

THE LICENSING OF SIZEWELL 'B' WAS UNLAWFUL

1. INTRODUCTION

1.1. MY BACKGROUND

I joined the United Kingdom Atomic Energy Authority in 1955 at age 25, having served an apprenticeship in radio engineering and with first degrees in mathematics and physics. I operated nuclear research reactors until 1961 until transferring to assessment of the hazards of nuclear reactor operation, which continued until 1977. I left the employment of the UKAEA in 1982, and gave expert evidence to the Sizewell 'B' public inquiry on behalf of the Town and Country Planning Association, and later on my own behalf, to the Hinkley Point 'C' public inquiry.

1.2. THE PURPOSE OF THIS SUBMISSION TO THE 2001 ENERGY REVIEW

The history of nuclear energy production is rooted in the war time development of nuclear weapons. This development continued apace in the post-war years, driven by political pressures stemming from international distrust, known as the cold war, which lasted for more than forty years. Thus the initial development of nuclear power plants was supported more by military necessity than by civil needs. The resulting hazard levels tolerated were considerably greater than would have been the case in the absence of the military necessity. It follows that the tradition of military secrecy instilled into the nuclear industry is only penetrated when something quite serious goes wrong, and the public perception over the decades has been formed accordingly to be most deeply distrustful. The purpose of this submission is to explain just how the effects of the above mentioned pressures resulted in the use of standards of design safety for nuclear engineering which I know to be highly unsatisfactory. If public acceptability of the widespread use of nuclear energy is to be achieved, then there is no alternative to the long term adoption of much safer design standards. When the testing of nuclear weapons in the atmosphere was banned by international agreement, militarily essential development continued underground. The future threat posed by the rising concentration of carbon dioxide in the atmosphere is serious. When its severity is seen to be as serious as intercontinental war, then perhaps it may be possible to afford safe nuclear energy. Unless something else comes along. In a further submission I hope to review possible nuclear power reactor designs.

1.3. DESIGN FUNDAMENTALS

Ideally the services provided and used by human society would be incapable of generating disaster regardless of whatever happened. Practice falls far short of this, always avoidably. Railway rails unmaintained to the point where one rail breaks into fifty pieces under a moving train and the railway system is seriously debilitated for a year. An air bus runs out of fuel half way across the Atlantic. Nuclear submarine nuclear power plants develop generic faults in pressure piping, not for the first time. Ferries sink. Dams break. Bridges fall. Buildings and aeroplanes catch fire. Vehicles crash. And so on. Experience suggests that only the laws of nature offer the prospect of true reliability. Engineering therefore should recognize this accordingly. When that is insufficient then further increase in reliability can only be had by ensuring that system failure can only happen after a plurality of lesser failures, reliance then being placed on the lesser chances of the coincidence in time of combinations of such lesser failures. Lifts are suspended by large numbers of steel wire strands in their suspension cables which are checked for broken strands with sufficient frequency to ensure that the cables do not break; and brakes are provided to arrest the lifts in case they do break. Air liners have more than one engine, and the strength of the wings is provided by two main spars. Most sub-systems in an airliner are at least duplicated.

1.4. REFERENCES TO THE NUCLEAR INSTALLATIONS INSPECTORATE SAFETY ASSESSMENT PRINCIPLES FOR NUCLEAR POWER PLANTS

In what follows, certain of the NII Safety Assessment Principles have been quoted and their true effects are explained. In each case the numbering is the same as that given by the NII and either a paragraph number (e.g. §201), or a combination of paragraph number and safety assessment principle number is given (e.g. §190SAP136).

2. SAFETY AND THE LAW

2.2. THE DUTY OF CARE

At common law there is a general duty for everyone to take reasonable care not to kill, injure, or inflict loss or damage on others.

2.3. AS SAFE AS REASONABLY PRACTICABLE

In the safety assessment principles for nuclear power stations the HSE/NII state the intention to abide by the law and follow the 'as safe as reasonably practicable' principle:

"\$1. The operators of nuclear plants in this country are like their counterparts in other industries, and places of work in general, in that they must conform to the general health and safety standards laid down in the Health and Safety at Work etc. Act 1974 (HSW Act)."

"\$7. In carrying out an assessment, the NII assessors need to judge the extent to which the safety submission shows that the design of the plant is in conformity with the principles. Not all of the principles are relevant to every plant, but the extent to which the relevant principles are met will be an important factor in any decision on licensing. The law requires the plant to be as safe as reasonably practicable."

When a nuclear power station is as safe as reasonably practicable (ASARP) the total risk will be as low as reasonably practicable, so that ASARP and ALARP have the the same meaning."

"\$10. For the assessment of plants which exist today ('old plants') there is a further point to be considered in that the safety standards used in their design and construction may differ from those used in plants currently being designed and built. The existence of such differences has to be recognised by our assessors when applying the SAPs in the assessment of old plants. The ALARP principle is of particular importance to such assessments, and the age of the plant and its projected life are important factors to be taken into account when making judgements on the reasonable practicability of making improvements to those plants."

"\$22. In the earlier publications of the SAPs, five fundamental principles were presented at the beginning of the documents. Those principles derived from recommendations of the International Commission on Radiological Protection which were subsequently implemented by the Ionising Radiations Regulations 1985. They embody the requirements for statutory radiation dose limits to be satisfied and for the ALARP principle to be applied to radiological exposures resulting from normal operation and to the risks from accidents. The fundamental principles are still relevant today and, indeed,

the principles in the subsequent sections are aimed at ensuring that, when a proposed plant comes into operation, these principles will be satisfied."

"\$28. Reference was made earlier to HSE's tolerability of risk (TOR) paper, The approach described in that paper has been carried through into these principles. The concept of a limit of tolerability has been translated into basic safety limits (BSLs) for the risks from normal operation and from accident conditions. A proposed plant must satisfy these limits in order to be considered for licensing. Having satisfied the BSLs, the ALARP principle comes into play to drive the risks from the plant even lower."

"\$107. The ALARP principle has been discussed in the introduction to the principles and again in Fundamental Principles and Safety Analysis. ALARP applies equally in assessments made against the principles in this section."

"\$110(SAP63) For reactor plants, the following characteristics should be Incorporated as far as reasonably practicable:

(a) temperature coefficients of reactivity, power coefficients and coolant voidage coefficients should be such as to ensure stable reactor behaviour at all times;

(b) there should be adequate margins between the normal operational values of safety-related parameters and the values at which the physical barriers to release are challenged;

(c) the thermal characteristics should be such that operational perturbations in power or coolant flow do not cause large or rapid temperature changes, or unacceptable changes in the physical state of the coolant, the fuel and the fuel cladding material."

"122 (P75) A qualification procedure should be in place to confirm that all safety systems and safety related equipment will perform their required safety functions throughout their operational lives, under the operational, environmental and accident conditions specified in the design. The procedure should, where reasonably practicable, include a demonstration

that individual items can perform their required functions under the specified conditions."

"§139 (SAP75) A qualification procedure should be in place to confirm that all safety systems and safety related equipment will perform their required safety functions throughout their operational lives, under the operational, environmental and specified (usually design basis) accident conditions. The procedure should, where reasonably practicable, include a demonstration that individual items can perform their required functions under the specified conditions."

"§152(SAP100) Wherever reasonably practicable, provisions should be made for in-service functional testing of all safety systems and other safety-related equipment sufficient to prove the complete system and the safety-related function of each component. Where complete functional testing is claimed not to be reasonably practicable, an equivalent means of functional proving should be demonstrated. It should be possible to carry out these tests without loss of any safety function."

"§328 (SAP256) As far as reasonably practicable, reactor components should be fabricated from materials which are free of elements susceptible to neutron activation and liable to contaminate the heat transport system."

"§329 (SAP257) Facilities for removing and storing the reactor coolant to allow inspection and repair work should be provided where appropriate and reasonably practicable."

It seems clear from the above selection from the NII safety assessment principles for nuclear power stations that the intention is that the power station should conform with the common law Duty of Care. The majority of the NII safety assessment principles for nuclear power stations are good and sound. However, the NII disregard the above safety assessment principles when it comes to the risk of explosion of the Sizewell 'B' reactor pressure vessel. Unfortunately the laches rob these good principles of their value since all of the otherwise reasonably practicable safety is blown away and counts for nothing if the reactor pressure vessel explodes.

2.4. THE HEALTH AND SAFETY AT WORK ETCETERA ACT 1974

I am sure that if asked openly the NII would reply that they require the operators of nuclear plants in this country to conform to the general health and safety standards laid down in the Health and Safety at Work etc. Act 1974 (HSW Act). In particular they would say that it is the operator's duty to conduct their undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in their employment who may be affected are not thereby exposed to risks to their health or safety (Section 3 of the HSW Act). This means that before any accidents have happened to some plant or equipment which it is intended shall be brought into use, the owner of Sizewell 'B' should have made a balance in which the measures necessary to avert the risk in time, trouble, or money, should have been placed on the one hand; and the cost of the consequences of the risk if it is realised should have been placed on the other hand, and if there is a gross disproportion such that cost of the measures necessary to avert the risk exceeds the cost of the consequences of the risk, then the owner would have discharged the duty of care upon him. In short, the risk must be reduced to a level which is as low as reasonably practicable (ALARP): this is the 'ALARP principle'. In the case of Sizewell 'B' with the present design that balance is far, far to the wrong side with the total risk enormously outweighing the costs of its avoidance.

2.5. THE NUCLEAR INSTALLATIONS ACT

The nuclear industry must also comply with the Nuclear Installations Act 1965. The NII Act is a piece of legislation, subsidiary to the HSW Act, which applies specific regulatory controls to nuclear plants. Under this Act, no site may be used for the purpose of building and operating a nuclear power station unless a licence has been granted by the Health and Safety Executive (HSE).

\$2 The nuclear industry differs from other industries in that it must also comply with the Nuclear Installations Act 1965 (as amended). The NI Act is a piece of legislation, subsidiary to the HSW Act, which applies specific regulatory controls to nuclear plants. Under this Act, apart from certain exceptions, no site may be used for the purpose of installing or operating any nuclear installation unless a licence has been granted by the Health and Safety Executive (HSE). Licensed installations currently in operation include nuclear power stations and research reactors, nuclear fuel manufacturing and isotope production facilities, fuel stores, fuel reprocessing plants, radioactive waste stores, and a site for both storage and disposal of radioactive waste.

\$3 Inspectors are appointed under the HSW Act to administer the NI Act. The Nuclear Safety Division of HSE exercises that responsibility through HM Nuclear Installations Inspectorate (NII). The NII has within its remit the responsibility for granting licences, for attaching appropriate conditions to the licences and for making judgements on the acceptability of responses made by licensees to the requirements of those conditions. (The term 'licensee' is used in this document to include applicants for licences as well as those who already hold licences.)

2.6. IONISING RADIATIONS REGULATIONS 1985

Laws stem either from previous decisions by Courts of Law, and which go back into the mists of long history, or from statutes, as currently amended, passed by a majority of Parliament. However some statutes enable or empower ministers to issue regulations which have the force of law inasmuch as requirements are given and punishments for transgression are specified. Recommendations of the International Commission on Radiological Protection have been implemented in the Ionising Radiations Regulations 1985 in which the government has embodied the requirements for statutory radiation dose limits to be satisfied and for the ALARP principle to be applied to radiological exposures resulting from normal operation and to the risks from accidents.

2.7. BASIC SAFETY PRINCIPLES FOR NUCLEAR POWER STATIONS

Whatever the risk of Sizewell 'B' actually is, and whatever the law actually demands, the basic principles which the government says that it must follow read as follows:

"\$24 (SAP2) The exposure of any person to radiation shall be kept as low as is reasonably practicable."

"\$25 (SAP3) The collective effective dose to operators and to the general public as a result of operation of the nuclear installation shall be kept as low as is reasonably practicable."

"\$26 (SAP4) All reasonably practicable steps shall be taken to prevent accidents."

"§27 (SAP5) All reasonably practicable steps shall be taken to minimise the radiological consequences of any accident."

Here the requirement for nuclear power stations to be as safe as reasonably practicable is hammered home, so that particularly as regards large accidents to new nuclear power stations the onlooker might well expect to find the balance between the precautions against large accidents to grossly outweigh the consequences of such accidents, properly allowing for the demonstrable probability of such accidents, whatever it may be. But such is not the case. In fact it is quite the other way round.

3. RISK FROM NUCLEAR POWER STATIONS

In its TOLERABILITY OF RISK FROM NUCLEAR POWER STATIONS, at APPENDIX 1, paragraph 1, the NII defines risk as:

"the probability that a specified undesirable event will occur in a specified period or as the result of a specified situation".

The NII continues:

"both the probability and the event, and perhaps also its severity, have to be specified. Thus risk can never be reduced to a single quantity; it must always contain at least two separate. In the context of the risks from a nuclear power station, the risks of greatest interest are those associated with radiation."

In this the word 'perhaps' has been inserted by the NII in order to suggest that the 'severity' of the consequences (undesirable event) is not a matter which the NII will require licensees to determine. This intention is unlawful. The specified situation mentioned here is, of course, the accident causing the risk. It should be noted particularly that having said the above, in the case of the accident in which the reactor pressure vessel of the Sizewell 'B' nuclear power station explodes, the NII seek to avoid the determination both of the probability of that situation and the total of all of the undesirable events which result from it. If it is intended to relate risk to a particular outcome of some mishap, then both the mishap and the particular outcome must be specified. If they are not, and the risk is unqualified, as for example in 'the risk from a

nuclear power station', then the risk is the totality of all of the undesirable outcomes during the whole existence of the nuclear power station.

3.1. INDIVIDUAL RISK VERSUS TOTAL RISK

When potential danger threatens, as it does in every day life, we weigh up the chance of mishap in our minds, and make a decision and then act on it. Do we cross the road now or do we wait until the approaching car has passed by? We meet such threats continuously and are quite accustomed to dealing with them. The risks of injury to ourselves are personal risks and in the context of an injury to oneself resulting from radioactive material accidentally discharged from a nuclear power station it is referred to as 'individual risk'. People insure themselves against ordinary risks, but because the upper limit of the consequences is so huge, it is not possible to obtain insurance cover for the risk of injury arising from radioactive material discharged accidentally from a nuclear power station. Of course such a large accidental discharge of radioactive material would not just injure one person; it would cause a large number of injuries of varying severity, together with extensive evacuation from home and property, perhaps for more than a lifetime, and by irremediable contamination much property would be spoiled. The collective value of all of this would form part of the total risk, which for a large accident to a nuclear power station would be vastly greater than the individual risk. In the case of the Chernobyl accidental explosion, the consequences seriously damaged the economies of the Ukraine and Belorussia. The NII refers to the total risk as the 'societal risk', a term which confuses the average man. Other, lesser, considerations would include the loss of the power station itself and the electricity which in the absence of the accident it would have generated. It might also include the cost of abandoning any similar power stations after the unacceptable risk had been generally recognised. The NII, in addition to substituting unlawfully individual risk in place of total risk, substitutes one value of the probability and consequences for each accident sequence which it has considered. The probabilities of future events are not known and can only be estimated. This difficulty can be properly dealt with by representing the accident probability by a probability density function, and the amount of the undesirable results as a family of distributions. These can of course be replaced by average values combined with probability density distributions, and can be easily combined to describe the total risk of the plant over its intended 'lifetime'. But the NII has not been seen to do any of these mathematically reasonable things. Neither has it required them to be done by the licensee.

3.2. RISK REDUCTION

The ASARP legal principle requires that for a proposed nuclear power station the total risk must be ascertained for selected design alternatives. Given the result of these the

relationship between the total risk and alternative design costs should enable the ASARP principle to be applied with ease. If the legal principle be not satisfied then further the risk and cost of additional design alternatives must be evaluated until either the principle is satisfied or the project is found to be impracticable. The ASARP principle can only be applied piecemeal to the design alternatives and the treatment must be comprehensive overall for each of the designs studied, and true. The risk of the Sizewell 'B' reactor pressure vessel explosion may be reduced either by reducing the demonstrated probability of that explosion, or by reducing the probability that a given amount of radioactive material will be discharged as a result. In the case of Sizewell 'B' the inability of the licensee to demonstrate that the pressure vessel alone was ASARP should have led to an alternative design made ASARP by virtue of a containment building having a demonstrated capability ensuring that in the event of the explosion the containment would remain intact and the station would remain ASARP. This was not done.

3.3. THE MEANING OF GROSS DISPROPORTION

At the Sizewell 'B' public inquiry the ASARP legal principle was said to be satisfied when the costs of the risk aversion were shown to be ten times the cost of the total results of the risk. Given that the total cost of the Chernobyl reactor explosion was in excess of one million million pounds, the failure to evaluate the risk of the Sizewell 'B' nuclear power station exploding has concealed the fact that the consequences of that event would be even larger.

3.4. THE NII HAVE EVADED THE PROPER CONSIDERATION OF RISK IN THE LICENSING OF SIZEWELL 'B'

The BNFL/Westinghouse design of pressurized water reactor is used in the Sizewell 'B' nuclear power station. The NII was involved in consideration of the possibility of licensing of that design for construction in the UK at least as long ago as 1977. The NII had been aware long before that, that the PWR design included a thick-walled welded steel reactor pressure vessel which had explosion as an acknowledged failure mode. This pressure vessel is a large complicated single component, the explosion of which would be extremely disruptive, potentially discharging the whole of the reactor core from the station. The NII have never disclosed any way of showing this risk to be acceptable. Therefore since there can be no doubt that the NII would have published such an important demonstration, it must be concluded that the NII is, for whatever reasons, unable to do so, and the NII has no alternative but to seek to evade this issue. It is transparently obvious that the NII had decided that it would not at any stage be seen to have properly considered the risks of large accidents. This has had the effect of concealing the true nature of those risks from public knowledge. A possible

explanation for this is that the construction and use of the Sizewell 'B' nuclear power station was seen as being (politically?) desirable, and because the (publicly) unacceptable risks had to be concealed from the public. The outrageous outcome with which we are now faced was a foregone conclusion. The total risk of explosion of the Sizewell 'B' reactor pressure vessel has been concealed by the NII in that the NII, have unlawfully licensed Sizewell 'B' without either the probability or the results having been determined.

3.5. HOW THE PROBABILITY OF EXPLOSION OF THE SIZEWELL 'B' REACTOR PRESSURE VESSEL WAS NOT CONSIDERED

The magnitude of the consequences of an explosion of the Sizewell 'B' reactor pressure vessel are of similar magnitude to the consequences of the Chernobyl nuclear power station explosion. The upper limit for the probability of an event of Chernobyl magnitude has not been properly ascertained democratically inasmuch as people generally including Members of Parliament are not sufficiently informed about that. However, having regard to the public attitude towards being killed by lightning strike, a publicly acceptable figure for a reactor explosion would seem to be about the same as that, at less than one chance in ten millions per year for a single plant. The practical experience with thin welded steel pressure vessels, combined with experience with thick reactor vessels, and knowledge of the uncertainties of thick welded vessel technology leads to the conclusion that the probability of explosion is a thousand times greater than this, and the occurrence of such an explosion is clearly foreseeable. The following safety assessment principles which the NII say that they have used in the licensing of Sizewell 'B' were devised by the NII during the assessment. They have the effect of permitting that licensing whilst the probabilities of large accidents such as the explosion of the reactor pressure vessel are thought to be unsatisfactory and have not been evaluated. From this it is perfectly clear that in the case of large accidents the law requiring Sizewell 'B' to be as safe as reasonably practicable has been broken on this account.

"\$11 The principles are written bearing in mind existing and anticipated plant designs and the form of safety cases likely to be submitted to the Inspectorate. As far as safety cases are concerned, however, licensees may wish to put forward a submission which differs from this expectation and, as in the past, the NII will be prepared to consider such an approach. There are also other possible designs: novel plant concepts and novel plant features are currently being developed by the nuclear industry. Again the Inspectorate will be flexible in its response. In the past there have been plant items whose safety was difficult to justify in such a way as to readily satisfy the SAPs, the pressure vessel being the most obvious example. That possibility was catered for in the existing SAPs by having a principle which

allowed for such plant items to be justified on a special case basis and this route has been used on a number of occasions. An amended version of the 'special case' principle is included in these revised SAPs and is available for similar use in the future on difficult plant items or on quite novel design features. If, however, situations arise which call for a different assessment approach, the principles will be re-examined and revised as appropriate. In summary, therefore, the revised SAPs are intended to cater for non-standard as well as the standard approach. In no case, however, should this flexibility be seen as a means of bypassing the rigours of the assessment process; special cases receive particularly close scrutiny."

In the Nuclear Installations Inspectorate Safety Assessment Principles For Nuclear Power Station, §11, the phrase 'non-standard' means that if the ASARP principle cannot be satisfied in respect of explosion of the Sizewell 'B' reactor pressure vessel the law requiring the station to be ASARP will be broken without any requirement to mitigate the undesirable results by the use of an explosion proof containment.

"§19. Where items of plant can be represented in the probabilistic safety analysis by failure rate data this link between the engineering principles and the basic safety standards is clear. For those items whose contributions to the risk cannot be quantified, the link is less obvious and the engineering judgements are more difficult. Reference has been made earlier to an assessment process known as the 'special case' procedure which may be applied to some of those items. Particular attention needs to be addressed to these cases in order to be satisfied that they do not make an excessive contribution to the overall risk from the plant."

In the cases where "contributions to risk cannot be quantified" the proper approach is to require design alternatives to be provided such that not only can the contributions to risk be quantified, but the safety of the design depends upon known facts and not upon deemed "engineering judgement". The risk of explosion of the Sizewell 'B' reactor pressure vessel dominates all of the other risks of that nuclear power station and yet in §19 the NII have seen fit to contrive their special case procedure whereby the law requiring the plant to be ASARP is flouted instead of that principle being applied properly.

"§45. Nuclear plants are, therefore, designed to cope with a wide range of potential accidents (design basis accidents), but it may not be reasonably practicable to make design provision against the more unlikely accidents. The analysis of accident conditions follows two complementary approaches: deterministic and probabilistic. The deterministic approach is used in the

analysis of design basis accidents which is required, in line with international practice, as a robust demonstration of the fault tolerance of the plant, of the effectiveness of its safety systems and with the aim of determining the limits to safe plant operation. For the purposes of design basis accidents, uncertainties in the transient and radiological analyses are covered by the use of appropriate conservatism in the treatment."

Only accidents for which the risks are acceptable have been included in what the NII call the design basis accidents. In the case of explosion of the Sizewell 'B' reactor pressure vessel the treatment is conservative in the sense that the probability is underestimated by the NII, and §45 seeks to divert attention away from that.

"§48. For the probabilistic safety analysis, the accident frequency principles for the most part do not address directly either individual risk or the risk to society as a whole, but are chosen to provide surrogates for these risks - surrogates which are related to the design and operation of the plant in question. Thus a full risk analysis of all off-site effects is not required, although the licensee may see it as worthwhile to provide such an analysis, particularly for major new installations."

§48 is a bald admission by the NII of their dereliction of the duty of care to the community against the risk of explosion of the Sizewell 'B' reactor pressure vessel. The law requires the plant to be ASARP and this cannot be demonstrated without the essential total risk evaluation.

"§58(SAP 21).The safety case should present a list of all initiating faults which are included within the design basis of the plant. All initiating faults identified under §16 should be considered for inclusion in this list, but the following need not be included:

(a) faults internal to the plant which have an expected frequency lower than about one in one hundred thousands per year; and

(b) failures of structures, systems or components for which acceptable special case arguments have been made in accordance with SAP 70.

(c) hazards excluded in accordance with SAP 119."

In §58, safety assessment principle 21, the NII exclude consideration of explosion of the Sizewell 'B' reactor pressure vessel even though it is the worst possible accident, and it has an expected frequency greater than one in a hundred thousands per year.

"§69 (SAP32) A probabilistic safety analysis of the overall design and system of operation should be performed to enable an assessment of the risk arising from the plant to be made, and a judgement as to its acceptability against the accident frequency principles, SAP42 to SAP46. The probabilistic safety analysis should also confirm that a balanced design of the plant has been achieved, such that no particular class of accident or feature of the plant makes a disproportionate contribution to the overall risk."

Because the NII have not included a demonstration of the expected frequency of explosion of the Sizewell 'B' reactor pressure vessel the disproportionate contribution of the risk of that explosion has been hidden from view in the NII licensing assessment.

"§75 (SAP 38) Where no relevant statistical data are available, judgements should be made and their basis stated. Particular attention should be paid to determining the sensitivity of the results of the probabilistic safety analysis to such judgements."

The substitution of judgement in place of demonstration of the probability of explosion of the Sizewell 'B' reactor pressure vessel does not demonstrate that power station to be ASARP, and therefore is unlawful.

"§77 (SAP 40) For some fault sequences, It will not be possible to calculate the frequency of occurrence because the data are inadequate or no appropriate models are available. For example, for certain structural components such as pressure vessels, where failure could lead to severe consequences, the failure frequency required to meet the accident frequency principles may be well below the values which can be justified by standard statistical estimation techniques. In all such cases, a considered judgement should be made of the contribution to the predicted frequencies from such faults."

In §77 the NII blatantly admits its intention to flout the law requiring the Sizewell 'B' power station to be ASARP.

"§79 (SAP42) The total predicted frequencies of accidents on the plant, which would give doses to a person outside the site, should be less than the values given in the following table:

Maximum	Total predicted frequency, per year
effective dose, mSv	BasicSafetyLimit
1	1 per year
10	1 per 10 years
100	1 per hundred years
1000	1 per thousand years
> 1000	1 per ten thousand years

Note. A subsidiary aim should be for no single class of accident to contribute more than about one tenth of the total frequency in any dose band, to avoid placing excessive reliance on particular features of the plant or on particular assumptions in the analysis."

In §79, safety assessment principle 42, the NII define an hyperbolic relationship between one element of individual risk expressed as effective (whole body?) radiation dose, and an undefined quantity called 'total predicted frequency'. This relationship suggests that the basic safety limit for the frequency of an accident resulting in the death of one person only must be less than once in ten thousand years. The risk of Sizewell 'B' is enormously greater than that, and this is effectively concealed by the

failure of the NII to require the plant to be demonstrated to be ASARP.

"82 (P45) The total predicted frequency with which the plant suffers damage and a significant quantity of radioactive material is permitted to escape from its designed point of residence or confinement, in circumstances which pose a threat to the integrity the next physical barrier to its release, should be

BSL	BSO
10-4 per year	10-5 per year

Note. Such plant damage is interpreted as a degraded core in the case of a reactor. For other plant, it would include a major breach of vessel pipework etc., together with the potential for events such as fire, explosion, or aggressive chemical attack which might lead to degradation of the containing cell or its ventilation/filtration system even though there may be a safety system provided to prevent such degradation."

In §82 safety assessment principle 45, the acceptable frequency for an accident in which all of the physical barriers are breached and most of the radioactive material in the reactor core is discharged is given as one in one hundred thousand per year. This is not demonstrated to be in accordance with ASARP/ALARP, and is therefore unlawful.

"§117(SAP70) Where a structure, system or component forms a principal means of ensuring nuclear safety and it is not practicable to demonstrate that the accident frequency principles P42 to P46 are satisfied in the event of its failure, the plant may only be accepted after the application of a special case procedure agreed as an alternative demonstration. The procedure should include a comprehensive examination of all the relevant scientific and technical issues, taking account as appropriate of precedents set under comparable circumstances in the past."

In the case of the Sizewell 'B' nuclear power station, the NII have used §118, safety assessment principle 70, to justify the issue of a licence in the absence of a satisfactory demonstration of the reliability of the reactor pressure vessel against

explosion. The possible alternative of reliable containment has not been considered. Therefore the plant is not ASARP and the issue of the licence is unlawful.

"§118(SAP 71) Where the special case procedure is applied or where any safety system is required to achieve a high reliability, an independent assessment of the item should be carried out in addition to the checking provided as part of the design process. The object of the assessment should be to confirm the adequacy of design specification and that the manufacture, construction and commissioning satisfies that specification."

It is apparent that not having located any properly independent agency, the NII have issued a licence without §118, safety assessment principle 71 being satisfied. I am independent and I have provided such independent assessment and it has been disregarded. A satisfactory standard of reliability of the Sizewell 'B' reactor pressure vessel against explosion has not been demonstrated.

"§132 (SAP 83) All structures, systems and components should be designed, constructed and inspected to the highest standards commensurate with their safety categorisation as follows:

(a) Category 1 - Conservative design and construction standards should be adopted for this, the highest category together with a strict interpretation of these assessment principles in line with the ALARP requirement. For some items (such as those whose failure would lead directly to an event beyond the design basis) the special case procedure (§117 SAP 70) may need to be used;

(b) Category 2 - Appropriate national or international codes or standards should be adopted, with particular consideration being given to demonstrating the ability of the item to perform the required safety function;

(c) Category 3 - Normal industrial standards can be applied."

In §132 safety assessment principle 83, the NII again repeat their intention to license the Sizewell 'B' in the absence of a demonstration of ASARP in respect of explosion of the reactor pressure vessel.

"§200 The general lack of adequate reliability data for structural components leads to assessment being based primarily on established engineering practice. Even when there is some confidence in assessing reliability on the basis of existing data and a probabilistic safety case is possible, it is unlikely to be acceptable without substantial support from theoretical analyses and engineering judgement. As a result, although the radiological consequences of failure of structural components may be significant, it is often not possible to calculate the risk for inclusion in the probabilistic safety analysis."

In §200, the NII, having licensed Sizewell 'B' without the plant having been shown to be ASARP, the NII blandly remarks that the most serious accidents will not be included in their assessment. This is unlawful.

"§201 Reference has already been made in paragraph 117 to those special cases where the component forms a principal means of ensuring safety; the reactor pressure vessel is an example, For such components there are two particularly important aspects to be addressed: that the structure should be as defect free as possible. and that it should be demonstrated to be defect tolerant, in particular that the critical crack sizes should be large with respect to the inspection technique. In order to achieve these fundamental requirements, several related but independent arguments should be used, based on the following:

(a) the use of sound design concepts and proven design features;

(b) the analysis of the potential failure modes for all conditions arising from design basis faults:

(c) the use of proven materials;

(d) the application of high standards of manufacture including in-process inspection, and constructions for the materials and processes used;

(e) high standards of quality assurance throughout all stages of design, procurement, manufacture, stages of design, procurement,

manufacture, construction and operation;

(f) pre-service and in-service inspection to detect defects at sizes below those which have the potential for causing or developing into a failure potential for causing or developing into a failure mode, and to size these defects conservatively;

(g) the provision of in-service plant and materials monitoring;

and

(h) the existence of a leak-before-break case."

The measures listed by the NII in §201 were referred to by the Counsel to the Sizewell 'B' public inquiry as "a rag-bag" of measures, and these are not effective in demonstrating that the Sizewell 'B' nuclear power station is ASARP in respect of explosion of the reactor pressure vessel. This is unlawful.

"§213(SAP 155) The manufacture and construction should use appropriate materials, proven techniques and approved procedures to minimise the occurrence of defects which might affect the required integrity of structures or components."

In §213/SAP 155, the use of qualitative safety by the NII in its assessment of the safety of Sizewell 'B' does not demonstrate that nuclear power station is ASARP, and is therefore unlawful.

"406 (SAP 325) The plant parameters relevant to safe operation should be identified and operational limits on those parameters derived such that in the event of any design basis fault sequence:

(a) the integrity of the physical barriers to radioactive release is maintained and the fault consequences limited as required by P25; and

(b) no safety-related component (or structure or system) required to prevent or mitigate the fault sequence will be caused to operate outside the conditions for which it has been qualified."

In the case of Sizewell 'B', by excluding explosion of the reactor pressure vessel from consideration, using \$406/SAP 325 the NII licensed a plant in which all of the physical barriers to the discharge of radioactive material from the reactor core would be ineffective in that all too probable possibility.

3.6. HOW THE NII EVADED THE PROPER CONSIDERATION OF THE CONSEQUENCES OF EXPLOSION OF THE SIZEWELL 'B' REACTOR PRESSURE VESSEL

The following safety assessment principles which the NII say that they have used in the licensing of Sizewell 'B' have the effect of permitting that licensing whilst the consequences of large accidents such as the explosion of the reactor pressure vessel have not been evaluated. From this it is perfectly clear that in the case of large accidents the law requiring Sizewell 'B' to be as safe as reasonably practicable has been broken.

"\$11 The principles are written bearing in mind existing and anticipated plant designs and the form of safety cases likely to be submitted to the Inspectorate. As far as safety cases are concerned, however, licensees may wish to put forward a submission which differs from this expectation and, as in the past, the NII will be prepared to consider such an approach. There are also other possible designs: novel plant concepts and novel plant features are currently being developed by the nuclear industry. Again the Inspectorate will be flexible in its response. In the past there have been plant items whose safety was difficult to justify in such a way as to readily satisfy the SAPs, the pressure vessel being the most obvious example. That possibility was catered for in the existing SAPs by having a principle which allowed for such plant items to be justified on a special case basis and this route has been used on a number of occasions. An amended version of the 'special case' principle is included in these revised SAPs and is available for similar use in the future on difficult plant items or on quite novel design features. If, however, situations arise which call for a different assessment approach, the principles will be re-examined and revised as appropriate. In summary, therefore, the revised SAPs are intended to cater for non-standard as well as the standard approach. In no case, however, should this flexibility be seen as a means of bypassing the rigours of the assessment process; special cases receive particularly close scrutiny."

Whenever the licensee of a nuclear power station proposes to include in its design some item which is both absolutely vital to the safety of the design and the failure probability of which cannot be demonstrated to be small enough for the ASARP principle to be satisfied, the NII permits the use of a 'special case procedure' which it has devised, in which its judgement of the deficient safety case is substituted for the reasoned evaluation which would satisfy the ASARP requirement of the law. Evaluation of accident consequences forms no part of the NII 'special case procedure, as §11 makes clear.

"§19. Where items of plant can be represented in the probabilistic safety analysis by failure rate data this link between the engineering principles and the basic safety standards is clear. For those items whose contributions to the risk cannot be quantified, the link is less obvious and the engineering judgements are more difficult. Reference has been made earlier to an assessment process known as the 'special case' procedure which may be applied to some of those items. Particular attention needs to be addressed to these cases in order to be satisfied that they do not make an excessive contribution to the overall risk from the plant."

Since the NII have not required the licensee to evaluate the total of the undesirable results of any accident, there can be no question of anyone being "satisfied that they do not make an excessive contribution to the overall risk". If this had been done it would be quite clear that the plant is not ASARP, and this fact remains hidden from public view.

"§45. Nuclear plants are, therefore, designed to cope with a wide range of potential accidents (design basis accidents), but it may not be reasonably practicable to make design provision against the more unlikely accidents. The analysis of accident conditions follows two complementary approaches: deterministic and probabilistic. The deterministic approach is used in the analysis of design basis accidents which is required, in line with international practice, as a robust demonstration of the fault tolerance of the plant, of the effectiveness of its safety systems and with the aim of determining the limits to safe plant operation. For the purposes of design basis accidents, uncertainties in the transient and radiological analyses are covered by the use of appropriate conservatism in the treatment."

The total of the undesirable results of explosion of the Sizewell 'B' reactor pressure vessel have not been evaluated, conservatively or otherwise. The NII has issued the

license unlawfully therefore.

"\$46. A deterministic approach is also followed for those accidents which are beyond the design basis and hence are liable to have serious consequences. But the analysis of these accidents differs from that of design basis accidents As in that it should be performed preferably on a best-estimate basis, since it is required primarily to give realistic guidance on the actions to be taken in the event of such an accident occurring, and also to provide an input to the probabilistic safety analysis."

The total of the undesirable results of explosion of the Sizewell 'B' reactor pressure vessel have not been evaluated, There is no estimate, best or otherwise; and if there was it would (unlawfully) be in terms of individual risk instead of the required total risk distributions. The NII has issued the license unlawfully therefore.

"\$48. For the probabilistic safety analysis, the accident frequency principles for the most part do not address directly either individual risk or the risk to society as a whole, but are chosen to provide surrogates for these risks - surrogates which are related to the design and operation of the plant in question. Thus a full risk analysis of all off-site effects is not required, although the licensee may see it as worthwhile to provide such an analysis, particularly for major new installations."

In order to satisfy the ASARP principle, evaluation of the total of the undesirable results of the explosion of the Sizewell 'B' reactor pressure vessel would be required. The NII are wrong therefore, to say as they do in \$48 "Thus a full risk analysis of all off site effects is not required--", and the issue of the license by the NII is therefore unlawful.

"\$55(SAP 18) For fault sequences which lead to a release of radioactive material or to a dose of direct radiation, radiological analysis should be performed which determines the maximum effective dose to a worker on the site and to a person outside the site directly downwind of the release. (The detail of this analysis differs according to its application, see P24 and P36.)"

The effective dose to a single person outside Sizewell 'B' nuclear power station, as specified by the NII in \$55(safety assessment principle 18) does not correspond with the total risk determination required by the law as a substantial element in the

satisfaction of the ASARP principle, and the use of that is therefore unlawful.

"\$56(SAP 19) For the purpose of analysis the fault sequences may be grouped and a 'bounding case' for each group specified. Bounding cases should be selected having regard to the relevant physical and chemical processes involved and the demands made on the safety systems, and should have consequences at least as severe as every member of the groups of fault sequences which they are claimed to bound."

The possible explosion of the Sizewell 'B' Reactor pressure vessel has not been included amongst any of the faults, the 'effects' which have been analysed. The total of undesirable results has not been evaluated for any fault. The issue of the license by the NII under these circumstances is unlawful.

"\$58(SAP 21).The safety case should present a list of all initiating faults which are included within the design basis of the plant. All initiating faults identified under \$16 should be considered for inclusion in this list, but the following need not be included:

(a) faults internal to the plant which have an expected frequency lower than about one in one hundred thousands per year; and

(b) failures of structures, systems or components for which acceptable special case arguments have been made in accordance with SAP 70.

(c) hazards excluded in accordance with SAP 119."

The possible explosion of the Sizewell 'B' Reactor pressure vessel has not been included amongst any of the faults, the 'effects' which have been analysed. The total of undesirable results has not been evaluated for any fault. The issue of the license by the NII under these circumstances is unlawful. No fault should be excluded from consideration until the plant has been shown to be ASARP, as a whole.

"\$61(SAP 24) For each design basis fault sequence or bounding case (see P19) leading to a release of radioactive material, the radiological analysis to

determine the maximum effective dose to a person outside the site should be performed on a conservative basis. In addition to the general requirements of P18, it should assume:

(a) the person remains at the point of greatest dose for the duration of the release, although for extended releases more realistic occupancy may be assumed after a suitable interval;

(b) the weather conditions have characteristics which produce the highest dose to that person; and

(c) no off-site emergency countermeasures are effected, other than certain food bans whose implementation is shown to be highly likely."

The use of 'maximum effective dose to a person outside the site' is not a measure of the total risk, particularly in the case of the explosion of the Sizewell 'B' reactor pressure vessel, and therefore does not permit the ASARP principle to be applied and is therefore unlawful.

"§62(SAP 25) It should be shown that, following any design basis fault sequence:

(a) none of the physical barriers to the escape of radioactivity is breached or, if any are, then at least one barrier remains intact;

(b) there is no release of radioactivity except in the most severe cases and, even then, no person outside the site will receive an effective dose of 100 mSv or more; and

(c) no person on the site will receive an excessive dose from the release of radioactive material or by direct radiation including that from criticality incidents."

Explosion of the Sizewell 'B' reactor pressure vessel breaches all of the physical barriers immediately and discharges most of the radioactive material present in the reactor. The plant has not been shown to be ASARP under these conditions and therefore is unlawful.

"\$63(SAP 26) The design basis analysis should establish the minimum safety system requirements for each initiating fault within the design basis and present the results in a schedule of safety systems, and should also identify the operator action requirements."

In the event of explosion of the Sizewell 'B' reactor pressure vessel none of the engineered protection would make the slightest difference to the course of the accident, nor would there be any operator actions which might mitigate the consequences except for initiating the administration of stable iodide tablets and instant evacuation over an enormous area downwind.

"\$64(SAP 27) The design basis fault analysis should also provide information relevant to:

(a) the trip settings and performance requirements for the safety systems and safety related equipment;

(b) the determination of the plant operational limits (see P325) and the formulation of the operating rules;

(c) the preparation of the plant operating instructions for fault conditions."

In the event of explosion of the Sizewell 'B' reactor pressure vessel none of the engineered protection would make the slightest difference to the course of the accident, nor would there be any operator actions which might mitigate the consequences except for initiating the administration of stable iodide tablets and instant evacuation over an enormous area downwind.

"\$69 (SAP32) A probabilistic safety analysis of the overall design and system of operation should be performed to enable an assessment of the risk arising

from the plant to be made, and a judgement as to its acceptability against the accident frequency principles, SAP42 to SAP46. The probabilistic safety analysis should also confirm that a balanced design of the plant has been achieved, such that no particular class of accident or feature of the plant makes a disproportionate contribution to the overall risk."

The sub-total of the possible undesirable results has not been evaluated and disclosed for any accident in the case of Sizewell 'B'. The uncertainty in the expectation of the undesirable results invalidates the method of comparison which the NII call for in §69 (safety assessment principle 32) so that the plant has not been shown to be ASARP and is therefore unlawful.

"§73 (P36) The maximum effective dose to a person outside the site should be calculated for a person situated at the nearest habitation or at a distance of 1 km from the plant, whichever is nearer, or at the point of greatest dose if that is further away."

The maximum effective dose to an individual, does not provide a measure of the sub total of undesirable results of any single accident nor of any group of accidents to Sizewell 'B', and is therefore unlawful.

"§79 (SAP42) The total predicted frequencies of accidents on the plant, which would give doses to a person outside the site, should be less than the values given in the following table:

Maximum effective dose, mSv	Total predicted frequency, per year Basic Safety Limit
1	1 per year
10	1 per 10 years
100	1 per hundred years

1000

1 per thousand years

> 1000

1 per ten thousand years

Note. A subsidiary aim should be for no single class of accident to contribute more than about one tenth of the total frequency in any dose band, to avoid placing excessive reliance on particular features of the plant or on particular assumptions in the analysis."

The maximum effective dose to an individual, does not provide a measure of the sub total of undesirable results of any single accident nor of any group of accidents to Sizewell 'B'. The sub-total of the possible undesirable results has not been evaluated for any accident in the case of Sizewell 'B'. The uncertainty in the expectation of the undesirable results invalidates the method of regulating total risk which the NII call for in §79 (safety assessment principle 42) so that the plant has not been shown to be ASARP and is therefore unlawful.

"§81 SAP44 The total predicted frequency of an accident on the plant with the potential to give a release to the environment of more than:

Amount of

Large release

10 000 TBq of Iodine 131

or 200 TBq of Caesium 137

or quantities of any other isotope or mixture of isotopes which would lead to similar consequence to either of these should be less than:

BasicSafetyLimit

1 in 100,000 years"

The amounts of radioactivity considered as acceptable discharges in safety principle SAP44 are only one thousandth part of what is actually present in the Sizewell 'B' reactor during its operation. In the Chernobyl reactor explosion the fraction of the radioactivity in the reactor core which was discharged to the inhabited environment during the accident was somewhat greater than one thousandth part. In fact it was more than half. Thus, arguing that the fraction discharged after explosion of the Sizewell 'B' reactor pressure vessel would be similar to that at Chernobyl, which on the face of it seems reasonable, the allowable frequency of such an accident should be less than one in one hundred million years if it is to conform to the government risk criterion quoted above. Furthermore any consideration of the two isotopes mentioned does not permit the evaluation of the total risk of discharge of most of the radioactive materials in the reactor within a few seconds of an explosion of the reactor pressure vessel of the Sizewell 'B' nuclear power station.

"§117(SAP70) Where a structure, system or component forms a principal means of ensuring nuclear safety and it is not practicable to demonstrate that the accident frequency principles P42 to P46 are satisfied in the event of its failure, the plant may only be accepted after the application of a special case procedure agreed as an alternative demonstration. The procedure should include a comprehensive examination of all the relevant scientific and technical issues, taking account as appropriate of precedents set under comparable circumstances in the past."

The special case procedure does not include an evaluation of the undesirable results of the failure of the Sizewell 'B' reactor pressure vessel.

"§118(SAP 71) Where the special case procedure is applied or where any safety system is required to achieve a high reliability, an independent assessment of the item should be carried out in addition to the checking provided as part of the design process. The object of the assessment should be to confirm the adequacy of design specification and that the manufacture, construction and commissioning satisfies that specification."

The special case procedure does not include an evaluation of the undesirable results

of the failure of the Sizewell 'B' reactor pressure vessel.

"406 (SAP 325) The plant parameters relevant to safe operation should be identified and operational limits on those parameters derived such that in the event of any design basis fault sequence:

(a) the integrity of the physical barriers to radioactive release is maintained and the fault consequences limited as required by P25; and

(b) no safety-related component (or structure or system) required to prevent or mitigate the fault sequence will be caused to operate outside the conditions for which it has been qualified."

Explosion of the Sizewell 'B' reactor pressure vessel immediately breaches all of the physical barriers to the discharge of radioactive material from the reactor, and the total of the undesirable results of this have not been evaluated so that the plant has not been shown to be ASARP and the issue of a license by the NII is unlawful.

4. CONCLUSION

4.1. THE NII HAS ACCEPTED A FALSE SAFETY CASE JUSTIFYING ITS ISSUE OF THE LICENCE

In the case of the risk of explosion of the Sizewell 'B' reactor pressure vessel, the NII has not required the licensee to:

(a) use in the demonstration that the plant is ASARP, a value of the probability of that explosion which can be proven; and

(b) submit an alternative design in which the probability of that explosion would not prevent the plant from being ASARP;

(c) use in the demonstration that the plant is ASARP, a value of the total undesirable results which would be caused by that explosion and the resulting loss of physical containment of the radioactive material in the reactor.

4.2 FALSE STANDARDS ADOPTED FOR THE ACCEPTABILITY OF RISK

The HSE has introduced standards for the acceptance by the public of risks to the public which, the HSE says are based upon the requirements of the law, In §4 of their safety assessment principles the HSE say:

"the general approach to the regulation of risks, in which the ALARP principle again plays a central role, may be summarised in the following way:

(a) For any activity the level of risk may be so great that the activity cannot be allowed to continue. This upper limit defines the bound between risks which are just tolerable and the which are intolerable.

(b) Even when the level of risk is tolerable, it must be reduced to a level which is as low as reasonably practicable, (c) A point is reached at which the risk is, or has been made, so small that no further precaution necessary."

In this the HSE have made it perfectly clear that between the negligible risks denoted in (c) and the unallowable risks referred to in (a), all other risks must be the subject of the balance necessary to demonstrate 'AS SAFE OR AS LOW AS REASONABLY PRACTICABLE'. There has been no open debate in the public arena about the acceptability of the risks of large accidents to UK nuclear power stations. This is hardly surprising given the present accuracy of the public understanding of such risks in the light of Chernobyl knowledge. What is also certain is that the risk of Sizewell 'B' does not satisfy (b) or (c) above, and then, because in the case of the Sizewell 'B' nuclear power station the satisfaction of such requirements seemed to the old CEBG to necessitate unnecessary costs, the HSE had to find a way of overcoming or evading them. The law requires that Sizewell 'B' must be "AS SAFE AS IS REASONABLY PRACTICABLE". The HSE/NII interpret this in paragraph 7 of their safety assessment principles, saying that:

"§7 In carrying out an assessment, the NII assessors need to judge the extent to which the safety submission shows that the design of the plant is in conformity with the principles. Not all of the principles are relevant to every plant, but the extent to which the relevant principles are met will be an important factor in any decision on licensing. The law requires the plant to be as safe as reasonably practicable. Some of the

principles embody specific statutory limits. Apart from these, the principles in this document should be met as far as is reasonably practicable, and that expression could have been written, at the risk of being tediously repetitive, into almost every SAP. There cannot, therefore, be a rigid interpretation of the principles. On the other hand, the engineering principles in particular represent the NII's view of good practice and we would not expect modern plants to have difficulty in satisfying the majority of them."

BUT SIZEWELL 'B' DOES NOT DO SO.

Rodney Fordham

28 August 2001

signed Rodney Fordham

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