AN INVESTIGATION INTO THE NATURE OF CONTRACTOR'S ALL RISKS INSURANCE, WITH PARTICULAR REFERENCE TO CIVIL ENGINEERING AND BUILDING RISKS

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A project report submitted to the Faculty of Engineering, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

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DECLARATION

I declare that this project report is my own, unaided work. It is being submitted for the Degree of Master of Science, in Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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ABSTRACT

The prime goal of this project report is to investigate whether it is sensible for contractors to utilise the facilities offered by Contractor's All Risks (CAR) insurance; following an outline of the main characteristics of CAR, the approach adopted refers mainly to an investigation of accidents and losses that have occurred on civil engineering and building projects and relating these incidents to the cost of insurance of each project.

Research for this investigation concentrates primarily on conclusions that become evident from analysing, on a worldwide basis, the number of losses that have occurred per site during the course of construction of various types of civil engineering structures (such as dams, tunnels, harbour works) and buildings (such as highrise office blocks). A statistical model for each kind of structure is then drawn in graphical format to enable the reader to ascertain the appropriate minimum insurance premium (or rate) related to the minimum corresponding deductibles.

Deductions made from these statistical models indicate that the premium rate and corresponding deductibles vary from high values for exposed risks such as dams and harbour works, to lower values for less exposed risks such as office buildings.

In conclusion, the findings of this investigation indicate that due to the high number and high costs of losses, especially on exposed risks, Contractor's All Risks insurance is indeed not only viable, but highly recommended.

PREFACE

At the time of conducting this research project, the author was in the employment of a major reinsurer and dealt primarily with construction related insurance matters on a daily basis.

The author is a civil engineer and during his exposure to the construction engineering insurance market, became very interested in the technical aspects of assessing major civil engineering and building risks on the basis of historical loss data; pursuance of this interest has culminated in setting the parameters for this research project.

Furthermore, in the author's work environment, it became apparent that in many instances, little was known about construction insurance by any parties (developers, consultants and contractors) concerned within the construction industry.

The author thus felt a need not only to broaden and explain the concept of construction insurance to members of the construction industry, but also to use this opportunity as a basis for loss data research.

DEDICATION

In memory of my daughter,

Lise Beeby,

who during the course of this study,

left earth for a better place.

ACKNOWLEDGEMENTS

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1 INTRODUCTION

1.1 General

The construction industry, especially the civil engineering side, is very prone to losses suffered as a result of the occurrence of natural catastrophies (such as Cyclone Demoina 1984, Natal Floods September 1987). The magnitude of these occurrences can have disastrous effects on construction sites, such as bridge and road washaways, breaching of dam walls, flooding of coffer dams, collapse of tunnels, etc., (damage resulting from the Natal Floods was estimated to be R500 million). In some instances, these natural occurrences can cause indirect damage to third party property within or adjacent to the construction site for which the contractor will be held responsible, e.g., breaching of a dam: a wall of water from the breached dam can cause loss of life and serious damage further downstream.

As the title of this research project implies, it will be the intention of the author to investigate the nature of Contractor's All Risks (hereinafter always referred to as CAR) insurance within the civil engineering and building industry.

Before outlining this project, it may be necessary to make the reader of this report realise that CAR insurance covers the whole spectrum of losses that can occur on any construction site. Losses may vary from petty theft (for instance building materials such as bricks and cement), defined as minor losses, to total collapse of dams and highrise buildings, defined as major losses.

Minor losses are to a certain extent taken care of by the deductible (that monetary part of any claim or loss that the contractor bears) associated with that particular loss and which is also specified in the CAR insurance policy.

It is the major losses (for which there are usually also associated deductibles) which are of real concern in this project report.

Bearing in mind the possibilities of large losses occurring on construction sites, the value of insurance protection cannot be underestimated. In the past, contractors have not considered insurance as an important aspect; in fact, from the author's own experience, contractors in general were unsure of the nature of CAR insurance and viewed construction insurance with suspicion and even more so when premiums increased rapidly. There is, however, a tendency for large losses to occur in the engineering sphere and for this reason, the construction industry should pay more attention to the aspects of CAR insurance; above all, construction projects are constantly becoming larger, thus increasing the possible financial loss exposure. The claims experience of insurance companies have furthermore indicated that losses suffered during the past few years on construction insurance have been significant; Gasche (FIDIC 1978) mentioned that the contract works insurance loss ratio in Germany was 93,5% of premiums in 1975 and 104,9% in 1976 respectively.

Considering the above, CAR insurance may thus be construed as a facility whereby a contractor (or principal) could purchase protection against unforeseen events which may cause major damage (and concomitant delays) to the construction works and associated third party property.

In the past, insurance premiums were a relatively small percentage of the contractor's overhead costs, but at present, insurance premiums are higher, requiring the need to examine the cost of insurance and the associated cover more closely. One of the main reasons for the increased cost of insurance has been the large losses which have occurred recently, such as Cyclone Demoina 1984, the Natal floods in September 1987 and Orange Free State floods in March 1988. Insurance premiums had to be increased in general in order for the insurers to maintain their solvency margins, resulting in CAR insurance becoming more expensive; this, in turn has led to resistance by contractors to insure. This issue will be further dealt with in Chapter Two, Literature Survey.

The remainder of this chapter will be utilised to

* Specify the characteristics and purpose of CAR insurance and what it entails.

* Identifying the current involvement of parties participating in the construction industry (e.g. consultants, contractors, etc.) with respect to CAR insurance and their concomitant problems and thereby establishing the necessity of this research project.

* Indicate how the involvement of all concerned parties and their problems could be addressed in order that all disciplines could have a better understanding of CAR insurance.

1.2 Characteristics and Purpose of CAR Insurance

Contractors have expressed ignorance (Brown 1987, Madge 1987) about CAR insurance in the past. This has been substantiated by the author's experience, thus it is considered necessary at the outset to explain the characteristics and purpose of CAR insurance.

Contractor's All Risks (CAR) insurance is a relatively modern branch of engineering insurance. The basic concept of CAR insurance is to offer comprehensive and adequate protection against loss or damage in respect of the contract works, construction plant and equipment and/or construction machinery, as well as for third party claims in respect of property damage or bodily injury arising in connection with the execution of a construction project.

The rapid development of technology, which has also occurred in the civil engineering field, the increasing demand for construction work of any kind and the growth in the values of individual building projects have resulted in an increase of the technical and economic risks during construction and an ever-increasing demand for CAR insurance protection all over the world. In addition, owing to increasingly keen competition, contracting firms are frequently not in a position to include in their tender prices a sufficient margin for the hazards involved. Since an insurance premium can be calculated much more accurately by a professional insurer than the hazard margin by a contractor, CAR insurance contributes to reducing the overall construction expenses and at the same time offers efficient financial protection for all parties concerned.

Therefore, there is an increasing tendency on the part of principals, consulting engineers, architects and financiers to make the inclusion of a CAR policy a condition for the award of the tender. This is also a condition stipulated in many contracts involving government projects.

Certain important aspects of CAR insurance have to be considered; these are as follows:

1.2.1 The Insured

A CAR insurance may be concluded by

* the principal;

* the contractors engaged in a project, including all sub-contractors.

In order to prevent overlaps or gaps in the cover provided, a CAR insurance should be concluded for all parties concerned.

1.2.2 The Subject Matter Insured

CAR Insurance can be taken out for all building and civil engineering projects, such as

* residential and office buildings, hospitals, schools, theatres;

* factories, power plants;

* road and railway facilities, airports;

* bridges, dams, weirs, tunnels, water supply and drainage systems, canals, harbours.

In particular, the cover comprises the following:

1.2.2.1 **Contract Works**

This term implies all the operations to be carried out by a contractor and his sub-contractor in compliance with the building contract, including preparatory work on the site, such as excavation, grading and levelling work, the execution of temporary structures like diversion cuts and protective dams, as well as the use of all the materials stored on the site which are to be incorporated in the structure.

The assembly or erection of machinery, plants and steel structures may be included under a CAR policy provided that their value, including erection costs, is less than 50% of the total sum insured.

1.2.2.2 **Construction Plant and Equipment**

This term implies workers' accommodations, storage sheds, preparation and mixing plant, scaffoldings, utilities (electricity, water supply), etc.

1.2.2.3 **Construction Machinery**

This term implies earthmoving equipment, cranes and the like, as well as site vehicles not licensed for use on public roads, no matter whether such machinery is owned or hired by the contractor.

1.2.2.4 **Costs for Clearance of Debris**

This term implies the expenses incurred for the removal of debris from the site in the event of a loss indemnifiable under CAR insurance.

1.2.2.5 **Third Party Liability**

This term implies legal liability arising out of property damage or bodily injury suffered by third parties and occurring in connection with the contract works on or near the building site. However, the insurers will not indemnify any claims from the employees of the insured or workmen who are connected with the construction project.

1.2.2.6 **Surrounding Property**

This term implies property located on the site as well as property surrounding the site. A distinction is made, however, between

* property belonging to or held in care, custody or control of persons named in the policy as the insured (in this case cover is only granted by way of an endorsement on the CAR policy, thereby extending cover to the employer's or principal's existing property; double insurance (assuming that the existing property is also insured) can be avoided by an adjustment to the normal premium during the period of the contract (Atkins, 1980)), and

* property belonging to or held in care, custody or control of persons who may be regarded as third parties for the purposes of the policy, i.e. persons who are neither insurers nor insured (in this case indemnity is payable according to the principles of third party liability cover, Section II of the CAR policy).

1.2.3 **Scope of CAR Insurance Cover**

CAR insurance provides an "all risks" cover - every hazard is covered which is not normally specifically excluded. This means that almost any sudden and unforeseen loss or damage occurring during the period of insurance to the property insured on the building site will be indemnified. The most important causes of losses indemnifiable under CAR insurance are:

* fire, lightning, explosion, crashing aircraft, extinguishing water or other fire fighting measures;

* flood, inundation, rain, snow, avalanche, tsunami;

* windstorm of any kind;

* earthquake, subsidence, landslide, rockslide;

* theft, burglary;

* bad workmanship, lack of skill, negligence, malicious acts or human error.

CAR insurance also covers loss of or damage to building material, construction machinery and construction plant and equipment occurring during on-site transport, intermediate storage, or during assembly or disassembly.

The cover provided by CAR insurance is only subject to a few obvious exclusions which the international insurance market usually applies. These exclusions are named in the policy and essentially comprise:

* loss or damage due to war or warlike operations, strike, riot, civil commotion, cessation of work, requisition by order of any public authority (it is possible to include the risks of strike and riot in special cases, but such an inclusion is subject to careful prior examination);

* loss or damage due to nuclear reaction, nuclear radiation or radioactive contamination;

* consequential loss of any kind or description whatsoever, such as claims from penalties, losses due to

delay, loss of contract (it is however possible to obtain an extension to the CAR policy in order to be covered against loss of profit, increased interest charges and other additional costs attributable to the physical loss and/or damage insured by the policy (Advanced Study Group 208A (1985), FIDIC (1978));

* loss or damage due to mechanical and/or electrical breakdown or derangement of construction machinery, plant and equipment (i.e. loss or damage not caused by exterior influences, whereas any physical loss of or damage to the building project resulting therefrom is covered); a separate Plant All Risks policy is usually issued for this type of cover;

* loss of damage due to faulty design, which is usually the design consultant's responsibility and covered in terms of Professional Indemnity insurance;

* the cost of replacement, repair or rectification of any deficiencies in the contract works (e.g. use of defective or inadequate material, which may be covered by Products Liability insurance, alternatively, it has been proposed (FIDIC (1981)) that insurers could offer supplementary cover to the employer only (thus not to the contractor) in respect of damage due to faulty materials (or workmanship), with the insurer retaining right or recourse against the negligent contractor); however, loss of or damage to correctly executed items resulting from the inadequacy of other items of the contract works is generally covered under CAR insurance.

1.3 Identification of the Involvement and Problems of Parties Participating in the Construction Industry

On a typical construction project, the following disciplines are usually encountered:

* the principal or owner or developer;

* the professional consultants (architect, quantity surveyor, engineers, etc.);

* the contractor(s) (including subcontractors).

For each of the above parties, the insurance requirements are totally different.

The principal may elect to take out a principal controlled insurance (P.C.I.) policy which would include, inter alia, the main section of the works (Brown, 1987:53 and Freeman, 1989:12). This type of cover may, however, not be adequate for the contractor who must then establish whether additional insurance cover is necessary to protect himself.

The consultants, on the other hand, have their own professional indemnity (PI) insurance. Professional liability claims are increasing (Campbell, 1988:51) and consultants are thus becoming more aware of their need for this type of insurance. Although PI insurance is separate from CAR insurance, certain provisions may be made in a CAR insurance policy to cover certain design risks which would otherwise fall within the scope of PI insurance.

Finally, the contractor may be compelled to take out CAR insurance (specifically so in terms of Clause 21 of the General Conditions of Contract (1982)). In other instances, the contractor may opt to self-insure, especially in view of increasing insurance costs (Sounes, 1987 and Freeman, 1989).

In the past, insurance premiums relating to construction projects were a relatively small percentage of overhead costs (Sounes, 1987) and little consideration was given to realistically determining the actual need for a specific type of cover. However, with current conditions relating to increasing premiums and large deductibles, it has become necessary, not only for the contractor, but also for the principal and the consultant, to become more aware of the insurance aspect of each type of construction project.

1.4 Addressing Problems Relating to the Concept of CAR Insurance

In order to address this aspect, it will be the intention of this project report to describe the background of how CAR insurance developed into its present form and to broaden the concept of loss awareness (i.e. risk management) for specific types of risks by means of statistical models; these models are to be analysed in order to give a base for influencing the decision whether to insure a project or not. The basis of the analysis will be an investigation of the number of major losses that have occurred on various insured projects and these results will be used as the main resource available to broaden the concept of the need for CAR insurance.

It is the overall aim of this project to create a better understanding of the nature of CAR insurance not only for contractors, but for principals and consultants as well.

1.5 Approach to be Adopted in the Research Project

The author intends to outline the structure of this project as follows:

* Chapter Two: A literature survey will be carried out of how CAR insurance developed into its present form and current literature on aspects of CAR insurance in general. The author will identify any shortcomings and questions which need to be addressed.

* Chapter Three: In order to increase loss awareness on various types of civil engineering and building projects, claims that have occurred on these projects need to be investigated. For this purpose, statistical models have been compiled in both tabular and graphical form. Example on the use of a statistical model is also included in this chapter.

* Chapter Four: will centre on discussion of results emanating from the statistical model research.

* Chapter Five: Conclusion

2 LITERATURE SURVEY

In order to investigate the nature of CAR insurance, it was first necessary to establish the extent of current literature on the matter.

2.1 Origin of CAR Insurance

The concept of construction insurance came into being and thrived during the period immediately after the Second World War (Bunni, 1986:14). Concentrated reconstruction programmes for cities, towns and their infrastructures that were devastated during the war, together with rapid technological advances which occurred in new materials and methods of construction, created a need for construction insurance (Bunni, 1986:14).

CAR insurance (also referred to as contract works insurance or construction insurance) is thus a relatively "new" class of insurance, which has been developed during the last forty years.

Construction insurance is furthermore a highly specialized class of insurance requiring technically orientated skills to underwrite and maintain this type of cover.

CAR insurance protection has not usually been a compulsory inclusion into the contract works documents, however it has become a fairly recent requirement in terms of the Insurance Clause of the General Conditions of Contract (1982), as approved by the South African Institution of Civil Engineers.

2.2 *Development of CAR Insurance*

CAR insurance is linked directly to the construction industry and as such, is never stagnant. Cover provided by CAR insurance has to keep abreast of the development of new construction materials, equipment and techniques.

The development of CAR insurance in South Africa is very closely linked to the European system, where in fact our engineering insurance originated from. Certain aspects of the European CAR insurance were modified and adopted to suit *the more adverse conditions found in South Africa.*

2.3 Current Literature

2.3.1 General

The author has found it difficult to establish detailed sources of literature dealing with CAR insurance, the reasons being as follows:

* the uniqueness and specialized type of protection offered by CAR insurance;

* the fact that CAR insurance can be tailored to suit any type of construction project and is thus infinitely variable;

* construction insurance forms part of engineering insurance which in turn is a small division of short-term insurance;

* CAR insurance has until fairly recently not been incorporated as part of the contract conditions (General Conditions of Contract, 1982) of civil engineering projects and as such has not received any particular attention;

* there is little or no mention of this type of insurance in the media (compared to other classes of short-term insurance such as motorcar and householder's insurance);

* CAR insurance can be construed to form part of the requirements of construction and building works and as such, literature concerning insurance matters appears to be restricted to publications within the construction and building environment.

2.3.2 Scope of Current Literature

2.3.2.1 Textbooks

Little information on CAR insurance is available in textbook form, particularly within the South African Insurance Industry. During the literature research, the author found four textbook references which were of interest:

1. K. Gerathewohl (1982) defined the aspects of engineering insurance in general and then made specific mention of CAR insurance. He also mentioned the inclusion of cover for the property of third parties within the ambit of a standard CAR policy.

Gerathewohl stated that an important criterion for the contractor wishing to take out a CAR policy was the technical service (such as providing loss minimisation proposals and discounts for work carried out in dry periods) that an insurer was able to offer in addition to insuring the risk itself, in fact the technical service might be the main reason for taking out a CAR policy in the first place. In turn, the insurer should, in his own interest, try to gain an exact idea of the construction project to be insured.

Furthermore, Gerathewohl stressed the special and highly individual nature of engineering insurance, as well as the fact that CAR risks were constantly becoming larger as time progresses. He cited the following examples during the period 1970 to 1976:

> The average cost for a nuclear power station rose from US$200 million to US$500 million during this period (p157);
>
> that of an oil refinery from US$80 million to US$300 million (p157).

Inflation also had a strong effect on CAR insurances, especially on large projects with construction periods spanning several years.

An important observation made by Gerathewohl was the fact that there was a tendency towards large losses in engineering insurance; one of the main reasons for this occurrence, being the fact that CAR insurance also covers major perils (so-called "Acts of God") which include natural hazards (such as earthquake, storm, flooding, etc.).

Gerathewohl further pointed out that there was no detailed tariff pricing (or rating) system for insuring CAR projects, as was the case with other types of property insurances. Each major civil engineering or building project thus had to be assessed on its own merits and due allowance had to be made for the technical features of the particular project, its specific exposure to major perils, the duration of the project and the experience of the contractor involved.

A key statement made by Gerathewohl concerning losses for various types of risks has been borne out by his comments as follows:

> The probability of a loss occurring is determined by observing, if feasible for as many years as possible, the claims experience in each risk category and adjusting the findings by means of technological assessments. As a result, the size of the losses to be anticipated is also taken into consideration before retentions are determined.

The above statement by Gerathewohl has put the aim of this project into perspective, viz. to carry out an observation of the loss history for various types of construction projects and to utilize these findings for the benefit of both the insured (i.e. the contractor) and the insurer.

2. N.G. Bunni (1986) gave a very broad background on the development of construction insurance through the years and how it was intertwined with legal issues pertaining to construction insurance in general.

Bunni confirmed the author's earlier statement that there was little or no published material dealing with construction insurance (pvii). Bunni's book dealt with the following issues:

* the subject of CAR insurance from its rationale to its everyday practice and highlights the importance of the interaction between CAR insurance and construction law;

* other concomitant facets of CAR insurance, such as third party liability and professional indemnity are discussed and explained.

Bunni's book was very generalised and comprehensive. His findings and statements were primarily based on British construction policies and procedures and he supported the Federation Internationale Des Ingenieurs - Conseils (FIDIC) Conditions of Contract for works of Civil Engineering Construction (which do not apply to South African construction procedures, but are similar to our General Conditions of Contract).

An important issue in Bunni's book is his view that it was important to identify and analyse the effect of risks on major construction projects and that such an analysis can be done through knowledge of previous experience (including the loss history) on similar projects. Bunni therefore set the parameters of the author's intended field of research (just as Gerathewohl (1982), did), which will involve the analysis of the loss history for various types of construction project to establish the level (premium and associated deductible) of insurance required.

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Other CAR insurance aspects covered in Bunni's book provided fascinating reading, especially the legal issues, but due to the British procedures and factors relevant to the British construction industry mentioned in his book, these were not relevant to the South African context of this research project.

3. **P. Mudge** (1987) outlined the insurance clauses that usually appeared in building and engineering contracts and what these clauses imposed upon either the contractor or the employer. He further explained the extent of cover offered by the various policies issued by insurers.

Mudge's book specifically referred to forms of contract conditions and clauses based on the (British) Institution of Civil Engineers' Conditions of Contract, which are not applicable to the South African Construction industry.

4. **C.J. Freeman** (1989) was appointed by the Construction Research Advisory Committee of the Civil Engineering Advisory Council to investigate civil engineering construction insurance in South Africa.

His book (Draft Practical Guideline Document 3) outlined a survey of the methods of insuring construction risks from the point of view of the client (or principal or employer) as well as the contractor.

Most of the points raised in Freeman's guideline have already been mentioned in Chapter 1, Introduction.

An important statement that Freeman made in his guideline, was that there had been a lack of published information on the effectiveness of construction insurance cover in South Africa and that the matter should be addressed.

2.3.2.2 Periodicals

Several articles dealing with construction insurance were found in various local monthly periodicals, such as **The Civil Engineering Contractor.** These articles were short and concise and dealt with pertinent matters that have been used to form a basis of the Literature Survey regarding the latest issues concerning CAR insurance.

In his article "Insurance for Civil Contractors" (June 1987), C. Sounes dealt with the matter of self-insurance for contractors. He stated that self-insurance, for those contracts which did not force the contractor to take out insurance, could be effective when carefully planned, especially when losses were relatively foreseeable. (An example of foreseeability with regard to insurance losses, is for instance the construction of an earth coffer dam in a river during the peak rainy season. Damage to the coffer dam is foreseeable and could thus be self-insured, as the insurance company would levy a high premium for this kind of exposure, or, alternatively, refuse to insure).

Sounes did not advocate total self-insurance; he states that the risk which is not being insured must be "affordable" to the contractor, i.e. when the loss actually occurs, such an occurrence would not be detrimental to the contractor himself. In order for the contractor to establish which risks should be self-insured, Sounes advised that the contractor dealt with specialist construction insurance brokers.

E.L. Brown (1987) stated that there have been considerable changes in the construction insurance industry, causing premiums to escalate alarmingly and deductibles to be set at high levels. One of the reasons for these increases was the widespread losses caused by heavy rainstorm damage, such as Cyclone Demoina in 1984.

Brown confirmed in his article that the contractor was traditionally responsible for the entire contract until completion and that he thus carried the entire risk of the construction project (both temporary and permanent works), including everything that is brought onto the construction site. In view of this, the onus was thus on the contractor to obtain the relevant CAR cover to protect the interests of both the employer and himself.

In Brown's abovementioned article, he also referred to the aspect of the Principal Controlled Insurance (PCI). He stated that this kind of insurance is a type of CAR cover which is more orientated towards the principal, developer or employer, such as ESCOM, SATS or even a municipality; he stated that a PCI policy is designed primarily to accommodate these kinds of institutions with premiums and excesses adjusted accordingly.

He warned contractors to establish the details of the PCI policy (when it applies) in order to ascertain its limitations and deductibles, which might be set-off against their own insurance claims. Contractors were also advised to establish whether additional cover is necessary, such as cover for large excesses. Brown stated that PCI has many advantages, such as a single overall policy for a large or several projects, covering all contractors and sub-contractors and with known deductibles; however, he felt that these advantages were outweighed by the disadvantages to the contractor, which included inter alia:

* lack of communication between the various parties involved, especially regarding insurance matters;

* the need for additional cover not provided for within the PCI context, such as plant and equipment;

* the contractor's liability for deductibles over which he has no control;

* settlement of claims are paid directly to the principal who is expected to arrange payment to the contractor - the contractor has thus no direct access to the insurers to negotiate payment of the claim;

* settlement of claims could be rendered impossible should the insurer of the principal collapse (which has in fact occurred recently with the demise of A.A. Mutual Insurance).

Brown further promoted the concept of the contractor taking out CAR insurance; he advised him to obtain the best and most economic cover, but the contractor might have to accept the risk for certain aspects of the contract, as well as exclusions mentioned in the CAR policy in order to remain competitive in his pricing. (It should be remembered that insurance costs are part of overhead costs and the higher the insurance costs become, the less chance the contractor has of being awarded the contract in an open tender situation).

Brown concluded his article with comments regarding standardising the CAR insurance policy with the minimum amendments and endorsements to accommodate each different type of risk. The benefits of such a universal policy were obvious - both the employer's and the contractor's risks are clearly defined and each party's needs could readily and efficiently be accommodated.

A. Greig, in his article entitled "Risk Management" (August 1987), concurred with E.L. Brown's comments regarding the rapid rise in insurance premiums. Greig's opinion as to the cause of these increases was based on the fact that he felt that there was inadequate loss control, i.e. poor risk management; he stated that the real way to reduce insurance premiums was to reduce losses by proper risk management and verified his opinion with the following statement:

> The real way to reduce premiums is to reduce losses, but senior management is usually under pressure from the shareholders, who

> constantly expect their companies to improve profits, and unfortunately, the benefits of sound risk management cannot easily be reflected in the company's accounts as a profit-making activity.

An example of how CAR insurance *premiums* (and associated deductibles) have increased over the past few years may be illustrated as follows:

> In 1983 market related terms for a standard road contract, were a rate of 0,3% of the contract value, with a major and minor deductible of R25 000 and R1 000 respectively. A contract value of say R5 million (in 1983) would thus generate a premium of R15 000. At present market conditions, the rate would probably be 0,5% with associated deductibles of R50 000 major and R10 000 minor respectively, resulting in a comparative premium of R25 000 for R5 million (note that the equivalent contract value for a R5 million project in 1983 would be approximately R25 million today, generating a real premium of R125 000 compared to a present value premium (at rate 0,3%) of R15 000 x 5, i.e. R75 000, which is much less than R125 000).

It would suffice to say here that although Greig advocated risk management to reduce losses, he was not against insurance and admitted that insurance, when selectively applied, formed part of the overall *risks management* programme.

In another article entitled **"Better Risk Management Information"** (May 1988) (and a similar article entitled **"Exposure Monitor from Hosken"**

(May 1988), C. Sounes stated that with the control of risk management tools, contractors were in a better position to be made aware of risk information relating to uninsured risks. Contractors were thus made aware of a possible accumulation of risk exposures on various construction projects and remedial action (in terms of additional CAR insurance cover) could then be taken.

Sounes further mentioned in both the above articles, the development of a new type of insurance called Building Defects or Decennial Insurance which in simple terms is a ten year, non-cancellable insurance policy which provides an indemnity for structural defects in a new building. As most of the losses envisaged with this type of insurance would relate to Professional Indemnity cover, this falls outside the context of CAR insurance and is only mentioned here.

In another article, "*Contractor in Breach of Contract*" (1988), E.L. Brown referred to the contractual obligation of the contractor to take out a CAR insurance policy in terms of Clause 21 of the General Conditions of Contract (1982). He stated that it would be unlikely for the contractor to fulfil his obligation in this respect, as the insurance cover prescribed in terms of Clause 21, namely to cover "*all loss or damage from whatever cause*", is not available from insurers.

This situation of the contractor being in breach of contract from the outset in terms of the existing Conditions of Contract, was being reviewed by the General Conditions of Contract Revision Committee (of which Brown was a member) and the aim of the Committee was to update the current edition of the General Conditions of Contract, inter alia Clause 21, Insurance of Works.

D. Lake, in his article "Contractors All Risks Insurance" (November 1988), expressed his concern regarding the deductibles associated with CAR policies, especially on contracts in northern Natal where extremely heavy rainfalls had occurred. He further stated that the observation of sound engineering practices and loss minimizing measures were important considerations for the insurers who were insuring civil engineering and building projects.

Lake also called for closer co-operation between the insurer and the insured (i.e. the contractor) in order to establish parameters by which certain risks (such as flooding, wind damage and collapse) could be minimized.

Finally, further sources of information have been obtained from several in-house publications issued by the Munich Reinsurance Company of South Africa Limited. These publications refer to CAR insurance in general, policy wordings, loss events and risk minimisation techniques. Information from those publications have been incorporated into the text of the research project where required.

Furthermore, it should be stated here that the author is involved with the construction insurance industry and many observations and comments appearing in this project report originated from experience gained from CAR insurance matters.

2.4 Results of Literature Survey

Conclusions reached as a result of the *Literature* Survey are as follows:

* Opinions expressed by authors tend to be generalized, although they appear to be based on experience gained as a result of loss events!

* Contractors have *widely varying* views on CAR insurance, some believe it to be onerous and unnecessary, while others deem it a necessity. (*This is borne out* specifically by the author in his work environment). In almost all instances, contractors believe that insurance premiums are far too high.

* *CAR insurance* cover seems market related. In times of high occurrences of natural catastrophies (e.g. Cyclone Demoina) and losses, CAR *insurance is* in demand and vice versa. In period of low demand, insurance cover tends to be broad, less restrictive and premium costs relatively low (depending on the type of risk to be insured).

* It appears that very little statistical research has been conducted on matters pertaining to CAR insurance.

* It is evident that there is a definite need to analyse *loss history* data in order to establish a guideline (with respect to premium and associated deductibles) for suitable CAR insurance protection.

The justification for this research topic lies within Gerathewohl's (1982) statement that, within the *engineering* market, there is a tendency for large losses to occur, including the fact that the probability of these losses occurring should be investigated by *determining* the loss history in each risk category.

The above observations clearly indicate that an opportunity exists for statistical research in the field of CAR insurance. *It is thus* the intention of the author to use this chance to investigate and analyse loss data to enable the construction industry to achieve a better *understanding of CAR* insurance and its ramifications.

3 STATISTICAL ANALYSIS OF RISKS

3.1 General

Hitherto, determination of premiums and associated deductibles have been based on a rather ad hoc rating guidance system for each kind of risk (road, dam, office block, etc.). This latter system was usually an "in-house" facility within each company, and was closely guarded to avoid exposure to competitors. It has not been possible for the author to divulge these ratings for each type of risk within the context of this research project; however, the system proposed in this chapter - to establish suitable rating parameters - may be seen as an ideal and easy reference method to simplify assessing the insurance terms for each type of risk.

Many similar civil engineering and building risks seem repetitive in nature, in other words, the same sequence of events would probably occur during the course of construction of say, various earth dams. During these similar operations, it is not only experience that is gained by the particular contractor (which would stand him in good stead in future similar projects), but these similar projects form a historical basis that could be established regarding design problems, mishaps, accidents, time delays and construction problems.

This historical basis could be of use to consulting engineers and contractors specialising in that particular field, but would be of definite use to the insurance industry.

Freeman (1989) further underlines the need for further research, particularly in the field of insurance losses, especially those claims that have presented serious problems.

When the insurance fraternity is approached to insure a large civil engineering risk, the first step is to establish the nature of the risk, e.g. is the particular risk a very exposed risk subject to damage from flooding or fire? If this is the case, the insurers would probably ascertain whether such a similar project was constructed in the past and what the particular claims history has been. This would then serve as a basis for the appropriate rate or premium and deductible for the project in question.

In view of the above comments, it would thus be advisable for the insurance industry to establish a data bank regarding similar projects and their related claims history. This project report sets out the first steps to be taken for the possible establishment of such a data bank.

3.2 Risk Underwriting for the Insurer

The art of establishing a suitable rate and deductible structure for a particular project requires the following:

* an insurer with suitable technical background and experience in the particular risk field;

* establishing the suitability of the contractor (know-how, past claims experience, reliability, completion on time);

* ascertaining the most exposed areas of the risk and the corresponding expected claims that could arise;

* investigating which sections of the project are carried out in the rainy season (jeopardy of flooding and storm damage) and which are carried out in the dry period (in general a much safer period);

* reviewing previous similar projects to establish possible causes of losses and to compare proposed rate or premium to be levied, together with the appropriate deductibles.

The above list may indeed be extended, but most of the above points are in the writer's viewpoint, the prime requirements. In many projects, however, a basis is required from which the underwriting level commences. An ideal base would be to consider a particular class of risk (i.e. a dam, or building) and to obtain as much relevant statistical data that would be of significance, such as information relating to:

* number of similar projects completed;

* total sums insured in each case;

* construction period per project;

* location of each project;

* number of claims per project;

* value of claims per project.

Information pertaining to the above items could be made available by reviewing the history of similar projects over, say, the last ten year period. This study would be time consuming, however, by means of computerisation of risk information (and corresponding claims) it would be possible to draw up such a statistical data bank.

3.3 Statistical Models

When assessing a risk, the insurer should be reasonably flexible regarding particular rates with particular deductibles, in other words, it is not a question of one single rate with one or more fixed deductibles for a particular project, but rather a rate and deductible proposal with one or more alternatives. A basic rate with appropriate deductibles may be adjusted, as an alternative, by a lower rate or rates with correspondingly higher deductibles.

The question now arises with which rate and deductible should the insurer commence and what other alternatives should he offer. By reviewing a statistical model for the particular risk in question, the insurer would be in a position to offer a rate equivalent to the minimum proposed by the model for a particular level of deductible applicable and as an alternative, propose a lower rate (once again, a minimum according to the model) with higher deductible.

The purpose of the statistical model is thus to recommend minimum rates each with its own level of deductible(s), for a particular type of risk (dam, building, etc.), as well as to consider other alternatives with higher rates and lower deductibles. All the data obtained from Munich Reinsurance is factual and was obtained by monitoring losses that actually occurred over a period of time on each type of risk considered in this chapter. Information relating to premium and deductibles for each risk was also supplied by Munich Reinsurance. It is the author's intention to establish a graphical relationship between the premium level and associated deductible for each type of risk, by combining the said risk data (i.e. losses, premiums and deductibles). These graphs could then be used as an easy reference to establish criteria for premium levels and associated deductibles for each type of risk.

The statistical model for a specific risk is prepared from data relating to the average expected number of claims that may occur on that particular risk. The more information relating to the type of risk, such as numbers of projects, value of claims per project, sum insured per project, number of claims per project, etc., that can be gathered, the more accurate the statistical model becomes.

25X1

The information that will be used for the statistical model was provided by the Munich Reinsurance Company, based in Munich, West Germany. The source of the data related to claims information that have been compiled by the insurance industry in order to assess the degree of profitability (from an insurance point of view) of various construction projects.

The aim of analysing this information was thus to establish a basis for calculating the probability of a loss occurrence; this could be done by observing for as many years as possible (Gerathewohl, 1982:162), the claims experience in each major civil engineering category (dams, tunnels, etc.) and adjusting the findings by means of technological assessments.

The information gathered for the statistical analysis was obtained by compiling all the claims details for a particular risk (say earth dams) in a tabular format (refer Section 3.3.1, Statistical Model for Earth Dams), in which losses (i.e. claims) and dates of these losses per structure (in this case, an earth dam) are indicated. From this data, basic statistical information could be ascertained. Other useful information, such as the number of similar risks, their sums insured and their respective contract periods has also been collated. Details of the statistical procedure adopted will be dealt with in the first model.

Statistical models for the following types of risks will be reviewed:

1. Earth dams;

2. Dams in conjunction with hydro-electric works;

3. Harbour works;

4. Construction works within harbour areas;

5. Underground railway tunnels;

6. Underground tunnels, mines and shaft sinking;

7. Bank and office buildings;

8. Multi-storey buildings.

At this stage, information pertaining to road and bridge risks has not yet been collated for statistical analysis and risk assessment will have to be based on the existing rating guidance system mentioned at the beginning of this chapter.

3.3.1 Statistical Model for Earth Dams

The construction of an earth dam is considered to be a highly exposed risk; it involves the temporary (or permanent) blocking off of the natural flow of a water course and this may lead to flooding and/or breaching problems. It may, therefore, be important to the contractor to establish when the most crucial sections of the construction have been planned to occur in terms of the highest expected rainfall period. Above all, it would be of great significance to the insurer to compare the dam under consideration with information that would be available from an earth dam statistical model.

A statistical model for earth dams could be established as follows:

A number of similar type earth fill dams could be considered to serve as a basis for comparison. For this

25X10

model we have (at present) nine dams, each of a different contract value and duration. A study has been made of the number and value of claims (in this case, 104) for each project. By means of statistical methods, a comparison has been made between the average claim value per contract and the average contract value. A datum level was thus established which defined the division between a possible profitable (from the insurer's viewpoint) insured project or a possible non-profitable (i.e. too many expected losses) insured project. This exercise was expanded further by altering the deductible levels.

Details regarding the establishment of the abovementioned datum level were obtained from Table 3.3.1.1, Loss History for Earth Dams. The table indicates the number of losses and their corresponding dates that have occurred in nine different (but similar) earth dam construction sites.

The contract value (in *Deutsche Mark (DM)*) and corresponding contract duration (in years) for each of the 9 contracts may be seen in Table 3.3.1.2. Note that the currency value of each contract has been converted into the same Deutsche Mark base value so that the data may be compared; the same has been done with the other losses listed in Table 3.3.1.1.

Please note that at the time of writing this report (August 1989), the following exchange rate applied:

1 Deutsche Mark = 0,746 Rand.

From Tables 3.3.1.1, 3.3.1.2 and 3.3.1.3, the information required to plot the statistical model may be derived.

Table 3.3.1.1 *Loss History for Earth Dams*

Dam 1 (*Nigeria*)		Dam 2 (Canada)		Dam 3 (Iraq)	
Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss
346 862	81.07.16	486 720	78.02.24	4 597 816	78.12.12
117 666	80.10.01			32 740	77.11.12
139 615	78.11.09			217 524	78.04.24
260 170	80.07.30			334 466	79.06.26
25 467	80.07.30			555 800	80.04.03
310 482	80.05.15				
91 460	80.12.21				
307 462	81.01.21				
243 425	80.03.16				
20 163	81.01.01				
146 928	80.04.09				
223 528	79.01.23				
217 112	81.02.09				
24 970	82.05.26				
256 890	82.05.26				
514 247	80.12.14				
304 660	81.07.15				
181 335	81.04.15				
350 910	81.07.16				
270 308	81.07.17				
171 661	81.02.24				
Total = 4 525 321		Total = 486 720		Total = 5 738 346	
No. of Losses = 21		No. of Losses = 1		No. of Losses = 5	

Table 3.3.1.1 Loss History for Earth Dams

Dam 4 (Australia)		Dam 5 (Canada)		Dam 6 (Cameroon)	
Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss
7 510	82.10.02	208 777	77.12.20	550 383	80.03.19
17 522	85.05.20	94 426	77.01.19	4 760	77.11.09
7 820	83.05.30	185 000	77.03.12	7 660	79.04.17
133 440	83.06.22			33 045	79.03.21
33 151	79.11.15			42 780	79.03.21
6 733	78.12.28			48 213	79.06.02
38 220	81.02.08			23 670	79.06.17
23 425	81.11.13			23 275	77.09.09
24 520	83.11.22			6 372	78.10.06
4 276	82.10.03			28 230	78.12.29
195 667	81.02.08			28 320	78.10.06
37 470	82.08.19			12 325	79.01.18
377 943	82.02.21			23 283	79.06.09
21 832	85.06.06			20 607	79.08.06
110 864	83.05.03			72 722	79.10.16
42 120	81.08.20			69 645	79.10.22
6 415	81.08.17			27 946	79.11.06
				19 725	79.12.08
				48 918	80.01.21
				26 221	80.01.05
				228 773	80.01.09
				19 820	80.01.02
				68 114	80.02.02
				10 400	80.01.18
				5 040	80.01.16
				8 383	80.06.18
				11 835	80.04.22
				24 735	80.03.19
				550 000	80.03.19
				9 192	80.04.21
				21 303	80.03.15
				29 056	80.03.04
				21 610	80.05.31
				4 208	80.06.23
				13 973	80.02.13
				15 600	80.07.13
				15 325	80.07.10
				11 345	80.07.08
				7 969	80.06.14
				15 325	80.07.26
				29 668	80.05.22
				14 100	80.06.04
				47 330	80.07.06
				4 886	80.08.29
				5 780	80.07.30
				6 137	80.01.01
				58 235	80.01.10
Total = 1 088 928 No. of Losses = 17		Total = 488 203 No. of Losses = 3		Total = 2 376 242 No. of Losses = 47	

Table 3.3.1.1 Loss History for Earth Dams					
Dam 7 (Venezuela)		Dam 8 (Libya)		Dam 9 (Indonesia)	
Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss	Loss Amount (DM)	Date of Loss
55 623	85.03.15	286 963	79.09.27	1 050 000	84.08.30
35 000	85.11.23	198 514	80.12.19	1 050 000	84.09.12
61 315	86.04.25	1 655 580	80.12.19	1 145 000	83.06.18
				410 000	83.02.15
Total = 151 938		Total = 2 141 057		Total = 3 655 000	
No. of Losses = 3		No. of Losses = 3		No. of Losses = 4	

Table 3.3.1.2 Sums Insured and Contract Periods of Earth Dams under Consideration

Dam No.	Contract Value (DM)	Contract Duration (years)
1	524 709 120	9,67
2	409 367 700	4,25
3	437 693 136	6,58
4	122 170 000	9,00
5	461 169 677	4,54
6	104 194 045	5,08
7	317 052 360	6,00
8	164 301 547	6,00
9	573 040 925	6,16
	Total = 3 113 698 510	Total = 57,28

Table 3.3.1.3 Loss Data for Earth Dams		
Total Number of Losses:		
Dam No.	No. of Losses	Loss Amount (DM)
1	21	4 525 321
2	1	486 720
3	5	5 738 346
4	17	1 088 928
5	3	488 203
6	47	2 376 242
7	3	151 938
8	3	2 141 057
9	4	3 655 000
9	104	20 651 755

Calculation of minimum rate with no deductible was carried out as follows:

$$\text{Deductible} = 0 \quad \text{Rate} = \frac{\text{Total loss amount (all risks)}}{\text{Total contract value (all risks)}}$$

$$= \frac{20\ 651\ 755}{3\ 113\ 698\ 510}$$

$$= 6{,}63255 \times 10^{-3}$$

Note that the rate is dimensionless.

This is the first point of the statistical model, for net rate only, which makes no allowance for mark-up, management and administrative expenses and business overheads; the net rate is then adjusted by means of a weighting factor (this may differ from company to company and/or country to country). From many years of experience, the policy of the Munich Reinsurance Company has been to apply a weighting factor of 66,7% which has also provided for a margin of safety within which the insurer has a moderate form of flexibility. If the loading factor of 1,667 is applied, the gross rate is calculated as follows:

Gross Rate (for deductible = 0) $= 1{,}667 \times 6{,}63255 \times 10^{-3}$

$= 11{,}05646 \times 10^{-3}$

$= 11{,}056\ 46$ per thousand

or

$= 11{,}0565$‰ *

* Where ‰ is an abbreviation for "per thousand".

This was the first point on the curve for Figure 3.3.1, Statistical Model for Earth Dams.

Other points for the model were then plotted; note that the deductible was defined in this particular case in terms of a fraction (here $^{1}/_{1000}$ or 10^{-3} or per mille) of the sum insured.

From a statistical point of view, we have a fairly small sample (9 separate contracts with 104 losses) which were used for our model.

As we have considered the application of the minimum (so-called "burning cost") rate for each kind of risk, we have to take the <u>average</u> contract value (also defined as the average sum insured) of all the various contracts into consideration, thus:

Average contract value (in DM) from Table 3.3.1.3 for 9 projects

$$= \frac{3\ 113\ 698\ 510}{9}$$

$$= 345\ 966\ 501{,}1$$

A second point for the model (Figure 3.3.1) was established as follows (note that the deductible level could commence at any suitable value above 0), for example:

Deductible: 0,01 per mille or $0{,}01 \times 10^{-3}$ of average contract value (in DM)

$$= 0{,}01 \times 10^{-3} \times 345\ 966\ 501{,}1$$

$$= 3\ 459{,}665$$

In order to calculate the corresponding rate (at $0{,}01 \times 10^{-3}$ of average contract value), it was necessary to consider the <u>*net loss*</u> (*i.e. the loss less the deductible just calculated*). This was done by deducting the sum of each individual loss from the total loss amount (refer to Table 3.3.1.3, Loss Data):

Total number of losses	=	104
Total loss amount (in DM)	=	20 651 755
Deductible, as calculated above (in DM)	=	3 459,665

The rate (at deductible $0{,}01 \times 10^{-3}$ of average contract value) was defined in terms of the following equation:

$$\frac{\text{Total loss amount} - \text{Deductible per loss}}{\text{Total Contract Value}}$$

$$= \frac{20\,651\,755 - 3\,459{,}665 \times 104}{3\,113\,698\,510}$$

$$= 6{,}51699 \times 10^{-3}$$

This value was once again a net rate and as for the first point, the gross rate became:

Gross Rate (for deductible $0{,}01 \times 10^{-3}$) $= 1{,}667 \times 6{,}51699 \times 10^{-3}$

$= 10{,}86383 \times 10^{-3}$

or

$= 10{,}863\,83‰$

This value was plotted on Figure 3.3.1.

Table 3.3.1.4 *Data for Statistical* Model for Earth Dams

Number of similar risks	9
Total sums insured (*monetary unit*)	$3{,}114 \times 10^9$
Average sum insured (monetary unit)	$3{,}46 \times 10^8$
Average *contract period* (years)	6,37
Rate without deductible Zo (per thousand)	11,056
Total loss amount, *all risks* (*monetary* unit)	$2{,}065 \times 10^7$
Total number of losses	104
Average number *of claims per risk*	11,56

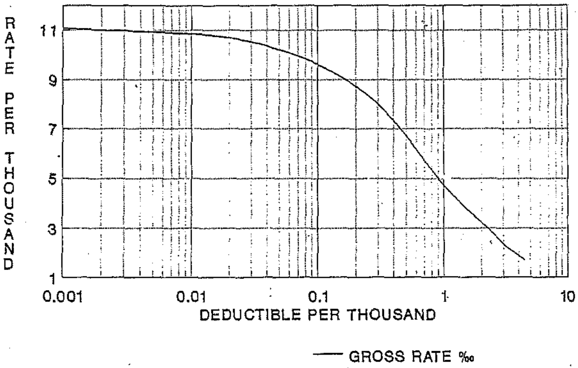

FIGURE 3.3.1 STATISTICAL MODEL FOR EARTH DAMS

The manual calculations of these points were tedious and in order to provide speed and flexibility with the various calculations, a computer programme was devised. This programme was adapted from a method developed by Munich Reinsurance Company to assess underwriting guidelines for civil engineers and construction projects and has been modified to suit calculations for each type of risk considered for the various models. Results of further calculations appear in tabular form in Appendix A1. Values appearing in these tables have been rounded off to give a better curve fit. Key data for the computer programme may be seen in Table 3.3.1.4.

In all these calculations relating to monetary values, such as Total Loss Amount, Deductible per Loss, Average Contract Value, Total Contract Value, etc., a currency unit (in the example, Deutsche Mark) was required. The deductibles in Figure 3.3.1 and Appendix A1 were expressed in terms of the contract value and its corresponding monetary unit, therefore, the statistical model may be used with any currency.

The values calculated in Appendix A1 were then plotted to establish the full extent of the statistical model, which may be found in Figure 3.3.1.

The result of the above exercise was thus the establishment of a series of datum points, each datum point represented the cut-off between expected losses (i.e. low rates) and expected profitability (i.e. higher rates).

Note that the profile of Figure 3.3.1 was that of a lognormal distribution. It may be seen that this would also be the case for the other types of civil engineering projects to be considered in the following sections. This type of distribution was to be expected, as the rate should decrease as the deductible increases.

In order to highlight the practical use of Figure 3.3.1, the following example was considered:

Example 3.3.1

The construction of a large earth fill dam was proposed. The estimated contract price was R60 million. The contractor wished to establish the insurance premium for insuring the project on a Contractor's All Risk basis.

A twofold solution to the above example was found by proposing a suitable rate (and then calculating the premium) and utilizing Figure 3.3.1 to deduce the appropriate deductible and vice versa. Thus a proposed rate of 5,4‰ (per thousand, compared with % which is per hundred) would require a deductible of 0,78‰ of the sum insured. Calculations or terms then became:

Rate = 5,4‰

Premium = 5,4‰ x R60 million
= R324 000

Deductible = 0,78‰ x R60 million
= R 46 800.

It should be borne in mind that the above terms were not to be *considered obligatory*. Other factors, such as, inter alia, experience of contractor, adverse weather and/or flooding conditions, duration of contract, earthquake danger and above all, the judgement of the insurer, might influence the final decision regarding the suitability of the proposed terms. In cases where terms would be offered to the contract which were less than those proposed by utilizing Figure 3.3.1, there would be no guarantee that the project would in fact be non-profitable (from the insurer's viewpoint); however, the *lognormal* distribution is a probability distribution and there would thus be a high probability that the project would be non-profitable should terms be offered which fall within the distribution.

Detail has been provided for the statistical model for earth dams. This, however, was not deemed necessary for the other following models.

3.3.2 Statistical Model for Dams in Conjunction with Hydro-Electric Works

For this model, information relating to thirteen dams and 154 claims have been analysed, from which Figure 3.3.2 has been deduced. As may be seen, the distribution was once again that of a lognormal distribution.

Details of the statistical data may be found in Table 3.3.2 and the derivation of the distribution appears in Appendix B. Once again the net rate has been adjusted by a weighing factor of 1,667 (as for the Earth Dam Model) resulting in the overall or bruto rate. This was the case for all the proposed models for this project.

Figure 3.3.2 was very similar to Figure 3.3.1, as may be expected. However, earth dams are more exposed to scour, overtopping and breaching damage compared with dams used in conjunction with hydro-electric works, the latter usually being constructed of concrete. Thus it may be expected that a slightly higher premium would be charged for earth dams, which was in fact the case.

Table 3.3.2 Data for Statistical Model for Dams in conjuction with Hydro-Electric Works

Number of similar risks	13
Total sums insured (monetary unit)	7,763 $\times 10^{9}$
Average sum insured (monetary unit)	5,971 $\times 10^{8}$
Average contract period (years)	6,1
Rate without deductible ‰ (per thousand)	9,726
Total loss amount, all risks (monetary unit)	4,529 $\times 10^{7}$
Total number of losses	154
Average claim amount per risk (monetary unit)	2,9409 $\times 10^{5}$
Average number of claims per risk	11,86

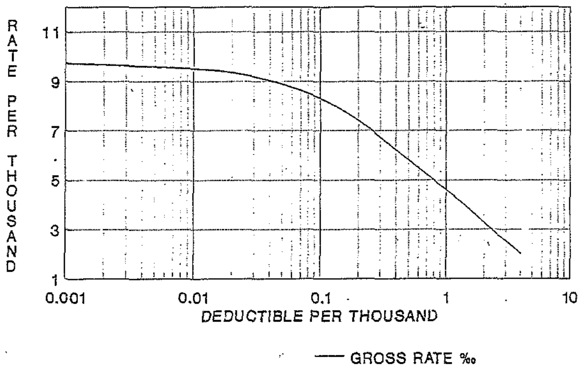

FIGURE 3.3.2 STATISTICAL MODEL FOR DAMS IN CONJUNCTION WITH HYDRO-ELECTRIC WORKS

3.3.3 Statistical Model for Harbour Works

For the derivation of Figure 3.3.3, information relating to twenty different projects and a total number of 169 claims was evaluated. Details of the derivation appear in Table 3.3.3 in summarised form and in Appendix C in more detail.

In this case the analysis resulted in a flat lognormal distribution, which indicated that small increases in the rate would have a considerable effect on the deductible. The level of the deductible was thus very sensitive to small changes in the rate.

Table 3.3.3 Data for Statistical *Model for* Harbour Works	
Number of similar risks	20
Total sums insured (monetary unit)	$8{,}231 \times 10^9$
Average sum insured (monetary unit)	$4{,}115 \times 10^8$
Average contract period (years)	3,46
Rate without deductible ‰ (per *thousand*)	5,450
Total loss amount, *all risks* (monetary unit)	$2{,}691 \times 10^7$
Total number of losses	169
Average claim amount per risk (monetary unit)	$1{,}693 \times 10^5$
Average number of claims per risk	8,45

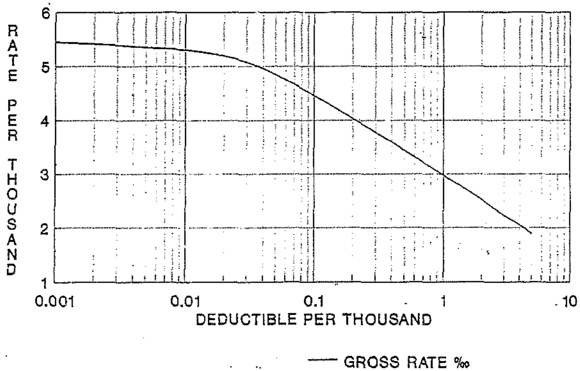

FIGURE 3.3.3 STATISTICAL MODEL FOR HARBOUR WORKS

3.3.4 Statistical Model for Construction Works within Harbour Areas

Projects under this heading include the construction of dry docking areas, jetties and quays within the harbour area and general protection construction works. The number of projects and dams utilized for calculating the lognormal distribution were 26 and 186 respectively. The distribution has been depicted in Figure 3.3.4.

Details of the derivation may be found in Figure 3.3.4 and Appendix D.

This distribution was not as flat as the one in Figure 3.3.3, however, the rate level was much higher than the casa of normal harbour works.

Table 3.3.4 *Data for Statistical Model for Construction Works within Harbour Areas*

Number of similar risks	26	
Total sums insured (monetary unit)	9,29	$\times 10^{9}$
Average sum insured (monetary unit)	3,574	$\times 10^{8}$
Average contract period (years)	3,93	
Rate without deductible Zo (per thousand)	5,531	
Total loss amount, all risks (monetary unit)	4,21	$\times 10^{7}$
Total number of losses	186	
Average claim amount per risk (monetary unit)	2,276	$\times 10^{5}$
Average number of claims per risk	7,19	

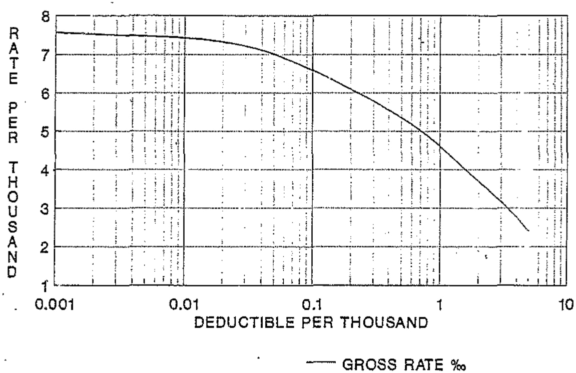

FIGURE 3.3.4 STATISTICAL MODEL FOR CONSTRUCTION WORKS WITHIN HARBOUR AREAS

3.3.5 **Statistical Model for Underground Railway Tunnels**

Underground railway tunnels have been a fairly new field of construction risk analysis and for this reason data was only available for two risks, with a total number of fifty-two losses.

Detailed data may be found in Table 3.3.5 and Appendix E. The lognormal distribution was as depicted in Figure 3.3.5. The distribution was somewhat uneven and could probably be attributed to the small sample population. Better results could be expected if the sample size were increased.

Table 3.3.5	*Data for Statistical Model for Underground Railway Tunnels*
Number of similar risks	2
Total sums insured (monetary unit)	2,938 $\times 10^9$
Average *sum insured (monetary* unit)	1,469 $\times 10^9$
Average contract period (years)	6,25
Rate without deductible ‰ (per thousand)	5,257
Total loss amount, *all risks (monetary* unit)	9,265 $\times 10^6$
Total number of losses	52
Average claim amount per risk (monetary unit)	1,782 $\times 10^5$
Average number of claims per risk	26

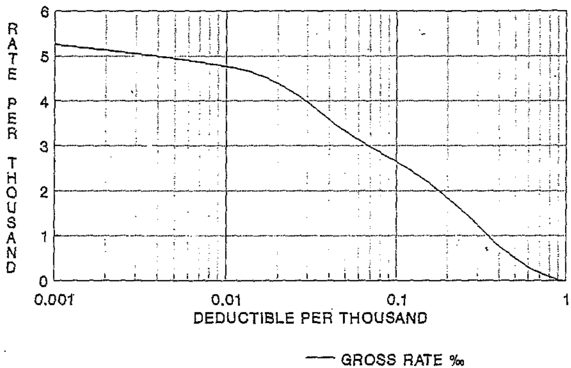

FIGURE 3.3.5 STATISTICAL MODEL FOR UNDERGROUND RAILWAY TUNNELS

3.3.6 Statistical Model for Underground Tunnels, Mines and Shaft Sinking

For this analysis eight different risks with a total number of sixty-eight claims were evaluated. Statistical data may be found in Table 3.3.6 and Appendix F and the lognormal distribution was depicted in Figure 3.3.6.

Comparison of Figure 3.3.6 with Figure 3.3.5 revealed significant differences; the rating for the former was much higher than for the latter. Exposure to losses was thus much higher in the case of underground tunnels and shaft sinking.

Table 3.3.6 Data for Statistical Model for Underground Tunnels, Mines and Shaft Sinking

Number of similar risks	8
Total sums insured (monetary unit)	$3{,}623 \times 10^9$
Average sum insured (monetary unit)	$4{,}528 \times 10^8$
Average contract period (years)	4,77
Rate without deductible %o (per thousand)	1,667
Total loss amount, all risks (monetary unit)	$1{,}528 \times 10^7$
Total number of losses	68
Average claim amount per risk (monetary unit)	2,24[illegible] $\times 10^5$
Average number of claims per risk	4,50

25X1

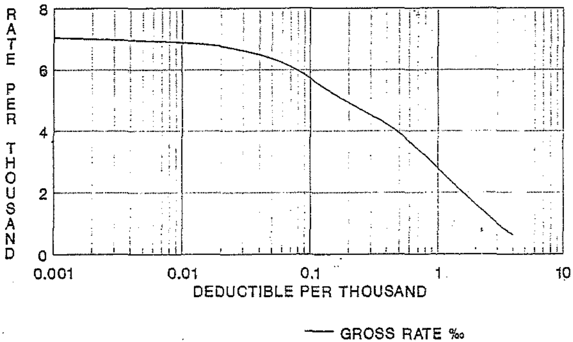

FIGURE 3.3.6 STATISTICAL MODEL FOR UNDERGROUND TUNNELS, MINES AND SHAFT SINKING

3.3.7 Statistical Model for Bank and Office Buildings

These types of structures appear to be more common than *those mentioned* in previous models and there are thus a larger number of risks that may be analysed which in turn leads to a more representative lognormal distribution.

Details appear in Table 3.3.7.

Thus distribution is represented by Figure 3.3.7 and the calculations appear in Appendix G.

It is of importance to note that the proposed rating appearing in Figure 3.3.7 is significantly reduced compared to the previous statistical models. *The reason for this is* that structures such as banks and office buildings are not as exposed to possible severe loss situations such as earth dams (e.g. flooding, breaching, etc.) or tunnels (e.g. collapse), i.e. the probable maximum loss (so called "P.M.L.") for office buildings is much less than that of dams, tunnels, shafts, bridges, harbour works, etc. The main loss situations for these buildings are fire, storm and/or water damage, collapse of excavated basement foundations, etc.

Data compiled for Figure 3.3.7 was derived from analysing 33 different risks with a total number of 223 losses.

Table 3.3.7 Data for Statistical Model for Bank and Office Buildings

Number of similar risks	33	
Total sums insured (monetary unit)	8,425	$\times 10^9$
Average sum insured (monetary unit)	2,553	$\times 10^8$
Average contract period (years)	3,14	
Rate without deductible ‰ (per thousand)	4,489	
Total loss amount, all risks (monetary unit)	2,2690	$\times 10^7$
Total number of losses	223	
Average claim amount per risk (monetary unit)	1,01749	$\times 10^5$
Average number of claims per risk	6,758	

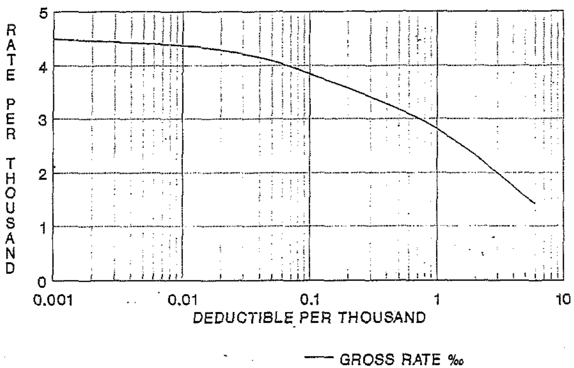

FIGURE 3.3.7 STATISTICAL MODEL FOR BANK AND OFFICE BUILDINGS

3.3.8 **Statistical Model for Multi-Storey Buildings**

Multi-storey buildings include the following:

Blocks of flats and offices,
Shopping centres,
Schools,
Universities,
Hospitals,
Airport buildings and
Hotels.

The population size for this model was large, viz. 74 risks with a total number of 430 claims. Results from this model would thus be more accurate than with any of the previous models. The distribution was once again of the lognormal type and was represented by Figure 3.3.8. Calculations may be found in Appendix H and a summary of the key data may also be found in Table 3.3.8.

Table 3.3.8 Data for Statistical Model for Multi-Storey *Buildings*	
Number of similar risks	74
Total sums insured (monetary unit)	1,704 $\times 10^{10}$
Average sum insured (monetary unit)	2,303 $\times 10^{8}$
Average contract period (years)	2,957
Rate without deductible ‰ (per thousand)	4,253
Total loss amount, all risks (monetary unit)	4,347 $\times 10^{7}$
Total number of losses	430
Average claim amount per risk (monetary unit)	1,011 $\times 10^{5}$
Average number of claims per risk	5,81

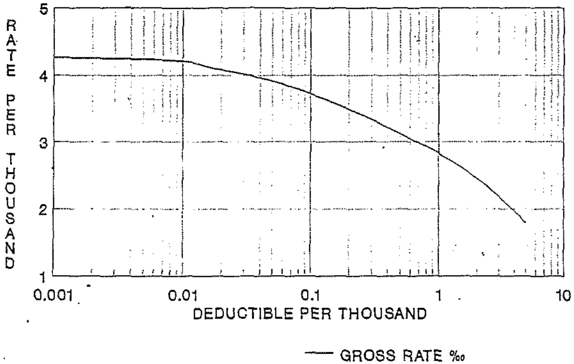

FIGURE 3.3.8 STATISTICAL MODEL FOR MULTI-STOREY BUILDING

3.3.9 Conclusion to Statistical Models

The eight models described were by no means the final proposals for the various types of projects. Each model could further be improved upon if the number of samples (i.e. the number of risks with corresponding losses) were increased. The information pertaining to each sample or risk was of a historical nature and as time progresses, it would be possible to expand on the sample size.

There appear to be also several other projects or risks in the civil engineering field for which statistical models could be prepared; these include items such as bridges, roadworks, construction plant and housing complexes. There may thus be scope to expand the statistical models to cover almost all the fields of the civil engineering and building industry.

4. RESULTS

4.1 General

It should be noted from the various statistical models discussed in Chapter 3, that the average number of claims for each type of risk was relatively high; it would be informative to summarise these as follows:

Risk	Number of Claims Per Risk
Earth Dams	11,56
Dams with Hydro-Electric Works	11,86
Harbour Works	8,45
Construction Works in Harbours	7,19
Underground Railway Tunnels	26,00
Tunnels, Mines and Shaft Sinking	4,50
Bank and Office Buildings	6,76
Multi-Storey Buildings	5,81

From this summary it may be seen that the probability of a risk occurring on any of the above risk classes would be fairly high (especially the "wet risks", such as dams and harbour works and also underground works such as tunnels and mining operations), which underlines the necessity of CAR insurance in these cases.

4.2 Summary

The following observations can be made from the statistical model analyses:

* in all cases, the higher the rate (or premium), the lower the deductible; in other words as the rate increased, the deductible decreased;

* in graphical form, each statistical model was affected by the number of similar risks *analysed, together with* the number of associated losses; the greater the number, the smoother (i.e. better fitting) the curve;

* each statistical model was independent of a monetary unit and would thus be universally acceptable;

* each *statistical model represented* (in graphical form) the "burning costs" associated with each type of risk; the area below each curve designated a high probability loss zone and rates and deductibles falling within this zone should be avoided by insurers;

* in the case of building projects, losses were less frequent and the average claim amount per risk was less by comparision with higher exposed risks such as earth dams;

* values (rates and deductibles) for curves for buildings were lower than for exposed risks such as dams and harbour works;

* results indicated that similar exercises would be possible with *other* civil engineering projects, such as roads and bridges, as well as other building projects such as factories, warehouses and housing;

* rates and deductibles presented in graphical format provide a reliable source of the minimum terms required for the type of project under consideration; these terms could be **"proved"** *by reference and are thus not subject* to the whim of the insurer.

* a weighing factor (in our example 67%) could be incorporated into the calculations thereby giving a safety margin; this margin is flexible andcould be adapted to suit prevailing circumstances.

5. CONCLUSIONS

5.1 Summary and Conclusions

In view of the evidence that losses occurred on all different types of construction projects (as vindicated by the number of actual losses used in the statistical model analyses), the author would advise that CAR insurance should be taken seriously by all institutions (contractors, consultants and developers) within the construction industry, especially on major construction projects.

Cognizance should also be taken of the fact that construction risks are becoming larger (for instance, toll road projects, extensive shopping complexes and office developments such as Johannesburg's Bank City project), resulting in larger construction periods which in turn lead to greater exposures from natural hazards such as flooding and storm damage. CAR insurance protection in these instances, is in the author's opinion, a necessity and the principal and/or consultant should insist that the contractors procure adequate insurance.

On large civil engineering and building contracts, the contractor has usually been compelled to take out CAR insurance cover and such insurance has been compulsory when the General Conditions of Contract 1982 (for use in connection with Works of Civil Engineering Construction), have been applied to the project. In such cases, the viability of insuring a project would be limited to the type of insurance the contractor wished to have, i.e. would he require complete insurance (market related premiums with corresponding deductibles), or only "catastrophe" type of cover with very low premiums and high deductibles? These two options (with variations in between) would be at the contractor's entire discretion.

The insurers, however, may not wish to provide this type of "catastrophe" cover and the contractor then has little choice, but to avail himself of usual insurances available in the market.

Furthermore, the insurers are in a strong position (and will be even more so in future) to analyse the insurability of a particular construction project. The kind of information obtained from the statistical models of Chapter 3, enables the insurers to assess the minimum insurance requirements of a particular type of risk, be it a dam, building or tunnel. The statistical models are based on information relating to the number of projects and concomitant claims and are a powerful tool in risk assessment. As mentioned in Chapter 3.3.9, Conclusion to Statistical Models, the sample size of models are increasing all the time as new projects are completed. This in turn not only leads to more accurate statistical models, but also opens the door for further different types of projects to be analysed.

As far as insurers are concerned, there seems thus a need for contractors to utilize the insurance protection offered by a CAR policy. This statement is not made to underline the existence of the insurance industry, but in view of the large number of losses (refer to each statistical model) that have been occurring at various projects, it seems evident that contractors should not consider insurance as an unnecessary expense.

5.2 *Future Developments*

Building and civil engineering projects will continue to be constructed and losses and claims related to these projects will continue to occur. Keeping historical track of this project and loss data, insurers will have at their disposal, statistically accurate information, which will enable them not only to provide realistic terms to the construction industry, but also to provide guidance to contractors in terms of the type and occurrence of claims.

There is thus vast scope for the improvement and expansion of the statistical models developed in this study.

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DATA FILE: EARTH DAMS

Total Sums Insured	=	0,3114E10 (Currency Unit (CU))
PML Loss Share	=	0,000 (%o)
Total Contract Periods (years)	=	57,3
Average Sum Insured (SI)	=	0,3460E9 (CU)
Total Loss Amount (All Risks)	=	0,2065E8 (CU)
Average Claim Amount (Per Risk)	=	0,1986E6 (CU)
Average SI Per Contract Period	=	0,3463E9 (CU)
Gross Rate Loading Factor	=	1,667

APPENDIX A2

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	6,63255	11,05646
0,01000	6,51699	10,86383
0,01500	6,46011	10,76900
0,02000	6,40612	10,67901
0,02500	6,35515	10,59404
0,03000	6,30609	10,51225
0,03500	6,25808	10,43222
0,04000	6,21135	10,35432
0,04500	6,16582	10,21834
0,05000	6,12192	10,20525
0,05500	6,07852	10,13289
0,06000	6,03606	10,06211
0,06500	5,99582	9,99503
0,07000	5,95741	9,93100
0,07500	5,92150	9,87114
0,08000	5,88597	9,81358
0,08500	5,85383	9,75834
0,09000	5,82208	9,70541
0,09500	5,79046	9,65269
0,10000	5,76031	9,60244
0,15000	5,48443	9,14255
0,20000	5,23963	8,73446
0,25000	5,01613	8,36189
0,30000	4,80081	8,00306
0,35000	4,59415	7,65844
0,40000	4,39573	7,32769
0,45000	4,20926	7,01684
0,50000	4,02635	6,71193
0,55000	3,85315	6,42319
0,60000	3,69322	6,15659
0,65000	3,54812	5,91472
0,70000	3,41909	5,69963
0,75000	3,29730	5,49660
0,80000	3,18804	5,31447
0,85000	3,08477	5,14231
0,90000	2,98847	4,98177
0,95000	2,90513	4,84286
1,00000	2,82549	4,71010
1,50000	2,24909	3,74923
2,00000	1,93941	3,23299
2,50000	1,66163	2,76994
3,00000	1,38385	2,30688
3,50000	1,23057	2,05136
4,00000	1,11946	1,86614
4,50000	1,00835	1,68092

APPENDIX B1

DATA FILE: DAMS IN CONJUNCTION WITH HYDRO-ELECTRIC WORKS

Total Sums Insured	= 0,7763E10 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 80,3
Average Sum Insured (SI)	= 0,5971E9 (CU)
Total Loss Amount (All Risks)	= 0,4529E8 (CU)
Average Claim Amount (Per Risk)	= 0,2941E6 (CU)
Average SI Per Contract Period	= 0,6213E9 (CU)
Gross Rate Loading Factor	= 1,667

APPENDIX B2

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	5,83454	9,72617
0,01000	5,71696	9,53017
0,01500	5,66205	9,43864
0,02000	5,60923	9,35059
0,02500	5,55787	9,26498
0,03000	5,50812	9,18204
0,03500	5,45931	9,10067
0,04000	5,41287	9,02325
0,04500	5,36934	8,95069
0,05000	5,32743	8,88083
0,05500	5,28667	8,81288
0,06000	5,24710	8,74691
0,06500	5,20899	8,68339
0,07000	5,17289	8,62321
0,07500	5,13821	8,56540
0,08000	5,10404	8,50844
0,08500	5,07076	8,45296
0,09000	5,03768	8,39781
0,09500	5,00491	8,34319
0,10000	4,97400	8,29166
0,15000	4,69732	7,83043
0,20000	4,44620	7,41181
0,25000	4,22450	7,04223
0,30000	4,03070	6,71917
0,35000	3,86527	6,44340
0,40000	3,72162	6,20395
0,45000	3,59479	5,99251
0,50000	3,48069	5,80231
0,55000	3,37723	5,62984
0,60000	3,28272	5,47229
0,65000	3,20086	5,33584
0,70000	3,12497	5,20932
0,75000	3,05311	5,08953
0,80000	2,98387	4,97412
0,85000	2,91917	4,86626
0,90000	2,86062	4,76865
0,95000	2,80881	4,68228
1,00000	2,76265	4,60534
1,50000	2,31323	3,85615
2,00000	1,94527	3,24276
2,50000	1,68700	2,81223
3,00000	1,50380	2,50683
3,50000	1,34995	2,25037
4,00000	1,19611	1,99391

APPENDIX C1

DATA FILE: HARBOUR WORKS

Total Sums Insured = 0,8231E10 (Currency Unit (CU))

PML Loss Share = 0,000000 (%o)

Total Contract Periods (years) = 7 074,3

Average Sum Insured (SI) = 0,4115E9 (CU)

Total Loss Amount (All Risks) = 0,2691E8 (CU)

Average Claim Amount (Per Risk) = 0,1693E6 (CU)

Average SI Per Contract Period = 0,6704E7 (CU)

Gross Rate Loading Factor = 1,667

DEDUCTIBLE (%.)	NET RATE %.	GROSS RATE %.
0,00000	3,26953	5,45031
0,01000	3,19003	5,31779
0,01500	3,15059	5,24203
0,02000	3,11198	5,18767
0,02500	3,07532	5,12656
0,03000	3,03991	5,06753
0,03500	3,00529	5,00982
0,04000	2,97079	4,95231
0,04500	2,93658	4,89529
0,05000	2,90339	4,83996
0,05500	2,87248	4,78843
0,06000	2,84532	4,74314
0,06500	2,81970	4,70044
0,07000	2,79557	4,66022
0,07500	2,77226	4,62136
0,08000	2,74964	4,58364
0,08500	2,72873	4,54879
0,09000	2,70881	4,51558
0,09500	2,68980	4,48389
0,10000	2,67167	4,45368
0,15000	2,52169	4,20365
0,20000	2,41424	4,02453
0,25000	2,32834	3,88133
0,30000	2,25942	3,766[illegible]
0,35000	2,20059	3,66839
0,40000	2,14887	3,58217
0,45000	2,10350	3,50653
0,50000	2,06041	3,43471
0,55000	2,01820	3,36433
0,60000	1,98275	3,30524
0,65000	1,95203	3,25404
0,70000	1,92203	3,20403
0,75000	1,89363	3,15668
0,80000	1,86831	3,11447
0,85000	1,84581	3,07696
0,90000	1,82331	3,03945
0,95000	1,80081	3,00195
1,00000	1,77831	2,96444
1,50000	1,62429	2,70769
2,00000	1,50718	2,51247
2,50000	1,40718	2,34577
3,00000	1,33092	2,21865
3,50000	1,28092	2,13530
4,00000	1,23092	2,05195
4,50000	1,18092	1,96860
5,00000	1,13092	1,88525

APPENDIX D1

DATA FILE: WORKS WITHIN HARBOUR AREAS.

Total Sums Insured	= 0,9292E10 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 102,2
Average Sum Insured (SI)	= 0,3574E9 (CU)
Total Loss Amount (All Risks)	= 0,4210E8 (CU)
Average Claim Amount (Per Risk)	= 0,2276E6 (CU)
Average SI Per Contract Period	= 0,4622E7 (CU)
Gross Rate Loading Factor	= 1,667

APPENDIX D2

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	4,53128	7,55365
0,01000	4,46013	7,43503
0,01500	4,42459	7,37579
0,02000	4,38960	7,31746
0,02500	4,35549	7,26059
0,03000	4,32252	7,20564
0,03500	4,29048	7,15223
0,04000	4,25904	7,09983
0,04500	4,22770	7,04757
0,05000	4,19647	6,99552
0,05500	4,16583	6,94444
0,06000	4,13593	6,89459
0,06500	4,10866	6,84914
0,07000	4,08328	6,80683
0,07500	4,05909	6,76650
0,08000	4,03587	6,72780
0,08500	4,01342	6,69036
0,09000	3,99167	6,65412
0,09500	3,97069	6,61915
0,10000	3,95081	6,58601
0,15000	3,78195	6,30452
0,20000	3,65264	6,08895
0,25000	3,54917	5,91646
0,30000	3,46430	5,77499
0,35000	3,39061	5,65215
0,40000	3,32446	5,54187
0,45000	3,26308	5,43956
0,50000	3,20617	5,34468
0,55000	3,15293	5,25593
0,60000	3,10100	5,16937
0,65000	3,05083	5,08573
0,70000	3,00505	5,00942
0,75000	2,96246	4,93842
0,80000	2,92015	4,86790
0,85000	2,87873	4,79885
0,90000	2,83879	4,73227
0,95000	2,80210	4,67111
1,00000	2,76557	4,61020
1,50000	2,43036	4,05140
2,00000	2,214[illegible]4	3,69097
2,50000	2,04705	3,41244
3,00000	1,89321	3,15598
3,50000	1,76388	2,94039
4,00000	1,64850	2,74805
4,50000	1,53337	2,55612
5,00000	1,43721	2,39583

DATA FILE: UNDERGROUND RAILWAY TUNNELS

Total Sums Insured	= 0,2938E10 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 12,5
Average Sum Insured (SI)	= 0,1469E10 (CU)
Total Loss Amount (All Risks)	= 0,9265E7 (CU)
Average Claim Amount (Per Risk)	= 0,1782E6 (CU)
Average SI Per Contract Period	= 0,1826E10 (CU)
Gross Rate Loading Factor	= 1,667

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	3,15344	5,25679
0,01000	2,89344	4,82337
0,01500	2,76344	4,60666
0,02000	2,63344	4,38995
0,02500	2,50552	4,17670
0,03000	2,37847	3,96491
0,03500	2,25725	3,76284
0,04000	2,14542	3,57641
0,04500	2,05605	3,42743
0,05000	1,98863	3,31504
0,05500	1,93022	3,21768
0,06000	1,87723	3,12935
0,06500	1,82574	3,04351
0,07000	1,78014	2,96749
0,07500	1,73938	2,89955
0,08000	1,70046	2,83467
0,08500	[illegible],66546	2,77633
0,09000	1,63390	2,72371
0,09500	1,60770	2,68004
0,10000	1,58270	2,63837
0,15000	1,33270	2,22162
0,20000	1,09591	1,82689
0,25000	0,91331	1,52249
0,30000	0,73831	1,23077
0,35000	0,57919	0,96552
0,40000	0,44258	0,73777
0,45000	0,36744	0,61253
0,50000	0,29244	0,48750
0,55000	0,22296	0,37167
0,60000	0,17296	0,28832
0,65000	0,12512	0,20858
0,70000	0,10012	0,16691
0,75000	0,07512	0,12523
0,80000	0,05012	0,08356
0,85000	0,02512	0,04188
0,90000	0,00012	0,00021
0,95000	0,00000	0,00000
1,00000	0,00000	0,00000

APPENDIX F1

DATA FILE: UNDERGROUND TUNNELS, MINES AND SHAFT SINKING

Total Sums Insured	= 0,3623E10 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 38,2
Average Sum Insured (SI)	= 0,4528E9 (CU)
Total Loss Amount (All Risks)	= 0,1528E8 (CU)
Average Claim Amount (Per Risk)	= 0,2248E6 (CU)
Average SI Per Contract Period	= 0,6628E7 (CU)
Gross Rate Loading Factor	= 1,667

APPENDIX F2

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	4,21922	7,03344
0,01000	4,13422	6,89175
0,01500	4,09172	6,82090
0,02000	4,04922	6,75005
0,02500	4,00672	6,67920
0,03000	3,96438	6,60863
0,03500	3,92323	6,54002
0,04000	3,88345	6,473[illegible]
0,04500	3,84470	6,40912
0,05000	3,80655	6,34551
0,05500	3,76842	6,28196
0,06000	3,73030	6,21840
0,06500	3,69217	6,15485
0,07000	3,65434	6,09179
0,07500	3,61684	6,02927
0,08000	3,57934	5,96676
0,08500	3,54184	5,90425
0,09000	3,50434	5,84173
0,09500	3,46691	5,77934
0,10000	3,43004	5,71787
0,15000	3,12856	5,21532
0,20000	2,94791	4,91416
0,25000	2,81079	4,68559
0,30000	2,70261	4,50526
0,35000	2,61511	4,35939
0,40000	2,52761	4,21353
0,45000	2,44011	4,06767
0,50000	2,35261	3,92181
0,55000	2,26511	3,77594
0,60000	2,17918	3,63269
0,65000	2,10112	3,50257
0,70000	2,02635	3,37793
0,75000	1,96380	3,27365
0,80000	1,90130	3,16946
0,65000	1,83880	3,06527
0,90000	1,77630	2,96108
0,95000	1,71380	2,85690
1,00000	1,65130	2,75271
1,50000	1,23340	2,05608
2,00000	0,95234	1,58755
2,50000	0,75300	1,25526
3,00000	0,57543	0,95925
3,50000	0,45043	0,75087
4,00000	0,37500	0,62526

DATA FILE: BANK AND OFFICE BUILDINGS

Total Sums Insured	= 0,8425E10 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 103,5
Average Sum Insured (SI)	= 0,2553E9 (CU)
Total Loss Amount (All Risks)	= 0,2269E8 (CU)
Average Claim Amount (Per Risk)	= 0,1017E6 (CU)
Average SI Per Contract Period	= 0,3229E9 (CU)
Gross Rate Loading Factor	= 1,667

APPENDIX G2

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	2,69284	4,48896
0,01000	2,62528	4,37634
0,01500	2,59487	4,32565
0,02000	2,56845	4,28161
0,02500	2,54483	4,24223
0,03000	2,52282	4,20553
0,03500	2,50237	4,17146
0,04000	2,48336	4,13976
0,04500	2,46508	4,10929
0,05000	2,44720	4,07948
0,05500	2,42984	4,05054
0,06000	2,41350	4,02331
0,06500	2,39767	3,99691
0,07000	2,38243	3,97151
0,07500	2,36763	3,94683
0,08000	2,35340	3,92312
0,08500	2,33998	3,90074
0,09000	2,32699	3,87909
0,09500	2,31522	3,85947
0,10000	2,30372	3,84030
0,15000	2,20956	3,68333
0,20000	2,14274	3,57195
0,25000	2,08518	3,47600
0,30000	2,03811	3,39753
0,35000	1,99721	3,32935
0,40000	1,96051	3,26817
0,45000	1,92824	3,21437
0,50000	1,89724	3,16270
0,55000	1,86953	3,11650
0,60000	1,84567	3,07673
0,65000	1,82439	3,04126
0,70000	1,80318	3,00590
0,75000	1,78197	2,97054
0,80000	1,76076	2,93518
0,85000	1,73955	2,89982
0,90000	1,71920	2,86591
0,95000	1,70023	2,83428
1,00000	1,68205	2,80397
1,50000	1,51311	2,52236
2,00000	1,38661	2,31148
2,50000	1,28055	2,13468
3,00000	1,19214	1,98730
3,50000	1,11639	1,86102
4,00000	1,04063	1,73473
4,50000	0,97346	1,62275
5,00000	0,92057	1,53460
6,00000	0,84523	1,40900

DATA FILE: MULTI-STOREY BUILDINGS

Total Sums Insured	= 0,1704E11 (Currency Unit (CU))
PML Loss Share	= 0,000000 (%o)
Total Contract Periods (years)	= 218,8
Average Sum Insured (SI)	= 0,2303E9 (CU)
Total Loss Amount (All Risks)	= 0,4347E8 (CU)
Average Claim Amount (Per Risk)	= 0,1011E6 (CU)
Average SI Per Contract Period	= 0,2997E9 (CU)
Gross Rate Loading Factor	= 1,667

DEDUCTIBLE (‰)	NET RATE ‰	GROSS RATE ‰
0,00000	2,55130	4,25302
0,01000	2,49403	4,25302
0,01500	2,46775	4,11374
0,02000	2,44515	4,07606
0,02500	2,42479	4,04213
0,03000	2,40614	4,01104
0,03500	2,38898	3,98242
0,04000	2,37323	3,95618
0,04500	2,35843	3,93150
0,05000	2,34452	3,90832
0,05500	2,33112	3,88598
0,06000	2,31809	3,86425
0,06500	2,30594	3,84400
0,07000	2,29426	3,82453
0,07500	2,28302	3,80579
0,08000	2,27216	3,78769
0,08500	2,26151	3,76994
0,09000	2,25136	3,75302
0,09500	2,24154	3,73664
0,10000	2,23202	3,72077
0,15000	2,15363	3,59010
0,20000	2,09248	3,48817
0,25000	2,04135	3,40293
0,30000	1,99857	3,33162
0,35000	1,96135	3,26957
0,40000	1,92809	3,21412
0,45000	1,89824	3,16436
0,50000	1,87107	3,11908
0,55000	1,84523	3,07600
0,60000	1,82262	3,03831
0,65000	1,80263	3,00498
0,70000	1,78554	2,97649
0,75000	1,76940	2,94960
0,80000	1,75386	2,92369
0,85000	1,73832	2,89778
0,90000	1,72324	2,87264
0,95000	1,70337	2,84786
1,00000	1,69407	2,82401
1,50000	1,57299	2,62217
2,00000	1,46800	2,44715
2,50000	1,38592	2,31032
3,00000	1,30689	2,17858
3,50000	1,23718	2,06238
4,00000	1,17631	1,96091
4,50000	1,12226	1,87080
5,00000	1,07259	1,78801

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