for occurrences, as this helps TSSA in addressing any potential gaps in the safety system and reducing risk to Ontarians. Inspections due to the nature of most occurrences tend to be completed by inspectors' basic analyses to determine cause(s). However, where a root cause cannot be determined by an inspector alone, and also depending on the nature of the reported occurrences, the level of complexity and 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 criteria of the high profile. This formal approach, *High Profile Root Cause Analysis* (HPRCA), 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 E1). 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 HPRCA process is to determine all causal factors and not to identify blame. An additional benefit of the HPRCA 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 a HPRCA, 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; and/or
3. 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.
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 E1: High profile root cause analysis flowchart.



The HPCRA Process

The HPRCA 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 HPRCA 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 E2 – E4 below:

Figure E2: Relevant conditions (at the time of the occurrence).

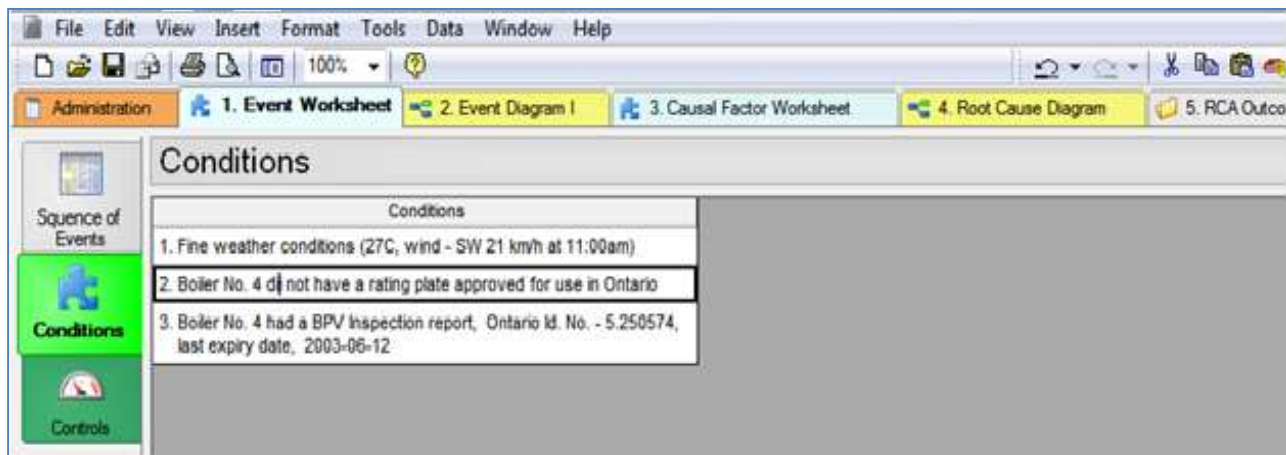


Figure E3: Incident information – data collection.

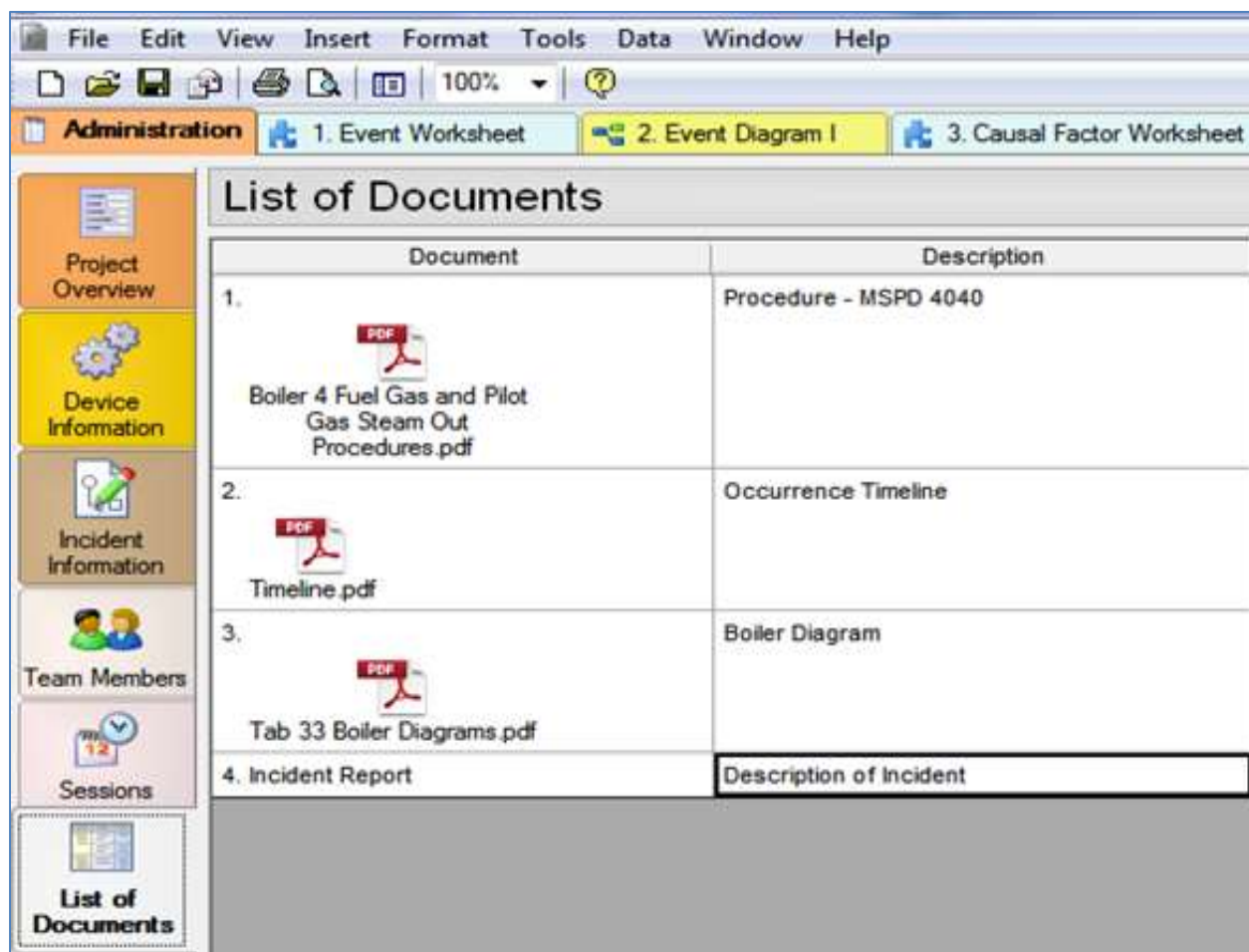
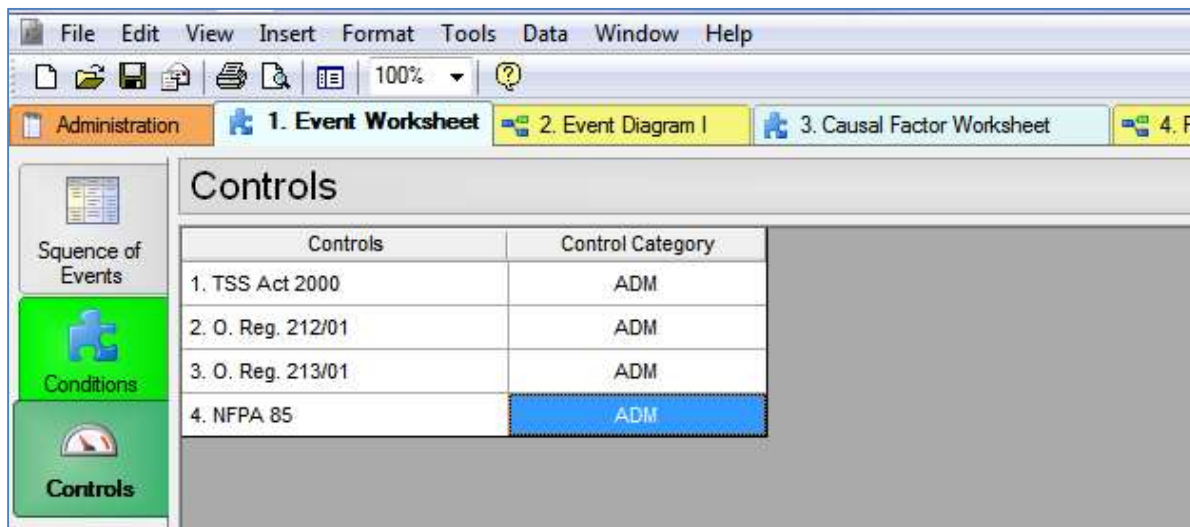


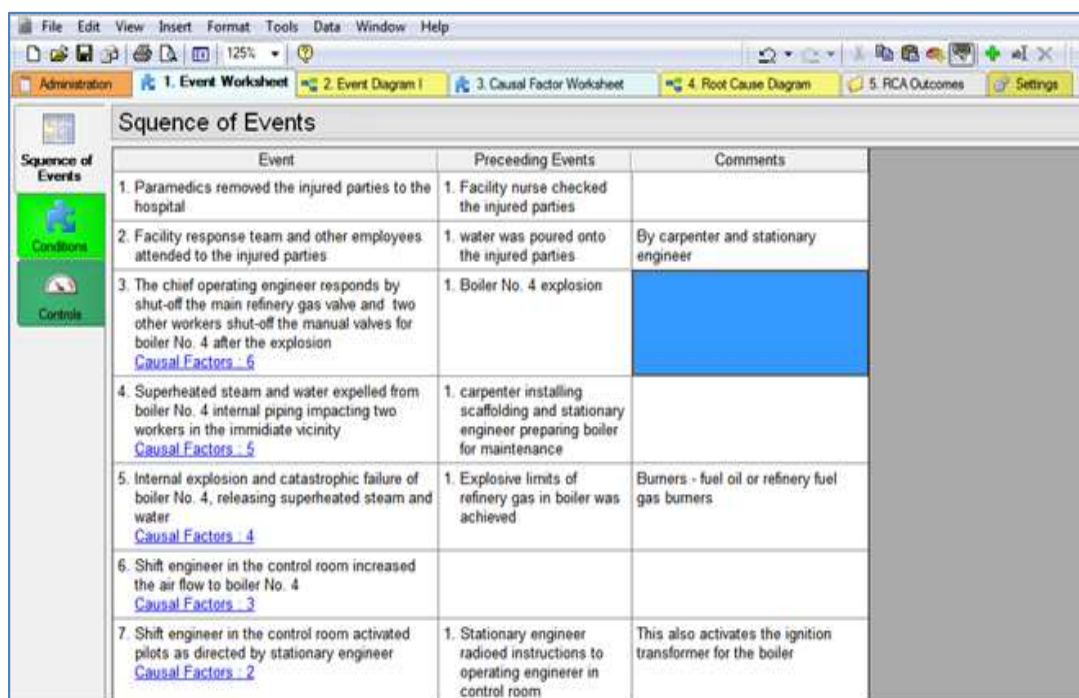
Figure E4: Relevant controls (regulatory or other controls).



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 backwards and using a combination of events capable of leading to the final event (see Figures E5 and E6). The analysis of each upstream event is identified or put in sequence with combinations of events/conditions, (e.g., single or in series/parallel configurations) capable of causing the final event. The determination and evaluation of identified causal factors by application of the “5 Whys Principle?” (see Figure E7 - e.g. asking why or how this could happen?) until associated causes can be determined. This procedure is followed for each causal factor chain identified until the 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 occurrences.

Figure E5: 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 - 5	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 E6: Sequence of events – event diagram.

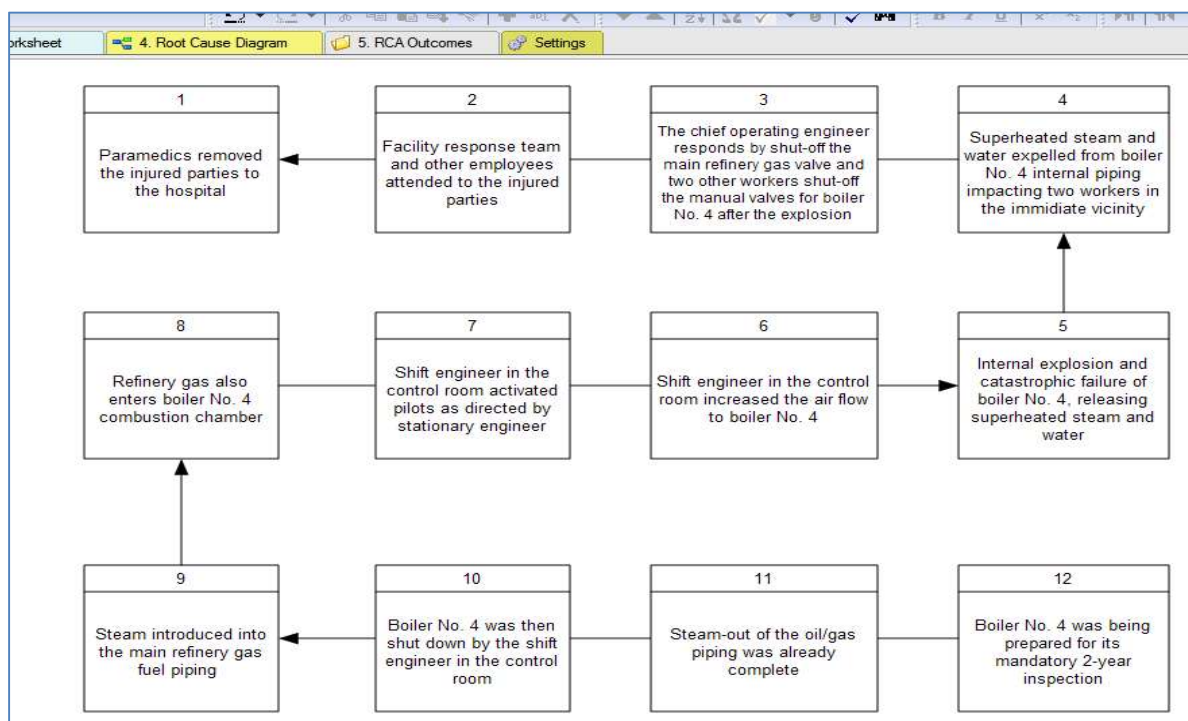


Figure E7: Analysis of causal factors - 5 Whys approach.

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 the lock 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 expel unburnt refinery	CONTRIBUTING CAUSE		1. To ensure unburnt gas will not		To eliminate the									

(c) Report Preparation – The final phase the HPRCA 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 E8 – E10). A summary report is developed when all phases are completed by the HPRCA facilitator and submitted to the program statutory director including relevant recommendations and conclusions.

Figure E8: HPRCA diagram.

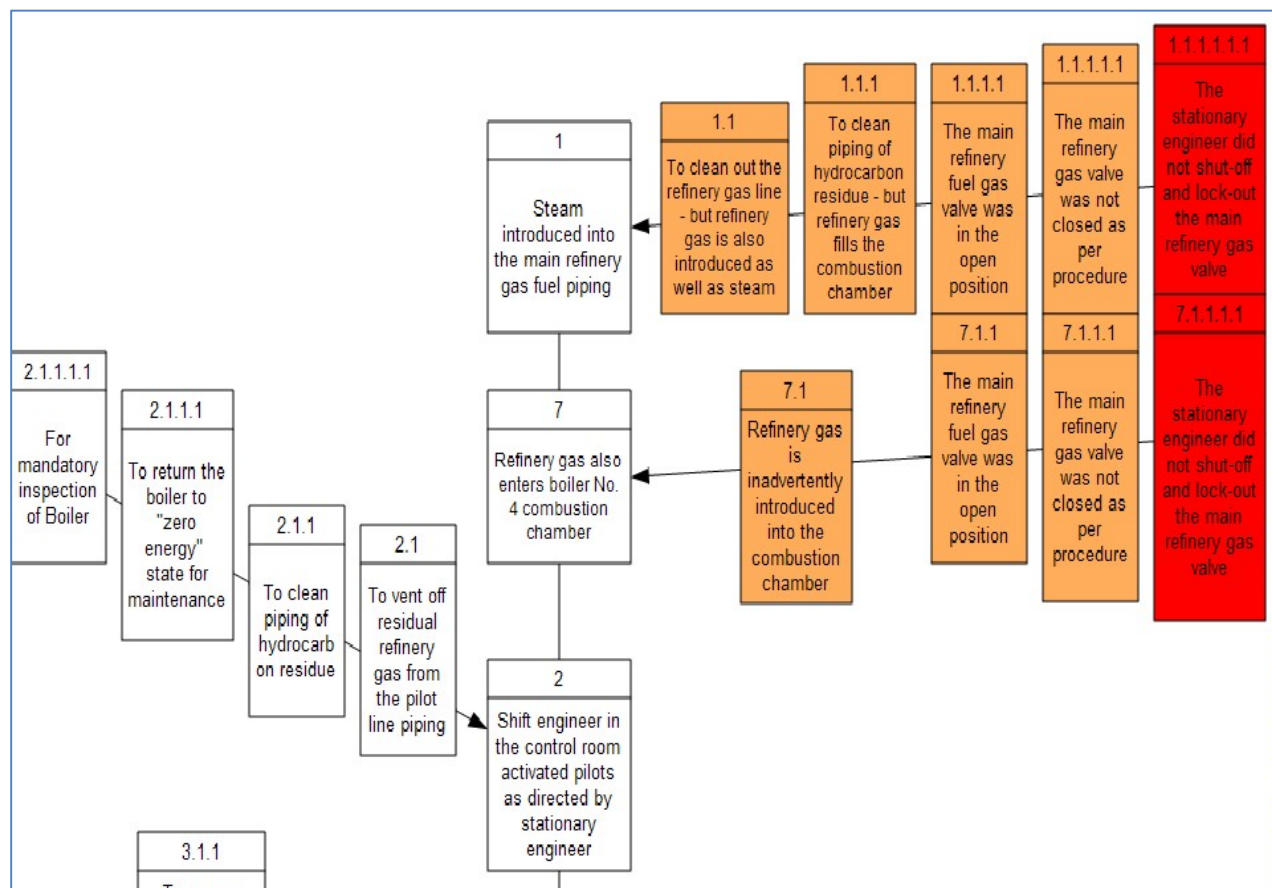
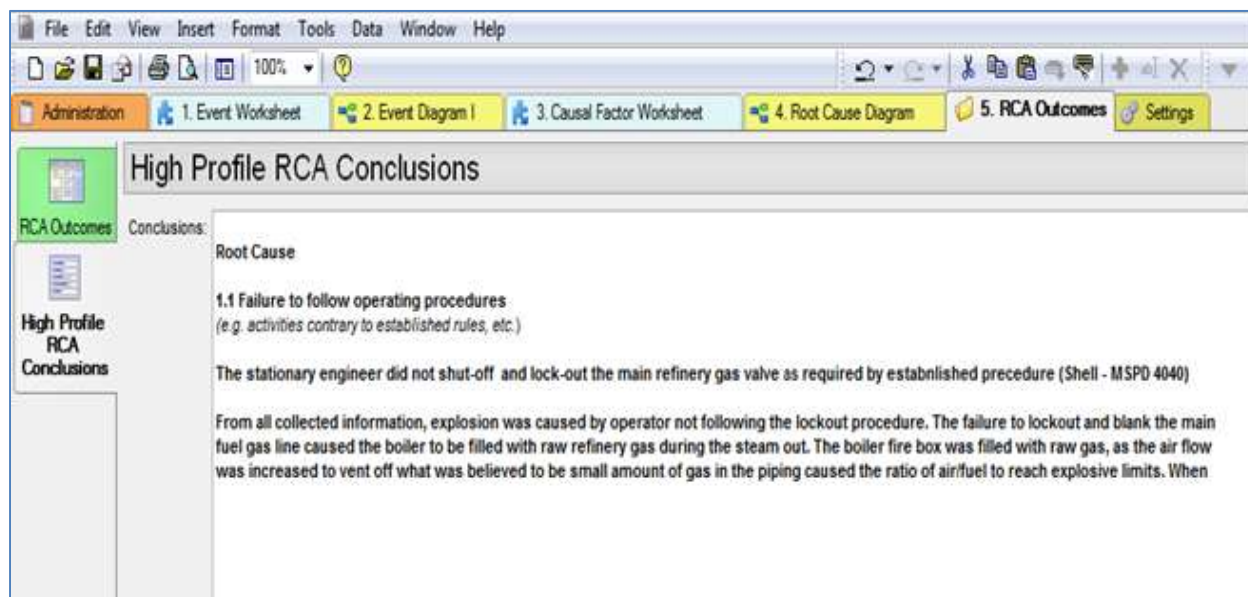


Figure E9: HPRCA outcomes.

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 E10: HPRCA conclusions.



The HPRCA Team - Roles and responsibilities

The HPRCA 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 Public Safety Risk Management (PSRM) team at TSSA provides facilitation for the HPRCA 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 HPRCA management. The facilitator develops the summary report with the significant findings of the HPRCA for reporting purposes.

Safety Program Experts

The safety program provides the resources required (i.e., HPRCA team – engineers, inspectors, etc.) for the execution of the HPRCA 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 HPRCA 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.



HPRCA – Examples at TSSA

Below are a few examples of completed HPRCA on incidents that have provided useful information to safety programs for further safety issue management.

1. Elevator (HPRCA 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 E11) was issued on April 15, 2015 to address this issue.

Figure E11: 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** (HPRCA Criteria - Where regulatory non-compliance and the root cause could not be determined by the inspector alone)

An elderly man entered the 5th 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** (HPRCA 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 F – 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 2018. 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 F1. The BPV CAD was amended 1 July 2018 to reflect the changes incorporated in the O.Reg. 220/01 that were put in place on 1 July 2018.

Table F1: TSSA BPV Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	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	2001
Boilers and Pressure Vessels CAD Amendment BPV-18-01	2018

During 2018, there were no BPV director's orders, advisories, bulletins or guidelines issued.

2.0 Operating Engineers Safety Program

Current TSSA legislation and regulatory information for the Operating Engineers safety program is shown in Table F2.

Table F2: TSSA OE Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 219/01: Operating Engineers Regulation	2001
Ontario Regulation 219/01: Director's Order	2003

During 2018, there were no OE director's orders, advisories, bulletins or guidelines issued.

3.0 Amusement Devices Safety Program Area

Current TSSA legislation and regulatory information for the Amusement Devices safety program is shown in Table F3.

Table F3: TSSA AD Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 221/01: Amusement Devices Regulation	2001
Ontario Regulation 187/03: Certification and Training of Amusement Device Mechanics	2003
Amusement Devices CAD	2001
Amusement Devices CAD Amendment 530/09	2009
Amusement Devices CAD Amendment 534/12	2012
Canadian Bungee Safe Code of Practice	2000

During 2018, the following were issued; but no AD bulletin.

- one AD director's order
 - Additional Inspection Requirements for Corrosion of Aging Rides.
- two AD advisories
 - Zip Line Harness Requirements 536/17.



- Free Fall Descenders versus Auto Belay Devices 537/17.
- one AD guideline:
 - Water Slide Accommodation Guideline & Requirements for Regulatory Documentation Updates October 2017.

4.0 Elevators Safety Program Area

Current TSSA legislation and regulatory information for the Elevating Devices safety program is shown in Table F4.

Table F4: TSSA ED Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2001
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2001
Elevating Devices CAD	2001
Elevating Devices CAD Amendment 261-13	2013

During 2018, the following were issued; but no ED bulletin.

- one ED director's order:
 - Requirement for Passenger Elevators with Single Speed Controls 269/17.
- one ED advisory:
 - Construction Hoists in the Tunneling Sector 270/17.
- one ED guideline:
 - What's New in ASME A17.1 CSA B44 2013 & 2016 Summary of all Changes.

5.0 Escalators and Moving Walks Safety Program Area

Current TSSA legislation and regulatory information for the Escalators and Moving Walks safety program is shown in Table F5.

Table F5: TSSA EM Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2001
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2001
Elevating Devices CAD	2001
Elevating Devices CAD Amendment 261-13	2013

During 2018, there were no EM director's orders, advisories or bulletins issued. There was one EM guideline issued during 2018:

- What's New in ASME A17.1 CSA B44 2013 & 2016 Summary of all Changes.

6.0 Passenger Ropeways (Ski Lifts) Safety Program Area

Current TSSA legislation and regulatory information for the Ski Lifts safety program is shown in Table F6.

Table F6: TSSA SL Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 209/01: Elevating Devices	2001
Ontario Regulation 222/01: Certification and Training of Elevating Devices Mechanics	2001
Elevating Devices CAD	2001
Elevating Devices CAD Amendment 261-13	2013

There were no SL director's orders, advisories, bulletins or guidelines issued during 2018.



7.0 Fuels Safety Program

Current TSSA legislation and regulatory information for the Fuels Safety program is shown in Table F7.

Table F7: TSSA FS Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 210/01: Oil and Gas Pipeline Systems	2001
Ontario Regulation 210/01: Director's Order	2001
Oil and Gas Pipeline Systems CAD	2001
Oil and Gas Pipeline Systems CAD Amendment FS-238-18	2018
Ontario Regulation 211/01: Propane Storage and Handling	2001
Propane CAD	2001
Propane CAD Amendment FS-224-17	2017
Ontario Regulation 212/01: Gaseous Fuels	2001
Ontario Regulation 212/01: Director's Order	2001
Gaseous Fuels CAD	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
Ontario Regulation 213/01: Fuel Oil	2001
Ontario Regulation 213/01: Director's Order	2001
Fuel Oil CAD	2001
Fuel Oil CAD Amendment FS-219-16	2016
Ontario Regulation 214/01: Compressed Gas	2001
Liquid Fuels Handling CAD FS-229-17	2017
Compressed Gas CAD	2001
Compressed Gas CAD Amendment FS-143-09	2009
Ontario Regulation 217/01: Liquid Fuels	2001
Ontario Regulation 217/01: Director's Order	2001
Ontario Regulation 216/01: Certification of Petroleum Equipment Mechanics	2001
Ontario Regulation 215/01: Fuel Industry Certificates	2001
Amendment to Ontario Regulation 215/01 - CDT Activation (Ontario Regulation 184/03)	2003

During 2018, there were no FS director's orders, bulletins or guidelines issued. There were seven FS advisories issued during 2018:

- Incident Report Criteria for Hydrocarbon Fuels Industry FS-227-17.
- Unvented Heaters inside Livestock or Poultry Facilities (B149.1-15, clause 7.37) FS-214-14-R2.
- Guidelines for Compliance with Requirement to Obtain Locates (O.Reg. 210/01, s.9) FS-223-17.
- Furnaces used for Construction and Finishing Heat (B149.1-15, 4.1.3) FS-232-17.
- Acceptable Format for Pipeline Locates FS-233-17.
- Monitoring of Sumps FS-205-13 R1.
- Protection Against Vehicular Traffic FS-114-07 R3.

8.0 Upholstered and Stuffed Articles Safety Program

Current TSSA legislation and regulatory information for the Upholstered and Stuffed Articles safety program is shown in Table F8.

Table F8: TSSA USA Legislation and Regulatory Information.

Legislation and Regulatory Information as of 2018	Latest Revision
Ontario Regulation 218/01: Upholstered and Stuffed Articles	2001

There were no USA director's orders, advisories, bulletins or guidelines issued during 2018.



Appendix G – 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 G1.

Table G1: 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 G1, 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 G1: TTC tool depicting failure scenarios.

The screenshot shows the 'TTC Tool: Database' interface. The top ribbon includes 'FILE', 'HOME', 'CREATE', 'EXTERNAL DATA', 'DATABASE TOOLS', 'HELPS', and 'TABLE'. The 'TABLE TOOLS' tab is active, showing options like 'New', 'Save', 'Refresh', 'Delete', 'More', 'Totals', 'Spelling', 'Find', 'Replace', 'Go To', and 'Select'. The main area displays a table with two columns: 'ID' and 'Failure Scenario'. The table lists 20 failure scenarios, each with a unique ID. The 'Failure Scenarios' table is shown below the ribbon.

ID	Failure Scenario
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 combplate 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 G2 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 G2: 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 logic⁴⁶ searches for clause IDs and inspector issued TTCs. This interim approach helps TSSA for analysis, reporting and inspection scheduling purposes.

⁴⁶ https://en.wikipedia.org/wiki/Fuzzy_logic