

SNC-Lavalin T&D: A Model in SHE Management

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1

Introduction

Safety, Health, and Environment (SHE) Management is fundamental to success in any kind of business setting and operation. Although in recent years SHE management has received the utmost consideration in all major sectors, it still needs improvement to reduce losses and harm from all sorts of hazard, both to humans and to the environment. All accidents are preventable, and the goal of SHE management is to achieve ZERO incidents. One major aspect of reaching this goal is the delivery of health and safety education to engineering and business graduates. It is important to develop adequate awareness of health and safety issues in graduates in these fields during their university education. This case study is aimed at helping engineering and business undergraduate students become aware of existing and potential hazards and how to mitigate risk through a good management and practice, in a leading construction industry. This chapter presents the background, overall goal, and rationality of this study.

1.1 Background

Minerva is a not-for-profit organization dedicated to improving business effectiveness through health and safety management education. Minerva encourages universities and colleges to incorporate health and safety management education into the core curricula of engineering and business programs. Minerva's major initiatives include, but are not limited to: (i) organizing annual training and workshops for engineering and business professors, (ii) providing awards for contributions to health and safety, (iii) preparing teaching materials such as case studies, PowerPoint presentations, and teaching modules, and (iv) building partnerships with organizations that believe in Minerva's vision and are the patrons of Minerva's mission. This case study will enrich Minerva's teaching materials to be used in engineering and business classrooms.

SNC-Lavalin is one of the leading engineering procurement and construction groups in North America and beyond, having constructed numerous projects worldwide. SNC-Lavalin takes extraordinary measures to provide a safe and healthy work environment. This encompasses its employees, contractors, communities, and the public at large. The company's focus on health and safety is vital not only during the project but as a long-lasting legacy that carries forward SNC's name and reputation.

1.2 Why SNC-Lavalin T&D

It is noteworthy that SNC-Lavalin T&D (Transmission and Distribution) is a business unit of SNC-Lavalin (in-depth discussion of the business structure is presented in chapter 3). Safety is the top most priority at SNC-Lavalin's all business units. The company has achieved tremendous successes in health and safety. It has received many safety awards as an example presented in figure 1.1.

As of November 2011 SNC-Lavalin T&D has exceeded one million hours of operation without any recordable incidents. SNC-Lavalin develops project-specific safety programs for each project through extensive review. The company provides adequate health and safety training to its employees. It encourages health and safety among its workers through various incentive programs. It also enforces health and safety standards at workplaces. The SNC-Lavalin family as a whole continues to be a North American construction leader with total recordable incident and lost-time frequency rates amongst industry best. SNC-Lavalin T&D has therefore been selected as eminently suitable for this case study. The information thus shared can profitably be used in classrooms for instructional purposes.

ExxonMobil-2004 Safety Awards

The employees of SNC-Lavalin GDS Baytown were awarded a “Certificate of Excellence” by ExxonMobil for their exceptional safety performance, at the ExxonMobil Baytown Technology and Engineering Complex. In March of 2004 the team picked up a “Safety Achievement Award” from ExxonMobil for exceeding safety performance goals at the company's refinery and its chemical plant in Baytown. In April, the SNC-Lavalin GDS teams at each location received a “Contractor Merit Award for Safety Performance” from the National Petrochemical & Refiners Association (NPRA). This was the third consecutive year in which SNC-Lavalin GDS employees at the ExxonMobil Refinery have received this award. Finally, an “Outstanding Safety Performance Award” was given to the Baytown employees of SNC-Lavalin GDS in May by the prestigious Houston Business Roundtable in the Specialty Contractor – Technical Support category. SNC-Lavalin GDS was nominated for this award by both ExxonMobil and Chevron Phillips Chemicals.

Figure 1.1 Description of safety awards given to SNC-Lavalin GDS, Baytown, USA

1.3 Scope and focus

The scope of this case study is to understand SNC-Lavalin T&D's SHE management practices and how these have enhanced:

- A reduction in lost time accidents
- An improvement in labour management relations
- Product quality and production efficiency
- Profitability

This case study sets out to reveal how the company has achieved this high standard of SHE management. To this end, the following areas will be focused on:

- Current practices of SHE management
- Improvement of business effectiveness
- Implementation and enforcement strategies
- Strategies for sustaining and improving existing safety cultures and practices

1.4 Methodology

Comprehensive research methodologies were used to ensure quality of data. Collected data were filtered through cross-checking.

Literature review: The authors reviewed many internal documents of SNC-Lavalin and documents specific to SNC-Lavalin T&D, including policy, guidelines, plans, standards, and procedures. In addition, external documents including relevant research papers, academic review papers, journals, guidelines, procedures, and books were studied. A full list of reviewed literature can be found in the reference section.

Interviews: In order to identify actual safety practices and to assess the effectiveness of safety training provided to the workers, the authors visited several construction sites of SNC-Lavalin T&D's two of the largest projects in Alberta. One of these projects is Cassils to Bowmanton (including West Brooks to Medicine Hat), which is a 240 kV and approximately 150 km transmission line construction work. The other one is Bowmanton to Whitla, which is a 240 kV and approximately 135 km transmission line construction work. The duration of both projects is five years; 2009 to 2014. The two projects together are known as CBW. The authors interviewed people from various levels of SHE management to field-level workers, including those employed by a subcontractor. Semi-structured questionnaire and observation techniques were used for the interviews. In the semi-structured questionnaire there were 14 open-ended questions and two Likert-scale-based statements that respondents were asked to rate on an ordered scale from 1 to 5, where 1 indicated that the respondent *strongly disagreed* and 5 that they *strongly agreed* with the statement. To minimize error and to accurately represent this group of respondents, the Stratified Random Sampling (SRS) technique was used.

2

Literature Review

This chapter presents a summary of relevant research papers, academic review papers, guidelines, procedures, and books. It also emphasizes why SHE management and education are critical.

2.1 Brief statistics on work-related accidents and their consequences

According to the International Labour Organization (ILO), each day some 6,300 people die worldwide because of work-related accidents or disease, which is more than 2.3 million deaths per year. Over 337 million work-related accidents occur annually; many of these result in extended absences from work (ILO, 2011). The economic burden of poor safety and health practices is staggering. Roughly 1.25 trillion US dollars is siphoned off annually by costs such as lost working time, workers' compensation, the interruption of production, and medical expenses. Beyond the economic issues, there is a moral obligation: the human costs are far beyond what is acceptable.

The cost to Canada from workplace injuries and fatalities continues to be high. Some estimates indicate that annual costs may be as high as \$20 billion (Robinson et al. 2006). According to the Association of Workers' Compensation Boards of Canada (AWCBC) there was a total of 800,000 hours of claims in Canada. The province of Alberta contributed 18% of these. Table 2.1 presents some of the key statistics of Canadian Occupational Health and Safety data in 2009.

Table 2.1: Key facts in 2009 occupational health and safety data

Key Statistical Measures (KSM)	Canada	Alberta
Number of Claims Reported (#)	799,296	140,198
Total number of Lost-Time Claims (#)	260,284	26,843
Number of New Lost-Time Claims for Assessable Employers (#)	235,788	26,112
Number of New Lost-Time Claims for Self-Insured Employers (#)	24,496	731
Current Year Benefit Costs Incurred for Assessable Employers. Excludes Admin. Costs (\$thousands)	\$5,007,202	\$651,068
Assessment Revenue for Assessable Employers (\$millions)	\$8,477.9	\$897.7

2.2 Standard practices in SHE management

The essence of SHE management systems is to protect the human and environment including animals from all kinds of work-related hazards. It deals with safety standards and

practices generalizable to all sectors and industries (Manuele 2005, Grainge 2005), and it is important to note that “zero tolerance” of any kind of incident is a fundamental standard. Safety parameters can be set subject to number of variables factors including context, degree of hazard involvement, degree of acceptable risk, and relevancy. The following key principles are strongly recommended for occupational health and safety (Alli 2001).

- *All workers have rights:* Workers themselves, as well as employers and governments, must ensure that these rights are protected and foster decent conditions of labour.
- *Occupational health and safety policies must be established:* Such policies must be implemented at both the governmental and enterprise levels. They must be effectively communicated to all parties concerned.
- *There is need for consultation with the social partners (that is, employers and workers) and other stakeholders.* This should be done during formulation, implementation, and review of such policies.
- *Prevention and protection must be the aim of occupational health and safety programs and policies.* Efforts must be focused on primary prevention at the workplace level. Workplaces and working environments should be planned and designed to be safe and healthy.
- *Information is vital for the development and implementation of effective programs and policies.* The collection and dissemination of accurate information on hazards and hazardous materials, surveillance of workplaces, monitoring of compliance with policies and good practices, and other related activities are central to the establishment and enforcement of effective policies.
- *Health promotion is a central element of occupational health practice.* Efforts must be made to enhance workers’ physical, mental, and social well-being.
- *Occupational health services covering all workers should be established.* Ideally, all workers in all categories of economic activity should have access to such services, which aim to protect and promote workers’ health and improve working conditions.
- *Compensation, rehabilitation, and curative services must be made available to workers who suffer occupational injuries, accidents, and work-related diseases.* Action must be taken to minimize the consequences of occupational hazards.
- *Education and training are vital components of safe, healthy working environments.* Workers and employers must be made aware of the importance and the means of establishing safe working procedures. Educators must be trained in areas of special relevance to different industries, which have specific occupational health and safety concerns.
- *Workers, employers, and competent authorities have certain responsibilities, duties, and obligations.* For example, workers must follow established safety procedures; employers must provide safe workplaces and ensure access to first aid; and the competent authorities must devise, communicate and periodically review and update occupational health and safety policies.
- *Policies must be enforced.* A system of inspection must be in place to secure compliance with occupational health and safety and other labour legislation.

The Institute of Directors and Health and Safety Executive, a UK-based organization, has recommended the following essential principles: (IOD and HSE, 2007)

- **Strong and active leadership from the top:**
 - Visible and active *commitment from the board*;
 - Establishing effective 'downward' communication systems and management structures;
 - Integration of good health and safety management with business decisions.

- **Worker involvement:**
 - Engaging the workforce in the promotion and achievement of safe and healthy conditions;
 - Effective 'upward' communication;
 - Providing high quality training.

- **Assessment and review:**
 - Identifying and managing health and safety risks;
 - Accessing (and following) competent advice;
 - Monitoring, reporting, and reviewing.

2.3 Compliance & legislative authorities, and standard & benchmark providers

There are number of governmental legislative and enforcement agencies, inter-governmental agencies, and non-for-profit agencies that work hard to minimize work-related harm to humans and the environment. The government agencies have two major functions: (i) overall policy and legal document development, and (ii) enforcement and monitoring of compliance. By contrast, inter-governmental agencies like ILO and OECD provide high-level policy assistance and technical assistance to national governments and multinational businesses. In addition, not-for-profit and consultancy agencies or member-based agencies often provide training, set examples of standards, and assist to develop guidelines. These agencies not only develop policy or enforce implementation, they also assist industries and other sectors to provide benchmarks, performance indicators, and standards. A number of such examples are given below:

American National Standards Institute (ANSI): Empowers its members and constituents to strengthen the U.S. marketplace position in the global economy while helping to assure the safety and health of consumers and the protection of the environment.

American Society of Safety Engineers Foundation (ASSEF): Generates funding and provides resources for scholarship, applied research, academic accreditation, and related academic initiatives in order to advance the safety, health, and environmental profession.

Canadian Centre for Occupational Health and Safety (CCOHS): This was established in 1978 by the Canadian Centre for Occupational Health and Safety Act, which mandates CCOHS to promote the fundamental right of Canadians to a healthy and safe working environment. CCOHS operates under a tripartite council consisting of representatives from business, labour, and government (federal, provincial, and territorial).

Canadian General Standards Board (CGSB): This is a federal government organization that offers client-centred, comprehensive standards development and conformity assessment

services in support of the economic, regulatory, procurement, health, safety, and environmental interests of stakeholders—government, industry, and consumers.

Canadian Standards Association (CSA): A not-for-profit membership-based association serving business, industry, government, and consumers in Canada and the global marketplace.

International Labour Organization (ILO): The ILO is the international organization responsible for drawing up and overseeing international labour standards. It is the only tripartite United Nations agency that brings together representatives of governments, employers, and workers to jointly shape policies and programs promoting decent work for all.

The Organization for Economic Co-operation and Development (OECD): This is an international economic organization of 34 countries founded in 1961 to stimulate economic progress and world trade. Canada is one of the OECD's founding members. The organization is a forum of countries committed to democracy and the market economy, providing a platform to compare policy experiences, seek answers to common problems, identify good practices, and co-ordinate domestic and international policies of its members.

Occupational Health and Safety Council (OHSC): The OHSC is an administrative body that performs an advisory function in accordance with the power and authority specified under the Occupational Health and Safety Act. The Council consists of nine members, including the chair, and has representation from employers, employees, and the public. The Council, on considering an appeal, may confirm, revoke, or vary decisions made with regard to orders, licenses, or permits, and report outcomes involving disciplinary action and imminent danger investigations as described in the Act.

Institution of Occupational Safety and Health (IOSH): This is the chartered body for health and safety professionals in the United Kingdom.

International Organization for Standardization (ISO): This is the world's largest developer and publisher of International Standards. ISO is a network of the national standards institutes of 163 countries. ISO is a non-governmental organization that forms a bridge between the public and private sectors. On the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

In order to understand how the SHE management team at SNC-Lavalin is contributing to achieving the company's outstanding health and safety record, it will be useful to look at the management team and its roles and responsibilities related to SHE. This chapter briefly describes the core business of SNC-Lavalin, and also examines the company's corporate structure, leadership, and management as they relate to SHE.

3.1 The overall business of SNC-Lavalin

SNC-Lavalin was founded in 1911 in Montreal as an engineering and construction group. Swiss-born Arthur Surveyer was the founder of this company.

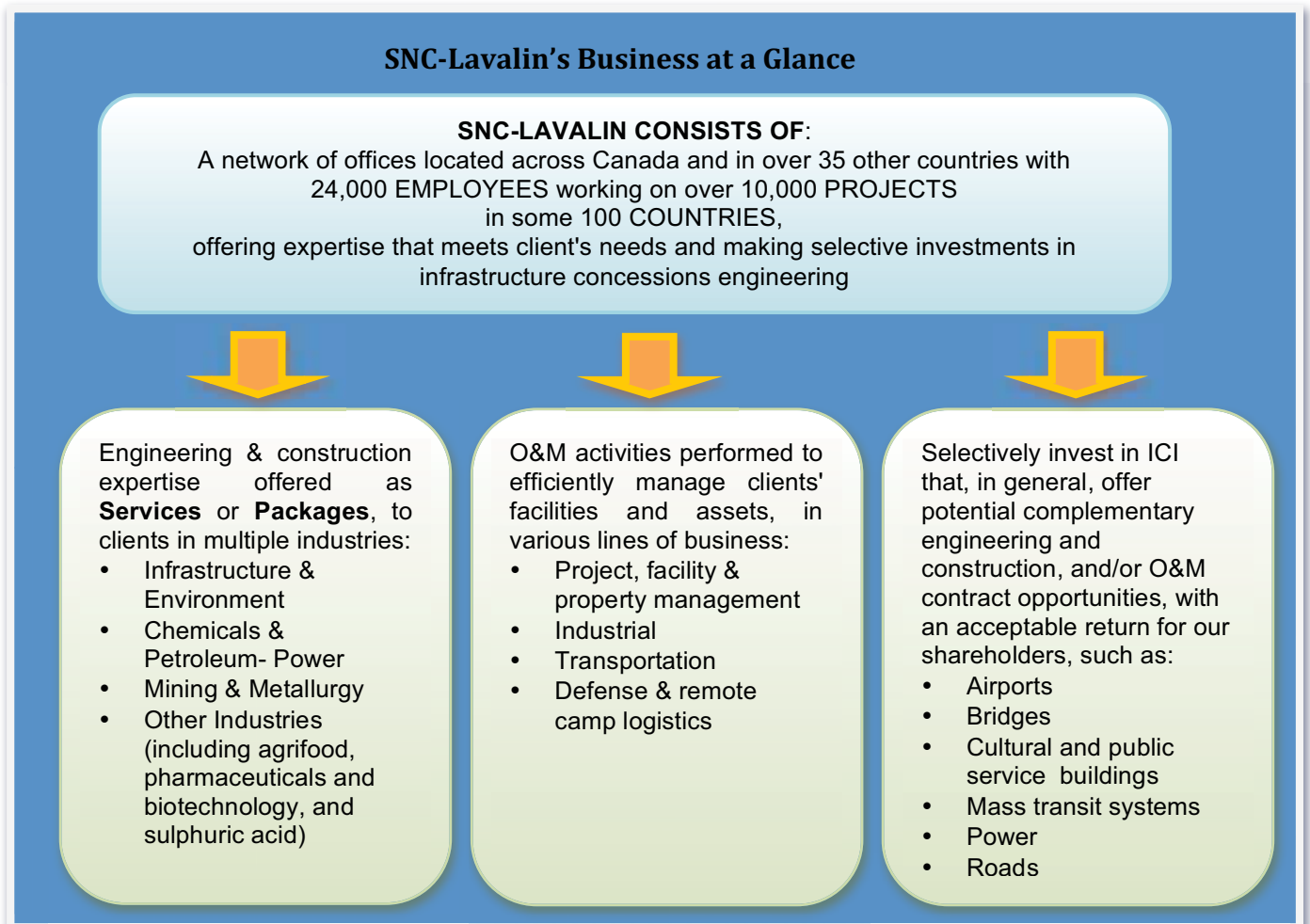


Figure 3.1 SNC-Lavalin's overall business schematic (Source: Annual information form 2011)

Although the company was established as an engineering and construction group, over the years it has expanded its business and expertise and has built outstanding presence in procurement, construction, project management, and project financing services. It serves a variety of industry sectors including power systems, water management, mining and metallurgy, chemicals and petroleum, mass transit, heavy construction, environment, agrifood, and pharmaceuticals as illustrated in figure 3.1.

As of 2010, SNC-Lavalin’s market capitalization is \$9.027 billion. SNC-Lavalin has offices across Canada and in over 35 other countries around the world, and is currently working in 100 countries. SNC-Lavalin owns a number of subsidiaries, associated companies, and infrastructure concession investments globally, as illustrated in figure 3.2

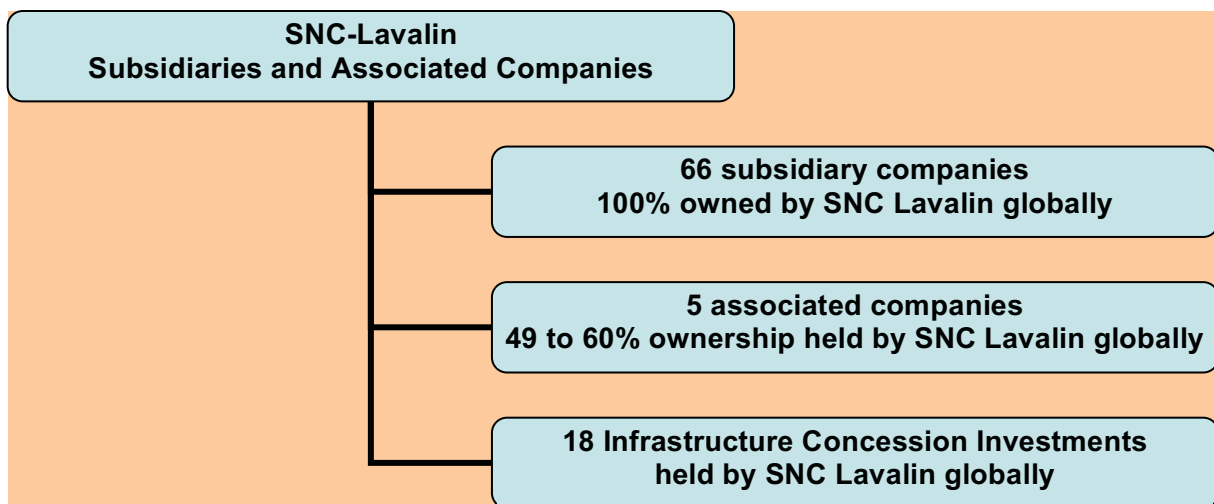


Figure 3.2 SNC-Lavalin-owned subsidiaries and associated companies as of 2011

SNC-Lavalin possesses 89 established corporations. About 74% of those are 100% owned by SNC-Lavalin. The company has investment relationships with about 20% of those and 6% are SNC’s associated companies. A list of all companies and percentages of SNC-Lavalin’s ownership is presented in Annex-1.

SNC-Lavalin maintains exceptionally high standards for quality work, health safety, and environmental protection, and is committed to delivering projects on budget and on schedule to the complete satisfaction of its clients.

Safety Award New Brunswick Road Builders and Heavy Construction Association 2008

SNC-Lavalin won a “Safety Award” in the Large Companies category from the New Brunswick Road Builders and Heavy Construction Association at its Annual Summer Meeting on July 18-19 in Dieppe, New Brunswick. SNC-Lavalin is responsible for the operation, maintenance, and rehabilitation of 275 kilometers of highway from the Quebec border to Longs Creek, west of Fredericton, and Route 95 between the United States border and Woodstock.

3.2 SNC-Lavalin corporate structure

The SNC-Lavalin Group Inc. (Corporation) was incorporated under the laws of Canada on May 18, 1967 and was later incorporated under the Canada Business Corporations Act on March 24, 1980.

Figure 3.3 illustrates the corporate structure of SNC-Lavalin. According to the company's by-laws the Board of Directors is responsible for supervising its business management and affairs. They also have the statutory authority and obligation to protect and enhance the assets of SNC-Lavalin in the interest of all of its shareholders. The Board approves the goals of the business and the objectives and policies within which it is managed, and then evaluates management performances. Reciprocally, management keeps the Board fully informed of the progress of the Corporation towards the achievement of its established goals and of all material deviations from the goals or objectives and policies established by the Board in a timely and candid manner.

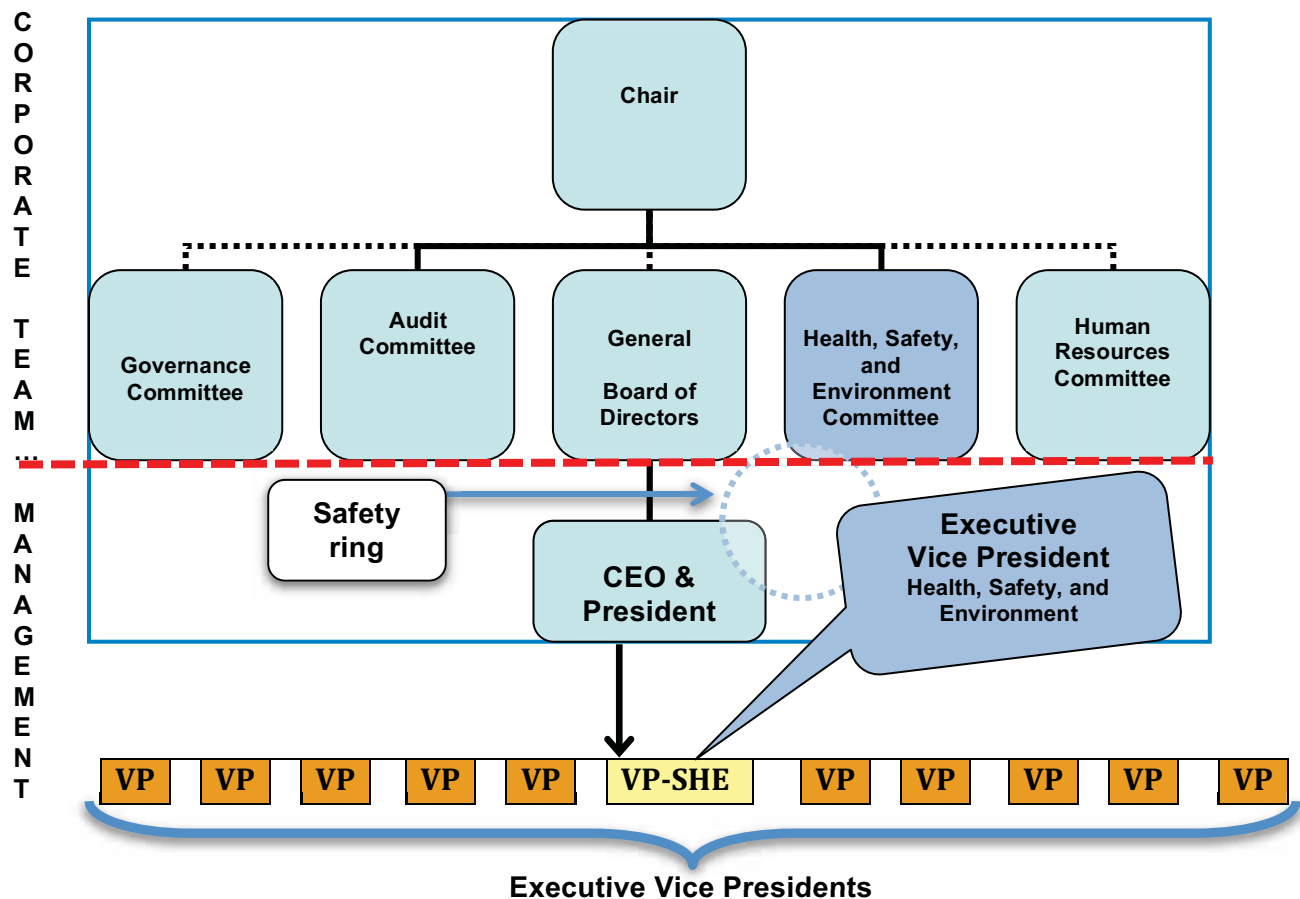


Figure 3.3 Corporate team and management structure of SNC-Lavalin

The Board has established five standing committees to support and assist the General Committee, among which it has a dedicated Health, Safety, and Environment Committee.

The Health, Safety, and Environment Committee consists of the members of the Board only. According to the corporate governance guidelines, the Chair of the Committee is appointed for at least three years. The duties and responsibilities of the committee include the following:

- Review the responses by the Corporation or its subsidiaries, as the case may be, to health and safety, and environmental issues, including compliance with applicable legislation, regulatory requirements, and industry standards;
- Review with management whether such policies are being effectively implemented;
- Review and consider, as appropriate, reports and recommendations issued by the Corporation and its subsidiaries relating to health and safety, and environmental issues, together with management's response thereto.

The bottom part of figure 3.3 (below the red dotted line) presents the leadership and management of SNC-Lavalin. The management team is mainly comprised of 11 Executive Vice Presidents who report to the CEO and President. There is one Executive Vice President who is specifically responsible for Health, Safety, and Environment within the corporation and reports to the Board through the CEO and President. The CEO establishes a bridge between management and governance structure on Health, Safety, and Environment issues within the corporation.

Thus, at SNC health, safety, and environment starts from the very top level of corporate governance and goes down to the field-level workers through Vice President, Director, Engineers at all levels, Project Manager, Project Coordinator, Health and Safety Educator and Advisor, Supervisors, and others associated with a project.

3.3 General HSE policy, management, and implementation structure

The Board of Directors with the assistance from the leadership and management team develops overall SHE policy and goals. The leadership and management team is mandated to monitor and measure performance of Health, Safety, and Environment at the corporate level and reports to the Board of Directors General Committee. The general HSE policy of SNC-Lavalin is quite broad and comprehensive as stated below.

**Gas Processors Suppliers Association
(GPSA) Safety Award SNC-Lavalin, USA, 2007**

SNC-Lavalin GDS of Houston, Texas, picked up a "Gas Processors Suppliers Association (GPSA) Safety Award." Its annual Outstanding Safety Awards Program is meant to honour the best safety standards among its members.

1. As an engineering construction and manufacturing company operating worldwide, the SNC-Lavalin Group and its subsidiaries make occupational health and safety a primary objective in all of their activities both in Canada and abroad.
2. The Board of Directors established the Occupational Health and Safety Committee and mandated it to monitor the general Policy on Occupational Health and Safety. Each

business unit, operating division, or wholly-owned subsidiary is responsible for enforcing the laws and regulations under this general policy, along with the operating guidelines issuing therefrom, which are applicable to all employees without exception.

3. Measures implemented by SNC-Lavalin include, among other things:
 - 3.1. Training employees so they can help integrate the occupational health and safety standards into SNC-Lavalin activities;
 - 3.2. Developing construction, operating, and working methods to ensure that occupational health and safety objectives are part of SNC-Lavalin project quality criteria;
 - 3.3. Producing an annual report on SNC-Lavalin's progress in attaining its occupational health and safety commitments and objectives.
4. SNC-Lavalin, with regard to all the establishments where it is assigned a mandate or responsibility in occupational health and safety matters, has an objective of ZERO accidents in the workplace and the elimination at source of any risk or danger.
5. All units, divisions, and subsidiaries are responsible for reporting any fatal or serious accident resulting in lost time or property damage and to present their reports on such matters to the company's Occupational Health and Safety Committee.
6. SNC-Lavalin has identified measurable objectives, which are specific and adapted to each type of operation in which it is involved, and which will be subject to periodic review.
7. SNC-Lavalin favours a return-to-work policy to assist those who have been involved in a workplace accident at any of its worksites or facilities.
8. The Director, Occupational Health and Safety, is responsible for verifying official directives regarding occupational health and safety and for assuring that all offices, plants, and worksites comply with laws, regulations, and operating policies. Status reports are submitted to the company's Occupational Health and Safety Committee.

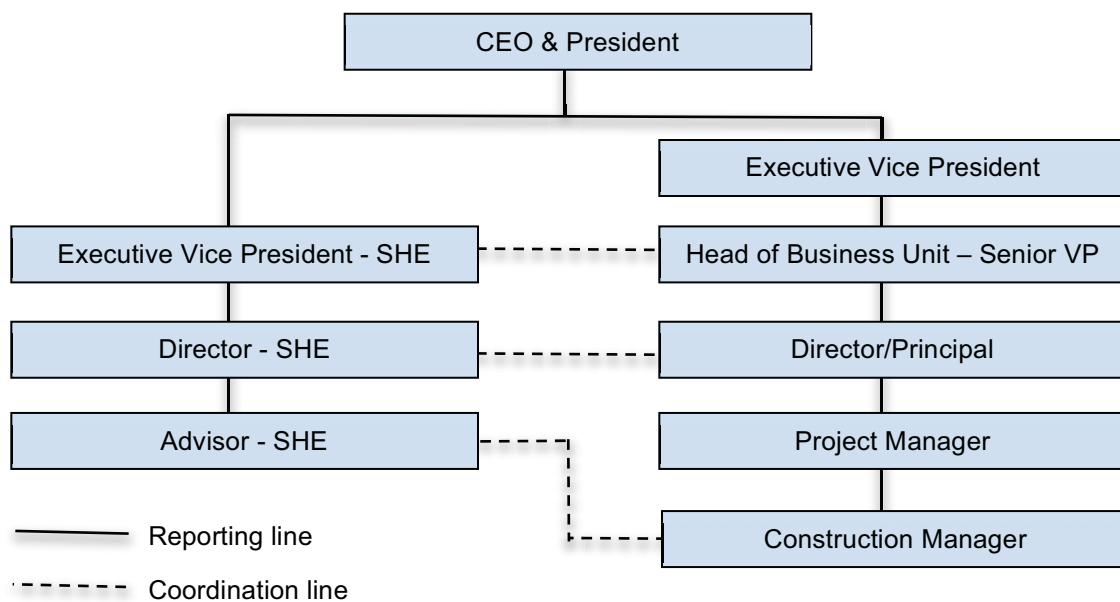


Figure 3.4 SHE management and implementation organogram within SNC-Lavalin

This general policy is supplemented by another business unit health and safety policy specific to construction worksites and context-specific legitimacy and protocols. Every business unit of SNC-Lavalin develops its own set of safety standard and performance indicators, guidelines, and project-specific plan based on corporate policy and on its business goal and hazard assessment. SNC-Lavalin corporate team and management leadership enforces implementation of the policy without exception. Figure 3.4 illustrates the SHE management and implementation organogram within a single business unit. This example is drawn from the SNC-Lavalin T&D business unit.

3.4 SNC-Lavalin excellence in SHE management

Over years of operations SNC-Lavalin has received a number of prestigious awards for its quality work, excellent safety records, and outstanding achievements as listed in table 3.1. These have also endorsed SNC-Lavalin’s global reputation in quality project management and high safety records. Details of these awards are described throughout the text in highlighted boxes.

Table 3.1: List of recent awards received by SNC-Lavalin

Year	Names of Awards
2011	EMAL – Emirates Aluminum Smelter Complex United Arab Emirates
2009	Shaybah Central Processing Facilities – Saudi Arabia
2008	Petro-Canada Ultra Low Sulphur Diesel Project – Montreal, Canada
2006	Project: Gulf Farabi n-Paraffin and Linear Benzene Facility, Saudi Arabia
2005	Project: BHP Billiton Hillside 3 Smelter Expansion, Mozambique

These awards of excellence reaffirm SNC-Lavalin's commitment to excellence in terms of services and technical expertise for its clients and shareholders and for the health, safety, and environment of its employees and the communities in which they work. The awards reflect SNC’s corporate values and ongoing efforts to achieve high standards in all it undertakes.

Contractor Safety Award SNC-Lavalin, Canada

The SNC-Lavalin Sarnia office was presented with a "Contractor Safety Award" for outstanding contributions to safety improvement at the annual Imperial Oil Sarnia Refinery Contractor Safety Forum. SNC-Lavalin met all the eligibility criteria, including zero recordable injuries, more than 10,000 on-site hours, a score greater than 85% on the Industrial Education Co-op Safety Audit, and demonstrated safety leadership.

3.5 SNC-Lavalin Transmission and Distribution (T&D): A business unit

SNC-Lavalin T&D (Transmission and Distribution) is a business unit that undertakes giant projects in power systems, particularly related to transmission and distribution of power.

A number of critical factors including leadership and management; performance and reporting; enforcement and encouragement; communication; training and human capacity building; incidents; risk assessments and degree of hazards were considered to conduct this case study. The following is a summary of these factors. It also justifies selection of SNC-Lavalin T&D as a model for this case study.

Dealing with degree of hazards and hazardous substances	<ul style="list-style-type: none"> • T&D deals with a huge amount of hazards annually.
Risk assessment and risk management	<ul style="list-style-type: none"> • T&D analyze and manage risk exceptionally well from planning and design to post-project completed process.
Low incident rate	<ul style="list-style-type: none"> • Compared to other industries, T&D's incident rate is historically very low.
Commitment towards continuous human capacity development	<ul style="list-style-type: none"> • T&D continuously update their employees, contractors, suppliers, and all stakeholders with SHE training.
Open and transparent communication	<ul style="list-style-type: none"> • T&D has established and made open communication a part of its company culture.
Enforcement and Encouragement	<ul style="list-style-type: none"> • T&D has strong enforcement and encouragement strategies in place to meet the goal of ZERO incidents.
Performance measurement and reporting	<ul style="list-style-type: none"> • In every single project SHE reporting system is strictly practiced.
Leadership and commitment	<ul style="list-style-type: none"> • From the top to bottom of management, SHE is taken as the number one priority without any compromise.

4. *Major Hazards and Safety Measures at SNC-Lavalin T&D's Worksite*

Electricity lies at the heart of modern civilization, so much so that few of our systems would function without it. In counterpoint to this usefulness, however, electricity can be extremely dangerous with very high risk of fatalities. In general the electrical systems we employ have reasonably good safety records, and it is rare for the average person to stop to consider how many people are working behind the scenes to deliver safely this electricity to our homes and workplaces. At what level of risk are some of these individuals working to make our lives easy? SNC-Lavalin T&D, which is SNC's transmission and distribution unit, builds electricity transmission and distribution systems. Thus, this section will present some technical aspects of SNC-Lavalin T&D's projects, and risks associated with these projects.

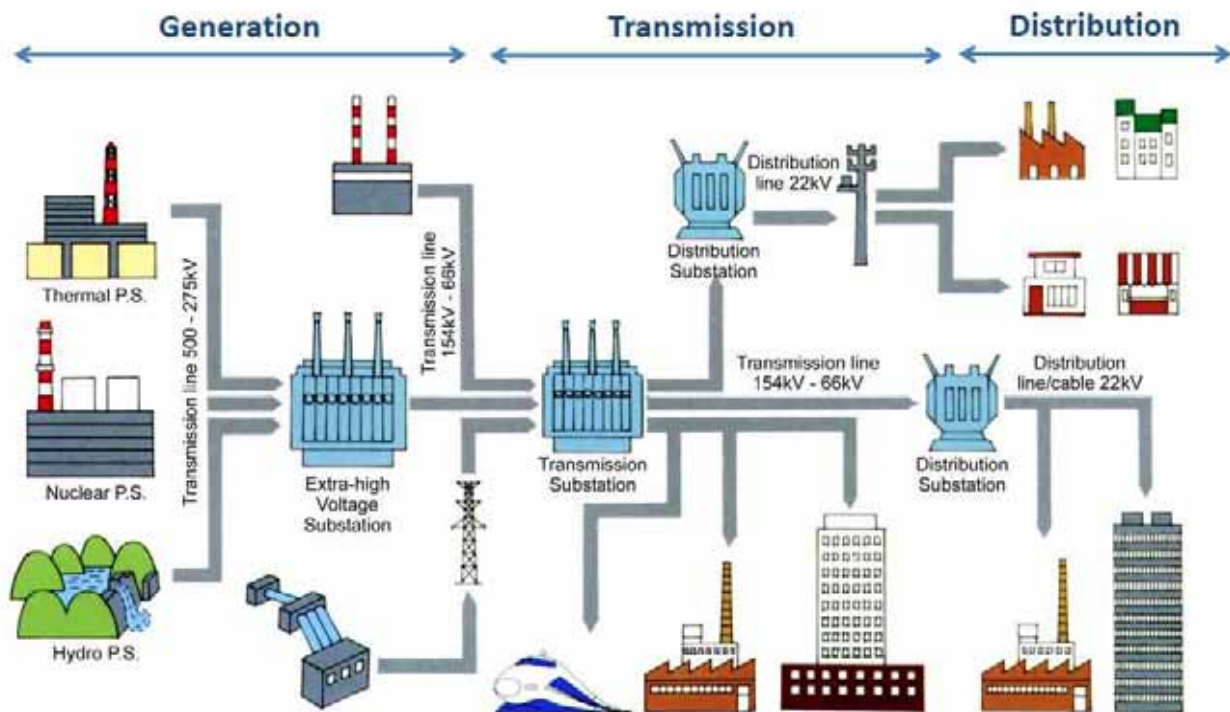


Figure 4.1. Schematic of a power system: Generation, transmission, and distribution

4.1 Transmission and distribution systems

An electrical power system has three major subsystems, namely generation, transmission, and distribution as illustrated in figure 4.1. Electricity is generated in power stations, using various sources such as thermal (natural gas or coal), nuclear, hydro, solar, and wind. The transmission system transmits power from these stations to myriad destinations through hundreds of kilometres of transmission lines. This distribution system is what distributes

electricity to the end users. The voltage at its place of usage usually varies between 100 V and 240 V. From the power station to end user there are several places where voltage is either increased or decreased using step-up or step-down transformers. A substation is where the voltage is transformed, along with other important functions. SNC-Lavalin T&D constructs the transmission and distribution systems described here.

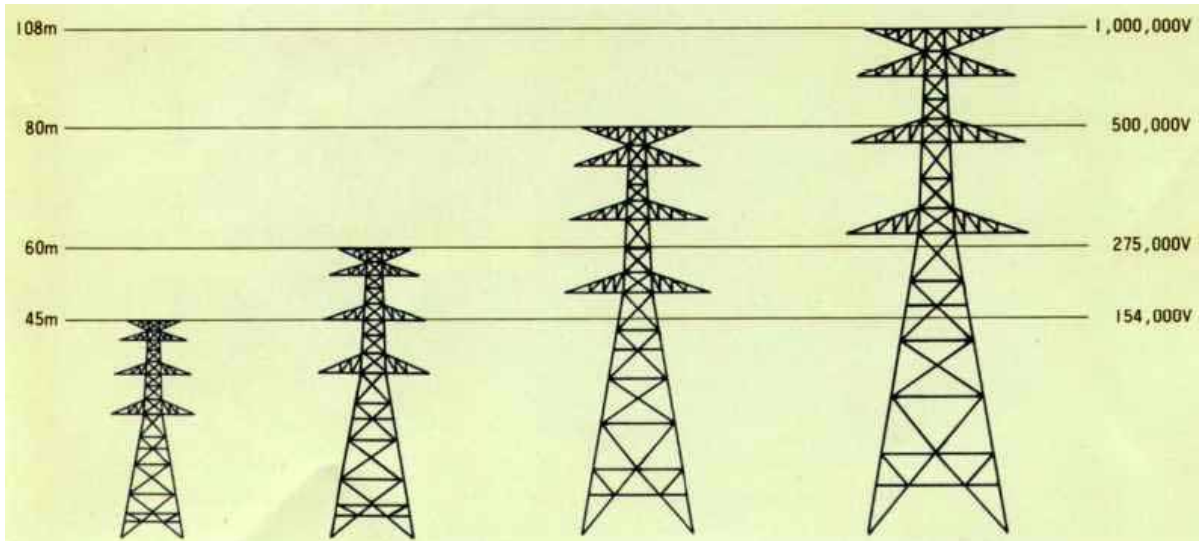


Figure 4.2. Approximate variations of transmission line height with line voltage

Generally transmission takes place at very high voltage in order to reduce transmission losses. The transmission line voltage can go as high as 1000 kV, which is more than nine thousand times higher than the voltage we use at residences in Canada. The construction requirements vary with transmission line voltages. Figure 4.2 shows an approximate height requirement that varies with transmission line voltage. Distribution takes place at relatively lower voltages but still at the kilovolt range. In order to ensure an uninterrupted power at the user end, thousands of people are working on the ground for construction and maintenance of such giant and hazardous systems. Maintenance may require working on a live line with a million volts.

4.2 Major hazards at transmission and distribution construction sites

There are many hazards to people working in transmission and distribution systems, both for construction and maintenance. These hazards include electric shock, arc flash, fire, burn, noise, fall, wild animals, poor road communication, climatic conditions, and many others.

4.2.1 Electric shock

Electric shock is a physiological effect that occurs when body becomes part of a circuit. The primary variable for determining the severity of electric shock is the electric current that passes through the body. This current depends on voltage and resistance. Body resistance may differ but a 100k Ω resistance is typical. Skin provides the highest resistance while the limb for example has a resistance of only about 200 Ω . A voltage of 15V may cause a noticeable electric shock, while a shock from a 110V line may lead to a fatal accident. A live

transmission line or a substation has voltages at levels of several hundred thousand, and maintenance workers are required to work on such live lines and substations. Figure 4.3 is a picture taken at a site constructed by SNC-Lavalin T&D where an AltaLink's live line crew is touching a live electric line with appropriate safety protection. Any minor negligence in safety at this worksite may cause instantaneous death.



Figure 4.3 A photograph showing live line crews working on a 138 kV energized line at a construction site near Brooks, Alberta. Another worker is seen to climb a pole with a risk of fall.



Figure 4.4 Arc flash



Figure 4.5 Arc flash and shock hazard warning sign at a workplace

4.2.2 Arc flash

Air is an insulator (infinite resistance) and current cannot flow through air. A very high voltage (sufficient energy) can lead to a breakdown of this insulator, resulting in an electric arc. An electric arc can cause substantial damage, fire, or injury. Temperature can go as high as 20,000°C which can cause metal burn. Arc flash can also produce a tremendous amount of infrared (IR) to ultraviolet (UV) light energy. Because of a sudden explosion of

air this arc blast produces a noise that can lead to hearing loss as well. Arc blast at a distance of two feet can be 145 decibels (dB) where the sound from a jet engine at 200 feet is 132 dB. The threshold of pain is 130 dB. Arc flash may take place at many places with lower voltages. Such equipment or sites must have appropriate hazard warning as shown in figure 4.5. Working at these sites requires appropriate personal protection equipment (PPE). Anyone exposed to arc flash can have serious burn thus flame resistant (FR) clothing is required as a PPE.

4.2.3 Climatic and atmospheric hazards

Climatic and atmospheric hazards are critical for SNC-Lavalin T&D construction site workers. Crane operation is an essential part of T&D line and substation construction. Gusty wind or storms may lead to serious hazards when cranes are in operation. SNC-Lavalin T&D follows a set of recommendations at what wind speed and at what height of operation the crane work should be suspended. However, the safety guide recommends that a crane operator can suspend the operation at a wind speed that is still safe according to the guideline. It is the crane operator's call if he or she realizes a potential hazard because of wind, but in all instances work must be suspended if the wind speed exceeds the recommended limit. The authors of this report experienced a situation at a construction site near Brooks, Alberta where crane operation had to be suspended by the SNC's onsite safety advisors due to gusty wind. The work was being done by a subcontractor. The workers including the crane operator were not very willing to suspend the work because the wind speed was in a gray zone in terms of the recommended wind speed limit. It was SNC-Lavalin T&D's safety advisors who overruled because of potential hazards. Wind has the further effect of blowing a lot of dust, which can be hazardous to the workers since most worksites are in remote fields with no nearby communities. Rain, snow, thunder, and other poor weather conditions may lead to additional hazards. It may not be suitable to work in extreme winter and summer conditions. In some years these construction projects are suspended for two months in summer because of high temperature and humidity. Winter is considered more suitable than summer. But a wind speed of 10 km/h may be hazardous in the wintertime, depending on temperature as discussed in section 4.3.5.



Figure 4.6 A photograph showing yellow sticks at a worksite near Medicine Hat, Alberta

4.2.4 Environmental hazard

There are various environmental hazards to the workers at remote sites. These include underground gas pipeline explosion, oil spill, and fire. Soil digging may damage underground supply lines. Heavy equipment is required to be moved to construction sites

where there is no road. Vehicles are often required to drive through fields with underground supply lines such as gas pipelines. Coloured sticks are used to mark these hazards and anyone driving in such fields must follow appropriate safety guidelines. The authors visited one such a remote site, shown in figure 4.6. The international colour code for marking underground facilities is given in table 4.1.

Table 4.1: The international colour code for marking underground facilities

Facilities	Color code	
Proposed excavation	White	
Temporary survey markings	Pink	
Electric power lines, cable conduit, and lighting cables	Red	
Gas, oil, petroleum, and gaseous materials	Yellow	
Telephone, cable TV, communication, alarm, and signal lines	Orange	
Potable water	Blue	
Sanitary sewers, storm sewers, and drain lines	Green	
Reclaimed water, irrigation, and slurry lines	Purple	

4.2.5 Other hazards related to construction sites

There are many other potential hazards on these construction sites, including falls, wild animals, road communication, telecommunication, and medical emergencies.

Falls are a hazard that may be catastrophic. The incident may involve a person or an object falling from an elevated position. The workers at SNC-Lavalin T&D are frequently exposed to these risks as shown in figure 4.7. However, appropriate safety precautions are taken to mitigate these risks and SNC-Lavalin T&D is able to maintain a very high level of safety standards. In recent years SNC-Lavalin T&D has been using helicopters to lift towers.



Figure 4.7 A photograph showing workers at risk of fall and of being hit by falling objects



Figure 4.8 A photograph showing a challenging road communication on the way to a construction site at a drive of about an hour and a half from Medicine Hat, Alberta

Construction workers work at remote sites where they build towers through hundreds of kilometres. Wild animals often pose a hazard to them. The authors of this report spoke to a worker who encountered a rattlesnake which just missed him. Some parts of Alberta have higher density of this dangerous species. Other wild animals such as bears and coyotes are common too. Some locations are nearly impossible to reach by ordinary vehicle. The authors visited a construction site near Medicine Hat, Alberta where they had to leave their vehicle in Medicine Hat and SNC-Lavalin T&D provided a special truck and assigned a safety advisor to accompany them. Figure 4.8 shows an example of the challenging track that the authors had to navigate on the way to that construction site. Regular cell phone networks are not available at many construction sites. Some of the vehicles are equipped with all sorts of communication facilities and are used as a mobile office. However, the workers on the ground have somewhat limited facilities. Their only resting place is inside a vehicle. In wintertime they may even be required to work in the dark. The size of such a team could be as small as a couple of people. Working in a small team at this type of remote site in adverse weather with very limited facilities is challenging indeed and may entail mental stress as well. Other hazards include, but are not limited to, machine or engine crash, pinched hand, twisted ankle, being hit by loose or falling objects, or broken legs or hands.

4.3 Some examples of safety measures

SNC-Lavalin T&D's safety manual is very detailed and does not ignore even a minor hazard at a workplace or to the public at large. The previous section describes some of the major hazards although the actual list is long. In this section some of the safety measures will be discussed for readers to get a sense of the company's high standard safety practices.

4.3.1 Training

An appropriate safety, health, and environment (SHE) training is required for anyone working at or visiting a construction site. There are different levels of training depending on the type of work or responsibilities. Here is an example of training requirements. Level-1 training is required for anyone working under supervision. Level-2 training is required for anyone giving tours or inspecting. Level-3 training is required for anyone entering a facility as a work leader. The authors had to take a Level-1 training and were accompanied by a safety advisor at all times. The training covered environmental hazards as well as health and safety.

Table 4.2: Description of personal protection equipment (PPE)

PPE	Required at what workplaces
Hard hats	At all worksites
Safety glasses	At all worksites
Safety footwear	At all worksites
Fire resistant clothing	When performing work near energized equipment
Hearing protection	Sites where the sound level may exceed 85 dB
Respiratory protection	If Hantavirus hazard is present
Fall protection	If working above 3 m or at a potential danger

4.3.2 Personal protection equipment (PPE)

Use of personal protection equipment (PPE) to reduce exposure to hazards is a requirement of every SHE regulatory authority. Employers are required to determine what PPE should be required to protect their workers. SNC-Lavalin T&D has a very high standard PPE guideline. The type and level of PPE requirements also vary with the nature of work and the hazards associated with it. The following is an example of PPE requirements at SNC.

The PPE equipment listed in table 4.2 has specific requirements depending on hazards. As an example, a worker with an arc flash hazard must wear UV (ultra violet) and IR (infrared) light protected safety glasses. According to the requirement, the glasses should be able to provide protection against 99.9% UV and 85% IR. In another example, the safety footwear has specific height requirements to protect ankles.

4.3.3 Noise hazard protection

The arc flash described in section 4.2.2 is not the only source of noise hazard; air-operated tools, helicopter operation, engines, etc. can cause a potential noise hazard as well. Most workplaces are engineered to reduce the noise level. The CSA (Compliance, Safety, Accountability) has recommended standard hearing protections as presented in table 4.3. The company has additional measures and follow-up programs for workers who are exposed to noise hazard. Managers must initiate a noise level survey at any work location where the noise levels are suspected to exceed 85 dB. Workers exposed to noise greater than the occupational exposure limits must have their hearing tested within six months of

being exposed to the noise as a baseline, within 12 months after the baseline test, and then every two years thereafter.

Table 4.3: Noise occupational exposure limits and required hearing protection

Exposure level (dB)	Duration	CSA hearing protection class
82	16 hours	C, B or A
83	12 hours, 41 minutes	C, B or A
84	10 hours, 4 minutes	C, B or A
85	8 hours	C, B or A
88	4 hours	C, B or A
91	2 hours	B or A
94	1 hour	B or A
97	30 minutes	A
100	15 minutes	A
103	8 minutes	A
106	4 minutes	A earplug + A or B muff
109	2 minutes	A earplug + A or B muff
112	56 seconds	A earplug + A or B muff & limited exposure
115 & >	0 seconds	A earplug + A or B muff & limited exposure

4.3.4 Fire-resistant clothing

All employees working in electric arc and flash fire risk areas must wear fire-resistant outerwear clothing. SNC-Lavalin T&D is compliant with the requirements of Can/ULC-S801-10, which is the Canadian national standard on electric utility workplace electrical safety for generation, transmission, and distribution (Standard Council of Canada: www.scc.ca). The term ATPV (Arc Thermal Protective Value) is used to rate these clothes. This value refers to the minimum incident energy (in calories per cubic centimetre) that protective equipment can be exposed to and prevent onset of a second-degree burn. Ratings are based upon the total weight of the fabric. Table 4.4 presents the weight classification for fire-resistant clothing.

Table 4.4: Weight classification for fire-resistant clothing

Clothing class number	ATPV	Clothing guideline description	Total weight (oz/yd ²)	Estimated incident energy for onset of second degree burn (cal/cm ²)
2	5-8	One FR layer plus cotton shirt under (2) ATPV ≥ 8	9-12	8-18
3	8-25	One FR layer plus FR coverall plus cotton shirt under (3) ATPV ≥ 25	16-20	25-50
4	25-40	One FR layer plus FR switching coat plus cotton shirt under (4) ATPV ≥ 40	24-30	40-60

For fire-resistant clothing to be effective, it must be clean, in good repair, and worn as the outermost layer. A qualified person must do any repair. When worker visibility is a safety concern, the outer layer of arc-rated clothing must meet the requirements of CAN/CSA-Z96 – High visibility safety apparel or industry standard(s) equivalent or greater in worker protection.

4.3.5 Climatic and atmospheric hazard protection

As in previous subsections, here a couple of types of protection are discussed as examples. The actual guideline is very long and detailed. Exceeding a certain level of humidity and temperature may lead to health hazard. Humidex is an index used by Canadian meteorologists to describe how hot the weather feels to the average person, by combining the effect of heat and humidity.

Table 4.5 shows the recommended danger zones and table 4.6 shows the humidex index table. Degree of heat stress may vary with age, health, and body condition.

Table 4.5: Danger zone indicator based on humidex

Humidex	> 55	40 – 54	32 – 39	31 & below
Danger Category	Extreme danger	Danger	Extreme caution	Caution

Table 4.6: Humidex (humidity index) with temperature and humidity

Temp (°C)	Relative Humidity								
	25%	30%	40%	50%	60%	70%	80%	90%	100%
38	42	43	47	54	57				
37	40	42	45	49	54	55	58		
36	39	40	43	47	51	56	57	58	
35	37	38	42	45	48	51	54	57	
34	36	37	41	43	47	49	52	55	58
33	34	36	38	42	44	47	50	52	55
32	33	34	37	39	42	45	47	50	52
31	31	33	35	38	40	43	45	48	50
30	31	31	34	36	38	41	43	46	48
29	29	30	32	34	37	38	41	44	46
28	28	29	31	33	35	37	39	41	45
27	27	28	29	31	33	35	37	39	41
26	26	27	28	29	31	33	35	37	39
25	25	26	27	28	30	32	33	35	37
24	24	25	26	27	28	30	32	33	35
23	23	23	24	25	27	28	30	32	33

Table 4.7: Threshold limit values work/warm-up schedule for four-hour shift

Air Temp (°C) →		-26 to -28	-29 to -31	-32 to -34	-35 to -37	-38 to -39	-40 to -42	-43 and below
0 mph Wind	Max work period	Normal breaks 1	Normal breaks1	75 min	55 min	40 min	30 min	Non-emergency work should cease
	No. of breaks			2	3	4	5	
5 mph Wind	Max work period	Normal breaks 1	75 min	55 min	40 min	30 min	Non-emergency work should cease	
	No. of breaks		2	3	4	5		
10 mph Wind	Max work period	75 min	55	40 min	30 min	Non-emergency work should cease		
	No. of breaks	2	3	4	5			
15 mph Wind	Max work period	55 min	40 min	30 min	Non-emergency work should cease			
	No. of breaks	3	4	5				
20 mph Wind	Max work period	40 min	30 min	Non-emergency work should cease				
	No. of breaks	4	5					

It has been discussed that in summertime a high wind may suspend construction work but a wind of even 10 km/h may be hazardous in wintertime. Hazard also depends on temperature and humidity. The maximum duration of shifts in summertime and wintertime are different depending on climatic conditions. A cold environment can be countered by properly worn layered protective clothing and by physical activity. In the wintertime rest is mandatory depending on wind speed and temperature. Table 4.7 shows the work/rest schedule, which protects a worker from hazard due to cold.

5

Health and Safety Management System Within SNC-Lavalin T&D

This chapter describes SNC-Lavalin T&D's safety leadership, management functions, communication, enforcement, and encouragement.

5.1 Safety goal and objective

SNC-Lavalin T&D has developed its own Health, Safety, and Environmental guidelines and implementation plan. This is based on the HSE policy of SNC-Lavalin at large and other acceptable guidelines. The overarching goal of their guidelines is to achieve *zero incidents*. SNC-Lavalin T&D management team believe *all incidents are preventable*.

During their field visits the authors found that the guidelines and plan are widely disseminated to staff, subcontractors, and other relevant stakeholders. Even at the site offices all staff were equipped with appropriate PPE where applicable. The T&D business unit has incorporated its Health Safety and Environment Management System (HSEMS) in every step of function and business. "HSEMS strategy includes best management practices, modern control methods and processes which are technically sound, economically feasible, minimize waste generation and prevent environmental spills and releases" (SNC-Lavalin T&D HSEM policy, 2011). The safety management plan is part of their Quality Management System, known as QMS 9000 series.



Fig 5.1 We Care logo

SNC-Lavalin T&D is highly committed and puts utmost effort into implementing a "We Care" philosophy, from its head office to the field. It was evident at all levels starting from the workers through to the top management. It was also observed through their work practice that the workers understand this philosophy. As an example a foreman at a construction site stated that "safety is a living thing, which is always changing." This is a success for the HSE management team at SNC-Lavalin T&D. However, there is always room for improvement, as discussed in section 5.3.

The HSE plan and guidelines are specific to national and provincial legislation, international standards, and best practices. As an example, while operating in Alberta SNC-Lavalin T&D incorporates the following applicable legislation, regulations, and standards:

Codes, acts, and regulations:

- Alberta Labour Code
- Alberta Occupational Health and Safety Act, Regulation and Codes
- Alberta Environmental Protection and Enhancement Act and Regulations
- Alberta Workers' Compensation Act and Regulations
- Alberta Safety Codes Act, Regulations, and Codes

General industry standards:

- American National Standards Institute (ANSI)
- Canadian Standards Association (CSA)
- National Fire Protection Association (NFPA)

5.2 Safety leadership and management functions

SNC-Lavalin T&D believes that loss prevention is a direct responsibility of **everyone** in their workplaces including management, supervisors, and employees, together with their selected contractors, vendors, and service providers. Table 5.1 provides a site visit schedule.

Table 5.1: Site visit schedule for SHE management

Inspection	When	Who is responsible
Project visit	Every six months	<ul style="list-style-type: none"> • Senior Vice President and General Manager
	Every six months	<ul style="list-style-type: none"> • Vice –President Operations
	Every quarter	<ul style="list-style-type: none"> • Vice –President Health, Safety Environment, Quality & Construction Director of Projects
Safety audit	Once per project	<ul style="list-style-type: none"> • Manager Health, Safety & Environment or designated
Work site Inspection	Weekly	<ul style="list-style-type: none"> • Construction Manager/Coordinator
Vehicle and equipment	Pre-use and monthly	<ul style="list-style-type: none"> • Operators
Office Safety Inspection	Monthly	<ul style="list-style-type: none"> • Functional Managers and Supervisors, accompanied by workers on a rotating basis

5.3 Safety communication

A two-way communication system is in place within the T&D business unit. The safety policy, guidelines, and plan are conveyed to employees, contractors, and relevant external stakeholders through trainings, orientations, meetings with individuals, discussions, presentations, posters, signs, etc. This is a downward communication from the top level of management. The management team reminds its people every time and at every level. This was also made evident through the following quote from a field coordinator: *“Let people be reminded that their family is waiting for them at home.”*

Another important upward communication takes place from field-level workers to the very top level of management. In response to a question by the authors the employees stated that they are involved in the process of HSE policy and guideline development. This is so because all levels of workers have opportunities to convey their experiences and opinions to the top management. However, the authors did not find adequate evidence of how health and safety policy was shared with the public, particularly with the groups who are at potential risk of something happening at their project sites.

The questionnaire included a statement and a question as follows:

“The goal of safety trainings is to achieve ZERO incidental rates – the safety training I (the respondent) received met this goal.” How do you (the respondent) agree to this statement?

Strongly disagreed 1 2 3 4 5 **Strongly agreed**

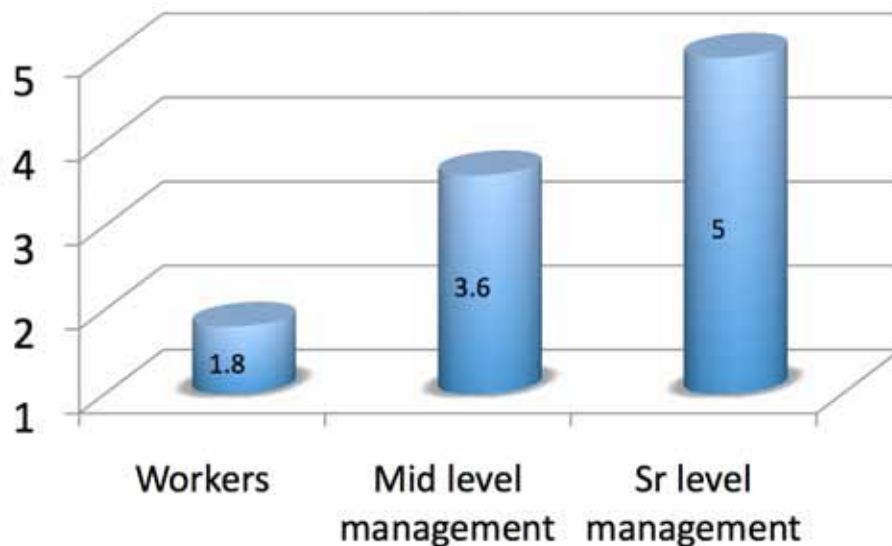


Fig 5.2 Responses to a question regarding the goal of zero incidents. 5 on the y-axis represents strongly agreed and 1 represents strongly disagreed.

The result is summarized in figure 5.2. Here the senior-level management includes project managers and construction managers. The mid-level management includes safety educators, safety advisors, and supervisors. The workers include workers and foreman. Senior management think it is possible to reach this goal. However, the mid-level has a moderate feeling on the goal of zero incidents. The workers who are the real players on the ground think differently. Their answers were based on what is happening at workplaces. The question stressed zero incidents. It is true that the goal of zero incidents has not been met yet but this is the goal of SHE management. This also indicates that there is room for improvement.

5.4 Enforcement and encouragement

The reviewed safety plan of T&D demonstrates a fine balance between risk, reward, and potential consequences (Ref: StepBack). This behavioural-based safety approach was introduced by SNC-Lavalin across the corporation. T&D also has enforced this protocol. The company has a strong enforcement policy as summarized in Table 5.2. The Positive Incentive Program is one of the company's incentive programs. The program offers rewards to workers for their *right behaviour*. Most workers appreciate this policy. The authors found that most of the employees and sub-contractors were aware of this program. However, some of the sub-contractors have their own enforcement and reward policies for health and safety. This program helps motivate other workers by setting up examples. The authors have heard the following enforcement and encouragement policies from the interviewees.

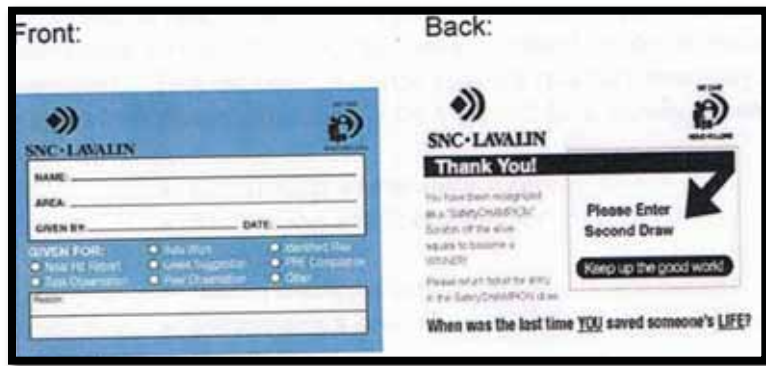


Figure 5.3 Positive incentive scratch card

Table 5.2: Enforcement and encouragement policies based on responses from interviewees.

Encouraged to keep the workplace safe	Enforced to keep the workplace safe
<ul style="list-style-type: none"> • Mandatory <ul style="list-style-type: none"> ○ Orientation ○ Job-specific higher level training 	<ul style="list-style-type: none"> • Corrective actions: <ul style="list-style-type: none"> ○ Counselling ○ Verbal notice ○ Reorientation
<ul style="list-style-type: none"> • Promote safety behaviour <ul style="list-style-type: none"> ○ Positive reward ○ Motivating others by rewarding a person in a group ○ Monetary bonus, car, recognition, clothing, special gifts (such as free trip, iPod, TV) ○ Positive incentive program 	<ul style="list-style-type: none"> • Soft threat: <ul style="list-style-type: none"> ○ Advice to construction group ○ Unpaid time off ○ Remove from jobsite ○ Take issue at higher level ○ Written warning
<ul style="list-style-type: none"> • Work plan <ul style="list-style-type: none"> ○ Tailboard ○ Hazard analysis tools ○ Review mitigation plan ○ Stop work if risk is eminent 	<ul style="list-style-type: none"> • Hard threat: <ul style="list-style-type: none"> ○ Dismissal

Complete the StepBack card prior to starting each task, and when conditions/location change		
Project Name:		Project No:
Contractor:		Date:
Description of Task:		
Environment Hazards	Access / Egress Hazards	Electrical Hazards
<input type="checkbox"/> Spill potential	<input type="checkbox"/> Manlifts (inspected & tagged)	<input type="checkbox"/> Lockout procedure in place (GOT)
<input type="checkbox"/> Spill Kits	<input type="checkbox"/> Ladders (inspected & tied off)	<input type="checkbox"/> Potential test
<input type="checkbox"/> Waste properly disposed	<input type="checkbox"/> Slip/trip/falls	<input type="checkbox"/> GRDS installed both ends of work area
<input type="checkbox"/> Waste plan identified	<input type="checkbox"/> Hoisting (tools, equipment)	<input type="checkbox"/> Working on/over energized equipment
<input type="checkbox"/> Excavation permit required	<input type="checkbox"/> Evacuation (alarms, routes, phone #'s)	<input type="checkbox"/> Electrical cords/tools inspected
<input type="checkbox"/> Other workers in area	<input type="checkbox"/> Confined space entry permit required	<input type="checkbox"/> Fire extinguishers
<input type="checkbox"/> Weather conditions	Rigging Practices Hazard	<input type="checkbox"/> Hot work permit required
<input type="checkbox"/> MSDS reviewed	<input type="checkbox"/> Lift plan required	Overhead/Elevated Work
Ergonomic Hazards	<input type="checkbox"/> Proper tools used	<input type="checkbox"/> Barricades & signs in place
<input type="checkbox"/> Awkward body position	<input type="checkbox"/> Tools inspected	<input type="checkbox"/> Hole covering identified
<input type="checkbox"/> Over extension	<input type="checkbox"/> Equipment inspected	<input type="checkbox"/> Harness/lanyard inspected
<input type="checkbox"/> Prolonged twisting/bending motion	<input type="checkbox"/> Proper slings (inspected)	<input type="checkbox"/> 100% tie-off
<input type="checkbox"/> Working in a tight area	<input type="checkbox"/> Others working overhead/below	<input type="checkbox"/> Tie-off points identified
<input type="checkbox"/> Lift too heavy/awkward lift	<input type="checkbox"/> Critical lift plan required	<input type="checkbox"/> Falling items
<input type="checkbox"/> Part of body in line of fire	<input type="checkbox"/> Designated signalman required	<input type="checkbox"/> Foreign bodies in eyes
<input type="checkbox"/> Repetitive motion	Ensure PPE Requirements	<input type="checkbox"/> Hoisting or moving loads overhead
<input type="checkbox"/> Hands not in line of sight	<input type="checkbox"/> Hard hat	Personal Limitations/Hazards
<input type="checkbox"/> Working above your head	<input type="checkbox"/> Safety glasses	<input type="checkbox"/> Procedure not available for task
	<input type="checkbox"/> Gloves (Kevlar or leather)	<input type="checkbox"/> Confusing instructions
	<input type="checkbox"/> CSA boots	<input type="checkbox"/> Trained to use tool & perform task
	<input type="checkbox"/> Fire Retardant Clothing	<input type="checkbox"/> First time performing task
	<input type="checkbox"/> Hearing protection	<input type="checkbox"/> Distractions
	<input type="checkbox"/> Additional PPE required:	<input type="checkbox"/> Pre-use log & checklist completed
Is the worker working alone? Yes <input type="checkbox"/> No <input type="checkbox"/>		<input type="checkbox"/> Permit reviewed with crew
If yes, what is the communication system put in place for the level of hazard?		<input type="checkbox"/> Fit for duty (no fatigue/drugs/alcohol)

Fig 6.2 The required hazard assessment part of the StepBack card

The company has recently introduced a program known as StepBack. The primary focus of this program is to take precautions pre-incident and take the highest possible level of actions to minimize rate of incidents. This program satisfies the ILO work policy of *right to refuse*. The program allows an individual to evaluate potential risk associated with the work to be done and allows this person to make his or her own decision on whether to do this work or not. This also assists the field risk-assessment as a part of the overall risk management process. Samples of this stepBack card is shown in figures 6.1 and 6.2. Figure 6.3 shows a risk calculator. It was found to be displayed at the visited sites and employees were keeping it with them at all times. The employees confirmed that they check it every day before starting work and at the tailboard meeting.



Figure 6.3: A sample of a risk calculator

The authors asked the interviewees to list potential hazards at their worksites and to classify them into three categories: high, medium, and low. Table 6.1 is a summary of responses received. It is in agreement with the hazard analysis described in chapter 4.

Table 6.1: A summary of potential hazards identified by workers

High	Medium	Low
Falling objects	Pinched hand	Ankle twist
Fire	Broken leg/hand	Small cut
Underground gas pipeline explosion	Oil spill	Poor weather conditions
Machine/engine crash	Legs or hands broken	Poor road communication
Physical injuries	Poor traffic	Wildlife
Catastrophic: life in danger	Vehicle accident	Communication system disorder
Electrocution		Dust contamination

Figure 6.4 presents T&D's safety statistics since the founding of the company. The apparent increase in the years 2009 and 2010 does not represent an actual increase of rate of incidents. The y-axis represents the absolute number of incidents. In comparison to the total volume of projects in recent years, the rate of incidents is even lower in recent years. SNC-Lavalin T&D's incident statistics are much better than the average record in Alberta, as shown in figures 6.5 and 6.6. SNC-Lavalin T&D has exceeded one million hours without major recordable incidents as shown in figure 6.7, which is the cover page of the SNC-Lavalin T&D newsletter published in November 2011.

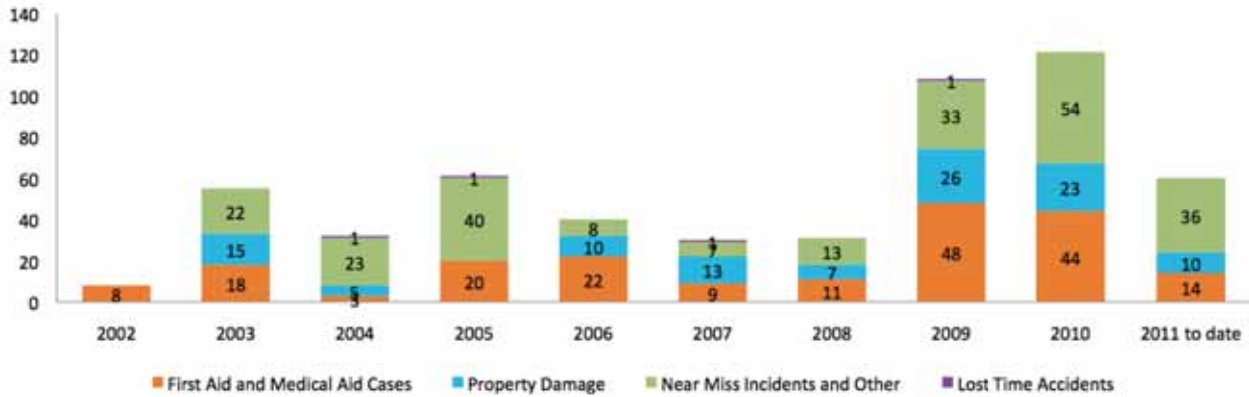


Figure 6.4 SNC-Lavalin T&D's incident record

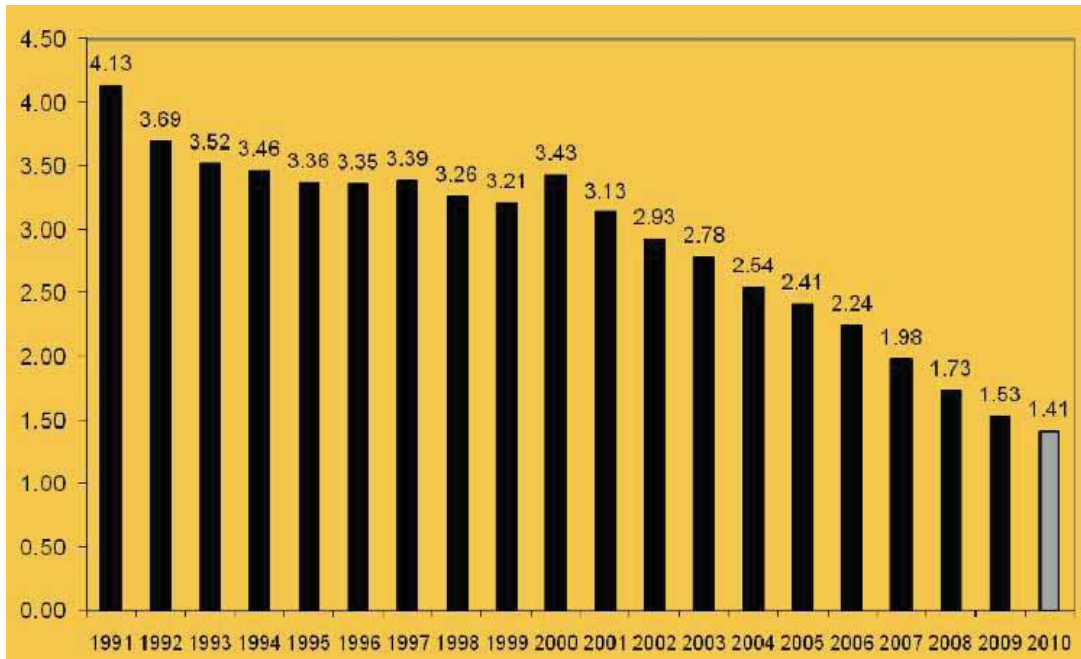


Figure 6.5 The lost-time claim rate in Alberta from 1991 to 2010. Source: WCB; the lost-time claim rate was calculated on person-years worked provided by WCB since 1991.

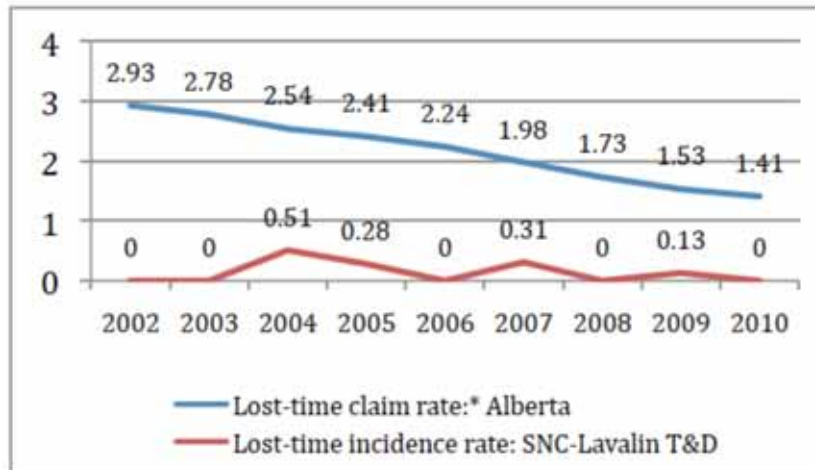


Fig 6.6 A comparison of lost-time

It was revealed that the following key points helped T&D achieve this success in health and safety.

- Management is actively committed to, and involved in, safety activities;
- Management's involvement is quite visible in daily operations;
- Managers often set a good example in regard to health and safety;
- Engineers consider health and safety as an utmost requirement while designing a project
- When an incident occurs managers take part in the follow-up process;
- Managers actively monitor the activity plans for safety goals and objectives;
- Safety is always on the agenda of regular meetings;
- Safety is never compromised with operational goals, cost, or other issues;
- Adequate resources are allocated for a safe operation;
- Monitoring mechanisms are in place;
- A safety culture has been created where all employees can take actions for reasons of safety without the fear of possible negative consequences.

6.2 Human resource development

One of the interview questions was designed to find out how much of their training employees received from school and how much of it they received from employers. It was interesting to see that almost everyone received most of the training from his or her employer(s), as illustrated in figure 6.6. About 90% of the workers and mid-level managers acknowledged that the training they received at school did not impact on changing safety culture. In other words, the training received at school in general failed to make a behavioural change or did not improve the safety culture. Some workers were open enough to comment that the issue of health and safety is still not of paramount importance to them and they are compliant on health and safety issues mostly because of enforcement. Most of them, however, strongly recommended that health and safety education should be mandatory in engineering and other technical programs offered by university and colleges. They particularly highlighted that education, no matter what the level and duration, should

focus on changing behaviour. This is in agreement with the ILO recommendation for health and safety. Here is a quote from the ILO Global Strategy on Occupational Safety and Health document: "It is essential to provide education to raise awareness of safety [OSH] issues to all starting from schools and other educational and training institutions. In addition, certain groups need more advanced safety [OSH] education and training, including management, supervisors, workers and their representatives, and government officials responsible for safety and health." (ILO, 2003)

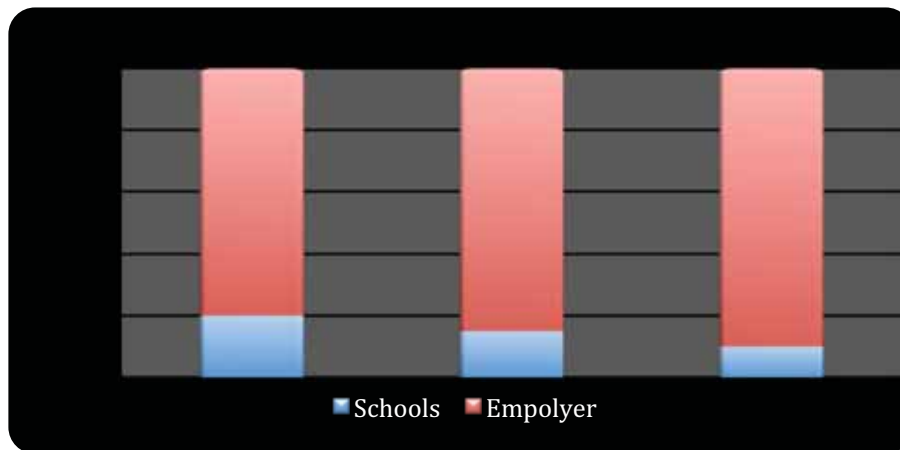


Fig 6.7 Safety training received from school and from employers

The authors have received the following feedback from employees that the company has:

- Allocated adequate human resources and time for HSE;
- Taken steps forward so that workers understand safety performance measurement objectives;
- Provided the opportunity to learn all possible hazards of a certain work, with the worker having the right to refuse;
- Developed guidelines and plans that clearly state a procedure for employees to remove themselves, or be removed, from safety-related work when temporarily unfit for work (as determined by a manager or by the staff) without fear of possible negative consequences;
- Established system and ensured all staff receive appropriate safety education and training before engaging in work or visiting site;
- Developed a communication process to regularly analyze and provide feedback to upper level;
- Established a system to keep records of all safety-related education and training provided by the company.

7

Discussion and Conclusion

Health and safety is an area of study that is constantly evolving. Technological development and innovation of new tools are also adding new hazards in industry, therefore boundaries of health and safety management are continuously changing in nature, characteristics, and periphery. A company or business can respond to this situation by preparing their team with up-to-date knowledge.

7.1 Leadership commitment

Leadership commitment is fundamental in health and safety. Many high-profile safety cases over the years have been rooted in failures of leadership (IOD and HSE, 2007). Pormfret (2008) argued that safety through leadership is more fulfilling, more rewarding, more economical, and more democratic than safety by work group imposition or indeed by government imposition. SNC-Lavalin T&D has high-quality leadership commitment towards health and safety. An interesting question was asked to all interviewees regarding a possible leadership role. Here is the question. *Assume that you have the full authority to make any change at SNC-Lavalin T&D. What change(s) would you make to improve the health and safety at SNC-Lavalin T&D?* The following are some of the responses:

- Enhancing further training opportunities for the field-level workers to deal with new technologies;
- Introducing a computer database that will have health and safety training records of all employees in detail. The system should automatically send a reminder to the respective employee whenever any training is about to expire. It is noteworthy that there are trainings which expire after a certain time. However, it was not verified whether SNC-Lavalin T&D already has this kind of database.
- Making the essential PPE materials readily available at the worksite. For example, if a pair of hand gloves is torn, a replacement is not readily available at the worksite. According to the respondent, they need to stop teamwork or to continue work with a greater risk in this situation. Also, in order to get a new pair, they need to show the torn one as proof. The respondent wanted to shorten this process and to make the essential PPE available at worksites. It is noteworthy that SNC-Lavalin T&D and its subcontractors provide all PPE materials free of cost.
- Increasing the amount of scholarship and opportunity for professional development through formal schooling.
- Creating an open environment at the workplace where employees could learn from their colleagues when they do something wrong instead of being reported. It is noteworthy that there is a reporting system in place. However, the reporting system is not to penalize an employee for doing something wrong. It is there for the management to find out the root cause and to correct or improve the system if applicable.

7.2 Policy design and implementation

The goals of a health and safety policy include ensuring a safe work environment, achieving zero incidents, minimizing incident investment and cost, increasing productivity and overall corporate profitability, and enhancing the company's reputation. SNC-Lavalin T&D has developed its HSE guidelines and plan based on corporate policy, international standards, and legislation. The guideline has the following notable elements:

- The company ensures full participation of all levels of employers as well as other stakeholders in designing the HSE guidelines.
- The company develops its guidelines and plan based on project-specific hazard assessment and best practices aligned to its corporate policy. A policy of prevention then protection is followed.

The company has both the enforcement and encouragement processes to increase overall health and safety. The most effective design and implementation of a safety program can best be achieved through a joint effort involving technical subject matter experts and safety professionals knowledgeable in safety management systems (Floud 2011).

7.3 Safety management system

The OECD (2008) recommends that an effective safety management system should address the following:

- Organizational structure (including the roles, responsibilities, training, education, qualifications, and interrelationship of individuals involved in work affecting safety);
- Identification and evaluation of hazards;
- Facilities and operational control;
- Management of change;
- Planning for emergencies;
- Monitoring performance (concerning the ongoing assessment of compliance with the Safety Policy and the safety management system, and mechanisms for taking corrective action in the event of non-compliance);
- Audit and review (addressing the periodic, systematic assessment of the Safety Policy and effectiveness and suitability of the safety management system); and
- Accident investigation and learning from experience.

The T&D health and safety management system addresses all of these except management of change, which was not very clearly defined.

7.4 Concluding remarks

It is evident that SNC-Lavalin T&D has very high standards and an effective health and safety management system. The company can be a role model for many others. The sharing of successful experience and approaches among all those involved in health and safety is the most efficient way of facilitating the development of practical preventative measures for new and traditional problems. Health, Safety, and Environment is critical for the existence and growth of any business. Building and maintaining a preventative health and safety culture requires making use of all available means to increase general awareness, knowledge, and understanding of the concepts of hazards and risks and how they may be prevented or controlled. Schools can play a greater role in developing safety awareness in general.

Case Questions

1. Besides managing SHE risks, what are the benefits of using a written job-planning tool such as Step-Back.
2. Review Figure 5.2, ask the students to brainstorm the organizational factors that could lead to the significant differences in perception between management and workers.
3. What are the cost reductions that SNC-Lavalin gains on a typical project from managing SHE? Quantify the cost advantage between zero injuries and the injury average.
4. How do the sustainability of SNC Lavalin T&D's performance be affected by critical factors such as leadership, training, and recruiting the right people to manage and run the business? If appropriate, other critical factors can be introduced.
5. Discuss the advantages and disadvantages of transmission and distribution line construction work in summer and winter? Consider all types of hazards including the climatic hazards.
6. Assume you are an engineer at SNC Lavalin T&D and you are preparing a project proposal for SNC. You have observed that introduction of high-level health and safety measures increase the estimated cost of the project. This may negatively impact the bidding process. As every other company, SNC would like to get this project. How would you make a balance between these two factors, i.e., getting the project by reducing the estimated cost and doing no compromise with the required health and safety practices? Which factor would be more important to you and why?
7. It is a common complaint by the field-workers that engineers have less connection with the real situations at field. According to the field-workers the engineers do not make adequate visits to the field. In your opinion, how important is it for the engineers to visit construction sites in order to improve the health and safety performance?
8. In Table 6.1 the workers who were interviewed have identified potential hazards into three categories. Do you agree with them? Justify whether or not you agree with this table. You are encouraged to include further hazards if appropriate.
9. Discuss the hazards associated with a high-voltage transmission line for people living near to it. What are the standard regulations for a safe distance of living? How does it change with line voltages?
10. How would the people living close to a construction site be aware of potential hazards associated with the construction work? At what degree the construction company has responsibility of making the people aware of potential hazards. Discuss this issue with a specific type of construction work of your choosing.

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Annex-1: Subsidiaries and Associated Companies of SNC-Lavalin

Type	Name	Voting securities held
S U B S I D I A R Y	B E Morgan Associates (Proprietary) Limited <i>(South Africa)</i>	100%
	C.J. MacLellan & Associates Inc. <i>(Nova Scotia)</i>	100%
	Genesis Network Architecture and Engineering Inc. <i>(Canada)</i>	100%
	Groupe Qualitas Inc. <i>(Quebec)</i>	100%
	Intecsa-Inarsa, S.A. <i>(Spain)</i>	100%
	Itansuca Proyectos de Ingenieria S.A. <i>(Colombia)</i>	60%
	Marte Engenharia Ltda <i>(Brazil)</i>	100%
	Minerconsult Engenharia Ltda <i>(Brazil)</i>	100%
	Nexacor Realty Management Inc. <i>(Canada)</i>	100%
	P.T. SNC-Lavalin TPS <i>(Indonesia)</i>	95%
	Pellemon Inc. <i>(Canada)</i>	100%
	S.A. SNC-Lavalin N.V. <i>(Belgium)</i>	100%
	SLIVIA Inc. <i>(Quebec)</i>	60%
	SLP Customer Support Inc. <i>(Canada)</i>	100%
	SNC Italia S.p.A. <i>(Italy)</i>	100%
	SNC-Lavalin (Malaysia) Sdn. Bhd. <i>(Malaysia)</i>	100%
	SNC-Lavalin (S.A.) Inc. <i>(Canada)</i>	100%
	SNC-Lavalin (Shanghai) International Trading Co. Ltd. <i>(China)</i>	100%
	SNC-Lavalin Aéroports S.A.S.U. <i>(France)</i>	100%
	SNC-Lavalin Algérie EURL <i>(Algeria)</i>	100%
	SNC-Lavalin America, Inc. <i>(Colorado)</i>	100%
	SNC-Lavalin Angola Lda <i>(Angola)</i>	100%
	SNC-Lavalin Arabia LLC <i>(Saudi Arabia)</i>	100%
	SNC-Lavalin ATP Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Australia Pty. Ltd. <i>(Australia)</i>	100%
	SNC-Lavalin Chile S.A. <i>(Chile)</i>	100%

SUBSIDIARY	SNC-Lavalin Construction (Atlantic) Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Construction Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Construction Inc. (Ontario) <i>(Canada)</i>	100%
	SNC-Lavalin Construction International SAS <i>(France)</i>	100%
	SNC-Lavalin Constructors Inc. <i>(Delaware)</i>	100%
	SNC-Lavalin Defence Programs Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Dominicana S.A. <i>(Dominican Republic)</i>	100%
	SNC-Lavalin Egypt LLC <i>(Egypt)</i>	100%
	SNC-Lavalin Electronics Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Engineering India Private Limited <i>(India)</i>	100%
	SNC-Lavalin Engineers & Constructors, Inc. <i>(Texas)</i>	100%
	SNC-Lavalin Eurasia OOO <i>(Russia)</i>	100%
	SNC-Lavalin Europe B.V. <i>(Netherlands)</i>	100%
	SNC-Lavalin Europe S.A.S. <i>(France)</i>	100%
	SNC-Lavalin Inc. <i>(Canada)</i>	100%
	SNC-Lavalin India Infrastructure Advisors Private Limited (India)	100%
	SNC-Lavalin International Inc. <i>(Canada)</i>	100%
	SNC-Lavalin International S.A.S. <i>(France)</i>	100%
	SNC-Lavalin Mühendislik VE Taahhüt Limited Sirketi <i>(Turkey)</i>	100%
	SNC-Lavalin Nuclear Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Operations & Maintenance Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Peru S.A. <i>(Peru)</i>	100%
	SNC-Lavalin Pharma Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Pharma S.A. <i>(Belgium)</i>	100%
	SNC-Lavalin Polska Sp. zo.o. <i>(Poland)</i>	100%
	SNC-Lavalin Power Ontario Inc. <i>(Canada)</i>	100%
	SNC-Lavalin Project Services, Inc. <i>(Pennsylvania)</i>	100%
	SNC-Lavalin Romania S.A. <i>(Romania)</i>	100%
	SNC-Lavalin S.A.S. <i>(France)</i>	100%

SUBSIDIARY	SNC-Lavalin Services Ltd. <i>(Canada)</i>	100%
	SNC-Lavalin South Africa (Proprietary) Limited <i>(South Africa)</i>	100%
	SNC-Lavalin Sucres & Bioindustries S.A.S. <i>(France)</i>	66%
	SNC-Lavalin Transportation Korea Inc. <i>(Korea)</i>	100%
	SNC-Lavalin UK Limited <i>(United Kingdom)</i>	100%
	Société d'Études et de Réalisations S.A.S. (SODER) <i>(France)</i>	100%
	Socodec Venezuela C.A. <i>(Venezuela)</i>	100%
	SNC-Lavalin Infrastructure Private Limited <i>(India)</i>	100%
	The SNC-Lavalin Corporation <i>(Delaware)</i>	100%
	VEB Engineering LLC <i>(Russia)</i>	49%
	VST Ingenieros Limitada <i>(Chile)</i>	100%
TC Dôme S.A.S.	100%	
ASSOCIATED COMPANY	Nishi-Khon / SNC-Lavalin Limited <i>(Northwest Territories)</i>	49%
	OAo Vnpineft <i>(Russia)</i>	48%
	SNC-Lavalin Gulf Contractors LLC <i>(United Arab Emirates)</i>	49%
	Société d'expertise et d'ingénierie L.G.L., S.A. <i>(Haiti)</i>	33.3%
	SNC-Lavalin PAE Inc. <i>(Canada)</i>	50%
INVESTMENT ENTITY	407 International Inc <i>(Ontario)</i>	16.8%
	AltaLink L.P. <i>(Alberta)</i>	76.9%
	Ambatovy Minerals S.A. LLC <i>(Madagascar)</i>	5%
	Astoria Project Partners LLC <i>(New York)</i>	21%
	Astoria Project Partners II LLC <i>(New York)</i>	18.5%
	Chinook Roads Partnership <i>(Alberta)</i>	50%
	Groupe Immobilier Santé McGill, S.E.N.C. <i>(Quebec)</i>	60%
	In Transit BC Limited Partnership <i>(British Columbia)</i>	33.3%
	Malta International Airport p.l.c. <i>(Malta)</i>	15.5%
	Myah Tipaza SpA <i>(Algeria)</i>	25.5%
	Okanagan Lake Concession Limited Partnership <i>(British Columbia)</i>	100%

I N V E S T M E N T E N T I T Y	Ovation Real Estate Group (Quebec) Inc. <i>(Quebec)</i>	100%
	Shariket Kahraba Hadjret En Nouss SpA <i>(Algeria)</i>	26%
	Rayalseema Expressway Private Limited <i>(India)</i>	36.9%
	Société d'Exploitation de l'Aéroport de Tarbes Lourdes Pyrénées SEATLP SAS <i>(France)</i>	100%
	Société d'Exploitation de Vatry Europort SA (SEVE) <i>(France)</i>	53.1%