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Canada

The Impact of the Occupational Health and Safety Act on the Construction Industry in the Province of Quebec

Henri-Paul Martel, Eng.

A Thesis

in the

Centre for Building Studies

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"... accidents are too expensive anyways. And not only in terms of productivity or capital costs; but, and especially so, in terms of human costs also".

Claude DaoÛst, President AECQ [28]

ABSTRACT

The impact of the Occupational Health and Safety Act on the Construction Industry in the Province of Québec.

Henri-Paul Martel, Eng.

Occupational Health and Safety legislation in North America was first introduced in the U.S. in 1908 to protect government employees. In 1914, Ontario created the first Workmen's Compensation Board (WCB) in Canada. The "Commission des accidents du travail" (WCC) in Québec was established in 1928.

Until the seventies, occupational health and safety was considered a notion proper to specialists, government agencies and large corporations. Since then however, regulatory, social and economic necessities have made the subject an integral part of the construction process. As such all sectors of the industry practice health and safety at work in a different and more constructive way, covering all levels and trades of the construction industry.

In this thesis, a survey of the effects of occupational health and safety acts on the construction industry in Québec is presented and analysed for its impacts on construction management. The study covers the planning, site management and cost aspects of the project management process.

It shows that construction management professionals must now include occupational health and safety as one of the main objectives to attain complete project success.

Available statistics suggest that Bill 17 (adopted in 1979) and Bill 42 (in 1985) have not completely met their primary objectives of decreasing accident rates. Minor modifications in the law could increase its acceptance by the construction industry and make the "Commission de la santé et de la sécurité du travail" (CSST) mandates easier to administer. However, contractors, owners and consultants appear to cope with this relatively new management constraint forwarded by these bills. In this respect, a safety planning model has been developed in the present thesis. The model can be most useful in planning the early stages of the construction process.

For the first time in Québec, a mathematical relationship between the costs of projects and the costs of complying with Bill 17 has been developed. Using a multiplicative (power) model, the percentage cost for compliance can be calculated. The results indicate clearly a rapid drop from approximately 10% to 2% for the 0,5 to 10 million-dollars region of project cost. Further on, the decrease rate is very small, being 0,5% in the 150 million-dollars region of projects costs. The survey has also shown that the weighted mean percentage for the sample studies is 1,02%. The results correlates closely with similar studies done in the U.S.

The insured and non-insured costs of prevention are compared to the direct and indirect costs of accidents. Whilst these costs are more indicative than "accounting costs", the comparison shows that accidents are costing the industry almost three times the money invested in prevention in the last 6 years.

To illustrate the application of the developed model for safety planning and the formulation of the cost aspect of the safety program, the developed methodology has been applied on an ongoing project in Québec. The example project indicates how safety is integrated in the planning phase and which control tools are used. The cost of compliance has been predicted by the developed model and compared to the actual cost incurred. Good agreement has been found between the two costs: 0,95% and 1,06% of the total project costs respectively. Thus assuring the reliability of the model.

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THE IMPACT OF THE OCCUPATIONAL HEALTH AND SAFETY ACT ON THE CONSTRUCTION INDUSTRY IN THE PROVINCE OF QUEBEC

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LIST OF NOTATIONS AND SYMBOLS

α	Level of significance.
ANOVA	Analysis of variance.
β	Slope of regression line.
$\bar{C}$	Average % of projects costs for complying with Bill 17.
C_i	Percentage (%) of project cost for compliance with Bill 17 for the i^{th} project.
$\bar{C}_w$	Weighted mean % of project costs for complying with Bill 17.
COV	Coefficient of variation.
DF	Degrees of freedom.
D_n	Value of the Kolmogorov-Smirnov number.
D_n^{α}	Critical value of the Kolmogorov-Smirnov number.
F-Ratio	Ratio of mean sum of squares of "Model" over "Error" (Result of ANOVA).
μ	Mean value.
P_i	Project cost in 10^6 \$ for the i^{th} project.
$\phi s(S)$	Cumulative probabilities
r	Correlation coefficient
S_e	Standard error of estimate
SD	Standard Deviation of sample
σ	Standard Deviation of population
T-Value	Ratio of estimate to standard error
X_m	Median value
ζ	S.D of ln x in log normal distribution

LIST OF ABREVIATIONS

B. and P.W.	Building and Public Works
CCQ	Commission de la construction du Québec (called OCQ prior to Jan. 1, 1987) ("Québec Construction Commission").
CILRA	Construction Industry Labour Relations Act.
CM	Construction Management.
CSST	Commission de la santé et de la sécurité du travail ("Occupational Health and Safety Commission").
EMR	Experience Modification Rate
GDP	Gross Domestic Product
GIP	Gross Interior Product
I.L.O.	International Labour Organization
IRSST	Institut de recherches en santé et sécurité du travail ("Occupational health and safety research Institute").
OSHA	Occupational Safety and Health Act (USA).
PM	Project Management.
R.S.Q.	Revised Statutes of Québec
STAT CAN	Statistics Canada.
WC	Workmen's Compensation.
WCB	Workmen's Compensation Board.
WCBO	Workmen's Compensation Board of Ontario.
WCC	Workmen's Compensation Commission.
WHO	World Health Organization.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Since the introduction of Québec Occupational Health and Safety Act (more commonly referred to as Bill 17) in 1979, many changes have taken place in the way work safety has to be thought of and applied in Québec construction industry. Prevention, safety programs, GSST, principal contractor, cost of safety, have become major subjects of discussion by all intervening parties in this important sector of the economy.

The Act and the Commission that is derived from it, "Commission de la santé et sécurité du travail" (CSST)*, was the first phase of a major reform that was completed in 1985 with the passing of Bill 42 that revamped the Workers Compensation Act of 1931. Whilst Bill 17 more or less set the scene and put forward the primary objective of prevention, Bill 42 concerns itself primarily with compensation and rehabilitation.

The prior consultations and the passing of these two acts mobilized a lot of energy from the main forces of the labour scene in the province. It seems that the animosity towards Bill 17 paralleled that of the

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* The English version of the Act keeps the original French language name for the Commission. A reasonable translation for the CSST would be the Occupational Health and Safety Commission. The acronym CSST will be used throughout the thesis.

U.S. construction industry towards OSHA in the seventies. The synergy hoped for by the creators of the Act did not really materialize to the extent anticipated.

However, to an observer who would have left the domestic construction sector in the early eighties (to work abroad for example) and came back in the last year or two, there is no doubt that occupational health and safety is now seriously studied, taken into consideration and applied in all projects. Whether these changes are voluntary or perceived as forced upon the industry is quite irrelevant. The fact is that safety must be considered as important as quality, schedule and costs.

1.2 CONSTRUCTION SAFETY IN CANADA AND QUEBEC - AN OVERVIEW

It is said that 1 000 000 canadians are involved in a work related injury every year [18]. As for the frequency of occurrence, a work injury occurs every 6 seconds of the working day and one work-related death occurs every 2,1 hours [16]. In terms of losses, 15 340 000 days were lost and 1 965 754 000$ were paid in benefits for the year 1982 [16]. It must also be noted that from 1970 to 1979, the workdays lost due to work-related accidents were 1,53 times the number of days lost due to strikes and lock-outs [14].

In the following paragraphs the construction industry in Canada and Québec are briefly described in terms of their relative importance and how they stand in general with safety at work.

1.2.1 Construction Safety in Canada

The canadian construction industry with its 61 449 millions dollars of work in 1985 [13] represents roughly 14% of the country gross interior product (GIP). The number of people employed in the construction industry in Canada represents approximately 5% of the total work force of the country [15].

It is, however, astonishing to realize that this group had accounted for 8,9% of the time-loss injuries in 1985. In 1983 and 1984, the proportions were 10,0% and 8,7% respectively [19]. Of the 24 major occupation groups, for the years 1983 to 1985, the construction industry with an average of 9,2% was in third place behind the product fabricating, assembling and repairing occupations (12,8%) and the service occupations (10,2%). Table 1.1 shows the percentage distribution of time-loss injuries for the twenty-four (24) major occupation groups in Canada.

Considering that approximately 575,000 people were employed in the construction industry in Canada [15] and that the employers paid 2 727 millions dollars in assessment for 1984 [83], it can be easily understood that any reduction of the accident rate represents a substantial decrease in the number of workers free of injury. In fact, if it is assumed that no workers has more than one time-loss injury per

TABLE 1.1 - PERCENTAGE DISTRIBUTION OF TIME-LOSS INJURIES BY OCCUPATION-CANADA

MAJOR GROUPS	% DISTRIBUTION			
	1982	1983	1984	1985
Management and adm.	0.4	0,4	0,4	0,4
Nat. sci., eng. & maths	0,6	0,5	0,5	0,6
Social sciences	0,3	0,3	0,3	0,3
Religion	-	-	-	-
Teaching	0,8	0,8	0,8	0,7
Medecine and health	4,0	4,4	4,3	4,3
Art, lit. and recre.	0,2	0,2	0,2	0,2
Clerical	4,2	4,2	4,1	4,4
Sales	3,0	3,2	3,2	3,1
Services	10,0	10,2	10,0	10,3
Farming	1,3	1,4	1,4	1,3
Fishing and hunting	0,1	0,1	0,1	0,2
Forestry	1,6	1,9	1,7	1,6
Mining and quarrying	1,2	1,1	1,1	1,1
Processing	9,0	0,4	9,0	8,3
Machining	7,1	6,1	6,3	6,7
Product fab. & assembly	12,9	12,6	13,1	12,9
Construction	11,2	10,0	8,7	8,9
Transport	6,8	6,8	6,5	6,6
Material handling	7,9	7,9	7,5	8,3
Other craft and eqpt.	1,2	1,1	1,1	1,1
Occ. not classified	4,7	5,3	4,9	4,7
Occ. not stated	3,3	4,0	6,7	11,9
Not coded	8,1	8,0	8,2	2,3

Source: STAT CAN, Work Injuries Statistics [18] [19].

year (not completely accurate but sufficient for comparison purposes), a reduction of 1% in the rate represents close to 600 workers not affected, with the added advantages of the social and financial gains that accompany the reduction in accident rate.

1.2.2. Construction Safety in Québec

In a speech delivered in 1981 [91], Mr. R. Sauvé, then President of the CSST, mentioned that in Québec, each year, one worker in 13 has an accident, 1 in 33 comes out with total disability and 1 in 10 000 dies at work. In the white paper on Occupational Health and Safety published in 1978 [80], it was shown that the building and public works sector was the only one of all the economic sectors having the greatest number of work-related accidents, occupational diseases, and accidents and diseases by 100 workers, present in all three categories.

Despite this high accident rate, the Québec construction industry is an important sector of the economy. For the year 1983 [17], 12% of the provincial gross domestic product (GDP) came from construction. This sector also represents 4% of the Québec GIP [72].

The proportion of construction workers to the total provincial work force, as drawn from a CSST report published in 1985 [7], is shown in Table 1.2

TABLE 1.2 - QUEBEC CONSTRUCTION WORKERS AS % OF ACTIVE WORK FORCE

	1980	1981	1982	1983	1984
Active Work Force (in '000)	2 959	3 040	2 998	3 069	3 123
Construction Workers (in '000)	115	125	113	116	122
% of Total	3,9	4,1	3,8	3,8	3,9

On the other hand, the annual proportion of occupational injuries in construction as compared to all sectors can be seen in Table 1.3.

TABLE 1.3 - CONSTRUCTION INJURIES VS TOTAL INJURIES (WITH TIME-OFF WORK)

	1979	1980	1981	1982	1983	1984	1985	1986
Total Injuries with time-off work (in '000)	160,5	171,2	187,4	157,4	157,9	176,9	196,7(3)	208,5
Construction Injuries with time-off work (in '000)	13,3	13,2	14,0	10,8	10,0	11,7	12,3(3)	15,0
% of Total	8,3	7,7	7,5	6,9	6,4	6,6	6,3	7,2

Sources: (1) 1979-1983 CSST (Reference [78], Table III-3 & III-15)
(2) 1984-1985-1986 CSST (References [73],[74],[75])
(3) CSST Verbal information on July 16, 1987 from Technical Development Service.

Looking at these statistics, two observations can be made and they seem to favour the Québec occupational health and safety system as it applies to the construction industry. First, the proportion of injuries with time-off work (about 7%) appears lower than the canadian average (about 10%), Secondly, the proportion of construction injuries has decreased since 1979 from 8,3% to 6,3% in 1985, thus being lower by almost 25%, even though the number of injuries decreased by only 8%. 1986 saw the rate increase to 7,2%. The increase for that year would be due to a rise in the activities of the B. and P.W. sector for that period [8].

The one statistics that makes construction standout as a dangerous industry is the accidental death rate. Even though it accounts for about 14% of all deaths at work, the building and public sector shows a rate of 0,28 death per 1000 workers as compared to an average rate of 0,09 for all sectors. In other words, there are 3 times as many accidental deaths in construction as there are in all sectors. These figures are valid for the year 1980 to 1986 [73,74,75,79].

However, it must not be overlooked that 153,7 millions were paid as assessments to the CSST by the construction employers in 1986 [75]. This represents 7,9% of the total payroll of 1,942 million dollars [75]. For 1984, the assessment paid (104,7 millions) represented approximately 3% of the construction portion of the provincial GIP [25,75].

Considering the low profit rate in this highly competitive industry, it would sound as good financial sense to attempt to lower the assessments paid as long as the industry is assured of benefiting from a better than average record.

1.3 DEFINITIONS

To ensure clarity and avoid the confusion of different terminologies, the terms and expressions used frequently throughout this thesis are defined below.

1.3.1 Building and Public Works (B. and P.W.) Sector

In this thesis, when a reference is made to the construction industry, the statistics used and the meaning conveyed is that of the building and public works sector which includes more than the construction activites governed by Québec Construction Industry Labour Relations Act (CILRA) (the "Decree").

Over and above salaried workers on job sites involved in residential, commercial, industrial and civil engineering works, (workers whose hours are reported to the CCQ), the B. and P.W. sector also includes [8]:

- All the employees part of the construction division of the employers' CSST classification (including those off the job sites);
- The self-employed craftsmen;
- The construction work done by private or public bodies for their own use; and
- Pre-fabrication off the job sites.

This definition of the B. and P.W. sector explains the reason for the larger number of employees included in the CSST statistics than the number generally presented by the CCQ.

The B. and P.W. sector as defined in this section is also more in line with STAT CAN's classification of economic activities [12].

1.3.2 Accident

Generally an accident can be defined as "... any unexpected occurrence that interrupts the regular progress of an activity" [5] or as "an unplanned event which has the probability of causing personal injury or property damage" [47].

An indirect definition given by King and Hudson [46] states that "a condition of safety is only reached by removing the risks or hazards which could result in an accident".

Bill 42 [70] defines it as " ... a sudden and unforeseen event, attributable to any cause, which happens to a person, arising out of or in the course of his work and resulting in an employment injury to him".

An accident with time-off work would be one that require payment of benefits, that is an absence (with claim) beyond the day of occurrence of the accident.

1.3.3 Accident Rates and Frequencies

Accident rates or frequencies are generally defined on different basis and these must always be well specified to ensure uniformity, and permit meaningful comparisons.

The I.L.O (International Labour Organization) has concluded that because of the different injury definitions used in the world, the only valid comparison statistic is the FAFR (Fatal Accident Frequency Rate) [46], published in the "ILO Yearbook of Labour Statistics". It is defined as the number of fatal accidents par 10^6 man-hours worked. Other statistics used by the ILO are:

$$\text{Frenquency Rate (FR)} = \frac{\text{Total no. of accident*} \times 1\,000\,000}{\text{Total of man-hours worked*}} \quad - - - - (1.1)$$

$$\text{Incidence Rate (IR)} = \frac{\text{No of accidents* X 1·000}}{\text{Average no. of workers at risks*}} \quad \text{- - - - -} \quad (1.2)$$

In the U.S., the OSHA calculates the rate using the following formula:

$$\text{Incidence Rate (IR)} = \frac{\text{No. of incidents * X 200 000 hrs}}{\text{No. of hours worked *}} \quad \text{- - - - -} \quad (1.3)$$

(* = per period)

The 200 000 hours are equivalent of 100 workers x 40 hres/week x 50 weeks/years.

The period could be a month or a year or whatever time span the rates are calculated for.

The U.S. Bureau of Labour Statistics compiles and publishes the IR for 14 separate classifications of construction work and various firm sizes. The American National Standards Institute (ANSI) [63] with its method Z16.1 measures the frequency and seriousness of injuries differently as follows:

$$\text{Frequency Rate} = \frac{\text{No. of disabling injuries X 1 000 000}}{\text{Employee-hours of exposure per period}} \quad \text{- - - - -} \quad (1.4)$$

$$\text{Severity Rate} = \frac{\text{Total days charged X 1 000 000}}{\text{Employee-hours of exposure per period}} \quad \text{- - - - -} \quad (1.5)$$

In the case of death and permanent disabilities, 6 000 days each are charged.

In Québec, the CSST uses the following indecies to compare rates:

$$\text{Frequency Index (or Rate)} = \frac{\text{No. of injuries X 1 000 000}}{\text{No. of worked hours per period}} \quad \text{- -} \quad (1.6)$$

$$\text{Severity Index} = \frac{\text{No. of days lost X 1 000}}{\text{No. of worked hours per period}} \quad \text{- -} \quad (1.7)$$

The number of injuries are compiled from the record that job sites must keep and submit to the CSST periodically.

The hours worked still need to be defined officially as to which quantities will be used. There are presently three methods of computing hours in Québec:

1. From CCQ records: even though these may be the most accurate records, they only account for the hours reported by the firms for construction workers covered by the Québec Construction Industry Labour Relation Act (CILRA), and commonly called the "Decree". Needless to say construction workers employed in the so called "black-market" are not accounted for.

2. From the CSST records for the building and public works sector: the difference with the CCQ method is that the CSST registers construction hours from the employers classification as listed in the CSST Rate Table [27]. All employees of a firm and not only those governed by the "Decree" are covered. It also includes employees working abroad for a Québec registered firm.

3. Hours compiled by Statistics Canada (STAT CAN): the STAT CAN hours include all construction related work hours done by private firms, governmental agencies and departments with their own employees, and which are not strictly covered by the CILRA. The STAT CAN coverage is closer to the CSST's than CCQ's.

1.3.4 Assessment Rate

The assessment rate is the amount per 100$ of salary (up to a maximum of 34 500$ for 1986) [77] that the employer must pay to the CSST. The rate is determined by the CSST every year in four phases:

1. An average rate is computed for all employers from the projected financial needs and assessable salaries for the following year.

2. The average rate is then distributed between the industrial units, based on their accumulated accident record over the last 5 years. From the analysis of expenses and total salaries, an average index is calculated to compare the performance of each unit. The unit assessment rate is derived from this index.

3. Each unit with similar accident costs is assigned to a class which corresponds to the assessment rate.

4. Finally, the CSST compares the assessments and accident expenses for each employer and for the third year preceding the present assessment computations. A merit/demerit system is applied to reevaluate up or down the unit rate of the individual employer.

The industrial units, classes and assessment rates are published yearly by the CSST [27].

1.4 SCOPE AND OBJECTIVES

It is generally accepted that there are three factors that motivate safe practices at work, be it in a factory or on a job site. Halpin and Woodhead [37] define them as:

- Humanitarian concerns;
- Economic costs and benefits; and
- Legal and regulatory considerations.

Whilst the human factor is quite self-explanatory and need not to be dwelt upon in depth, i.e. no sane person would consciously want to hurt a fellow worker, the other two factors can certainly be elaborated on.

The purpose of this thesis is to prepare a comprehensive study on construction safety in Québec considering the management and financial aspects, costs, implementation and evaluation of Bill 17. The objectives can be stated as follows:

1. To provide a state-of-the-art review on construction safety, since this thesis is believed to be the first one in Canada (in Québec certainly) on the subject.

2. To investigate the impact of Bill 17 on the construction industry in Québec, including:

   - Evaluation of the Bill;
   - Its implementation and enforcement; and
   - The cost and management aspects.

3. To develop a mathematical relationship between the cost of safety and the cost of a related construction project in Québec.

4. To carry out a cost analysis relating costs of accidents to costs of prevention in an effort to focus the attention on the need for more sustained efforts on accident prevention.

5. To propose a comprehensive and practical procedure for the implementation of safety in construction job site.

1.5 LAY-OUT OF THE THESIS

The thesis consists of three major parts. In the first part (Chapters 2 and 3), a review of construction safety in Canada in general and Québec in particular is carried out identifying the importance of the construction industry on the federal, and provincial levels. Some definitions relating to occupational safety are given and the

objectives of this study are set. The literature is reviewed in Chapter 2. In Chapter 3, a brief history of occupational health and safety legislation is presented. The present acts which regulate safety in the construction industry in Québec are described.

The second part constitutes the main core of the study, and is made up of two chapters. Chapter 4 describes a survey conducted throughout the construction industry in Québec on safety and presents the analysis results and the main findings. This chapter also addresses the impact of Bill 17 on project management, planning and control along with the related influences on site management and organization. In Chapter 5, an in-depth study of the costs incurred by the construction industry on safety is presented. And, based on the survey data collected, a model relating these costs to the project costs is developed. Prevention costs and accident rates and costs are compared and a brief assessment of the impact of Bill 17 on productivity is made.

The last part of this thesis comprise two chapters. In Chapter 6, a project under construction in Québec was analysed for its safety aspects and related costs. The actual costs incurred on the project and those predicted by the developed model are compared. The results are further analysed and discussed in light of the survey results. Chapter 7 presents the conclusions of this study together with a number of recommendations.

CHAPTER II

LITERATURE SURVEY

2.1 GENERAL

Safety in general includes many particular aspects related to construction. Nevertheless, the construction industry can benefit from safety research work done in other sectors. In this chapter, a survey of related literature on safety in general, and safety as applied to the construction industry in particular, is compiled in four sections including:

- History of occupational health and safety legislation;
- Management and safety;
- Cost and statistical data; and
- Legislations, regulations and regulatory agencies.

2.2 HISTORY OF OCCUPATIONAL HEALTH AND SAFETY LEGISLATION

According to Halpin and Woodhead [37], Germany enacted the first Workmen's Compensation Act in 1884, followed by Austria (1887), England (1897), and it was not until 1908 when the U.S. voted an act for government employees and in 1917 allowed the states to enact workmen's compensation laws and enforce them.

Alain Pontaut, in his book: "Santé et Sécurité: Un bilan du régime québécois de santé et sécurité au travail, 1885-1985" [69], paralled the Québec evolution with that of the other provinces, Europe and the United States. He also presented in great depth the labour conditions and the various commissions that were set up, their results and the numerous legislative attempts. It was stated in reference [69] that the first Workmen's Compensation Board in Canada was created in Ontario in 1914, following the publication of the Meredith Report in 1913 which recommended the adoption of the German system of mandatory employers' mutual insurances, administered by a government corporation. In the seventies, occupational health and safety reforms around the world led to the:

- William-Sleiger Occupational Health and Safety Act (OSHA) in the United States in 1970;
- Rubens Report in 1972 in the United Kingdom followed by legislative action;
- Major modifications to legislation in Ontario (1976), Saskatchewan (1972), Alberta (1976), Manitoba (1978), New Brunswick (1976), Newfoundland (1978); and many others;
- Occupational Health and Safety Act in Québec in 1979.

The Québec Government White Paper on Occupational Health and Safety

[80] published in 1978 highlighted the government's actions between 1885 and 1978, starting with the protection of workmen in "The Factories Act", the adoption of the professional risk principle in 1909 in the "Act Respecting the Responsibility for Accidents Suffered by Workers in the Course of their Work, and the Compensation for injuries Resulting Therefrom". In 1928, the first Workmen's Compensation Act was established expanding the coverage of the compensation plan and setting up the Workmen's Compensation Commission (WCC) to arbitrate the disputes related to accidents at work. In 1931, a new Workmen's Compensation Act was enacted that finally established the collective responsibility of employers and also mandated the WCC to manage the mandatory indemnity fund financed with employers' contributions.

2.3 MANAGEMENT AND SAFETY

Safety as an integral part of construction management is now accepted largely in the construction management science literature even though the approaches can vary.

The motivators for a safer work place: humanitarian, economic, regulatory, etc. have been summarized by Barrie and Paulson [4] in addition to program guidelines for all levels of an organization. In this reference, importance is given to the behavioural approach (what motivates people) to safety rather than the physical one (the procedural approach).

On the other hand, Nunnally [64] stressed safety procedures and precautions to be followed for major construction operations along with the environmental health problems caused by noise, dust, radiation, toxic materials, heat and cold. He pointed out that a poor safety record can make a construction firm lose its competitive advantage as well as the fact that one of the major "inequities" of OSHA is that it makes management solely penalized for safety violations.

The economic and regulatory aspects of construction have been outlined by Halpin and Woodhead [37]. It is shown that contractors with good safety records can obtain substantial savings through the merit rating system, up to 60 000$ on 200 000$ of premium costs for instance. A working summary on the application of OSHA in inspection, record keeping and the safety program is also presented.

As a broad guideline to contractors and managers, Maguire [60] has pointed out that "safety management is as much an attitude as it a science". As such, he advocates the employment of safety engineers wherever possible and formal foremen training on the benefits of a safety program. His summary description of important excerpts of OSHA represents a comprehensive guide on this legislation.

As for the resposibilities and associated authorities, Gans [35] has outlined seven ways for managing safety on a job site operating under a construction management (CM) type contract:

". Contractor only,

. CM assisted,

. CM direction,

. Owner representative,

. Safety consultant,

. Safety corporation,

. Owner wrap-up insurance."

It was also stated that these methods must be studied carefully in the light of on-site responsibility and authority and that, whatever the approach, limits of liability must be established in advance and contracts priced and drafted accordingly.

The different approaches to safety by construction management scientists are based on extensive research works, particularly those of the Construction Institute of Stanford university, since the late sixties, and stressing the behavioural attitude towards safety.

Safety motivation was the subject of a detailed study by Levitt [56].

Through an in-depth case study, a questionnaire of 45 members of the National Constructors Association and a comparison with their EMR (Experience Modification Rate), he found that the three main sources of safety motivation for top managers were:

1. Humanitarian concerns;
2. Insurances and other costs of accidents; and
3. The company safety image.

He also managed to identify seven guidelines to help these managers in reducing accident rates in their firms. His report was also published in the ASCE Journal of the Construction Division with Parker as co-author [57]. A report by Rinefort [88] on Texas firms drew the same conclusion, i.e. that there was "a strong correlation between top management interest and the work injury frequency rate".

The effect of middle management on safety in construction was also studied. In 1976, Hinze [39], by interviewing 45 superintendents on the job, showed that they can have a sizeable effect in reducing accidents by supporting job safety policies, taking responsibility for eliminating unsafe conditions and activities from the job and by having a human approach with the foremen and workers. The same study revealed that "smaller crews have unique characteristics which are advantageous to good safety performances". In another analysis of the same survey, Hinze also found out that "good management practices are essential for good safety performance". [40]

Hinze [40] and jointly with others [42,44] carried out studies on the human and behavioural aspect of construction safety. From a series of interviews and surveys, he concluded that:

- A positive safety performance is related to management style and is compatible with safety;
- Excessive pressure on the workers does not increase productivity but injuries;
- Training new workers and foremen and low turnover are ingredients to better safety records; and
- Safe workers are those in a "pleasant work setting" as job problems disturb workers and can lead to injuries.

On the subject of management, Hinze has reported that firms with close job control i.e. efficient communications and "top management ability to physically monitor jobs", will have a better than average safety performance. In "Safety: Function of Job Control" [45], it was pointed out that company growth can have a negative influence on injuries if not planned for.

Safety programs play a large part in successful safety management. This is one of the reasons why large firms (companies with an annual volume of more than 50 M$) normally have better frequency rates. It has been established by Hinze and Harrison [43] from a questionnaire answered by large firms that the following factors play a significant role in a better that average safety record:

- A very formal safety personnel:
- Full-time safety personnel;

- Formal accident and cost reports; and
- Rewards and incentives.

The important role all those involved in construction and particularly the owners, can play in controlling accidents has been amplified by Levitt [58, 90]. Based on previous research works, he stated that there is "irrefutable evidence that accidents are controllable, to some extent, by all levels of construction management". Owners must pay attention to safety and use it as one of their main criteria for selecting contractors. This is important for humanitarian reasons, public image and economics. Some criteria for selection could be:

- Comparative safety records;
- Management safety accountability; and
- Formal safety program.

This aspect has been further stressed in a Business Roundtable Report titled "Improving Construction Safety Performance" [11].

The Construction Safety Association of Ontario [59] took a similar stand when it declared that "the greatest realistic constribution to further reducing frequency rates in Ontario construction can be made by those commissioning construction". All professionals involved in the public or private sectors must be required to build safely.

The behavioural approach to safety is also stressed by Fullman [34] when he showed that intangible personnel influences are not given the importance given to the mechanics of prevention, which is a mistake. Fullman also shows that small and large companies have the best safety records.

Teamwork and employees involvement are also identified as essential ingredients to the success of a good safety program [68]. The role of a company safety department is to work with all employees for their work to be meaningful.

The physical approach to safety is also an important aspect as it specifies the tools people must work with. The first publication on the subject of the management of safety is probably the "Manual of Accident Prevention in Construction" by the Associate General Contractors (AGC) of America Inc. [62] published in 1927. The main emphasis is on safe construction practices as the AGC states that it is "estimated that 50% of all construction accidents could have been prevented by common sense attention to basic safety practices".

A physical approach to safety is also taken by Bush [10]. Instead of elaborating on safe practices by themselves, he relates them with construction methods and applicable OSHA regulations. One annex to his book is a very comprehensive guide on "How to comply with the occupational safety and health Act" which sets out in working language

the OSHA requirements for an effective safety program.

Successful safety activities were also studied by Rinefort [88]. Based on an extensive survey, he reported the following conclusions:

- The correct combination of inexpensive and cost effective safety activities produced better results than large monetary expenditures spent at random; and
- The most efficient activities were:
  - safety rules,
  - off the job safety,
  - safety training,
  - safety orientation meetings,
  - medical facilities and personnel.

For effective management of safety performance measuring tools must be available. From an ENR survey made in 1984 of the 400 largest contractors, Laufer and Ledbetter [52], concluded that the most effective and widely used measures for safety performance were:

- Lost-day cases;
- Doctor's cases; and
- Costs of accidents.

They also suggested that industrial safety should put more emphasis on the control of hazards rather than accidents and that "the severity of an accident stands in inverse relationship to frequency".

The evaluation of a firm's safety policies and practices has also made the subject of research using expert systems and knowledge engineering. Levitt [55] has developed HOWSAFE which is an expert system, using an IBM PC, to diagnose the safety performance of a construction firm.

In Québec, the CSST recognized the importance of the prevention program by publishing a detailed guide [26] on the preparation of a construction safety program. It sets out in elaborate details all that is to be done to prepare a complete and efficient program. The procedure is based on the three following steps:

1) Identifying the type of job site;
2) Ways to avoid accidents; and
3) Defining the responsible parties for the implementation of the actions necessary to avoid accidents.

In summary, "health and security must be managed as production and be integrated to it". This statement was made at the 12th International Colloquium on the Prevention of Occupational Risks in the Construction Industry in September 1985 [29].

2.4 COSTS AND STATISTICAL DATA

A pioneer on the cost of work injuries has been Heinrich. In his book "Industrial Accident Prevention" [38] published in 1931, he sorted out the hidden or indirect costs of accidents which he estimated at four times the direct cost of work injuries.

The subject of indirect costs was also studied by Simonds in his Ph.D. thesis in 1949 [93] and later together with Grimaldi [91]. They concluded that a 1:1 ratio (indirect or non-insured to direct or insured costs) could be used as an approximation when the indirect costs could not be accurately computed.

Rinefort [88], from a survey of 140 firms in the chemical, paper and wood products fields in Texas, related the costs and frequency rate of work injuries to a number of safety and health loss control activities. A surprising finding was that "firms with higher injury costs often spend more to prevent their work injuries than those firms which have lower costs of injuries". It also indicated that "business firms do have control over the largest proportion of those factors which, when taken together, determine the costs of their injuries".

A survey conducted in France by Lenet and published in 1978, [53] indicated that indirect costs are four times higher than the direct

costs. It also indicated that in 1975, industrial accidents and diseases cost the equivalent of 4,5% of the GDP.

Two studies were made in Canada on the costs of accidents. In the first one, Manga et al. in a technical report for the Economic Council of Canada [6] estimated the factor of indirect to direct to be between 2 and 10 after reviewing the work of Wallach [100], Crosby [22], Smart and Sanders [95], who suggested a multiplier of between 2 and 6 and Findley [31], who estimated the range to be between 4 and 10. Halpin and Woodhead [37] mentionned a figure of "nine times the amount spent on comprehensive insurance".

The cost factors related to work accidents and to prevention costs were also studied by Labour Canada in the period of 1969 to 1979 [14]. The report summarizes the different statistics of lost workdays, gravity and compensation costs (direct costs of accidents). It used the works of Manga [61] and Rinefort [88] to illustrate the tendencies of the costs. It also showed that 50% of the Workmen's compensation (WC) premiums were paid as indemnities in the U.S. as compared to 77,6% in Canada. It also indicated that in the U.S., 12% of the amount spent for work accidents was invested for prevention. The study estimated that not more than 1% of the annual capital investment was spent for accident prevention in Canada.

In the construction industry, few studies were made in the past few years on the cost of accidents and the amount invested for prevention. Trade magazines generally discuss at lenght the high cost of WC premiums. ENR of August 14, 1986 [101] cited the 1986 increases in some 25 States that vary from 17,5% in Utah to 53% in Montana. In another ENR article [66], on the other hand, it is stated that Ohio will limit the amount of the settlements to 300% of workers' compensation benefits or 2M$ whichever is less.

A technical report by R.E. Levitt et al of Standford [58], had for objective, amongst others, "the assembly and analysis of data to provide economic justification for owners to work to get their construction contractors to improved safety performance". As mentioned before, this report was the basis for a further study by the Business Roundtable published in 1982 [11]. The latter report's main findings were:

- Accidents cost 6,5% of the amount spent by users of industrial, utility and commercial construction;

- The ratio of indirect/direct costs varies between 4:1 and 17:1;

- The cost of safety is approximately 2,5% of the direct labour costs;

- The average ratio of indirect/direct costs for loss-time accidents varies from 1,1 to 4 but this is believed to be conservatively low; and

- A 30% reduction in accident cost is an achievable goal.

One of the most complete investigation on the effect on cost for OSHA compliance is probably the paper published by Koehn and Musser [48]. From a survey made on 273 construction firms in the U.S., the results indicated that for larger firms (ENR 400), the percentage of the constuction costs spent for complying with OSHA rules and regulations decreased from 2,8% to 1,4% from 1976 to 1981 and from 4,5% to 2,4% for smaller construction firms (Ohio firms).

In an effort to get top management interested in safety, Robinson [89] developed a matrix to be used as a rapid and simple tool to report the costs of accidents together with the project cost reports in order to visualize quickly the financial burden of accidents. To illustrate its simplicity, the matrix is reproduced in Appendix D. It was developed using a statistical approach to study the data collected on several thousand accidents that happened over a period of three years. Based on the type of injury and the part of the body affected, direct costs can be obtained, and a multiplier of 2 to compute the indirect costs is used.

Very few studies have been identified on the cost of safety or accidents in Québec. The high costs of annual assessments and the CSST administrative burden have made the headlines of many articles in the periodical of the Québec Contractors Association (A.E.C.Q.) "Chantiers":

- "La CSST, un monstre difficile à cerner" [25], April 1986, indicates that the annual budget of the former WCC was 482,5 M$ with 800 employees. In 1986, it is 1 300 M$ with 1 800 employees.

- "CSST Le temps des choix" [24], July/August 1986, indicates that the annual deficit of 228,4 M$ in 1984 will grow to 547,8 M$ in 1985 whilst the capitalization rate (the ratio of capital assets to future commitments) drops from 61.5% to 53,4% over the same period. For the construction industry, the total assessment is estimated to grow from 138 M$ in 1986 to 178,5 M$ in 1987.

Only one study has been identified that attempted to estimate the cost related to Bill 17. It is an unpublished draft report dated December 1980 and entitled "Coûts assumés directement par l'employeur: Impact de la Loi 17 sur les secteurs prioritaires" [21]. Based on different assumptions, the study gives various maximum and minimum costs (either actual or assumed) for computing the costs of a certain number of

safety measures which are borne directly by the employers. A summary of these potential costs is listed later in Chapter 5, Table 5.1.

Statistics on work accidents seem to have started to be maintained in 1925 by the U.S. Bureau of Labour Statistics (BLS) of the Department of Labour [85]. The National Safety Council also measured the performance of reporting organizations using ANSI Standard Z16.1 [61]. The recent statistics of the Bureau published in ENR [20] included the following table:

TABLE 2.1 - "HOW INDUSTRY INJURIES AND ILLNESSES STACKUP"

INDUSTRY	TOTAL CASES * 1984	1985
Construction	15,5	15,2
Manufacturing	10,6	10,4
Mining	9,7	8,4
Transportating	8,8	8,6
Services	5,2	5,4
Private sector	8,0	7,9

* Incidence rates per 100 full time workers

Sources: US Bureau of Labour Statistics

In the same article ENR also declared that the BLS has asked the National Academy of Sciences "to review the entire safety and health statistics system" and to make recommendations for improved evaluation techniques.

This recommendation is not as superfluous as it looks since a study by Bird and Germain published in 1966 [6], showed that for every disabling injury, 100 minor injuries and 500 property damage accidents happened (based on a study of 90 000 accidents over a period of 7 years in a U.S. steel company). This ratio can be compared to that of Heinrich [38] which indicated in 1931 that for every medical case, 30 first-aid cases and 300 minor accidents (no injuries) occurs.

On the international scale, the International Labour Organization (ILO) is the main source of statistics. However, data on an international scale must be studied very carefully since working hours and reporting practices are different from one country to the other as pointed out by King and Magid [47].

In Canada, STAT CAN's Labour Division regularly publishes Work Injuries Statistics. The last issue of March 1987 covering 1983-1985 [19] indicates that the construction trades occupations accounted respectively for 10,0, 8,7 and 8,8% of all time loss injuries in Canada in the years 1983, 1984 and 1985, respectively.

The Occupational Safety and Health Division of Labour Canada published a study dated March 1984 and titled "Employment Injuries and Occupational Illnesses, 1972-1981 [16] with preliminary data for 1982. Amongst other information it showed that the total benefits payments to injured workers in all sectors for 1982 amounted to 1 965,8 million dollars.

In a publication from the CSST which compares different provincial regimes [83], it is noted that the percentage of claims versus total employment is 12,8% in Québec, 9,2% in Ontario, 5% in Alberta and 12,6% in British Colombia for the year 1984. For the other provinces, the percentages varied between 7,5% and 11,9%.

In Québec and especially since the advent of the CSST, statistics are now more available and better analyzed. However, except for 1984 and 1986 when the CSST published a "statistical annex" to the annual report [72, 75], specific data for the construction industry are generally difficult to obtain.

In March 1984, the OCQ published a summary of three reports in a brief titled "Les Accidents de travail au Québec. Résumé" [1] and covering the years 1976 to 1978. The three reports are: " Le contexte socio-économique et le chantier, milieu de travail de la construction" (August, 1980), "Etude sur les caractéristiques des accidents du

travail dans l'industrie de la construction" (October 1980), and "Analyse détaillée des accidents-blessures" (February, 1981). From OCQ data and that obtained from the WCC, their detailed analysis concluded that:

- As in France, Ontario and Québec, the accident rate in the construction industry is 2,5 times higher than the one for the other sectors;

- The risk of accidents is higher with non-qualified workers;

- Metal handling trades represent 6 of the 10 trades having the highest relative risk; and

- Firms with 51-200 employees have the highest rate of accident.

It is to be noted that a similar trend exists in the U.S. construction industry as supported by the studies of Hinze and Pannullo [45] and Fullman [34].

Two detailed studies on occupational injury frequencies and types were published by the CSST in 1985 for the years 1979-1983 [78] and 1980-1984 [79]. They put all the sectors of the economy in relation to one

another and compare the number of occupational injuries, their frequencies and main characteristics. For the construction industry, the following is noted:

TABLE 2.2 - SUMMARY CHARACTERISTICS OF THE QUEBEC CONSTRUCTION INDUSTRY

	1979	1980	1981	1982	1983	1984
% of all occupational injuries	8,4	8,2	8,0	6,9	6,2	5,7
% of construction employees versus all sectors	4,4	3,9	4,1	3,5	3,4	3,5

Source: Table I-7, III-2 and III-14 [78] [79]

Statistical data specific to the construction industry are contained in another CSST report published in August 1985 [7]. It looks at the socio-economic context of the industry: with 5% of the GIP of the province, it represents 15% of the Québec production when accounting for the business it generates in other sectors. Approximately 20% of canadian construction workers are from Québec [7]. The following table drawn from the report is quite revealing of the status of the industry for work accidents in comparison with other sectors.

TABLE 2.3 - FREQUENCY OF COMPENSABLE INJURIES PER WORKER IN QUEBEC

SECTOR	1980	1981	1982	1983	1984
Building & Public Works	0,14	0,14	0,11	0,10	0,10
Mines and Quarries	0,13	0,16	0,13	0,09	0,14
Public Administration	0,05	0,07	0,07	0,09	0,07
Transportation	0,16	0,18	0,16	0,15	0,16
Commerce	0,06	0,06	0,06	0,07	0,08

Source: Table 3.1.2 [7]

Of the cost factor, it is shown that a total of 280 619 161$ has been paid in compensation from 1980 to 1984 with an average of 4 767$ and 42,2 days lost per injury.

TABLE 2.4 - COMPENSABLE INJURIES - QUEBEC CONSTRUCTION INDUSTRY

	1980	1981	1982	1983	1984
No. of Injuries	13 470	14 134	10 918	10 246	10 077

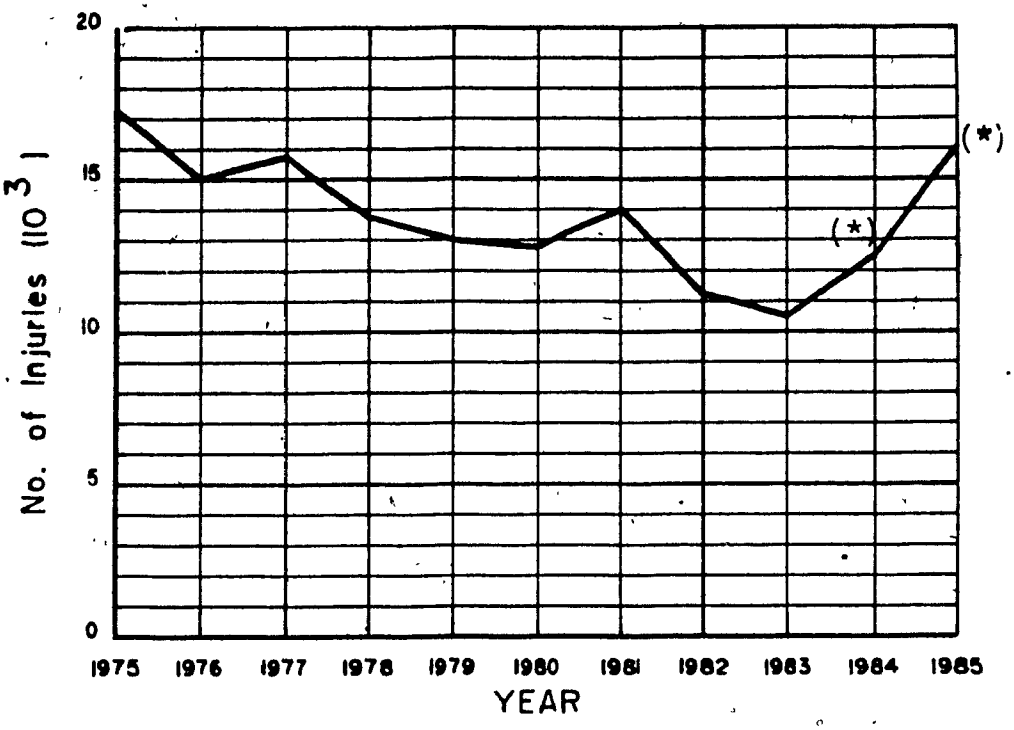
Source: Table 3.1.1. [7]

The authors conclude that:

1. For the period corresponding to the operation of the CSST, the number of injuries with time-off work has decreased from 13 470 in 1980 to 10 077 in 1984, and the benefits paid decreased as well from 85 4 M$ to 34,6 M$;
2. The significant drop from 1982 could correspond to the period of application of the regulation concerning the prevention program; and
3. Risks of occupational injuries and illnesses are related more to the type of work done by the employee than directly to his trade.

Another CSST report on the construction industry, dated February 18, 1986 [8], looks at the reasons for the increase of 26% in compensable injuries between the first semester of 1984 and that estimated for the same period of 1985 as shown in Figure 2.1.

The study compares the frequencies based on three sources of labour statistics: OCQ, CSST, and STATCAN. The relative increase in the frequency is calculated to be 11,6% from 1984 to 1985 (1st semester). It followed an earlier increase of 13,7% between 1983 and 1984. The increase would be due to the higher level of activity in the building and public works (B. and P.W.) sector and particularly in the industrial and commercial groups. That report also recommended that, from now on, the CSST total insurable wages be used to related the injuries instead of OCQ or STATCAN figures.



(*) estimated figures

FIG. 2.1 - Frequency of Compensable Injuries per Year (reproduced from Ref [8])

2.5 LEGISLATIONS, REGULATIONS AND REGULATORY AGENCIES

Occupational health and safety is a heavily regulated area. As Fullman mentioned [34]: too many rules might not increase the number of accidents "but excessive regulations does seem to lead to divided responsibility and that inevitably weakens the supervisory process".

In the U.S., the "Occupational Safety and Health Act" of 1970 [98] regulates safety at work. The Act includes the Construction Safety Act of 1969 as a reference. In 1974 a reconciliation of the mass of

regulations and references pertaining to the construction industry was adopted as Part 1926 of OSHA: "Construction Safety and Health Regulations" [97]. Under OSHA Legislation, the Assistant Secretary of Labour for Occupational Health and Safety administers and enforces the Act through the Occupational Safety and Health Administration with 10 offices around the country. There are two major agencies;

- Occupational Safety and health Review Commission; and
- National Institute for Occupational Safety and Health (part of the Department of Health, Education and Welfare).

In Canada, labour legislation is mainly a provincial jurisdiction. Each province and each of the two territories have their Workmen's Compensation Board. In a comparison of the various canadian regimes published by the CSST in 1985 [83], it is noted that there are significant differences between the provincial regimes for the compensation programs in the:

- Universality of the regimes;
- Maximum assessable salaries (between 17 000$ in Prince Edward Island and 45 500 in Newfoundland) and the way they are reevaluated yearly or otherwise;
- Benefits for temporary and permanent disabilities (from 90% of net income to 75% of gross income);
- Maximum and minimum monthly benefits;

- Methods of adjustment for permanent disability pensions;
- Assessments rates. For example in 1985, the average rates were 2,88$ (per 100$ of salary) in British Columbia, 2,31$ in Ontario and 1,88$ in Québec (For 1987 these rates are 2,04$, 2,88$ and 2,50$ respectively [77]); and
- Capitalization rates.

It is also noted that the Québec regime is different from all others in Canada for his paritanism (i.e. equal representation of workers and employers) and his unique structure (the CSST) for prevention, inspection, compensation and financing.

In Ontario, occupational health and safety is governed by the "Occupational Health and Safety Act", R.S.O. (Revised Statutes of Ontario) Chap. 321, 1980. The WCBO (Workers's Compensation Board of Ontario) administers the compensation program and the Minister of Labour is responsible for enforcing the Act through the Construction Health and Safety Branch for the construction industry. "Regulation 691" [67] covers safety on the job site. The Construction Safety Association of Ontario looks after prevention by advice, training and research works.

In Québec, occupational health and safety is governed by the "Act Respecting Occupational Health and Safety" [71] or Bill 17. It led to the creation of the CSST (Commission de la santé et de la sécurité du

travail) which is the unique agency responsible for prevention, inspection, compensation and financing. The construction industry has its own safety regulations combined in the "Safety Code for the Construction Industry" [85]. The practice of the CSST and the difficulties it has experienced since it was introduced in 1980 are well covered in Pontaut's book [69].

Occupational health and safety throughout the world is described by King and Hudson [46], giving brief description of international organizations such as ILO and WHO (World Health Organization), and of national structures concerned with construction safety in the UK, USA, Canada, Brazil, Japan, India, Kenya, France and the European Economic Community (EEC).

CHAPTER III

OCCUPATIONAL HEALTH AND SAFETY LEGISLATION IN QUEBEC

3.1 GENERAL

One hundred years have elapsed between the first act protecting Québec workers in 1885 to the adoption of the most recent one in 1985.

The vast and complete reform of the occupational health and safety regime in Québec has led to the adoption of Bill 27 in 1979, which established the foundation of the system and its new guiding principles. The reform was completed in 1985 with the adoption of Bil 42 on compensation and financing of the CSST.

In this chapter, these two Acts will be studied with particular emphasis on their specific applications to the construction industry.

3.2 BRIEF HISTORY OF WORKER'S PROTECTION BY THE QUEBEC GOVERNMENT

At the turn of the century, a work related accident was considered as a risk inherent to the job. The employer could not be held liable unless the worker victim of an accident at work personally sued under the civil code and the employer was found negligent [69].

Whilst the Factory Act of 1885 was the first law adopted to protect the workers, it is only in 1909 when an Act concerning the responsibility of work related accidents and the compensation for resulting damages was voted. The 1909 Act was the first one establishing the employers' individual responsibility, without regards to fault.

In 1931, the Workers' Compensation Act established the employers collective responsibility based on the principle of professional risk. It also gave a larger mandate to the Workmen's Compensation Commission (WCC), which was created in 1928, including the administration of the "mutual insurance" for employers.

From 1931 to 1978, few major changes occurred except that many inquiries were held and a very bad image was gradually building up for the WCC.

It might be interesting to mention that in 1974, all the regulation measures applicable to the construction industry were unified in one text, the "Safety Code for the Construction Industry". The Québec Construction Office (OCQ), founded in 1975, was named solely responsible for the inspection and application of the Code.

3.3 BILL 17 ON OCCUPATIONAL HEALTH AND SAFETY

3.2.1 The 1978 White Paper on Occupational Health and Safety

In October 1978, the then Minister of Social Development, Pierre Marois, published the controversial white paper on occupational health and safety, "Québec's Policy for the Health and Safety of its Workers" [80].

This statement of policy was composed of two main sections. The first one was an evaluation of the situation prevailing at the time. It led to the second part which contained the broad guidelines of the proposed reform and set the scene for the submission of Bill 17:"An Act Respecting Occupational Health and Safety". The proposed regime was based on employers' and employees' participation with the ultimate objective of eliminating at the source the causes of accidents and diseases, putting prevention as the main priority.

3.3.2 The Act

"An Act Respecting Occupational Health and Safety", was tabled on June 20th, 1979 in the National Assembly and adopted on December 21st of the same year (R.S.Q., chapter S - 2.1). In accordance with the principles that had been put forward in the White Paper, Chapter II of the Act clearly set out the objectives:

"The object of this act is the elimination, at the source, of dangers to the health, safety and physical well-being of workers.

This act provides mechanisms for the participation of workers, workers' associations, employers and employer's associations in the realization of its object".

The act was innovative in many ways. Among other things, it establishes the legal frame for the:

- Worker's right of refusal to work;
- Obligations of the employer and the worker;
- Reassignment of a pregnant worker;
- Prevention programmes;
- Safety representatives;
- Health and safety committees, both the establishment (or construction sites) and sector-based committees;
- Establishment of a corporation called "The Commission de la Santé et Sécurité au Travail" (CSST);
- Inspection system;
- How and where the CSST can intervene with regulations;
- Financing; and
- Substitution for the WCC.

The provisions of the acts were put in effect progressively and as of March 1987, only Divisions III, "Job-site Committee" and IV "Safety Representative" of Chapter XI "Special Provisions Respecting Construction Sites", are not being applied.

3.3.3 Special provisions regarding the construction industry

As an industry that was singled out in the White Paper, it is no surprise to see that the Act focuses special attention on the construction industry. Given the temporary status of a construction site, the great number of entities involved, its special labour relation regime and major economic importance, the special references to the construction industry seem logical.

It is the only economic sector specifically referred to in the Act. Chapter XI, "Special Provisions Respecting Construction Sites", contains six (6) divisions;

"I Definitions and Applications
II Principal Contractor and Employers
III Job-Site Committee (not enforced)
IV Safety Representative (not enforced)
V Inspection
VI Major Construction Sites"

At least eight (8) other articles throughout the text make specific references to a construction site or job-site.

Article 196, which puts forward the notion of principal contractor ("Maître d'oeuvre"), is certainly the one which has been greatly debated and whose applications is still to be clearly defined. This subject will be discussed further in section 4.4.

A surprising procedure in Division VI (Articles 220,221 and 222) states that;

- The Commission must be given a 6 months-notice for the opening of a major contruction site (more than 500 workers); and
- Once the Commission has been informed of the particularities of that site, "the Commission shall adopt" ... and "... communicate the content of the programme...".
  (the underlines are the author's)

This procedure is quite different from the one in article 58, where it is stated that "... a prevention programme for each establishment under his authority (the employer) is implemented ...". Article 58 makes no limitation as to the size of the establishment.

Finally, it is worth mentioning that the "Safety Code for the Construction Industry" [85] is now applied as a regulation derived from and enforced under c. S-2, r.6 of the Act. The CSST inspectors (mostly former OCQ inspectors) see to its compliance throughout the industry.

3.4 BILL 42 ON INDUSTRIAL ACCIDENTS AND DISEASES

Whilst Bill 17 was essentially a new Act, Bill 42 was more an update of the Workman's Compensation Act of 1931 to make it compliant with Bill 17, the latter being regarded as the main Act. However, Bill 42 does contain some innovative articles of its own which changed the way of thinking for compensation and financing.

3.4.1 The Act

"An Act Respecting Industrial Accidents and Occupational Diseases" was tabled on November 22, 1983 in the National Assembly and adopted on May 23, 1985 with an effective date set at August 19, 1985, under R.S.Q., chapter A-3.001 [70].

The tabling of Bill 42 followed a detailed study of compensation for the injured worker that led to a three volume "Blue Book" deposited in 1979. The aim was to harmonize this regime with others in operation in Québec. All the concerned parties were in agreement that the regime in place since 1931 had to be modified. However, the parliamentary commissions on the proposed regime were lengthy and the debates spirited. In fact, the second commission in 1984 set a record for its 135 hours of sitting [23].

The object of this Act is clearly stated in article 1: "...to provide compensation for employment injuries and the consequences they entail for beneficiaries", and its general scope in article 7: "This Act applies to every worker to whom an industrial accident happens in Québec or who contracts an occupational disease in Québec and whose employer, when the accident happens or the disease is contracted, has an establishment in Québec".

The Act considerably extends the notion of work accident when it states in article 28 that: "an injury that happens at the work place while the worker is at work is presumed to be an employment injury". However, article 27 specifically excludes "an injury or a disease arising solely as a result of the gross and wilful negligence of the worker who is a victim... unless it ends in death or severe permanent physical or mental impairment".

The Act forces the CSST to finance itself in such a way as "to meet its expenses as they become payable and avoid unduly burdening employers in future years with payments to be made for employment injuries ...". With that, the Act fixes the sums to be collected for 1984 to 1988 at 90% of the benefit payments to be made during these years. It also excludes the use of the loss experience prior to January 1st, 1986, for increasing the rate assessment.

In summary, the Act considerably improves the protection of workers who have suffered an industrial accident. The 1985 CSST Annual Report [74] sums up the main points of this Act:

- The new scheme applies to all workers who suffer an employment injury in Québec;
- An injured employee is entitled to an income replacement indemnity for as long as he cannot return to work;
- Lump sum compensation is provided for those suffering from permanent physical or mental impairement;
- Benefits are provided for the dependants of workers who die as a result of work injuries;
- The worker can choose his health establishment and health professional;
- It affirms the right to physical, social and vocational rehabilitation of an injured worker;
- It establishes the right (within certain constraints) to return to work;
- It protects the workers from being penalized when they return to work; and
- A board of appeal is set up where every decision by the CSST may be contested.

3.4.2 Special provisions regarding the construction industry

As was the case with Bill 17, Bill 42 also made provisions for some of the particularities of the construction industry. The most important one has to do with the mobility and temporary nature of construction work, and its special placement scheme, when dealing with the right to return to work of a construction worker (Division II of Chapter VII). Article 248 makes for the return to "be subject to the rules respecting hiring and placement prescribed by a regulation respecting the placement of employee made under the Act respecting labour relations in the construction industry (chapter R-20)". Article 249 allows the OCQ to issue the "A" classification certificate when the hours have not been accumulated due to a work injury. Incidently, this article will more than likely be invalidated with the elimination of the "A" certificate in effect since January 1987. The job-site committee is the body empowered to set the modalities of application of the right to return to work (article 250).

First-aid and emergency services on a job are dealt with at length in this Act. Articles 190 and 191 impose medical aid by the principal contractor, article 454 allows for the CSST to adopt regulations on the subject and article 459 sets the penalties the principal contractor is subject to when not providing the first-aid and emergency services required.

Bill 42 also makes it mandatory for construction workers to inform the employer and the OCQ of a disability and of his return to work (Articles 274 and 277).

3.5 THE CSST

The "Commission de la 'santé et de la sécurité du travail" (CSST) was created in 1979 by article 137 of Bill 17. Its corporate guidelines, functions and administration are detailed in chapter IX of the Act: "The functions of the Commission are to prepare, propose and implement policies relating to worker health and safety, to ensure a safer work environment" (Article 166). Its different mandates are governed by the six laws which it administers:

- The Act Respecting Occupational Health and Safety (R.S.Q., c.S-2.I);
- The Act Respecting Industrial Accidents and Occupational Diseases (R,S.Q., A-3.001);
- The Workmen's Compensation Act (R.S.Q., c.A3)
- The Act Respecting Indemnities for Victims of Asbestosis and Silicosis in the Mines and Quarries (R.S.Q., c.I-7);
- The Crime Victims Compensation Act (R.S.Q., c.I-6) and the Act to Promote Good Citizenship (R.S.Q., c.C-20); and
- The Government Employees Compensation Act (R.S.Q., c.G-8).

Its board is a parity group composed of fifteen members named by the government:

- Chairman and general-manager of the Commission;
- 7 members from the most representative union associations; and
- 7 members from the most representative employers' associations.

An outline of the organizational chart of the Commission is shown in Figure 3.1.

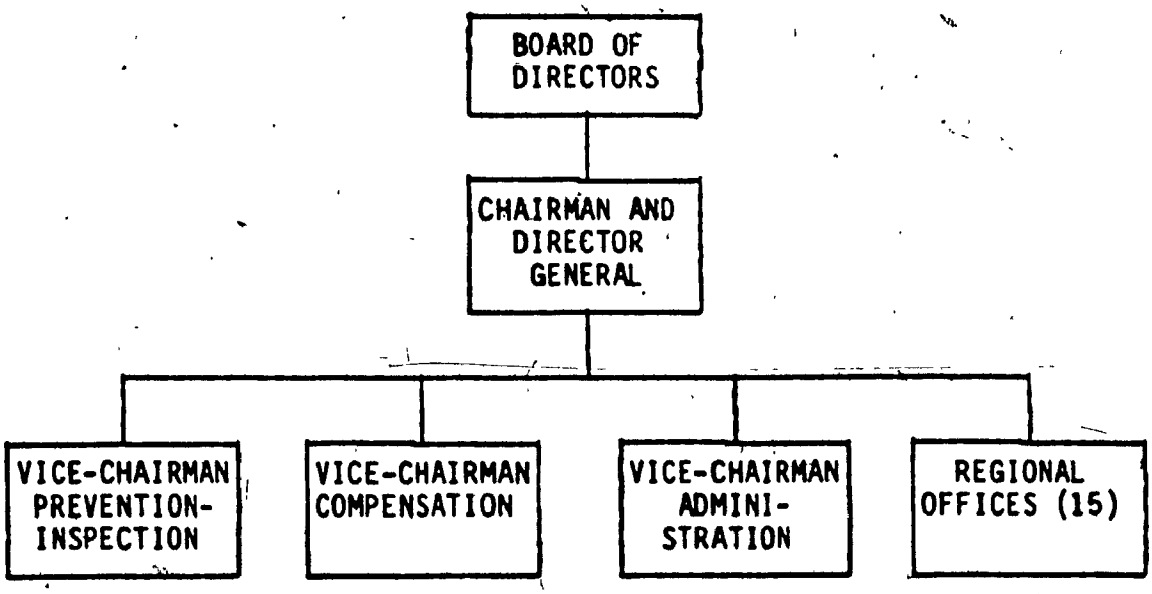


FIG. 3.1 - Organizational Structure of the CSST

The vice-chairmen are also appointed by the Government.

Geographically, the Commission has its offices as follows:

- Head Office - Québec City;
- Administrative centre - Montréal;
- Reaseach Institute - Montréal; and
- Regional Offices spread out in the 15 main cities of the province.

Each regional office has the following services in operation:

- Prevention-inspection;
- Compensation; and
- Administration.

They are responsible for applying the Commission's programs and providing services to all those requiring them. They act as decision-making centres with the different central branches acting more as advisory groups to the regions.

At the end of 1986, the CSST employed 2 459 employees of which 362 were in inspection [75].

It might be interesting to note at this point that contrary to Ontario

where three (3) agencies are involved in occupational health and safety:

1. Prevention: Construction Safety Association of Ontario;

2. Enforcement: Construction Health and Safety Branch - Ontario Ministry of Labour; and

3. Insurance: Workers' Compensation Board of Ontario;

the CSST in Québec is the unique agency covering all of these responsibilities.

3.6 THE FUTURE

Bill 17 has now been in application for seven years and Bill 42 for about 24 months. Both have been the subject of numerous criticisms particularly from the employers' associations. In a survey by the "Scowen Committee" [84] conducted in 1986, occupational health and safety received 44% of the impact mentions of the firms surveyed as compared to 11% for the labour code and 10% for the french language charter [33]. In the survey made as part of this thesis (sec. 4.5), more than 72% of the respondents declared that the effect on their firm of the implementation and enforcement of the law has either been

annoying or clearly counter-productive. Generally the main points against the CSST are related to:

- The high costs of Bill 42 and indemnities that are sometimes higher than the salaries received prior to the injury or illness;
- The automatic presumption for accident on the work site (article 28 of Bill 42);
- The high administrative costs (specifically when compared to Ontario);
- Costs that should not be assumed by the CSST such as building inspection, re-assignment of pregnant workers and Review Board operating costs;
- The 14-day period paid by the employers, which seems to encourage a delayed return to work;
- Lack of information on the regime (specifically for the workers);
- Partiality towards the employees;
- Excessive bureaucracy; and
- A merit/demerit system which is non-effective.

There are other points but those mentioned above seems to summarize the Québec industry's response on the subject in the last few years [30, 32, 49, 50, 51, 86, 99].

Numerous and constant criticisms, particularly from the different employers' associations, regarding the costs involved in the administration of the Québec occupational safety and health regime have been voiced [24, 25, 28, 30, 32, 49, 50]. Two factors should be looked at to see if these criticisims are valid: the percentage of the WC premiums going to compensation, and the administrative and overhead costs.

The percentages of income going to compensation can be compared as follows:

- United States: ≈ 65% [11, 34]
- Canada : ≈ 78% [14]
- Québec : ≈ 106% [73, 74, 75]

The Québec regime thus appears more expensive than the ones in the U.S. and the other provinces of Canada. This is confirmed by data from the Canadian Centre for Occupational Health and Safety which indicates that the cost of the regime, per worker, is 346 $ in Québec as compared to 270 $ for Ontario and 280 $ for Canada as a whole [32].

Complimentary to the above figures, it can be shown that the costs of

administering the different regimes are as follows:

- U.S. : ≈ 35% of WC premiums
- Canada: ≈ 22% of WC premiums
- Québec: ≈ 10% of income

It can therefore be concluded that the CSST overhead costs are very low but the compensation costs of the Québec regime are quite higher than those in the U.S. or the whole of Canada. These observations indicate that the high costs in Québec are not an effect of bad administration or mismanagement on the part of the CSST but rather that the compensation measures, particularly in Bill 42, would have to be revised if Québec is to bring its occupational health and safety costs in line with those of neighbouring regions. Even though recommendations on this subject can be made by the CSST, major amendments to the regime will require legislative actions and that is the provincial government's responsibility.

The CSST definitely feels that changes have to be made as it has formed a review committee [9] to "study different aspects of the mandates and the operations of the CSST" so that eventually, it will be able "to propose to the government measures to improve the regime it administers". The findings of the committee will help the CSST to participate in the deregulation debate that the Québec government initiated and of which the Scowen Report [84] is an important element.

The recommendations of the Scowen Report, concerning deregulation of the occupational health and safety regime, are so far-reaching and believed to be important enough that they are included in Appendix G. In general, the recommendations call for a less rigid, more selective and more cost-conscious regime so as to be competitive with other neighbouring systems.

Based on the Scowen Report [84] and on indications given by the present President and General-manager of the CSST [51], the following changes can be foreseen:

- A tightening of the cost control of the Commission by a more rigorous interpretation of articles in the ACTs (17 and 42);
- Improvement in the services offered by the CSST along with a vast communication and public relation campaign;
- Changes in the merit/demerit system by reducing the 3-year effective period;
- Likely amendments to article 28 of Bill 42 on the 14-day period paid by the employers; and
- Reassignment to other government departments or agencies of some of the programs not directly related to the CSST's primary objectives.

Some of the changes will be under CSST jurisdiction whilst others will require legislative action. Whatever they are, the debates will be long and arduous.

CHAPTER IV

SAFETY AND CONSTRUCTION MANAGEMENT IN QUEBEC

4.1 GENERAL

There is no doubt that the Québec Occupational Health and Safety Act has an impact on the way projects are planned and organized, so as to satisfy its requirements and particularly the new approach on prevention. As the White Paper [80] of 1978 stated: "It is the employer's responsibility to ensure that the place of work is set up and the work organized with the health and safety of his workers in mind".

In this chapter, the importance of a project safety programme integrating planning and control is outlined and a comprehensive model is proposed, incorporating all related safety acts and regulations. Necessary site management organization identifying the principal contractor, responsible for the implementation of a safety programme, is presented.

Industry response to the various aspects of the Act and its implementation is established by means of a province-wide survey conducted for this purpose.

4.2 PROJECT PLANNING AND CONTROL

The emphasis put on prevention by Bill 17 ensures that safety is integrated to the other usual considerations during the planning stages and eventually to all other phases of a project. To enforce this aspect of integration, the Act specifically states that:

1) The employer must "ensure that the organization of the work and the working procedures and techniques do not adversely affect the safety or health of the worker;" (Article 51-3);

2) The employer must "use methods and techniques intended for the identification, control and elimination of risks to the safety or health of the worker;" (Article 51-4);

3) The obligation for a principal contractor to send a notice of opening and closing of a construction site "within the time and on the terms and conditions provided by regulation" (Article 197); and

4) "A prevention programme must be transmitted to the Commission before work begins, ..." (Article 200).

Notwithstanding this regulatory aspect, Barrie and Paulson [4] have

reiterated the importance of integrating safety and planning when they state that "thorough and conscientious preplanning is essential to economy, efficiency and high productivity in almost all construction operations; safety and health considerations should be an integral part of this process."

Traditionally, the goals of project management (PM) have been to establish a balance between schedule, costs and quality as illustrated in Figure 4.1

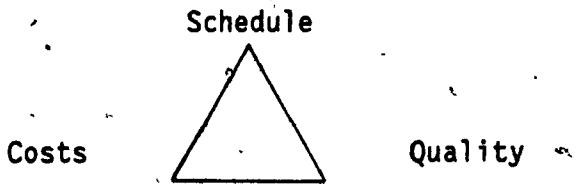


FIG. 4.1 - Traditional PM Goals

In view of the new requirements of the Act for prevention and the steadily rising cost of worker's compensation premiums, contractors must now include safety as an integral part of project planning and as such the traditional triangle should be changed to a square as shown in Figure 4.2.

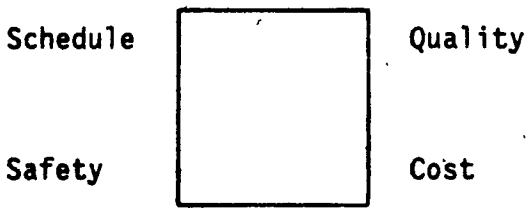


FIG. 4.2 - Safety as an Integral Part of Project Control

Be it by professionalism or compliance with the law, safety and health consideration must start at the design and planning stage. Based on the usual planning considerations, it could be stated that the following aspects need to be considered (amongst others):

- Construction methods;
- Sequence of operations;
- Lay out of the site;
- Cost estimate of safety equipment and installations;
- Incentive clauses in contracts;
- Responsibility for programme preparation; and
- Training and pre-qualification of field personnel.
- etc.

It has already been proven [56, 57] that top management has a substantial effect on accident record of construction firms. In as much as it is well known that major cost savings on a project are realized at the start during the conceptual design, decisions on safety policy taken during the planning stage will have a lasting and continuous effect on job safety. From a comprehensive literature review, careful and detailed study of Bill 17, Bill 42 and regulations, and including the project considered in Chapter 6, important decisions related to project safety policy include the identification and selection of the:

- Principal contractor (to be decided by project delivery method);
- Type of construction contracts and the safety clauses to be included;
- Field personnel (managers and superintendents);
- Contractors with proven above average track record on safety; and
- Main elements of the safety program.

4.3 CONSTRUCTION SITE MANAGEMENT AND ORGANIZATION

The visible effects of Bill 17 on the construction industry appear on construction sites. Specific safety measures are covered by the "Safety Code for the Construction Industry" [85]. The Code has been in application since 1974 and was further updated to comply with Bill 17. It covers areas such as powers of inspectors, obligations of the head of establishments, organization of safety including the operation of the site safety committees, the safety officer, and a large number of detailed safety measurers protecting the worker, the equipment, the materials and the work itself. The Code is still the "bible" of safety on construction sites.

There is also a number of regulations that has been adopted in compliance with Bill 17 and, in most instances, to amplify articles of

the Code. At least 12 are directly related to the construction industry and can be identified in Appendix C where a partial listing of health and safety regulations is provided.

One obligation derived from Bill 17 is that related to safety courses:

> "(i)management and control staff working mainly and usually on a construction site and workers working on a construction site after 1 July 1983 (must) have taken a safety course and hold a certificate issued by the Commission or by an organization it recognizes" [85].

For management and control personnel this obligation is in effect since November 1st, 1985 (Order in Council 1948-84, dated 30th August, 1984). These safety courses are given by universities or centres for professional training of the Department of Labour. Failure to obtain this certificate by field personnel can bring the issuance of a notice of infraction (warning) by the CSST and, eventually, possible eviction from the site for non-compliance.

One regulation that proved to be expensive and, to a certain point, abusive is the First Aid Minimum Standard Regulation. (1922-28, 22nd August, 1984). Amongst other things, it makes compulsory for any job site with over 100 workers to have a complete first aid station including a full time nurse. This is mandatory even in urban centers. However, a recommendation for amendment has been approved by the CSST in 1985 and published for modifications in the Official Gazette on March 19th, 1986. The amendment eases the obligation when the job site

is within an urban area. The effective date of the amendment is not known yet.

The one article of the Act that leads all discussions when representatives of the Commission meet with members of the industry, particularly owners, consultants, architects, and construction managers is article 196, which states:

> "A principal contractor is bound to the same extent as an employer to observe the obligations imposed on employers by this act and the regulations, particularly that of taking the necessary steps to protect the health and ensure the safety and physical well-being of construction workers".

Chapter I of the Act defines the principal contractor as "the owner or any other person who, on a construction site, is responsible for the carrying out of all the work". However, the CSST is introducing a very restrictive interpretation of the delegation that can be made by an owner [76].

In a recent publication by the Québec Construction Federation [54] it is established that the general contractor is not always the principal contractor. According to the Federation, the CSST looks at four (4) questions in identifying the principal contractor:

"1. What type of construction site;

2. Who controls the job site and the employees working on the job;

3. Who is responsible for the whole of the works; and

4. Who has the ultimate authority level on the site."

A more complete and far reaching judgment on the principal contractor has been given by the Professional Injury Board of Appeal on September 17th, 1986 in the case involving the City of Québec vs a general contractor from Québec city, Savard & Dion Inc. The Board puts forward eight principles to determine who is the principal contractor on a job site: (Translation is the author's own)

"1. The principal contractor must be identified before work begins;

2. The identification of the principal contractor is made from the contractual documents, should the occasion arise, the subject documents to be studied in the light of their application during construction work;

3. The qualification given the intervening parties by the contractual documents is not determinative in identifying the principal contractor for the purpose of the Act;

4. The principal contractor is either the owner or the person who, on the job site, has the responsibility for the execution of the whole of the work;

5. One must try to determine first if, on the job site, there exists a person responsible for the execution of the whole of the work. The person may be the owner if he assumes the responsibility for the execution of the job;

6. The responsibility for the execution of the work is determined to be the taking over in a real and concrete manner, of the whole of the work, on the site itself where the job is done;

7. The responsibility for the acceptance, the control or the surveillance of the work to be executed is a separate and distinct responsibility from that of the execution of the whole of the work; and

8. In the event no person being considered in charge for the execution of the whole of the work can be identified, the owner will then be deemed to be the principal contractor".

As can be seen, principles 3 and 7 are new but they appear to confirm a position the CSST has been taking for a while. These principles will probably become the guidelines by which the CSST will render decisions of the principal contractors.

In a construction management contract where the usual practice is to have contracts signed between the owner and a number of contractors, but with the construction manager (CM) having all the power to harmonize the activities of the various participants on the site, the CSST does not recognize the CM as the principal contractor. A recent decision by the Trois-Rivières Regional Office of the CSST in the OXYCHEM CANADA INC. project in Bécancour seems to confirm the trend. (Report No I00945, dated May 23rd, 1986).

As the owner does not normally take an active part in the site management, this leads to an ambiguous situation where, in fact, the CM acts as the principal contractor but the owner, even though he may not have full-time representatives on the site is still the principal contractor or "Maître d'oeuvre". Only in turnkey-type contracts will the CSST accepts without discussion that the general contractor is the principal contractor, but there must not be more than one turnkey contract on the same site.

These rulings on the principal contractor definition will, if they go unchallenged, lead to changes in CM contracts to bring them in line with article 196 of the Act. The traditional way of using consultants as construction managers must be revised in terms of the added responsibilities they might have to absorb.

In the Québec context, the seven ways of managing safety on a site as put forward by Gans [35] and mentionned previously in Chapter 2, could not be used as such. However they could help an owner weigh the pros and cons of different delivery methods.

Corollary to the principal contractor concept is the notion of construction site. The Act defines the construction site as:

> "A place where foundations, erection, maintenance, renovation, repair, alteration or demolition work is carried out in respect of a building or of civil engineering works, on and

> at the site itself, including the preparatory work determined by regulation and the lodging, eating or recreational facilities put at the disposal of the construction workers by the employer".

From that definition, the two criteria used by the CSST to determine whether or not what has to be built is one or more job sites can be derived. This applies especially in large jobs such as in the case of transmissions lines, impounding reservoirs with many dams and dikes, subway lines, etc. On these sites extended over a large territory, it must be decided if there will be one principal contractor for all the construction areas or one principal contractor for each area. As there normally is one owner and many prime contractors, the question is undoubtedly complex. Often the owner does not want to take on the responsibilities of a principal contractor (for example: Hydro-Québec or the Québec Department of Transportation) and phrases his contract accordingly.

The CSST criteria for selection are:

1. The work ("oeuvre") and its final destination; and
2. The duration and phases of construction.

Therefore "to determine a construction site necessitates the definition of the whole projected final work, realized over a pre-determined period of time". [76]

As can be seen, planning a job site can no longer be done in an isolated manner as it was made a few year back. The organization, the lay-out, the manning and the operation must now consider the added "constraint" of prevention. That constraint and its components must be included as standard, normal planning elements.

4.4 PLANNING FOR SAFETY

4.4.1 Need for an Integrated Plan

It became apparent during the course of the present research work, particularly for the material presented in the previous section, that safety planning for a project becomes an arduous task. The necessary informations are spred throughout various legislative texts, regulations and other publications. To overcome this difficulty and facilitate the work of those responsible for project planning in ensuing that safety really becomes an integral part of the main project objectives, a comprehensive planning model has been developed incorporating present safety regulations and construction practices.

4.4.2 Project Planning Guide for Safety

The developed model is included in Appendix B. It has been derived

from the principal contractor's point of view. It is to be used during the planning phase of a project put it covers all project phases. This model incorporates the main requirements spelled in all related regulatory texts including:

- The Act [70];
- The Safety Code for the Construction Industry [85];
- Current regulations; and
- The experience gained on a number of projects and numerous consultation with the CSST.

The model comprises one (1) master network supported by three (3) subnetworks. The master chart shows the overall plan from project inception to commissionning, encompassing formal notification to the CSST of the impending project.

The subnetworks are structured in such a way as to be compatible with the main phases of the project development cycle: conceptual planning, design and procurement, and construction. The first one establishes the safety policy and responsibilities and sets the foundations for the detailed safety plan indicated in subnetwork II.

In the latter network, four (4) main mesures are to be studied on details:

- Prevention program preparation;

- Site safety measures design;
- Study of engineering and work methods with the objective of safety; and
- Write-up of contracts safety clauses.

All the elements being in place for safe construction by the completion of subnetwork II, the principal contractor must then see to:

- Application of his own and contractor's safety programs; and
- Ensure that the mandatory and project statistics are compiled and distributed.

This is outlined in the third subnetwork.

4.5 A SURVEY ON THE INDUSTRY'S PERCEPTIONS TO BILL 17

4.5.1 Survey Method and Respondents' Profile

To find out if the employers' perception of the Act six years after its adoption is in phase with the original intents of the Act, a survey has been carried out in the form of a questionnaire sent to selected contractors operating in Québec.

The questionnaire is based partly on one that had been previously prepared in the U.S. in 1981 [48] with due modifications to suit the

Québec situation. The questionnaire used in the present study is shown in Appendix A. It consists of four parts:

1. Evaluation of the present law;
2. Implementation and enforcement of the law;
3. The cost of compliance with the law; and
4. Profile of the respondents (company data).

The questionnaire was sent to 91 contractors. 25 answers were received covering an annual construction volume of 902,5 million dollars. Of the 25 replies, 16 had sufficient cost data to give significant results for a cost study. These 16 contractors represented an annual construction volume of 500,5 M$, roughly 5% of Québec's total construction volume in 1985. Figure 4.3 shows a histogram of the 25 contractors' annual volume of business.

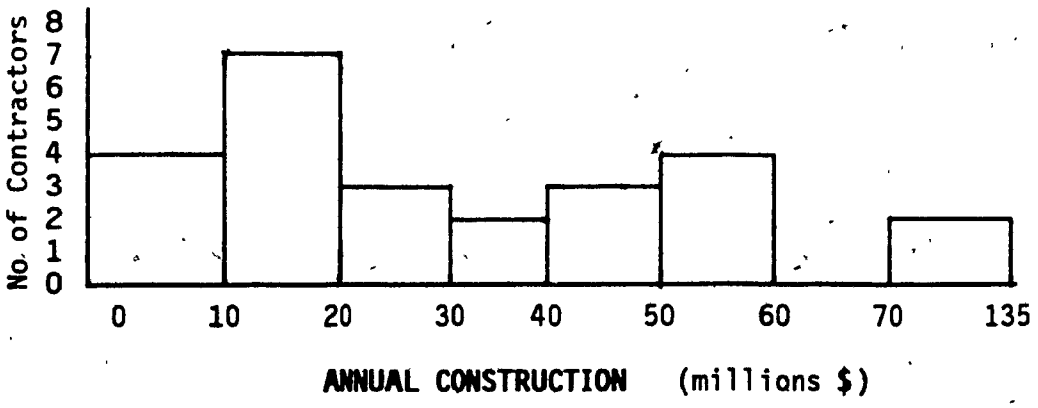


FIG. 4.3 Histogram of Surveyed Contractors' Annual Construction Volume

The 25 firms represent 0,2% of the 13 743 construction firms practicing in Québec and having presented at least one monthly report to OCQ in 1985 [36].

A survey by the newspaper "Québec Construction" published in September 1986 [36], revealed that Québec's top 200 construction firms have an annual construction volume in Québec starting at 2,3 M$ for the 200th firm and up to 174 6M$ for the largest firm. The histogram for these top 200 firms is illustrated in Figure 4.4. Thus it can be fairly assumed that the firms which participated in the present questionnaire are part of the top 200 construction firms in Québec. They were chosen without knowing their annual business revenues and largely because the author dealt with them at one time or another or because they were known firms throughout the industry. They were expected to be in the largest firms and it was assumed that because of their size and the variety of project they handled, their awareness of safety, its costs and related issues, would be higher than in smaller firms.

The main classification of work performed by these firms is shown in Table 4.1. It is to be noted that there are more numbers in the table (47) than the number of questionnaires received (25) as most of the firms are involved in more than one field of activity.

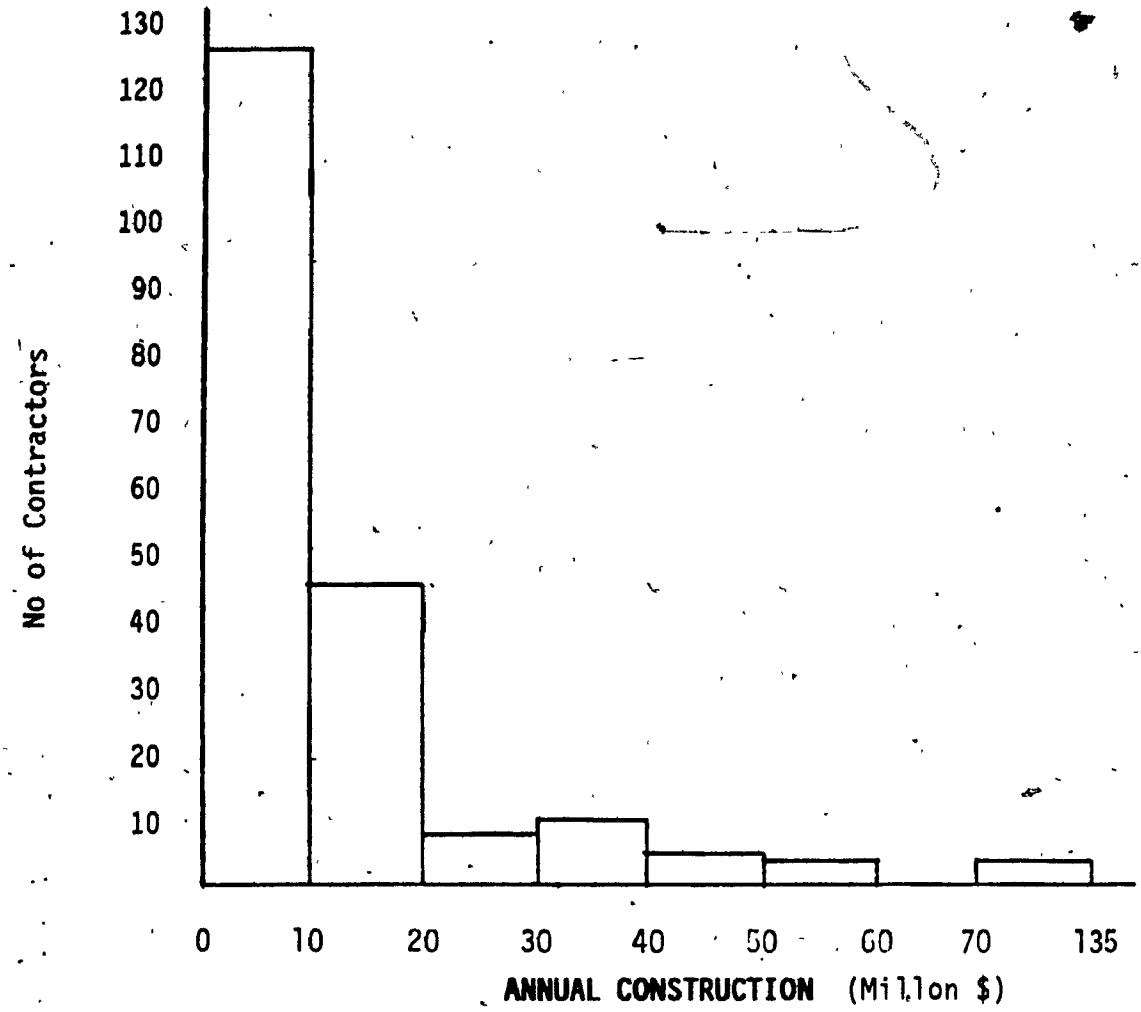


FIG. 4.4 - HISTOGRAM OF QUEBEC TOP 200 CONTRACTORS' ANNUAL VOLUME OF BUSINESS IN QUEBEC

It can be seen that the respondant are active mainly in the building, civil engineering, and industrial sectors. Even though one might say that the survey results will be biased towards these sectors and that the residential sector could have more (or less) than its share of accidents, a CSST study [8] has concluded that the residential sector with 19% of the assessable salaries had 20% of the total accidents.

The industrial, commercial and civil works sector had 80% of the accidents for 81% of the total assessable salaries. Thus the survey sample will truly be representative of the total population.

TABLE 4.1 - MAIN CLASSIFICATION OF WORK OF RESPONDANTS

Classification	Number	Percentage
Buildings (residential and Commercial)	13	28
Heavy civil works	12	25
Highways	4	9
Industrial	18	33
	47	100%

4.5.2 Respondents' Perceptions of the Law

The Act and its content has been dealt with in Chapter 3 and its effects on project management and site organization have been studied in Sections 4.2 and 4.3. Thus having established what should be done, the perceptions of the surveyed contractors on these issues will now be analysed.

Tables 4.2 and 4.3 show the firms' management perceptions to the Act, i.e. their evaluation of Bill 17, the way it was implemented and its enforcement by the CSST.

By looking at the answers to questions 1.a and 1.d, there is no doubt that a clear majority does not consider the text of the Acts to be clear, and therefore must be modified. This is valid regardless of the size of the firm. As for the comments received, the ones that stand out are the need to clarify the obligations of the workers and the highly favorable prejudice given to the employees, especially that in Bill 42: too much "latitude" which opens the door to abuses, the law is too generous; contractors should not have to pay for social measures such as re-assignment of pregnant workers and the benefits to victims of criminal actions.

From the above comments, it is not surprising to see the responses to question 1.b asking to whom the law benefits. The contractors do not feel they benefit from the law and 93% declare that it favors the workers. Comments to that question cross-ckecked with those given for questions 1.a and 1.d and discussed above. In the "others" part of the questionnaire, comments mentioned that the government and public service employees benefit from the Act and regulations as more jobs are created!

TABLE 4.2 - EVALUATION OF THE ACT (BILL 17)
(Responses as percentages)

	YES	NO	UNSURE
1.a) Do you feel that the text of the law as applied to the construction industy is clear and simple ?	15	74	11
b) Do you feel that the regulations benefit:			
1) The general public.?	25	50	25
2) The contractor ?	9	73	18
3) The construction worker ?	93	7	-
4) Others (please explain) ?	57	43	-
c) Do you feel that the requirements of the Act (Bill 17) apply to the type of work with which your company is involved ?	70	22	8
d) Should Bill 17 be modified ? If the answered is yes, please explain in the comment section below how it may be improved	77	-	23
e) Do you feel that Bill 17 has reduced the number and severity of construction accidents on your projects ?	20	72	8

Questions 1.c and 2.c, when looked at in parallel, show the same percentage of employers (70%) declaring that the requirements of the Act do apply to the type of work in which their company is involved and that good construction practices usually satisfy the requirements of the law. This would seem to indicate that, in general, the employers feel that the law is applicable without too much difficulty to their operations and that their work methods are mostly safe. The apparent contradiction with the answers to questions 1.a and 1.d, where it was largely felt that the Act should be modified, can be explained in the comments on these questions. The modifications requested relate mostly to loose interpretations and abuses by some workers in taking advantage of apparent (but not identified) loopholes in the law.

Again, these revealing and major comments could explain why most of the respondents feel that Bill 17 has not reduced the number and severity of accidents: the workers are not assigned enough responsibility by the Act and too much of the burden is borne by the employers.

The questions concerning the implementation and enforcement of the law by the CSST both yield similar answers. On the positive effect side, 20% are satisfied. The results are, however, different from the negative aspects, as 40% found them annoying and a relatively high 32 to 35% found them counter productive for a combined negative impact experienced by 72 to 75% of the respondents. One comment received was

that too much power is given to the inspectors who often use them in a discriminatory and abusive mannner. (It is not the intent with this one comment to generalize a situation but it could be symptomatic).

The results certainly indicate that the large majority of contractors do resent the intrusion of the CSST in their operations. Even though they have learned to cope with the Act as depicted from the answers to questions 1.c and 1.d, they have not yet accepted it as an integral part of their way of doing construction work. This negative perception would correlate highly with the answers to question 2.c and should have an impact on the cost of complying with the Act.

54% of the respondents declare that they did change the manner in which their projects had to be organized and staffed (question 2.d). This percentage is not substantially higher than those who declare not having changed, (46%). Here again, the size of the firms does not show any positive correlation with either the positive or the negative answers. The answers are not surprising as the Safety Code in use prior to Bill 17, for instance the 1978 version consulted, already contained most of the measures included in the post-Bill 17 version of the Code. For example, on the specific matter of the prevention officer, the 1978 Code already made mandatory their presence on a job site with similar number of workers present. Therefore the prevention officer required on a job site is not a new obligation for construction firms.

TABLE 4.3 - IMPLEMENTATION AND ENFORCEMENT OF BILL 17
(Responses, as percentages)

	VERY SMOOTH	SATISFAC-TORY	ANNOYING	COUNTER PRODUCTIVE	NO COMMENT
2.a) What is the effect on your firm since the implementation of Bill 17 in 1982 ?	-	20	40	32	8
b) How do you see the enforcement of the law by the CSST ? If you see it as "counter productive" please specify in what way or where in the comment section below	-	20	40	35	5

	YES	NO	UNSURE
c) Do good general construction practices usually satisfy the requirements of the law ?	69	23	8
d) Did Bill 17 change the manner in which the projects had to be organized and staffed ?	54	46	-
e) Do you have a specific group to look after prevention matters and compliance with Bill 17 ?	58	42	-

When asked if they had a specific group to look after prevention matters and for compliance with Bill 17, 58% answered yes and 42% had a negative answer. In this case, the size of the firms showed a definite pattern as all those with an annual volume of business below 10 M$ responded negatively to the presence of a safety group in their organization. The larger firms are more likely to have more than 150 workers on any one site. But again not all large firms would have a permanent safety staff as only 33% of the so-called "larger" firms (more than 10M$ in annual construction work) give a positive answer.

This survey seems to indicate overall that even though the employers are well aware of the presence of the Act and of the CSST and can cope with them, their acceptance certainly does not show great enthusiasm and a large positive perception. They rather feel that more exasperating obligations have been added with no matching affirmative results.

The results of this survey are very much in line with those observed in an unpublished study carried out internally in 1986 in one of the CSST regional offices. Some of the irritants for the employers were:

- Presumption for the workers favoring abuses;
- Too many regulations;
- High costs of financing;
- Intermeddling in the firms' management;

- Too many intervening parties; and
- Interference by the inspectors.

The CSST survey also listed some irritants on the workers' side, such as:

- The 14-day regime can deprive a worker of all income;
- Delays in the adoption of new regulations;
- Not enough inspectors;
- Joint sector-based association not in place (especially in the construction sector);
- Partial to the employers; and
- Not enough information on the regime.

This internal CSST survey put forward concrete suggestions and work priorities (which were described in chapter III) to deal with these criticisms, and the results should be felt in a year or two.

CHAPTER V

COSTS RELATED TO CONSTRUCTION SAFETY

5.1 GENERAL

There is no doubt that safety and accidents have related costs. Easy to recognize are the WC premiums paid by contractors, the costs of a prevention officer and a first aid station. But these elements represent only a portion of the total of the costs associated with safety and accidents. The indirect costs must be added as they represent the largest portion of the total cost. And these must be known if a well-informed decision is to be taken.

This chapter will look at the costs associated with safety and the financial burden put on firms by accidents. In order to illustrate the differents types of costs used in this thesis and to show the relationship between them, a costs matrix has been prepared and is shown in Figure 5.1. It indicates the prevention and accidents costs borne by the employers, the CSST and the total value of work safety and accidents in Québec.

By comparing safety and accidents costs, contractors should see what course of action is best for them. As Rinefort [88] suggested "most employers will consciously or unconsciously pursue a course of action in regard to occupational injuries and illnesses which will best benefit them".

	PREVENTION	ACCIDENTS	TOTAL
CSST PROGRAMS COSTS	INSURED OR PREVENTION/INSPECTION COSTS	DIRECT OR COMPENSATION COSTS	TOTAL CSST COSTS FOR CONSTRUCTION (FROM ASSESSMENTS)
EMPLOYERS' COST	NON-INSURED OR COMPLIANCE COSTS (COST MODEL)	INDIRECT (MULTIPLIER OF DIRECT COSTS)	TOTAL EMPLOYERS' COSTS FOR SAFETY AND ACCIDENTS
TOTALS	COSTS OF PREVENTION	TOTAL COSTS OF ACCIDENTS	COSTS OF SAFETY AND ACCIDENTS IN QUEBEC

FIG. 5.1 - SAFETY AND ACCIDENTS COSTS MATRIX

5.2 THE COSTS OF PREVENTION

Since Bill 17 had, at its inception, the objective of eliminating at the source the "dangers to the health, safety and physical well-being of workers", it is fair to assume that for this objective to be met, additional resources would have to be provided for prevention and inspection. In that context, when more resources are contemplated, it means that higher costs are involved.

From the results of the survey, the costs of prevention borne by the employers are compiled and a mathematical relationship relating these

costs to the project costs is derived. By adding the costs incurred by the CSST for prevention/inspection, the total amount invested by the industry in prevention will be calculated.

Thus two types of prevention costs are investigated:

- The non-insured costs i.e. the costs borne directly by the employer or principal contractor; and
- The "insured" costs i.e. the costs incurred by the CSST in prevention/inspection.

5.2.1 The Non-Insured Cost of Prevention

5.2.1.1 General

As mentioned above, the non-insured costs would be those borne directly by the employer to meet the requirements of the Act as set in the regulations, the directives of the Commission and, to a large extent, the "Safety Code for the Construction Industry" [85].

This subsection on non-insured prevention costs is divided into four parts. In the first, a comprehensive definition, including all its composite elements, is given. The second is a summary of studies done in Québec and the U.S. on the subject. In the third part, a relationship between project costs and non-insured prevention costs is

developed by analyzing the results of the province-wide survey conducted for this purpose and referred to earlier in Chapter 4. The final part applies the findings in estimating the total non-insured costs for construction in Québec.

5.2.1.2 Definition

The non-insured prevention costs include two main components [19]:

- Those related to personnel and
- The capital costs and other expenses.

The costs related to personnel include the salaries and the production losses of employees made available for duties such as:

- Site committee meetings every two weeks (article 2.5.2 of the Code [85]);
- Participation in the joint sector-based association; and
- Introductory safety meetings, tool-box meetings, etc.

and the potential costs of:

- Health examination during work (article 10(2), 51(12), 113(6), and 223(13) of the Act);
- Right of refusal (article 12 to 31 of the Act); and

- Safety representative (when articles 209 to 215 of the Act will be enforced).

The capital costs or other expenses could be those necessary to work safely and in compliance with the different regulations. These costs are very substantial and could include the:

- Preparation and administration of a prevention program;
- Capital costs of safety and sanitary facilities;
- Inspection of equipment and machinery;
- Safety officer;
- First aid station building, equipment and staff;
- Individual protection equipment; and
- Safety documentation etc.

5.2.1.3 Related Research

A CSST working document, dated December 1980 [21], made an attempt at compiling the potential costs associated with non-insured costs. Table 5.1 summarizes the results obtained and some of the hypotheses used to calculate the costs that would be incurred by the employer, for the building and public works sector.

TABLE 5.1 - NON-INSURED COSTS AS ESTIMATED BY A CSST WORKING DOCUMENT IN 1980 [21]

NO.	COST ITEM	AVERAGE COST($)	COST PER WORKER ($)
1.	Site Committee	7 147	-
2.	Joint-sector based assoc.	16 077	-
3.	Safety representative	8 710	
4.	Employee formation and information	-	30
5.	Healt Examination	-	14
6.	Right of refusal	Note (1)	
7.	Temporary closing of a site	Note (2)	
8.	Expertise	Negligeable	
9.	Records	-	20
10.	Programs for norms compliance	Note (3)	
11.	Individual protective equipment		96
12.	Instrument and prevention apparatus	4 850	-
12.	First Aid - Person (each) - Kit (each)	291 40	

Notes:

1. For all the industries of this group (Building and public works, chemical, forest, sawmills, mines/quarries, metal products): 3 150 hrs. or 29 900. $
2. For all the industries in this group: 3 000 hrs. or 28 500. $
3. Different studies give the following figures:
   - 3% of annual investments
   - 5 - 10% of operations costs
   - 930$ / worker for noise reduction
4. The average cost is for job sites of 500,000$ and more.
5. The costs are given in dollars of 1980.

To see how the findings could work in practice, they have been used to calculate the costs for an assumed typical construction with the following characteristics: 2,5 million dollars job, scheduled to last 6 months with an average of 65 employees, and a manpower content of 40% of the total cost. Table 5.2 shows the total costs for the employer's charges related to the application of Bill 17, based on the 1981 study and using 1980 dollars. The total costs come to 131 632 $ and represents 5,3% of the job cost. As will be seen later, the figure of 5,3% represents a realistic measure for a project of that size.

The cost of complying with OSHA and the resulting safety programs has been discussed in a report by the Business Roundtable in the U.S. [11], as part of the Construction Industry Cost Effectiveness Project. This report indicates that from a survey made in 1980 from a significant sample of contractors, the cost of administering a health and safety program is estimated at about 2,5% of the direct labour costs. That percentage would include roughly what was defined precedently as the non-insured costs. By assuming a labour cost content of 30 to 40% on a project (average 35%), the cost of safety in the U.S. construction industry could thus be evaluated at somewhere between 0,75 and 1% of the total project costs.

TABLE 5.2 - BILL 17 RELATED COSTS FOR A TYPICAL SITE

NO.	COST ITEMS	CALCULATIONS	TOTAL COSTS
1.	Site committee:		7 594 $
2.	Joint sector based association:		16 077 $
3.	Safety representatives:		6 329 $
4.	Formation:	65 X 30 $ =	1 950 $
5.	Health examination:	65 X 14 $ =	910 $
6.	Right of refusal:	assume 50 hrs: 50 X 15 $/hrs.	750 $
7.	Temporary closing:	assume 10 hrs: 10 X 65 X 15 $/hrs.	9 750 $
8.	Expertise:		0 $
9.	Records:	65 X 20 $ =	1 300 $
10.	To comply to norms & regulations (assume 3% of job cost)		75 000 $
11.	Protective equipment:	65 X 96$=	6 240 $
12.	Prevention equipment:		4 850 $
13.	First Aid:	2 persons X 291$	582 $
		5 kits X 40$	200 $
		TOTAL	131 632 $
			or 5.3% of the total job

Notes: 1. 1980 dollars

5.2.1.4 Survey Results Analysis

In order to test both the assumptions that were made in 1980 for the Québec situation and the validity of the U.S. figures, the respondents were asked, as part of the survey described in section 4.4.:

- If Bill 17 has increased the cost of construction with which their company is involved in (Appendix A, question 3.c); and
- The approximate cost of complying with Bill 17 on work which their company performed (Appendix A, question 3.d)

Table 5.3 illustrates the responses to the first question.

TABLE 5.3 - RESPONDENTS PERCEPTIONS OF THE EFFECTS OF BILL 17 ON COSTS (Responses as percentages)

Has Bill 17 increased the cost of construction with which your company is involved?	
Hardly at all:	24
Quite a bit :	20
Substantially:	48
Not evaluated:	8

It can be seen that 68% of the respondents declare that Bill 17 has indeed increased the cost of construction including almost half (48%) who say it has increased them substantially.

Thus, for constractors Bill 17 did have a very noticeable effect on their costs. It remains to be seen whether or not these increased costs had any effect on their safety records. Industry statistics did show an improvement of the safety in the construction industry, at least from 1979 to 1983. However, a rising trend for 1984-1986 has appeared. That aspect will be analyzed in section 5,3.

The question concerning the costs of complying with the requirements of Bill 17 is most revealing and interesting. In question 3.d, of the questionnaire, contractors were asked to list by sector, the total approximate project cost and the approximate related costs of complying with Bill 17. The results are summarized in Table 5.4. The detailed analysis of the collected cost data constitutes the quantitative part of the present survey and on which the findings of the thesis in this respect are based.

The raw data are presented in Appendix H. A simple examination indicates that the arithmetic average percentage of the project cost for compliance ($\bar{C}$) is 3,79% with a standard deviation of 4,70%. However, the weighted average ($\bar{C}_w$), given by

TABLE 5.4 - PROJECTS AND COMPLIANCE COSTS SUMMARY

SECTOR	NUMBER OF ANSWERS RECEIVED	APPROXIMATE TOTAL PROJECT COSTS	APPROXIMATE COSTS OF COMPLYING WITH BILL 17
Building (Residential & Commercial)	8	38 100 000 $	505 000 $
Heavy Civil Works	9	109 040 000 $	3 218 000 $
Highway	3	16 000 000 $	525 000 $
Industrial	13	325 500 000 $	4 754 000 $
Other (specify)	___	NIL	NIL
Total	33	488 640 000 $	9 002 000 $

Note: Collected data were given either in dollars or in simple percentages.

$$\bar{C}_w = \frac{\sum_{i=i}^{n} C_i P_i}{\sum_{i=i}^{n} P_i} \qquad (5.1)$$

In which, P_i = Project costs in 10^6 $ for the i^{th} project

C_i = Percentage of project costs for compliance with Bill 17 in percentage (%) for the i^{th} project

n = Total number of projects considered.

is 1,84%. The difference between $\bar{C}$ and $\bar{C}_w$ indicates that in small projects the percentage of cost for complying with Bill 17 is relatively higher than for large projects.

To investigate the type of potential relationship between C_i and P_i and its validity, a regression analysis has been performed, tests made and associated statistical parameters calculated.

The percentage costs (C) have been plotted against the project costs (P) as shown in Figure 5.2.

A visual interpretation of the scatter plot permits the following assumptions:

1) Do an overall analysis instead of sectorial analysis. This is based on the following reasons:

   a) Preliminary approximate curve fitting by sector shows that the four curves have close and similar shapes.

   b) Using the whole data set in constructing an overall curve rather than a group of curves allows a more accurate representation of the relationship.

2) Five points could be excluded from the data group, since they are extremely outside the general trend of the data collected. They are shown in Figure 5.2 and represent the following pairs: (2,20), (8,5), (8,5 7,5), (30,5) and (45, 4,5).

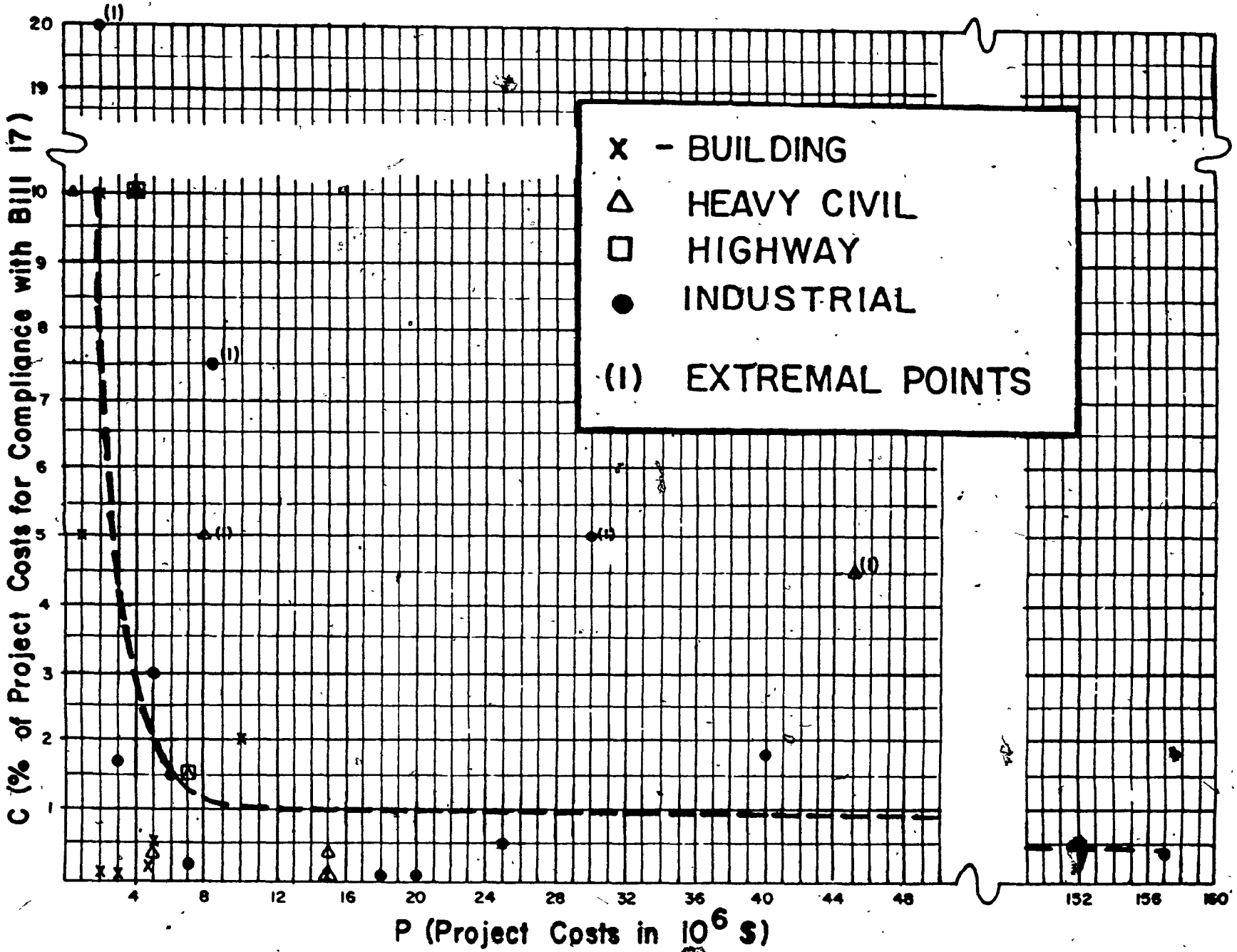


FIG. 5.2 - PC Scatter Plot by Sector

Eliminating extremes is a valid statistical analysis procedure. However, summary analysis were conducted with 26,30 and 33 points to ensure all possibilities were studied. They yielded results with correlation coefficients (r) ranging from -0,36 to -0,40 and standard errors of estimates coefficients (Se) ranging from 1,55 to 1,62. Accordingly the decision to proceed with the elimination of five (5) extremal point is valid as the "r" are lower and the "Se" are higher than those that will be obtained in the following analysis.

Having eliminated the five points considerably outside the range of the data collected, the remaining sample of 28 points (Table 5.5 columns (1) and (2)) will now be analyzed to find the relationship that can best fit the data collected.

A regression analysis was carried for each of the following models using the Statgraphics program [96].

1. Linear $(y = a + bx)$
2. Multiplicative (power) $(y = ax^b)$
3. Exponentiel $(y = e^{a+bx})$
4. Reciprocal $(1/y = a + bx)$

The results are summarized in Table 5.6 and the associated curves are shown in Figure 5.3.

The last three models are also treated as linear relationships after suitable transformations. The linear functions are:

- Multiplicative (power) : $\log y = \log a + b \log x$
- Exponential : $\ln y = a + bx$
- Reciprocal : $y^{-1} = a + bx$

TABLE 5.5 - DATA GROUPS FOR REGRESSION ANALYSYS

(1) PROCOST	(2) OSCOST	(3) PROCOST1	(4) OSCOST1	(5) PROCOST2	(6) OSCOST2
0,04	10,0	0,04	10,0	10,0	2,0
0,1	10,0	0,1	10,0	10,0	2,0
1,0	5,0	1,0	5,0	15,0	0,1
2,0	10,0	2,0	10,0	15,0	0,1
2,0	0,1	2,0	0,1	15,0	0,4
3,0	0,1	3,0	0,1	18,0	0,1
3,0	0,7	3,0	1,7	20,0	0,1
4,0	10,0	4,0	10,0	25,0	0,5
4,0	10,0	4,0	10,0	40,0	1,8
4,0	10,0	4,0	10,0	157,0	0,4
5,0	3,0	5,0	3,0		
5,0	0,4	5,0	0,4		
5,0	0,2	5,0	0,2		
5,0	0,5	5,0	0,5		
6,0	1,5	6,0	1,5		
7,0	1,5	7,0	1,5		
7,0	0,2	7,0	0,2		
7,0	1,5	7,0	1,5		
10,0	2,0				
10,0	2,0				
15,0	0,1				
15,0	0,1				
15,0	0,4				
18,0	0,1				
20,0	0,1				
25,0	0,5				
40,0	1,8				
157,0	0,4				

Procost: (P) project cost in 10^6\$
Oscost : (C) % of project cost to comply with Bill 17
" " 1: 0 - 8 MM\$ project region
" " 2: > 8 MM\$ project region

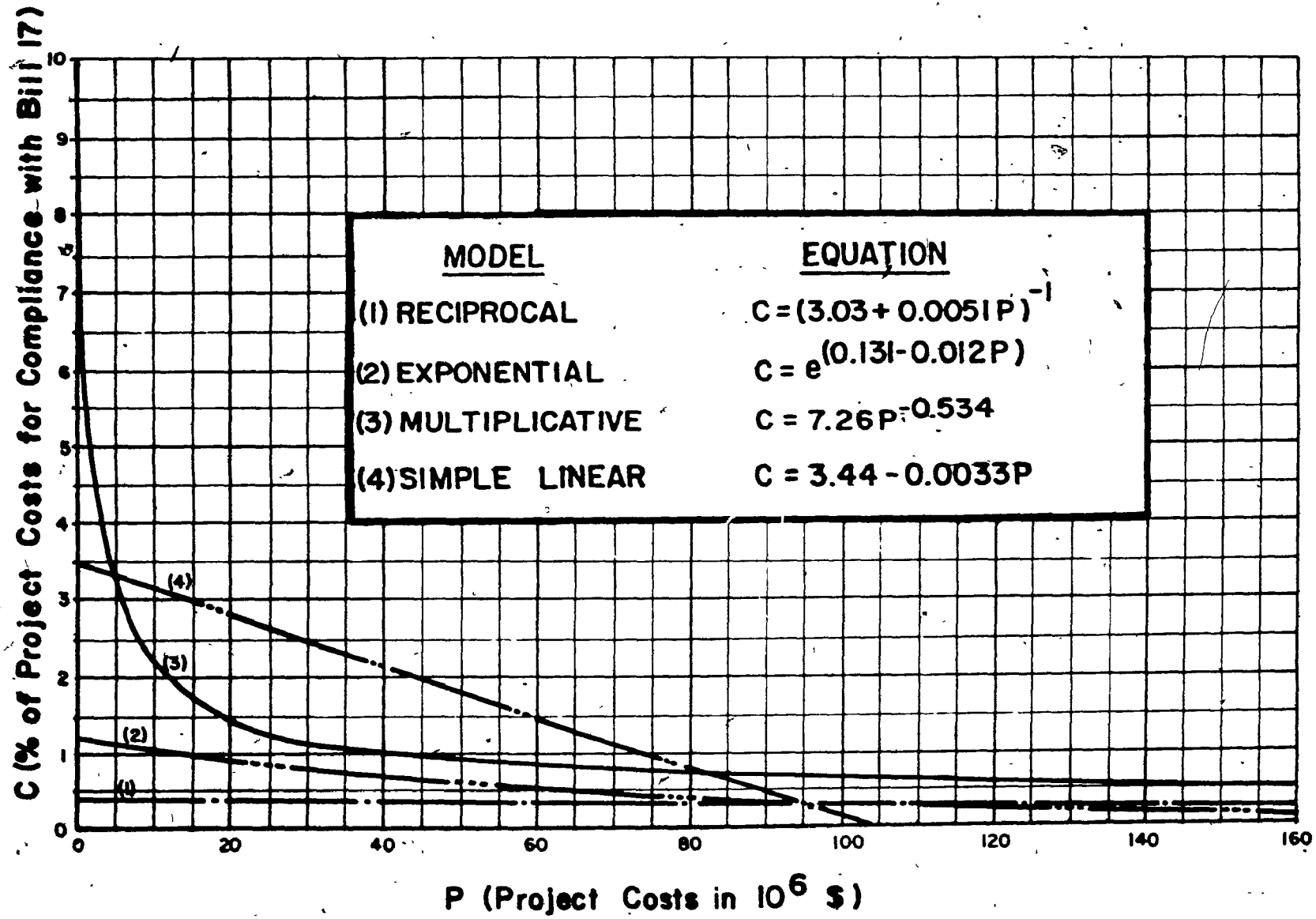


FIG. 5.3 - Regression Curves of C vs P - 4 Models

TABLE 5.6 - SUMMARY RESULTS OF REGRESSION ANALYSIS

MODEL	EQUATION	STATISTICAL VALUES r	Se	F-RATIO
Simple Linear	$C = 3,439 - 0,0332P$	-0,25	3,84	1,73
Reciprocal	$C = (3,027 + 0,005P)^{-1}$	-0,038	3,97	0,038
Exponential	$C = e^{(0,131 - 0,012P)}$	-0,201	1,69	1,09
Multiplicative	$C = 7,26\ P^{-0,534}$	-0,509	1,49	9,05

r = correlation coefficient

Se = Standard error of estimate

F-Ratio = Ratio of mean sum of squares of "Model" over "Error" (Result of Analysis of Variance).

The multiplicative model is retained as it has the lowest standard error of estimate (Se) and the closest to ±1 correlation coefficient (r) of all the four models. The regression parameters of this model are shown in Table 5.7 and the related curve in Figure 5.4.

TABLE 5.7 - REGRESSION ANALYSIS PARAMETERS FOR THE MULTIPLICATIVE MODEL (C = a P ** b)

PARAMETER	ESTIMATE	STANDARD ERROR	T VALUE
Intercept (Log a)	0,8609	0,4097	2,101
Slope (b)	-0,534	0,1775	-3,009

T value: $\frac{\text{Estimate}}{\text{Standard Error}}$

The resulting equation is therefore

$$C = 7{,}26\ P^{-0{,}534} \quad \text{- - - - - - - - - - - - - - - - (5.2)}$$

or

$$\log C = 0{,}8609 - 0{,}534 \log P \quad \text{- - - - - - - - - - - - (5.3)}$$

which describes the relationship of cost spent for safety in compliance with Bill 17(C) as a % of project construction cost (P).

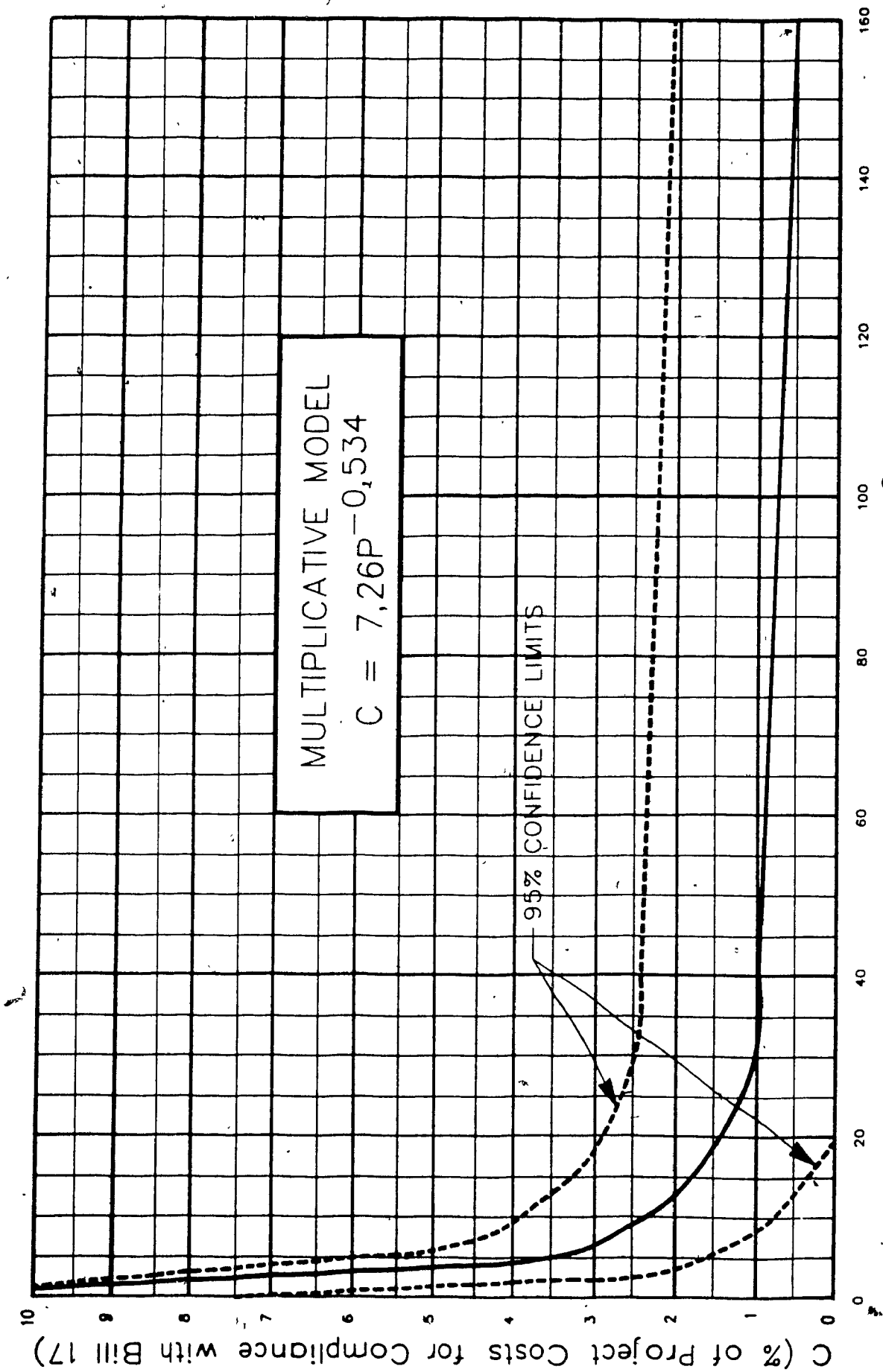


FIG. 5.4 - Regression Curve - Multiplicative Model

The distribution function of the dependent variable (C) is assumed to be log-normal based on the following tests:

1. Kolmogorov-Smirnov [2,65]; and
2. Probability plot [2].

Details of the tests are included in Appendix J.

Since the distribution is characterized as being log-normal, this non-normality leads to the use of non-parametric tests to determine the validity of the multiplicative (or power) model retained from the regression analysis. Two such tests are used:

1. Analysis of variance (ANOVA) [65]; and
2. Null hypotesis test for β [65].

Those tests are also detailed in Appendix J.

The analysis indicates that multiplicative model is valid but the results are not consistant. The low value for the correlation coefficient ($r = -0,509$) amplifies the incertainty about the data as it means that the unexplained variations between the calculated and observed values are somewhat large and are more than can be attributed to chance.

Therefore, the relationship of C versus P described above is useful for industry-wide predictions to provide a general trend but could be of limited value for individual estimates. A more elaborate research project with a large sample would lead to a more accurate relationship for individual predictions. For the purpose of the present thesis, the general trend is deemed significant with a lower limit of P = 0,5 M$ as compliance percentages for projects costs below this limit are much too high to be realistic.

Examination of Figure 5.2 might suggest that a piecewise (or partial) regression analysis could yield a better accuracy. To do so, the data were separated into two groups:

a. $0 < P > 8$ million dollars (region 1)

b. $P > 8$ million dollars (region 2)

The data pairs for both regions are presented in Table 5.5, colums (3), (4), (5) and (6). The above separation was based directly on the nature of the scattered data.

Furthermore, according to an OCQ study conducted in 1981 [21], of 1 379 construction projects with values over 500 000 $ each, 1 274 or 92% had a value below 4,9 million dollars. Thus, a 0 to 8 million dollar region would, therefore, be valid for at least 92% of the construction projects in the Province of Québec.

The regression analysis was carried out using the models previously described in section 5.2.1.4. The four best models compatible with the data collected in the two regions are give in Table 5.8 and illustrated in Figure 5.5 for region 1.

TABLE 5.8 - SUMMARY OF PIECEWISE REGRESSION ANALYSIS

COST	MODEL	r	Se
0 - 8 (10^6 $)	$C_1 = 8,40 - 1,08\ P_1$	-0,55	3,77
	$C_1 = 8,68\ P_1^{-0,49}$	-0,42	1,59
> 8 (10^6 $)	$C_2 = 0,83 - 0,0024\ P_2$	-0,13	0,87
	$1/C_2 = 5,56 - 0,022\ P_2$	-0,21	4,65

In the 0 - 8 M$ region, the analysis indicates that the linear model where "r" equals -0,55 is significant enough for group-type prediction. For the > 8 M$ region, the results are not significant enough to be used at this stage and thus studies are needed in this region.

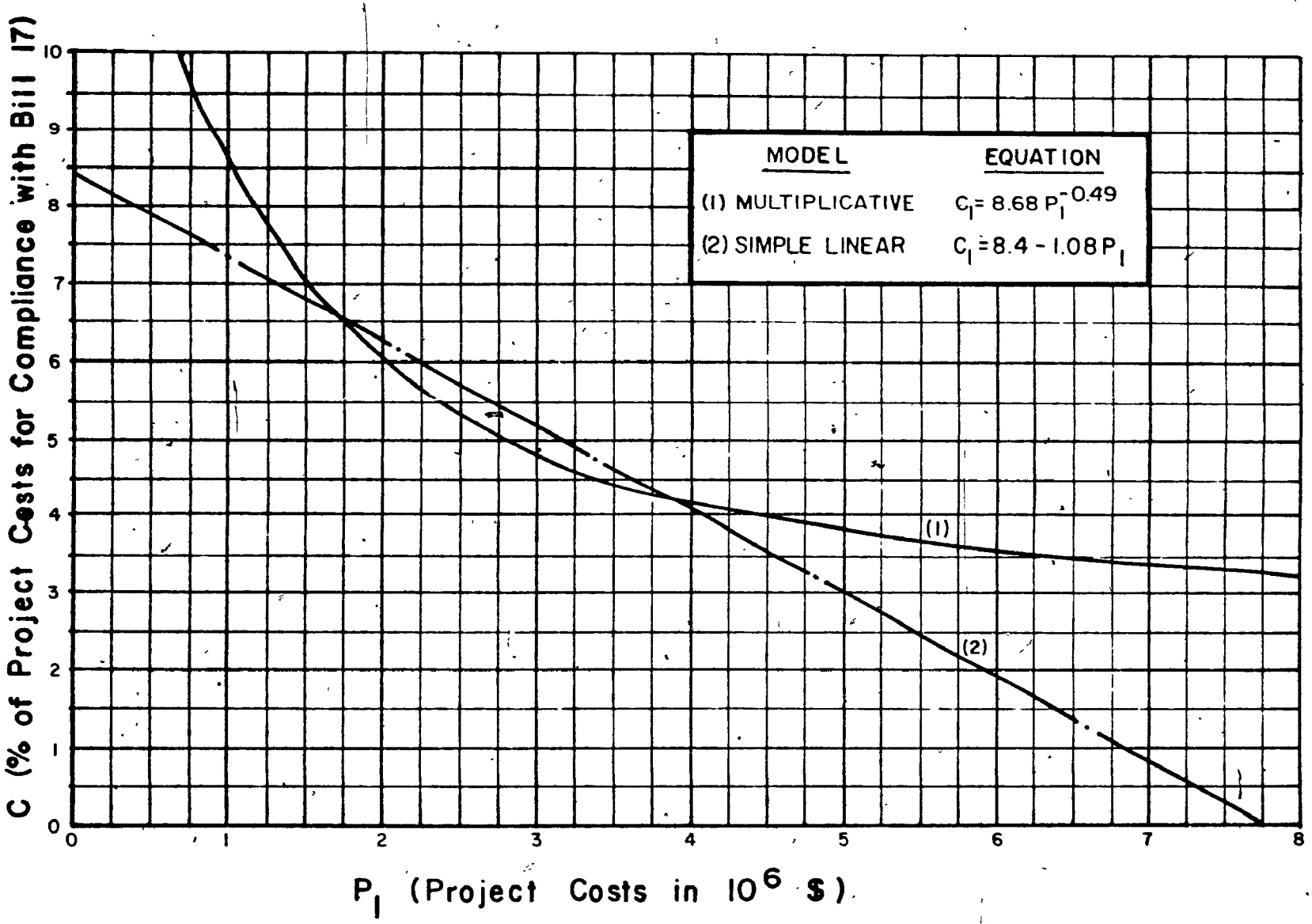


FIG. 5.5 0-8 M$ Region Regression Curves (2 Models)

The regression analysis conducted from the survey results on safety compliance costs versus project size does indicate a definite pattern in the way safety costs are related to project costs. Figures 5.4 and 5.5 show the same trend with the compliance costs decreasing rapidly from 10% to about 2% as project costs increase from 0,5 to 10 M$. From there on the decrease rate is much smaller, being about 0,5% in the 150 M$ range of project cost.

This variation in the compliance costs indicates that for the smaller contractors, the absolute financial value of safety appears to be higher, and with reasons, as they cannot depreciate it over a large amount of construction work. This economy of scale can be illustrated with one major element of the safety program: the safety officer. According to the Construction Safety Code [85], the number of full-time safety officers required on a site is determined according to the following ranges:

150 to 299 workers	-	1 officer
300 to 599 workers	-	2 officers
600 to 1 100 workers	-	3 officers

The proportion thus varies from 1:150 on a relatively small project to 1:400 for a large project. This apparent increase in overhead cost for that one element of a safety program (i.e. the Safety Officer) in complying with the Safety Act on smaller projects is certainly indicative of a trend for most of the other elements.

To summarize the results, Table 5.9 illustrates the different measures of the statistical analysis performed as applied to the safety cost within the three broad ranges of project costs studied. These results are valid for the revised data, that is with the five (5) external points excluded.

TABLE 5.9 - SUMMARY OF STATISTICAL ANALYSIS

PROJECT COSTS	C (%)	SD	95% CONF. INTERVAL	$\bar{C}_w$ (%)
0 - 157 M$	2,97	3,89	± 1,47	1,02
0 - 8 M$	4,21	4,37	± 2,08	2,91
> 8 M$	0,75	0,83	± 0,51	0,62

C = Compliance costs expressed as a percentage (%) of project costs

SD = Standard deviation

$\bar{C}_w$ = Weighted mean percentage

Two studies conducted in the U.S. come to the same conclusions as far as compliance costs for the OSHA versus the volume of business. From a 1981 survey of the construction industry by Koehn and Musser [48], the relationship results were derived and are as shown in Table 5.10 and plotted in Figure 5.6.

TABLE 5.10 - US OSHA COMPLIANCE COSTS VERSUS ANNUAL CONSTRUCTION VOLUME

ORGANIZATION	ESTIMATED MEAN ANNUAL VOLUME OF WORK	WEIGHTED % OF COMPLIANCE WITH OSHA
Indiana Contractors	11,1 X 10^6 $	1,34
Ohio - OCA	13,2 X 10^6 $	2,09
Indiana - AGC	22,1 X 10^6 $	0,87
ENR 400	90,0 X 10^6 $	0,76

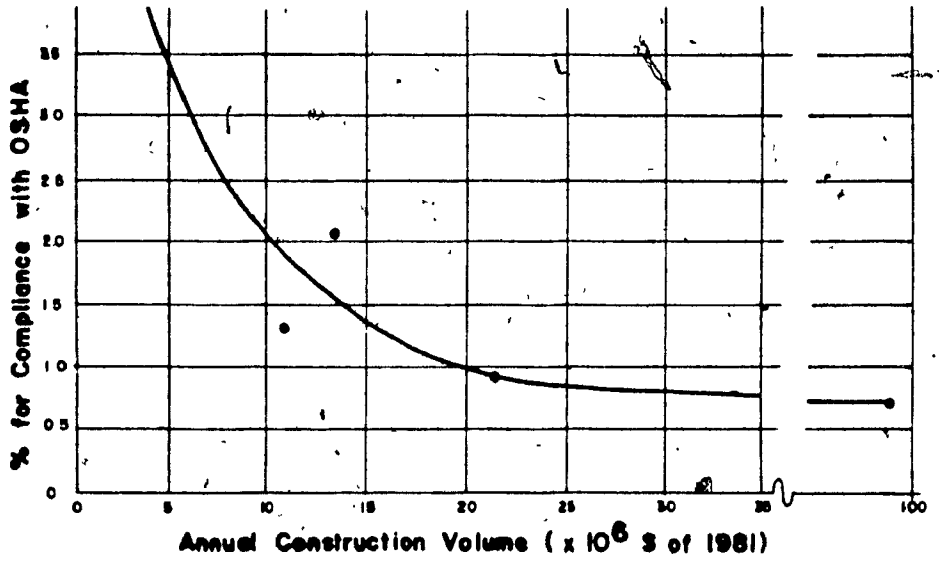


FIG. 5.6 - OSHA Compliance % of Project Costs in 1981 [48]

To compare the Québec survey results and that of the U.S. as reflected by the Koehn and Musser study [48], the curve from Figure 5.6 (OSHA) and that obtained from Equation 5.2 (Québec Bill 17) have been superimposed as shown in Figure 5.7. As can be seen the similar trend is apparent considering the 5-year span that separates the two surveys.

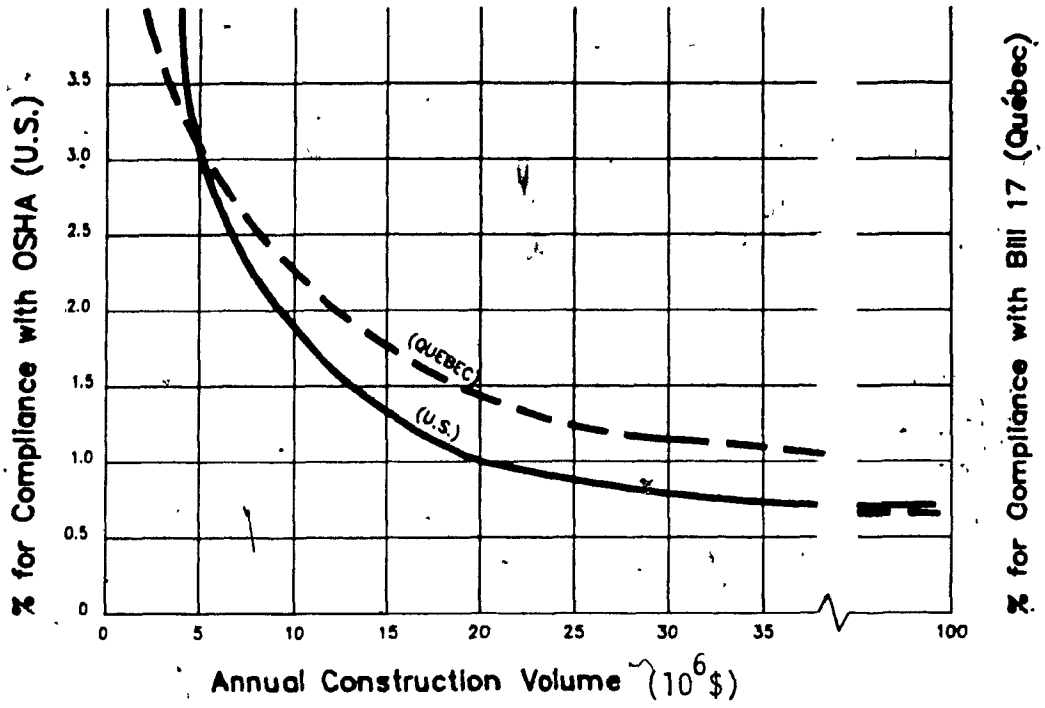


FIG. 5.7 - OSHA Compliance - % of projects costs (in 1981) vs Québec Compliance % (in 1986)

The National Association of Manufacturers related the costs per worker of OSHA versus the size of the firm in a survey done in 1976-1977. The resulting graph as reproduced from a study by Labour Canada [31] is included as Figure 5.8. It indicates that the cost per worker decreases rapidly from 660$ for a firm with 100 workers to 270$ for one with 1 000 workers and then stays relatively constant at 245$ for 5 000 workers. It is interesting to note the trend between Figure 5.8 (manufacturing) and Figure 5.7 (construction).

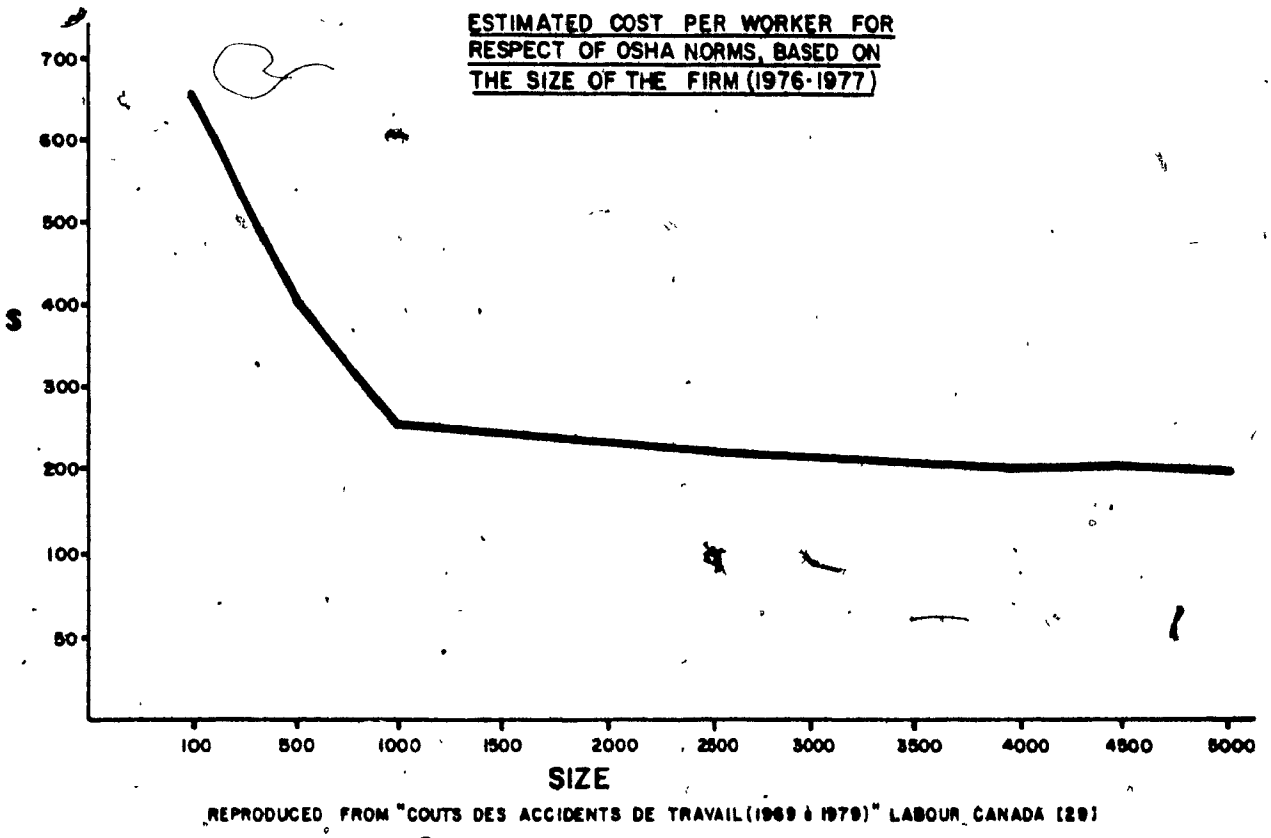


FIG. 5.8 - OSHA Costs per Worker (1976-1977)

The results of the Québec survey on costs conducted in the present study correlates closely with those established in the U.S., particularly that on the construction industry with a cost percentage for the overall U.S. industry of 0,95% versus the 1,02% found for Québec. Such a close agreement was depicted even though the surveys are five years apart. The trend of a decreasing compliance percentage cost as the projects cost increases is also similar in the surveys.

5.2.1.5 Total Non-insured Safety Costs in Québec

To illustrate what the non-insured safety costs in Québec represent, the mean weighted percentage of construction cost ($\bar{C}_w$) allocated to health and safety by the total population of contractors in the Province will be used. As mentioned previously, $\bar{C}_w$ is a better estimate than $\bar{C}$ as it tends to level the high percentages of small projects.

As calculated with the annual construction value published yearly by STAT CAN [13], the total approximate health and safety non-insured costs invested by the industry is presented in Table 5.11. The results are obtained by multiplying the annual construction volume by $\bar{C}_w$ (1,02%).

TABLE 5.11 - ESTIMATED NON-INSURED SAFETY COSTS

YEAR	ANNUAL CONSTRUCTION VOLUME (X 10^6 $)	HEALTH AND SAFETY NON-INSURED COSTS (X 10^6 $)
1986	13 068	133,3
1985	12 585	128,4
1984	11 780	120,2
1983	10 993	112,1
1982	10 219	104,2
1981	10 308	105,1
1980	9 352	95,4

NOTES: 1. In current dollars
2. 1986 figures are based on intentions of investment.

5.2.2 Insured Prevention Costs

As defined in Section 5.2 these represent the costs incurred by the CSST in prevention/inspection. In this matter, the 1984 CSST annual reports describes in length the Commission's role:

> "The Commission's role is to enable workers and employers to participate in improving health and safety in the work place and fully assume their rights and obligations as set out by the law".

The duties include:

- Set standards and oversee their application;
- Oversee regulations;
- Assistance for prevention programs;
- Assistance for participation mechanisms;
- Training, information and research services; and
- Inspection.

The annual cost of the prevention/inspection program for all sectors is indicated in Table 5.12 which is a summary of the figures drawn from CSST annual reports. To simplify the table and show a more realistic cost for each program, the different overhead costs have been calculated proportionaly and included in the cost of each program.

To approximate the proportion of the prevention/inspection program that goes for the building and public works sector in the absence of accurate data to that effect, the number of intervention files are used.

TABLE 5.12 - CSST ANNUAL ASSESSMENTS & PROGRAM COSTS ('000 $)

YEAR	ANNUAL INCOME (ASSESSMENT & INVESTMENTS)	PROGRAMS COSTS (1)		
		COMPENSATION PROGRAMS ((%)(2))	PREVENTION PROGRAMS ((%)(2))	PREGNANT WORKERS PROGRAM ((%)(2))(3)
1986	1 184 890	1 384 657 (117)	67 525 (6,0)	35 024 (3,0)
1985	990 815	1 239 879 (125)	65 060 (6,6)	32 413 (3,3)
1984	919 580	1 018 147 (111)	66 072 (7,2)	21 867 (2,4)
1983	921 147	925 325 (100)	42 828 (4,6)	-
1982	887 896	911 290 (103)	34 415 (3,9)	-
1981	864 071	841 966 (97)	23 049 (3,7)	-

Notes: (1) Costs include administrative costs, bad debts and public service pension plan constributions, proportionally divided between the programs.

(2) % of annual assessment.

(3) Program started in 1984

Source: 1981 - 1986: CSST Annual Reports.

The intervention files are those in which CSST personnel is called upon to intervene directly. They include:

- Assistance evaluation and control;
- Investigation following accidents;
- Interventions following complaints; and
- Application of the right of refusal.

The total number of files and the proportion in the B. and P.W. sector are shown in Table 5.13. The percentage obtained in used to calculate the B. and P.W. sector prevention costs spent by the CSST.

TABLE 5.13 - PROPORTION OF THE CSST PREVENTION/ INSPECTION PROGRAM COST SPENT IN THE B. AND P.W. SECTOR

YEAR	INTERVENTION FILES IN B. AND P.W. (1)	TOTAL NUMBER OF INTERVENTIONS FILES (2)	% IN B. AND P.W. (1)/(2) X 100% (3)
1984	5 673	20 434	27,8
1985	5 682	21 530	26,4
1986	5 578	21 609	25,8
TOTAL (3 years)	16 933	63 573	26,6

Sources: 1. CSST Annual Reports 1984 and 1986

2. CSST verbal information for 1985.

Thus, from 1984 to 1986, an estimated 26,6% of the CSST prevention / inspection program cost (i.e. insured costs) was spent in the construction industry. A further assumption is that this figure is valid for other years. The total money as calculated using these assumptions is shown in Table 5.14, column (3).

5.2.3 Total Cost of Prevention

Having estimated the costs of insured and non-insured prevention measures, both can now be added to give the total amount of money invested for prevention throughout the construction industry. The results are shown in Table 5.14. As can be seen, the ratio of the employer's contribution to prevention compared to the CSST's has been roughly 7:1 for the past three years.

TABLE 5.14 - TOTAL ANNUAL PREVENTION COSTS FOR THE B. and P.W. SECTOR IN QUEBEC (X 10^6 $) (Current dollars)

YEAR	(1) ANNUAL CONSTRUCTION VOLUME (X $10^6$$)	(2) NON-INSURED COSTS (EMPLOYERS) (X$10^6$$)	(3) INSURED COSTS (CSST) (X$10^6$$)	(4) TOTAL	(5) $\frac{(4) \times 100}{(1)}$ (%)
1986	13 068	133,3	18,0	151,3	1,2
1985	12 585	128,4	17,3	145,7	1,2
1984	11 730	120,2	17,6	137,8	1,2
1983	10 993	112,1	11,4	123,5	1,1
1982	10 219	104,2	9,2	113,4	1,1
1981	10 308	105,1	6,1	111,2	1,1

5.3 THE COST OF ACCIDENTS AND ACCIDENT RATES

5.3.1 The Evolution of Accidents 1979-1985

With its primary objective of "elimination at the source the danger to the health, safety and physical well-being of workers", Bill 17 should have had a positive effect on the reduction of the accident rate in the Québec construction industry.

In the survey described in Section 4.5 contractors were asked in question 3.a (Appendix A), what effect Bill 17 had on their work accident insurance premiums, rate of accident/year and general liability insurance:

TABLE 5.15 - CONTRACTORS' PERCEPTIONS ON THE EFFECT OF BILL 17 ON THEIR INSURANCES AND ACCIDENT RATE (Responses as percentages)

	INCREASE	DECREASE	NO CHANGE
Since the law is in effect, what has been its impact on:			
1. Work accident insurance premium	88	4	8
2. Rate of accident/year	41	32	27
3. General liability insurance	56	0	44

For the 10 respondents who gave percentage increases for their assessments i.e. work accident insurance premium, the arithmetic mean increase since 1980 was 20% with a high of 35% and low of 10% (one 100% increase was not included in the totals as it was felt to be non-representative since no answer was given by this respondents to other questions of the survey).

From the results of the survey shown in Table 5.15, it is also seen that 59% of the respondents indicate that their rate of accidents per year has either decreased or remained the same. For those who reported an increase, the arithmetic mean was 18% with a high of 30% and a low of 4%. (A 125% increase was omitted being extremely outside the range of collected data). Table 5.16 relates the percentages given by the respondents for the assessments and the accident rate/year.

TABLE 5.16 - CONTRACTOR'S RESPONSES TO THE IMPACT OF BILL 17 ON WC PREMIUMS AND WORK ACCIDENT RATE

IMPACT ON WC PREMIUMS (%)				IMPACT ON ACCIDENT RATE (%)		
RESPONDANT NUMBER	INCREASE	DECREASE	NO CHANGE	INCREASE	DECREASE	NO CHANGE
1	18				20	
2	X			20		
3	20			30		
4	25					X
5	30					X
6	35			20		
7	15			125		
8	25				5	
9	20					X
10	10			4		
11	10					X

Note: X indicates no quantified answer.

An analysis of compensable injuries done by the CSST and published in September 1986 [8] is summarized in Table 5.17. The CSST study calculated the accident rate with two methods: 1) using the OCQ declared hours, and 2) using on the CSST total assessable salary with STAT CAN average hourly salary. Since the number of injuries published by the CSST covers the whole B. and P.W. sector (including the workers under the CILR Act), it was assumed that using the CSST salaries was more representative and more directly related to the published injury statistics.

TABLE 5.17 - ABSOLUTE AND RELATIVE COMPENSABLE INJURIES EXPERIENCE 1979-1985

YEAR	NUMBER OF COMPENSABLE INJURIES	INJURIES/10^6 HOUR WORKED (1)
1985 (2)	15 807 (estimated)	115 (2)
1984	12 494	101
1983	10 480	87
1982	11 208	111
1981	14 043	121
1980	12 781	109
1979	13 002	104

Notes:
1. Hours worked obtained by dividing the CSST total annual assessment by the Statistic Canada average hourly rate.
2. The hours have been estimated with an 11% increase from 1984 based on OCQ 1985 projection [82].

The yearly rates have been plotted in Figure 5.9. It can be seen that the variations are very important, there is a large increase from 103,9 to 120,5 from 1979 to 1981 respectively, followed by an encouraging and tremendous drop to 87,4 in 1983. But the 1984 rate and that estimated for 1985 seem to indicate a reversal in trend. With further analysis of these results, the CSST group that completed the study referred to earlier [8] came to the following conclusions:

1. The increase in the rate is proportional to the increase in the B. and P.W. sector activities; and

2. The increases for 1983 to 1985 would be directly proportional to the importance of the industrial and commercial building groups which represent 40% of the CSST total assessable salaries.

The study provides a good analysis of the occupational injuries situation in the B. and P.W. sector but fails to relate the findings with the basic objective of the Act to reduce accidents. Regardless of the level of activity of the B. and P.W. sector, the relative frequency should have been decreasing had the goals of the Act been met. The results indicate, in reality, a rather sharp increase from 1979 to 1981. This could probably be explained by the fact that the prevention mechanisms were really not in place until late 1980 and their effects

starting to be felt only about a year later. This would explain the rapid decrease in the 1982 and 1983 rates. Once the original effort was made by all those concerned, i.e. the employers, the employees and the CSST, it could be hypothesized that a combination of the following factors may have led to the reverse trend noticed for 1984 and 1985:

1. A general relaxation of all parties involved as things seemed to be going well;

2. The fierce competition in the industry;

3. The increased number of regulations resulting in a partial retraction of contractors in complying with the Act;

4. A feeling that a very expensive regime is not yielding the expected results and that the machine only gets bigger and bigger; and

5. An increase in the number of reported accidents as workers are better aware of regulations and available CSST services.

But whatever the causes, the general trend in the rate indicates that the overall objectives of Bill 17 are not met.

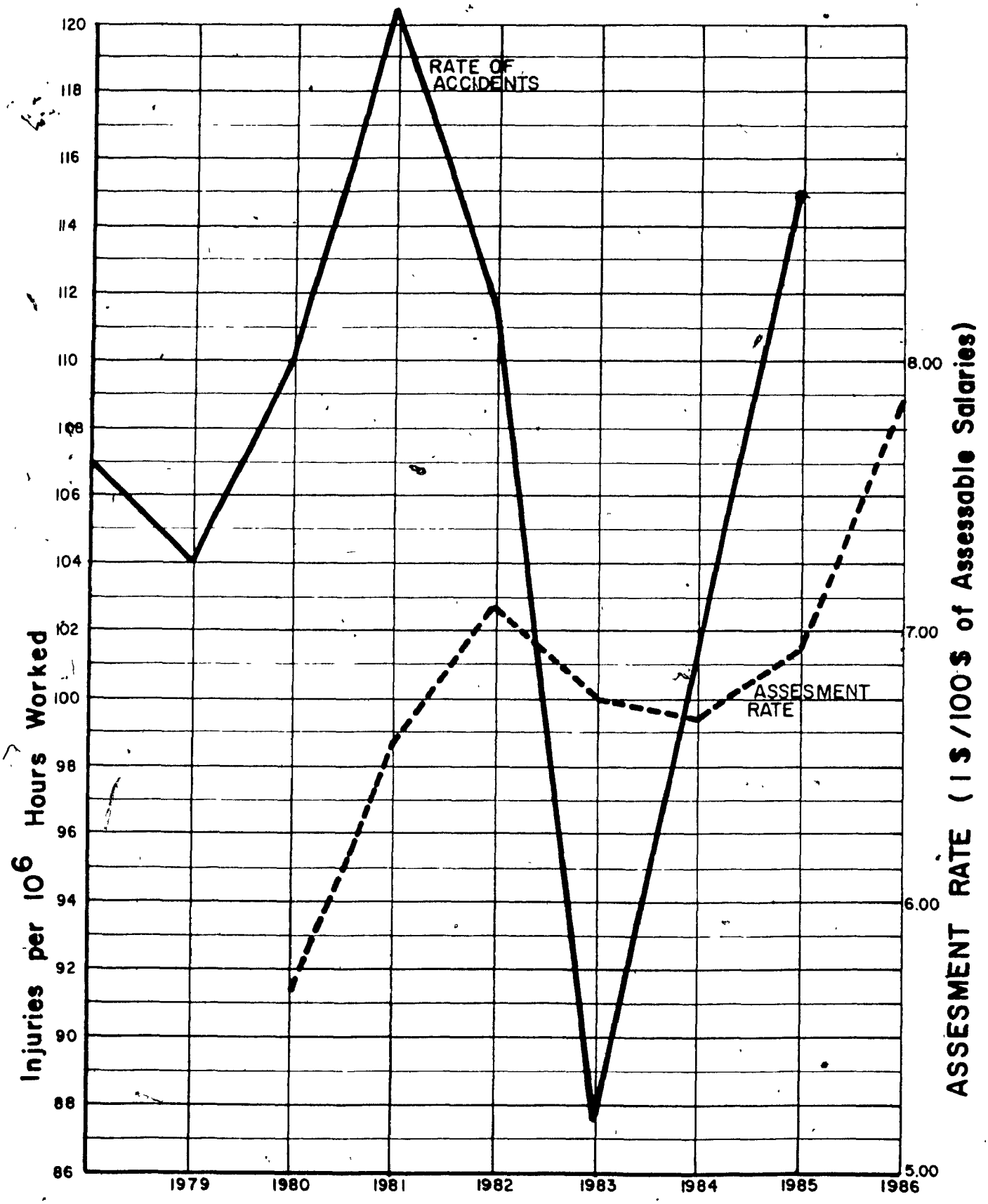


FIG. 5.9 - Injury and Assesment Rates (1980-1985)
B. and P.W. Sector

It was observed in the survey (Table 5.15) that, although 88% of the respondents saw their assessment rate increase, only 41% had seen their accident rate actually increase. To check the validity of these responses, a graph of the average assessment rate for the building and public work sector has been plotted in Figure 5.9 to examine the trend of the assessment rate and whether or not it follows that of the injury rate. It can be observed that, even though the assessment rate follows the general trend of the injury rate, the 1986 average rate per 100$ of assessable salaries stands at 7,84 $ versus 5,64 $ in 1980 (in current dollars). Incidentally, the building and public work sector rate is more than three times that of the average rate for all sectors [25].

The perceptions of the contractors on the relationship of injury and assessment rate appear at first to be well founded, especially when the percentage variations from one year to the next are compared for both the accident rate and the assessment rates, as illustrated in Table 5.18

TABLE 5.18 - YEARLY VARIATIONS IN THE ACCIDENT AND ASSESSMENT RATES

YEAR	ACCIDENT RATE VARIATION (%)	ASSESSMENT RATE VARIATION (%)
1984-1985	+14,0	+ 3,3
1983-1984	+15,3	- 0,6
1982-1983	-21,3	- 5,3
1981-1982	- 7,4	+ 7,9
1980-1981	+10,1	+16,3
1979-1980	+ 5,3	n/a

Note: 1. n/a : Not available
2. Sources: Accident rates - Table 5.17
Assessment rates - Reference [25]

As can be seen from Table 5.18, the mean annual variation of accident rates is +2,6% and the mean annual variation in assessment rates is +4,3%. But, one must take into consideration an economic situation where the mean inflation rate during the same period has been 8,7% [7]!

However, the reason that made the contractors feel that they are paying more than their share of assessments is probably due to the fact that, for the years 1980 to 1984, the B. and P.W. sector paid about 15% of the total assessments collected by the CSST, while having sustained only 7% of all occupational injuries [25].

5.3.2 Estimated Cost of Accidents

In this section, an estimate of the cost of accidents in the building and public works sector is made. The costs illustrated are estimates rather than accounted costs. They are intended for comparison with prevention/inspection costs calculated in Section 5.2.

The total cost of accidents is made up of two components:

1. Direct costs - they are those assumed by CSST and represent the cost of the compensation program. It is a portion of the assessments paid by the employers; and

2. Indirect costs - often called the hidden costs. These are costs incurred by employers but are non insured and not readily identifiable when accidents happen.

5.3.2.1 Direct Costs

The direct cbsts, as mentioned previously, are the insured costs, i.e. covering the compensation of injured workers and the administrative costs of such a compensation program. Table 5.12 showed the annual costs of the compensation program, to which a direct proportion of administrative expenses had been added to obtain a more realistic estimate. However, the B. and P.W. sector compensation costs are not readily available. To determine the portion of the compensation program invested for the B. and P.W. sector by the CSST, the proportion of compensable injuries (temporary, permanent and death benefits) in the B. and P.W. sector to the total number of claim files opened per year for accidents involving work stoppages, occupational diseases and deaths will be used. The comparison is displayed in Table 5.19. It should be noted that contrary to the expected results used for the CSST study referred to earlier [8] in Section 5.3.1, the number of injuries in the B. and P.W. sector for 1985 did not actually increase as estimated but stayed relatively the same as for 1984.

TABLE 5.19 - PERCENTAGE OF COMPENSABLE INJURIES - BUILDING AND PUBLIC WORKS SECTOR

YEAR	(1) COMPENSABLE INJURIES (B. & P.W.)	(2) TOTAL CLAIM FILES (ALL SECTORS)	(3) % ((1)/(2) X 100)
1986	14 098	208 486	6,76
1985	12 287	196 700	6,25
1984	12 494	179 239	6,97
1983	10 480	166 476	6,29
1982	11 208	169 666	6,61
1981	14 043	201 980	6,95

Source: 1. Rapport d'analyse sur l'évolution des lésions professionnelles en Bâtiment et Travaux Publics- Février 1986 [8].

2. CSST Annual Reports.

3. Statistiques sur les lésions professionnelles [78].

4. For 1985, CSST verbal information dated July 17, 1987, from the Technical Development Service.

Having established the proportion of the compensation program associated with the B. and P.W. sector in Table 5.19, the costs of accidents for that sector were calculated using the total CSST compensation costs as basis of calculations. The results are presented in Table 5.20:

TABLE 5.20 - DIRECT ACCIDENT COSTS - BUILDING AND PUBLIC WORKS SECTOR

YEAR	TOTAL COMPENSATION COSTS (X 10^3\$)	ESTIMATED B. & P.W. COMPENSATION COSTS (X 10^3\$)	ACTUAL CSST COMMITMENTS (X 10^3\$) (1)
1986	1 384 657	93 603	n/a
1985	1 239 879	77 492	n/a
1984	1 018 147	70 964	57 575
1983	925 325	58 202	62 412
1982	911 290	60 236	n/a
1981	841 966	58 516	n/a

Notes: 1. - As obtained from the CSST statistics Section
n/a - Not available.

The sum of the estimated costs for the years 1983 and 1984 compared favourably with the commitments for the same years obtained from the CSST's Statistical Section in January 1987. Commitments are the authorized expenditures for medical assistance, compensation for lost-time, and the capitalized value for pensions due to permanent disability and death. It takes about three years for commitments to mature to 99%. It is important to note that the commitment figures shown in Table 5.20 do not include a portion of the administrative cost of the CSST unlike the estimate B. and P.W. compensation costs. In the latter case the added administration costs represent approximately 12% of the estimated compensation costs. It can be seen from Table 5.20 that the estimated compensation costs calculated in this section are reasonably valid, being relatively close to those actually committed by the CSST.

5.3.2.2 Indirect Accident Costs

The hidden, i.e. non-insured costs of accidents are those that are borne directly by the employer and cannot be recuperated (except maybe insured damage costs). A report by Levitt et al. [58] from Stanford listed these items of costs as being hidden:

1) Wages paid to other workers for time not worked;
2) Costs of overtime necessitated by the accident;
3) Cost of loss of efficiency;
4) Cost to break-in or teach a replacement worker;
5) Extra wage costs to rehabilitate the returning worker at a reduced capacity;
6) Costs to clean up, repair or replace damage from the accident;
7) Cost to reschedule work;
8) Costs of wages for supervision associated with the accident; and
9) Costs for safety and clerical personnel to record and investigate the accident.

As mentioned in Chapter II, a number of studies have been performed to measure the indirect cost of accidents as a multiplier of the direct costs. Heinrich, Wallach, Findley and Manga have found multiplying factors of 4, 2 to 6, 4 to 10 and 2 to 10 respectively [38,100,31,61]. Later Le Net [53] gave a multiplier of 4 which was the figure used in the 1978 Québec White Paper on Occupational Health and Safety [80].

More recently, the Stanford study mentioned [58] has been used for the Business Roundtable Report [11] to give a multiplier varying between 1,1 and 4 which was "<u>believed to be conservatively low</u>", and could go as high as 17. The same report mentions that the multiplier is affected by many variables which include:

"- The type of project,
- The diligence of the investigation,
- The severity of the accident,
- How critical the affected project is to the construction contractor's clients' activities, and more."

Thus, it can be assume that an average multiplier of 4 should provide a fairly good estimate of the indirect costs as derived from the direct costs of accidents. Furthermore, since this same multiplier was used for the Québec White Paper and the Business Roundtable Report, it can be used for the industry at large.

Having determined the two elements of accident costs (direct and indirect), the total cost was calculated by simply adding them. The results are presented in Table 5.21 for the building and public works sector in the province of Québec over a period of 6 years (from 1981 to 1986).

TABLE 5.21 - TOTAL COSTS OF ACCIDENTS FOR THE QUEBEC BUILDING AND PUBLIC WORKS SECTOR

YEAR	(1) DIRECT COST (X 10^3\$)	(2) INDIRECT COSTS (X 10^3\$) [(1) X 4]	(3) TOTAL COSTS (X 10^3\$)
1986	93 603	374 412	468 015
1985	77 492	309 968	387 460
1984	70 964	283 856	354 820
1983	58 202	232 808	291 010
1982	60 236	240 944	301 180
1981	58 516	124 064	292 580

Source: (1) - Table 5.20

5.4 COMPARISON OF PREVENTION AND ACCIDENT COSTS

In Section 5.2, estimated prevention costs were found to be made of two main components: non-insured costs and the insured or CSST costs. In Section 5.3, both components of estimated accident costs were considered. Figure 5.10 shows the costs matrix discussed earlier in section 5.1 and to which the different cost components have been allotted. As can be seen, accident and safety represent a 600 million dollars business in Québec or 5% of the annual construction volume in the province.

	PREVENTION COSTS	ACCIDENTS COSTS	TOTALS
CSST PROGRAMS COSTS	INSURED 18,0	DIRECT 93,6	111,6
EMPLOYERS' COST	NON-INSURED 133,3	INDIRECT 374,4	507,7
TOTALS	151,3	468,0	619,3

FIG. 5.10 - Québec Construction Safety and Accidents Costs for 1986 (in 10^6\$)

Table 5.22 summarizes the results and illustrates the comparison between prevention and accident costs from 1981 to 1986 together with some illustrative ratios. As can be seen, accidents cost the construction industry in Québec almost three times the amount invested in prevention.

TABLE 5.22 - COMPARISON OF PREVENTION AND ACCIDENT COSTS

YEAR	ANNUAL CONSTRUCTION VOLUME (10^6\$)	PREVENTION COSTS (X 10^6\$)	ACCIDENT COSTS (X 10^6\$)	RATIO ACCIDENT / PREVENT. COSTS	RATIO PREVENT.\$ / CONST.VOL. (%)	RATIO ACCIDENT\$ / CONST.VOL. (%)
1986	13 068	152	468	3.1	1,2	3,6
1985	12 585	147	387	2,5	1,2	3,1
1984	11 780	138	355	2,6	1,2	3,0
1983	10 993	124	291	2,3	1,1	2,6
1982	10 219	114	301	2,6	1,1	2,9
1981	10 308	111	293	2,6	1,1	2,8

The results presented in Table 5.22 can now provide an answer to the question posed earlier in the introduction to this chapter. Furthermore, the Business Roundtable Report [11] indicated as a realistic achievable goal a 30% reduction in accident costs by the construction industry in the U.S. If this goal is to be applied to Québec, it would mean tremendous savings for the construction industry: 150 million dollars would be spared by the purchasers of construction services in Québec.

More than likely, this 150 M\$ would be invested in supplementary construction work which would benefit all members of the industry. This is not counting the priceless humanitarian and social gains that could be achieved from a lower injury rate.

5.5 IMPACT OF PRODUCTIVITY

Productivity can generally be defined as the ratio of output over input. All contractors want to maximize that ratio by minimizing the input as the output is normally a well defined product to be delivered to a client. The input is made up of a number of resources such as men, material, machinery and money [87].

To evaluate the contractors perception to the impact of Bill 17 on their productivity they were requested, as part of the survey (Appendix A), to estimate the impact of the Act (positive or negative) on the productivity in their firm. The answers are summarized and tabulated below.

TABLE 5.23 - CONTRACTORS' PERCEPTION OF THE IMPACT OF BILL 17 ON PRODUCTIVITY (Answers as percentages)

	INCREASE	DECREASE	NOT EVALUATED
Impact of Bill 17 on productivity in your firm.	4	29	67

Only one respondent (out of 24) showed positive impact, estimate at + 5%. In fact, the same respondent also gave a 20% decrease in this accident rate. However, only one answer cannot indicate a trend.

Of the seven respondents that indicated a decrease in productivity, four gave estimates that varied between 7,5% and 25% with an arithmetic mean of 15%. That figure would appear to be high when compared to the weighted average increase in project cost of 1,02% described earlier in Section 5.2. As a 15% decrease in productivity (assumed to be in labour content) would increase the labour costs by 15% and as the latter represents approximately 35% of total project costs, it can be concluded that a 5,2% increase in total project costs could be expected

Since 67% of the respondents declared that the impact of productivity has not been evaluated, productivity loss can only be estimated indirectly utilizing the data indicating a decrease in productivity and that indicating the increase in project cost due to Bill 17. The direct quantitative impact still need to be evaluated.

CHAPTER VI

CASE STUDY

6.1 GENERAL

To find out how the requirements of the Act Respecting Occupational Health and Safety (Bill 17) affect the planning, organization and costs of a project, an on-going project was studied. All the major safety planning steps and costs elements will be described and parallels will be made with the material developed so far in this thesis.

6.2 PROJECT DESCRIPTION

The project constitutes the construction of a chemical plant in the province of Québec with an estimated total cost of 45 million dollars including a labour content around 325 000 man-hours and manpower peak at around 300 workers. Construction started in June 1986 and was completed in November 1987, a period of 18 months.

The owner had a construction management (CM) contract with a consultant to completely oversee the construction and manage the job site. There is no full time owner's representative on the site which is 175 km away from the owner's head office.

The CM scope of services included the following responsibilities:

- Planning the job sites;
- Scheduling of construction and procurement;
- Coordination of engineering services;
- Administration of all contracts as owner's representative;
- Preparation and negotiation of all changes;
- Occupational health and safety;
- Surveillance of construction;
- Site procurement services;
- Quality control; and
- Site security and site management in general.

6.3 SAFETY PLANNING

Contractually, the consultant was to fill the role of principal contractor (based on Bill 17 requirements for such a site). In that capacity, the consultant had to initiate the Notice of Opening of a Construction Site to the CSST, prepare and administer the prevention program, and also provide for a safety officer on the site.

Many meetings were held with CSST representatives before and after the program presentation for approval. The major point of discussion was the principal contractor definition and whether or not the consultant met the criteria to fill that role. These discussions lasted for about 2 months before a final decision was reached.

Based on the fact that the contracts are signed between the owner and a number of prime contractors, and notwithstanding the fact that the consultant was the owner's representative, the contractors' role interlocutor on site and wholly responsible for site management, the CSST decided that the owner had to be the principal contractor (Report No. I00945, dated May 23, 1986). As such, the consultant maintained his contractual responsibilities as CM towards the owner but, to the CSST, was only the owner's representative.

As part of the planning for the project, the following activities have been integrated;

- Safety clauses to be included in the specific conditions of the contracts. These clauses reinforced and related articles of the Act and the Code, and added further incentives for the contractors to act according to the program. For example, a 500$ fine could be applied for each absence from the site safety committee. An abstract from the specific clauses covering work safety is included in Appendix E;

- The hiring of a full-time nurse along with the installation of a nursing station and related equipment;

- Occupationnal health and safety equipment such as:
  - sanitary facilities,

- fire protection equipment,
- warning devices due to the proximity of another chemical plant,
- safety signs, and
- safety documentation;

- Introductory safety meetings;
- Organization of the site safety committee;
- Working methods such as coordination of steel erection and ground level work, safe use of toxic cleaning material, protection from welding operations, etc; and
- Designing and printing of the different safety formularies;

This planning was conducted in the sequence described in the developed safety planning guide shown in Appendix B.

6.4 SAFETY COSTS

All the activities that had to be completed or planned for the project bear a cost. In this section, actual costs incurred and/or estimated will indicate how much money was invested in safety and how it is broken down. Only the non-insured costs, as defined previously in section 5.2.1, will be shown, regardless if they are paid directly by the owner or indirectly through the contractors as the total project costs are borne by the owner in all cases:

1.	Program preparation: a) Specialist: 65 hres @ 50.$ b) Meetings with the CSST: 3 meetings x 3 pers. x 4 hres @ 50.$ c) Program typing & printing: 50 p. x 75 copies @ 0,05 + 10 hres @ 25.$	5 500.$
2.	Safety officer: 18 months @ 8 500.$	153 000.$
3.	Nurse: 14 months @ 4 000.$	56 000.$
4.	FA Post and equipment: - trailer: 18 months @ 700.$ - equipment & supplies: 15 000.$	27 600.$
5.	Introductory safety meetings: (Assuming 2:1 turnover frequently experienced) 150 employees x 2 x 0,5 hres @ 30.$	4 500.$
6.	Safety committee meetings: (Assume an average of 12 persons during the job at every 2 weeks less holidays) 33 meetings x 12 x 1 hr @ 30.$	11 900.$
7.	Tool box meetings: (15 min/week - for all employees) 150 emp. x (18-1.5) months x 4,3 weeks/month x 0,25 @ 30.$/hr	79 800.$
8.	Individual safety equipment: (hats, gloves, rain suits, belts, glasses, etc. for all personnel on site) 600 employees @ 25.$ (estimate)	15 000.$
9.	Safety equipment & documentation: (safety codes, signs, sirens, toxic vapor tester, etc.)	5 000.$
10.	Temporary construction such as guard-rails, fences, markers, safety belt hook-ups, etc.: Contract Manpower: 1 300 hrs @ 30.$: 39 000.$ Material : (estimated) : 27 000.$	66 000.$
11.	Site clean-up: (½ labourer for 16 months + containers: 1 400 hres x 30.$ + 10 000.$)	52 000.$
	TOTAL:	476 300.$

476 300.$ for a 45 M$ project represents 1.06% of the project cost for safety. This percentage is quite in line with the estimated cost predicted from the multiplicative model developed in Chapter 5.

For a 45 M$ project (P) the model yields a percentage (C) of 0,95% of project costs for complying with Bill 17 or 427 500.$. This represents 10% less than the actual cost and in the range of error of ± 10% normally accepted for a detailed estimate.

In must also be taken into account that the costs for prevention indicated are those that were clearly identified and known. There are certainly other costs that could be accounted for but they would require a level of effort not consistant with the degree of accuracy obtained.

6.5 PROJECT SAFETY CONTROL

There are different tools that can be used to control safety on a job site. In the present project, the tools used were the following:

1. Monthly statistics;
2. Job-site meetings; and
3. CSST inspection reports.

The effectiveness of the monthly safety statistics has been well demonstrated by Laufer and Ledbetter [52] as a safety performance measure whilst the other two are more regulatory measures. The monthly safety statistical report used in this project relates the hours worked by all entities on the site with the numbers of first-aid, medical assistance and lost-days cases during the month and on a cumulative basis. Pertinent parts of such a report are shown in Appendix F along with the related curves. This report formed an integral part of the monthly project report. The injuries are cumulated from the nurse's record that have to be maintained and presented to the CSST.

In accordance with Section 2.5 of the Safety Code, "Organization of safety", the site committee, composed of about 20 people at peak period, met every two weeks to specifically:

- Review the accidents that happened during the preceeding period and their causes;
- Study and recommend specific prevention measures; and
- Review the CSST intervention reports if any had been made.

It will also discuss any other subjects related to hygiene and safety on the site. Minutes are kept and circulated.

Another important control tool was the visit made weekly by the CSST inspector. His verbal remarks and intervention reports when made were

taken seriously and immediate actions taken to follow suit.

A sample of CSST intervention report is shown in Appendix K. These reports are to be discussed at Safety committees. When none are established, the Report must be posted for all workers to see.

Overall, the safety organization on this project was an integral part of all activities and the job was planned accordingly. For exemple, when steel was being erected, other trades working below or too close were shifted to another location, pipe cleaning with toxic products was only carried out after regular working hours, etc.

The regional CSST inspection services regularly cited the project as a model to be followed.

CHAPTER VII

SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The number of people employed in the construction industry in Canada and Québec represent 4% of either work force but they account respectively for 8% and 7% of the total injuries with time-off work. The literature survey indicates that a number of studies have been conducted in the U.S. on work safety in the construction industry covering the aspects of construction management and costs. The Québec scene has experienced numerous studies dealing with the pathological and statistical aspects of work accidents, but very little has been done on the related financial and management elements.

Legislation in the field was first adpoted in 1885, with continued improvement until 1979 when Bill 17 was introduced. It was the first part of a major reform of the Québec occupational health and safety regime, which has been completed in 1985 with Bill 42 updating the old Workmen's Compensation Act of 1931. Bill 17 also created the "Commission de la Santé et Sécurité du Travail" (CSST). The construction industry has seen its unique characteristics well covered by both Acts.

Project planning and control and site organization must now integrate safety with schedule, cost and quality, to ensure successful project completion. The definition of the principal contractor is an important aspect to be identified at project's start. The CSST now rarely accepts a construction manager to be the principal contractor. It has to be either the owner or the general contractor in a turnkey contract. A safety planning guide has been developed as a tool for project planners.

A province wide survey has been carried out and yielded valuable results on the impacts of the safety acts on the construction industry. It indicates that the legislation is not clear enough, is a burden to apply by contractors and has not yet produced the expected results of reducing the injury rate. Changes in the acts should be made to render them more acceptable in their application while not modifying their primary objectives.

A statistical analysis showed a definite relation between projects cost and the cost of complying with the safety acts. As the project cost increases, the % of compliance decreases substantially. A mathematical model was developed to relate compliance costs to project costs.

Prevention and accident costs along with injury rates were examined in depth. The prevention costs consists of insured and non-insured costs. The non-insured costs are more substantial as they were estimated to be

seven times the CSST costs allocated to prevention/inspection in the building and public works sector in 1985. A large majority of contractors indicated in the survey that their workmen's compensation assessments increased whilst their accident rate either decreased or stayed the same. The direct or insured costs of accidents were estimated along with their indirect costs. Based on an industry accepted practice, indirect costs were calculated as four times the direct costs.

When comparing the calculated total costs of accidents with the amount of money invested in prevention, accident costs were found to be over three times as much as that of prevention (468 x 10^6\$ versus 152 x 10^6\$ in 1986 for example).

A case study of an on-going construction project in the province of Québec showed that the safety planning guide developed in this thesis can usefully be applied in practice. An analysis of the project cost elements related to safety yielded results well in accordance with these predicted from the mathematical model developed in the present study. Predicted costs of safety in compliance with the Act using the developed model are 0,95% of the total project costs while the estimated actual expenditures are 1,06%.

7.2 CONCLUSIONS

The following conclusions can be drawn:

1. Whilst many studies were done on the cost of complying with OSHA in the U.S., no comprehensive study has been done for the Québec construction industry;

2. The law is not clear and should be modified. A large majority of contractors feel that it heavily favors the worker;

3. Safety and health considerations must be taken into account at the design and planning stages of a project and should be given the same importance as schedule, cost and quality;

4. The notions of principal contractors ("maître d'oeuvre") and site definition are vital aspects to be clarified by the owner, together, if necessary, with the CSST in the project definition phase.

5. Employers are well aware of the importance of the Act and the role of the CSST. They can cope with them both but resent this intrusion in their management rights, particularly when they feel that the Act has not reduced the accident rate whilst the CSST budget keeps on growing.

6. The non-insured costs of prevention in the Province of Québec represent a weighted average of 1,02% for the construction industry as calculated from the survey sample. The percentage of compliance costs can be estimated by the multiplicative (or power) model developed.

7. The percentage of compliance costs drops rapidly from about 10% to 2% for projects in the 0,5 - 10 million dollar range of project costs. The decrease rate for higher project costs is much smaller, the percentage being 0,5% at the 150 million dollar mark of project cost. These results are in good agreement with those obtained from similar studies in the U.S.

8. For the year 1981 to 1986, the total of the direct and indirect costs of accident is almost three times the amount invested in prevention (insured and non-insured costs).

9. The survey results related to the impact of Bill 17 on productivity are not conclusive, but seem to indicate a negative trend.

7.3 RECOMMENDATIONS AND FURTHER RESEARCH

Based on the research conducted and the material compiled in this thesis the following recommendations can be made:

1. Construction engineering and management programs given at the various educational institutes, including the Centre for Building Studies, need to integrate the subject of occupational health and safety in the curriculum.

2. The Occupational Health and Safety Research Institute (IRSST) should give more importance to the development and management aspect of safety programmes.

3. Statistical data related to the construction industry need to be compiled by the CSST and made easily accessible. Efforts should be made to separate the work performed by contractors and that by other construction agencies.

4. Further detailed and comprehensive research is needed to substantiate the mathematical relationship derived in this thesis and to integrate and quantify more factors that could affect the cost aspects for quality safety. Areas to be investigated could include:

- Validity of the model initiated in the present thesis;

- Models for the whole province and for sectors other than B. and P.W.;

- Impact of safety on productivity; and

- Development of expert systems for all aspects of safety management including costs.

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APPENDICES

APPENDIX A

SURVEY QUESTIONNAIRE

SURVEY ON THE QUEBEC OCCUPATIONAL HEALTH AND SAFETY ACT

(BILL 17)

	YES	NO	UNSURE
1. EVALUATION OF PRESENT LAW			
a. Do you feel that the text of the law as applied to the construction industry is clear and simple?	_____	_____	_____
b. Do you feel that the regulations benefit:			
1) The general public	_____	_____	_____
2) The contractor	_____	_____	_____
3) The construction worker	_____	_____	_____
4) Others (please explain)	_____	_____	_____
c. Do you feel that the requirements of the Act (Bill 17) apply to the type of work with which your company is involved?	_____	_____	_____
d. Should Bill 17 be modified? If the answer is yes, please explain in the comment section below how it may be improved	_____	_____	_____
e. Do you feel that Bill 17 has reduced the number and severity of construction accidents on your projects?	_____	_____	_____

2. IMPLEMENTATION AND ENFORCEMENT OF THE LAW

	Very smooth	Satisfactory	Annoying	Counter productive	No comment
a. What is the effect on your firm since the implementation of Bill 17 in 1982	_____	_____	_____	_____	_____
b. How do you see the enforcement of the law by the CSST? If you see it as "counter productive" please specify in what way or where in the comment section below	_____	_____	_____	_____	_____

	Yes	No	Unsure
c. Do good general construction practices usually satisfy the requirements of the law?	_____	_____	_____
d. Did Bill 17 change the manner in which the projects had to be organized and staffed?	_____	_____	_____
e. Do you have a specific group to look after prevention matters and implying with Bill 17?	_____	_____	_____

3. THE COST OF THE LAW

	% increase	% decrease
a. Since the law is in effect what has been its impact on (please state a percentage):		
1. Work accident insurance premium	_____	_____
2. Rate of accident/year	_____	_____
3. General liability insurance	_____	_____

	% increase in productivity	% decrease in productivity	not assessed
b. Can you estimate the impact of the Act (positive or negative) on productivity in your firm	_____	_____	_____

c. Has Bill 17 increase the cost of construction with which your Company is involved	Hardly at all	_____
	Quite a bit	_____
	Substantially	_____
	Not evaluated	_____

d. Please list the total project (or construction) cost and the approximate cost of complying with Bill 17 on work with which your company is involved

	Approximate Total project Cost	Approximate Cost of complying with Bill 17
Buildings (Residential & Commercial)	_____	_____
Heavy civil works	_____	_____
Highway	_____	_____
Industrial	_____	_____
Others (specify)	_____	_____

4. YOUR COMPANY

a. Main classification of work

Buildings (Residential & Commercial)	_____
Heavy civil works	_____
Highway	_____
Industrial	_____
Others (specify)	_____

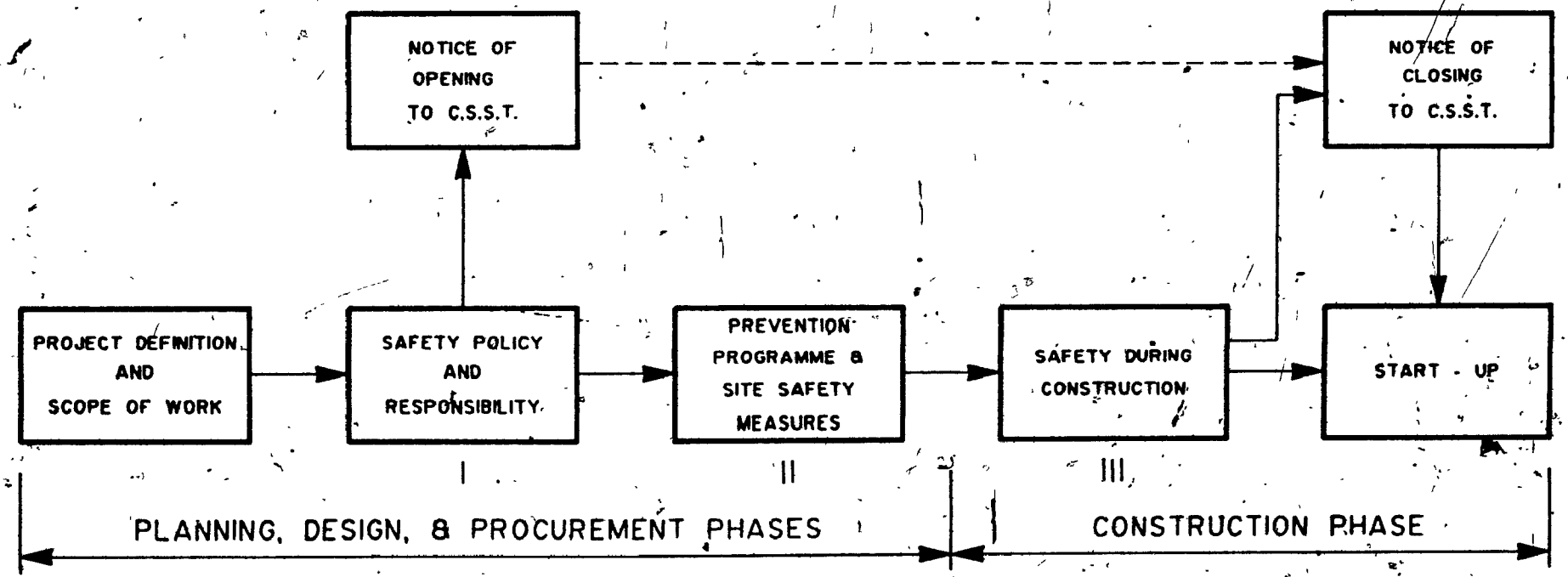
b. Approximate annual construction Cost (in Dollars) of projects with which your Company is involved?

$ _____

COMMENTS :

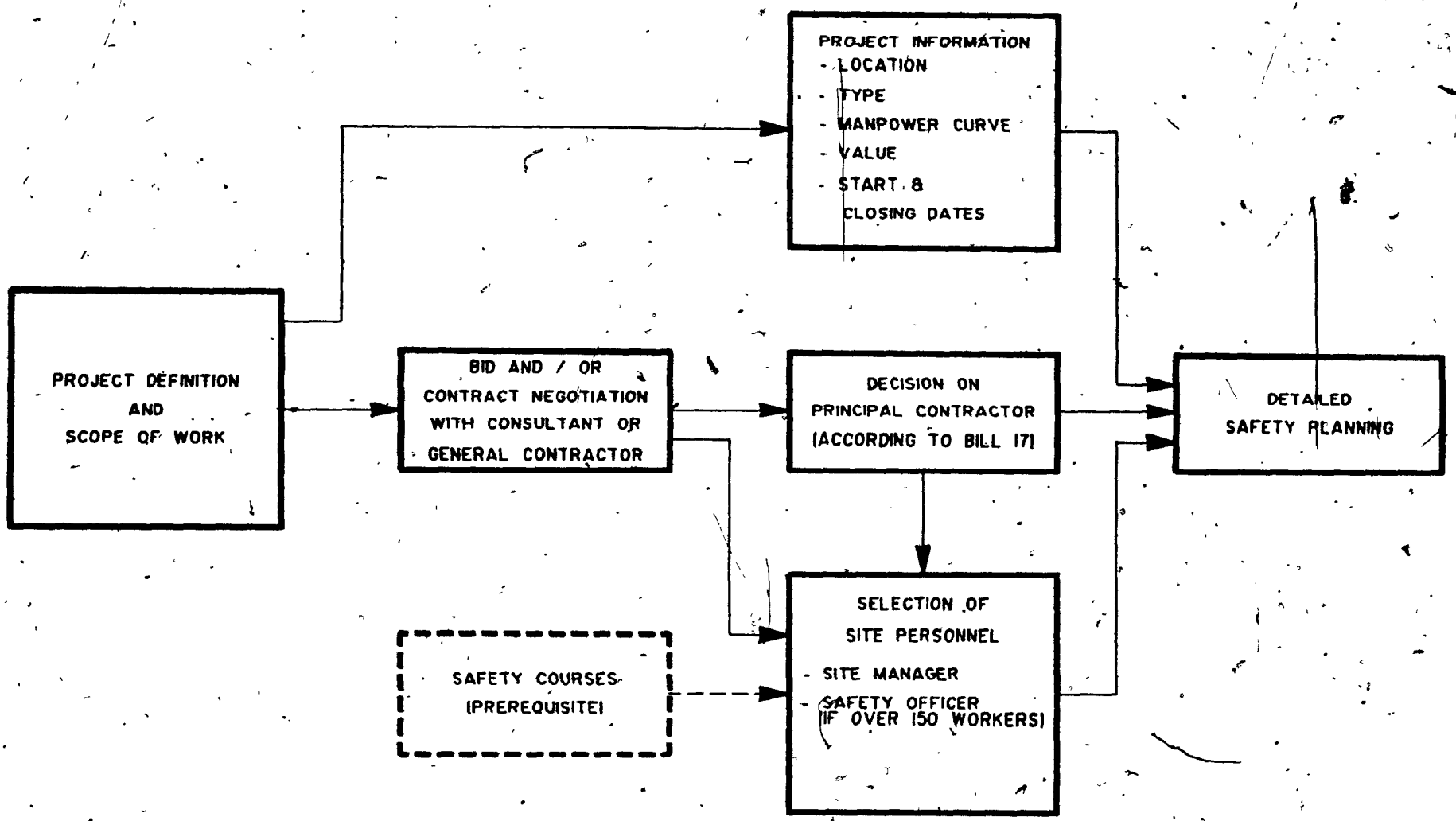
APPENDIX B

PROJECT PLANNING GUIDE FOR SAFETY



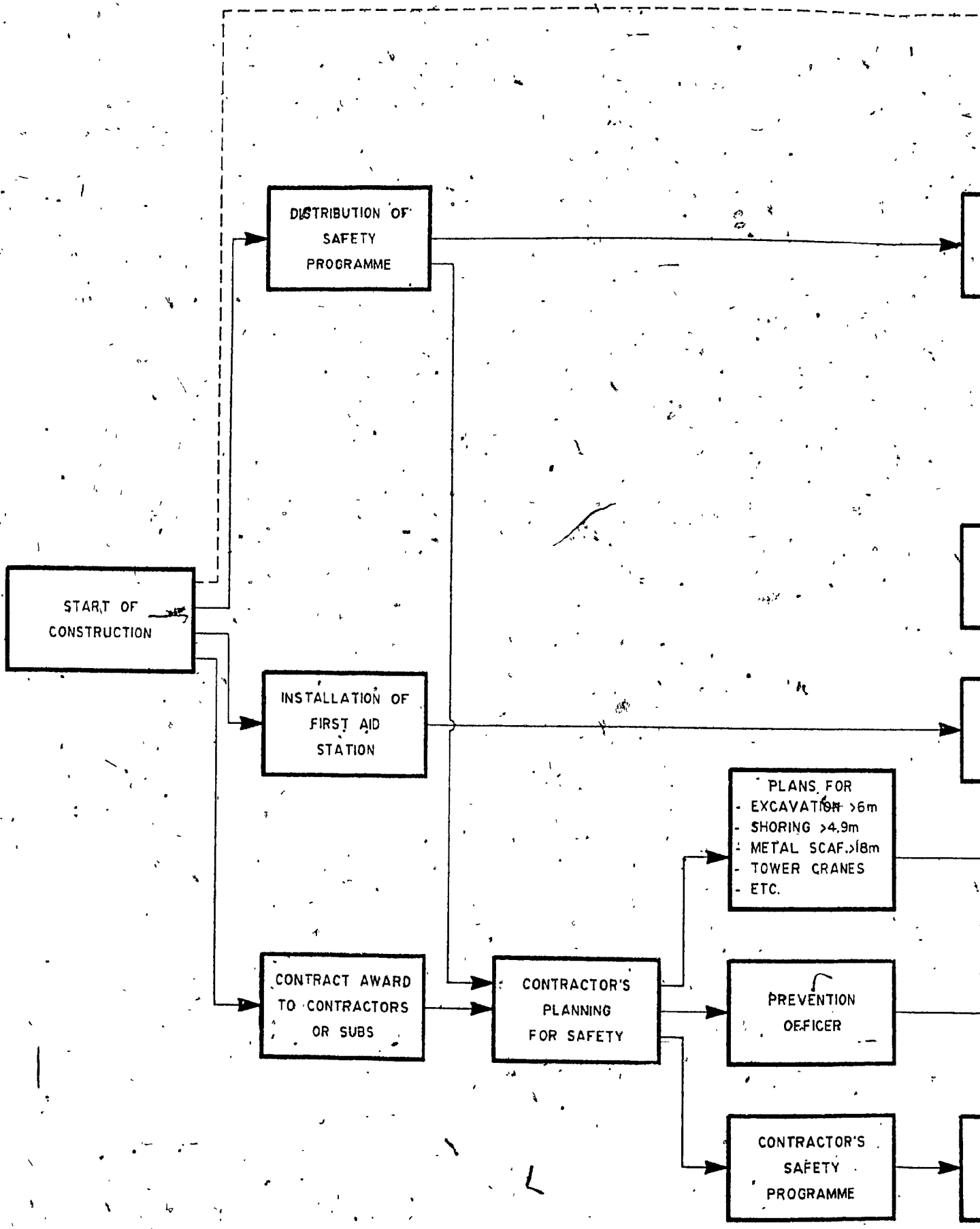
MASTER NETWORK

PROJECT PLANNING GUIDE FOR SAFETY

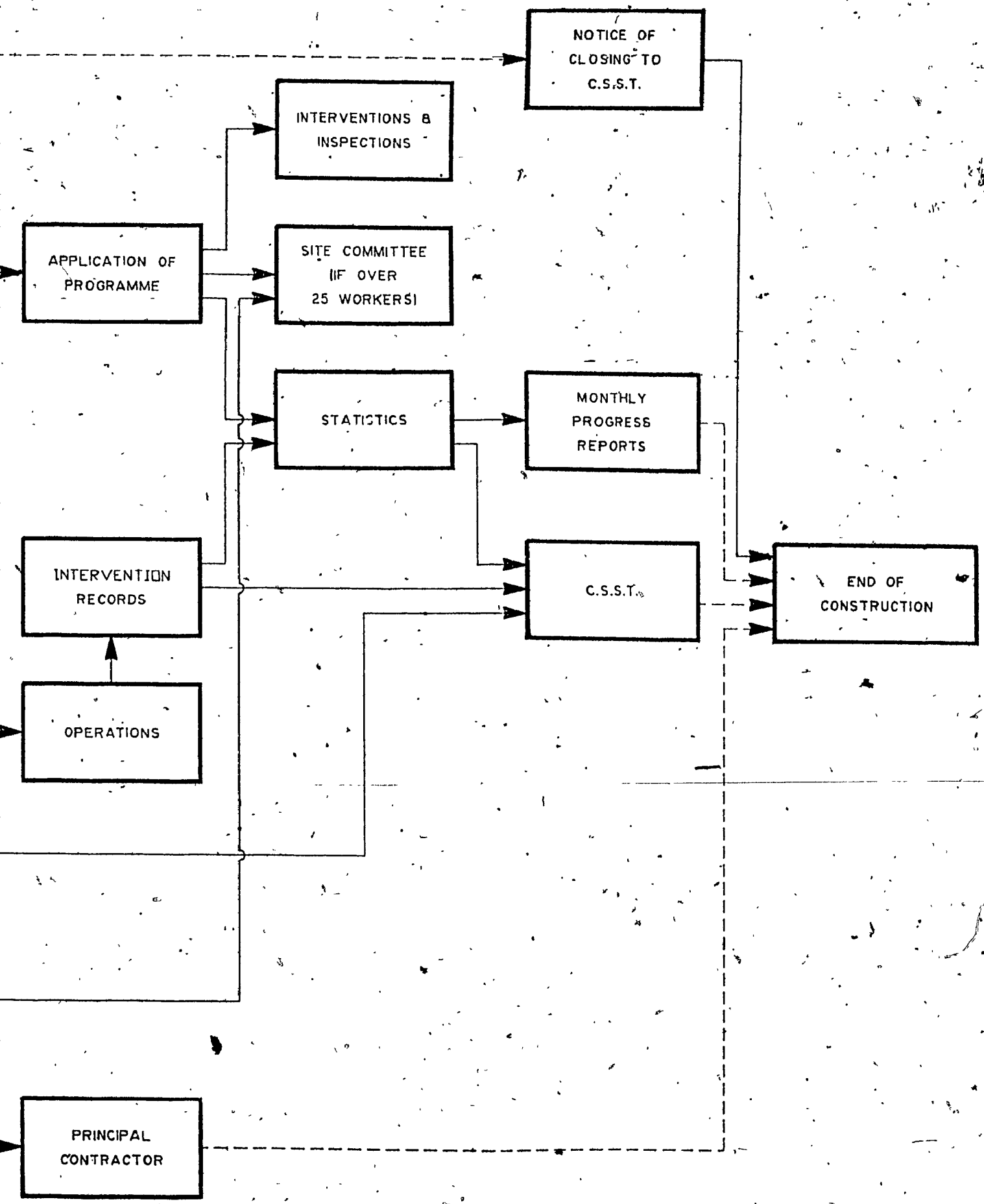


SUBNETWORK N° 1

SAFETY POLICY AND RESPONSIBILITY

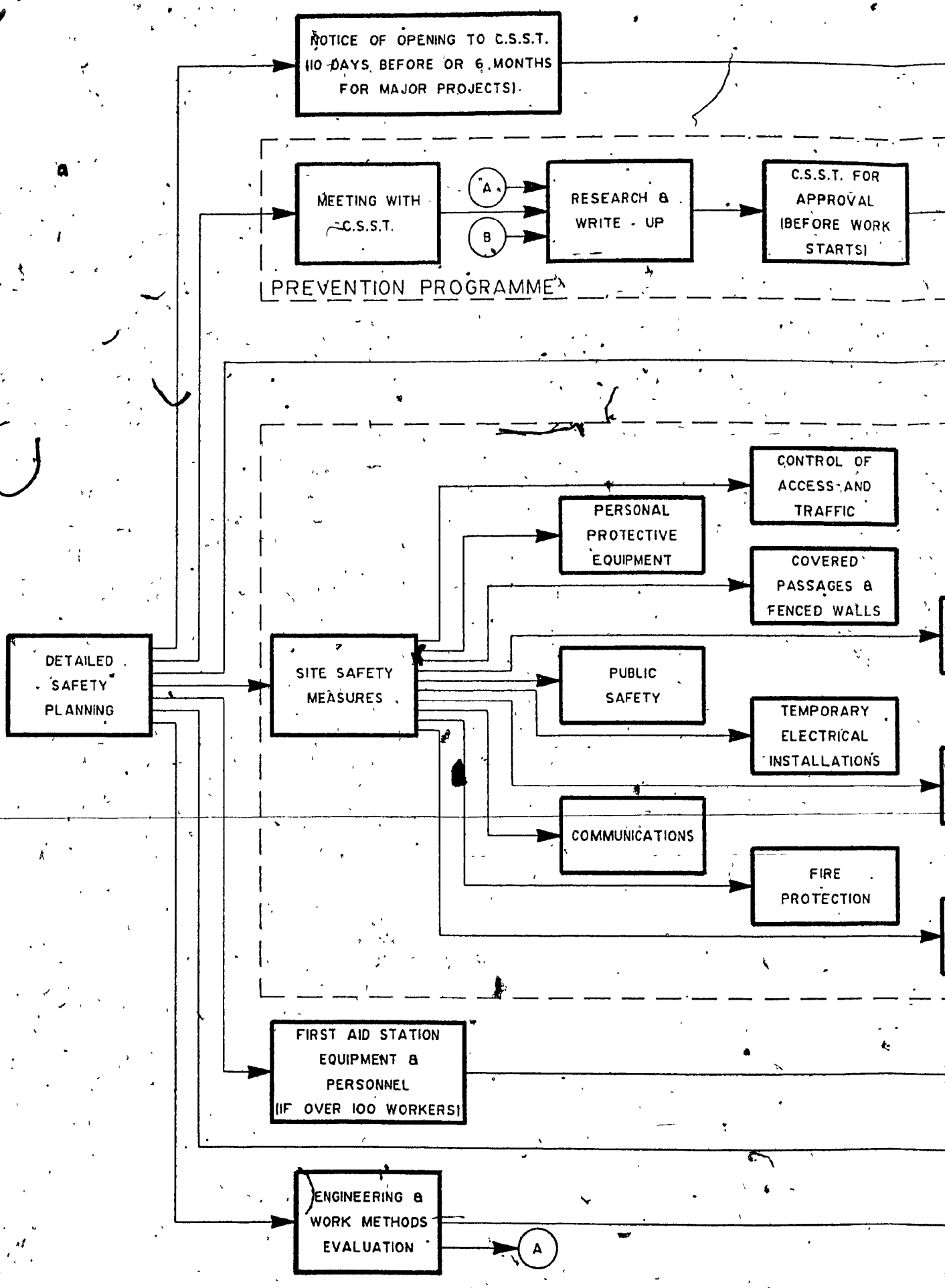


SUBNETWORK
SAFETY DURING CO

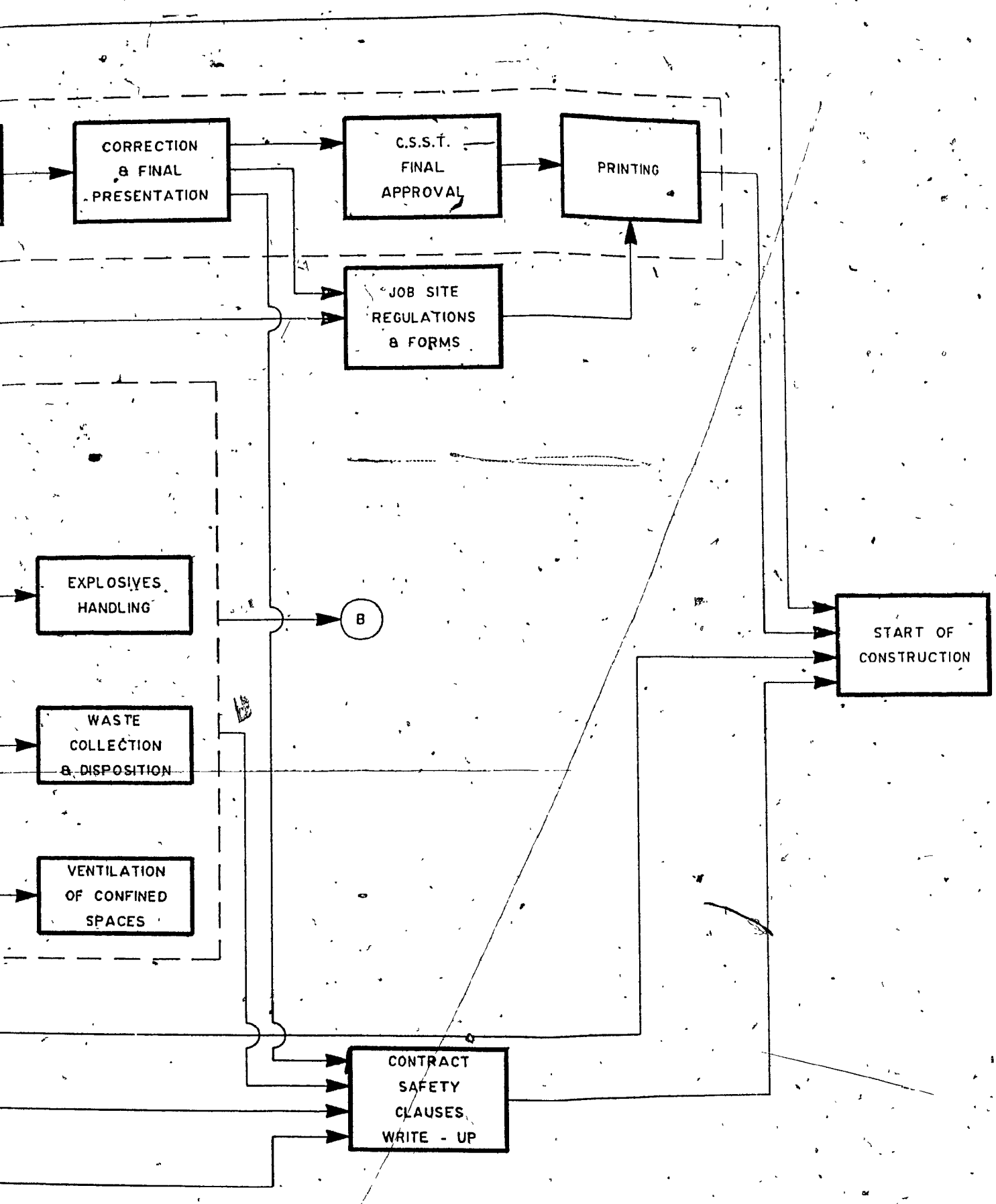


RK N° III

CONSTRUCTION


NOTICE OF OPENING TO C.S.S.T. (10 DAYS BEFORE OR 6 MONTHS FOR MAJOR PROJECTS)
MEETING WITH C.S.S.T.
A
B
RESEARCH & WRITE - UP
C.S.S.T. FOR APPROVAL (BEFORE WORK STARTS)
PREVENTION PROGRAMME
DETAILED SAFETY PLANNING
SITE SAFETY MEASURES
CONTROL OF ACCESS AND TRAFFIC
PERSONAL PROTECTIVE EQUIPMENT
COVERED PASSAGES & FENCED WALLS
PUBLIC SAFETY
TEMPORARY ELECTRICAL INSTALLATIONS
COMMUNICATIONS
FIRE PROTECTION
FIRST AID STATION EQUIPMENT & PERSONNEL (IF OVER 100 WORKERS)
ENGINEERING & WORK METHODS EVALUATION
A

DETAIL



SUBNETWORK II

AILED SAFETY PLANNING

APPENDIX C

PARTIAL LISTING OF OCCUPATIONAL HEALTH AND SAFETY REGULATIONS

APPENDIX C

PARTIAL LISTING OF OCCUPATION HEALTH AND SAFETY REGULATIONS

Regulations respecting:

The medical certificate of workmen (S-2.1, r.3);

Shipyards (S-2.1, r.4);

Ice cutting (S-2.1, r.5);

Industrial establishments (S-2.1, r.8);

Industrial and commercial establisments (S-2.1, r.9);

The shoring of concrete formwork (S-2.1, r.10); *

The handling and use of explosives (S-2.1, r.11); *

Mine rescue stations (S-2.1, r.13); *

The protection of compressed air workers (S-2.1, r.14);

The quality of the work environment (S-2.1, r.15);

The salubrity and safety of workmen in mines and quarries (S-2.1, r.19); *

Safety and health in foundry work (S-2.1, r.20);

Work carried out in the vicinity of electric power lines (S-2.1, r.21); *

Forestry operations (S-2.1, r.22);

The use of explosive actuated tools (S-2.1, r.23); *

Elevators, dumbwaiters, escalators and moving walks (S-3, r.1) *

Sanitary conditions in industrial or other camps (Q-2, r.3); *

Solid waste (Q-2, r.14);

Underground waters (M-13, r.3);

The application of the Public Health Protection Act (P-35, r.1);

Joint sector-based associations on occupational health and safety (S-2.1, r.1); *

Certificate for protective re-assignment of pregnant or nursing workers (S-2.1, r.2);

Prevention programmes (D.1282-82); *

Occupational health services (D.1281-82); *

Reviews related to inspections (D.147-83); *

Occupational health and safety committees (D.2025-83); *

Reviews related to inspections (D.147-83); *

Occupational health and safety committees (D.2025-83); *

The application of the Building Code (D.912-84) *

Skilled tradesmen (A-3, r.1); *

The Impairment Table (A-3,r.3); *

The computation of the weighted net income (A-3, r.4); *

The penalty for non-payment of an assessment (A-3, r.10); *

Reimbursement of damaged or destroyed clothing, prosthesis or orthesis (A-3, r.11); *

The assessment system based on merit (A-3, r.12); *

Joint assessment system based on merit (A-3, r.13); *

Joint sector-based construction association (D.209-84); *

First aid minimum standard (D.1922-84) *

Safety code for the construction industry (S-2.1, r.6); *

Health and safety - rubber and plastic products industry, chemical industry and refined petroleum products industries sector; and ★

Remuneration of review offices members. ★

Note: ★ Directly related or of special interest to the construction industry.

APPENDIX D

ROBINSON'S MATRIX FOR WORK ACCIDENT COST COMPUTATIONS

APPENDIX D

ROBINSON'S MATRIX FOR WORK ACCIDENT COST COMPUTATIONS

Numbers on the left side are for no-lost-time accidents; numbers to right are for lost-time accidents; NA - Not Applicable. All costs are in equivalent labor hours; to obtain a dollar value, multiply by job labour rate including fringe benefits; then round off totals.

Body Part \ Injury Type	Amputation	Strain Sprain Crush, Mash Smash	Facture	Cut Puncture Laceration	Burn	Bruise Abrasion	Other
Head, Face	NA	NA	50 600	20 220	25 550	20 75	25 450
Eye (s)	3 300 (1) 18 000 (2)	NA	NA	20 220	15 380	20 75	20 380
Neck and Shoulder	NA	25 520	110 600	20 220	25 380	20 150	20 520
Arm (s) and Elbow (s)	14 000 (1) 18 000 (2)	25 300	75 450	20 220	20 380	20 220	20 450
Wrist (s) and Hand	3 800 (1) 18 000 (2)	20 190	50 650	20 220	25 380	20 300	25 450
Thumb (s) and Finger (s)	600 ea.	20 190	25 380	20 220	15 380	15 220	15 380
Back	NA	150 750	NA 7400	20 220	25 550	25 380	25 750
Chest and Lower Trunk	NA	35 300	NA	20 600	25 380	20 220	20 680
Ribs	NA	25 75	35 300	NA	25 380	25 220	20 680
Hip	NA	25 75	35 900	15 220	25 380	25 380	35 300
Leg (s) and Knees	6 600 (1) 21 000 (2)	30 300	35 1100	20 220	25 380	20 220	20 600
Foots (feet) Ankle (s)	3 300 (1) 6 600 (2)	20 190	35 650	15 190	20 220	20 75	25 150
Toe (s)	520 ea. up to 3000	20 110	15 190	20 220	25 150	15 75	20 150
Hernia Rupture							15 600
Heart Attack							2200
Hearing Loss							750
Death							6000

Source: Robinson M.R., - Accident Cost Accounting as a Means of Improving Safety 1891

APPENDIX E

EXCERPTS OF CONTRACTS SPECIFIC CONDITIONS

COVERING SITE SAFETY

APPENDIX E

EXCERPTS OF CONTRACTS SPECIFIC CONDITIONS

COVERING SITE SAFETY

WORK SAFETY, OBLIGATIONS OF CONTRACTORS AND HIS SUB-CONTRACTORS (SUBS)

The Contractor and his sub(s) shall comply with the Act Respecting Occupational Health and Safety, its regulations, the Safety Code for the Construction Industry, all provisions of the Principal Contractor's safety programme, including any amendments to the said programme transmitted to the CSST and any measures derived from an annex to the said prevention programme.

In particular, the Contractor and all subs agree that the Consultant, acting as Principal Contractor's representative, shall present an introductory safety meeting to each worker on his first work day on the job site. The costs of this meeting is borne by the Contractor or his sub(s).

For the purpose of the present article, and in all cases, the Owner is the Principal Contractor as defined in article 1 of the Act Respecting Occupational Health and Safety. The Consultant is the Owner's and Principal Contractor's representative in all cases.

An employer's certificate stating that he is in order with the CSST shall be presented by the Contractor and his sub(s) to the owner before contract award.

The Contractor completely guarantees total compliance to all regulations, provisions and acts related to occupational health and safety by his sub(s) and by any person in his/their employment.

The Contractor shall inform the Consultant of any notice or lawsuit served to him in relation to the violation of an act or regulation concerning occupational health and safety on the site.

The Contractor who himself or for one of his sub(s) does not take remedial action to comply to a safety or hygiene notice given by the Consultant, and within the imposed delay, accepts that the Consultant takes remedial action at the Contractor's expense.

The Contractor shall immediately inform the Consultant of any accident happening during the execution of his contract.

The Contractor binds himself without reserve to indemnify the Owner and the Consultant of any losses, risks, costs, expenses, reclamations and disbursements directly or indirectly related to the omission of the Contractor, his sub(s) or any other person at his employ,

to conform integrally to the provisions of the present article, or arising out of any injury, disease or death of an employee of the Contractor or one of his sub(s) participating in the execution of the contract work.

The Contractor and his sub(s) shall provide all installations, equipment and supplies required by the acts, regulations, orders-in-councils or any directive adopted pertaining to occupational health and safety.

The Contractor and his sub(s) shall conform to site regulations notices to contractors, and to any other directive related to occupational health and safety issued by the Consultant.

The Contractor and his syb(s) shall insure that their employees wear and use on the site the safety equipments approved and required by the Québec Safety Code for the Construction Industry.

The Contractor shall install for his work site sufficient lighting, particularly if he intends to work after sunset. He must equally install and keep in safe condition all passages, ladders, railings, fences, barricades, lights and any other protective installations required by simple prevention, public authorities or the Consultant.

The Contractor shall inform the Consultant in writing of the person responsible within his company for accident prevention. This person shall particularly insure that the Contractor is represented on the site safety committee.

The Contractor and his sub(s) shall designate representatives to the site safety committee formed in accordance with the Act Respecting Occupational Health and Safety. The Consultant shall be informed of the name of the designated representatives(s).

The Contractor and his sub(s) shall insure that this representative is present at all meetings of the site safety committee.

After a written notice to that effect from the Principal Contractor, for each absence from the site safety committee of the designated person, a fine up to a maximum of 500$ for each absence can be levied from the responsible contractor. The said amount is to be deducted from the moneys owned to the Contractor by the Owner.

NOTE: Translation is the author's own.

APPENDIX F

SAFETY STATISTICS PROJECT REPORT

Fenco Lavalin

SAFETY STATISTICS

PERIOD NO:_____ PERIOD ENDING ON: _____

CONTRACTOR CONTRACT NO.	FIRST AID		MEDICAL ASSISTANCE		TIME-OFF WORK		TOTAL ACCIDENTS		NUMBER OF DAYS LOST		NUMBER OF HOURS WORKED		FREQUENCY FOR TIME-OFF WORK		GRAVITY FOR TIME-OFF WORK	
	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.
C11	0	2	1	1	0	0	1	3	0	0	200,00	3 262,00	0	0	0	0
C12	4	33	0	3	0	3	4	39	5	70	3 424,00	23 777,00	0	126,17	1460,2	2944,02
C13	0	5	0	1	0	1	0	7	98	99	1 750,00	18 465,00	0	54,15	5142,8	3736,79
C15	7	36	0	3	1	12	8	51	19	78	6 680,00	45 340,00	149,70	264,66	2844,3	1720,33
C15	1	6	0	0	0	0	1	6	0	0	964,00	3 492,00	0	0	0	0
C15	-	-	-	-	-	-	-	-	-	-	1 131,00	1 355,00	-	-	-	-
S22	0	1	0	0	0	0	0	1	0	0	---	2 908,00	0	0	0	0
S22	-	-	-	-	-	-	-	-	-	-	---	1 669,00	-	-	-	-
S22	-	-	-	-	-	-	-	-	-	-	---	1 890,00	-	-	-	-

Fenco Lavalin

SAFETY STATISTICS

PERIOD NO: _____ PERIOD ENDING ON: _____

CONTRACTOR CONTRACT NO.	FIRST AID		MEDICAL ASSISTANCE		TIME-OFF WORK		TOTAL ACCIDENTS		NUMBER OF DAYS LOST		NUMBER OF HOURS WORKED		FREQUENCY FOR TIME-OFF WORK		FREQUENCY FOR TIME-OFF WORK	
	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.	per.	cum.
	0	1	0	0	0	0	0	1	0	0	2 796,00	7 418,00	0	0	0	0
	-	-	-	-	-	-	-	-	-	-	122,50	122,50	-	-	-	-
C04	-	-	-	-	-	-	-	-	-	-	24,00	24,00	-	-	-	-
C08	-	-	-	-	-	-	-	-	-	-	180,00	180,00	-	-	-	-
1986	-	49	-	4	-	11	-	65	-	102	---	96 172,50	-	114,37	-	1060,59
1987	-	192	-	26	-	33	-	250	-	318	---	271 170,75	-	121,69	-	1172,69
TOTAL	32	273	6	36	3	47	41	356	46	466	35 841,25	402 384,50	85,61	116,88	1312,2	1158,09

FIGURE 1

- The frequency is calculated as follows:

$$\frac{\text{No. of time-off work} \times 1{,}000{,}000}{\text{No. of hours worked}}$$

Period Frequency:_____

Cumulative Frequency:_____

Period: _____

Cumulative: ----------

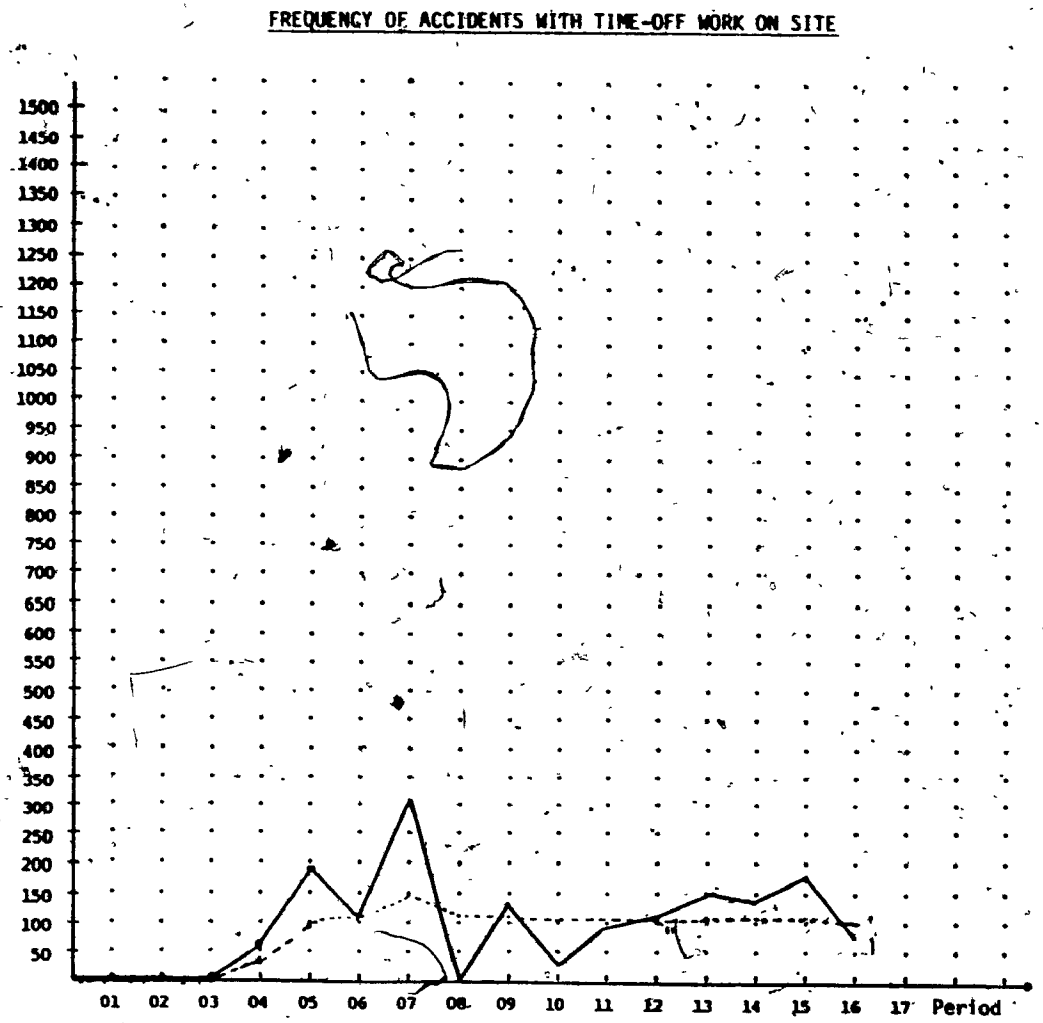


FIGURE 2

The gravity is calculated as follows:

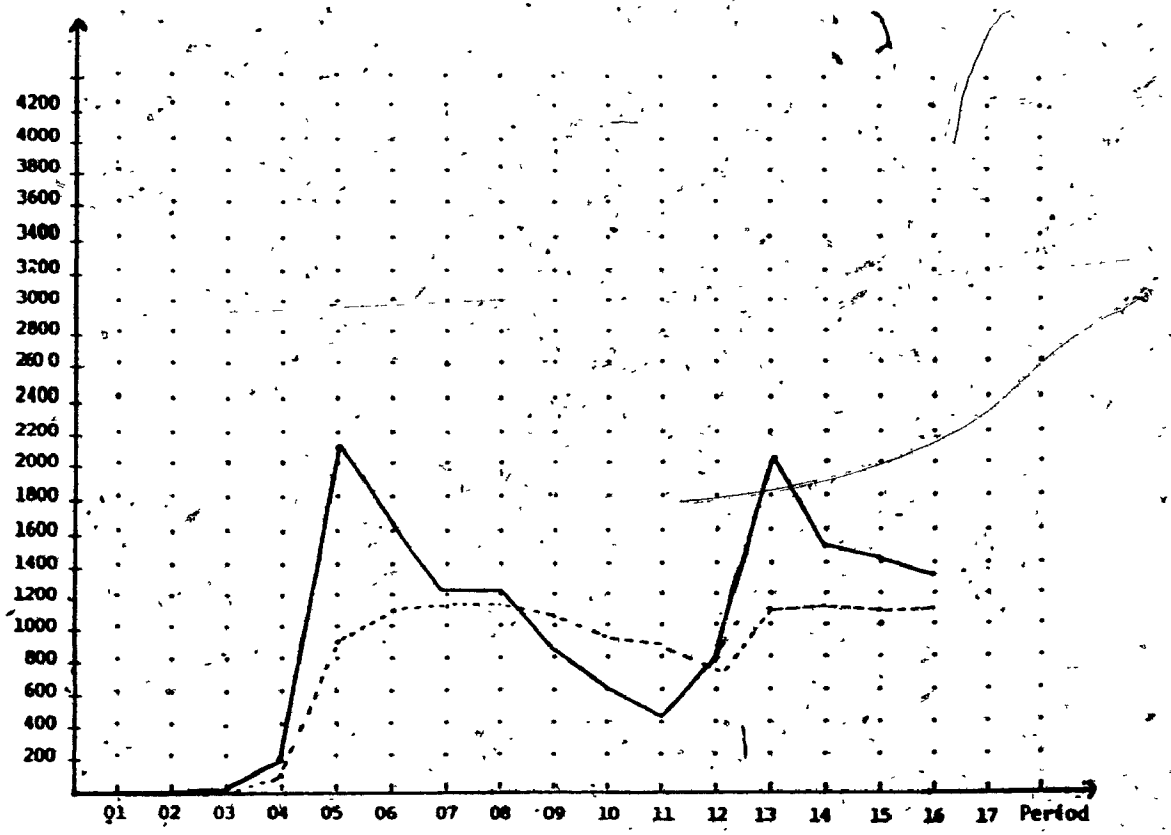
$$\frac{\text{Days lost} \times 1{,}000{,}000}{\text{Hours worked}}$$

Period Gravity:_____

Cumulative Gravity:_____

Period : _____

Cumulative: ----------



APPENDIX G

SCOWEN REPORT RECOMMENDATIONS FOR DEREGULATING THE QUEBEC OCCUPATIONAL HEALTH AND SAFETY REGIME

APPENDIX G

SCOWEN REPORT RECOMMENDATIONS FOR DEREGULATING THE QUEBEC OCCUPATIONAL HEALTH AND SAFETY REGIME [84]

Deregulation of the Occupation Health and Safety Regime

"The Commission de la santé et de la sécurité du travail" (CSST) is the mandatory of the Québec Government for all questions relative to health and safety at work. With this mandate, it is responsible for prevention and inspection as well as compensation for work accident victims, and the financing policies arising therefrom. In fact, the integration of all aspects of the management of the occupational health and safety regime constitutes one of the peculiarities of the Québec approach: The CSST manages in an integrated fashion the application of five acts and some fifty-five regulations respecting health and safety.

The Committee recommends:

Relative to administration:

37. That the CSST Act be amended so that it can put forward a less normalized management style and a more positive interaction mode with industry so as to reduce accidents and unberden the procedures and norms to be respected.

38. That the principle of health and safety committees used as tools of concertation, consultation and decision be maintained.

39. That, for a firm with less than 50 employees, the occupational health and safety committees have no decisional power.

40. That the CSST requirements relative to programmes be made less rigid so as to orient them towards the objective rather than execution norms, and to take into account the real situation of each firm.

Relative to prevention/inspection:

41. That the obligation to prepare health and safety programmes be limited to units where the risks are important and that the extension of the programmes to offices, services, etc. where risks are less important, be done at a rate which does not go beyond that of neighboring provinces, particularly Ontario.

42. That, for accident prevention purposes, be accepted the fact to privilege the protection of the worker as much as the elimination of dangers at the source.

43. That the assessment system be modified so that it becomes an incentive to prevention.

44. That the function of safety representive as a compulsory element of the system be abolished.

45. That the inspection and review systems be modified to allow for faster decisions rendering.

Relative to compensation/financing:

46. A tightening of the controls so as to reduce system abuses, and particularly "backaches" and short term absences, and that, for these aspects, the medical examination process be reevaluated.

47. That the compensation program costs be maintained at a level below that of our neighbours, particularly Ontario, and that, in a continuous manner, necessary comparative studies be made.

48. That the Québec Government assumes, at public expenses, the costs of inspection and of the programmes not related to occupational health and safety, including the preventive re-assignment of the pregnant workers.

49. a) That the costs of the regime for the industry be maintained at levels comparable to those prevailing in Ontario, as well as the principal competitor regions of the Québec industries, whilst ensuring that this objective is not attained to the prejudice of a sane capitalization of the regime.

b) That, if the two objectives are in conflict, the industry be consulted in the establishment of an assessment policy".

NOTE: Translation is the author's own.

APPENDIX H

SURVEY DETAILED DATA ON COSTS

APPENDIX H

SURVEY DETAILED DATA ON COSTS

P (10^6\$) PROJECT COSTS	C % FOR COMPLIANCE	C*P (10^4\$) COMPLIANCE COSTS	SECTOR(*)
0,04	10,0	0,4	C
0,1	10,0	1,0	B
1,0	5,0	5,0	B
2,0	10,0	20,0	B
2,0	0,1	0,2	B
2,0	20,0	40,0	I
3,0	0,1	0,3	B
3,0	1,7	5,1	I
4,0	10,0	40,0	C
4,0	10,0	40,0	H
4,0	10,0	40,0	I
5,0	3,0	15,0	I
5,0	0,4	2,0	H
5,0	0,2	1,0	C
5,0	0,5	2,5	B
6,0	1,5	9,0	I
7,0	1,5	10,5	C
7,0	0,2	1,4	I
7,0	1,5	10,5	H
8,0	5,0	40,0	C
8,5	7,5	63,7	I
10,0	2,0	20,0	B
10,0	2,0	20,0	C
15,0	0,1	1,5	B
15,0	0,1	1,5	C
15,0	0,5	6,0	C
18,0	0,1	1,8	I
20,0	0,1	2,0	I
25,0	0,5	12,5	I
30,0	5,0	150,0	I
40,0	1,8	72,0	I
45,0	4,5	202,5	C
157,0	0,4	62,8	I
488,64	125,2	900,2	

Notes: (*) B= Building
C= Heavy Civil
H= Highway
I= Industrial

APPENDIX J

STATISTICAL ANALYSIS TESTS FOR RESULTS OF REGRESSION ANALYSIS

APPENDIX J

STATISTICAL ANALYSIS TESTS FOR RESULTS OF REGRESSION ANALYSIS

1.0 GENERAL

The result of the regression analysis conducted in Chapter 5 indicated that the survey data followed the power model as shown:

$$C = 7{,}26\ p^{-0{,}534} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (J.1)$$

To determine the validity of that relationship, the type of distribution function will first be determined. From that, applicable tests to validate the equation will be performed.

2.0 DISTRIBUTION FUNCTION

The distribution function of the dependent variable (C) is assumed to be log normal based on the following tests:

a. Kolmogorov-Smirnov Test [2,65]

The critical value D_n^{α} for the α = 0,05 level of significance and 28 DF is found to be:

$$D_n^{\alpha} = D_{28}^{0.05} = 0,25$$

from table J.2 attached.

Using the Statgraphics program [96], D_n was calculated for 18 different distribution functions. The acceptable function at the chosen level of significance (0,05) is the one that meets the criteria:

$D_n < D_n^{\alpha}$

The log-normal distribution yielded D_n=0,1374, thus less than the critical value of 0,25.

b) Probability Plot [2]

The dependent variable (C) was plotted on log-normal probability paper. A straight line can be obtained from the plotted data points, thus a log-normal distribution can be assumed. From that line, the mean ($\bar{C}$) and standard deviation (S.D.) can also be calculated. The graph and related calculations are shown in Figure J.1.

3.0 VALIDITY OF THE RELATIONSHIP

The distribution function being assumed to be log-normal, this non-normality leads to the use of non-parametric tests to determine the validity of the multiplicative (or power) model retained from the regression analysis. Two such tests are used.

a. Null Hypothesis Test for β [65]

The value of the random variable having the t-distribution with (n-2) DF is calculated using the formula:

$$t = \frac{(b - \beta)}{Se} \sqrt{\frac{Sxx}{n}}$$

Where $Sxx = n \sum_{i=1}^{n} C_i^2 - \left(\sum_{i=1}^{n} C_i \right)^2$

Se = Standard error of estimate
b = Estimated slope of regression line
β = Theoretical slope of regression line

To test the null hypothesis (β = 0 or no relationship between x and y):

$$t = \frac{(0{,}534 - 0)}{1{,}492} \sqrt{\frac{11\ 889{,}28}{28}} = 7{,}37$$

The critical value t_{α} = 2,06 (from Table J.3)

Since $t > t_{\alpha}$, the null hypothesis ($\beta = 0$) must be rejected and a relationship between C and P can be inferred.

b. Analysis of Variance [65]

The ANOVA calculations in the Statgraphics program [96] gives the "Analysis of Variance Table" from which the F-Ratio is extracted. F is a value of a random variable with an F distribution.

By comparing F with the critical value F_{α} for predetermined level of confidence (α) and degrees of freedom (DF), the hypothesis test for consistency of the results can be effected and it can be concluded the results differ more than might be expected on the basis of chance.

The Analysis of Variance Table is shown in Table J.1

The critical value for F at the 0,05 level of significance ($F_{0.05}$) and 26 DF is 4,23 as taken from Table J.4

Since F = 9,053 (as calculated) exceeds $F_{0,05}$ = 4,23 the null hypothesis can be rejected at the 0,05 level of significance, and the results are qualified as non-consistent.

TABLE J.1 - ANALYSIS OF VARIANCE FOR THE MULTIPLICATIVE MODEL

SOURCE	SUM OF SQUARES	DF	MEAN SQUARES	F-RATIO
Model	20,1789	1	20,1789	9,053
Error	57,9515	26	2,2289	
Total (corr.)	78,1308	27		

Correlation Coefficient (r) : -0,509

Standard Error of Estimate (Se): 1,492

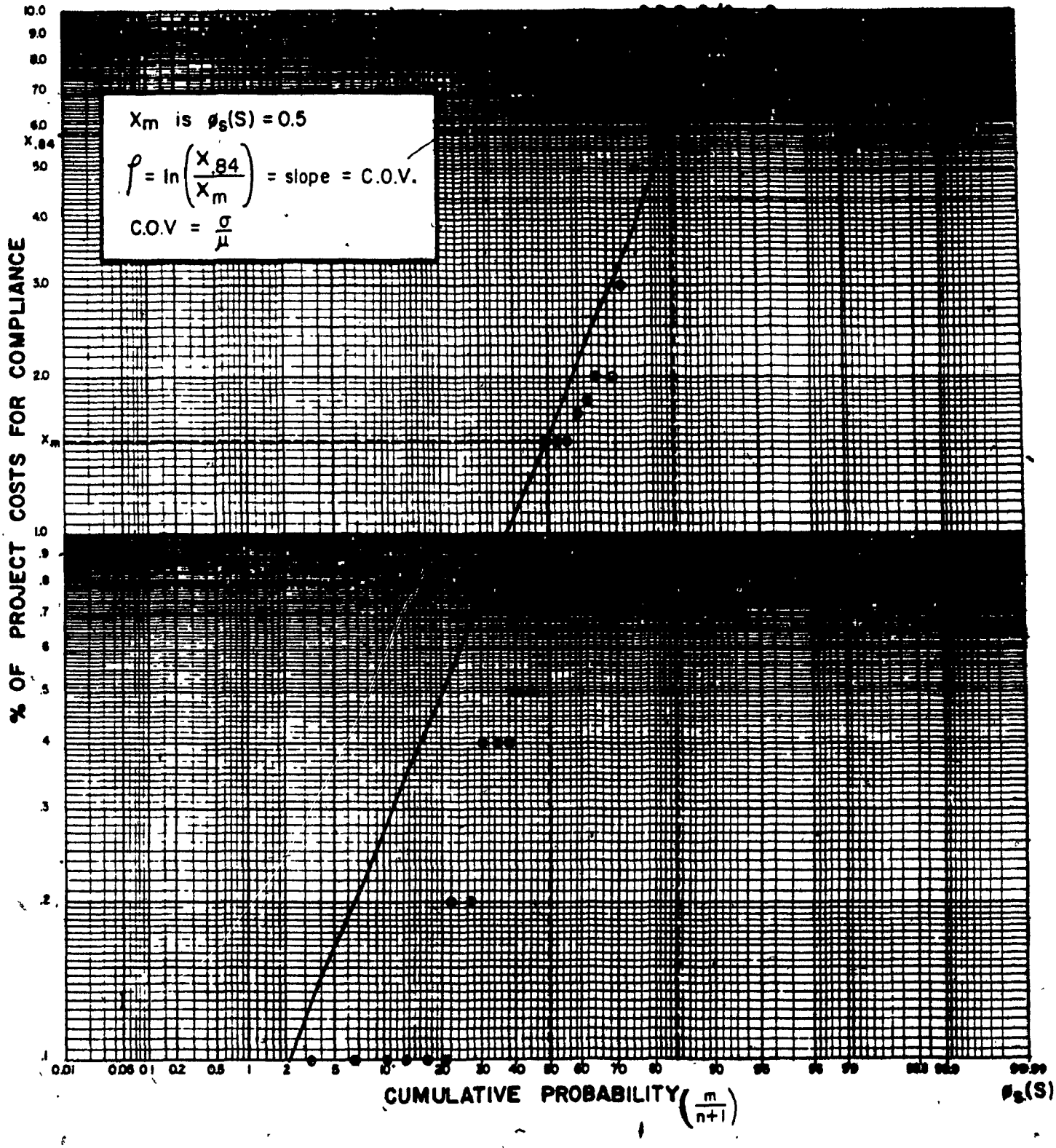


Fig. J.1- Plot of C on Log Normal Probability Paper

TABLE J.2 - CRITICAL VALUES OF D_n IN KOLMOGOROV-SMIRNOV TEST

n \ α	0.20	0.10	0.05	0.01
5	0.45	0.51	0.56	0.67
10	0.32	0.37	0.41	0.49
15	0.27	0.30	0.34	0.40
20	0.23	0.26	0.29	0.36
25	0.21	0.24	0.27	0.32
30	0.19	0.22	0.24	0.29
35	0.18	0.20	0.23	0.27
40	0.17	0.19	0.21	0.25
45	0.16	0.18	0.20	0.24
50	0.15	0.17	0.19	0.23
>50	$1.07/\sqrt{n}$	$1.22/\sqrt{n}$	$1.36/\sqrt{n}$	$1.63/\sqrt{n}$

SOURCE: TABLE A.4, Ang. and Tang [2]

TABLE J.3 - VALUES OF t_ν IN NULL HYPOTHESIS TEST FOR β

ν	$\alpha = 0.10$	$\alpha = 0.05$	$\alpha = 0.025$	$\alpha = 0.01$	$\alpha = 0.005$	ν
1	3.078	6.314	12.706	31.821	63.657	1
2	1.886	2.920	4.303	6.965	9.925	2
3	1.638	2.353	3.182	4.541	5.841	3
4	1.533	2.132	2.776	3.747	4.604	4
5	1.476	2.015	2.571	3.365	4.032	5
6	1.440	1.943	2.447	3.143	3.707	6
7	1.415	1.895	2.365	2.998	3.499	7
8	1.397	1.860	2.306	2.896	3.355	8
9	1.383	1.833	2.262	2.821	3.250	9
10	1.372	1.812	2.228	2.764	3.169	10
11	1.363	1.796	2.201	2.718	3.106	11
12	1.356	1.782	2.179	2.681	3.055	12
13	1.350	1.771	2.160	2.650	3.012	13
14	1.345	1.761	2.145	2.624	2.977	14
15	1.341	1.753	2.131	2.602	2.947	15
16	1.337	1.746	2.120	2.583	2.921	16
17	1.333	1.740	2.110	2.567	2.898	17
18	1.330	1.734	2.101	2.552	2.878	18
19	1.328	1.729	2.093	2.539	2.861	19
20	1.325	1.725	2.086	2.528	2.845	20
21	1.323	1.721	2.080	2.518	2.831	21
22	1.321	1.717	2.074	2.508	2.819	22
23	1.319	1.714	2.069	2.500	2.807	23
24	1.318	1.711	2.064	2.492	2.797	24
25	1.316	1.708	2.060	2.485	2.787	25
26	1.315	1.706	2.056	2.479	2.779	26
27	1.314	1.703	2.052	2.473	2.771	27
28	1.313	1.701	2.048	2.467	2.763	28
29	1.311	1.699	2.045	2.462	2.756	29
inf.	1.282	1.645	1.960	2.326	2.576	inf.

SOURCE: TABLE 4, MILLER AND FREUND [65]

TABLE J.4 - VALUES OF F_α FOR ANALYSIS OF VARIANCE

ν_2 = Degrees of freedom for denominator	ν_1 = Degrees of freedom for numerator																		
	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161	200	216	225	230	234	237	239	241	242	244	246	248	249	250	251	252	253	254
2	18.50	19.00	19.20	19.20	19.30	19.30	19.40	19.40	19.40	19.40	19.40	19.40	19.40	19.50	19.50	19.50	19.50	19.50	19.50
3	10.10	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.38	2.38	2.30	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.93
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23																		
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

"This table is reproduced from M. Merrington and C. M. Thompson, "Tables of percentage points of the inverted beta (F) distribution," *Biometrika*, Vol. 33 (1943), by permission of the *Biometrika* trustees.

SOURCE: TABLE 6(a), MILLER AND FREUND [65]

APPENDIX K

SAMPLE CSST INTERVENTION REPORT

Distribution des copies

En vertu de la Loi sur la santé et la sécurité du travail des copies du présent formulaire sont distribuées aux personnes et organismes suivants.

selon l'article 19

- travailleur
- employeur
- représentant à la prévention
- maître d'oeuvre

selon l'article 183

- employeur
- association accréditée
- comité de chantier
- comité de santé et de sécurité
- représentant à la prévention
- chef du département de santé communautaire
- maître d'oeuvre

Liste des lois et règlements

1. Loi sur la santé et la sécurité du travail (L.R.Q., c S-2.1 et mods)
2. Règlement sur le certificat médical des ouvriers (R.R.Q., 1981, c.S-2.1, r.3 et mods)
3. Code de sécurité pour l'industrie du bois ouvré (R.R.Q., 1981, c.S-2.1, r.5 et mods)
4. Code de sécurité pour les travaux de construction (R.R.Q., 1981, c.S-2.1, r.6 et mods)
5. Règlement sur la coupe de la glace (R.R.Q., 1981, c.S-2.1, r.7 et mods)
6. Règlement sur les établissements industriels (R.R.Q., 1981, c.S-2.1, r.8 et mods)
7. Règlement sur les établissements industriels et commerciaux (R.R.Q., 1981, c.S-2.1, r.9 et mods)
8. Règlement sur l'étaiement des coffrages à béton (R.R.Q., 1981, c.S-2.1, r.10 et mods)
9. Règlement sur la manutention et l'usage des explosifs (R.R.Q., 1981, c.S-2.1, r.11 et mods)
10. Règlement sur la qualité du milieu de travail (R.R.Q., 1981, c.S-2.1, r.15 et mods)
11. Règlement sur la salubrité et la sécurité du travail dans les mines et carrières (R.R.Q., 1981, c.S-2.1, r.19 et mods)
12. Règlement sur la sécurité et l'hygiène dans les travaux de fonçage (R.R.Q., 1981, c.S-2.1, r.20 et mods).
13. Règlement sur les travaux exécutés dans le voisinage des lignes électriques (R.R.Q., 1981, c.S-2.1, r.21 et mods)
14. Règlement sur les travaux forestiers (R.R.Q., 1981, c.S-2.1, r.22 et mods)
15. Règlement sur l'utilisation des pistolets de scellement (R.R.Q., 1981, c.S-2.1, r.23 et mods)
16. Règlement sur les normes minimales de premiers secours et de premiers soins (Décret 1922 - 84 du 22 août 1984 et mods)
17. Règlement sur les ascenseurs, monte-charges, petits monte-charges, escaliers roulants et tapis roulants (R.R.Q., 1981, c.S-3, r.1 et mods)
18. Code du bâtiment (R.R.Q., 1981, c.S-3, r.2 et mods)
19. Autres règlements en vigueur
20. Règlement sur la protection des ouvriers travaillant avec l'air comprimé (R.R.Q., 1981, c.S-2.1, r.14 et mods)
21. Règlement sur les chantiers maritimes (R.R.Q., 1981, c.S-2.1, r.4 et mods)
22. Règlement sur les conditions sanitaires des campements industriels ou autres (R.R.Q., 1981, c.O-2, r.3 et mods)
23. Règlement sur les postes d'appareils de sauvetage dans les mines (R.R.Q., 1981, c.S-2.1, r.13 et mods)
24. Règlement sur l'application d'un Code du bâtiment (Décret 912-84 du 11 avril 1984 et mods)
25. Règlement sur les maladies professionnelles (R.R.Q., 1981, c.A-3, r.8 et mods)
26. Règlement d'application de la Loi sur la protection de la santé publique (R.R.Q., 1981, c.P-35, r.1 et mods)
27. Règlement sur les services de santé au travail (Décret 1281-82 du 26 mai 1982 et mods)
28. Règlement sur le programme de prévention (Décret 1282-82 du 26 mai 1982 et mods)
29. Règlement sur les comités de santé et de sécurité (Décret 2025-83 du 28 septembre 1983 et mods)
30. Règlement sur le représentant à la prévention dans un établissement (Décret 1879-84 du 15 août 1984 et mods)
31. Règlement sur l'application du Code du bâtiment (Décret 912-84 du 11 avril 1984 et mods)
32. Loi sur les accidents du travail et les maladies professionnelles (L.Q., 1985, chapitre 6)

Pour toute communication, veuillez vous adresser à **Commission de la santé et de la sécurité du travail**

Directions régionales

BAS SAINT-LAURENT - GASPÉSIE
105, rue des Gouverneurs
2e étage
RIMOUSKI (Québec)
G5L 8G1
(418) 727-3550
Télex: 051-55355
Région 01

SAGUENAY - LAC-SAINT-JEAN
Place du Fjord
901, boul. Talbot, 4e étage
CHICOUTIMI (Québec)
G7H 6P9
(418) 696-3200
Télex: 051-35142
Région 02

QUÉBEC
1, Parc Samuel Holland, 4e étage
QUÉBEC (Québec)
G1S 4R7
(418) 643-3648
Télex: 051-7232
Région 03

MAURICIE - BOIS-FRANCS
1555, boul. des Forges
5e étage, bureau 500
TROIS-RIVIÈRES (Québec)
G9A 4J8
(819) 372-3400
Télex: 066-37167
Région 04

ESTRIE
1335, rue King ouest
SHERBROOKE (Québec)
J1J 2B8
(819) 821-5660
Télex: 066-38158
Région 05

ÎLE-DE-MONTRÉAL
1199, rue de Bleury, 5e étage
C.P. 8054, succursale postale A
MONTRÉAL (Québec)
H3C 4E1
(514) 873-7088
Télex: 052-5342
Région 06

LAVAL
1759, boul. Laval
LAVAL (Québec)
H7S 2N6
(514) 686-7716
Télex: 052-4664
Région 61

LAURENTIDES
1555, rue Labelle
SAINT-JÉRÔME (Québec)
J7Z 5N6
(514) 431-4666
Télex: 066-39515
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MONTÉRÉGIE
25, boul. Lafayette, 3e étage
LONGUEUIL (Québec)
J4K 5B7
(514) 679-4280
Télex: 052-4667
Région 62

LANAUDIÈRE
Place du Centre
430, rue Lajeunesse
JOLIETTE (Québec)
J6E 7Z1
(514) 756-0200
Télex: 052-66658
Région 63

OUTAOUAIS
15, boul. Gamelin, 6e étage
HULL (Québec)
J8Y 6N5
(819) 778-6600
Télex: 053-3518
Région 07

ABITIBI - TÉMISCAMINGUE
23, rue Gamble ouest
ROUYN (Québec)
J9X 3P3
(819) 762-8301
Télex: 057-40540
Région 08

CÔTE-NORD
Au Grand Passage
700, rue Shewenegan, bureau 20
606, boul. Laure
SEPT-ÎLES (Québec)
G4R 4K8
(418) 962-3661
Télex: 051-34161
Région 09

NOUVEAU-QUÉBEC
Case postale 600
RADISSON (Québec)
J0Y 2Z0
(819) 638-8878
Région 10

Gouvernement du Québec