

# **ELEVATOR MACHINE ROOM EQUIPMENT GUARDING**

**A BEST PRACTICES GUIDELINE PRODUCED  
BY INDUSTRY STAKEHOLDERS**

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**May 21, 2009**

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**Cover photograph is courtesy of Telford D. John & Associates. This photo shows but one example of elevator equipment guarding. It is not the soul option and therefore not reflective of other options available.**

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## GUIDELINE COMMITTEE

In response to concerns raised by Building Owners and the Elevator Industry, the Technical Standards and Safety Authority (TSSA) in conjunction with its Elevating Devices Advisory Council recommended the formation of a task group drawn from industry stake holders. Its purpose was to review the issue of elevator machine room equipment guarding and assist in the development of an industry produced guideline or reference document highlighting current best practices concerning equipment guarding. The guideline could then be used by building owners and the elevator industry to better understand the requirements of elevator machine room equipment guarding, and assist in the development of appropriate design requirements for such provisions when applied to elevator installations.

The Committee first met in the spring of 2007 and the results of their efforts is this guideline.

Committee participants were;

- **Mr. Clifford Ayling** (chair), Ayling Consulting Services Inc. & Brookfield Properties Ltd.
- **Mr. Donald Brown**, Ministry of Labour
- **Mr. Wayne De L'Orme**, Ministry of Labour
- **Mr. John Egan** (secretary), Fujitec Canada, Inc.
- **Mr. Roger Girling** (secretary), Canadian Elevator Contractors Association (CECA)
- **Mr. Cy Gray**, TSSA
- **Ms. Karen Hanna**, Ministry of Labour
- **Mr. Telford John**, Telford D. John & Associates
- **Mr. Rob Kremer**, TSSA
- **Mr. Robert Last**, Arcturus Realty Corporation
- **Mr. Bob Miller**, Otis Canada, Inc.
- **Mr. Troy Pelletier**, Minto Properties & FRPO
- **Mr. Peter Russel**, H. H. Angus & Associates
- **Mr. Rick Sokoloff**, Independent Elevator Contractors Association (IECA)
- **Mr. Ron Takamaki**, Takamaki Consultants Inc.

In addition, the following groups participated to some degree during the process of preparing this Guideline.

- **Elevating Devices Advisory Council (EDAC)**, working in combination with the TSSA.
- **Field Advisory Committee (FAC)**, working in combination with the TSSA.

The work of this Guideline Committee and the purpose of this Guideline were not to replace or amend regulatory requirements relating to equipment guarding. The purpose of the Guideline is to assist employers, supervisors and workers on recognizing hazards and determining the ways that they may best comply with their obligations under the **Occupational Health and Safety Act (OHS)**, and the relevant regulations made under the **OHS**. This Guideline also provides the workplace parties with information to consider in determining how to prevent injuries and protect worker health and safety while maintaining public safety. The Guideline should not be taken as a statement of law or what is necessary to comply with the law, nor does it relieve the workplace parties from their obligations to comply with the provisions of the **OHS** and its associated regulations.

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Ministry of Labour (MOL) inspectors will assess the workplace situations against the relevant provisions in the **OHSA** and its regulations. Although the Guideline will be made available to both MOL and TSSA inspectors, the Guideline will not be enforced by MOL and TSSA inspectors. Rather, it will be used as a resource document while conducting their respective regulatory mandates. These inspectors will continue to apply and enforce the specific requirements of their respective codes and regulations.

Comments about the Guideline can be forwarded to the Field Advisory Committee (FAC) via email. The email address is [edfac@tssa.org](mailto:edfac@tssa.org). Please note that the FAC meets three times per year. Inquires and questions will be included as part of their ongoing meeting agendas, and responses will follow thereafter.

The date of this guideline is May 21<sup>st</sup>, 2009.

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## Part 1

# INTRODUCTION

The implementation of guarding equipment within elevator machine room spaces is part of the mandate of the Ministry of Labour (MOL) to protect the health and safety of workers and to reduce workplace injuries. No amount of training, certification, licensing or experience will likely prevent 100% workplace injuries. The potential for inadvertent injury within an unprotected environment is high, notwithstanding current accident and injury statistics within these locations. Reliance upon a locked machine room access door, with limited available access does not constitute sufficient or appropriate guarding, even when used with lock out/tag out procedures and the safe shutdown of live equipment whenever the elevator machine room access door is opened. Once through the door, where live unguarded equipment remains in operation, a worker is still exposed to potential hazards within the machine room.

The requirements for elevator machine room equipment guarding comes from Sections 24, 25, 75 and 76 of the Regulations for Industrial Establishments, **Ontario Regulation 851 (O. Reg. 851)** made under the **OHSA**. The **OHSA** and its regulations are enforced by the MOL. MOL has had an increased enforcement present in Ontario workplaces since 2004 with the hiring of 200 additional occupational health and safety inspectors. Since 2004, MOL has been proactively visiting firms that may not have been previously inspected (e.g., retail, offices and related services, tourism, hospitality and recreation services). Many of these firms have elevating devices on the premises, which are included as part of the workplace, and therefore can be inspected by an MOL inspector.

The **OHSA** applies to Ontario workplaces, with exceptions as outlined in Sections 3 and 4 of the **OHSA**. There are many Regulations made under the **OHSA**, the applicability of each is dependent upon the particular workplace. **Ontario Regulation 213/91** sets out occupational health and safety requirements for a “construction project” whereas **Ontario Regulation 851** applies to “industrial establishments”. There are also regulations applicable to Health Care and Residential Facilities, **Ontario Regulation 67/93** and to Mines and Mining Plants, **Ontario Regulation 854**.

The **OHSA** defines an industrial establishment as “an office building, factory, arena, shop or office, and any land, buildings and structures appertaining thereto.” In other words, many buildings that contain elevators, such as commercial, institutional, recreational, educational and other building occupancies would be considered as “industrial establishments” with respect to worker health and safety.

It is the elevator owner’s responsibility to ensure that elevator equipment is compliant with the requirements of the **OHSA** and **O. Reg. 851**. This Regulation is performance based. It establishes the outcome or expectation of appropriate guarding, but it does not itemize, define or explain specific guarding designs or expectations, nor does it address the special considerations that need to be considered when installing equipment guarding to an existing or new elevator installation.

The focus of this Guideline is to assist stakeholders with compliance by;

- explaining the requirements for equipment guarding,
- confirming and identifying related safety code and design requirements that specifically affect elevating devices,

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- Explaining, in layperson terms, some of the technical considerations that need to be accounted for when designing elevator equipment guarding.

The guideline includes a number of anticipated questions with appropriate answers. It is hoped that these will provide additional guidance and clarification to assist the reader in understanding essential issues associated with elevator machine room equipment guarding.

When it comes to the retrofitting of elevator machine room equipment guarding, it is important to realize that there are no grand-fathering exemptions. The requirements for elevator machine room equipment guarding apply to installations installed in the early part of the 20<sup>th</sup> century, as well as those now being installed. Secondly, there is no far off compliance deadline or implementation date. The requirement for compliance exists now, and can be found in Sections 24 and 25 of **O. Reg. 851**. Where elevator machinery has an exposed moving part or in-running nip hazard that may endanger the safety of any worker, the equipment is to be guarded by a guard or other device that prevents access to the moving part or pinch point. Non-compliance with these sections of **O. Reg. 851** will result in orders to comply being issued by MOL, where the inspector finds that a provision of the **OHSA** or the Regulations is being contravened.

Failure to comply with the requirements of the **OHSA** or its Regulations or an order to comply issued by an MOL inspector, Director or Minister is considered an offence in accordance with Section 66 of the **OHSA**. An offence carries a maximum fine of \$25,000 or up to one year's imprisonment, or both per noted offence (multiple elevators can result in multiple offences). For corporations, convictions can result in fines can be as much as \$500,000 per offence.

The requirement for equipment guarding for elevating devices is not unique to the Province of Ontario. Other provinces have taken a leadership role in identifying the requirement for providing elevator machine room equipment with protective guarding as a significant workplace safety assist (i.e., Manitoba). Many countries in Europe are beginning to mandate elevator equipment guarding. Australia has required elevator equipment guarding now for many years. Finally, most newly installed elevator equipment is coming with protective guarding already in place, though many not to the standard as expected for compliance with the requirements of **O. Reg. 851**. Therefore, worldwide recognition of the requirement for guarding provisions is increasingly being realized.

**QUESTION: Why is this happening now?**

As part of an initiative to reduce workplace accidents and incidents by 20%, since 2004 the Ministry of Labour significantly increased its complement of field inspectors. Increased numbers of field inspectors has meant stepped up and focused inspections. Industries and locations that may have not seen an MOL inspection since its original construction are now being visited. In addition, it was found that in many locations there existed workplace hazards from operating machinery that, in the context of the requirements of **O. Reg. 851**, Sections 24 and 25, were not compliant. Also, there is increasing awareness of the safety hazards associated with unprotected elevator equipment that has now been recognized internationally as requiring corrective action.

**QUESTION: Who regulates elevating devices?**

There are a number of overlapping regulatory requirements where elevating devices are concerned. The building which houses the elevating device must confirm to the Ontario Building Code (**OBC**), the

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requirements of which are enforced by municipal building officials. Electrical equipment must meet the requirements of the Canadian Electrical Code (C22), a standard that is enforced and regulated in Ontario by the Electrical Safety Authority (ESA). The Technical Standards and Safety Authority (TSSA) regulates the design, installation, operation and maintenance of elevating devices, to ensure the device's safety requirements meet the Technical Standards Safety Act, associated with Ontario Regulations and the Canadian Standards Association (CSA) **B44** Safety Code for Elevators. Issues relating to health and safety within the workplace are covered under the **Occupational Health and Safety Act (OHSA)** and various regulations made under **OHSA** as enforced and administered by the Ministry of Labour (MOL).

**QUESTION: What right of access does the MOL have to an elevator machine room? I thought access to these spaces was restricted by Ontario Regulation 209/01 (Elevating Devices)?**

By provincial mandate, under Section 54 (1)(a) of the **OHSA**, an MOL inspector has complete authorization to enter all workplaces and areas of a building, including an elevator machine room. As the requirements of the **OHSA** prevail per Section 2 (2) of the **OHSA**, this right of access supersedes the requirements of **Ontario Regulation 209/01**.

**QUESTION: Who is the lead regulator in terms of elevator machine room equipment guarding, the MOL or the TSSA?**

The MOL has complete and total jurisdiction over the requirements and regulations associated with making the workplace safer as well as reducing the hazards to which workers are exposed. As such, elevator machine room equipment guarding falls directly under this umbrella, on the basis that the installation of such equipment prevents the worker from being exposed to the hazard of exposed moving parts and in-running nip hazards thereby protecting worker health and safety.

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## Part 2

# EXECUTIVE SUMMARY

The requirements for the guarding of elevator machine room equipment has been, to the surprise of many, a mandated requirement for many years as documented in the original publication of **O.Reg. 851**. However, it has not been until recently that the Ministry of Labour (MOL) has been enforcing these regulations through their stepped up site inspections. Refer to Section 4 for background information relating to the Ministry's stepped up enforcement and reasons for this policy.

Notwithstanding the Elevator Industry's safety record, and other regulations that require access to elevator machinery equipment spaces to be restricted to trained and licensed personnel, the need to equip elevator machine room equipment with safeguards for worker protection is a requirement. Reliance upon a locked elevator machine room door, restricted access, and training/certification of elevator personnel are not sufficient safeguards. These provisions alone will not satisfy the guarding and protection expectations as mandated under the MOL regulations.

There are no exceptions or exemptions to these requirements in locations where Provincial regulations are in effect. Regardless of a building's era, function, use, the age of its elevator equipment, the elevator machine room equipment will require guarding, or some form of safeguard protection. The MOL will be enforcing these provisions.

It is not the responsibility of the MOL to design and specially set out the requirements and design for elevator machine room equipment guarding. They will not comment upon, approve or certify these requirements. Section 7 of **O. Reg. 851** prescribes the conditions whereby an employer is required to conduct a Pre-Start Health and Safety Review (PSR). Where a PSR is required in order to achieve compliance with Section 24 and 25 of the Regulation, Subsection 7 (11) of the Regulations prescribes that the PSR be conducted by a professional engineer. Protective elements such as guards for elevator machines should be manufactured in accordance with current applicable standards. The Canadian Standards Association Standard **Z432** Safeguarding of Machinery is one of the standards that can be used to support compliance with Sections 24 and 25 of **O. Reg. 851**. Other standards that can be used to support compliance with these sections of the Regulations are listed in the MOL publication "Guidelines for Pre-Start Health and Safety Reviews: How to Apply Section 7 of the Regulations for Industrial Establishments".

At the same time, the Technical Standards and Safety Authority (TSSA), the Provincial body now charged with regulating elevator safety in the Province of Ontario, will not comment upon the adequacy of elevator machine room equipment guarding. They are not responsible for enforcing and interpreting the requirements of **O. Reg. 851**. In other words, there is an inadequate supply of technical information relating to elevator machine room equipment guarding to which Owner's or building operators can refer. Such a reference would explain the available options; provide guidance and present specific requirements for such safeguards, as well as itemizing the unique equipment found within these spaces. Sections 7 and 8 of this Guideline present such information.

Recognizing that machine room equipment guarding is a requirement that will be enforced by the MOL, it is critical to ensure that the retrofitting of such provisions will not hinder equipment operation, nor compromise worker safety, or encumber equipment servicing and maintenance protocols. This is the function and goal of this Guideline.

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## Part 3

# PREFACE

The purpose of this guideline is to assist industry stake-holders with understanding the requirements for elevator machine room equipment guarding and provide technical guidance in terms of compliance with the applicable regulations.

This guideline does not define how to design or install elevator machine room equipment guarding. It serves to provide background details, along with specific equipment requirements that the designers and implementers of such guarding need to understand. Any equipment being installed to elevator machinery must take into account requirements such as ongoing maintenance and inspection, ready access to components, clearance with moving machinery, plus “walk around” and “working” clearances.

This guideline does not supplant the requirements of **O. Reg. 851** or any of the related safety code regulations associated specifically with elevating devices. This guideline does not attempt to provide definitive requirements for elevator equipment guarding. The design and extent of guarding will be dependent upon the unique design of the elevator installation. The type of elevator equipment will have an enormous impact on the extent and design of equipment guarding. Elevator machine room layout, location, spatial restrictions and point of access will also have a significant impact on equipment guarding. In other words, it is impractical to consider one standard of design. Each installation must be reviewed on the merits of its own unique application, and these must be factored into the final layout, fabrication and design of its guarding.

It is understood that the focus of this guideline is limited to elevators (passenger and freight). It can also be used for similar type equipment such as dumbwaiters.

### **QUESTION: Why isn't there one standard or guarding design specification?**

The requirements for equipment guarding need to be assessed not only on the merits of the equipment being guarded, but also its location, point of access, and, equipment type. Not all elevators are the same. Though the differences between equipment are significant, the types of hazards that need to be protected against are limited, and steps to remedy these are the focus of this guideline.

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## Part 4

# PURPOSE

The intent of this Guideline is to provide information on the requirements for elevator machine room equipment guarding, by:

- Itemizing and explaining the hazards associated with unguarded elevator machine room equipment.
- Explaining and describing the components involved.
- Providing an explanation of technical terms to allow the non-specialist to better understand the equipment involved.
- Itemizing specific elevator equipment attributes that must be factored into the final equipment guarding design.
- Identifying related elevator safety code requirements that will affect the design and installation of guarding provisions.
- Explaining the important steps that one must follow when adding any provisions to an elevating device, including the addition of component guarding.
- Reviewing possible equipment guarding options, though this discussion shall not be construed to representing or describing all possible guarding designs.

It is not the intent of this guideline to specify or design equipment guarding, or to recommend one form of equipment guarding over another. It does present certain cautions and constraints associated with basic equipment guarding scenarios. Equipment guarding must be designed by an appropriately qualified individual, cognizant of all regulatory requirements associated with elevator equipment, and also recognizing the service and maintenance implications associated with various guarding designs and provisions. The installation of elevator equipment guarding must be carried out by qualified contractors, licenced with the TSSA to work on elevator equipment. Failing that, it is the responsibility of the owner of an elevating device to ensure that any work done inside an elevator machine room is done under the direct oversight and supervision of an appropriately qualified and licensed elevating devices mechanic.

### **QUESTION: Who can I contact with respect to the specific guarding requirements for my elevator equipment?**

The first point of reference should be the relevant legislation this guideline; this Guideline is a resource that can provide further understanding of the legislative requirements. This document presents the do's and don'ts in terms of elevator machine room equipment guarding. However, this guideline is not all encompassing. As such, it is best to contact an elevator industry specialist, starting first with your equipment's maintenance and service provider or provincially licensed elevating devices consultant, knowledgeable and competent with this issue. Your maintenance provider should be able to provide technical guidance in terms of equipment guarding. It is not the position of either the MOL or the TSSA to advise as to how to guard this equipment. The best approach is to understand the legislative requirements for guarding and the special needs or requirements of the equipment involved. Only then can a truly practical, functional, cost effective and code compliant design be realized.

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**QUESTION: Who is responsible to pay for elevator machine room equipment guarding?**

First line of responsibility lies of course with the equipment owner. As owner and operator of such equipment, the owner is responsible to ensure all equipment and operating devices within the buildings are kept in a safe operating condition. In addition, the workplace must be kept as safe as possible and free of all known hazards.

**QUESTION: Why is the MOL calling the lack of equipment guarding as deficient and not the TSSA?**

The MOL's mandate is to regulate and enforce the requirements to protect worker health and safety. The elevator machine room is considered a building workplace location. As such, it then comes under the requirements of the **OHSA** and its associated regulations such as **O. Reg. 851**. As the TSSA does not mandate, nor supervise compliance with **O. Reg. 851**, they are not in a legal position to list equipment guarding, other than the provisions as mandated under the **B44** Elevator Safety Code, as a deficiency. It does not come under the regulations that the TSSA has been mandated to enforce.

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## Part 5

# REVIEW OF REGULATORY REQUIREMENTS

## 5.1 SUMMARY OF REGULATORY REQUIREMENTS

There are a few sources which must be considered when adhering to guarding requirements.

1. **Ontario Regulation 851** (Industrial Establishments)
2. **Ontario Regulation 209/01** as amended by Ontario Regulation 252/08 (Elevating Devices), including
  - TSSA Code Adoption Document, as referenced in Ontario Regulation 223/01
  - TSSA's latest Director's Order related to Alterations of Elevators, Dumbwaiters, Materials Lifts, Freight Platforms, Escalators and Moving Walks per the CSA **B44-07** Code
3. Ontario Electrical Safety Code, and
4. ASME **A17.1** / CSA **B44-07** Safety Code for Elevators

## 5.2 CRITICAL ELEMENTS OF ONTARIO REGULATION 851

All workplaces are to ensure that workers are not exposed to the hazard of moving parts or in-running nip hazards on machinery. Workplaces that are defined by the **OHS** as industrial establishments are required that the machinery be guarded in accordance with Section 24 and 25 of **O. Reg. 851**.

As was previously noted the requirements of **O. Reg. 851** are objective or performance based. They do not instruct nor advise how to guard equipment. They simply require that equipment in these spaces must be guarded.

The following are the key or essential articles with respect to equipment guarding, which, by association, are being applied to elevator equipment as found within machine room spaces.

### Machine Guarding

24. Where a machine or prime mover or transmission equipment has an exposed moving part that may endanger the safety of any worker, the machine or prime mover or transmission equipment shall be equipped with and guarded by a guard or other device that prevents access to the moving part. R.R.O. 1990, Reg. 851, s. 24.
25. An in-running nip hazard or any part of a machine, device or thing that may endanger the safety of any worker shall be equipped with and guarded by a guard or other device that prevents access to the pinch point. R.R.O. 1990, Reg. 851, s. 25.

Both of the above conditions are found with rotating elevator equipment. Upon entering an elevator machine room space with equipment in operation, one is confronted with turning sheaves, rotating brake drums, rotating selector components, and rotating governor elements, all of which constitute hazardous conditions that, by the above two regulatory requirements need to be guarded.

As an alternative to guarding, it is possible to provide such equipment with a protective element to ensure all aspects of movement are stopped, and be prevented from further operation, upon a worker's entry into the machine room space or perhaps upon approach to the equipment. Disconnecting power from the elevator system

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upon entry to a machine room is generally impractical for an elevator application, since this would lead to a complete loss of service or use of the device or devices (if multiple units are in a room) at the time of the worker's entry into the machine room. It could also result in elevator passenger entrapments, as the cars would have to immediately stop whenever the machine room door was open. Individualized enclosures may meet guarding requirements and would allow individual machines to shut down if the enclosures were constructed to remove power once opened. However, consideration would need to be given to ensure that equipment would not start if the enclosure was large enough for full bodily entry as well as prevent the access door from being closed with someone inside the guarded area.

### **5.3 OTHER CRITICAL REQUIREMENTS IN ONTARIO REGULATION 851**

In addition to the guarding of moving machinery, **O. Reg. 851** has requirements to ensure that elevator equipment maintenance or service repairs can only be done while the equipment is stopped and in such a manner so the equipment will not activate or re-energize. These requirements are covered in section 75 and 76.

#### **Maintenance and Repairs**

- 75.** A part of a machine, transmission machinery, device or thing shall be cleaned, oiled, adjusted, repaired or have maintenance work performed on it only when,
  - (a) motion that may endanger a worker has stopped; and
  - (b) any part that has been stopped and that may subsequently move and endanger a worker has been blocked to prevent its movement. R.R.O. 1990, Reg. 851, s. 75.
  
- 76.** Where the starting of a machine, transmission machinery, device or thing may endanger the safety of a worker,
  - (a) control switches or other control mechanisms shall be locked out; and
  - (b) other effective precautions necessary to prevent any starting shall be taken. R.R.O. 1990, Reg. 851, s. 76; O. Reg. 230/95, s. 1.

The preceding excerpts from the Regulation detail the requirement for protection to ensure workers are not endangered by rotating equipment. Sections 75 and 76 go one step further, requiring that when working on the equipment, protection must be provided to ensure the worker cannot get entangled, pinched, crushed or otherwise injured. In other words, if guarding must be removed for servicing, inspection, adjustment, lubrication or any other service task, additional measures must be in place to protect against the unplanned start up or exposure to severe hazards associated with the equipment.

It is important to realize that the requirements and protective measures utilized to address the specific concerns as noted in Sections 24, 25, 75 and 76 are administered and enforced by MOL, and only MOL. The TSSA has no jurisdiction in the determination or enforcement of these requirements. The regulations and requirements enforced by the TSSA are noted below.

### **5.4 RELEVANT REQUIREMENTS FROM ONTARIO REGULATION 209/01 (ELEVATING DEVICES)**

The following requirements and regulations are enforced and monitored by the TSSA.

When it comes to the requirements for elevator machine room equipment guarding, additional elevator industry specific requirements can be found in **Ontario Regulation**

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**209/01** (Elevating Devices). The following sets out key elements or requirements as found within this regulation that must be recognized and followed when it comes to implementing machine room equipment guarding.

From **Ontario Regulation 209/01** (Elevating Devices) section 10 (2) suggests that some allowances may be necessary for the inspection and testing of elevating devices. However safe work procedures are required in these instances as described in sections 10, 22 and 24.

**Safe Behavior**

- 10. (2) No person shall remove, displace, interfere with or damage any device installed in or about an elevating device for its safe operation except,
  - (a) a person making an inspection under this Regulation; or
  - (b) a contractor for the purpose of making a test or repair. O. Reg. 209/01, s. 10 (2).

**Duty of contractor**

- 22. A contractor shall take every precaution reasonable in the circumstances to ensure that his, her or its employees comply with the Act, this Regulation, the code adoption document and any applicable director's order. O. Reg. 209/01, s. 22; O. Reg. 252.08, s.14.

**Where no work to be done**

- 24. (1) No person shall undertake any work on an elevating device unless the person is employed by a contractor and is either a mechanic or a mechanic-in-training working under the supervision of a mechanic. O. Reg. 252/08, s. 15.
- (2) No person shall be involved in a task that is necessarily ancillary or incidental to the installation or maintenance of an elevating device unless they are supervised by a mechanic. O. Reg. 209/01, s. 24 (2).
- (3) No mechanic shall be assigned or undertake work beyond the scope of his or her certificate or, in the case of passenger ropeway mechanics, beyond the scope of his or her experience or training. O. Reg. 209/01, s. 24 (3).

These sections of **O. Reg. 209/01** serve to mandate that only qualified persons can work on or around elevator equipment within the Province of Ontario. No one is permitted to knowingly modify or alter an existing elevating device, without having the proper qualifications and certification.

**QUESTION: How does this effect elevator machine room equipment guarding?**

These regulations require an elevating device owner to ensure that only those qualified to perform work on elevator equipment are involved in the installation of machine room guarding. In other words, one cannot hire any trade to undertake this work, at least not without having it done under the direct supervision of an elevator mechanic or elevator contractor.

**5.5 ADDITIONAL REQUIREMENTS AS SET OUT IN THE B44 SAFETY CODE FOR ELEVATORS**

The **A17.1/B44** Code, developed as a national standard by ASME and CSA, governs the design, installation, performance, maintenance, and alteration requirements associated with elevator equipment. However, unlike the requirements of **O. Reg. 851**, the requirements of the **A17.1/B44** Code stem from or are based upon those in

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effect at the time of the original equipment's installation. In other words, changes in the **A17.1/B44** (with the exception of equipment maintenance requirements) are not retroactive, and the latest revisions are normally not mandated unless the equipment in question is undergoing an alteration or change, and typically, the newest requirements of the **A17.1/B44** are assigned only to the component or equipment being changed, not the installation as a whole.

Under the current **A17.1/B44**, the installation of equipment guarding to an existing elevator installation is not yet defined as an "alteration". Nonetheless, the TSSA, through requirements specified in an alteration guideline (supplemental requirements to **O. Reg. 209/01** and as recently published under TSSA Director's Order 226/07), has recognized the "addition" or "modification-change" of machine guarding. It is now considered a defined alteration that requires notification of this type of work (filing of a Minor B alteration notice is required). Filing a Minor B alteration notice with TSSA is required to ensure that installation work is undertaken by authorized contractors, using certified elevating devices mechanics. It will also be used by the TSSA to check and ensure all guarding provisions as installed comply with industry specific requirements as set out in the **A17.1/B44** Elevator Safety Code. However, the TSSA will neither certify, nor confirm that equipment guarding will meet the requirements and expectations of the MOL. Put another way, TSSA review is required to ensure the guarding provisions will not detract from the technical safety requirements as set out in the Elevator Safety Code and MOL is the only authority that can enforce guarding in accordance with the legislative requirements to protect worker health and safety. Acceptance by one entity does not ensure that compliance has been met with the regulatory requirement of the other.

It is not within the mandate of MOL to certify or to provide design criteria for the guarding of elevator machinery to comply with the requirements of Section 24 and 25 of **O. Reg. 851**. Section 7 of **O. Reg. 851** prescribes the conditions whereby an employer is required to conduct a Pre-Start Health and Safety Review (PSR). Where a PSR is required in order to achieve compliance with Section 24 and 25 of the Regulation, Subsection 7 (11) of the Regulations prescribes that the PSR be conducted by a professional engineer. Protective elements such as guards for elevator machines should be manufactured in accordance with current applicable standards. The Canadian Standards Association Standard **Z432**, Safeguarding of Machinery is one of the standards that can be used to support compliance with Sections 24 and 25 of the Regulations. Other standards that can be used to support compliance with these sections of the Regulations are listed in the MOL publication "Guidelines for Pre-Start Health and Safety Reviews: How to Apply Section 7 of the Regulations for Industrial Establishments."

It is in the long term interest of the Building Owner to ensure that any guarding as installed on elevator machine room equipment is both compliant with occupational health and safety requirements, as well as conforms to stated **A17.1/B44** requirements. Failure to do so will prove expensive.

From the most recent **A17.1/B44** Safety Code for Elevators, guarding requirements for new elevator equipment can be found in section 2.10. Note these same requirements would apply to an existing installation that is having its current machine replaced with a new unit.

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### **A17.1/B44 2.10.1 Guarding of equipment**

In machine rooms and secondary machinery spaces, the following shall be guarded to protect against accidental contact:

- (a) driving machine sheaves and ropes whose vertical projection upon a horizontal plane extends beyond the base of the machine
- (b) sheaves
- (c) exposed gears, sprockets, tape or rope sheaves, or drums of selectors, floor controllers, or signal machines, and their driving ropes, chains, or tapes
- (d) keys, keyways, and screws in projecting shafts Hand winding wheels and flywheels that are not guarded shall have yellow markings.

In addition to requirement 2.10.1, **A17.1/B44** provides the following requirements for working clearances and other important design requirements. These additional requirements involve dimensions that must be factored in to the design and installation of any stationary guarding provisions for elevating devices equipment.

### **A17.1/B44 2.7.2 Maintenance Path and Clearance**

- 2.7.2.1 A clear path of not less than 450 mm shall be provided to all components that require maintenance.
- 2.7.2.2 All components requiring maintenance in machinery spaces and control spaces shall have safe and convenient access.
- 2.7.2.3 A clearance of not less than 450 mm shall be provided in the direction of required maintenance access.

## **5.6 REQUIREMENTS FROM THE ONTARIO ELECTRICAL SAFETY CODE**

In addition to **O. Reg. 851**, and the above noted TSSA mandated regulations, there are additional provisions as set out within the Ontario Electrical Safety Code that also need to be taken into account, when planning elevator machine room equipment guarding.

The Ontario Electrical Safety Code requirements are derived from the Canadian Electrical Code Part I, **C22.1-02**, and those relating to elevating devices can be found in Section 38 of the Ontario Electrical Code. Several sections of this Standard, that are not specific to elevating devices, do affect the design of such equipment. For example, there must be sufficient horizontal clearance measured in front of the working electrical components within an elevator controller, as well as in front of all disconnect switches. This clearance is to be 1 metre, measured out from the face of the disconnect switch or controller.

It is suggested that one familiarize themselves with all requirements as set out within Section 38 of this Standard, however, Rule 38-004 merits specific mention as it relates to the guarding of live electrical equipment.

### **38-004 Live Parts Enclosed**

All live parts of electrical apparatus in hoistways, at the landings or in or on the cars of elevators, dumbwaiters, material lifts, and lifts for persons with physical disabilities, or in the wellways or at the landings of escalators or moving walks, shall be enclosed to protect against accidental contact.

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**QUESTION: Where can I get copies of these relevant regulations?**

Copies of **Ontario Regulation 851** are available from the Province of Ontario bookshop or electronically from the Government of Ontario web site [www.e-laws.gov.on.ca](http://www.e-laws.gov.on.ca) and searching for this regulation under the **Occupational Health and Safety Act, R.S.O. 1990**.

Copies of **Ontario Regulation 209/01** Elevating Devices are available from the Province of Ontario bookshop or electronically from the Government of Ontario web site [www.e-laws.gov.on.ca](http://www.e-laws.gov.on.ca) and searching for this regulation under the **Technical Standards and Safety Act, 2000, S.O. 2000, c.16**.

Copies of the Elevating Devices Code Adoption Document are available from TSSA's web site, found at [www.tssa.org](http://www.tssa.org). Click on the tab titled "Elevating Devices", and then follow the links to TSS Act & Safety Regulations.

Copies of the latest **A17.1/B44** Elevator Safety Code are available from Canadian Standards Association, either at their bookstore or electronically. Contact [www.csa.ca](http://www.csa.ca)

**QUESTION: What do I do if I get an MOL order that I disagree with?**

The inspector is expected to have explained the reason the order was issued. If you do not understand what the order was issued ask the inspector who wrote the order to explain the order. The inspector's contact information should have been provided to you on the field visit report that was issued during the visit.

If you still do not agree with the order consider whether you wish to appeal the order to the Ontario Labour Relations Board (OLRB). The contact information of the OLRB is contained in the field visit report that contained the order. The OLRB will decide if the order was issued in accordance with the law so you should contact an expert on the issue for which the order was written to determine if the order was indeed written in error.

It is important to either comply with an order or to appeal it formally before the compliance date. Ignoring an order may lead to increased enforcement activity up to an including prosecution.

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## Part 6

# MOL BACKGROUND INFORMATION

The Ministry of Labour's mission is to advance safe, fair and harmonious workplace practices that are essential to the social and economic well-being of the workers of Ontario. The Ministry's mandate is to set, communicate and enforce workplace standards while encouraging greater workplace self-reliance. The Ministry of Labour (MOL) administers the **Occupational Health and Safety Act (OHSA)** and the Regulations made under the **OHSA** (e.g. Regulations for Industrial Establishments).

The following will provide the Elevator Equipment Guarding Task Group with background information on the MOL intervention strategies to reduce workplace injuries.

- In 2004, the Minister of Labour introduced an intervention strategy to reduce the number of workers injured or killed on the job. The goal of this intervention strategy was to reduce illness and injuries that are serious enough to require time off work (lost-time injuries, or LTIs) by 20 per cent over four years: 2004 - 2008.
- To improve its enforcement role, in 2004, the MOL committed to hiring an additional 200 inspectors; many to be focused exclusively on the intervention strategy.
- This increase in enforcement presence by MOL, coupled with the intervention strategy, has resulted in MOL proactively visiting firms that may not have been visited from MOL prior to 2004 (e.g. retail, office and related services, tourism, hospitality and recreation sectors). Many of these firms have elevating devices on the premises, which are included as part of the workplace, and therefore can be inspected by an MOL inspector.
- Due to this intervention strategy, Ontario achieved a 20 per cent reduction in the annual rate of workplace injuries by 2008.

In June 2008, MOL launched a new four year workplace health and safety compliance strategy called *Safe at Work Ontario*.

Under this new direction, the Ministry identifies and engages workplaces according to a variety of factors.

The new identification criteria for workplaces to be inspected proactively are (but are not limited to):

- injury rates and associated costs
- compliance history
- hazards inherent to the work
- new businesses
- size of businesses
- specific events or incidents (e.g., critical or fatal injuries, or violence)
- new and/or vulnerable workers.
- injury rates and associated costs are determined through the use of WSIB data.

The new direction seeks to improve the health and safety of Ontario's workplaces. MOL inspections will focus on ensuring that an effective Internal Responsibility System (IRS) is in place, supported, where required, by a well-functioning Joint

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Health and Safety Committee. This is central to supporting the development of sustainable compliance through sustainable workplace health and safety culture.

As with the previous strategy, *Safe at Work Ontario* continues to focus on improving workplace health and safety practices through education, training, and enforcement of provincial legislation and regulations through partnership with the WSIB and Ontario's Health and Safety Associations. MOL's main concern is enforcement of the **OHSA**; WSIB focuses on prevention, and the Health and Safety Associations concentrate on training and education.

With respect to the evaluation of companies' injury-prevention performance, the Ministry analyzes data on workplace injuries as reported each year by employers to the WSIB. The analysis identifies companies with the highest injury rates and injury costs relative to other companies within their WSIB rate group. Companies can obtain a profile of their data from WSIB.

The level of MOL engagement for proactive inspections will depend on many factors, including:

- the nature and extent of past non-compliance identified, and the corrective actions required by the firm to achieve compliance
- the presence of a well defined, appropriate and sustainable IRS, consisting of a well functioning Joint Health and Safety Committee structure (where required) and suitable training and certification of members
- a firm's commitment to a strong culture of health and safety, including an appropriate level of health and safety awareness throughout the organization and an environment which fosters a commitment by workers, supervisors and the employer to prevent occupational injuries and illnesses.

Many regulations, codes and standards apply to the elevator industry in the province of Ontario. Both the Technical Standards and Safety Authority and MOL have jurisdiction with respect to elevators and accompanying legislation that employers must comply with; MOL being responsible for worker health and safety. It should be noted that Section 2 (2) of the **OHSA** indicates that "despite anything in any general or special Act, the provisions of this Act and the regulations prevail".

**QUESTION: What are the key elements associated with equipment guarding that I need to be aware of?**

Recently, an MOL representative summed up the expectations for equipment guarding with the following salient points:

- Moving parts must be guarded, unless they are locked out when entering the room.
- A locked door is not considered guarding unless moving parts are locked out prior to entering the room.
- Repairs are only to be done on mechanical components with the equipment locked out. For other nearby equipment that has exposed moving parts, a gate or barrier (guarding by distance) could be used to provide worker protection.

**Note:**

The first two options would be impractical for use with elevators, as they could lead to the inadvertent entrapment of passengers whenever the machine room access door was opened.

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## Part 7

# EXPLANATION OF HAZARDS AND HAZARD RANKING

Within this Section, we present a table showing common equipment components as found within a typical elevator machine room and their respective potential hazards. Photographs showing these components and highlighting the location of their most significant point of hazard are presented in Appendix Section C of this Guideline.

There are seven potential hazards that are listed, which by no means should be construed as being the definitive risks involved. Each machine room must be assessed on the merits of its unique design and type of equipment as contained therein. Therefore, it is critical that a proper hazard assessment be undertaken of each installation before finalizing the design and implementation of equipment guarding. Secondly, such guarding must be designed by knowledgeable and experienced industry persons cognitive of not only the known hazards, but also the required operating, servicing and maintenance requirements for the equipment in question. There is little benefit in providing guarding that is insensitive or constraining to the servicing and maintenance requirements of the equipment. Unlike process equipment, elevating devices transport persons in addition to freight and other materials. As such, the maintenance of the safe operation of the equipment is critical, and any guarding provisions must factor into its design, equipment servicing and access for inspection. A more detailed discussion of these requirements is presented in the following section.

## 7.1 COMMON HAZARDS

The seven most common hazards found within an elevator machine room or secondary level spaces are;

- **Entanglement** – exposure of limbs or clothing to being snagged by moving equipment, causing the worker to lose their balance and possibly be drawn into the moving element. The most common form of this exposure is found in a traction elevator machine room with ropes traveling over sheaves, or as found with high speed rotating shafts having exposed keys or other projections.
- **Pinching or nipping** – components or equipment elements that through changing positions or rotation can pinch or nip a worker's limbs, commonly fingers, or clothing.
- **Shearing** – components that through accidental contact can actually cause the loss of body parts.
- **Crushing** – similar to nipping but more destructive and damaging effects.
- **Abrasion** – components such as moving ropes or belts whose operation can lead to cutting injuries when contact with exposed skin occurs.
- **Tripping** – a common hazard in many machine rooms, given the location and positioning of operating equipment. Many components are mounted low to the machine room floor (i.e. governor or motor generator set), and can often cause a

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person to fall over, especially when backing up without being aware of equipment positioning.

- **Electrical Shock** – injury caused by momentary contact with live, unprotected electrical circuitry or components. Incoming voltages in elevator controls can range from 208 VAC to 600 VAC, and many drive motors operate at either building incoming power or variations thereof (i.e., between 240 and 460 volts).

## 7.2 TABLE A – HAZARD IDENTIFICATION CHART & PHOTO REFERENCE SUMMARY

REF.	COMPONENT	HAZARD							REF. PHOTO
		Entanglement	Pinching	Shearing	Crushing	Abrasion	Tripping	Electric Shock	
1	DRIVE SHEAVE & ROPES (Geared)	■	■	■	■	■			01, 02, 09, 10
2	DRIVE SHEAVE & ROPES (Gearless)	■	■	■	■	■			03, 04
3	DRUM MACHINE & ROPES	■	■	■	■	■			05, 06
4	HOIST ROPE					■			07, 08
5	DEFLECTOR/IDLER SHEAVE (Bmt Traction)	■	■	■	■	■			09, 10
6	DEFLECTOR SHEAVE (O.H. Traction)	■	■	■	■	■			11, 12
7	DOUBLE WRAP SHEAVE ( Secondary Sheave)	■	■	■	■	■			13, 14
8	BRAKE DRUM & SHOES	■	■		■				15, 16, 17
9	BRAKE COIL ASSY				■				18
10	MOTOR (Geared)	■	■			■		■	19, 21
11	MOTOR (Gearless)	■	■			■		■	20, 22
12	MOTOR ENCODER/TACH	■	■		■	■			23, 24
13	MOTOR GENERATOR	■	■			■		■	25, 26
14	GOVERNOR	■	■		■	■	■		27, 28
15	SELECTOR	■	■	■	■			■	29, 30
16	SELECTOR SHEAVE / SPROCKET / TAPE	■	■	■	■	■	■		30, 31

## 7.3 REFERENCE PHOTOGRAPHS AND ADDITIONAL MATERIAL

To assist in the discussion and understanding of the equipment as referred to in this guideline; we have included a number of photographs showing the equipment in question, for the most part in an unguarded condition. Please refer to Appendix C.

A high level review of specific guarding design requirements, as set out in the CSA Standard **Z432** titled “Safeguarding of Machinery” is presented in Appendix B.

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## Part 8

# EQUIPMENT GUARDING & SPECIFIC ITEMS OF CONCERN

Within this section, we will review equipment guarding requirements and design options available for the typical elevator machine room application.

Given the myriad of possible equipment designs, arrangements and machine room locations, it is impractical to cover all possible scenarios. We recommend the equipment Owner refers to an elevator specialist for a review and discussion of final guarding provisions. It is our hope that the details as furnished herein will allow the Owner to recognize the specifics of the equipment in question and understand important design issues relating to such equipment. Refer also to Appendix Section B which sets out additional design criteria for guarding as found within the CSA **Z432** standard.

This section will cover a typical traction elevator machine room arrangement, with guarding provisions being relevant to both geared and gearless equipment. Hydraulic elevator applications will only be given a brief review at the end of this Section, as the vast majority of these types of elevators now have their pump and drive motor contained within their oil reservoir, well away from inadvertent contact. We have not included a discussion relating to the new generation of elevator equipment commonly referred to as Machineroomless or MRLs, as their drive equipment is located within the hoistway. However, the same principals discussed in this Guideline can be applied to these types of installations.

Finally, within this section we use a number of industry specific terms and nomenclature. Please refer to Appendix Section A Glossary for an explanation of these references. Wherever possible we have included references to specific photographs contained within Report Appendix Section C, to enhance the reader's understanding of the equipment being discussed.

## 8.1 ESSENTIAL DESIGN ELEMENTS

The preceding sections of this guideline have presented a review of the rationale and reasons for the guarding of elevator machine room equipment. Before commencing a discussion of various equipment guarding options, it is important to first present a review of the essential design elements associated with such guarding provisions. This is to ensure that all are understood and incorporated into the final design, fabrication and installation of equipment guarding provisions.

1. Guarding provisions shall be designed to protect workers from the list of all possible hazards as explained in the preceding section.
2. Guarding should be designed so as to not hinder the inspection maintenance, service and testing of the equipment, the lack of which could impact public safety.
3. Guarding provisions need to be designed in accordance with the requirements of established regulations. Failure to comply will increase costs and could adversely affect worker safety, not to mention being deemed non compliant. Guarding provisions must be designed so as not to hinder or impair equipment operation.

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4. Guarding shall be designed to protect workers in all aspects of the equipment's function, both under normal operation and those evident or encountered during equipment servicing and adjustment tasks.
  5. Equipment cannot be allowed to run with guarding provisions removed, opened or otherwise circumvented without additional worker safety safeguards being implemented.
  6. Guarding should be designed so it will allow for visual awareness of all rotating elements, even when in place.
  7. Guarding shall be designed so it can be readily removable or openable with the use of a standard tool and without requiring the efforts of more than one technician or worker. It should not require the use of hoisting or lifting devices to effect its removal or reinstallation.
  8. Guarding provisions shall not impinge upon Elevator Safety Code required working clearances or adversely compromise safe access requirements to the equipment.
  9. Guarding provisions should be designed so as not to complicate or impair access to equipment for both routine / normal maintenance and typically expected service work (i.e., removal of drive motor or motor generator set for repair, or the change of suspension ropes, etc).
  10. Guarding means more than providing a cage or enclosure around moving equipment, or installing insulated protection around high voltage equipment. It must be recognized that elevator equipment may need to be operated or run with their primary guarding provisions removed for service access and adjustment purposes. As such, guarding must also include secondary or ancillary protection to ensure the known hazards associated with the equipment remain mitigated. More often than not, such secondary guarding provisions will entail more than just supplementary screening. Given the range of options available, it is recommended that such provisions be established in conjunction with the working practices of the elevator equipment contractor.
  11. Guarding shall be installed by qualified companies using certified elevating devices mechanics or under the supervision of a certified elevating devices mechanic. Once complete, the appropriate authorities must be advised. A Notice of Filing for a Minor B alteration must be sent to TSSA's elevating devices engineering office within 30 days following completion of the work. This document should be completed and submitted by the elevator contractor who performs or supervises the work.

## **8.2 ADDITIONAL GUARDING CONCERNS**

1. A locked machine room access door does not constitute sufficient equipment guarding. Additional safeguards are required and are being enforced by the MOL.
2. It is not recommended to use or consider guarding devices that will cause an elevator machine to stop should a person approach within a certain distance of its machine (i.e. pressure mat). It is possible that the elevator cabin could be carrying people, and such provisions could lead to passenger entrapments and possible injuries from sudden stops.

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3. Do not enclose or encase a machine and motor, rendering visual inspection of its rotating elements impossible. Elevators demand periodic and ongoing maintenance (in Ontario, periodic maintenance and inspection is a mandated requirement). Provisions that reduce or constrain visual inspection of the equipment can impair public safety, by complicating service access.
  4. Fasteners or connections used to secure guarding in place should use or incorporate common type fasteners (i.e., Slot, Phillips, or Robinson heads). Do not use wing nuts or butterfly type nuts or fasteners that will permit dismantling of the guarding. A tool should be required to dismantle, release and reconnect guarding fasteners.
  5. Guarding means must be constructed of fire resistive material. It cannot be allowed to add to the potential fire loading as found within the machine room prior to its installation.
  6. Any guarding provisions that impair or hamper service access to the equipment can result in higher ongoing equipment maintenance costs. Such charges will become an ongoing cost as they will be realized over the entire life cycle of the equipment.

### **8.3 SUGGESTED GUARDING SYSTEMS AND METHODOLOGY**

Before considering a suitable design for equipment guarding, one must first understand exactly what needs to be guarded.

Within a typical machine room one will likely find the following:

- Electrical Disconnects
- Machine (geared or gearless or drum type)
- Machine brake
- Drive motor
- Encoder
- Motor Generator Set
- Selector
- Car Controller Cabinet
- Group Dispatcher or Common Relay Panel Cabinet
- Car Governor
- Counterweight Governor
- Rope Gripper
- Light fixtures and light control switch
- Fire alarm devices
- Hoist beam
- Power receptacles
- HVAC equipment (used to service the elevator equipment room or space)
- Deflector Sheaves

For pictures of these various components, please refer to Appendix Section C – Reference Photographs.

Several of the above noted elements will not require guarding, and as such we make no further mention of them. They include;

- Electrical Disconnects

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- Light fixtures (except as required by CEC **C22.1** rule 30-314)
  - Light control switch
  - Fire alarm devices
  - Hoist beam(s)
  - Power receptacles

In the following discussion, we will review the specifics of each of the components to be guarded, itemizing specific guarding concerns and recommended provisions.

Now that we have identified the items that need to be guarded, it is time to consider the broad range of guarding designs and alternative systems available. Perhaps the most instructive method of reviewing available options is to discuss the two philosophies that, for the most part, represent opposite ends of the scale in terms of approaches to equipment guarding. One approach, identified as Option A, can be considered a macro or large scale effort. Under this scheme barriers are designed and erected around major components of whole elevator systems within the room – a type of global guarding. For example, this can result in the fencing in of major sections or sectors of the elevator machine room as opposed to guarding individual components.

At the other end of the scale is an approach that we will call Option B. This entails a modular design of guarding specific components of the elevator equipment, a micro level of safeguarding.

Either option, when comprehensively designed and constructed can comply with the guarding requirements of the Act. By extension, design options using a combination of these two philosophies can also be compliant with guarding requirements and regulations.

Option A is often simpler to design and quicker to install. Its simplicity is tempting to stakeholders. However, caution is urged to ensure the guarding system has been properly designed to include all regulatory and practical considerations. There are code issues specifying minimum working and walk around clearances associated with elevator equipment that must be adhered to. These are explained in greater detail within this section. Other considerations include;

- Are the barricades practical for a single maintenance technician or inspector to remove or restore.
- Will they impede service access to equipment
- Will they hide or hinder access to the equipment's electrical disconnects or circuit breakers
- Is it practical to remove all power from the enclosure equipment prior to entry through the barricade.

While simply to construct, Option A demands a more comprehensive analysis of regulatory and practical requirements. Involvement from the appropriate professionals is absolutely critical when considering this option.

Option B, is where individual components of the elevator equipment are fashioned with individual guards. Over speed governors and car selectors are good examples with individual components that can be effectively equipped with their own guards. Brakes and drive sheaves, mounted on to a machine would represent separate components or modules within one system (the drive machine) that would be guarded

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separately. One of the major benefits of Option B is that a technician need only remove the component guard to conduct maintenance or undertake work. While performing such work, the technician remains protected from other hazards through the retention of other guards within close proximity of the brake.

## **Machine**

All elevator machines have rotating sheaves which, left unprotected, can cause entanglement, pinching, crushing and abrasion injuries. Therefore, a first step to eliminating such hazards is to provide a guard that will shield access to its rotating elements.

In the case of geared machines, the speed reduction gear is already housed within its own protective enclosure (gear case), and these typically have covered inspection ports. No additional guarding should be required for this element. However, its drive sheave, deflector sheave(s), drive shaft, brake and motor elements need guarding protection. Guarding provisions for drive motors, deflector sheaves and brakes will be discussed separately below.

Drive sheaves are normally more accessible as deflector sheaves on a typical overhead installation are most often found below the machine room floor slab as shown in Photo #12.<sup>1</sup>

There are two potential options to guarding a typical geared machine. One approach is to provide each machine with its own specific and individual modular guarding system – the Option B approach. In this scheme various components of the systems are individually guarded or protected in a modular fashion, all part of a comprehensive approach used for each elevator within the same enclosure. The other alternative, Option A's approach entails the construction of a single protective enclosure, a more perimeter or barrier type approach, separating all or individual machines so they are located behind a protective cage. In essence, construct a partition within the elevator machine room, separating the drive or controller equipment from its drive machine and motor. As will be pointed out below, when considering the common guard approach, one must be careful to ensure that secondary guarding or lockout provisions will be available to protect workers on the machine side of the guard or barrier.

### *INDIVIDUAL GUARDING*

This option will see a protective enclosure constructed around the drive sheave and deflector sheaves plus other equipment described within. This enclosure should be constructed of steel, for fire resistance and stiffness purposes. Ideally, the enclosure around the sheave should be designed so it is perforated, allowing one to view through the enclosure to the rotating elements encased beneath. The size of these perforations must be designed taking into account the minimum distance from the hazard as a function of the barrier opening size (see Appendix Section B – Table 3). If the distance to the hazard is close, openings in the enclosure should be sized so as not to allow objects such as fingers to pass through and make contact with rotating

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<sup>1</sup> Recent elevator equipment designs now have the deflector sheaves on a typical overhead machine located within the machine room. This requires the machine be placed on a podium or support stand, raising the machine bedplate well above the machine room floor slab level, thereby allowing the entire deflector sheave to be positioned above the machine room floor slab.

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equipment. Typically, the allowable size of such openings will depend upon the distance from the guard to the surface of the machine located behind.

In addition, a guard must be installed so there is sufficient clearance between it and the rotating or moving surface enclosed underneath. Ideally, the horizontal and vertical clearances between the underside of the protective enclosure and the rotating surfaces located below should be no less than 12 mm, measured at the highest point (on drive and deflector sheaves this is usually the top of crown of the suspension ropes as they sit within the sheave grooves).

It is important that there is sufficient vertical and horizontal clearance that allows for the movement of the suspension ropes. Where suspension ropes are led off to a deflector sheave, sufficient clearance must be provided as to accommodate the greatest point of rope deflection. Secondly, many installations require a changing angle of downward deflection measured off the sheave to the car (and sometimes the counterweight). Refer to Photo #1 and note how the ropes are running down off the drive sheave down below the floor. In this photo, the ropes look to be in the same horizontal plane. However, as the elevator cab moves closer to the machine room floor slab, the ropes will start to splay apart. This is caused by the alignment and mounting arrangement of the rope hitch on the car top. There is a second concern, commonly referred to as “rope draw”. This tends to be more pronounced on the side of the machine that does not have a deflector sheave. As the car (or counterweight) moves up and down the hoistway, the pull off angle of the ropes, measured from the surface of the drive sheave increases. The extent of such movement can be more than 100 mm. This aspect of rope performance must be recognized and be appropriately compensated for in the design and installation of the machine guarding.

It is not recommended to use Plexiglas or other clear, non perforated materials when guarding drive sheaves and deflector sheaves. Suspension ropes are routinely lubricated. The resulting splash of rope lubricant and grease will eventually coat the underside of any clear material occluding vision of the ropes behind.

Ideally, sheave guards should be designed to allow the certified elevator mechanic to remove only a portion of the guard assembly, to view and access the surface area of the sheave and its ropes. This removable section should allow for unobstructed review (when removed) of the sheave crown (top of the sheave), rope crowns (apex point of travel for the suspension ropes as they pass around the sheave). It is also important to review the condition of the sheave grooves, so access to the clear part of the sheave (as best shown in Photo #7) should also be provided with internal nip guards.

Sheave guards must allow for ready access to points of lubrication (i.e. grease fittings, oil level measuring port, and crown gear inspection portals). It is important that there is easy access to all points requiring lubrication and that such access should be made readily available without requiring the removal of extensive sections of guarding.

It must be recognized there are times where it will be necessary to operate the elevator, under controlled circumstances (i.e. not automatic operation) where unfettered access is available to the machine (i.e., with sections of the primary guarding removed). However, when such circumstances are necessary, additional safeguards must be provided or available that will serve to ensure that workers remain protected from known hazards. In other words, it is not acceptable to operate elevator equipment without guarding or additional safeguards. Exactly what form these secondary or ancillary protection means take should be determined in

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conjunction with one's elevator maintenance service provider. It is likely that such additional or back up safeguards may be composed of a combination of additional measures (i.e. dead man switch) or other workplace procedures. They would be designed to ensure worker safety is not compromised to the same degree as available with the primary or main guarding provisions.

### *COMMON GUARDING*

This scheme entails an assembly consisting of a simple protective screen that prevents normal access to the portion of the elevator machine room that houses the drive machines and motors. In other words, this separation ensures a worker cannot gain access to the drive machine without first having to dismantle or unlock a portion of the screen.

It is understood that where this option is used, the technician or inspector must first disable the elevator to ensure it cannot operate once the separation screen is removed or opened up to allow direct access to the machine. Secondly, in the case of multiple elevator machines housed within a common machine room, it will be necessary to provide additional screens to ensure access to one machine does not leave an adjacent machine accessible or unprotected. Where additional screening is not provided, it will be necessary to remove adjacent cars from operation whenever service access is required to a neighbouring machine or where service is required for machine room lighting, fire alarm devices or HVAC equipment.

When planning a separation screen option, it is important to ensure the following design elements are incorporated into its design.

1. Screen may consist of openwork enclosure, with perforations sized to reject a sphere 25 mm in diameter.
2. Screen should be designed so as not to impinge on working clearances around the equipment, (allow a minimum of 460 mm horizontal clearance) between the screen and the closet edge or component of the machine. This will prevent one having to remove or open multiple sections of screening to gain access to both sides of the same machine.
3. The screen should be designed so the section that can be opened up to achieve access through to the machine side of the space and should have a minimum clear headroom height of 2,030 mm. Secondly, the clear opening width of the screen access section should be no smaller than 760 mm, or the width of the largest component that will need to be transferred through the opening as part of the installation's long term servicing, whichever is the larger.
4. It would be desirable to have the opening section hinged so as to allow for easier access. The removable or hinged section of the screen should be secured in place using fasteners or tool operated latches as opposed to a lockset.
5. Screen must be located so it does not hinder or impede access to the elevator equipment's electrical disconnect switches, machine room light control switch or machine room power receptacles.
6. Screen, when installed in front of or in close proximity to the elevator equipment disconnect switches must have at least a one metre horizontal clearance between the face of the disconnect switch and the closest section of the enclosure.

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7. Where a screen is installed, it cannot create a visual obstruction between the machine and its disconnect switch. If such an obstruction results, then an additional disconnect switch (which need not be fused) will be required. This auxiliary switch must be located so it is visible and accessible from the machine location.
  8. Screen, when installed in front of or in close proximity to side of the elevator car controller or dispatching controller (common relay panel) that requires service access, there needs to be at least one metre horizontal clearance, measured between the face of the car controller's electrical components and the opposing face of the screen enclosure.

### **Machine brake**

Guarding options for the brake are similar to those as described above for Machines. However, with respect to brakes, there are a number of additional items that need to be factored into the design of any guarding.

1. Brake spring tension needs to be regularly checked to ensure the appropriate setting is maintained.
2. On an annual basis, machine brakes need to be stripped down and overhauled as part of provincially mandated elevator maintenance requirements.
3. It is critical that regular inspections of the surface of an elevator's brake drum, as well as the condition of its brake shoes and pads, be carried out. (A leaking geared machine can result in oil leeching on to the brake drum surface, and then fouling its brake pads.)
4. Means to adjust brake spring tension cannot be constrained by equipment guarding, nor can guarding be allowed to impair the function and operation of the brake.
5. Guarding cannot impede service access to brake arm pivot pins and fittings. These need periodic lubrication.

In the event a section of guarding is removed from and around the brake and the car is energized to run, additional guarding or protection must be in place to protect workers.

### **Drive Motor**

Guarding provisions for drive motors will very much depend upon the type of motor in question. Direct current motors could require substantially greater or more elaborate guarding enclosures, especially older motor designs. Large gearless motors may prove extremely difficult to effectively guard given limited clearances between adjacent units. Such installations may necessitate a fencing or collective screening option as opposed to individual unit type guarding.

Some important design considerations specifically relating to the installation of protective guarding relating to elevator drive motors include:

1. Guarding must allow for ready inspection of motor brush rigging.
2. Guarding must allow for ready access to motor brush locations to facilitate brush replacement, stem holder positioning, plus adjustment of brush tension springs .

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3. Guarding must not impede air flow into the motor housing, particularly on motors that do not have forced ventilation provisions for temperature control.
  4. Guarding construction around motor openings must also recognize the potential hazard of electric shock, so insulating or shock resistant materials should be used where mounted close to electrical fittings.
  5. Guarding must not impair service access to lubrication portals, particularly on units having sleeve bearings.

### **Encoder**

There are some specific concerns with respect to encoder/tachometer guarding that must be covered off:

1. Guarding provisions must not impair service access to the encoder unit.
2. Guarding provisions must not impair or impinge upon the tension assembly where used to maintain encoder roller contact with the sheave rim (see Photo #24).
3. Guarding provisions should not obstruct vision of the encoder/tachometer, particularly on tachometer motors using a roller connection with the drive sheave.

### **Motor Generator Set**

The potential hazards associated with MG sets are similar to those as explained above with drive motors, including the potential for electric shock.

Guarding considerations as noted above for drive motors would also apply to motor generator sets, with important elements being visibility of brushes and brush rigging, access for lubrication, and restrictions of air flow into or out from the unit.

### **Selector**

The potential hazards associated with selectors are similar to those found with geared machines, plus the additional concern of electrical shock. Many older selectors were provided with metal covers that when affixed closed in all sides of the device. However, it is necessary to service the internal workings of a selector, something that can only be done with these covers removed. As such, the biggest impact for selector guarding provisions will be the additional safeguards to allow the selector unit to be serviced and adjusted with power to the elevator, and with its primary covers removed.

In terms of primary safeguards, the original metal protective covers for selectors should always be kept in place. Against manufacturer's recommendations, it has long been industry practice to remove selector covers and keep them off. Given the MOL guarding provisions an Owner must ensure all primary covers are kept in place. New mechanical fasteners may need to be added to these covers as discussed earlier. If not available new units will be required. Secondly, the form and means of secondary safeguards must also be worked out with the equipment's elevator maintenance company. These provisions may be addressed using workplace practices and additional control means as opposed to additional fixed guarding.

It will be critical for the Owner of an elevating device to ensure that primary and secondary means of protection are worked out and applied to installations having

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selectors, as it will no longer be acceptable to operate a selector without guarding or protection.

Setting out the appropriate secondary safeguards is well beyond the scope and focus of this guideline. There are a great number of options and alternatives available to achieve this end. The determination of such measures must involve the equipment maintenance provider in order to finalize the appropriate solution.

### **Car Controller Cabinets**

In terms of safeguards, the first order of protection must be to provide each car controller cabinet with a proper metal enclosure. Ideally, access doors into the car controller should be equipped with locks to ensure that access to their interior elements remains restricted to trained service technicians and inspectors.

Finally, controllers should be provided with protective covers to prevent accidental contact with high voltage terminals or connections. Such protection could consist of a Plexiglas screen to shield against accidental contact with terminal strips on a transformer to the installation of protective shields and screens on high voltage terminations.

On some older installations, particularly those provided with motor generator controls, a separate cabinet is provided to house starting switches and contactors. Some have no enclosure, merely a free standing slate back board. In such cases, consideration should now be given to providing such open work controllers with their own protective guarding or cabinets.

### **Dispatcher or Common Relay Panel Controllers**

An added risk with these panels is that they almost certainly have an external power source and in some cases will continue to have power to them unless all elevators are removed from service and shut down. Extra caution is urged when working in and around dispatching equipment.

### **Car Governor**

The potential hazards associated with governors are the same as noted above for machines with an additional concern of tripping over them. Some new governor designs have all elements contained within a totally enclosed cover, as can be seen in Photo #8, eliminate all serious hazards. Older type governors, plus a couple of widely used new governor designs still present several hazards.

One option is to design a protective enclosure around the car governor unit. However, when considering this alternative, please remember to ensure the housing will not impair the function and operation of the governor (particularly important when dealing with fly ball governors). Secondly, any protective enclosure must not impair the function and operation of over speed safety switches as mounted to the governor. Finally, the enclosure must be readily removable to allow for inspection, adjustment and maintenance of the governor and its various switches, actuating arms and spring tensions.

It is important to note that governor spring settings (used to set their actuating speed) are sealed by the TSSA, and it is part of normal maintenance to check the integrity of these seals (certainly this will be done by the TSSA inspector as part of their periodic inspection). Whatever protective means are provided, it must allow for ready access and inspection of these elements.

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Note that in the case of the silver coloured governor enclosure as shown in Photo #8, the top half of the enclosure can be removed to facility service access to this device.

### **Counterweight Governor**

The hazards and recommendations regarding the protection of counterweight governors are the same as noted above for car governors.

### **Rope Gripper**

In many cases, the rope gripper unit is installed in a location that has inconvenient access (i.e. located behind or underneath a machine). However, the potential for snagging, pinching or crushing hazards remain. As such, protective measures need to be installed that will prevent this from happening.

A protective metal work enclosure, encompassing the same screen design as suggested above to protect a traction drive sheave can be considered. Elements to be wary of are the need for ready access to the rope gripper device. This device uses springs as a means of applying brake pressure and hydraulics to release and reset. Its seals, lubrication of the cam surface, electrical contacts, brake pads, and other internal elements require ongoing maintenance access. Guarding must allow for its ready removal so as not to impair access to this device.

### **Deflector Sheaves**

The hazards created by such sheaves are similar to those as noted above for elevator machines: entanglement, pinching, crushing and abrasion.

Protective guarding options for deflector sheaves are similar to those as discussed above for machines. Like machine drive sheaves, it is critical to ensure ready access to deflector sheaves so as to allow service technicians to check, inspect and lubricate the sheaves.

Many deflector sheaves are installed within spaces having limited service access and low overhead. As such, any guarding provision should be sized and designed so as to allow for a single technician to remove all protection without the use of specialized hoisting means or additional labour.

Some older elevator installations have deflector sheaves with sleeve bearings as opposed to sealed bearings. These bearings require regular lubrication and most importantly require checking of internal lubrication levels.

Finally, as noted above in the discussion relating to machines, there is a degree of twist in the angle of suspension ropes as they lead off the sheave to the car or counterweight. The closer the car or counterweight approaches the top of the hoistway there is a marked turning or rotation in their horizontal alignment. This is especially important on installations using a 2:1 roping design. Twists or rotational aspects associated with hoist ropes must be known and then compensated for in the design of any guarding provisions as applied to a deflector sheave.

### **Hydraulic Elevators**

Modern hydraulic elevators have their drive motors and pumps contained within the oil tank, essentially eliminating the likelihood of contact with these moving elements. However, older hydraulic elevators and newly installed “dry” type machine designs have the drive motor and pump unit located underneath the oil tank where they are more accessible to workers and technicians.

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At one end of the drive motor's shaft of a dry type design there is a multiple grooved sheave. A similar, though smaller diameter sheave is also attached to the end of the pump unit. A series of "V" shaped rubber belts run between these sheaves, allowing for the rotational motion of the drive motor to be transmitted to the pump shaft.

Other hydraulic components such as oil fittings, valve and tank reservoir are not generally a source of potential hazard.

Potential hazards created by this dry type machine arrangement consist of entanglement, pinching and abrasion, with shearing being more prevalent than crushing injuries. The deep "V" groove profile in these sheave grooves would likely amputate a finger rather than pinch or crush it.

Access to the equipment's pump and motor is frequently protected by removable metal panels, particularly on newer units. However, many older installations and newer units now routinely operate with these panels removed. Going forward, it will be necessary for Owners to ensure these protective panels are installed and remain in place on their installations. Where they cannot be found then replacement panels should be considered.

A secondary guard, covering the drive sheave, belts, pump sheave and pump and motor shafts should always be provided to form permanent protection against accidental shearing/pinching hazards. Any secondary guard must have a perforated surface, to allow for visual inspection of the components behind as it is often necessary to watch the operation of these devices with the car under full speed operation.

As an alternative to new panels and a secondary guard, it is possible to effectively protect the drive shaft and sheave on the drive motor, as well as their interconnecting belts and the drive pulley at the end of the pump shaft. This requires the construction or installation of a perforated screen, designed to seal off access to these units. Perforations are required in order to allow for service technicians to view the multiple rubber belts (checking condition and tension), as well as check for oil leaks at the pump, and sheave wear at the drive motor. Again, perforations need to be sized to protect against accidental contact with these elements.

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## APPENDIX SECTION A

### GLOSSARY

This guideline makes use of many elevator industry specific and technical terms whose definitions will likely not be familiar to an industry outsider. This section sets out a non technical explanation for such terms, and it is hope that by inclusion of this section, the reader's appreciation and understanding of this guideline will be improved.

#### **1:1 Roping:**

Method of roping between the car and the drive machine, where the rope speed and the elevator's operational speed are the same.

#### **2:1 Roping:**

Method of roping between the car and the drive machine, where the rope speed is double that of the elevator's operational speed. Such roping is used to take advantage of the reduced live loads on the elevator drive equipment. Such a roping arrangement has its hitch points (or ends of suspension ropes) located at or below the elevator machine room floor as opposed to on top of the elevator car and its counterweight.

#### **A17.1:**

This is the Safety Code for Elevators as published by the American Society of Mechanical Engineers or ASME. For many years, this was the standard used to regulate the design, installation, operation and maintenance of elevating devices within the United States. It was also used as a reference standard in many other parts of the world. Since 2000, CSA and ASME have been working to standardize and harmonize their respective elevator safety codes, and as of 2007, the code is now a fully bi-national standard used between Canada and the USA. The current edition of this standard is titled **ASME A17.1-2007 / CSA B44-07 Safety Code for Elevators and Escalators**. It is jointly published by both ASME and the CSA.

#### **Act:**

For the purpose of this Guideline, reference to the Act shall mean the **Occupational Health and Safety Act (OHSA)** and Regulation for Industrial Establishments. Also referred to herein as **O. Reg. 851**.

#### **B44:**

This is the Safety Code for Elevators as published by the Canadian Standards Association (CSA). This national standard was adopted by each Province and regulated by provincial associations. The initial version was published in 1938; it was continually modified and updated to accommodate changing technology and practical experience. Since 2000, CSA and ASME have been working to standardize and harmonize their respective elevator safety codes. As of 2007, the code is now a fully bi-national standard used both in Canada and the USA. The current edition of this standard is titled **ASME A17.1-2007 / CSA B44-07 Safety Code for Elevators and Escalators**. It is jointly published by both ASME and the CSA.

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**Brake:**

Traction and drum machines are provided with a mechanical brake, designed to stop and safely hold an elevator. During typical operation, this brake is electrically lifted or “picked” against adjustable tensioned springs. In the event electrical power is removed from the brake, these springs ensure it immediately drops back against its drum or disk, bringing the car to a safe stop. While applied, the brake will securely hold in place the elevator and its counterweight.

Some older elevators have a control design whereby the brake is used to decelerate the car from full speed to a stop. Modern elevator controls use electrical circuitry to slow and stop the car under normal operation. Once the car has stopped, the brake is released to hold the car in position. However, in the event an elevator’s safety circuit is actuated, the brake is immediately applied to stop and hold the car and its counterweight, regardless of the type of control.

The most common form of elevator brake consists of a machined drum onto which two curved shoes or pads drop onto the surface of the drum. The brake drum or disk is directly coupled to the elevator drive shaft. On some machines, the brake is an external element (refer to Photos 15 and 16) whereby the brake arms and their shoes are located outside and above the rotating drum surface. There is one type of gearless machine (refer to Photo 17) that has its two brake arms applying force against an inside or interior rim on the drive sheave.

Brake designs can create three types of hazards; entanglement, pinching and crushing.

**Contractor:**

The definition as used herein is strictly limited to a person, firm, organization or company that is registered with the TSSA permitting them to maintain service, install, repair or inspect elevators in the Province of Ontario. Only contractors that are registered and licensed by the TSSA are able to modify, install, alter or make attachments or changes to the design of an elevator installation. The addition of equipment guarding can only be provided by properly qualified and registered contractors. Where the installation of equipment guarding is not being performed by a TSSA licensed contractor, then the work must be supervised and carried out under the direction of a TSSA licensed contractor or licensed elevating devices mechanic.

**Controller:**

Steel cabinet or enclosure, usually provided with hinged or lift off access panels, into which are mounted the controls and operating circuits that monitor, direct, and control the operation of the elevator. Controller cabinets are also provided to house the group operation controls in multi car installations. These cabinets are known as Dispatcher or Common Relay Panel Controllers. Some direct current drive elevators are provided with a cabinet to control the operation of its motor generator set. These controllers are also known as Starter Panels.

Controller cabinets contain the electrical circuits and interconnections required to supervise and control the operation of an elevator. Typically,

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controllers are housed within metal framed enclosures with either lift off or hinged access door panels allowing access to the components within. There are some older installations that may have an open enclosure without any wall panels or covers. These installations will require the retrofitting of suitable enclosures.

For elevators in Ontario, incoming power into a car controller may be 208/240/416/575 or 600 volts. These incoming power feeds are usually connected to terminal studs at the base of the car controller. Many older controller designs do not have protective lug covers or plastic shields over these high voltage terminals. There are also many controllers that have transformers housed within car controllers that have unprotected primary and secondary terminals. As such, the primary concern regarding car controllers is the potential for high voltage electric shock.

Modern elevator controllers must be enclosed within approved and certified cabinets, having CSA, Ontario Hydro, ESA, or ULC labels. Many controllers are also now equipped with lockable access doors. Older controllers may not have such certification, however, MOL guarding provisions do not mandate or require the upgrading of elevator controllers to meet these certification labelling requirements.

**Counterweight Governor:**

See also Governor.

Not all traction elevator installations are provided with a governor for their counterweight. These governors are required when there is occupied space underneath the elevator's hoistway.

The function and operation of the counterweight governor is the same as that as described above for the car governor. The only difference being their tripping speed is set higher to avoid situations where both the car and counterweight safeties would apply at the same time.

**CSA:**

Canadian Standards Association

**Deflector Sheave:**

Pulley used to offset or direct the vertical drop or location of the steel hoist ropes running between the elevator car and its counterweight. Where the horizontal distance between the hitch point for the car and the counterweight is larger than the diameter of the drive sheave, one or more deflector sheaves are used to guide the hoist ropes.

These devices are grooved sheaves that lead elevator suspension ropes off the drive sheave down to the car top and counterweight. The number and size of deflector sheaves will be a function of the elevator's size, machine placement and roping arrangement.

Refer to Photos #8 through #10 to see various deflector sheaves and their mounting arrangements.

Many installations having carrying capacities of 1,136 kg or less, are provided with drive sheaves of sufficient diameter that do not require the use of deflector sheaves (refer to Photo #1) in a typical overhead arrangement.

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However, most newly installed elevators, using smaller diameter sheaves, will require the use of deflector sheaves, and these are now normally located within the main elevator machine room space (refer to Photo #2 and #11).

In Photo #7 one can see the suspension ropes angling off the back side of a geared traction drive sheave. Note how they travel away from the drive sheave and then down to its deflector sheave.

#### **Dispatcher Cabinet:**

Typically only found in multi car group installations, this controller cabinet is used to interconnect all cars to the main central dispatching or group operation unit allowing for the effective and efficient assignment of elevators to landing call demands. These controls are normally housed within a steel enclosure, similar to car controllers as described above. However, unlike car controllers, most dispatch or common relay panels do not have high voltage, three phase power connections. As such, protection measures against high voltage shock are not nearly as serious when compared to a car controller. As such, the primary protective provisions for these units will be as described above for car controllers.

#### **Drive Sheave:**

The powered pulley connected to either the elevator drive motor's output shaft (gearless) or to the output side of the mechanical speed reduction unit (geared). The circumference of the sheave has a series of "U" or "V" shaped grooves cut into it, in which sit the elevator suspension or hoist ropes. The friction loads created as the suspension ropes pass over the grooved surface of the sheave causes motion to be transmitted from the drive motor to the elevator cab or counterweight.

#### **Drive Motor:**

Normally a three phase alternating current, or direct current electrical motor, used to raise and lower the elevator cab. The direction of motor rotation and speed (revolutions per minute) are directed and supervised by devices located within the elevator controller. Direct current motors (and some early design alternating current motors) use carbon brushes to control or regulate the operational speed of its motor. It is an important maintenance task to regularly inspect, repair and replace these brushes. Failure to do so in a timely fashion can result in equipment mis-operation and lead to significant motor damage.

Elevators typically have two types of drive motors;

- Direct current motors
- Alternating current motors

Motors are encased in a protective metal enclosure, often called a "yoke". They have several required access points (refer to Photos #19 and #21 for a typical geared traction elevator motor design). Gearless elevators generally have much larger motors, as can be seen in Photos #20 and #22. Direct current motors, whether they are for geared or gearless elevators, require access to multiple sets of carbon brushes that ring one end of the motor. Some older alternating current motors, known as "slip ring" motors also require access to carbon brushes, though these are becoming increasingly

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rare. Many motors are already provided with protective grilles or cover plates that seal off the various brush access openings. However, many older motors have large unprotected openings. It is important to remember that such openings were also used to assist in air circulation flows within the motor housing for cooling purposes.

Most newer drive motors, particularly the new variable voltage, variable frequency drive motors have well protected enclosures around the ends of their motor (no additional guarding provisions should be required in these instances).

**Drum Machine:**

Drum machines are used on dumbwaiters, some small freights, and were many years ago used on passenger and large freight elevators. Today, the use of such equipment is prohibited by the Elevator Code for a passenger elevator. On a drum machine, the suspension ropes are wound around the numerous grooves of the drum, similar to a winch or fishing reel. As the rope reels off or back on to the drum, the car moves down or up the hoistway.

**Dry Type Power Unit:**

Design of hydraulic elevator where the drive motor and the pump are located outside the oil tank reservoir. Typically the output shaft of the drive motor is connected to the pump through a series of rubber belts, creating pinching and shearing hazards.

**Elevating Devices Mechanic (EDM):**

All persons working on or inspecting elevators must have a valid and current license certificate as issued by the TSSA. There are a number of different licence classifications, ranging from EDM-A to EDM-F plus one more known as EDM-T. License certificate holders can only conduct work in keeping with the limitations of their licensing classification.

**Elevator Machine Room:**

Enclosure in which the machinery and electrical controls used for an elevator are contained. The room must be fully enclosed or otherwise secured against non-authorized access.

**Encoder:**

Modern elevator control systems and those installations that are been modernized during the past two decades, will likely have an encoder or small motor unit affixed to directly drive off the drive motor or machine. Another term used for this device is a “tachometer”. Refer to Photo #23 which shows one arrangement where the encoder is mounted off the end of the drive motor. Photo #24 shows another form of encoder mounting that has the unit driven off the rim of a gearless elevator’s drive sheave.

Encoders are used to provide real-time elevator operating speed and direction information to the elevator controller, allowing for more precise car speed control. Depending upon the encoder’s location and connection to the elevator machine, its potential hazards can be the same as encountered with the drive motor. As such guarding provisions would be similar.

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**Geared Elevator:**

A type of traction elevator that has a mechanical speed reduction unit between its drive motor and drive sheave. This speed reduction unit is designed to slow down the rotational speed of the drive motor at the drive sheave, so the operating speed of the drive sheave equals the elevator's rated speed. Geared elevators are the most common type of traction elevator, and are used in all types of buildings. Typically, they are used in low to mid rise commercial buildings, and mid to high rise residential applications. When the geared machine is mounted over top the elevator shaft, it is referred to as an "overhead" design. When the geared machine is placed to the side of the hoistway, or in some cases slightly remote, the design is referred to as an "offset". Where the machine is placed at the bottom or below the elevator shaft, it is referred to as a "basement" design.

The most common type of speed reduction unit consists of a hardened steel worm shaft, mated with a bronze ring or crown gear (worm-gear set). The mating surfaces of these two elements are contained within an oil bath for lubrication. Regular access to the machine to check the level of oil, as well as the condition of the oil and the ring gear is an important aspect of ongoing equipment maintenance.

**Gearless Elevator:**

This type of traction elevator is used in high-rise applications. As its name implies, there is no speed reduction unit between the drive motor and the drive sheave. In fact, the drive sheave is directly coupled to the drive motor's shaft. Hence the rpm of the drive motor is the same as the elevator drive sheave. Typically used in only very high rise residential buildings and mid to high rise commercial/institutional complexes, these elevators are now being used for all types of installations, and are now seeing increased usage with the new generation of machineroomless or MRL elevators.

**Governor:**

A rotating device mechanically connected to the elevator car, and in some instances its counterweight where there is occupied space below the elevator shaft, that is used to monitor elevator speed. Should car or counterweight speed exceed a preset limit, this device is designed to actuate electrical circuitry and mechanical means to bring the elevator to a controlled safe stop.

This is the device that is connected to the elevator so it operates at the same speed as the elevator cab. It is connected to the elevator car by means of a steel wire rope.

As the car moves up and down it draws this steel wire rope through a "U" or "V" shaped groove cut within the surface of the governor sheave, causing the sheave to rotate in tandem with the elevator. Centrifugally activated, balanced weights, driven by the sheave, rotate as the car speeds. Once the speed exceeds a preset limit these weights will strike a series of switches designed to actuate the elevator's safety circuit, thereby slowing the car down electrically. If the car continues to speed up, these weights will eventually contact or strike a fixed bracket, bringing the sheave to an abrupt

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stop. This in turn causes the release of safety jaws or clamps mounted on the elevator that grip onto the running surface of its guide rail columns, bringing the car to a safe and controlled stop. Pictures of two different styles of car governors can be seen in Photos #27 and #28. A close review of Photo #8 shows a number of silver coloured devices which are car governors shown located at a secondary level.

Many governors use two weighted cast iron balls or steel disks that rotate as the car moves. These weights are commonly referred to as “fly balls”, and can be seen at the top in Photo #28 (yellow coloured spheres). As the elevator speed increases, the arc in which these weights circulate expands, moving further and further away from the governor sheave. As the rotating arc of these weights increase, they create an additional “impact” hazard, especially of concern in tight working spaces.

**Hazard:**

The term used to encompass circumstances that could precipitate a number of possible or potential injuries that can arise as a result of contact with moving or live equipment. Essentially there are seven types of hazards that apply to elevator machine room equipment. These are; *Entanglement, Pinching or Nipping, Shearing, Crushing, Abrasion, Tripping, and Electrical Shock*. Refer to Part 7 for a detailed review of the various types of hazards and an explanation of the locations where such interference can occur.

**Hydraulic Elevator:**

Type of elevator used essentially for low rise, slow speed applications where motion to the elevator car is transmitted through changes in fluid pressure within a sealed or contained system. Hydraulic fluid from a holding tank is injected, under pressure, into a containment vessel called a cylinder. Upon entering the cylinder, the oil displaces a piston. Typically, one end of the piston is fastened to the elevator cab, thereby causing it to move in synchronization with the piston. Down direction motion is achieved through controlled gravity lowering, whereby the speed of oil being returned to the holding tank is regulated through a series of control valves. Since the mid 1980's the majority of hydraulic elevators have had their electrical drive motors and pumps located within the oil tank. These are referred to as submersible power units. Older designs utilized what is now known as a dry type power unit, whereby the drive motor and the pump were located outside of the oil tank.

**Machine:**

The term used to refer to the collection of components that raise or lower the elevator. These include the drive motor, brake, speed reduction unit, sheaves and encoders.

Generally, there are three standard types of machines provided for elevators. These are;

- Gearless - used in high rise applications whereby the drive motor and drive sheave are connected in line on a common shaft, without any mechanical speed reduction unit located between the drive motor and drive sheave. Refer to Photos #20 and #22 as found in Appendix C.

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- Geared – used in low and mid rise applications. This design utilizes a mechanical speed reduction gear set to reduce the rpm of the drive motor (input speed) to suit the required speed of the drive sheave and elevator (output speed). Refer to Appendix C Photo #2. Essentially, a geared machine includes the following components;
    - Drive motor
    - Brake
    - Speed reduction unit or gearbox
    - Drive sheave
    - Bedplate

The vast majority of geared elevators are installed with the drive machine located directly over top its hoistway or shaft. However, these machines can also be found in the basement, behind or at the side of the hoistway. A basement machine placement is commonly referred to as “basement traction”. A machine placed at the side of the hoistway is commonly referred to as an “offset traction”. Basement and offset applications require additional deflector sheaves to properly lead suspension ropes off the drive sheave and to the car top or counterweight. Refer to Photo #9 for a typical basement traction arrangement and Photo #10 for an offset installation.

- Drum – widely used in older passenger and freight elevator applications, though now rarely seen except for dumbwaiters. For many years now the Elevator Safety Code has disallowed the use of such machines for passenger applications. A drum design has one end of the suspension rope affixed to the inside of the winding drum’s drive sheave, and then allows to rope to reel in or off the outer surface of its sheave, depending upon the car direction of travel. Refer to Photos #5 and #6 to see a typical drum machine.

**MOL:**

The Ontario Ministry of Labour is the provincial government ministry responsible for the protection of health and safety in the workplace. MOL is responsible for the administration and enforcement of the **OHSA** and its regulations.

**Motor Generator (MG) Set:**

On older, direct current installations, a motor generator set is used to convert incoming building three phase alternating current power into direct current which is then applied to the elevator drive motor.

A motor generator or MG set generally is long cylindrical object that has an alternating current drive motor connected on the same shaft with a direct current motor generator. Refer to Photos #25 and #26. Some older installations actually have a second generator set, know as an exciter attached to the same shaft. This can be seen in Photo #25.

It is the electrical mechanical device used to convert incoming building three phase alternating current into direct current that is then applied to the elevator’s drive motor. (There are still a few older installations where the incoming building power to the mg set is direct current.) Incoming building power drives the MG set’s motor, whose shaft is coupled with a direct current generator. The generator side of the unit has a series of carbon brushes

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used for commutation. Motor generator sets have a high rotational speed which accelerates carbon brush wear. It is an important aspect of routine maintenance to monitor, adjust and replace these carbon brushes, plus clean the armature and brush rigging of dirt, film and carbon build up.

**OHSA:**

For the purpose of this Guideline, reference to the **OHSA** shall mean the **Occupational Health and Safety Act (OHSA)** and Regulations for Industrial Establishments. The **OHSA** is also referred to throughout this document as **O. Reg. 851**.

**PSR:**

Pre-Start Health and Safety Review. Technical assessment of equipment to assess the effectiveness and compliance of safeguard provisions and their effectiveness in mitigating known hazards. This is a formal review as conducted by a licensed professional engineer, knowledgeable in the requirements and expectations surrounding the guarding requirements for machinery in industrial applications.

**Rope Gripper:**

In the late 1980's, all newly installed traction elevators in the Province of Ontario were required to have an additional safety device that would prevent the elevator from over speeding in its up direction<sup>2</sup>. Shortly thereafter, the Code required that a device also be provided that would prevent an elevator from uncontrolled movement with its doors open, when the car is in the "landing zone". Both requirements are now mandated for all newly installed traction elevators, as well as existing traction elevators that undergo a major modernization or upgrading.

There are really only two types of devices that serve these purposes (not including the use of a double brake on a gearless elevator). These are;

- Hollister Whitney Rope Gripper or commonly known as a "rope gripper"
- Bode Brake

The Bode Brake was popular during the early 1990's. However, it has seen almost no use since then. The rope gripper device has now become the industry standard design to achieve this form of protection. Therefore, we limit this discussion to the rope gripper.

A typical rope gripper mounting can be seen in Photo #8, look to the light blue coloured component. Rope grippers are essentially spring actuated braking pads or callipers that clamp on to the suspension ropes of an

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<sup>2</sup> It is perhaps not well known that a traction elevator is counterbalanced between 40 and 50% of its rated carrying capacity. A lightly loaded elevator will actually weigh less than its counterweight. Under such conditions, if positive drive control was lost, the counterweight weighing more will actually drive the elevator cab upwards. Gravity acting on the counterweight, with the elevator cab attached will see the elevator cab actually free fall in the up direction, as it is dragged in this direction by the downwards free falling counterweight. Elevator cab safeties will work when the elevator cab is over speeding in the down direction. They will not stop the elevator cab in the event it over speeds in the up direction. To compensate for this limitation, up direction over speed safeties act regardless of car direction, and are capable of stopping an over speeding elevator regardless of its travel direction.

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elevator, once it over speeds, bringing the car and its counterweight to a controlled stop. Hydraulics are used to release and hold off the brake pads, allowing the elevator to run.

**Secondary Level:**

An elevator equipment space, located underneath and usually accessible from the elevator machine room. It is commonly provided on higher speed gearless elevators. This space typically houses rotating equipment such as deflector sheaves, governors, rope grippers and, in certain newer installations, the car position control device.

**Secondary Sheave:**

Pulley that is normally used on gearless elevators and is located directly beneath the machine or drive sheave. It too has a grooved surface over which pass the suspension or hoist ropes.

**Selector:**

Mechanical device used in older elevator installations which is used to supervise car speed control, door operation, response to car and landing call demands, plus positioning of an elevator. Essentially, a selector is a small scale mechanical reproduction of the elevator's hoistway and the car within. The selector unit is coupled to the elevator cab by either a steel aircraft cable or a perforated and toothed steel band commonly referred to as a tape.

Selectors are provided in older elevator systems to translate car position information to the elevator car controller. Refer to Photos #29 and #30. Typically, these units involve a series of switches and devices that are mechanically coupled to the elevator cab so its relative movement is mirrored by the controls within the selector.

Some installations have their selector carriage (the moving element that works in synch with the elevator cab) travel vertically (Otis, some Turnbull and Armor) while others are designed so the selector carriage moves horizontally (some Turnbull, some Horn, Dewhurst). To transmit actual car operational data to the selector, its carriage is mechanically driven in synchronization with the elevator cab. Connection between the selector and the car is either by a steel air cord (aircraft cable) or perforated steel tape. These connections often pass over a series of sheaves to ensure their proper drop and lead to the car below (refer to Photos #30 and #31).

Mechanically driven selectors were widely used on elevators installed up to the early 1980's. After this date, many companies did away with selectors and now use solid-state means to convert car position information to the elevator's controller. However, one manufacturer still uses a mechanically coupled car position information unit that requires a deflector sheave assembly, similar to the sheave as shown in Photo #31 (Note, the sheave shown in this Photo is equipped with a fixed metal guard, although it would be considered non-compliant. Most installations do not have any protective enclosure.)

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**Submersible Power Unit:**

Design of hydraulic elevator whereby the drive motor and pump are both located within the oil tank reservoir. In essence these rotating elements are set within the enclosure, somewhat protected against accidental contact.

**Traction Elevator:**

A type of elevator using a series of steel wire ropes to connect the car and its counterweight. Tractive or friction forces imparted to these steel ropes cause the elevator to move up and down. There are two basic types of traction elevator; geared and gearless. For electrical efficiency, a traction elevator is provided with a counterweight, the mass of which is directly proportional to the design load and dead weight of the elevator cab. The counterweight is directly connected to the elevator cab through a series of steel wire ropes.

**TSSA:**

Technical Standards and Safety Authority, (Elevating and Amusement Devices Safety Program). This is the designated administrative authority in the Province of Ontario charged with the enforcement of safety legislation and regulations affecting the design, installation, alteration and maintenance of elevating devices. The TSSA enforces the requirements of the Elevator Safety Code (**B44**) as well as various safety alerts, bulletins, orders and regulations that arise regarding elevator safety. The TSSA is not responsible for regulating worker or workplace safety – this is the purview of the MOL.

**Wire Ropes or Suspension Ropes:**

Traction or rope driven elevators utilize a series of steel wire ropes to suspend both the elevator car and its counterweight. These same ropes transmit vertical motion to these suspended elements through friction or tractive forces created as these ropes pass through a series of shaped grooves, cut into the surface of the drive sheave. Over time, ropes will wear. They also require periodic lubrication and service access for inspection and adjustment. As these are a critical safety element in a traction elevator installation, it is essential that ready access to these ropes be available at the machine for inspection and servicing.

**QUESTION: How do I know what type of elevator equipment I have in my building?**

Ask your equipment maintenance contractor. Newer buildings may have ready access to the formal Design Submission registration as filed by their equipment's original installation contractor with the TSSA. Design Submissions are also required for equipment modernizations or alterations. If one can still not define or determine the type of equipment they have, contact your TSSA inspector.

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## APPENDIX SECTION B

# GUARDING PHILOSOPHY & REQUIREMENTS

### Safeguarding of Machinery

Although elevator machine room installations vary in many ways, including available space, car drive machine type, elevator roping arrangements, equipment layout, not to mention equipment space or physical sizing, they all share common hazards. These have been reviewed and identified in Part 7 of this Guideline.

In an effort to establish workable guarding requirements, CSA has published their Standard CSA **Z432** Safeguarding of Machinery. This standard specifies requirements for the design, manufacture, installation, maintenance, operation and safeguarding of industrial equipment to prevent injuries and enhance the safety of personnel who operate, assemble and maintain machinery. It does not apply to portable hand tools. As this standard has been prepared to cover all types of equipment and machinery, it essentially establishes a number of requirements and specific design expectations that can be applied to all types of equipment, including elevators.

**Z432** can be used by any industry, taking comprehensive guidance from its philosophical intent to develop workable, applicable, and relevant guarding measures. Many key sections can be extrapolated and incorporated into a well designed guarding system that will serve to eliminate the identified hazards as out in Part 7 of this Guideline.

Essential references to the requirements as set out in **Z432** that need to be used in the selection of appropriate guarding includes those as listed below. It is important to realize that the following requirements are not a complete representation of all elements and expectations relating to the design and application of equipment guarding as set out in this Standard. It is essential that a good understanding of CSA **Z432** be obtained by the designer and installer of equipment guarding.

### Essential Guarding Design Issues

While **Z432** covers a wide variety of subjects, from hazard assessment to guard design and construction, the following is a short listing of essential guarding design issues which are further expanded upon in the CSA Standard **Z432**, Safeguarding of Machinery.

#### 6.2.3 Requirements for design and construction of guards and protective devices

- 6.2.3.1.1 General

In designing safeguards, the types and protective device and their methods of construction shall be selected to take account of the mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so they cannot be easily defeated. They shall provide the minimum possible interference with activities during the operation and other phases of machine life in order to reduce any incentive to defeat them.

- 6.2.3.1.2 Guards and protective devices shall
  - (a) Be of robust construction
  - (b) Not give rise to additional hazards

- (c) Not be easy to bypass or render inoperative
  - (d) Be located at an adequate distances to the danger zone (refer to Table 3 in Section 10.12)
- 6.2.3.2.2 Fixed guards shall be securely held in place
  - (a) Permanently (i.e., welding) or,
  - (b) By means of fasteners (screws, nuts, etc.) making removal/opening impossible without the use of tools, where possible they should not remain closed without their fasteners.
- 6.2.3.2.6 Hazards from guards
 

Care should be taken to prevent hazards that might be generated by the

  - (a) Guard construction (sharp edges, corners, material, etc.)
  - (b) Movements of the guard (shearing or crushing zones generated by energy driven guards or by heavy guards that are liable to fall).
  - (c) By means of fasteners (screws, nuts, etc.) making removal/opening impossible without the use of tools, where possible they should not remain closed without their fasteners.
- 7.12 Safety colours and symbols.
- 9 Performance requirements for safeguarding devices
- 10 Application requirements for safeguarding devices
- 10.12 Minimum Distance from Hazard
  - Contains Table 3 (see below)
- 14 Maintenance
- Table A.7 Mechanical Hazards and Controls
  - contains several pictographs detailing various hazards and other relevant information.
- Table 3, as presented below:

**TABLE 3 – Minimum Distance From Hazard As A Function Of Barrier Opening Size**

The table sets out minimum opening sizes in equipment guarding based upon the distance from the guard to the actual hazard point. In other words, the closer the screen or guard to the hazard point, the smaller the opening size permitted in the guard's construction. **Table 3** as presented in **Z432**, contains both metric and imperial measurements. In the interest of brevity, the following table shows metric dimensions only.

BARRIER OPENING SIZE (smallest dimension) mm	MINIMUM DISTANCE FROM HAZARD mm	
	(Slotted Opening Size)	(Square Shaped Opening)
0.0 to 6.0	≥13.0	≥13.0
6.1 to 11.0	≥64.0	≥48.0
11.1 to 16.0	≥89.0	≥66.0
16.1 to 32.0	≥166.0	≥166.0
32.1 to 49.0	≥445.0	≥445.0
49.1 to 132.0	≥915.0	≥915.0

While CSA-Z432 provides guarding design requirements that MOL references to assist with compliance evaluation, it is important to note that MOL does not enforce the requirements contained in Z432.

Note: CSA-Z432 Safeguarding of machinery is available for viewing from the MOL web site at [www.labour.gov.on.ca](http://www.labour.gov.on.ca) and selecting > "View CSA Standards" located below the Quick Search section.

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## APPENDIX SECTION C REFERENCE PHOTOGRAPHS

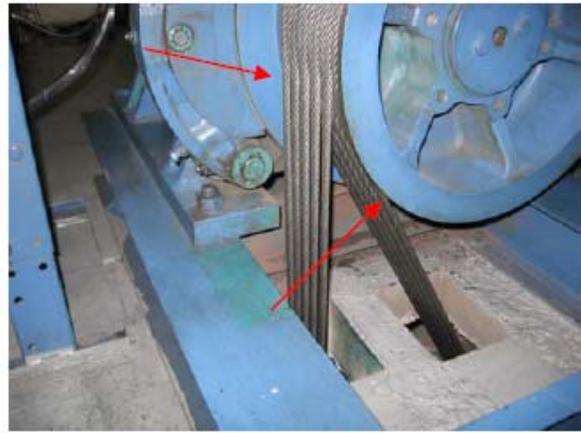
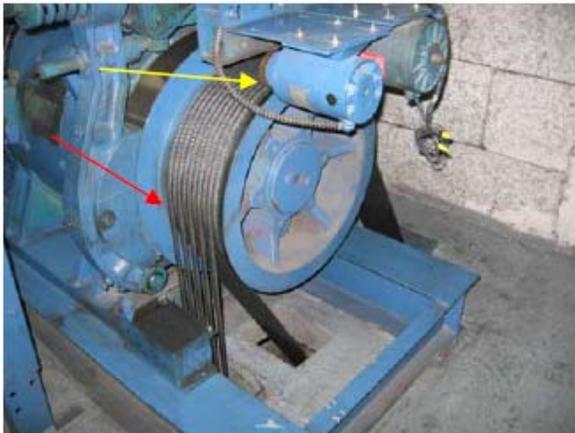
Within this section, we present a series of photographs that show various elevator machinery components and elements that will serve to supplement the written descriptions as found within the Guideline. Below each photograph is its reference number. This is the number noted in the forgoing text. Arrows highlight potential hazards.



Photo #1 – Worm gear traction sheave



Photo #2 – Overhead geared traction machine



Photos #3 & #4 – Overhead gearless traction machine with tachometer/encoder shown in left hand photo (see also Photo #24), and close up of drive sheave shown in right photo.

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



Photos #5 & #6 – Overhead drum drive machine. Suspension rope coils around the drum or unwinds off the drum, depending upon car direction of travel. Used for dumbwaiters, older small capacity freights, and very old small capacity passenger elevators. Note, open end of electrical motor, potential shock hazard.



Photo #7 – End shot of typical geared machine



Photo #8 – Secondary level showing deflector sheaves (black color wheel), rope gripper (light blue color box, car position unit (red color arrow) and car governors (silver objects, which you will note are fully enclosed).

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



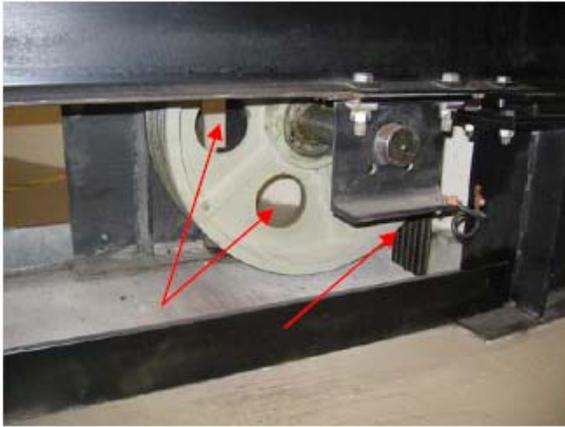
Photo #9 – Basement Traction Machine with deflector sheave



Photo #10 – Offset Traction Machine with deflector sheaves

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



Photos #11 & #12 – Deflector Sheaves

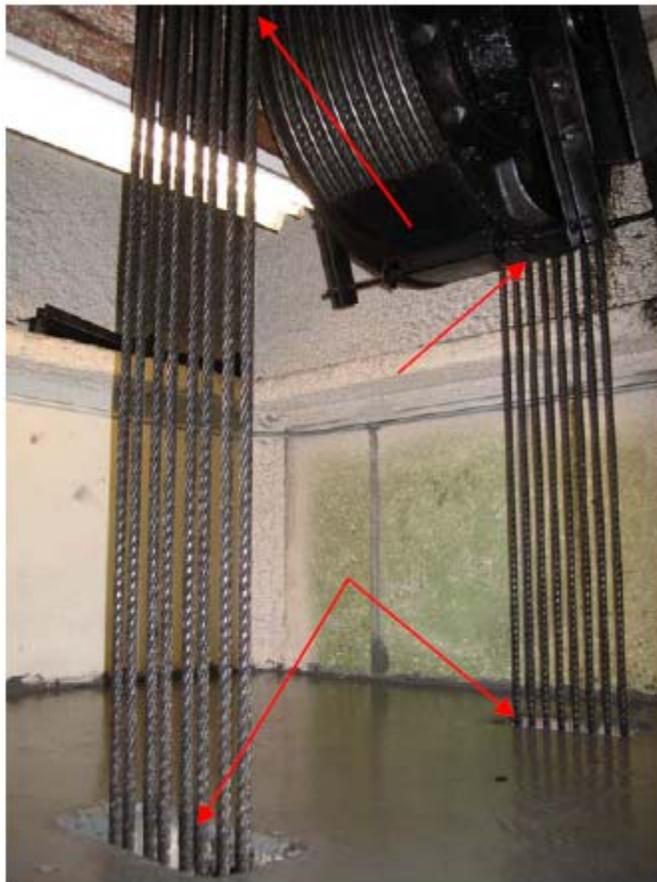


Photo #13 – Deflector sheave located within Secondary Level

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



Photo #14 – Close up of Deflector sheave on gearless traction elevator



Photo #15 – Coupling fitting used to connect motor drive shaft and machine brake pulley.

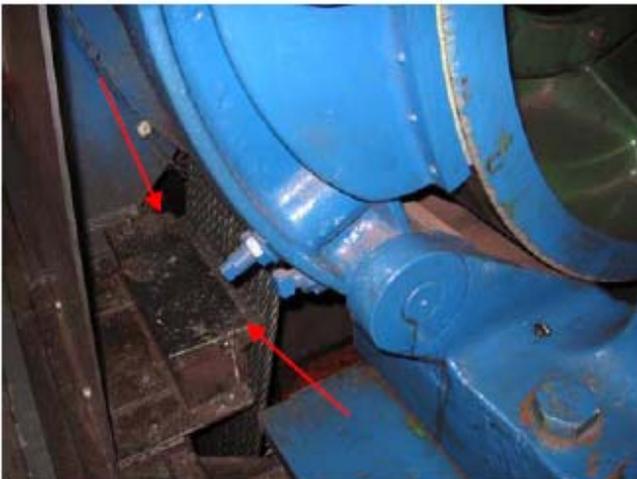
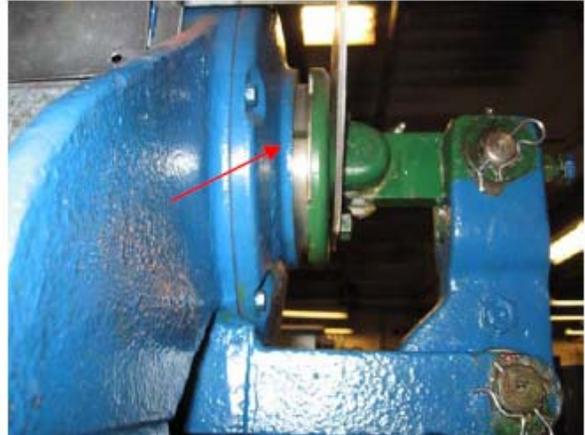
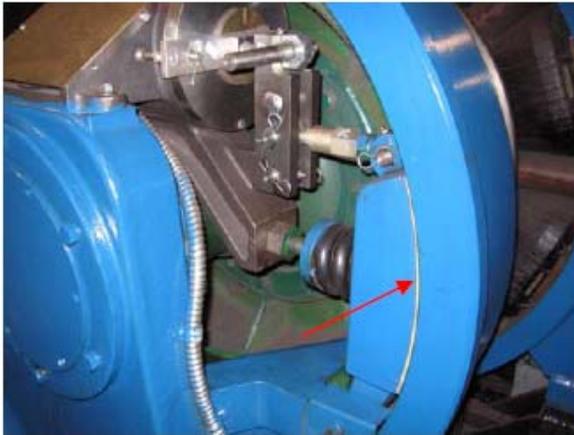


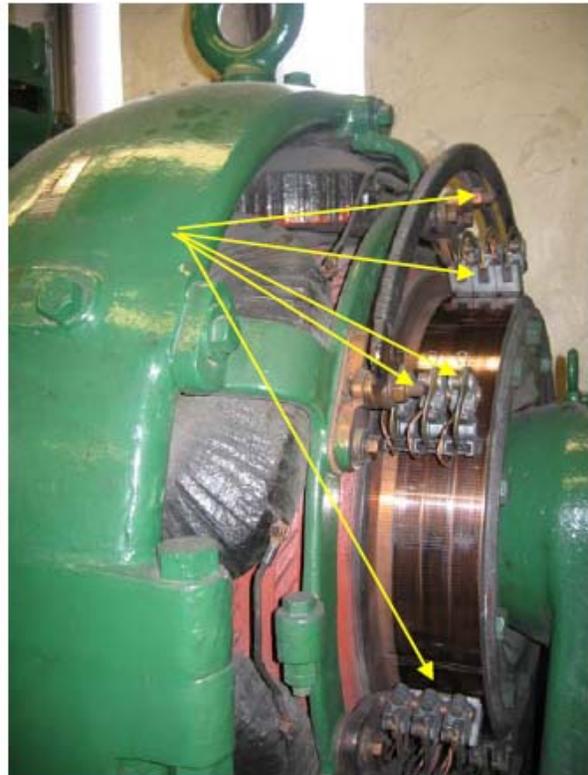
Photo #16 – Close up of brake pulley also showing ropes leading down to deflector sheave.

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



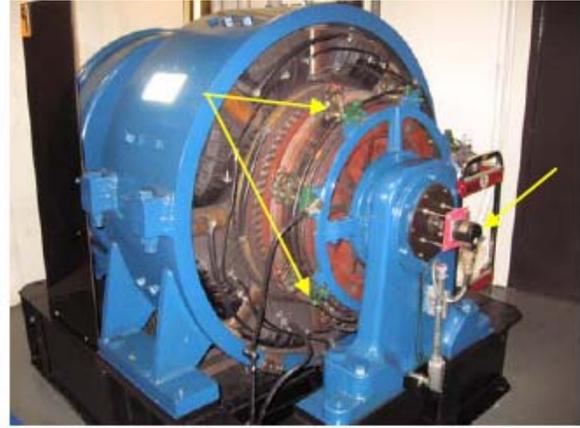
Photos #17 & #18 – More examples of elevator brakes, used on gearless traction machines.



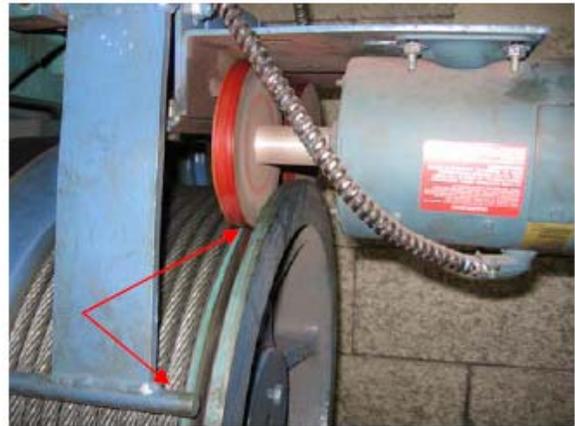
Photos #19 & #20 – Examples of electrical shock hazards associated with elevator drive motors.

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



Photos #21 & #22 – Examples of electrical shock hazards associated with elevator drive motors. On the right most photograph, note also the encoder (yellow arrow).



Photos #23 & #24 – Examples of encoder and tachometers as mounted to elevator drive machines. The tachometer as shown in the right most photo is a close up of the unit as shown in Photo #3,

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd



Photos #25 & #26 – Examples of elevator motor generator sets and the potential for electrical shock hazard associated with each.

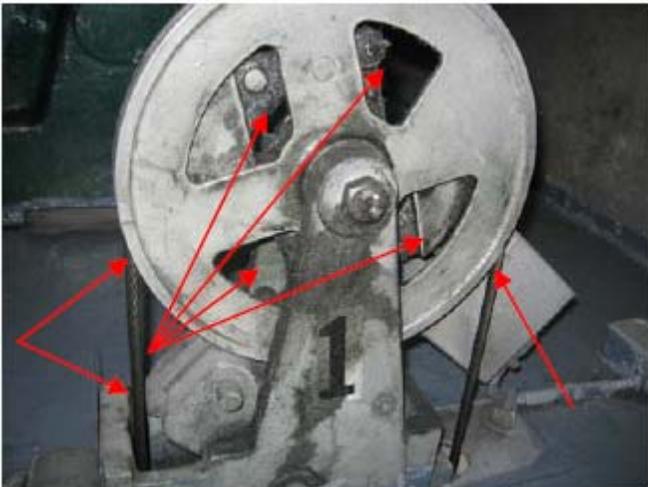


Photo #27 – Open framework type governor

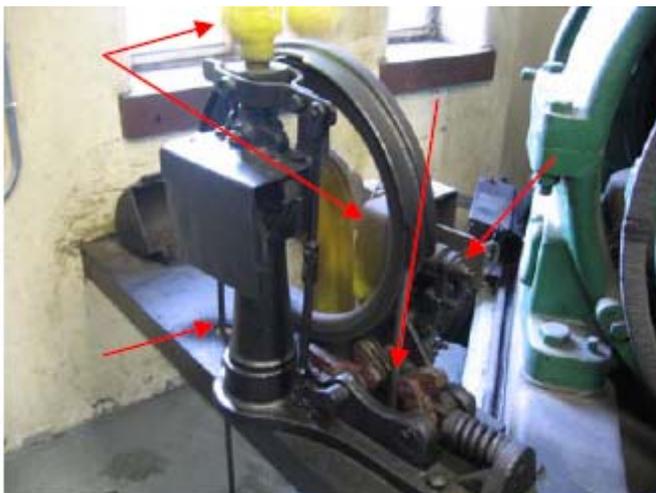


Photo #28 – Flyball type governor

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd

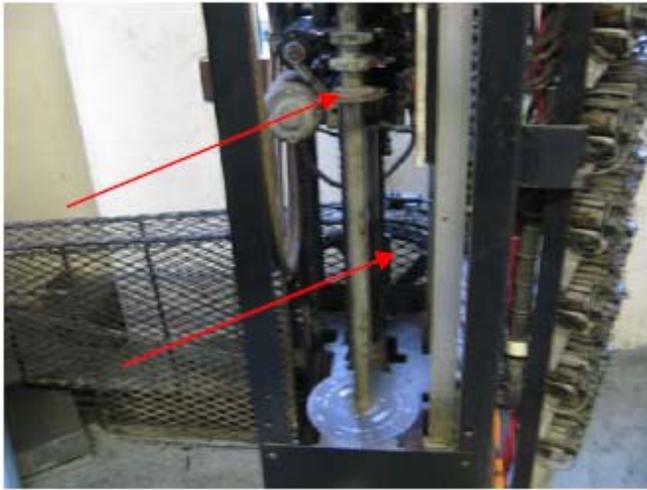


Photo #29 – Electro mechanical selector



Photo #30 – Electro Mechanical Selector tape sheave

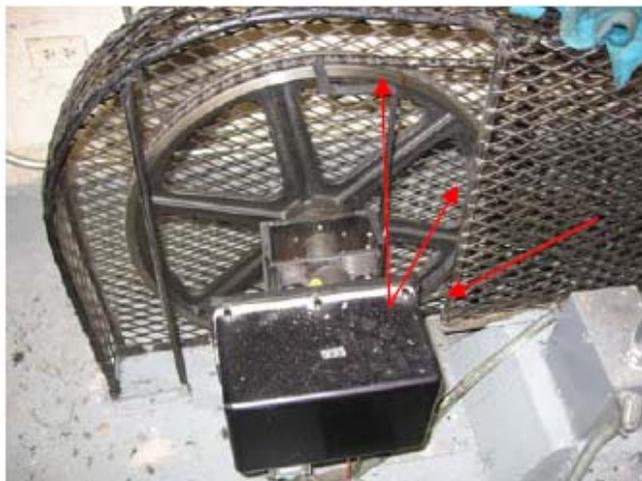


Photo #31 – Close up of selector / car position unit sheave with original protective screening that is non compliant in terms of the requirements for equipment guarding.

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APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd

Photo of typical overhead geared traction machine prior to the installation of component guarding.



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## APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd

Same machine as shown on the previous photo but now equipped with individual component guarding. Note guarding covers the drive sheave and areas where suspension ropes previously ran unprotected. Coupling used to connect drive motor to machine brake is now completely encased. Note, openings in drive motor are also covered as too is the drive motor encoder at the end of the motor.

For maintenance and inspection purposes, individual section guards will likely require removal which will require secondary or ancillary levels of protection to ensure the known hazards associated with the equipment remain mitigated.



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## APPENDIX C – REFERENCE PHOTOGRAPHS Cont'd

The photo below shows an installation where a “global” guarding option has been utilized. Subsequent to its installation the screen design had to be modified to better suit the specifics of this elevator machine room’s equipment arrangement, plus better comply with Elevator Safety Code access requirements.



**Photographs as used within this Guideline were made available through the courtesy of Telford D. John & Associates and the TSSA. Photograph captions and highlights were inserted by the authors of this Guideline.**

**END OF GUIDELINE**