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Nuclear energy and insurance[1]

by

H. W. FRANCIS

Introduction

The first development in respect of the practical application of nuclear fission were directed towards the production of the atomic bombs which were to drop on Hiroshima and Nagasaki in 1945. With the end of the Second World War attention turned to the use of this new form of energy for peaceful purposes, and high in the list of priorities was its use for producing electricity.

In the early 1950's it became clear that nuclear power could take its place with coal and oil in the production of electricity at acceptable level of cost. At this time the insurance markets of the western nation realised this new source of energy posed special problems by reason of the unknown perils associated with it, both as regards material damage and liability to the public, quite apart from the enormous values concerned. In 1955 U.K. Insurers set up a committee "to study insurance problems associated with the development of atomic energy". This committee produced its report in 1957 — a wide-ranging and farseeing work which has been the cornerstone of the British Insurance (Atomic Energy) Committee ever since. It laid down the basis for insuring reactors, and the liabilities associated with them, by means of a Market Pool and set out the principle that all responsibility for radioactive contamination emanating from nuclear installations should be channelled to the operator even when due to the negligence of others, in order to avoid the unnecessary accumulation of liabilities which could otherwise arise. Other insurance markets came to the same broad conclusions.

Reactor Systems[2]

Before dealing with the insurance aspect in greater detail, it may

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[1] Texte de la communication de M. Francis au Rendez-vous de septembre 1976 à Monte Carlo. Nous la reproduisons avec l'autorisation des autorités du Rendez-vous de septembre. Les termes français sont tirés de la version française remise aux congressistes.

M. Francis est membre du Comité des assureurs britanniques pour l'énergie atomique de Londres. A.

[2] Les types de réacteurs.

perhaps be of interest if I were to give a brief non-technical description of the major reactor types in operation or now being developed.

As you will know, thermal reactor have a moderator to slow down the neutrons so that a sufficient number react with Uranium 235.

The choice of moderators leads to two families of reactors:

(i) The graphite moderated reactors such as Magnox, Advanced Gas Cooled and High Temperature in which the heat is transferred by gas.

(ii) Water moderated reactors such as Pressurised Water, Boiling Water and the Candu/Steam Generating Heavy Water Reactor in which water also transfers the heat.

(i) **Gas Cooled Graphite Moderated Reactors** [3]

(a) **Magnox** [4]

The fuel is natural uranium metal clad in a magnesium alloy. The moderator is graphite, and heat is extracted by passing carbon dioxide gas over the fuel in the core and then the heated gas transfers its heat to water in a steam generator, the resultant steam driving a turbine coupled to an electric generator.

(b) **Advanced Gas Cooled** [5]

Here the fuel is uranium dioxide in stainless steel cans, and operates at higher temperatures than in a Magnox reactor and also at higher heat output rates, resulting in a smaller reactor core and a more efficient steam cycle. Again, carbon dioxide gas is used as the coolant as in the Magnox reactor.

(c) **High Temperature Reactors** [6]

The fuel consists of small spheres of uranium dioxide coated with silicon carbide in a graphite matrix. The fuel can thus operate at higher temperatures than metal clad fuel, and a larger proportion can be burned up in each cycle in the reactor.

The coolant is helium gas under pressure — this takes up the heat generated in the core, and is carried to the heat exchanger where super-heated steam is produced and then fed to the turbine.

[3] Réacteurs à modérateur de graphite, refroidi au gaz.
[4] Magnox.
[5] Refroidi au gaz — type avancé.
[6] Réacteurs à haute température.

(ii) **Water Moderated Reactors** [7]

(a) **Pressurised Water Reactors** [8]

The fuel comprises uranium dioxide in zirconium cans, the moderator being light water i.e. ordinary water, which also acts as the coolant. The water is kept under very high pressure to prevent it from boiling. The heated coolant is carried to the steam generator where the heat is transferred to the secondary circuit from whence the steam produced is fed to the turbine.

(b) **Boiling Water Reactors** [9]

The fuel comprises uranium dioxide in zirconium cans, whilst the moderator and coolant is ordinary water. However, in this case the pressure and temperature are so maintained that the water in the reactor core boils.

(c) **Candu/Steam Generating Heavy Water Reactors** [10]

The fuel is again uranium dioxide in zirconium cans, but the moderator is heavy water. Each cluster of fuel elements is in a separate pressure tube, and the pressure tubes are in a tank of heavy water. In the Candu version, heavy water at pressure is heated over the fuel in the pressure tubes and then pumped to a steam generator where it boils ordinary water in a separate circuit, the steam thus produced being used to drive the turbine. In the SGHWR, ordinary water at pressure is heated by passing it over the fuel in the pressure tubes, and allowing it to boil. The steam from the boiling coolant is then used to drive the turbine.

(iii) **Fast Reactors** [11]

The fuel is a mixture of plutonium and uranium oxides in stainless steel cans, but no moderator is used. Fuel elements are placed inside a tank of liquid sodium which is the coolant. The core is surrounded by a blanket of uranium carbide in stainless steel cans. The sodium is heated by the core, and pumped through an intermediate heat exchanger, where it heats sodium in a sec-

[7] Réacteurs à modérateur d'eau.
[8] Réacteurs à eau, sous pression.
[9] Réacteurs à eau bouillante.
[10] Réacteurs à eau lourde, à générateur de vapeur — type Candu.
[11] Réacteurs rapides.

ondary circuit. This sodium then transfers its heat to water in a steam generator, the steam from which drives the turbine.

The Need for Nuclear Insurance [12]

The comparatively sudden development of nuclear energy introduced hazard with which Insurers were unfamiliar as distinct from the conventional hazard such as fire and explosion with which they had previously been concerned. The process of nuclear fission is accompanied by the production of intense and dangerous radiations which may be lethal to man and gravely damaging to property. Processes, industrial or otherwise, which, if something went wrong, involved the prospect of severe contamination of property or serious injury to people by radioactivity on a large scale, were something quite new when Insurers began to meet the need for nuclear insurance in the 1950's. Radioactivity is a source of damage or injury that can be detected by none of the human senses, and it may cause injury or illness which does not become manifest for a very long time after the subject has been exposed to radiation. Even if a nuclear incident causes no physical damage either to the installation itself or to the surrounding property, the associated contamination may prevent access or use a long time, and its removal may be a lengthy and expensive business.

The magnitude of the values at risk in a large nuclear installation such as an atomic power station, taken together with the possible extent of compensation to third parties in the event of an accident, is very considerable. The value of just one reactor unit itself, apart from the ancillary plant and property on a nuclear power station, may today be of the order of £ 75M say $ 160M or even more, whilst the civil liability risks involved might lead to the payment of damages representing greater financial liability than any encountered hitherto outside the field of natural disasters.

Governments and operators alike impose stringent safety requirements, but it is recognised that there can be no complete guarantee against accidents, and in this field a comparatively minor failure of equipment or of the human element could well lead to very grave consequences. National governments have, therefore, addressed themselves to the control of nuclear activities, and to legislating to establish

[12] Le besoin d'assurance nucléaire.

the liabilities of the operators and to fix the financial limits of such liabilities. International concern was manifested firstly by the preparation and introduction of the so-called Paris Convention on Civil Liability in this field, followed by the International Atomic Energy Agency's own (Vienna) Convention on such liabilities.

Thus there is a clear need for the operators of nuclear installations to effect insurance in order to protect themselves and those providing the finance for such installations against the possibility of loss or damage to the enormous financial commitments involved, whether by way of investment in physical assets or by way of liabilities imposed by legislation.

Nuclear Insurance Pools [13]

Concurrently with the evolution of the principles of liabilities for nuclear incidents, Insurers gave much thought to the practicability of providing the necessary insurance cover through normal channels. The usual practice in regard to the insurance of large risks embraces a system of reinsurance which today can spread a large risk virtually around the world. Because the original direct insurance is usually divided among a large number of Insurers, some reinsurers may find themselves committed on the same risk from a number of different sources. In the case of nuclear installations, the relatively small number of insurances in respect of both material damage and third party cover, with the high values at risk, makes such a system unworkable because reinsurers could find themselves faced with an excessive accumulation of amount on an individual risk in a field of activity in which the special hazards are perhaps even today not fully understood, and where, therefore, the potential losses are not easily capable of assessment.

In consequence, Insurers concluded that the only practical method of underwriting was on a net line basis through the medium of Pools where each member accepts fixed amounts entirely for his own retention and without his resorting to reinsurance.

International Co-Operation

In order to marshall the large insurance capacity needed in many countries, national nuclear insurance Pools were established comprising

[13] Les pools d'assurance nucléaire.

the Insurers operating in the country concerned. Organisations proposing to build and operate a nuclear installation usually approach them direct or through brokers or in some countries through a leading member of the Pool, to discuss the question of insurance. The national Pool may decide to consult similar Pools in other countries with a view to augmenting their own capacity, thus also providing an appropriate spread of the risks concerned.

In the absence of a national nuclear Pool, application for nuclear insurance cover would normally be made to the Market insurance association concerned. The association would then know where to obtain any advice or assistance that might be required.

Even where the capacity of a national insurance Pool might be very limited, it has an important role to play because it will be familiar with the insurance customs and legislation applicable in its own country, and its offices would provide a base from which inspections, surveys and the claims work arising from a major incident could be organised with, if necessary, technical help from other Pools. With the increasing size and value of the modern nuclear installation, it is usually necessary for the capacity of all the national Pools to be used if the operator is to secure the amount of protection he requires. This is achieved by means of reinsurance obtained by the national Pool primarily concerned direct from overseas Pools without the intervention of intermediaries. This eliminates the usual placing operations with consequent saving of time and expense since the availability of capacity is already known.

There must clearly be frequent and continuing consultation between Pools on all kinds of technical problems associated with the insurance of nuclear installations, and it should be noted that this international collaboration and reinsurance is possible only to the extent that premiums and claims payments are rapidly and readily transferable. On the point of international collaboration, I would like to remind you that it has been customary for the British Pool to arrange at intervals international Conferences of the Presidents of the national Pools in order to discuss together the problems of atomic risks insurance, and these Conferences have proved to be a very valuable forum for discussion, although it should be stressed that no mandatory decisions are, or indeed can be, made. In February representatives of 18 Pools from

Europe, North America and the Far East met in London to discuss matters of common interest.

Installations which may be insured [14]

Virtually every type of nuclear installation used for peaceful purposes is insurable. Some of the minor risks such as radioisotopes used for medical or industrial purposes, X-ray machines and laboratory equipment using nuclear materials which are not capable of criticality (i.e. starting a chain reaction) are generally covered under conventional insurance policies. But all other types of nuclear installation, whether a small research reactor, a large power producing reactor, a fuel fabricating, enrichment or reprocessing plant, or an experimental prototype reactor, are usually insured by the nuclear Pools. Various forms of Material Damage and Liability insurances, of which further details will be given, are available. Insurers are conscious that the market for nuclear insurance is limited and, therefore, the Pools can be relied upon to make every possible effort to provide a reasonable degree of cover, even for the most unattractive of experimental and prototype installations or the most demanding of clients.

Insurance requirements in relation to the amount of liability established by law [15]

Before dealing with the insurance covers which are available to operators, it is necessary to refer to the international Conventions relating to the liability of operators of nuclear installations. There are three international Conventions relating to this liability, although only two have so far been ratified. One is the so-called Paris Convention signed in 1960 and drafted by the Nuclear Energy Agency of the O.E.C.D. The Second Convention is the Brussels Supplementary Convention under which adhering States undertake to provide additional compensation from Government funds, and this has now come into force. The third is the Vienna Convention drafted in 1963 by the International Atomic Energy Agency which has so far not attracted the necessary number of ratifications for it to become operative. The provisions of the Vienna Convention are in general very similar to those of the Paris Convention.

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[14] Les installations assurables.
[15] Montant nécessaire pour satisfaire aux exigences de la loi.

These international Conventions contain certain fundamental provisions which are reflected in most if not all the national nuclear liability which derives from them. The salient features of these laws are as follows:

(i) Operators of nuclear installations must be duly authorized and the installations licensed by the State.

(ii) The liability of the operator for any radioactive contamination arising from nuclear material on the site is strict or absolute, which means that the operator is liable at law without proof of negligence against him.

(iii) Notwithstanding that other parties such as suppliers or contractors may be liable in tort for the consequences of a nuclear accident on the licensed site, only the operator is liable. Thus the principle of channelling of liability mentioned is the subject of specific legislation.

(iv) The operator's liabilities must be covered by insurance or other approved financial guarantee up to a specific limit, the balance of any such liability being the responsibility of the State.

(v) Because of the concept of channelling, only the operator is required to provide insurance. In this way is avoided the duplication of liabilities, insurances and the legal and other complexities which could flow from them.

(vi) The operator's liability is limited in terms of time by the application of a ten year prescription period i.e. the operator, and therefore his Insurers, are relieved of third party claims arising more than ten years after the occurrence of the nuclear incident concerned. This is very important since radiation-induced illness such as leukaemia can take very many years to show themselves.

(vii) The minimum of financial security required from the operator under the Conventions is U.S. $ 5M or their equivalent. In practice, however, a number of countries have adopted very much higher requirements under their national legislation. This point will be referred to later in the paper.

Although under the Conventions it is open to each country to limit its operator's liability subject to a minimum of U.S. $ 5M per incident, insurers must know the limit of their liabilities in respect of any one site. Insurance cover is therefore available only on the basis of one fixed amount for the insured lifetime of a given installation. This amount is reduced by each claim payment unless it is reinstated by agreement and if the necessary insurance capacity is available. The important point is that the cover should not be reduced or exhausted as a result of the first incident without measures being taken to ensure that financial security up to the required amount is available for subsequent incidents.

In the United Kingdom the statutory requirement for insurance (or the provision of other financial security) is £ 5M per installation per cover period. The cover period means in practice usually the life time of a licensed installation unless there is a change in ownership or unless substantial claims have to be paid reducing the remaining cover of £ 3M, in which case a fresh cover period may be established by the Government, requiring a further £ 5M of financial security. It is also of interest to note that under U.K. legislation no distinction is made between employees and third parties, although practice may vary in this respect between one country and another.

(à suivre)

General Insurance Register. Property casualty coverages & services in Canada: 1976-77. Stone & Cox. General Insurance Year Book. Toronto.

Voilà un livre substantiel qui prend une forme un peu différente des années antérieures, mais qui, au premier abord, nous paraît fort intéressant. Non pas qu'on y trouve des théories fracassantes ou des idées extraordinaires, mais parce qu'il nous apporte des renseignements pratiques, comme les principaux intercalaires utilisés par les assureurs, le nom des experts reconnus au Canada, celui des évaluateurs immobiliers, des avocats qui font métier de conseiller les assureurs. De quelque trois cents pages, le recueil contient également le répertoire des courtiers d'assurances au Canada, les états financiers des sociétés traitant dans notre pays et, enfin, une liste des conseillers techniques des assureurs et assurés.

En somme, un instrument de travail valable et, encore une fois, que nous conseillons au lecteur.