STUDY ON THE INSURANCE, PRIVATE AND FINANCIAL MARKETS IN THE FIELD OF NUCLEAR THIRD PARTY LIABILITY

No. ENER/D2/2017-562

Final report

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EXECUTIVE SUMMARY

In the 1950s, recognising that the possible cross-border consequences of a nuclear accident required an international nuclear liability regime, a special third-party liability regime was developed to cover nuclear sites. Today three Conventions (the Paris/Brussels Conventions, the Vienna Convention and the Convention on Supplementary Compensation – CSC) share similar principles and provide the foundations for the nuclear liability arrangements. Nuclear liability is limited in time and amount by these international Conventions and by national legislation that largely follows the principles established by the Conventions, so that beyond the financial security limits imposed on nuclear operators, the state can accept responsibility as insurer of last resort, as in many other aspects of industrial society. The nuclear site operators are liable for any and all nuclear damage caused by them, regardless of fault. They therefore normally take out insurance for this nuclear third-party liability (NTPL); in most countries they are required to do so.

The 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (the Earth Summit) witnessed the unveiling of the Rio Declaration[1], a short document that laid out guiding principles for global sustainable development; among the 27 principles are two of particular relevance to the nuclear sector. Principles 13 affirms '*states shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage'* and principle 16 states that *'national authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution'.* Although the main nuclear liability Conventions pre-dated this Earth Summit by decades, the major nuclear accident at Fukushima in 2011 and those prior to the Rio Declaration demonstrated that the nuclear liability regimes in place at the time fell short when measured against these principles; in both cases the polluters may not have borne the full cost of the pollution caused and the regimes provided only limited compensation amounts for victims.

A principal reason for the limited compensation following the above noted major nuclear incidents was the lack of adequate insurance capacity to cover the full scope of the site operators' financial security requirements; the broadening of the coverage demanded by the revised nuclear liability Conventions[2] presents traditional insurers with difficulties, as the new cover requirements apparently push at the boundaries of insurability even more.

This study is focused on nuclear third-party liability and it was commissioned to investigate ways of i) closing the insurability gaps, where the full financial security amount is not attainable because of a lack of capacity for the full scope of cover required and ii) developing additional capacity, in order to increase private coverage for NTPL in case of a severe nuclear accident. The study researches the state of the nuclear liability insurance market today, analyses the insurers' difficulties with the revisions to the nuclear liability Conventions and proposes new solutions to encourage the deployment of more nuclear liability capacity (including for the full scope of the liability). The study has five main objectives:

A. Provide a description of the different providers of nuclear third-party liability (NTPL) insurance which operate in the EU;
B. Provide an estimate of the NTPL insurance capacity available at the global and EU level and identify the factors that constrain the availability of this capacity;
C. Identify the currents gaps in the provision of NTPL insurance as well as possible private sector solutions to cover these gaps;
D. Provide an estimate of NTPL insurance capacity to provide for increased coverage and identify possible solutions to be set up for that purpose;
E. Assess the main impacts of the different solutions and mechanisms identified and indicate which solutions would be more effective for covering the gaps of the insurance.

[1] See: https://www.un.org/geninfo/bp/enviro.html

[2] The 1997 Revised Vienna Convention and the 2004 Revised Paris and Brussels Conventions.

Study structure

The study is organised into seven sections.

The first section contains a short introduction to the existing NTPL legal regimes and the discrepancy between the likely cost of damages resulting from a severe nuclear accident and the actual availability of NTPL insurance capacity to cover it.

The second section describes the methodology used during the research phase of the study. The methodology adopted respected fully the principles of objectivity, reliability and evidence-based assessment. In some cases the competitive nature of the insurance market restricted either access to or full disclosure of some information; therefore, most quantitative information is presented in an aggregated format, to respect the confidentiality of individual market players. The section concludes with a commentary on any obstacles and limitations; the research team encountered few obstacles and the only material limitation was the commercially sensitive nature of some of the data obtained.

The remaining five sections cover the European Commission's objectives in detail, with two sections largely devoted to the state of the NTPL insurance market today and two sections looking at possible new sources of NTPL capacity and its optimal deployment. The seventh section outlines the study recommendations and conclusions.

The Annexes to the study contain a glossary of insurance terms, information about the EU nuclear power station sites, their financial security requirements and detailed quantitative output from the research.

To further aid the layman's understanding of the nuclear insurance market, six Technical Annexes separately provide descriptions of various aspects unique to the nuclear insurance market, including information on the origins, development and operation of the two main groups of NTPL insurance capacity providers, guides to possible new capacity providers and the relationship between capital, capacity and underwriting.

The NTPL insurance market today

The third section of the study focuses on the current insurance market for NTPL. For the purposes of the research the market is sub-divided into two groups, being risk-transfer insurers and self-insurers; in the former group are the majority of major 'household name' private insurers which provide insurance capacity as members of the nuclear insurance pools, via other managing general agents (MGAs), as individual stand-alone players and as reinsurers to the self-insurance capacity providers. The self-insurance capacity providers are insurers owned or controlled by the nuclear site operators, being mutuals, captive insurers or those participating in the German operator pooling mechanism.

The fourth section analyses the capacity available for both the existing[3] and revised[4] NTPL arrangements in the EU and globally; it compares this capacity with that available for other low frequency, high severity events such as natural catastrophes and major pollution accidents. The section also identifies the major gaps in capacity availability between the existing and revised NTPL arrangements and describes the constraints that are preventing a greater deployment of private market insurance capacity to meet the requirements of the NTPL Convention revisions and to provide for increased coverage.

The key findings relating to insurance capacity are:

[3] For the purposes of the study, the existing legal regimes are assumed to be those that require: i. Financial security to cover nuclear damage for damage to property and bodily injury; ii. an amount of financial security not higher than €1.2 billion or €2.5 billion for Germany; and iii. A prescription period no longer than 10 years after the nuclear incident/occurrence.

[4] For the purposes of the study, the revised legal regimes are assumed to be those that require: i. Financial security to cover nuclear damage for damage to property, the environment, bodily injury, economic loss and the cost of preventive measures; ii. an amount of financial security of more than SDR 300 million (RVC) or €700 million (RPC) and up to €1.2 billion (€2.5 billion in Germany); and iii. a prescription period of 30 years for bodily injury and no longer than 10 years after the final nuclear incident/occurrence for other damage.

- Capacity for the existing NTPL arrangements is freely available for the full scope of nuclear damage in all EU MS. Excluding the €2.5 billion operator pooling arrangements in Germany, almost €2.4 billion of NTPL capacity is available, well in excess of the maximum requirement of €1.2 billion; of this €2.4 billion, about €2.2 billion is provided by the risk-transfer market and about €200 million by the self-insurance market.
- Capacity for comparable low frequency high severity events is available as follows:
    - The private market can demonstrably provide capacity of more than €70 billion for natural catastrophe losses; this is because the losses from these events are spread across many types of insurance and amongst many insurers and reinsurers.
    - Private market capacity for individual marine pollution events is more limited, with about €2.6 billion available. Statutory regimes comparable to the nuclear NTPL regimes are in place and the insurance capacity is organised by Protection and Indemnity Clubs which include material shipowner mutual participation.
    - Private market capacity for fixed offshore facilities are not as yet governed by statutory regimes and available capacity amounts to between €3 and €5 billion, although the Deepwater Horizon event cost its owner BP materially more than this.
- Capacity for the revised NTPL arrangements is not available for the full scope of nuclear damage in all EU MS. Excluding the full scope cover of €2.5 billion provided by operator pooling arrangements in Germany, about €250 million of full scope NTPL capacity is available, which currently falls well short of the revised Paris/ Brussels Conventions requirement of up to €1.2 billion; of this €250 million, about €100 million is provided by the risk-transfer market and about €150 million by the self-insurance market. Notably only the nuclear mutuals provide full scope cover for their full offered capacity.

The extension of the period to bring a claim for bodily injury from 10 to 30 years is the principal remaining gap in cover required by the revised NTPL Conventions; it is largely this issue that is preventing the acceptance by risk-transfer insurers of the revisions to the Paris/Brussels and Vienna Conventions.

The NTPL capacity constraints that have been emphasised are:

- *Insurers' perception of the language of the revised NTPL Conventions*: many insurers consider that the nuclear damage definition is too open without a trigger or similar defining characteristic.
- *The radioactive contamination exclusion clause and net line commitment*: these embodiments of the nuclear liability channelling principle constrain insurance capacity by restricting insurers' commitment and the use of reinsurance; they also distinguish the nuclear insurance sector as unique and different, so creating a barrier to entry for some insurers.
- *Lack of actuarial data*: the small number of nuclear sites and low occurrence of recordable sector accidents makes analysis of nuclear insurance difficult in the framework of today's regulatory environment; insurance generally requires large amounts of data to calculate premiums.
- *Nuclear industry perception*: the polarisation of opinions about nuclear power applies equally to the financial sector as it does to the general population; this acts as a barrier to entry for many insurers and their investors.
- *Nuclear industry size*: the few numbers of insurable nuclear sites, the relatively small size of the nuclear sector and its limited growth for insurance are discouraging factors for many insurers.
- *Volatility*: with risk transfer insurers generally limited to net line commitments and analysis of the sector often dependent on theoretical data, the modelling of NTPL insurance produces volatile outcomes that can require more capital to underwrite nuclear when compared to other classes of insurance.
- *Judicial inflation*: insurers have generally poor experience of modelling and assuming long-term exposure because claims are driven by medical, legal and compensation costs that suffer from a higher rate of inflation than normal inflationary indicators would suggest. This is a key disincentive for many insurers.

- *Rating agencies*: a combination of several of the above listed constraints can materially impact an insurer's credit rating, which discourages participation in nuclear insurance.
- Amongst the self-insurance capacity providers, capacity is constrained by limited access to the risk-transfer reinsurance market, which in turn restricts the growth of the self-insurance entities.

New capacity and solutions

The fifth section of the study considers from where new capacity for NTPL insurance might be sourced; both existing players and new markets are investigated. The study research shows that additional capacity is available for NTPL insurance from new sources within the capital markets, as well as some other sources within the traditional insurance market should demand increase; in particular the scale of the capital markets represents an exciting opportunity to deploy more private capital to the NTPL exposure.

This section also considers 13 potential solutions (listed below) to increase NTPL capacity; the study reviewed each concept and either rejected or retained each concept.

Description	Primary objective	Retained Y/N
Extend the German Solidarity Agreement	Increased capacity	NO
EU-wide version of the USA SFP layer	Increased capacity	NO
All EU Member States to join the CSC	NTPL equality of cover in EU	NO
All EU Member States to join the RPC	NTPL equality of cover in EU	NO
EU MS governments indemnify insurers for 10-30 year bodily injury exposure	Increased capacity	NO
Remove the 10-30 year bodily injury prescription period from the NTPL Conventions	Increased capacity	NO
Introduce a threshold/trigger for operator's financial security attachment for current regimes	Increased capacity	NO
RPC 1st tier amount or RVC full amount funded as USA for all EU MS	Increased capacity	YES
All policies have single, lifetime limits	Increased capacity	YES
More homogeneity for policy language and reinstatement provisions	Increased capacity	NO
Increase mutual participation with new mechanisms for reinsurance	Increased capacity	YES
Change policy type from losses occurring to claims made	Increased capacity	NO
Catastrophe only, EU wide, single event, cover excess of the current legal regimes	Increased capacity	YES
Establish EU wide Protection Gap Entity	Infrastructural improvement	YES

This section concludes that most of the retained solutions could be implemented without the need to employ creative interpretations to circumvent the international NTPL regimes; it also concludes that the effectiveness of the proposed solutions could be maximised if they were implemented on an EU-wide level. An NTPL regime at an EU-wide level offers the best way to achieve wide-ranging protection of potential nuclear accident victims and to ensure resources are available for their compensation and associated claims management.

In the sixth section each of the new concepts that was retained after the preliminary analysis in section 5 is described and assessed against the following criteria:

- Whether they could provide the full scope of cover;
- Whether they will provide additional NTPL capacity;
- Whether they could provide NTPL capacity across the whole EU;
- The practicality of introducing each concept;
- The likely cost to operators of each concept;
- Whether the existing or proposed legal regimes can easily accommodate each concept.

The assessment for each concept is summarised below:

1. *Permit the build-up of funds to cover the RPC 1st tier amount or RVC full amount for all EU MS*: this concept is intended to increase insurer capacity provision by providing a financial buffer against certain losses that would be allocated, by mutual agreement, to the largely operator owned fund. The fund could be built up by taking a fixed proportion of each operator's NTPL premium. The early stages of this fund's development would be the most challenging phase, but with political support such obstacles could be overcome using existing insurance products.
2. *Ensure all NTPL insurance policies to have single, lifetime period limits*: this concept will provide greater amounts of capacity from the risk-transfer market as it removes one of the key constraints on capacity, although it will not relieve the shortage of capacity for the full scope of the revised NTPL Conventions. There are no apparent legal, geographical or practical obstacles in the way of its introduction, and it is a change which could easily be incorporated by those insurers that do not offer it yet.
3. *Increase the NTPL mutuals' participation with new mechanisms for reinsurance*: as the only capacity provider that can offer full scope cover for the revised NTPL Conventions for its total capacity, increasing this capacity within the existing NTPL framework should offer a quick solution to fulfil the scope of NTPL cover required by the revised Conventions. There are no material legal obstacles and capacity provided by mutuals will be cheaper and probably more acceptable to the operators over time; however, a wider pool of reinsurance providers will be key to permitting increased mutual capacity provision.
4. *Create a new catastrophe only, EU wide, single event, NTPL insurance cover excess of the current legal regimes*: this concept would use a trigger mechanism to achieve materially greater capacity; the trigger would separate the existing difficult aspects of the revised NTPL Conventions from catastrophe only scenarios, for which substantial capacity is available and can be readily deployed. It will offer new, unconstrained capacity for a single, defined catastrophic occurrence, covering all EU NPPs, during one calendar year; however, it can only deliver these benefits if operators are obligated to purchase higher amounts of financial security. Alternatively, governments or the EC could purchase this cover and re-charge the operators proportionally.
5. *Establish an EU wide Protection Gap Entity to organise and manage NTPL exposure*: this concept envisages the EC mandating the creation of an entity that would oversee the implementation of several of the solutions described in this study combined together in a single management framework. The entity would be a supra-national organisational and management framework that would 'own' the nuclear risk at an EU-level and would be responsible for the segmentation and redistribution of the exposure to the optimum provider(s), so allowing the current NTPL market difficulties to be addressed and the NTPL exposure allocated across a wide range of capacity providers.

This section also considered in more detail triggers that could be used to sub-divide the exposure, so allowing optimal allocation of risk to unlock increased NTPL capacity. The triggers considered are:

1. The International Nuclear Event Scale (INES);
2. A specific monetary amount;
3. A formal event description, such as the US NRC's description of an Extraordinary Nuclear Occurrence (ENO);
4. Multiple simultaneous radiation off-site monitoring point readings;
5. A state inspired trigger, such as when emergency procedures or evacuations are initiated;
6. A supra-national trigger; for example, based on selected values in the Basic Safety Standards Directive (BSSD) that identifies harm to individuals, property and/or the environment.

These were scored using various suitability criteria and this identified that the most suitable triggers for the insurance and capital markets are triggers 1, 3 and 4 from the above list.

Conclusion and recommendations

The final section of the study recommends the optimal concepts based on the research and analysis conducted. The recommended concepts yielding short-term results with minimal complications are:

- Ensure all NTPL insurance policies to have single, lifetime period limits.
- Increase the NTPL mutuals' participation with new mechanisms for reinsurance.

The recommended concepts that could be implemented in the medium term are:

- Permit the build-up of funds to cover the RPC 1st tier amount or RVC full amount for all EU MS.
- Create a new catastrophe only, EU wide, single event, NTPL insurance cover excess of the current legal regimes
- Establish an EU wide Protection Gap Entity.

The study concludes that implementation of these concepts, either individually or combined, will permit the deployment of materially greater NTPL capacity than is currently available; achieving this greater internalisation of the costs of higher financial security amounts will enhance the credibility of the nuclear industry and offer greater private market compensation for victims of a severe nuclear accident.

ACRONYMS AND ABBREVIATIONS

Abbreviation or Acronym	Description
BP	British Petroleum
BSC	1963 Brussels Convention Supplementary to the 1960 Paris Convention
BSSD	Basic Safety Standards Directive
CLC	Civil Liability Convention
CLEE	Convention of Civil Liability for Oil Pollution Damage resulting from Exploration for and Exploitation of Seabed Mineral Resources
CSC	1997 Convention on Supplementary Compensation for Nuclear Damage
EC	European Commission
EIOPA	European Insurance and Occupational Pensions Authority
ELINI	European Liability Insurance for Nuclear Installations
EMANI	European Mutual Association for Nuclear Insurance
ENO	Extraordinary Nuclear Occurrence
EU	European Union
FS	Financial security
HoD	Head(s) of damage
IAEA	International Atomic Energy Agency
ICRP	Industry Credit Rating Plan
ILS	Insurance Linked Securities
ILW	Insured Loss Warranty
INES	International Nuclear Event Scale
INLEX	International Expert Group on Nuclear Liability (formed by IAEA)
IOPC	International Oil Pollution Compensation Fund
JP	1988 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention
MGA	Managing General Agent
MS	EU member state
NEA	Nuclear Energy Agency (part of the OECD)
NEIL	Nuclear Electric Insurance Limited
NIRA	Nuclear Industry Reinsurance Association
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission (US nuclear regulator)
NTPL	Nuclear Third-Party Liability
OECD	Organisation for Economic Cooperation and Development
OPOL	Offshore Oil Pollution Liability Agreement
P&I	Protection and Indemnity
PC	1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy
PGE	Protection Gap Entity
RBC	2004 Protocol to amend the Brussels Supplementary Convention
RCE	Radioactive contamination exclusion (clause)
RPC	2004 Paris Convention on Nuclear Third-Party Liability
RVC	1997 Vienna Convention on Civil Liability for Nuclear Damage
SA	Solidarity agreement
SDR	Special Drawing Rights
SFP	Secondary financial protection layer (US operator pooling)
SME	Small and medium sized enterprises
TEPCo	Tokyo Electric Power Company
UK	United Kingdom of Great Britain and Northern Ireland
US/USA	United States of America
VC	1963 Vienna Convention on Civil Liability for Nuclear Damage
WENRA	Western European Nuclear Regulators' Association
WNA	World Nuclear Association

1 INTRODUCTION

Recognising the potential for catastrophic nuclear accidents, in the late 1950s and early 1960s lawmakers developed third-party liability regimes for nuclear operators; throughout the world the foundation for most of these are two international conventions: the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy, adopted under the auspices of the Organisation for Economic Co-operation and Development (OECD) and the 1963 Vienna Convention on Civil Liability for Nuclear Damage, adopted under the auspices of the International Atomic Energy Agency (IAEA).

These two Conventions contain similar principles that balance the strict (not fault-based) and exclusive liability of the nuclear operator with a limitation in time and amount of this liability; the operator must provide financial security for the liability and the courts of the State where the accident occurs have exclusive jurisdiction, providing non-discriminatory compensation to victims regardless of nationality, domicile or residence.

Despite common principles, differences remained between the two Conventions in respect of the amounts set for the liability of nuclear operators and hence the level of financial security required[5]. Moreover, the adequacy of these liability amounts was quickly questioned, resulting in the supplementing of the Paris Convention with the 1963 Brussels Convention, which provides additional compensation to victims through the establishment of a three-tier system. The first tier is provided by the operator for an amount established under the national law, which cannot be lower than the minimum amount provided in the Paris Convention; the second tier consists of public funds provided up to a certain amount defined in the Convention by the State in which the liable operator is situated, unless the national law transfers the obligation to the operator; and the third tier is made up by the contributions from all parties to the Brussels Convention.

The Chernobyl accident in 1986 further challenged the adequacy of the Conventions; therefore a Joint Protocol was adopted in 1988 to provide a link between the Paris and Vienna Conventions, by extending the liability of the operator of a nuclear installation situated in the territory of a Party to one of the Conventions to nuclear damage suffered in the territory of a Party to the other Convention. Also, both the Vienna and Paris/Brussels Conventions were revised, respectively in 1997 and 2004, to increase the liability amounts provided under the Conventions and to extend the range of damages giving rise to compensation, by including environmental damages, economic losses and preventive measures and extending the time during which a claim for bodily injury can be made from 10 to 30 years. The Protocol amending the Vienna Convention entered into force on 4 October 2003, but has so far only been ratified by 14 Contracting Parties (compared with 42 for the 1963 Vienna Convention). The Protocols amending the Paris and Brussels Conventions have not yet been ratified by enough countries to enter into force. Of particular relevance to this study, none of the EU Member States that are parties to the Paris and Brussels Conventions has yet deposited its instrument of ratification to the amending Protocols, due to the requirement laid down in Council Decision 2004/294/EC4, by which all EU Member States Parties to the Paris Convention have to deposit simultaneously their instruments of ratification or accession to the Protocol.

In 1997 a new international instrument, the Convention on Supplementary Compensation for Nuclear Damage (CSC) was adopted, with the objective of establishing a system of supplementary state funding at both national and international levels, modelled partly on the Brussels Supplementary Convention. The objective was also to establish the basis for a global system, open to all states, including those already parties to the Paris-Brussels or Vienna regimes. The CSC, which entered into force on 15 April 2015[6], provides for a two-tier compensation

[5] Under the 1960 Paris Convention, the minimum amount for the liability of the operator is set at SDR 5 million and the maximum at SDR 15 million; however in 1990 the NEA steering committee recommended that PC states set the maximum liability amount at not less than SDR 150 million (c. €187 million); most have done so. The 1963 Vienna Convention provided for a minimum amount USD 5 million, being a USD gold value of $35/oz at 29th April 1963.

[6] Currently the CSC has ten Contracting Parties, amongst which six have at least one nuclear power plant in operation (Argentina, Canada, India, Japan, Romania and United States).

system: the first tier is provided by the operator and, if necessary, the state where its installation is situated; the second tier is provided by the State parties on the basis of installed nuclear capacity and a UN rate of assessment.

However, the Fukushima accident in 2011 showed that a wide gap still exists between the available financial securities, as set out in the revised international conventions and in the national liability laws, and the potential cost of third parties' compensation resulting from a severe nuclear accident. At the end of July 2019, compensation paid to victims of the Fukushima accident amounted to over Yen 9 trillion (about €75 billion[7]), yet the statutory site financial security amount required at the time in Japan was only ¥120 billion[8]. This wide gap could be repeated in most nuclear countries, including the EU member states; where nuclear operators do not have unlimited liability, it is likely that the state will pay when the financial security amounts are unable to cover the cost of third parties' compensation resulting from a severe accident. Even where the operator's liability is unlimited, once its corporate funds are exhausted the state will still have to pay any further nuclear damage compensation.

The low amounts of financial security are often attributed to a shortage of insurance capacity, as the available insurance market for nuclear sites is apparently limited by the broad scope of liability encompassed within the operators' obligation to compensate for all nuclear damage. The limited availability of insurance for nuclear liability stands in stark contrast to the availability of insurance for other costly catastrophes, such as severe weather, where events with insured losses of over $50 billion are increasingly being paid.

In this context, this study's broadest objectives are twofold: (i) to understand better the current NTPL market and why more capacity is not available and (ii) to discover how more insurance or other private capital capacity could be attracted to the NTPL sector and under what circumstances. Therefore, it differs from previous EC studies about NTPL because it is mostly about insurance rather than the NTPL legal framework or the nuclear industry itself, although it cannot entirely ignore either of these. A more detailed description of the objectives is shown in Annex B.

Overall this study provides the European Commission with the information needed to consider new options that will enhance the available compensation for victims of a severe nuclear accident. The Commission's unique status permits it to consider developing the first comprehensive regional NTPL compensation regime; the research team hopes that the output from this study will contribute to the inevitable debate that such a regime will attract.

To assist the reader's understanding of the insurance market, a glossary of insurance terms is provided in **Annex A**; also, certain peculiarities of the nuclear insurance market are described in more detail in a series of **Technical Annexes**.

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[7] Converted at ¥121.03 to €1

[8] See: OECD NEA publication '*Japan's Compensation System for Nuclear Damage*' p.16; available at http://www.oecd-nea.org/law/fukushima/7089-fukushima-compensation-system-pp.pdf

2 METHODOLOGY

2.1 INTRODUCTION

The methodology used to achieve the study objectives respected fully the principles of objectivity, reliability and evidence-based assessment. However, material amounts of the underlying information required in the fulfilment of this study were commercially sensitive, thus confidential and in some cases unobtainable. Qualitative information is presented simply and factually when available; quantitative information is less individually attributable and was collated from multiple sources.

The insurance market generally is very competitive, and this restricted stakeholders' ability to discuss certain issues with the research team; therefore, opinions and observations obtained from extensive market experience have provided a material part of the study's output. Using this approach, the team acquired more data more accurately than was possible just by using standardised questionnaires.

2.2 DATA COLLECTION

Objective A: Provide a description of the different actors from the insurance, private and financial markets (insurers, re-insurers, insurance mutual and operators' pools, nuclear operators' in-house insurance companies, etc.) which operate in the EU in the field of nuclear third-party liability.

The methodology used to develop the output for this objective, being a picture of the risk-transfer and self-insurance participants in the NTPL market, presents the qualitative information descriptively and the quantitative information in a tabular format.

The qualitative output for this objective was gathered from public sources, such as report and accounts, articles and studies on the market and from information gathered from questionnaires, meetings and discussions held with key stakeholders. It was supplemented with market knowledge gained from practical working experience from within the team.

The quantitative output lists in a tabular format the self-insurance entities showing all the relevant information required. The gathering of this data was from public sources, again such as report and accounts and regulatory listing and it was supplemented by quantitative evidence that emerged from the qualitative study and from meetings and discussions.

The output differentiates between 'aggregators' of capacity (such as pools and other MGAs) and other individual market players. The objective also required an in-depth examination of the nuclear pools active in the EU; for this work the published information was supplemented using questionnaires that requested information across the full scope of the project and which were designed to incorporate as much information gathering as possible into one campaign.

The type and membership of the various nuclear pools were also analysed, to expose any material differences amongst the pools operating in Europe.

Objective B: Provide an estimate of the capacity of the insurance, private and financial markets currently available for each respective head of damage, at the global and EU level, for third party liability in case of a nuclear accident and identify the constraints regarding the availability of this capacity.

Gathering the information for the quantitative capacity section was achieved using published information, the responses from the questionnaires and from direct contact in meetings or discussions. A full and completely accurate picture of capacity was not possible due to commercial considerations, but the team has achieved as full a picture as possible given the commercially sensitive circumstances. The information is presented in a tabular form.

This objective also demanded a comparison of NTPL capacity available with that available for other low frequency/high severity events and for catastrophe events. The information on these sectors was researched from published material and supplemented with discussions with some key market players which verified the findings.

The work on capacity constraints was completed using qualitative data from various sources including published materials but was primarily researched during numerous discussions with insurers and regulatory bodies. The team investigated at length the perception of the nuclear risk, the insurance market's reluctance to offer liability cover with long prescription periods, why exposure accumulation is a constraint on capacity, the new regulatory framework on capital requirements for event scenarios and also considered whether the radioactive contamination exclusion clause acts to constrain capacity.

To verify the information researched, the team consulted a key player in the provision of actuarial advice to insurers, as the insurers themselves were not willing to reveal details of their own actuarial models.

Objective C: Identify currents gaps in the insurance, private and financial markets in the field of nuclear third-party liability, as well as possible solutions to cover for these gaps including through the identification of possible multiple layer schemes and mechanisms, focusing on private solutions.

The methodology used to deliver the information for this objective is predominantly qualitative and was researched using reviews of the market and discussions. The team's investigation included questioning key players in the low frequency/high severity loss market and natural catastrophe market; the team's objective here was to discover whether there are lessons that the NTPL market can learn from other sectors to allow more capacity to develop for the nuclear risk.

Objective D: Provide an estimate regarding the capacity of the insurance, private and financial markets to provide for increased coverage in the field of nuclear third party liability and identify possible solutions to be set up for that purpose, such as legal solutions to increase legal certainty for the insurers or other actors, or multiple layer schemes and mechanisms, including trigger mechanisms.

This objective is more forward looking and demanded greater qualitative and subjective output. Nonetheless, the team maintained the rigour of research and presents a broad picture of possible NTPL provision options to increase capacity and to widen cover scope; the research encompassed discussion with some larger EU insurers to discover whether they have an appetite for more NTPL provision or whether the existing structures are restricting their access to nuclear business. The team also looked outside the EU to understand what it takes to encourage material additional capacity into the market.

The second part of this objective required an investigation of possible new mechanisms outside the existing arrangements. In this section we consider several different schemes using published information and the outcome of discussions across a wide range of stakeholders. The team investigated whether the cat bond/ILS market can provide any useful capacity for NTPL in future and considered other, new solutions that can offer a good fit with the EC's objectives. For any of the solutions investigated, the key criterion was whether a solution can realistically and cost-effectively either provide the full scope of the revised NTPL Conventions' cover or can add material new capacity, perhaps outside of the current regimes, on a cost effective basis for the industry, as the likely cost of any scheme on operators is crucial to understand.

In this section the team also includes an overview of the legal implications of introducing any of these schemes in Europe; the legal members of the team have provided a review of the solutions presented and have identified what legal adaptations may be required to implement each solution.

Objective E: Assess the most relevant and important likely impacts of the different solutions and mechanisms identified and indicate which solutions/mechanisms would be more effective for covering the gaps of the insurance, private and financial markets in the field of nuclear third party liability and for providing an increased coverage in this field.

The work to complete this objective focused on grouping the information gathered during the project work with the aim of establishing a ranking between different solutions; the team reviewed and compared the solutions identified using the criteria listed below to indicate to the EC which solution is likely to be the most effective in closing cover gaps and providing additional full scope capacity for NTPL.

Criterion	Comment
Scope of cover	Does the solution provide the full scope of cover required by the NTPL Conventions' nuclear damage definitions?
Capacity	Does the solution provide material additional capacity for NTPL, so distancing governments and taxpayers further from financial loss caused by a nuclear accident?
Geographical scope	Does the solution provide the same cover/capacity in all EU member states?
Practicality	Does the solution present any practical obstacles to its introduction?
Cost	Is the NTPL solution(s) identified affordable for the nuclear industry?
Legal framework	Does the NTPL solution(s) identified require changes to the current or revised legal framework(s)[9]?

Whilst this assembled information is largely qualitative, it does assist with the prioritisation of the practical options that can deliver the objectives and receive acceptance by most stakeholders.

2.3 OBSTACLES AND LIMITATIONS

Obstacles

The research team encountered very few obstacles during the project. At the interim stage the team highlighted three difficulties encountered and in the absence of any new obstacles since then, in this Final Report these are reviewed again.

1. Some stakeholders expressed a degree of project fatigue over the prospect of another EC study into this field. Some considered that previous EC studies have resulted in limited action and this acted in some cases as a disincentive to provide information or to make an active contribution to this project. To surmount this obstacle, the research team consistently emphasised the opportunity for many stakeholders if the EC is furnished with a good understanding of the market and can act in an informed way to achieve its objectives taking the interests of all the major stakeholders into account. This helped to ensure that ultimately the research team was able to overcome most hesitating contributors and overall, most stakeholders have contributed information willingly.
2. At the interim stage the captive insurers stood out as a group that had not been as helpful as other stakeholders. The information that was ultimately obtained is not as extensive as initially hoped and compares unfavourably with the willing contribution made by most other stakeholders; nevertheless, all requests were responded to, even if with scant detail, and through the use of various sources, it has been possible to establish some detail of their role.

[9] Being the existing NTPL Conventions, any proposed revisions and the various implementing national regimes

3. At the interim stage no response had been forthcoming from the actuarial entity; this shortcoming was corrected during subsequent research work and the information provided was very valuable.

Limitations

This study has differed from previous studies on this subject because it has been an insurance led project[10]; although this approach offers a different and critical new perspective, as has been noted frequently elsewhere in the study, the insurance sector is very competitive and much commercially sensitive information has not been made available to the research team during their work on this project. Despite this, the EC does have enough information to understand how the nuclear insurance market functions, what the major issues are that prevent full commitment to NTPL cover and to consider new solutions that will bring additional capacity bear upon this market from the private sector. The study certainly leaves the EC with a concept of how to activate the market mechanisms that could deliver more full scope capacity in future, should a decision be made to act upon any of the recommendations in this report. If this decision is made and the recommendations are to be acted upon, this well-qualified and now well-informed research team stands ready to assist the EC with the next chapter of this work.

Objectives

The research team respectfully considers that all the objectives set out by the EC at the start have been met fully by the submission of this study.

[10] The lead researcher is an insurance professional, without a legal background.

3 THE NTPL INSURANCE MARKET TODAY

3.1 INTRODUCTION TO THE NUCLEAR LIABILITY INSURANCE MARKET

The nuclear third-party liability (NTPL) insurance market is different to the normal insurance market because the capacity providers are mostly grouped into only two competing blocks of capacity, being nuclear industry mutuals and nuclear insurance pools. An in-depth study of the nuclear insurance market written in the last century concluded: '*owing to the high severity low frequency loss pattern typical of nuclear risks, a highly competitive market consisting of numerous individual or small groups of insurers has not developed*'[11]; little has changed since then.

The first providers of nuclear specific insurance were the nuclear insurance pools, which were founded in the late 1950s, at the same time as the nuclear industry commenced commercial operation of nuclear power plants. There was an understanding that if commercial nuclear power was to develop it would need insurance; however, the understanding amongst insurers of the nuclear energy risk was at that time influenced by the recent experience of the immense destructive power of a nuclear reaction, demonstrated by the 1945 explosions of the two atomic bombs at Nagasaki and Hiroshima in Japan.

In response to demands from governments to insure these new risks, insurers around the world began to consider suitable mechanisms for providing nuclear insurance; recognising that a catastrophic loss with widespread contamination over a large area was possible and that such a loss could easily exceed the resources of a single insurer, the insurance markets opted for a pooling mechanism as being the best method of delivering maximum capacity to such a limited number of complex and potentially damaging risks[12].

By the 1960s nuclear pools were operating in Germany, Switzerland, Sweden, UK and the USA; typically, pools were formed by their national insurance trade body to maximise market access and capacity and to this day the pooling system is made up of national pools that cooperate internationally. Although able to offer immediate risk-transfer capacity, the international cooperation amongst the insurance pools offered limited true competition in the eyes of the buyers of insurance - the site operators; therefore, in the 1970s nuclear mutual insurance entities were established by the operators as a competing source of capacity.

The first of these nuclear mutuals was established in 1973 in the USA and since then, the mutuals have expanded their offering from just material damage (1st party property) cover to include NTPL; specifically, the mutual European Liability Insurance for Nuclear Installations (ELINI) was established in 2002 for this purpose alone. Mutual insurance now is a material component in the global nuclear capacity mix, although less so in the NTPL market; globally there are 3 significant mutual capacity providers, with Nuclear Electric Insurance Limited (NEIL) of the USA dominating the domestic property insurance coverage, having largely usurped the domestic insurance pool by 2010. Arguably, with a global safety peer review[13] mechanism in place and generic nuclear regulatory regimes, the sector homogeneity should suit greater operator mutuality, but aside from the nuclear pools and the few existing mutuals, there has been little new capacity development in the past 10 years. Only

11 See J. Dow '*Nuclear Energy and Insurance*' ch. VI. 1989 - Witherby & Co.

12 Ibid.

13 The World Association of Nuclear Operators (WANO) provides a peer review service to member operators.

recently[14] has a new Managing General Agent (MGA) independent of the pools and the mutuals been established.

With such relatively limited insurer participation, the nuclear Insurance market has developed an image of a specialist, hard to enter and risky sector that is constrained by numerous factors, not least a legal regime that is perceived as complex and which makes the risks difficult to insure. The result is insurance capacity from all sources that falls well below the likely cost of a severe nuclear accident.

3.2 CAPACITY PROVIDERS IN THE EU

The NTPL insurance capacity providers in the EU (and indeed globally) are easily sub-divided into two groups, being either largely self-insurance or risk-transfer insurance. In the context of this report, these two terms mean:

- **Self-insurance**: most of the exposure assumed by these insurers is underwritten by insurance entities that have the operators themselves as leading stakeholders, either using a captive or mutual insurer or some other method.
- **Risk-transfer insurance**: most of the exposure assumed by these insurers is underwritten by insurance entities financially independent of the nuclear operators.

This distinction is important to understand because whatever type of insurer is involved, the ability to meet the cost of a catastrophic nuclear accident claim is the key criterion for determining the utility of the insurance product. Determining the solvency of each insurer and spread of the exposure over many entities is therefore an important consideration in guaranteeing full and swift claim payment; in the words of Insurance Europe '*insurance is the transfer of risk. It transfers the risk of financial losses as a result of specified but unpredictable events from an individual or entity to an insurer in return for a fee or premium*[15].' Therefore, it is axiomatic that insurance provided by nuclear operators will be organised differently to insurance provided by independent financial institutions to ensure each fulfils their claim obligations; it is for this reason that this report separates the capacity providers into these two categories.

3.2.1 SELF-INSURANCE

In the EU self-insurance capacity is provided by three types of entity, being mutual insurer, captive insurer and solidarity arrangement. Mutual insurers are the dominant provider in terms of spread of risk, although in capacity terms the solidarity agreement provides the largest capacity.

3.2.1.1 MUTUAL INSURERS

A mutual insurance company is an insurance company owned entirely by its policyholders; the mutual model was established hundreds of years ago[16] and has been operating successfully ever since, with use of mutual insurance extremely common today across a range of generally homogenous policyholders. For example, there

[14] In 2011 a new MGA called Northcourt was established; see Technical Annex 3.

[15] Insurance Europe brochure: '*How Insurance Works*' available at: https://www.insuranceeurope.eu/search/type/Publication

[16] The first mutual insurance company was established in the UK in 1696 and offered fire insurance (see: http://reic.uwcc.wisc.edu/mutualinsurance/)

are mutuals operating today for the oil industry[17], for shipowners[18], for health[19] and for agricultural risks[20]; therefore, it is not exceptional that there are mutuals for the nuclear industry too. The relevant risks of each individual policyholder's entity are collectively insured by the whole group of mutual participants, thus spreading claims across the whole community of mutual members. Mutuals normally developed as a response to some inadequacy in the risk-transfer market, whether through perceived incorrect risk pricing, insufficient scope of cover or a feeling that the risk-transfer market could not understand the sector's risk profile as well as the sector stakeholders themselves.

Mutual companies were established to focus on and serve the insurance needs of their policyholders without also having to meet the investment or other needs of shareholders; therefore, the policyholders can benefit from cheaper insurance premiums. Generally mutual insurance company members with policies of insurance have all the same advantages as policyholders of non-mutual insurance companies in the form of policy rights and protections afforded by the regulatory framework. In most cases membership of a mutual insurance company exists if the individual or business remains a policyholder. Membership is not equivalent to ownership of an equity interest in the mutual insurance company and the mutual member cannot freely sell or pledge as security the mutual insurance policy or his/her rights in it.

Mutual insurance policyholders are generally not responsible for losses that exceed the mutual insurer's financial resources; however, to meet excessive liabilities some mutual insurers have the right to call upon policyholders to obtain additional funds if that becomes necessary - for example where a claim exceeds the financial resources of the mutual. For exposures that are outside of the mutual's risk appetite or to enable the mutual to offer more capacity, reinsurance from the traditional risk transfer market can be purchased, thus introducing an element of risk-transfer into the capacity mix. The key objective with a mutual is to maintain control of the premium spend and insurance arrangements for a specific group of risks. Operating profits in a mutual company are often either wholly or partially retained to finance future growth, provide a cushion against future liabilities, adjust rates or premiums, and to bolster the company solvency rating; the mutual members also decide whether profits earned by the company can be rebated to policyholders in the form of dividend distributions or can be used to reduce future premiums. Initial capital to start a mutual insurance company can be raised from current or prospective policyholders or as debt, which will be repaid from the company's operating profits over time.

In the world of nuclear insurance, there are several mutuals operating today; these have developed since the mid-1970s [21] as a response to perceived lack of choice of insurance from the risk-transfer market. These nuclear mutual insurance companies are owned by the policyholders (nuclear site operators) and they provide alternative capacity to that provided by the traditional risk transfer insurance market; today there are several mutual insurers operating in European Union that offer nuclear third-party liability capacity:

- European Liability Insurance for Nuclear Installations (ELINI);
- Nuclear Industry Reinsurance Association (NIRA);
- Blue Re;
- Overseas Nuclear Electric Insurance Limited (Overseas NEIL).

ELINI, Blue Re and NIRA are all closely related and operate throughout the EU and globally. ELINI operates as an insurer and is domiciled in Belgium; NTPL reinsurance support is provided to its members' insurance policies by NIRA and Blue Re, both domiciled in Luxembourg.

17 See: https://www.oil.bm/

18 See: https://www.shipownersclub.com/

19 See: https://healthy.kaiserpermanente.org/

20 See: http://www.ja-kyosai.or.jp/index.html

21 Nuclear Mutual Limited (NML) was established in 1973 in Bermuda

Overseas NEIL operates from Ireland and provided limited NTPL capacity to only one of its members in the EU during 2016. NEIL's primary focus is on providing first party property insurance in the USA, therefore it has few members in Europe and only provided NTPL capacity to help its single Belgian member to fulfil specific legal requirements prevailing in Belgium[22]. This provision of NTPL capacity was confirmed as a 'one-off' event and, under the current business strategy, will not be repeated[23].

Further details about ELINI, Blue Re and NIRA can be found in **Technical Annex 1**.

3.2.1.2 CAPTIVE INSURERS

A captive insurance company is a wholly owned subsidiary company that provides risk-mitigation services for its parent company or a group of related companies. Among the advantages to a company or commonly owned group of companies of establishing a captive insurer are improved risk management, better understanding of claims and losses, improved risk pricing and control, improved management of the risk-transfer market's pricing and volatility and easier access to reinsurance markets. The key distinction between mutual self-insurance and captive self-insurance is that a captive is where a business is putting its own capital at risk through the creation of its own insurer, whereas the mutual policyholder has not invested any assets in the mutual insurance company and as soon as the insurance ceases, so does the policyholder's 'ownership' status in the mutual.

There are different types of captive, being:

- Single parent captive: a captive established by, owned by and insuring a single entity.
- Group captive: a captive established across a business conglomerate that can insure any part of the group.

The first captives were established in the 1920s, as a response to the '*absence or unwillingness of commercial insurers to cover important risks*'[24]. Today there are over 7,000 captives established globally[25] and despite their obvious link to a specific business entity, the management of captives is frequently outsourced to insurance entities; for example, the major insurance brokers have captive management divisions.

In the nuclear sector there are three captives operating in the EU at present:

- Wagram Insurance Company DAC;
- Oceane Re S.A;
- Rutherford Limited.

Both Wagram Insurance Company and Oceane Re are wholly owned subsidiaries of Électricité de France S.A. (EdF) and Rutherford is owned by the UK's Nuclear Decommissioning Authority (NDA); therefore, any insurance or reinsurance they provide is limited to the insurable interest of their parent company (being EdF and NDA respectively).

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22 In Belgium, because of parliamentary delays, by default the full amending legislation for the 2004 revised Paris Convention entered into force on 1st January 2016 (Law 29). Operators had 90 days to comply and obtain €1.2 billion NTPL financial security for the full scope of the revised Paris Convention. With insufficient capacity available for this, 20% cover was ultimately obtained from primarily the mutual ELINI, using additional reinsurance from Overseas NEIL. Aware of the capacity insufficiency, during 2016 the Belgian government worked quickly to alter the national legislation; this culminated with the *Loi de Reparation* enacted on 7th December 2016, which suspended the application of the elements of Law 29 that were difficult for the insurers (e.g. new damage definitions and 10-30 year prescription periods). This suspension remains in force today, with the latest expiry date being 1st January 2020. After 7th December 2016, the additional reinsurance requirements (sourced by ELINI from Overseas NEIL) were therefore no longer required and lapsed.

23 Confirmed in interview.

24 See: https://www.captive.com/resources/captive-insurance-history/before-1985

25 Source: Captive Insurance Survey 2017 – Zurich Insurance

Information on the EdF captives is limited to that which is publicly available, thus capacity amounts are not provided; however, EdF has confirmed that its captives will cover the full scope of the revised NTPL Conventions once they are ratified. Wagram is domiciled in Ireland and Oceane Re is domiciled in Luxembourg.

The UK captive that insures the NDA is domiciled in Guernsey (Channel Islands) and it provides a primary £75 million (€83.3 million) of NTPL capacity for the NDA's sites; it purchases reinsurance for the remaining financial security requirement in excess of £75 million. At the time this study was written the captive management has not decided whether it will offer the full scope NTPL coverage demanded by the revised Conventions.

3.2.1.3 OPERATOR POOLING

In the EU operator pooling is unique to Germany; additional financial security supplemental to the risk-transfer/mutual self-insurance cover is provided on a mutualised basis by the nuclear operators themselves for German nuclear sites only. The origins of the scheme date back to the late 1950s when, despite it being an original signatory to the 1960 Paris Convention, Germany developed a supplementary compensation regime independent of the Paris Convention with a much higher financial security amount than the original amount required by the 1960 Paris Convention[26] (being Deutsche Mark 500 million – approximately equivalent to €250 million). This unique arrangement offered more monetary protection to nuclear accident victims.

The German nuclear financial security system has evolved since then, with the operators' liability becoming unlimited in 1985 and in 2002 the financial security requirement increasing to €2.5 billion.

Today the capacity providers for the supplemental financial security amount are the German operators and their parent organisations, being:

- Energie-Baden-Württemberg AG (EnBW);
- PreussenElektra GmbH (which is a subsidiary of E.ON SE);
- RWE Power AG;
- Vattenfall Europe Nuclear Energy GmbH.

The €2.5 billion financial security amount is split into two tiers (or layers). The first tier (or primary layer) capacity is provided jointly by the nuclear insurance market (the German nuclear insurance pool - *Deutsche Kernreaktor Versicherungsgemeinschaft*[27]) and the industry mutual (ELINI) for the full €255.655 million. The capacity for the second tier of €2.244 billion is provided by the four utilities that own the various NPP sites in Germany, in accordance with the 2001 Solidarity Agreement (*Solidarvereinbarung*). Each utility partner to the Agreement pledges to provide its share of the second-tier financial security amount to the liable operator, if for any reason the liable operator cannot meet its own compensation obligation. The Agreement's obligations for the second layer are retrospective as no premium is payable in advance; there is no accumulation of funds and nothing is payable by the operators until and unless a nuclear incident occurs. However, a certification is prepared annually by a public accountant on the basis of each participant's balance sheet, stating that it can provide for its share of the financial security amount.

Further details about operator pooling can be found in **Technical Annex 2**.

Table 1: Summary of EU self-insurance capacity providers

Name	Type	Domicile
Blue Re	Mutual	Luxembourg
Energie-Baden-Württemberg AG	Operator	Germany
European Liability Insurance for Nuclear Installations (ELINI)	Mutual	Belgium

[26] See: C Raetzke '*Nuclear Third-Party Liability in Germany*' in OECD NEA Nuclear Law Bulletin # 97

[27] See: https://www.versicherungsmagazin.de/lexikon/deutsche-kernreaktor-versicherungsgemeinschaft-dkvg-1985693.html

Name	Type	Domicile
Nuclear Industry Reinsurance Association (NIRA)	Mutual	Isle of Man
Oceane Re S.A.	Captive	Luxembourg
Overseas Nuclear Electric Insurance Limited (Overseas NEIL)*	Mutual	Ireland
PreussenElektra GmbH	Operator	Germany
Rutherford Limited	Captive	Guernsey
RWE Power AG	Operator	Germany
Vattenfall Europe Nuclear Energy GmbH	Operator	Germany
Wagram Insurance Company DAC	Captive	Ireland

**Overseas NEIL for 2016 only.*

3.2.2 RISK-TRANSFER INSURANCE

Capacity from the traditional risk-transfer insurance market has historically been mostly provided by the national nuclear insurance pools; as noted in the introductory section, nuclear pools were formed at the same time as the commercial nuclear industry. Since then the nuclear pools have been a vital part of the development of the civil nuclear industry; indeed, their provision of insurance to the nuclear industry has been one of the most durable private sector involvements in nuclear power. To access global capacity, nuclear pools cooperate with each other internationally which has resulted in the development of a global network of leading insurers all exposed to nuclear risks worldwide through their pool involvement (this system is explained in more detail in **Technical Annex 3**). Therefore, traditional open market competition amongst insurers is not as developed as in other industrial sectors with more numerous but less complex risks. The consequence of this is that there are only a limited number of risk-transfer alternatives to the nuclear pools, these being:

- Individual insurers that opportunistically underwrite individual nuclear risks;
- Limited capacity from alternative financial markets;
- Competing managing general agents (MGAs).

3.2.2.1 NUCLEAR INSURANCE POOLS

A nuclear insurance pool is a group of insurance companies that jointly cooperate to co-insure a particular class of insurance business; they are generally managed by 'not-for-profit' organisations that do not require capitalisation as insurers, given that each participating insurer (or pool member) is individually capitalised. Insurance pools develop when a combination of factors work against the evolution of a more normal, competitive market; if the risks to be insured are relatively few, considered particularly hazardous and the quantum of possible losses is high or unquantifiable, insurers will consider pooling. Today pools exist for exposures as diverse as terrorism, flood and aviation, all having a common purpose of providing clients '*with a degree of financial security and stability that is not available from a single insurance company*[28]'.

It was apparent to insurers from the outset that the civil nuclear power industry exhibited the key features noted above that favour pooling – there are relatively few risks[29], the consequences of a severe accident are likely to be extreme in both extent and cost[30] and radioactive contamination holds a special fear for humankind, being inevitably linked to atomic bombs. Therefore, nuclear pools developed alongside the industry they serve as the primary source of risk-transfer insurance capacity, to the extent that today there are 28 nuclear pools globally, with 14 of these in the EU.

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[28] Quote from Global Aerospace Pool - https://www.global-aero.com/about/financial-security/

[29] According to the World Nuclear Association at July 2019 there are 448 operating power reactors worldwide; see: https://www.world-nuclear.org/information-library/facts-and-figures/reactor-database.aspx

[30] The compensation amount paid by TEPCo in Japan since the Fukushima accident in 2011 amounts to c. € 75 billion by July 2019 (see: https://www7.tepco.co.jp/responsibility/revitalization/compensation-e.html). In addition, the site decontamination and regional clean-up cost has already exceeded $250 billion (BBC report – May 2019).

Nuclear pools fall into two groups, being direct, insuring pools and reinsuring pools, although these distinctions make little difference to the overall capacity availability and sharing.

- **Direct insuring pools** are pools that issue policies direct to the buying client (i.e. the nuclear site operator); policies are generally issued on behalf of the pool members by the pool, with ultimate policy security resting with the nuclear pool members in proportion to their share of the pool.
- **Reinsuring pools** are pools that provide reinsurance to the normal insurer(s) that have issued a policy to the buying clients. Typically, the insurer will issue a policy that includes all exposures (such as fire, explosion, machinery breakdown and *including* the nuclear exposure); it will then purchase reinsurance from the nuclear pool for only the nuclear elements of exposure, which will be reinsured and accepted by the nuclear pool on behalf of its members, again in proportion to their share of the pool.

Whatever type of national pool exists, they all provide NTPL capacity for the nuclear exposure that is excluded from normal policies (e.g. car insurance, homeowners) because of the radioactive contamination exclusion clause (RCE) (for further information about the RCE see Annex G).

Insurers that wish to provide capacity for the insurance of nuclear risks delegate their underwriting authority annually specifically for nuclear risks to the nuclear pool management entity. This entity can either be a stand-alone business (normally not for profit, as noted above) or it can be housed in the office of the largest pool member by share; as a cooperative joint venture amongst normally competing insurers, the scope of the pool management's authority is restricted to nuclear risks and underwriting guidelines are carefully established collectively amongst the members to ensure high standards of underwriting are maintained. Some smaller pools with limited experience of nuclear risks will defer to the larger pools that have a full-time underwriting team; this has resulted in strong cooperation between pools as well as an element of inter-dependence. Given the low frequency-high severity volatility inherent in nuclear business, the longevity of the liability obligation of NTPL insurance and the risk reciprocity amongst national pools, the solvency of the member insurers is monitored carefully with membership generally restricted to 'A' rated insurers only; pools are open to all locally based insurers, subject to solvency, and these members can join and leave the pool as they wish, normally at the annual capacity renewal.

With the earliest pools originating in the 1950s, the nuclear pools have developed significant nuclear underwriting and claims expertise and the network of global pools is based upon well established relationships between pools that reciprocally reinsure each other's nuclear risks. Some of the larger pool members that have become national, leading pool member companies[31] have been involved in nuclear insurance for many decades and have become influential in the wider nuclear pool community.

Below in Table 2 is a list of nuclear pools operating in the EU.

Table 2: Nuclear pools operating in the EU

Pool name	Domicile	Pool type	Number of members	Largest member %
SYBAN	BE	Insuring	13	29.3%
Bulgarian National Nuclear Insurance Pool (BNNIP)	BG	Insuring	8	21.8%
Croatian Nuclear Pool	CR	n/a[1]	4	*unknown*
Czech Nuclear Insurance Pool	CZ	Insuring	10	22.0%
Deutsche Kernreaktor-Versicherungsgemeinschaft (DKVG)	DE	Reinsuring	25	*various*[2]
Espanuclear	ES	Reinsuring	25	19.0%
Assuratome	FR	Reinsuring	34	14.5%
Hungarian Nuclear Insurance Pool	HU	Insuring	7	40.0%

[31] See list of leading nuclear pool member companies in Table 3 below.

Vereniging Nederlandse Pool voor Verzekering van Atoomrisico's (Atoompool)	NL	Insuring	12	23.0%
Romanian Nuclear Pool	RO	Insuring	*unknown*	*unknown*
Nordic Nuclear Insurers (NNI)	SE/FI	Insuring	15	20.0%
National Insurance Reinsurance Pool	SI	Insuring	6	54.6%
Slovak Nuclear Insurance Pool	SK	Insuring	9	45.5%
Nuclear Risk Insurers Ltd (NRI)	UK	Insuring	28	45%[3]
			196	

1. There are no nuclear sites located in Croatia; it provides co-insurance capacity for the Slovenian site

2. Largest member share is different for each country, according to member risk appetite

3. Approximate share of largest member

The list above shows that about 200 member companies contribute to the EU nuclear pool capacity; their shares and interest in nuclear insurance will vary materially. Often larger insurers will participate in two or more pools and will need to monitor carefully their overall accumulated exposure, as exposure to an individual loss could come from several pool memberships. Pools are not always willing to provide full membership lists and member shares, therefore this study could not provide a complete list of individual pool members; however, many of the larger, EU domiciled insurers are nuclear pool members and a sample of these is listed in Table 3 below.

Table 3: A selection of nuclear insurance pool member insurers

Insurer/Insurance group
Aegon
Allianz*
Aviva
Axa Global*
Česká pojišťovna
Chaucer (Lloyd's)
Delta Lloyd
Folksam
Generali*
Hannover Re
HDI*
Mapfre Global
Odyssey Re
Partner Re
Scor Global
Sirius International
Swiss Re*
XL Catlin (Lloyd's - now part of Axa)
Zurich Insurance*

** Member of more than 1 nuclear pool*

In terms of pool capacity, the above is not the full story; the pools from other non-EU countries also contribute capacity from their member insurers on a reciprocal basis to EU sited nuclear facilities, as reinsurers of the national pool. The national pool's panel of reinsurers is thus a collection of pools from around the world, all of whom contribute capacity in varying amounts, allowing the national pool to fulfil the insurance capacity demanded by its national nuclear operator. This global capacity is available for each pool for both 1st party property and 3rd party liability insurances.

A complete list of all pools is shown in annex F and an explanation of the global nuclear insurance pooling system can be found in **Technical Annex 3**.

3.2.2.2 OTHER RISK TRANSFER CAPACITY PROVIDERS

Development of additional risk-transfer market outside of the nuclear pool membership until recent years has been limited; the level of competition experienced in the motor insurance market[32], for example, has not been experienced in the nuclear insurance market due to the limited number of complex, potentially volatile nuclear risks. Some insurers from both within the pooling system and outside provide capacity on an 'open market' basis, to fit with individual risk appetite and business strategies. These individual insurer participations have occurred where nuclear risks are in a country without a nuclear pool[33] or where a site wants to purchase higher insurance than is available from its national pool, or even the global market. However, these capacity providers are few as once again the small number of risks and volatile risk profile deters most insurers.

In 2012 a new managing general agent, Northcourt, was established in the EU to provide additional, competing capacity to the nuclear pools. Structured in a similar manner to a nuclear pool, it brings together insurers that cooperate to provide capacity through a single entity that underwrites with authority delegated from the participating insurers. Since it started, its capacity has steadily grown and today it still provides the only material risk-transfer competition to the pooling system. Most notably, Northcourt has stated it will provide limited NTPL capacity for the full scope of the revised Vienna/Paris NTPL Conventions heads of damage; this makes it unique in the risk-transfer market.

Further background information on Northcourt is available in **Technical Annex 3**.

3.2.2.3 REINSURANCE CAPACITY

The application of the radioactive contamination exclusion (RCE) clause (see annex G) limits the use of reinsurance gearing to the nuclear insurance market; insurers tend to commit net line capacity only to a national pool, which organises reciprocal reinsurance with other pools or to the competing MGA (Northcourt). Nevertheless, like open-market insurance, reinsurance is utilised to a limited extent today and may be used more in future for NTPL; therefore, it warrants brief exploration in this study.

The nuclear mutuals use risk-transfer reinsurance markets for gearing, primarily for their property exposure[34]; reinsurance permits the insurer to offer greater capacity to its clients and the reinsurer will be able to select which part of the exposure it desires – as determined by its risk appetite. Such gearing is much less common for NTPL insurance; **Technical Annex 1** explains the process of reinsurance used by the mutuals in more detail and at present the reinsurance capacity for NTPL is mostly provided by other mutuals.

Reinsurance support for all NTPL insurers may increase in future, either as risk-transfer competition develops or new solutions emerge for delivering greater NTPL capacity. Reinsurance offers many entities the opportunity of providing targeted capacity at a specified financial level or for a specific scope of cover, with the benefit of lower risk-management and assessment costs than experienced by direct insurers.

Table 4: Summary of the risk-transfer insurance/reinsurance capacity providers for EU NPPs

Name	Type	Domicile
American Pool (ANI)	Pool	United States
Belgian Pool (SYBAN)	Pool	Belgium
Brazilian Pool	Pool	Brazil
British Pool (NRI Ltd)	Pool	United Kingdom
Bulgarian Pool (BNNIP)	Pool	Bulgaria
Chinese Pool (CNIP)	Pool	People's Republic of China
Croatian Pool	Pool	Croatia
Czech Pool	Pool	Czech Republic

32 There are more than 600 motor insurers operating in the EU – see Insurance Europe 'European Motor Insurance Markets' report, February 2019

33 For example, Greece, Italy, Portugal and Denmark have research reactors but no nuclear pool. Source: WNA

34 See EMANI annual report - https://www.emani.be/page.php?pagina=39

Name	Type	Domicile
Dutch Pool (Atoompool)	Pool	Netherlands
French Pool (Assuratome)	Pool	France
German Pool (DKVG)	Pool	Germany
Hungarian Pool	Pool	Hungary
Japanese Pool (JAEIP)	Pool	Japan
Korean Pool (KAEIP)	Pool	South Korea
Mexican Pool	Pool	Mexico
Nordic Pool (NNI)	Pool	Finland/Sweden
Northcourt	MGA	Malta
Romanian Pool	Pool	Romania
Russian Pool	Pool	Russia
Slovakian Pool	Pool	Slovakia
Slovenian Pool	Pool	Slovenia
Spanish Pool (Espanuclear)	Pool	Spain
Swiss Pool	Pool	Switzerland
Taiwanese Pool (NEIPROC)	Pool	Republic of China/Taiwan
Ukrainian Pool	Pool	Ukraine

4 NTPL INSURANCE CAPACITY AVAILABLE

4.1 FINANCIAL SECURITY FOR NUCLEAR SITES

Most legal regimes demand that car drivers have third party liability insurance; this insurance is to cover the policy holder for any claim brought against him/her by a third party – someone unrelated to the insurance contract. For example, if the policy holder has an accident and his/her car hits either a building or another person, then the owner of the damaged building or the injured person (the third parties) will probably make a claim against him/her. The third-party insurance policy will cover the driver against such a claim.

It is well known that most countries with nuclear sites have legal regimes that provide similar arrangements. International nuclear liability Conventions[35] and/or national nuclear laws provide a broadly consistent legal regime that requires financial security for nuclear sites to pay compensation for damage resulting from an incident that affects any third parties. To operate an active nuclear site in most nuclear states, the owner of that site must demonstrate to the appropriate regulatory authority that financial security up to the amount demanded by law is in place; the financial security is generally, but not exclusively, provided by insurance[36].

4.2 REGULATORY FRAMEWORK

That the nuclear industry is heavily regulated is undeniable; national nuclear regulators[37] govern much of the day-to-day activity of nuclear sites globally, often including their financial security requirements. The third-party legal and regulatory framework for the nuclear industry and its ramifications for nuclear operators, suppliers, lawyers and governments have been analysed, written about and opined upon exhaustively for decades; further such work is not the purpose of this study. This is an insurance-led study that will focus on the insurance aspect of the nuclear liability regimes.

In most countries, insurers are regulated by a financial services regulator; in the EU the principal financial services regulator is the European Insurance and Occupational Pensions Authority (EIOPA); EIOPA is part of a European system of financial supervisors that is comprised of three European Supervisory Authorities, one for the banking sector, one for the securities sector and one for the insurance and occupational pensions sector[38].

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35 As noted in the introduction, the 3 basic NTPL Conventions are: 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy, 1963 Vienna Convention on Civil Liability for Nuclear Damage, 1997 Convention on Supplementary Compensation for Nuclear Damage.

36 For example: 1960 Paris Convention, Art. 10 (a); 1963 Vienna Convention Art.7 (i): Convention on Supplementary Compensation, Annex Art.5.1(a).

37 For example: the Nuclear Regulatory Commission in the USA (NRC - see: https://www.nrc.gov/); Radiation & Nuclear Safety Authority in Finland (STUK – see: https://www.stuk.fi/web/en).

38 See: https://eiopa.europa.eu/about-eiopa

EIOPA's main responsibilities are to maintain stability of the financial system, to ensure transparency of markets and financial products as well as the protection of policyholders, pension scheme members and beneficiaries[39]. Today, one key aim of EIOPA is the implementation of the new Solvency II supervisory regime for insurance and reinsurance entities within the EU, which introduces an EU-wide harmonised regulatory regime for insurance and reinsurance. Part of this regulation includes a risk-based capital regime for insurance firms[40], designed to ensure any entity has enough financial resources to meet its obligations; day-to-day supervision of this element is left to national financial supervisory authorities.

A risk-based capital regime is a system of assessing the necessary amount of capital appropriate for an insurance entity to support its overall business operations in consideration of its size and risk profile; it is an important concept to understand in the field of nuclear third-party liability – more information on this topic can be found in **Technical Annex 5**.

4.3 GLOBAL AND MAXIMUM CAPACITY WITHIN THE EU FOR THE CURRENT LEGAL REGIMES

A comprehensive spreadsheet analysis of the current global capacity availability in the EU MS with operating nuclear power plants is shown in Annex E.

For the purposes of this section of the study, the **existing** legal regimes in the EU are assumed to be those that require:

i. Financial security to cover operators' compensation for nuclear damage that includes damage to property and bodily injury[41];
ii. An amount of financial security not higher than €1.2 billion or €2.5 billion for Germany;
iii. The time permitted to bring a claim is no longer than 10 years after the nuclear incident/occurrence.

Of course, some countries have already ratified the 1997 protocol to amend the Vienna Convention and/or the Convention on Supplementary Compensation, but Romania is the only EU MS with operating nuclear power plants in this category and there the insurers do not cover the 10-30 year period to bring a bodily injury claim.

The previous section and associated Technical Annexes contain descriptions of the capacity providers for NTPL insurance. Any global capacity available from non-EU insurance markets for EU nuclear sites is mostly provided by non-EU nuclear pools (a listing of all the pools is shown in annex F); this additional capacity is provided as reinsurance of each EU MS national pool. The US mutual NEIL was the only self-insurance capacity provider from outside the EU.

Table 5 below summarises the maximum capacity available from all sources for the current legal regime heads of damage.

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39 Ibid.

40 https://www.nortonrosefulbright.com/en/knowledge/publications/f12a4a4a/ten-things-you-need-to-know-about-solvency-ii

41 As specified in the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy and/or the Brussels Supplementary Convention and/or the 1963 Vienna Convention on Civil Liability for Nuclear Damage.

Table 5: Summary of CURRENT NTPL regime capacity availability by head of damage

Provider	Type	NTPL capacity		Heads of damage		Notes
		MAXIMUM possible	MAXIMUM available in ALL EU MS	Property damage	Death/injury (10 years)	
POOLS EU)	Risk transfer	€ 1,220,207,000	€ 1,220,207,000			
POOLS (non EU)	Risk transfer	€ 800,794,930	€ 800,794,930			
MGA	Risk transfer	€ 200,000,000	€ 200,000,000			
MUTUALS	Self insurance	€ 240,000,000	€ 155,000,000			*€240m only available in Belgium*
OPERATOR POOLING	Self insurance	€ 2,244,355,000	€ -			*Only avalable in Germany*
CAPTIVES	Self insurance	€ 83,333,333	€ -			*UK data only; NTPL captives only operate in France & UK*
		Max available in all EU MS:	€ 2,376,001,930			
Colour key:						
	Capacity available for full amount and scope of cover					
	No capacity available					
	Limited amount or uncertain capacity availability					

The table shows there is enough financial capacity available to meet what is currently required in the EU and that even after excluding the German, Belgian and UK captive specific capacity commitments, enough capacity remains available to cover the existing heads of damage (as defined in the 1960 PC and 1963 VC) to the full extent of the new financial security amounts required under the revised Conventions.

Please note that the table shows MAXIMUM capacities, not ACTUAL capacities; this distinction is explained in **Technical Annex 5**.

To summarise, today the pure financial *amount* of capacity available for any NTPL policy on the current legal basis in the EU today materially exceeds the financial security demands of the operators and/or the legal regimes[42]; also the full scope required of the 1960 Paris and 1963 Vienna NTPL Conventions in force are fully covered.

4.4 CAPACITY FOR COMPARABLE HIGH SEVERITY, LOW FREQUENCY EVENTS

The research team has also considered other events that have similar characteristics to a large nuclear loss, with the aim of investigating what capacity is available for such events and whether other legal or claims arrangements can offer the nuclear liability market new ideas.

Natural catastrophes*:* the team firstly considered what are comparative high severity, low frequency events. Table 6 below lists the 10 most costly insured events of recent history; it shows that the insurance market is capable of funding losses almost to the quantum of the current Fukushima compensation amounts and certainly for multiples of what is currently provided for NTPL or even combined property and NTPL events. However, none of the events listed in the table is directly comparable to a large nuclear accident emanating from a single site, as further explained below.

Table 6: Top 10 Costliest World Insurance Losses, 1970-2017(*) (2017 € billions)

Rank	Date	Country	Event	Insured loss
1	Aug. 25, 2005	U.S., Gulf of Mexico	Hurricane Katrina, storm surge, damage to oil rigs	73.609
2	Mar. 3, 2011	Japan	Earthquake (Mw 9.0) triggers tsunami	34.061
3	Sep. 19, 2017	U.S., Puerto Rico, U.S. Virgin Islands, Caribbean	Hurricane Maria	28.587

[42] See Annex D for details of the financial security amounts required in each EU MS.

Rank	Date	Country	Event	Insured loss
4	Oct. 24, 2012	U.S., Caribbean, Canada	Hurricane Sandy, storm surge	27.491
5	Sep. 6, 2017	U.S., Puerto Rico, U.S. Virgin Islands, Caribbean	Hurricane Irma	26.801
6	Aug. 25, 2017	U.S.	Hurricane Harvey	30.000
7	Aug. 23, 1992	U.S., Bahamas	Hurricane Andrew, storm surge	27.943
8	Sep. 11, 2001	U.S.	Terror attacks on WTC, Pentagon and other buildings	25.991
9	Jan. 1, 1994	U.S.	Northridge earthquake (Mw 6.7)	25.293
10	Sep. 6, 2008	U.S., Caribbean, Gulf of Mexico	Hurricane Ike, floods, damage to oil rigs	23.051

(*) Property and business interruption losses, excludes life and liability losses. Includes flood losses in the United States insured via the National Flood Insurance Program. U.S. natural catastrophe figures based on Property Claim Services data. Adjusted to 2017 dollars by Swiss Re. Note: Loss data shown here may differ from figures shown elsewhere for the same event due to differences in the date of publication, the geographical area covered and other criteria used by organizations collecting the data. Original table in USD, converted at $1.119: €1.

Source: Swiss Re, sigma, No. 1/2018.

All except one of the above events are natural catastrophe events (such as flood, earthquake and windstorm), which, whilst extreme, are neither always equivalently low frequency events (e.g. Japanese earthquake - more than 100,000 events annually according to the Seismology Society of Japan and there are frequent Caribbean windstorms), nor are they strictly comparable as the losses are widely spread across a region and they fall upon numerous insurers and numerous types of insurance (e.g. motor, homeowners, business policies), as well as individuals and often governments, where no insurance is taken or where government-backed schemes exist (e.g. French Caisse Centrale de Réassurance (CCR), Spanish Consorcio de Compensación de Seguros (CCS), UK Flood Re[43]).

Marine pollution: given that the amounts shown in the table above are *insured* losses, this indicates that insurance capacity to cover such natural catastrophe losses is generally available. Such amounts are clearly not available for nuclear events, as demonstrated in the previous section. Similar *single site* accidents offer better comparison with a nuclear event; to this end the research team contacted several entities to discover available capacity for individual pollution and similar historic loss events and whether these have any lessons for nuclear insurance. The key findings are:

- The maximum liability insurance capacity for an offshore (marine) pollution event is approximately $3 billion (€2.63 billion), including all reinsurance.
- To date no marine pollution liability insurance claim has exceeded $2 billion (€1.787 billion) (the approximate cost to insurers of the Exxon Valdez disaster in 1989, although according to Fortune Magazine, the total cost of clean-up, fines and compensation to Exxon was $3.5 billion).
- Protection and Indemnity (P&I[44]) insurance covers liability for almost all marine liability risks associated with the operation of a vessel. This insurance is generally provided by one of the P&I Clubs; these are groups of shipowners that share insurance services mutually.
- Two separate regimes for International and US exposure from oil pollution each provide compensation regimes with some similarities to the nuclear regimes.
- The International oil pollution regime consists of three tiers of cover:

[43] These government backed schemes for France, Spain and UK respectively provide either total or partial state support for the provision of natural catastrophe insurance in these states. See: https://www.ccr.fr/en/l-entreprise-ccr; https://www.consorseguros.es/web/la-entidad/acerca-de-ccs; https://www.floodre.co.uk/about-us/

[44] See: https://www.shipownersclub.com/what-is-pi/

- Tier 1 – International Convention on Civil Liability for Oil Pollution Damage[45] (CLC). This treaty requires shipowners to maintain in force financial security for an amount based on ship tonnage, but which is capped currently at SDR 89.9 million ($125.2 million/€109.8 million).
- Tier 2 – International Oil Pollution Compensation Fund[46] established in accordance with the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, (1992 Fund Convention). This voluntary arrangement is funded by entities (oil industry companies) that receive over 150,000 gross tonnage of 'persistent oil' per annum. This Convention sits above the CLC and requires membership of the CLC to function. It provides up to a further SDR 203 million ($282.7 million/€247.9 million). Currently 115 states are parties to the Fund Convention; although funded entirely by the oil industry, the funds and regime are administered by the IOPC member governments.
- Tier 3 – International Oil Pollution Compensation Fund established in accordance with the 2003 Supplementary Fund Protocol[47]. This voluntary arrangement sits above the IOPC Fund and therefore requires membership of the IOPC to function. It provides up to a further SDR 750 million ($1.04 billion/€915.7 million). Currently 32 states are parties to the Protocol; again this tier is funded by the oil industry and administered by the member states of the IOPC.

- The International oil pollution scheme makes the shipowner strictly liable for pollution events and no further funds are available once the scheme is exhausted.
- The USA scheme provides two tiers of coverage:
  - Tier 1 – for shipowners a strict liability arrangement with a variable amount based upon ship tonnage
  - Tier 2 – up to $1 billion (€894 million) excess of the shipowner's amount provided either by the operator responsible, or if payment is not forthcoming, through the Domestic Oil Spill Liability Funds which are sourced from the oil industry through levies, fines and clean up demands.
  - Insurance is purchased via the P&I Clubs to provide indemnity cover for any amounts that become due under this 2-tier regime.
- P&I Club insurance and reinsurance is provided for obligations under these schemes and where no pollution funding regime exists (i.e. outside of the oil industry).
- The oil pollution regimes do not cover fixed offshore facilities such as rigs.

Offshore fixed facility pollution: large pollution events from fixed facilities also offer comparable experiences with a single-site nuclear event; examples of these include the Piper Alpha rig explosion (1988) and the more recent Deepwater Horizon disaster (2010), which resulted in the largest oil pollution event in US history.

Capacity for these events is difficult to assess until after the event, given the absence of any comparable liability regimes. Instead regional agreements exist (such as OPOL – see below) and progress continues towards a wider treaty, the Convention of Civil Liability for Oil Pollution Damage, which stemmed from the Exploration for and Exploitation of Seabed Mineral Resources[48] (CLEE), which to date remains unratified. The original intention with the 1977 CLEE treaty was to provide adequate compensation to victims of pollution damage from offshore facilities; however, international agreement on a financial security amount remains elusive, especially since the cost of Deepwater Horizon has become apparent.

A summary of the Deepwater Horizon event is instructive for nuclear insurers:

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45 See: http://www.imo.org/en/About/conventions/listofconventions/pages/international-convention-on-civil-liability-for-oil-pollution-damage-(clc).aspx

46 See: https://www.iopcfunds.org/about-us/

47 See: https://www.iopcfunds.org/about-us/legal-framework/1992-fund-convention-and-supplementary-fund-protocol/

48 See: https://www.gov.uk/government/publications/convention-on-civil-liability-for-oil-pollution-damage-resulting-from-exploration-for-and-exploitation-of-seabed-mineral-resources-london-151977

- In 2010 an explosion and fire on the Deepwater Horizon platform resulted in the spilling of approximately 200 million gallons of oil into the Gulf of Mexico; the spill polluted over 1,300 miles of the US coastline.
- The accident resulted in over 390,000 claims against BP, the oil company responsible for the platform.
- According to Reuters, the accident has cost BP more than $65 billion[49] (€57 billion), of which about $20 billion (€17.87 billion) was paid in fines to various authorities.
- BP largely self-insures its exposure, but liability insurance policies for partner companies involved on the platform responded with approximately $5 billion (€4.38 billion) in claims.
- BP obligations were unlimited for clean-up and initially limited to $75 million (€65.8 million) for pollution damage under the 1990 US Oil Pollution Act (OPA); BP waived its limited liability for OPA pollution damage, offering to pay all proven pollution damage claims.

The Offshore Oil Pollution Liability Agreement[50] (OPOL) is a voluntary[51] regional agreement between oil companies operating in North West Europe, and in the void left by the failure of the CLEE treaty this interim arrangement which preceded it remains in force; operating companies agree to accept liability for pollution damage and the cost of remedial measures with only certain exceptions, up to a maximum of US $250 million (€ 219.2 million) per incident. Operators must demonstrate enough financial security to cover their financial obligations and a mutuality arrangement ensures that the default of any parties to the agreement is covered by the remaining members.

The insurers interviewed assessed the available capacity for offshore fixed facility events to be approximately $3 – 5 billion (€2.63 billion - €4.38 billion), with new capacity initiatives from insurers causing concern amongst operators, lest they are obliged to purchase and maintain what they perceive as unreasonably high levels of financial security.

4.5 ASSESSMENT

Natural catastrophes that cause widespread damage to properties, businesses and infrastructure with limited long-term exposure after the event are readily insured because the exposure is spread thinly throughout the network of local, national or international insurers and ultimately the international reinsurance market; also most losses are relatively short-tail, with losses manifesting themselves to claimants within several years. The financial cost is spread wide but generally not deep into individual insurers or markets and insured losses of tens of billions of dollars or euros are readily absorbed with little adverse effect on the market.

Individual, single site events contrast starkly with the picture for natural catastrophes. The Deepwater Horizon event ultimately cost insurers approximately $5 billion (€4.38 billion), although the actual cost of the event to the responsible operator was much greater. Available liability capacity for large pollution events remains low, at an estimated $3 - $5 billion (€2.63 billion - €4.38 billion) and no international agreement on ratifying a more organised compensation regime is possible because unlimited liability remains uninsurable and the oil industry fears the imposition of unviable financial security obligations. The insurance capacity will remain low until demand, in the form of compulsory financial security obligations, is increased; the market does not respond where there is no demand and demand will probably remain low because, aside from Deepwater Horizon, pollution losses excess of $2 billion (€1.787 billion) have not occurred and there is no complete global compensation regime.

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[49] See: https://www.reuters.com/article/us-bp-deepwaterhorizon/bp-deepwater-horizon-costs-balloon-to-65-billion-idUSKBN1F50NL

[50] See: http://www.opol.org.uk/

[51] As noted, membership in this organization is voluntary, however, it is a license requirement to either be a member or have the same liability coverage provided for by OPOL. Currently all operators in the UK are members of OPOL.

To summarise natural catastrophe events that cost tens of billions of euros and which involve large numbers of policyholders are easily accommodated by the insurance market because claims are spread thinly across multiple types of insurance, covered by many insurers and reinsurers; these events contrast with single site catastrophic accidents, such as at oil rigs, petrochemical refineries or nuclear power stations, where available capacity is materially lower. Accidents at these sites are generally covered by a single or very few policies (e.g. a site and perhaps key suppliers' property and TPL policies) with the majority of liability channelled through the site operator, so concentrating the loss on a specialist sector of the insurance market (e.g. energy or nuclear). This concentration of such capacity with relatively few providers increases volatility of outcome for the specialist single site insurers. Although capacity for non-nuclear single sites is generally greater than for nuclear sites (up to about €4 billion), the difference is not material and generally single site capacity availability for hazardous sites compares unfavourably with capacity available for natural catastrophes.

4.6 GLOBAL AND EU CAPACITY FOR THE REVISED LEGAL REGIMES

A comprehensive spreadsheet analysis of the current global nuclear capacity availability in the EU MS with operating nuclear power plants is shown in Annex E.

For the purposes of this section of the study, the **revised** legal regimes are assumed to be those that require:

i. Financial security to cover operators' compensation for nuclear damage that encompasses damage to property, the environment, bodily injury, economic loss and the cost of preventive measures [52];
ii. An amount of financial security of more than SDR 300 million (RVC) or €700 million (RPC) and up to €1.2 billion[53](€2.5 billion in Germany);
iii. The time permitted to bring a claim for bodily injury of 30 years and for other damage no longer than 10 years after the final nuclear incident/occurrence[54].

The 2004 Protocol to amend the Paris Convention has not yet been ratified by any EU Member State[55], but there are EU states that have adopted the 1997 Protocol to amend the 1963 Vienna Convention (Romania, Poland and Latvia); capacity for the full scope of these revised regimes suffers from limited availability at present due to the nuclear pools' unwillingness to cover the full scope of damage required.

Table 7 below summarises the maximum capacity available from all sources for the revised legal regimes. The table shows there is still capacity available surplus to what is required in monetary terms in any of the EU MS, even after excluding the German, UK and Belgian specific capacity commitments (well over €2 billion); however such capacity amounts are not available for the full scope of the revised Conventions, notably capacity for the time to bring a claim later than the initial 10 years (i.e. 10-30 years period) is not widely available from the risk transfer market.

Table 7: Summary of REVISED NTPL regime capacity and heads of damage availability

Provider	Type	NTPL capacity	Heads of damage						
		MAXIMUM possible	1	2	3	4	5	6	7
POOLS (EU)	Risk transfer	**€ 1,220,207,000**							
POOLS (non EU)	Risk transfer	**€ 800,794,930**							

52 As specified in the 2004 Amending Protocol to the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy (Article 1 (a) (vii) or the 1997 Amending Protocol to the Vienna Convention on Civil Liability for Nuclear Damage Article 1.1 (k).

53 See Annex D for full list of EU MS current financial security requirements.

54 For example see: Consolidated text of the Vienna Convention as amended by the 1997 Protocol, Art.VI, 1.(a)

55 It has been ratified by Norway and Switzerland https://www.oecd-nea.org/law/paris-convention-ratification.html

Provider	Type	NTPL capacity	Heads of damage						
MGA	Risk transfer	**€ 200,000,000**							
MUTUALS	Self-insurance	**€155,000,000**							
OPERATOR POOLING	Self insurance	**€ 2,500,000,000**							
CAPTIVES*	Self insurance	**€ 83,333,333**							

Number	Head of damage description
1	Bodily injury or loss of life up to 10 years after incident
2	Damage to or loss of property
3	Economic loss arising from injury, death or property damage & loss
4	Cost of reinstatement of significantly impaired environment
5	Loss of income from direct economic interest in environment
6	Cost of & any damage caused by preventive measures
7	Bodily injury or loss of life from 10 years to 30 years after incident

Colour key:

	Capacity available for full amount and scope of cover
	No capacity available
	Limited amount or uncertain capacity availability

**** UK captive data only.***

The salient points to note from the responses indicated in the above table are:

- The global network of nuclear insurance pools can commit a maximum of more than €2 billion of NTPL capacity for the majority of the cover requirements of the revised NTPL Conventions.
- However, the global nuclear insurance pools are unable to commit capacity for the 20-year extended time to bring a bodily injury claim in excess of the original 10-year period at present. This is because of numerous constraints on NTPL capacity that are described in sections 4.7 to 4.10 of this study. The current 10 year period remains insurable by the nuclear pools.
- The MGA (Northcourt) can commit up to €100 million for the 20-year extended time to bring a bodily injury claim in excess of the original 10-year period, being 50% of its maximum €200 million capacity for all other aspects of the NTPL cover. This is because some of its capacity providers are constrained in a similar way to the global nuclear pool capacity providers, but not all. Those capacity providers that are not constrained operate outside of the Lloyd's insurance market and have taken a more relaxed stance on the constraints that restrict many of the leading capacity providers that support the nuclear pools. They are comfortable taking this stance because (i) the MGA only issues NTPL policies with a single lifetime limit and (ii) they believe that the strict causality for nuclear damage contained within the revised NTPL Conventions will act to limit their exposure[56].
- The self-insurance providers can commit their full capacities to all aspects of the revised NTPL Convention cover requirements, with a maximum capacity commitment of up to €155 million for each EU MS (except Belgium where it was briefly €240 million – see footnote 22). However, their NTPL capacity provision is limited because many of the risk-transfer reinsurers the mutuals use are also constrained by factors described in section 4.7 to 4.11 of this study.

[56] The MGA capacity providers apparently take comfort from the causality 'chain' within the revised NTPL Conventions; there must be a nuclear incident to cause nuclear damage and this damage must be clearly demonstrated as bodily injury.

- The operator pooling arrangements in Germany provide up to an additional €2.5 billion of full scope NTPL cover for German sites only, to satisfy Germany's specific nuclear financial security requirement.
- Captives provide capacity of €83.3 million in the UK and an unknown amount[57] in France; in France it is assumed that these will cover the full scope of the revised NTPL Convention heads of damage and prescription periods.

In summary, there is not enough capacity available at present to provide for the full scope of the revised NTPL Convention heads of damage and prescription periods in all nuclear EU MS, other than Germany, where the operator pooling arrangement provides full scope cover, including for the 20-year extended period to bring a claim where the German nuclear insurance pool will not cover this exposure.

Annex E shows the maximum capacity amount available in each EU MS with a nuclear power reactor site; the table shows the variation in capacity available between each EU MS. It is important to understand the factors that underlie these variations in capacity commitment.

- The capacities shown are the maximum available from each capacity provider; the actual capacity provided in each state (whether within the EU or not) will be different. The factors that influence capacity allocation are numerous and generally confidential[58], as they relate to an individual player's competitive position; however, typical factors influencing capacity allocation to a non-domestic site will be technology, safety record, loss record, rate of exchange margin and for the pools, reciprocal business exchange considerations[59].
- The nuclear insurance pools provide capacity for both the sites located in their home country and for foreign sites; the capacity shown above for the pools is the maximum *foreign* commitment from each pool all added together. These amounts are lower than the maximum *domestic* commitment as pools almost always offer greater capacity to their domestic risks than to their foreign risks[60]; for example, Belgium's nuclear pool (SYBAN) offers €64 million of capacity to domestic sites, but only €36 million to foreign (i.e. non-Belgian) sites[61]. The reasons for this difference are, as noted above, likely to be commercial; however underlying most foreign (international) capacity allocation decisions are (i) allowing a margin for rate of exchange fluctuations (bearing in mind that insurers must not exceed their maximum commitments) and (ii) a reluctance to commit full capacity to risks extraneous to a capacity providers known domestic risk environment.
- The maximum financial security requirement within the EU is at present €1.2 billion, which is derived from the first two tiers of financial security requirements provided for by the revised Paris Convention and the Brussels Supplementary Convention. This maximum is surpassed only by Germany, where under the solidarity agreement the financial security amount is €2.5 billion[62]. The above summary shows that enough capacity exists in monetary terms to provide for this amount easily, but capacity provision is not sufficient for all the full scope of cover required (notably the 30-year bodily injury prescription period).

57 This information is not publicly available and was not disclosed to the research team.

58 See technical annex 5 for more information on this subject.

59 Ibid

60 Ibid

61 See annex E.

62 See technical annex 2.

4.7 CAPACITY CONSTRAINTS

The previous section demonstrates that at present full capacity is not available for the full scope of cover described in the Protocols to amend the Paris and Vienna Conventions[63]. Certainly, some insurers (e.g. some Northcourt members) can provide full scope cover, but the majority of the risk-transfer capacity providers cannot. This section examines the constraints that currently prevent greater participation from the risk-transfer market in the provision of nuclear liability generally and the full scope of the revised NTPL Conventions specifically.

The constraints are sub-divided into three groups that help illustrate the source of the constraint:

(i) Legal constraints are those that arise because of the peculiarities of the NTPL liability framework as opposed to the more familiar legal landscape for employers' or motor liability;

(ii) Sector constraints are those that arise because of the nature of the nuclear industry, when compared to other sectors (such as energy or non-nuclear power generation);

(iii) Market constraints are those that arise from the financial services' regulatory regime or where nuclear insurance is disadvantaged by different practice requirements to other types of insurance.

4.8 LEGAL CONSTRAINTS

- **Convention language**: several aspects of the revised NTPL Conventions' language have raised concerns with many insurers, especially in the risk-transfer sector.

  Firstly, the perceived broad definition of a nuclear incident, with no initiating trigger (for example, by linking the definition to the International Nuclear and Radiological Event Scale or similar) is of concern. Despite being unchanged since the original NTPL Conventions, when combined with the broader heads of damage and a longer period to bring a claim in the revised NTPL Conventions, the definition's compatibility with much current general liability market practice has been questioned. From the first insurance policies issued, a key aspect has been that they provide compensation for accidental, fortuitous events only[64]. Recently, with the advent of more pollution liability cover and claims, there has been debate amongst insurers and lawyers about whether 'accidental' constituted both temporal and unexpected elements, or just covered unexpected events. Pollution events in particular had encouraged insurers to sub-divide losses between those that are 'sudden and accidental' and those that are 'gradually occurring'[65]; debate has continued ever since over the validity of this sub-division, with insurers' pollution coverage becoming more complex, due to lengthy exclusions and cover write-backs. Today many insurers are wary of pollution insurance, especially where it clearly exposes them to gradually occurring events. The NTPL Convention language is relatively unambiguous in this context, with the nuclear incident definition being '*any occurrence or series of occurrences having the same origin which causes nuclear damage*'[66]; however, this phrase leaves many insurers uncomfortable, keen as they are to set clear parameters for their exposure. For example, the above definition would include any damage arising from releases of radioactive material within permitted regulatory limits; therefore, in the world of insurance this type of 'incident' does not readily pass the test of fortuity and neither can it be considered as providing a 'sudden and accidental' loss trigger.

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63 The 2004 Protocol to amend the 1960 Paris Convention and the 1997 Protocol to amend the 1967 Vienna Convention

64 For example, see: https://www.lexisnexis.com/legalnewsroom/insurance/b/propertyinsurance/posts/fortuity-rules-insurance-interpretation-no-fire-insurance-for-preexisting-condition-of-property

65 https://www.irmi.com/term/insurance-definitions/sudden-and-accidental

66 Art.1 (a) (i) of the 2004 Protocol to amend the Paris Convention; see also Art.1 (l) of the 1997 Protocol amending the 1963 Vienna Convention

Secondly the language which extends the Prescription Periods for bodily injury[67] (being the period of exposure during which a claim can be made against the operator for bodily injury) has caused much of the risk-transfer market significant difficulties, to the extent that this element of cover currently remains largely uninsurable. There is plenty of material on this matter[68] which need not be repeated in this study, suffice to say the extension of the prescription period from 10 to at least 30 years for bodily injury brings insurers more uncertainty as to the cause of any claim and more difficulty in generating attractive returns on capital (see below).

Thirdly the amending Protocols also introduce new environmental heads of damage with open definitions, offering cover for environmental damage and loss of use, again without clear triggers for cover attachment. For example, the ambiguity for insurers contained in phrases such as 'reinstatement of impaired environment', 'direct economic interest'[69] makes calculation of premium and reserves difficult: to what extent is the environment to be reinstated? What is the extent of direct economic interest? With no formal trigger and limited guidance, insurers found these definitions challenging. Capacity is now available for these heads of damage, but it is fragile and has only recently increased enough to cover the proposed financial security amounts.

The fundamental point for insurers is that in their view ambiguous language reduces certainty and increases the potential for volatility of outcome for exposure granted to nuclear liability; that same linguistic ambiguity allows national governments to introduce local interpretations of the NTPL Conventions, which causes greater likelihood of national differences in NTPL legislation and thus reduces homogeneity of the risk for insurers. With the low frequency of loss events and uncertainty of future loss patterns caused by ambiguous language, insurers can find easier, more lucrative types of insurance to cover. Therefore, the language of the Conventions today invite uncertainty over the point of attachment and scope of liability provided by the NTPL Conventions and this is a key capacity constraint.

- **Radioactive contamination exclusion clause**[70]: in the early days of nuclear power's development[71] insurers, law-makers and governments agreed that control of liability exposure for operators was key if the commercial nuclear industry were to develop. The liability channelling principle that is enshrined in the nuclear liability Conventions[72] attaches full, absolute responsibility to the nuclear operator for all nuclear damage; the radioactive contamination exclusion clause is the practical mechanism that implements the liability channelling principle for the insurance market and which ensures all liability attaches to the operator. Outside of the special nuclear insurance arrangements, all general insurance policies exclude radiation damage, such that the policyholder that has suffered damage can only seek redress from the nuclear operator, as the general insurance policy (for motor, homeowner, business etc.) will exclude this damage. The operator has its own nuclear liability policy (issued by nuclear insurers) that provides cover for nuclear damage to third parties (e.g. to a home, car, business etc.) and this policy is required to accept all claims against the site for nuclear damage, regardless of fault and up to a required financial security amount. Nuclear damage capacity is therefore only available through a special mechanism that allocates all responsibility to the operator's insurance policy; all general insurers are relieved of radioactive

67 Art. 8 (a) (i) 2004 Protocol to amend the 1960 Paris Convention; Art.VI 1.(a) of the 1997 Protocol amending the 1963 Vienna Convention.

68 For example: OECD NEA Nuclear Law Bulletin # 94 (2014): '*Challenges facing the insurance industry since the modernisation of the international nuclear third-party liability regime*' by Alain Quéré; OECD NEA Nuclear Law Bulletin # 77 (2006): '*Revised Paris and Vienna Nuclear Liability Conventions Challenges for Nuclear Insurers*' by Mark Tetley.

69 Both extracted from Article 1 (a) (vii) of the 2004 Protocol to amend the 1960 Paris Convention.

70 See also annex G, which covers the RCE clause in more detail.

71 For a history of the develop of nuclear insurance see: *Nuclear Energy and Insurance* by James Dow, published 1989 by Witherby, London and: *International Nuclear Law: History, Evolution and Outlook* page 387 article titled '*Insurance of Nuclear Risks*' by S Reitsma and M Tetley - published by OECD NEA 2010

72 See for example: 1960 Paris Convention Art.6 (b); 1963 Vienna Convention Art.VI (1)

contamination exposure and if they want to opt-in to provide NTPL cover, they must provide capacity to the nuclear operator via an insurance provider (e.g. national pool). This mechanism provides operators with high quality and secure coverage for their required NTPL insurance from the existing group of both self-insurance and risk-transfer markets, but the radioactive contamination exclusion clause creates a specialist insurance arrangement that can be a natural barrier to entry to many insurance market players, as interested insurers need to commit technical resource and perhaps additional capital to develop enough understanding to enter the special nuclear insurance market. When other factors, such as those listed below, are considered alongside this relatively uncompetitive market, the obstacles to greater market-wide participation become more apparent.

- **Net line commitment**: with NTPL cover focused on the operators of nuclear sites as the financial embodiment of the liability channelling principle and no exposure from radioactive contamination possible from other insurance policies (due to the imposition of the RCE clause), the insurance market needed to maximise the capacity available to each operator. The various international insurance markets agreed that a key factor in ensuring each insurer offered a maximum commitment was by prohibiting reinsurance outside the nuclear insurance pools' network; each participating insurer would provide a maximum capacity for its own account, without resorting to reinsurance gearing. This principle became important for the nuclear pools as it allowed them to become the focal point for nuclear capacity and enabled them to reciprocally reinsure each other without any worries about clashing with possible reinsurance arrangements of any of their member companies. The imposition of the RCE clause on all non-life, non-nuclear policies has embedded the net-line commitment globally, with the result that the concept of no reinsurance has persisted within nuclear insurance.

  A net line commitment without reinsurance benefits policy solvency but it is relatively unusual in today's market, and it restricts gearing of capacity. Net line commitments also amplify the volatility of accounts, as without the cushion of reinsurance cover, losses impact immediately the insurer's bottom line profit. This potential for volatility is considered by regulators when assessing capital models, so restricting capacity provision further (see further point below on volatility).

4.9 SECTOR CONSTRAINTS

- **Lack of actuarial data**[73]: the current insurance market's regulatory regime requires insurers to model their exposures from all classes of business, to ensure they have enough capital to meet possible losses without causing systemic market failure. For example, EIOPA states in a response to the team's questions, that '*insurers and reinsurers that provide capacity to the nuclear TP pools, have internal models and calculate their capital requirements according to the risk profile'*. If the data from any prospective business type are not good enough to permit justification of a capital model, insurers will be discouraged from participating in that business and will find other lines of business that are easier to underwrite. Despite a few well-known nuclear accidents, the availability of comprehensive actuarial data from the nuclear industry is low because the incidence of losses is low; compared to other classes of insurance with millions of losses that can help to build a pattern of performance, the nuclear industry has virtually no data in the public domain that provides this information and much of the data available is only theoretical. This lack of information for modelling makes electing to insure nuclear risks more challenging than other classes of insurance.
- **The perceived risk exposure:** Despite being a low carbon energy source and despite its excellent safety and performance record, nuclear power remains a divisive issue for the public generally. Financial institutions, including insurance companies, merely reflect the view of the population as a whole; moreover, the

[73] Insurers use the law of large numbers to help set premiums; this law states that as a sample size grows, its mean gets closer to the average of the whole population. Nuclear insurers have less than 500 power reactor sites, with a collective history of over 17,000 operating reactor years (source: WNA) for the performance analysis; this compares unfavourably with most other insurance types where millions of policies are issued annually, providing plentiful material for actuarial analysis.

shareholders of risk-transfer insurers are a mere reflection of society's composition. Public opinion on nuclear power is changeable, with a decline in popularity after the Chernobyl and Fukushima accidents, and numerous anti-nuclear groups fighting against nuclear power. Therefore, it is hardly surprising that many insurers steer away from the potential controversy of insuring the nuclear sector; other controversial sectors suffer similarly, such as scientific research using animals and more recently, coal mining. A large multinational insurer offering a small, net line share to a nuclear pool opens itself to an exposure which inevitably would attract unwelcome attention from some shareholders should a loss occur.

Political support for nuclear is also not universal, with countries (both within and outside the EU) offering a wide range of political opinion on nuclear energy; the short-term nature of political opinion, whether favourable or unfavourable, adds further uncertainty for insurers considering a type of insurance with very long-term liabilities.

Without dedicated expertise, the nuclear sector is considered too uncertain and difficult for many insurers to contemplate; this is evidenced by the shrinkage and consolidation of nuclear pool membership over time (e.g. in 1956 the UK Pool had 219 members, in 2018 it had 28 members[74]). This avoidance of nuclear reduces the available market compared to other sectors.

- **Sector size and opportunity**: Insurers require adequate return on capital from each line of business they underwrite and, as noted above, regulators such as EIOPA review insurers' justification of the capital amounts supporting their underwriting; therefore, individual types of business are competing for capital within each insurer. For several of the reasons noted in this section, nuclear insurance is not widely considered a competitive type of business when measured against return, unless there is a company that decides to focus enthusiastically on the sector. The complexities of the unique NTPL regimes, the difficult exposure they bring and the presumption that nuclear insurance is a specialist type of insurance with limited reward limits new entrants to the market. The global premium for nuclear insurance is approximately $800 million[75] (€716 million) which represents only about 0.034% of 2018 global non-life insurance premium[76]. The specialist, niche nature of nuclear insurance is thus a material constraint on capacity.

4.10 MARKET CONSTRAINTS

- **Volatility**: as part of Solvency II capital modelling insurers must assess business type volatility[77] and NTPL insurance is inherently volatile, being a low frequency, high severity loss type of business. There are also other factors that contribute to volatility: net line underwriting transfers losses straight to the bottom line and the passage of time increases volatility exponentially, therefore extending the prescription period from 10 to at least 30 years materially impacts capital modelling for NTPL insurers. This increase in volatility over time matters for insurers, as under the Solvency II regime they need to make provision for future claims (known as 'reserving' – see the glossary in Annex A) which now could be made up to 30 years after the final

[74] Although this shrinkage can also be partly explained by the fact that the number of insurers was much greater in the 1956 market than today, this also shows that today fewer insurers decide to join the nuclear pools.

[75] Project researcher's view based on assessment of the premium income of the global capacity providers, using various published and unpublished sources.

[76] See: Swiss Re SIGMA annual non-life insurance market assessments: https://www.swissre.com/institute/research/sigma-research/sigma-2018-03.html

[77] See technical annex 5.

'occurrence' of a nuclear incident[78]. Counterparty risk[79] also increases with time, which will demand a load on NTPL capital models to account for the potential for reinsurers (other pools or markets) or indemnity providers (such as Governments) not being able to honour their commitments to the insurer. Increased volatility and the need to comply with Solvency II results in an increased capital requirement, which deters insurers in favour of other, easier to support sectors.

- **Capital inefficiency**: return on capital is now the standard measure of insurance performance[80], with profit monitored closely by business line and the capital needed to support it. For example, for every 100 currency units of premium from motor insurance, about 30 currency units of capital are required to support the underwriting of that premium; insurers generally hope for a return of up to 15% on the 30 units of capital committed from the underwriting of the 100 units of motor premium. Motor insurance is simple, with plentiful actuarial analysis of historic data available and a simple, stable loss pattern, so has low capital requirements. Liability insurance requires more capital to support it, because it can have losses over a longer period, making it more volatile, and insurers need to reserve some of the premium received for the losses in the future; however actuarial analysis on general liability is relatively plentiful, so allowing insurers to model possible claims patterns with some justification. Despite this, the business performance is less certain than motor insurance and it has higher capital requirements. NTPL insurance suffers from multiple uncertainties, as outlined above; it will require capital of a similar level to very volatile accounts, perhaps nearer 200 units of currency capital to support 100 currency units of premium[81]. NTPL insurance must therefore materially outperform other lines of business to be competitive against them, given the high level of capital utilised; this is a key capacity constraint and has caused insurers to withdraw from nuclear insurance.

  Utilisation of capacity is also important to understand in the context of capital efficiency. All capacity providers work to a maximum commitment per event; thus an insurer will commit a specific amount to nuclear insurance based on the maximum exposure per loss (or site). Imagine an insurer that decides to contribute 1% of the revised NTPL financial security amount of €1.2 billion, being €12 million. If the remaining capacity available equated to exactly 99% of the maximum amount required (€1.188 billion), and only 1 site purchased insurance for €1.2 billion, then the insurer with 1% can expect to be fully exposed and achieve a maximum utilisation of his contribution. However, the reality is different; two factors can reduce the utilisation being (i) smaller limits such as Bulgaria which only requires €48 million (where our insurer's share of 1% will give only €480,000 of exposure against the maximum commitment of €12 million) and (ii) excess supply of capacity resulting in our insurer 'signing down' on his share. If €1.5 billion of insurance capacity was available, there is an oversupply of 125% when measured against the requirement of €1.2 billion; this will result in our 1% insurer's share being reduced to 0.8% or €9.6 million. Both these outcomes reduce the utilisation of the €12 million capacity committed and are additional factors that will reduce capital efficiency. With few maximum NTPL financial security requirements of €1.2 billion in force today and many countries having lower requirements, maximum capacity utilisation is only possible on few sites.

- **Annual policy limit accumulation ('stacking'):** some insurance markets recognised at an early stage that to encourage insurance capacity into the nuclear sector there would need to be a restriction on the possibility of NTPL policy limits for a single site accumulating over time. Consequently, in some national nuclear legislation the nuclear site operator's financial security amount is fixed for the whole period of the operator's

78 The Conventions define a nuclear incident as '*any occurrence or series of occurrences having the same origin which causes nuclear damage*' (e.g. 2004 Protocol amending the Paris Convention, Art. 1 (a) (i)). This could result in a nuclear incident extending over a long period of time (for example several years for a gradual exposure) and only once the final occurrence of the series of occurrences that could give rise to a claim has ended does the 30-year bodily injury prescription commence. This could result in a period of more than 30 years between the damage initially occurring and the claim being made.

79 Counterparty risk is the likelihood or probability that one of those involved in a transaction might default on its contractual obligation (e.g. a reinsurer)

80 See technical annex 5

81 Actual capital requirement will vary with each insurer and depends on many factors, such as portfolio content and diversity.

responsibility; the insurance policy is thus able to match this with a single financial security amount for the same period, be that a nuclear installation's lifetime limit or a license period limit. From the insurers' perspective there is no automatic reinstatement of cover[82], which thus prevents insurers' exposure to multiple losses at the same site.

Not all country's insurance markets adopted this concept; therefore, today there are nuclear sites and countries with annually renewing policy limits[83]. These policies could allow a claim to be made for each annual policy, perhaps from the same event if the incident is the result of several occurrences (so allowing the claimant to make a claim under several separate annual policies). The danger to the insurer of this accumulation can easily be appreciated, as it allows policy limits to stack up for each year the policy can be claimed against; in the case of the revised prescription periods that will apply to NTPL coverage, this could be up to 30 annual limits. For example, contrast the exposure of a maximum of €700 million for a site with a single, lifetime policy limit with the exposure of potentially €21 billion over 30 years for a similar site with an annually renewable policy limit. This aspect is a key capacity constraint; globally there is little consistency as to which countries have which type of cover.

- **Judicial (or superimposed) inflation[84]**: this concept is a factor for any long tail insurance provider to consider[85], whether insuring motor, environmental, industrial or nuclear liability, and the concept includes the often-cited phrase claims inflation. This measure of inflation is a key assumption for the non-life actuaries and is used for developing product pricing (premiums), claims reserving and capital models; yet it is also hard to predict with certainty and is therefore open to subjectivity.

  Like any insurance product, liability insurers are taking a fixed premium today in return for a promise to pay an unknown claim sometime in the future. Non-liability policies will typically last one year (so called 'short-tail' policies) and claims are normally made and may even be paid within this annual period. With short-tail policies, insurers know within a short time of the expiry whether the premium can be counted as profit or whether there is a loss to pay. Liability products are different, as insurers still take a fixed premium today in return for the promise to pay an uncertain claim in the future; however, the period to bring the claim may stretch many months or years into the future. For NTPL cover under the revised Conventions, this period is at least 30 years for bodily injury[86]. Calculating the amount insurers need to reserve for any claim and related costs this far ahead is difficult and fraught with uncertainty. Judicial inflation is a key component in this calculation.

  There are several aspects to the concept, being (a) the societal influences on the development of compensation case outcomes; (b) the more general increase in compensation awards and costs amounts that exceed normal inflation, where future courts will favour the claimant more and (c) the greater likelihood of copy-cat class actions once some adverse legal judgement has been established. The outcome of legal

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[82] NTPL insurance policies of this nature will provide cover for any valid claim in accordance with the national legislation; however, the aggregate policy limit will be restricted to one financial security amount. Should a replacement post-claim NTPL insurance be required for the site that has suffered a loss (for example for a 2nd reactor), this can be negotiated before cover is reinstated. This arrangement is viewed by insurers as being compliant with the national legislation and/or the NTPL Conventions. See also footnote 161.

[83] See Annex F for the researched information on which insurers have each type of policy period.

[84] A paper prepared for the 2014 Australian Actuaries Institute General Insurance Seminar by R Haden and T Lane defines the concept: "*Superimposed inflation is the growth in claims costs above that indicated by modelled claims costs including a normal inflation amount, which is included in the premium rates set*." This paper also sets out some of the causes of superimposed inflation. See: https://www.actuaries.asn.au/microsites/general-insurance-seminar-2014/program

Also see: Swiss Re paper on liability pricing & inflation:

https://www.swissre.com/china/Inflation_Risk_in_Casualty_Pricing.html

[85] 'Long tail' and 'short tail' are insurance market terms that describe insurance policies with a period of either extended liability beyond the policy expiry date or no liability beyond the policy expiry date, during which a claim can be made; see the glossary in Annex A.

[86] See note 67 above.

disputes has always been a primary concern for insurers; obviously the greater the time exposure, the greater the uncertainty of outcome for insurers. For NTPL insurance a low-key initiating occurrence today (such as a small release within regulatory limits) may cause nuclear damage to an individual who could bring a claim against the operator in 25 years' time; the decisions of the court 25 years hence on whether or how much compensation should be awarded is a source of material uncertainty for insurers. Decisions and awards will be based on societal and technical conditions of the future and today's insurers have little idea what these conditions might be, yet they must reserve some premium at the policy expiry for possible future claims.

In addition, insurers need to account for the impact of medical and legal costs inflation over this time span. Whether cover for costs is specifically provided for or not, estimating likely medical and legal costs in two to three decades' time is speculative at best. There are many factors that will drive this inflation, including the advancement of medical science that may link low-level radiation exposure directly to cancers, the increasing cost of future medical interventions that could involve expensive or new treatments unknown today, legislative changes and legal precedents, the role of claims management companies, conditional fee arrangements ('no win-no fee'), economic conditions and inflation of legal costs and wages[87]. All these factors are the cause of considerable uncertainty and when compounded severely constrain NTPL capacity

- **Rating agency influence:** the credit rating agencies play an important role in the insurance market by providing an analytical opinion on an insurer's financial stability; the ratings allow policyholders a choice between insurers based on their perceived stability. In deciding an insurer's business and financial risk profile, the credit rating agencies will consider factors such as volatility, capital efficiency and reserving methodology[88]. In this section is an explanation of how these factors are adversely influenced by underwriting NTPL business; therefore, it is axiomatic that insurers desiring a high credit rating score will be deterred from underwriting NTPL, so constraining the NTPL capacity availability. For example, the Lloyd's market stated[89] that its requirement for Lloyd's market insurers to report separately their 10-30 year NTPL bodily injury commitments is driven by the need to retain its coveted 'A' credit rating[90]; by monitoring this particular aspect of the future NTPL exposure, Lloyd's can also act to restrict exposure should increased volatility threaten the rating agencies' view of the market.

4.11 CONSTRAINTS FOR SELF-INSURANCE CAPACITY

With the risk-transfer market capacity constrained by a combination of the above factors, it is reasonable to imagine that the self-insurance nuclear market would have enjoyed strong growth as a result of these difficulties. This has not been the case, particularly with NTPL capacity; there are also self-insurance capacity constraints that are responsible for the slow development of this alternative source of capacity:

- Mutuals increase their capacity by generating more premium and thus more surplus[91]; this requires either existing members to buy more insurance or for new members to join and insure their sites with

87 Reference was made to an actuarial study for some of this information: '*Claims inflation, uses and abuses*' prepared for the 2005 Actuaries' General Insurance Research Organisation (GIRO) Convention, under the chairmanship of Simon Sheaf.

88 For more information on how rating agencies assess insurers, see (for example) Standard and Poor's '*How we rate Insurers*': https://www.spratings.com/documents/20184/774196/How+We+Rate+Insurers.pdf/b8c092fa-1ee9-4392-a8fd-0d88f93b1f40

89 Disclosed in interview.

90 Lloyd's has 3 credit rating agency scores: AM Best – A (Excellent); Standard and Poor's – A+ (strong); Fitch – AA- (Very strong); see: https://www.lloyds.com/investor-relations/ratings

91 See Technical Annex 1 for a description of this mechanism as it applies to the nuclear mutuals.

the mutuals. With limited market diversity in the provision of NTPL cover, operators can be reluctant to commit full capacity to one or other of the main groups of insurers (nuclear pools or nuclear mutuals); without a viable third competitor block, the loss of support of one of the two main players[92] could mean an inability to cover the full security requirement. Therefore, operators will maintain shares with both groups of insurers, which may have constrained the growth of the mutuals. In addition, with the relatively low number of sites globally, the prospect of obtaining plentiful new members is limited which also constrains growth. Limited growth limits the mutuals' capacity.

- The Fukushima accident has demonstrated that managing claims after a severe nuclear accident is a complex and long-term operation. The risk-transfer insurance markets are endowed with an extensive claims management infrastructure to cover all types of insurance; replicating this infrastructure in the self-insurance sector is difficult. Certainly, the EU nuclear mutuals have the advantage of being able to work alongside their members – the operators and they have developed comprehensive claims infrastructure, nevertheless some operators prefer not to have to get involved in this aspect and this curtails full commitment to a mutual.
- Managing and settling third-party liability claims using an insurer owned by the policyholders provides more opportunity for conflicts of interest to arise. For this reason, some operators may want to remain at 'arm's length' from their insurers.

4.12 CONCLUDING COMMENT ON CAPACITY CONSTRAINTS

Technical Annex 5 describes the approach underwriters take to reviewing and either accepting or rejecting risk; no matter what exposure is under consideration underwriters will try to calculate whether the opportunity for profit is outweighed by risk of loss. The constraints listed above are all to some degree disincentives to offering capacity for NTPL insurance; some insurers will find many of these a discouragement, others that just one or two put them off. The key point to appreciate is that the increasingly regulated insurance market finds it difficult to justify taking on exposure without clear parameters (i.e. definitions) of loss as this complicates the calculation of potential losses. With such a competitive open market, complex and difficult risks that are challenging to model are avoided in favour of perceived 'easier' classes of insurance. NTPL and nuclear insurance in general has always been perceived as difficult and has thus witnessed the development of a specialist, limited market to cover its exposure; to increase capacity new players need to be attracted to nuclear insurance and only by addressing at least some of these constraints will markets open up and allow capacity and competition for NTPL insurance to grow.

To summarise, this section has described numerous constraints acting predominantly upon the risk transfer insurance market to restrict the availability of NTPL capacity. With such a wide choice of insurance classes, the risk-transfer market can easily underwrite less difficult classes of insurance that will not have such an adverse effect on solvency modelling or credit rating scores. On the other hand, monoline nuclear mutual insurers have no such choice; the operators that own the mutual have the prevailing NTPL coverage legally imposed upon them and their mutual insurance partners have been created to assist with the underwriting of this exposure. For this reason, the mutuals have stated they will provide capacity for the full scope of the revised NTPL requirements, but their normal access to the risk-transfer dominated reinsurance market is suffering from the same constraints listed above, thus limiting the scale of capacity available for the revised NTPL scope[93]. By

[92] For example, if a site was insured 100% with a single insurer group (e.g. the nuclear pools) and suffered a material loss, the insurer group may be reluctant to insure the site again. This could leave the site without enough available capacity from the only other alternative insurer group (the nuclear mutuals) at renewal to comply with its financial security requirements. The creation of a new MGA in 2012 has changed this dynamic, but at present it cannot offer the full capacity for nuclear site financial security requirements; therefore, many operators share their capacity requirements between both pools and mutuals, without committing fully to either.

[93] See Technical Annex 1 for an explanation of the current reinsurance arrangements of the leading European nuclear mutuals.

unlocking new markets and optimally sub-dividing the NTPL exposure, it is anticipated that new capacity for the full scope of the revised NTPL arrangements will become available; this is explored in the following sections.

4.13 COVERAGE GAPS FOR THE CURRENT AND REVISED LEGAL REGIMES

In summary, the study research has established:

- There are no gaps in cover nor shortage of insurance capacity for the *existing* NTPL regimes in force in any EU MS.
- There is enough insurance capacity *amount* to cover most of the wider scope of cover and financial security limits of the revised NTPL regimes due to be introduced in some EU MS; however, there is a material shortage of capacity to cover the *full scope* of the revised NTPL regimes.
- Notably, there is a gap in cover for the time to bring a claim (the prescription period) for bodily injury beyond 10 years up to the revised period of 30 years.
- The only insurance capacity available for this aspect of the new liability arrangements is provided by the operator pooling mechanism in Germany (with the full revised PC capacity available), the nuclear insurance mutuals, the operator owned captive insurers and a single nuclear managing general agent insurer (with limited capacity available).

The next section investigates possible solutions to resolve this gap and that could provide material additional NTPL private capacity to the nuclear operators.

5 INCREASING NTPL CAPACITY FOR THE FUTURE

5.1 ADDITIONAL CAPACITY FROM EXISTING MARKETS

One aspect of this study's objectives was to investigate the availability of additional capacity from the existing market players; the responses received to the research team's enquiries demonstrate that increasing the financial security amount is possible immediately, as most of the current capacity providers could offer more capacity amount now. In terms of capacity in the current, relatively 'soft' market cycle[94], the insurance market is generally demand driven and many insurers could provide greater capacity than required today.

In the context of NTPL, demand is driven by the operators' financial security amounts, which are what operators are compelled to cover with insurance (or other financial security[95]). Nuclear site operators, like any other private sector business, will not buy insurance unnecessarily and if not required to do so; this is especially true of liability, where possible claims do not have an immediately obvious financial cost and because any good operator presumes its site will not suffer a severe accident. Typically, the obligation to buy third party liability insurance of any type is prescribed by regulators or state authorities[96], in recognition of the fact that if not compelled, many individuals and businesses would not consider buying such insurance. Therefore, the only way NTPL capacity demand will increase is if these financial security amounts are raised by regulators or state authorities.

The previous section demonstrated that there is material shortage of capacity to cover the *full scope* of the revised NTPL regimes. Therefore, in ascertaining whether additional capacity is available from existing providers, the research team investigated[97] two aspects:

1. Can the existing providers offer more capacity?
2. Do the existing providers believe that the current lack of cover for the full scope of the revised Conventions will be overcome?

Table 8 below shows the responses received from this research.

The first response column ('*can increase NTPL capacity*') illustrates that in general more capacity is available from the current capacity providers; this finding reinforces the earlier finding that enough capacity is available already to fulfil the current financial security requirements. If each active capacity provider could utilise its maximum capacity for NTPL, over €2.3 billion is available now and the responses received indicate that even more capacity is available if there was demand for it. Of course, capacity to cover the proposed full scope of the

[94] Insurance markets generally demonstrate a clear 'cycle' between a 'hard' (more expensive policies) and a 'soft' (cheaper insurance policies) market. A hard market produces higher profits for insurers, which attracts more capital to the market leading to an oversupply of capacity, which drives profits down. This leads to a soft market, where claims and more competition result in lower profits and even corporate losses; at this point some insurers close or withdraw from the market, so reducing capacity and driving premiums up again, because of capacity scarcity.

[95] For example, see: 1960 Paris Convention Art. 10 (a).

[96] For example third-party liability motor insurance for a prescribed minimum amount is compulsory in the EU, see https://ec.europa.eu/info/law/motor-insurance-directive-2009-103-ec_en

[97] The researchers invited all major capacity providers to respond to a questionnaire that investigated capacity, appetite for expansion, attitude to the current difficulties and policy periods.

NTPL Conventions remains insufficient, but assuming a solution for this problem can be found, then clearly capacity is available from the private markets to ease at least some of the cost burden of a severe accident falling upon the state.

The second response column ('*Expect to cover full scope of revised Conventions*') shows that, despite the current resistance from the majority of the risk-transfer market to offering capacity for the extended prescription period for bodily injury, about half of the EU MS nuclear pools believe that ultimately the risk-transfer market will offer cover for the full scope of the revised Conventions. This belief is supported by experience, as most risk-transfer insurers initially resisted providing cover for the environmental heads of damage[98] in the revised Conventions, yet today capacity for these heads of damage is readily available (see previous section).

The table shows that most of the self-insurance insurers already are comfortable providing capacity for the extended prescription periods as is the risk-transfer MGA; therefore, it is not unreasonable to take an optimistic view and assume that with the passage of time most insurers will provide capacity for the full scope of the revised Conventions (including the extended prescription periods). The advantage of the global nuclear pooling system[99] is that the pools tend to operate in unison, thus once one or two major nuclear insurance pools offers NTPL capacity for the full scope of the revised Conventions, the others will probably follow suit.

In the course of the research, the team also questioned the nuclear pools about their willingness to offer capacity in new ways, either with a trigger mechanism that initiated cover for the difficult elements within the scope of nuclear damage or outside the existing legal framework altogether. Several pools indicated that more capacity would be available for the difficult aspects of the revised Conventions (for example bodily injury) if a trigger with a clear attachment point for the insurance cover was introduced; some also indicated positively that more capacity could be available, depending on the type of product offered. These concepts are examined in the next section.

Table 8: New capacity from current providers

Type	EU NTPL capacity provider	Can increase NTPL capacity	Expect to cover full scope of revised Conventions
RISK TRANSFER	BE POOL	NO	YES
	BG POOL	NO	NO
	CZ POOL	YES	YES
	DE POOL	YES	NO COMMENT
	ES POOL	YES	YES
	FI/SE POOL	YES	UNSURE
	FR POOL	YES	STATE TO COVER
	HR POOL	YES	YES
	HU POOL	YES	YES
	NL POOL	NO	NO
	RO POOL	NO COMMENT	NO COMMENT
	SI POOL	YES	YES
	SK POOL	YES	NO

98 See OECD NEA Nuclear Law Bulletin # 77 2006: '*Revised Paris and Vienna Nuclear Liability Conventions – Challenges for Insurers*' by M. Tetley.

99 See technical annex 3.

Type	EU NTPL capacity provider	Can increase NTPL capacity	Expect to cover full scope of revised Conventions
	UK POOL	YES	NO
	MGA	YES	N/A
SELF INSCE	MUTUALS	YES	N/A
	CAPTIVES	NO COMMENT	NO COMMENT
	OP.POOLING	N/A	N/A

In summary the key points illustrated by this research are:

- Additional capacity from the existing players is readily available if demand increases; this extra capacity will be additional to the surplus of NTPL capacity already demonstrably available today.
- Although there is currently not enough NTPL capacity to cover the full scope of the revised Conventions, in time it seems that enough additional capacity will be available to meet the requirements related to the extended prescription periods.

5.2 NEW SOURCES OF CAPACITY

The NTPL Conventions permit the use of insurance and other financial security for the fulfilment of operators' financial security requirements[100]; therefore, consideration of new sources of capacity should not be limited to insurance markets. This section will look at sources of new capacity from both the current traditional insurance markets and from the wider capital markets; it does not consider any state backed insurance, indemnity or other state guarantees that might be available to operators, as the objectives for this study clearly state that research should cover the insurance, private and financial markets only.

5.3 INSURANCE MARKETS

5.3.1 SELF-INSURANCE

The previous sections of this report have illustrated that the self-insurance elements of the NTPL market consist of mutuals, captives and operator pooling arrangements. With many nuclear operators already contributing in some way to these entities, any consideration of new sources of self-insurance capacity inevitably is restricted to extensions or increases in operator participation in their own insurance.

[100] 1960 Paris Convention & 2004 Protocol to amend the Paris Convention - Arts. 10 (a); Brussels Supplementary Convention Art. 3 (b) (i); 1963 Vienna Convention Art. VII (i); 1997 Revised Vienna Convention Art. VII (1) (a).

5.3.1.1 MUTUALS

The primary purpose of a mutual insurance companies is to provide its members with insurance coverage at or near cost, since any dividends paid back to members represent excess premium payments. Therefore, it is axiomatic that in an ideal world the members will want to eliminate any surplus insurance costs they can by increasing their available capacity as much as possible; the brake on such increases in capacity are the risk appetite of the mutual members and the demand (or requirement) for insurance[101], as well as the factors described in the previous section. Additional capacity from this sector is dependent on whether the existing operators feel comfortable committing more to their mutual insurance entity and to some extent whether the necessary reinsurance cover is available to support the mutual for extreme events, but considering the overriding purpose of a mutual, this seems a reasonable supposition. However, although potential new capacity can result from the mutual's organic growth, only extensive new reinsurance support from the traditional or new capital markets could be considered as a new source of capacity. As mutual self-insurance is the main source of full scope NTPL capacity available today, increasing mutual capacity using more (or new) reinsurance arrangements is an attractive solution.

5.3.1.2 CAPTIVES

Any operator can establish a captive insurance entity, the purpose of which is to insure the risks of its owner so it can retain the captive insurer's underwriting 'profits'. Once again seeking more capacity from new captives will require nuclear operators to decide whether taking more control of their risk and insurance arrangements is a suitable business decision for them.

Unfortunately, sentiment among the existing captive community is largely unknown since the few captive owners already established in the EU have not responded extensively to the research team's enquiries. This lack of knowledge about these entities makes any statements about future captive insurance activities conjecture. However, considering experience of other sectors where captive insurers operate, it can be assumed that for nuclear captives a key objective is to provide insurance cover for some of the captive owner's needs, including NTPL for limited cost.

5.3.1.3 OPERATOR POOLING

Increasing the financial security amount demanded by the German Solidarity Agreement is a matter for the German government. If the amount is increased above the current €2.5 billion then it will be the existing operators that will have to contribute; this may be considered as new capacity, but it is not from a new source. What is apparent is that the risk-transfer insurance element of the German scheme is utilising only a small part of the available monetary capacity; therefore, if the German Government wanted to increase the overall amount available through the Agreement, increasing the insurers' amount to a higher capacity level[102] is immediately possible.

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101 See technical annex 1.

102 The project research shows that a maximum capacity of €255 million is available today for the full scope of the revised Conventions (see section 4 and Annexes E and F). The current risk transfer contribution is also €255 million but only for limited scope cover; if both these capacity amounts were used, the capacity under the German scheme could be increased by at least €255 million beyond the current headline €2.5 billion amount.

5.3.2 RISK-TRANSFER INSURANCE

5.3.2.1 TRADITIONAL INSURERS

The on-line presence of the global nuclear insurance pools' network contains the following statement: "*The risks presented by the civil use of nuclear power are categorised as low-frequency, high-cost events. On the one hand, they demand a deployment of capacity by the insurance market that is greater than in any other sphere of industrial activity, but on the other, the risks themselves are few in number and present an unbalanced portfolio with a scant statistical data basis. Worldwide, nuclear risks generate an overall amount of premium which is disproportionately small in comparison with their political, sociological and economic importance and the size of the risks assumed by insurers. By the formation of net-line Pools, the insurance industries of the world have succeeded in accumulating the maximum available capacity for this class of business. Thus, the Pooling System operates to the benefit of the nuclear industry and ultimately society as a whole*"[103]. The penultimate sentence indicates that the nuclear insurance pooling mechanism has already accumulated the 'maximum capacity available'. Is this statement true or are there lots more insurers who would like to offer new sources of NTPL capacity but for some reason cannot do so?

To examine the veracity of this statement, the research team has considered two factors:

1. How many big insurers are represented in the pools?
2. Are there obvious signs that there are sources of new capacity that for some reason are not able to participate in the NTPL insurance market?

Considering factor 1 above, the top 10 insurance groups[104] operating in Europe, as measured by overall premium volume are shown in Table 9 below:

Table 9: Europe's top 10 insurance corporate entities

Rank	Group	Country
10	**Groupama**	France
9	**Covea Insurance**	France
8	**AVIVA**	UK
7	**Ergo**	Germany
6	**MapFre**	Spain
5	**Talanx**	Germany
4	**Generali**	Italy
3	**Zurich**	Switzerland
2	**Axa**	France
1	**Allianz**	Germany

For commercial reasons the nuclear insurance pools have not revealed their membership lists, but the research team is aware that 6 of these 10 companies are capacity providers to the nuclear pools and 1 other has made a conscious decision to exit the nuclear pooling system for strategic reasons. This situation is repeated in other non-EU nuclear states, such as the USA, Japan and China[105], with the larger insurers providing pool capacity; enquiries amongst some other large insurers has indicated that an assessment of nuclear exposure has been

[103] Extract from Nuclear Pools' website: https://www.nuclearpools.com/about-us

[104] Information source from Property Casualty 360 (National Underwriter); excludes reinsurers.

[105] Where large insurers such as AIG, Tokio Marine and the People's Insurance Company of China respectively provide nuclear pool capacity.

undertaken, but nuclear insurance does not always fit all companies' current risk profile[106]. Many other insurers will operate in sectors wholly unsuited to NTPL[107], whilst some will have strategies that don't incorporate specialist sectors such as NTPL insurance[108]. Therefore, with the position of 7 out of 10 of these top insurers clear on NTPL and many others excluded from NTPL for other reasons, it is reasonable to assume that the nuclear pools have indeed made a valiant attempt at maximising the available capacity, certainly in their own domestic markets, although with limited success due the constraints already described.

The insurance market is vibrantly competitive; thus, there are always new players coming to the market or companies that review their strategy and decide to enter a new sector; what about these insurers? Is their capacity being exploited by the existing nuclear pools or can they freely offer capacity outside the nuclear pool? Again, anecdotal evidence shows that new insurers considering whether to enter the nuclear insurance sector will generally look to join a nuclear pool, rather than 'go it alone'. The nuclear pools have low barriers to entry[109] and most should welcome new members, which only leaves insurers that are either prepared to commit considerable resource, expertise and capital to nuclear or those with lower credit rating as sources of stand-alone capacity; the former group remains wholly unrepresented in the market and the latter group is generally unacceptable to operators due to their inadequate solvency.

This leaves looking for new sources of traditional capacity from insurers in countries that do not have a nuclear pool; in the world of insurance there are several mature and sizeable insurance markets that remain untapped for nuclear capacity, such as Bermuda, Ireland and Australia. These could indeed provide a new seam of capacity, but again the commitment required to overcome the constraints already described and enter the NTPL insurance sector have hitherto conspired to prevent material new traditional capacity.

In the next section of this study, mechanisms are reviewed[110] that could be created to bring materially more capacity to the NTPL insurance market from traditional insurance markets not yet involved.

5.3.3 ALTERNATIVE (NON-TRADITIONAL) MARKETS

Obtaining new NTPL capacity from outside the traditional risk-transfer market has long been a source of interest for the stakeholders in the world of NTPL capacity provision; the reason for this interest is simple: current traditional NTPL capacity availability, even at a maximum theoretical level, is between €2 and €3 billion, whereas the capital markets[111] offer potential capacity availability measured in multiples of this[112]. Of course, the two critical factors that will determine NTPL capacity availability from these seemingly enormous amounts is whether (a) new providers will consider NTPL an attractive return for their capital commitment and under what conditions, and (b) whether the ultimate product offered is affordable for the nuclear operators. However, it is

106 For example, Berkshire Hathaway indicated to the research team it was not interested in providing capacity for nuclear risks outside the USA.

107 For example: motor, SME, short tail property and life insurers.

108 For example: sector insurers such as agricultural, oil and gas and residential property insurers.

109 Most pools merely require insurers to have satisfactory credit ratings; see Technical Annexes 3 and 5.

110 See Section 6 for further details about these mechanisms.

111 For the purposes of this study, the capital markets are defined as mechanisms that permit the exchange of savings and investments between those with capital and those that require capital.

112 Estimating the size of the capital markets is tricky and depends on who you ask; in 2009 (just after the financial crisis) McKinsey estimated the global capital market size at $178 trillion (€159 trillion); in 2017 the global stock market capitalisation (one element of the capital markets) was estimated to be over $100 trillion (€89.3 trillion) by Goldman Sachs. Even in 2005, McKinsey estimated the capital market size as > $100 trillion. Obviously, variations in stock and bond market valuations change this figure frequently; for example, according to the Financial Times, the world capital markets lost $5 trillion (€4.46 trillion) of value in 2018. The reinsurance market capitalisation at the end of 2017 was approximately $600 billion(€535.7 billion), according to a study by Aon Benfield (see: http://thoughtleadership.aonbenfield.com/Documents/20180404-ab-analytics-rmo-april.pdf); although just the reinsurance market, this indicates that the overall capital markets are perhaps about 1,000 times bigger in capital terms than the insurance markets.

likely that even with material new capacity from this source, enough capacity to cover the costs of NTPL damages resulting from an event such as Fukushima could take decades or longer to develop.

Given the interest in expanding the population of NTPL capital providers, there are also some published thoughts on the subject. Alain Quéré, the general manager of the Swiss Nuclear Pool, in a recent paper[113], noted 2011 research by Swiss Re (the managing company of the Swiss nuclear pool) which "*confirmed that catastrophe bonds for nuclear risks merely offer very limited capacity at a high price*". The perception seemingly persists that any capital market cover will be too expensive and that the complex, long-tail risk profile of NTPL cover, as required by the NTPL Conventions, will not be attractive to the capital markets unless the returns are reasonable, so rendering them uneconomic for the nuclear operators.

There are other concerns about utilising these new sources of capital; Professor Pelzer examined their use in a paper about Operator Pooling[114]. He noted that the current insurance product is designed to closely match the legal requirement and is provided by regulated entities with the available infrastructure to settle mass claims; he considers that at present the same cannot be said for new, alternative sources of capital. Indeed, his view is that "*the conclusion of a third-party liability insurance contract is the yardstick also for any other type of financial security*". Pelzer also noted that there was a "*second problem of other financial security: it may be more costly than insurance*"[115].

However, these new sources of capital cannot be ignored; the difference between the amount of compensation paid following the Fukushima accident and the current NTPL capacity availability obligates this study to make an investigation of additional capacity providers, even if they are discarded later as being too expensive for operators. Also, it must be recognised that active participation of these new capital sources in the insurance sphere is relatively recent; therefore, with product development, refinement and innovation one should hope for continuously improving understanding and terms for a wider range of sectors.

The investigation conducted by the research team concentrated on the current capital market sectors active in the insurance market, which are those providing 'Catastrophe Bonds' (Cat Bonds) and the related 'Insurance Linked Securities' (ILS) markets. These terms and the background information on these markets are explained in **Technical Annex 4**.

The research team has identified that considerable new capacity could be available; sources interviewed concurred that the current Cat Bond and ILS markets have a capacity of over $100 billion (€90 billion) for well-known and understood natural catastrophe events, from these markets over $1 billion (€900m) could be open to NTPL exposure immediately. A defining feature of this market is the speed at which understanding develops, which leads to improved terms and capacity for the buyers; for example a similar high severity low frequency event reinsurer placed a new Cat Bond in February 2019; by April the capital market understanding of the risk has already evolved enough to guarantee that more capacity and a lower price will be available at the next renewal. Interviews with capital market experts indicate that this phenomenon has been consistent with each new sector entered.

A critical element to attracting new sources of capacity from the capital markets is the design of the interface between the traditional insurance market and the capital markets; this 'transformer' mechanism will need to repackage the exposure into a more understood and so palatable format for the new capital. From the team's enquiries, correct design of this mechanism will make the difference between success and failure of any new NTPL product. These markets are attracted to simple, clearly defined 'binary'[116] events, normally with

113 OECD NEA Nuclear Law Bulletin # 94 (2014): '*Challenges facing the insurance industry since the modernisation of the international nuclear third party liability regime*' by Alain Quéré

114 OECD NEA Nuclear Law Bulletin # 79 (2007) pp. 37 – 55: '*International Pooling of Operators' Funds: An Option to Increase the Amount of Financial Security to Cover Nuclear Liability?'* Discussion Paper for the IAEA INLEX Group Meeting on 21-22 June 2007 by Norbert Pelzer

115 Ibid.

116 This refers to clarity over the occurrence; it needs to be completely clear whether the event has or has not happened.

parametric[117] triggers that, once validly initiated will generate a single, instant loss payment; to generalise, these markets would understand a product that provided capacity for a catastrophic nuclear accident, but probably not gradually occurring nuclear damage that arose out of an authorised radioactive materials release from a site.

To conclude, the research shows that additional capacity is available for NTPL insurance from new sources within the capital markets, as well as some other sources within the traditional insurance market. It is also clear that the scale of the capital markets represents an exciting opportunity to deploy more private capital to the NTPL exposure; however, it must be structured correctly and be provided at an acceptable cost to ensure the fine balance between encouraging or discouraging the commercial exploitation of nuclear power is maintained. Below the study reviews a range of new concepts that could attract new capacity to the NTPL insurance market.

5.4 CONCEPTS TO INCREASE CAPACITY FOR NTPL INSURANCE

The previous sections have established that capacity from most traditional risk-transfer insurers for full scope NTPL coverage as advocated in the revised NTPL Conventions is constrained by the language used around the concept of nuclear damage and the prescription periods.

Grouping the new solutions into categories will ease the preliminary analysis and allow identification of the most practical solutions that fall within the operational scope of the EC; the groups used to sub-divide the solutions are:

- Solutions with legal implications;
- Insurance market solutions;
- New product solutions.

In Table 10 below the full list of new solutions considered by the research team is listed, with their category; subsequently and for each category of solution, each new concept is given a brief explanatory note outlining the basic details and those considered impractical are identified and will not be analysed further. In the next section, the solutions shown in the table as retained are analysed in more detail against the key study objectives and in the final section recommendations made as to the optimum solutions for adoption.

Table 10: Preliminary list of new solutions considered, by category

#	Category	Description	Primary objective	Retained Y/N
1	**Legal implications**	Extend the German Solidarity Agreement	Increased capacity	NO
2	**Legal implications**	EU-wide version of the USA SFP layer	Increased capacity	NO
3	**Legal implications**	All EU Member States to join the CSC	NTPL equality of cover in EU	NO
4	**Legal implications**	All EU Member States to join the Revised PC	NTPL equality of cover in EU	NO
5	**Legal implications**	EU MS governments indemnify insurers for 10-30 year bodily injury exposure	Increased capacity	NO
6	**Legal implications**	Remove 10-30 year bodily injury prescription period	Increased capacity	NO
7	**Legal implications**	Introduce a threshold/trigger for operator's financial security attachment for current regimes	Increased capacity	NO
8	**Insurance market**	RPC 1st tier amount or RVC full amount funded as USA for all EU MS	Increased capacity	**YES**
9	**Insurance market**	All policies have single, lifetime limits	Increased capacity	**YES**

[117] See Glossary in Annex A

#	Category	Description	Primary objective	Retained Y/N
10	**Insurance market**	More homogeneity for policy language and reinstatement provisions	Increased capacity	NO
11	**Insurance market**	Increase mutual participation with new mechanisms for reinsurance	Increased capacity	**YES**
12	**Insurance market**	Change policy type from losses occurring to claims made	Increased capacity	NO
13	**New product**	Catastrophe only, EU wide, single event, cover excess of the current legal regimes	Increased capacity	**YES**
14	**New product**	Establish EU wide Protection Gap Entity	Infrastructural improvement	**YES**

5.4.1 SOLUTIONS WITH LEGAL IMPLICATIONS

1 and 2: Introduce EU-wide operator pooling (i.e. extend the German Solidarity Agreement or introduce an EU-wide version of the US SFP)

"*The principal advantage of an operator pooling system is that large sums of private money, as opposed to public funds, can be made readily available to compensate victims of a nuclear accident*" states Mr Carroll in his excellent study on operator pooling[118]; indeed, the two operator pooling arrangements in the USA and Germany provide €12.164 billion and €2.5 billion respectively of financial security, far in excess of that provided by the basic NTPL financial security limits supported by traditional insurance elsewhere. With such amounts available through these two schemes, the obvious question must be: can these schemes be extended to work elsewhere? In the context of this study, could an EU-wide solidarity agreement or secondary financial protection layer be introduced? This question has already been addressed competently and carefully by both Carroll and Pelzer, therefore the assessment here will be brief.

Carroll states that "*Effective and reliable coverage of nuclear liability by a system of international operators' pooling will probably only be possible if there is a certain degree of political, legal and economic convergence amongst states whose operators could participate in such a system"*[119]*;* Pelzer also observes the same in his work on the subject[120]. Although significant changes have been made to the European nuclear safety legal framework since these studies were published[121], the views expressed in them are still considered valid and the perception remains amongst operators that regulatory and legal regimes are not yet sufficiently harmonised to allow wider pooling. For example, verification of these views was received by the research team during questioning of one of the scheme operators[122] on the prospect of extending the Agreement outside of Germany; extension was not considered feasible because: (i) there is not a long history of cooperation and trust, as there is within Germany, (ii) there is not yet a homogenous and long-established EU-wide safety culture, and (iii) there is no common NTPL legislation[123]. In practical terms, expert opinion indicates that a EU-wide scheme will be possible once there is more common ground with the NTPL legal framework; for nuclear safety legislation and operational

118 See OECD NEA Nuclear Law Bulletin # 81: '*Perspective on the Pros and Cons of a Pooling-type Approach to Nuclear Third-Party Liability*' by Simon Carroll

119 Ibid

120 Discussion paper for the IAEA INLEX Group meeting, 2007: '*International Pooling of Operators' Funds: An Option to Increase the Amount of Financial Security to Cover Nuclear Liability*' by N Pelzer.

121 In particular, the EU amended its Nuclear Safety Directive in 2014, taking account of the lessons learned from the Fukushima nuclear accident, the nuclear risk and safety assessments (stress tests) carried out in 2011 and 2012 and the safety requirements of the Western European Nuclear Regulators Association and the International Atomic Energy Agency.

122 Interview with Preussen Elektra, January 2019.

123 As indicated in Section 4.8, divergences in the implementation of the international conventions could reduce homogeneity of the risk for insurers.

standards, although the EU MS national frameworks may differ, their substance and standards are the same. The outcomes of the stress-test exercises also refute the perception of divergent approaches to safety culture and attitudes among EU MS[124]. The EC is the best placed institution to seek common ground in the NTPL area as well as to promote achieved level of harmonisation in the sphere of nuclear safety, which will serve well the interests of all stakeholders.

In the EU, 73 of the 126 operating reactors are managed by EdF group (58 in France and 15 in the UK), therefore any operator pooling scheme will demand a substantial contribution from EdF; as the operator of so many reactors, this is only fair, but it should be recognised that EdF's support for any scheme is critical. The financial cost imposed upon operators must maintain the balance between polluter pays obligations and successful commercial exploitation of nuclear power to the benefit of consumers and the atmosphere. A further cautionary comment on cost comes from a decommissioning operator: cost of any type added to a reactor that is not generating revenue is not welcome and could divert funds from the necessary task of decommissioning, which itself is important for public safety. The number of operating reactors in the EU will reduce as decommissioning increases; this means the cost burden could fall increasingly on either those sites without the revenue stream to pay for it or on the ever fewer operating sites remaining.

Technical Annex 2 outlines how the existing operator pooling schemes work; from this analysis and from Pelzer and Carroll's work, it can be appreciated that both schemes are integral parts of the national nuclear liability framework; also to succeed an EU wide scheme will require greater legal harmonisation in the field of NTPL than exists today. On the regulatory and nuclear safety front, greater convergence has been achieved thanks to the work of, for example, WENRA, WANO as well as the implementation of the EU stress tests and ensuing national action plans [125].

Additional capacity provided by a retrospective operator funded scheme has many attractions: it will provide significant private sector funding for nuclear damage compensation, it will cover the full scope of the revised NTPL Conventions nuclear damage and prescription period language and it provides a scheme that will endure as long as the nuclear operators and their corporate entities or parents survive. In short, it does not suffer any of the disadvantages currently restraining the risk-transfer insurance market. However, key steps towards NTPL legal harmonisation across the EU nuclear MS must be made first for such an ambitious and worthy scheme to succeed.

Notwithstanding possible Euratom Community[126] competence in the area of NTPL regimes, with NTPL legal harmonisation across the EU incomplete at present, and reluctance among operators to contemplate broadening of the pooling concept, the research team considers that the introduction of operator pooling across all EUMS is <u>not an optimum solution</u> at present.

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[124] In 2009 the European Commission published a report on the progress made in EU countries on implementing the Nuclear Safety Directive. Overall, the report found a good level of compliance with the provisions set out in the Directives. The next national reports will be submitted in 2020, in line with the requirements of the 2014 amended Nuclear Safety Directive. https://ec.europa.eu/energy/en/topics/nuclear-energy/nuclear-safety

[125] See: https://ec.europa.eu/energy/en/topics/nuclear-energy/nuclear-safety

[126] "The wording of the mandate of Article 98 of the Euratom Treaty is limited to the issuance by the European Atomic Energy Community of a directive to facilitate the conclusion of insurance contracts covering nuclear risks. In the absence of any express Treaty provision in this sense, the European Atomic Energy Community is under no obligation to act in the ambit of nuclear third-party liability when the issue does not relate to nuclear insurances. However, even though it is not obliged to act, the European Atomic Energy Community has the power to act in those fields", see TREN/CC/01-2005 Legal study for the accession of Euratom to the Paris convention on third party liability in the field of nuclear energy, page 41 and 48

Article 98 of the Euratom Treaty: "Member States shall take all measures necessary to facilitate the conclusion of insurance contracts covering nuclear risks. Within two years of the entry into force on this Treaty, the Council, acting with a qualified majority on a proposal from the Commission, which shall first request the opinion of the Economic and Social Committee, shall, after consulting the Assembly, issue directives for the application of this Article"; see https://www.consilium.europa.eu/media/29775/qc0115106enn.pdf.

3: All EU members to join the CSC

The prize with mandatory membership of the Convention on Supplementary Compensation for Nuclear Damage[127] (CSC) will be treaty relationships within all EU MS and also with the wider community of parties, which now includes Japan, Canada and the USA. The CSC would also deliver a more closely harmonised legal regime for all EU MS, although the existing capacity constraints would remain and insurance capacity for the full scope would not necessarily be available. Critically, with many of the key nuclear vendors and suppliers covered in the wider base of treaty relationships offered by the CSC, arguably EU citizens will benefit from procurement strategies based on safety and security rather than liability[128]. Whilst ratification of the CSC would result in higher financial security amounts in some EUMS (e.g. Bulgaria), it would allow a lower requirement in Paris Convention states[129]; this would be a difficult decision for some states and the public relations implications of considering a reduction in the nuclear liability financial security amounts may be insurmountable.

Implementation of the CSC in all EU MS will not deliver the full scope of cover required, as the state of the risk-transfer market that currently is constrained will not be altered. What this concept will deliver is a harmonised requirement of minimum cover across all EU MS which will increase certainty for all stakeholders; treaty relationships with other CSC parties such as the USA will also benefit accident victims as a simpler route to compensation will be provided.

Four immediate obstacles render this option less practical, being (i) the current entrenchment of the (revised) Paris regime in Western Europe at least, with its proposed higher financial security amount of at least €700 million; (ii) the political difficulties of achieving progress on a relatively new Convention for almost all EU MS[130], given the prolonged discussions over the 2004 Protocol to amend the established Paris Convention, (iii) the fact that five EU MS are not party to any NTPL Convention and will probably oppose introduction of the CSC and (iv) the opposition of many states to the CSC because it offers less financial security amounts than the RPC and because it offers 50% of the 2nd tier funds to victims outside the accident state.

The application of the CSC across all EU MS would offer obvious cost benefits to operators and an enhanced reach of treaty relationships for victims, thus offering more certainty of cover; however, the difficulties of introducing a new regime with lower financial security amounts than those existing in some countries are likely to outweigh the benefits of introducing the CSC.

The research team considers that the introduction of the CSC across all EUMS is <u>not an optimum solution</u> at present.

4: All EU members join the 2004 amended Paris Convention

If all EU MS signed up to the Paris Convention (as amended by the 2004 Protocol), this would deliver a harmonised legal regime and a minimum financial security amount requirement of €700 million across all EU MS. The existing capacity constraints would however remain and insurance capacity for the full scope of the revised Convention would not necessarily be available. If the shortfall of insurance capacity for the full scope of the revised Convention could be met using one of the other concepts here, the risk-transfer market would be able to focus its capacity on providing capacity either for the supplementary requirement of the Brussels

127 For full text and calculator: https://www.iaea.org/topics/nuclear-liability-conventions/convention-supplementary-compensation-nuclear-damage

128 Currently, absent treaty relationships, suppliers and vendors in non-Contracting States (such as USA, Canada, Japan, Russia, etc) can be sued in their own jurisdiction or somewhere else by any victims for any third party liability, based on fault, even if victims have obtained compensation from a liable operator in the EU. Also, any kind of service, equipment or supply can potentially expose vendors and suppliers to substantial liability claims for up to 60 - 80 years (being the typical nuclear plant lifetime). This makes contract negotiations time-consuming and costly, and vendors can require indemnity and hold harmless clauses that some EU operators or states may be unwilling to provide; the result is that non-contracting state suppliers often walk away. Therefore, competition in Europe amongst nuclear vendors is not necessarily based on safety and security, which should be the priority for the public, but instead can be based on the 'easiest' liability option.

129 Where the financial security limit will be a minimum of €700 million.

130 Among the EU MS only Romania is currently a CSC contracting party.

Supplementary Convention (BSC) or for a new insurance arrangement outside of the current legal regime altogether. For example if the operators or insurance mutuals provided the first €700 million tier of financial security, the approximate € 2 billion of risk-transfer market capacity could be used to cover the BSC tier or even to provide capacity for a new product excess of the NTPL Convention regime, so alleviating potential state involvement somewhat; therefore this concept could deliver material additional NTPL capacity across the EU.

The 2004 Protocol to amend the Paris Convention has been under discussion since the end of the last century, yet it remains unratified. The key difficulty with its introduction has been the unwillingness of most of the risk-transfer market to provide capacity for the full scope of cover required and widening the geographical scope of signatories will not change this situation. The practicalities of introducing this concept will remain challenging until more full scope capacity is available. Increasing the financial security requirement for some operators not already subject to a €700 million limit will increase the amount they pay for financial security; given that the operators already have to cover a lower financial security requirement (e.g. the SDR 300 million required by the revised Vienna Convention), the additional cost for most of them is not likely to be material[131].

Harmonisation of the NTPL legal framework by extending the 2004 Amended Paris Convention to all EU MS is a desirable outcome for all stakeholders, as it will deliver greater equality of outcome for accident victims throughout the EU. It will offer operators a consistent financial security limit and scope of cover wherever they operate and it will provide clarity of requirements for the capacity providers. However, it will be a challenge to overcome the current deficit of capacity for certain aspects of the Convention scope and even more of a challenge to secure the political will and overcome the complications to ratify the Convention in all EU MS, some of whom are not OECD members. In addition, the 5 EUMS that are not party to any NTPL Convention may not be in favour of such a solution.

The research team considers that the introduction of the revised PC across all EU MS is not an optimum solution at present.

5: All EU MS governments to indemnify insurers for 10-30 year bodily injury exposure

Section 4 explains that the most difficult aspect for most risk-transfer insurers of the revised NTPL Conventions' scope is the extension of the period to bring a bodily injury claim from 10 to 30 years. This concept would extend across all EU MS the arrangement that has existed in certain EU countries for some time, allowing the creation of a formal indemnification to insurers of this difficult aspect of the revised Conventions by Governments[132].

Formal state indemnification of the extended bodily injury prescription period will immediately provide the full scope of cover required by the revised NTPL Conventions, albeit by the state rather than the private market.

With the major capacity constraint indemnified by the state, risk-transfer insurers would be able to offer the full scope of cover for the full required amount demanded by the revised NTPL Conventions. Although private sector capacity would be increased, it would be accompanied by an indemnification from the state for one part of the revised NTPL scope of cover.

In some EU countries, the state has provided this extended prescription period cover for some time[133]; moreover, the Conventions require contracting parties (i.e. governments) to ensure compensation is paid where insurance or other financial security is 'not available or sufficient'[134]. Therefore, although there may be some political difficulty extending it to all nuclear EU MS, the precedent for such an arrangement exists and in the

131 But note Bulgaria's current Financial Security amount is only €48m (see annex D); an increase in this amount to SDR 300m or €700m will incur material additional premium cost for the Bulgarian operator.

132 This envisages state indemnities being provided to insurers for any claims that fall under the agreed scope of such indemnities. Thus if an insurer received a claim outside of the 10 year period, it would pass the claim onto the state. The benefit of retaining insurer involvement is that the insurance market possesses the necessary infrastructure to handle claims.

133 For example, the UK - see the Nuclear Installations Act 1965: https://www.legislation.gov.uk/ukpga/1965/57

134 For example, see: 2004 amending Protocol to the Paris Convention, Art. 10 (c).

short term this solution is likely to be implemented in markets where insurance is insufficient to cover the full scope of bodily injury cover demanded by the revised Conventions.

This concept has much to recommend it owing to its simplicity; however, it will be considered by some as a retrograde step as state involvement will increase, but this increase could unlock greater private market participation in NTPL and state intervention has numerous precedents already in the field of NTPL cover throughout the EU. Risk-transfer insurers have argued for some time that the causality of possible claims that may arise during long prescription period make them difficult to insure[135] and the use of state indemnities will resolve this issue.

However, taking some elements of the cover back within the scope of state funding on an EU-wide basis is unlikely to be acceptable as it is likely to be considered state aid to the nuclear industry; thus, although simple, the research teams considers that the **introduction of this solution across all EU MS is <u>not an optimum solution</u> at present.**

6: Remove 10-30 year bodily injury prescription period extension from the Conventions altogether

Like the previous concept, this concept seeks to remove the most difficult element of the revised NTPL Conventions altogether, for the benefit of those insurers that are unwilling to cover it. This may not be justifiable on the whim of the insurers alone, as for purposes of clarity of outcome for accident victims it may be a concept to consider. Of course, extending the prescription period so that the latency of most cancers is included within it seems justifiable, but making a claim so long after the occurrence is unlikely to be legally simple, given the broad spectrum of possible causes of cancer ranging from diet and smoking cigarettes to radiation exposure. Insurers, through experience of asbestosis and other industrial diseases, have knowledge of such issues which is why they are reluctant to cover this aspect of the Convention. Removal of this aspect of the Convention will also benefit the operators by reducing their longer-term liability; also, with liability still extending to 10 years for all heads of damage, any inconsistencies of prioritisation of claims can be alleviated.

Any change of this nature to the NTPL Conventions will require protracted negotiation to achieve the agreement of all Convention parties; this renders the concept impractical.

This is a simple concept that would alleviate difficulties with the current regime for both operators and insurers; however, relieving operators and insurers of nuclear liability exposure is unlikely to receive the support of governments, lawmakers or the public. Also, the widespread and practical difficulties in effecting this concept's amendments to all the Conventions make it a too complex to consider.

With the legal changes required for this solution likely to be politically and practically challenging, the research team considers that the removal of the 10-30 year bodily injury exposure from the NTPL Conventions is <u>not an optimum solution</u>.

7: Adapt the Convention definitions of 'nuclear damage' through interpretation, by introducing a threshold or trigger for the attachment of financial security

Research for this study has illustrated that the introduction of a trigger to initiate some or all aspects of 'nuclear damage' will increase insurers' capacity provision[136]; triggers provide all types of insurers greater certainty as to when coverage attaches, which makes underwriting, reserving, loss settlement and claim payment all materially simpler. Calculation of capital requirements under the Solvency II regime also will be easier, because insurers and their actuaries can assess more easily the 0.5% event that will demand capital[137]. At present operators are liable for all nuclear damage, even that resulting from radioactive releases within authorised limits[138]. The few

135 See OECD NEA Nuclear Law Bulletin # 94: '*Challenges facing the insurance industry since the modernisation of the international nuclear third-party liability regime*' by Alain Quéré

136 See previous section 4.8 (page 29).

137 See technical annex 5 for more information

138 None of the Convention definitions of nuclear damage differentiates between damage caused by authorised discharges and that caused by unauthorised discharges.

qualifiers are that the damage must be caused by the radioactive properties of nuclear material that cause a nuclear incident and in the case of the revised Conventions, the environmental impairment element of damage must be significant[139]. Therefore, the concept of damage is quite open which leaves operators with uncertainty as to liability and financial security providers with difficulties in assessing their exposure.

The addition of a trigger point that establishes nuclear damage could be implemented in two different ways:

1. Amend the Conventions to re-define the attachment point of the operator's liability (and that of the financial security) for nuclear damage.
2. Introduce Guidelines to define more clearly the point at which nuclear damage is considered to have occurred[140.]

Both methods would open perhaps up to 50% more capacity for NTPL and simplify legal assessments of claims. Some mechanism for assessment of nuclear damage will be required anyway following an accident, because a judgement will need to be exercised in determining what is 'significant' environmental damage.

As a starting point for discussions on possible triggers for the attachment of the liability under the existing regimes the following values may be used:

- A radiation dose limit above which nuclear damage is considered to have occurred, such as using certain values provided in the Basic Safety Standards Directive (BSSD). For example, the lower limit of the EU BSSD range for reference levels for emergency exposure situations[141] (20 mSv individual dose), with the trigger being the received dose (not the projected one). In the negotiations for establishing such a trigger, the lowest limit already agreed within the range for reference levels could be presented as the common denominator.
- A background environmental radiation dose limit above which significant damage is considered to have occurred. For example, a specified mSv reading[142] above normal background radiation could be considered as a trigger by insurers.
- The implementation of protective measures[143] if there is an imminent threat to human health. For example, a civilian evacuation trigger point (i.e. a projected dose of 100 mSv in the first 7 days after the exposure). Most of the EU MS apply the international intervention criteria (established by the

139 See: 2004 Paris Convention Amendment Protocol Art. 1 (vii) 4 and 5 and 1997 Vienna Convention Revision Protocol Art.1 (k) (iv) and (v).

140 In line with the terms of reference for the study, the present study is looking at possible solutions to provide for increased coverage in the field of NTPL, including through the introduction of trigger mechanisms. However further implementation of any trigger mechanism will require substantial additional legal review.

141 EC Directive 2013/59/EURATOM (the BSSD), ANNEX I, Reference levels for public exposure as referred to in Articles 7: "*Without prejudice to reference levels set for equivalent doses, reference levels expressed in effective doses shall be set in the range of 1 to 20 mSv per year for existing exposure situations and 20 to 100 mSv (acute or annual) for emergency exposure situations...*" Why reference levels and not clearance levels? Clearance levels represent a value at or below which an individual source of radiation may be removed from regulatory control whereas reference levels are levels of effective dose or equivalent dose or activity concentration (projected or measured) received by the public above which it is judged inappropriate to allow further exposures to occur. Therefore, considering the objectives of these concepts (removal from regulatory control of a source vs. implementation of protective measures "towards public") as well as measurements techniques, the research team assessed that clearance levels are not suitable for this purpose.

142 For example, the UK guidelines for radioactively contaminated land (see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718848/RCL_Statutory_Guidance_Final_220618.pdf) indicate an amount of > 3 mSv above background radiation could be considered contaminated. An agreed amount of this type could serve as a trigger for insurance policy attachment.

143 The protective measures (e.g. sheltering, evacuation, relocation, iodine prophylaxis, etc.) are required to be taken if the projected (calculated) doses or the doses actually received following a nuclear accident are higher than some specific values above which negative health effects could appear (i.e. the intervention levels, given in IAEA Safety Standards Series No. GSR Part 7 "*Preparedness and Response for a Nuclear or Radiological Emergency*" General Safety Requirements, International Atomic Energy Agency, Vienna, 2015").

International Atomic Energy Agency[144]) however, it should be noted that some EU MS (the non-nuclear ones) might have lower criteria than the international ones.

The establishment of a trigger based on scientific rather than other criteria will have greater credibility and immutability; both these qualities will be necessary to ensure acceptance of the triggers by all stakeholders.

This concept could unlock hundreds of millions Euro of additional capacity for all aspects of the financial security requirements[145], if priced attractively. The 'specialism' of the NTPL financial security arrangements will also recede, so lowering barriers to entry and increasing capacity through competition.

The chief obstacle to the introduction of these triggers will be the likely inertia and delay in making what will amount to significant changes to all the NTPL Conventions. Instead standardised guidelines implemented in all EU MS could bring material benefits of clarification to the Convention Heads of Damage definitions; if trigger mechanisms were introduced without compromising the basic Heads of Damage coverage, materially more capacity will be released.

This solution could be implemented by the adoption of international or EU-wide 'Guidelines' that will guide courts and clarify when nuclear damage has occurred in the event of the discovery of a nuclear incident; these will need to be crafted to ensure Convention obligations are not contradicted and could be overseen and adjudicated by the establishment of an EU-wide (or national) Claims Commission(s), which would facilitate the settlement of claims based on the Guidelines. Some liability below the thresholds would be 'lost' from the financial security coverage, but this could remain as a manageable financial exposure for operators.

However, this solution will demand major amendments to all the NTPL Conventions that will require considerable work and will take decades; even a 'softer' approach such as the adoption of common guidelines would take some time. For this reason, the research team considers **this solution is not an optimum solution. Nevertheless, triggers can serve to sub-divide liability amongst capacity providers; this concept is investigated further in section 6.1 of this study.**

5.4.2 INSURANCE MARKET SOLUTIONS

8: Facilitate the 1st tier financial security amount under the revised Paris Convention, or the revised Vienna Convention full amount, to be funded jointly by insurers and operators, like the US Industry Credit Rating Plan (ICRP) system

In the USA, despite fears about the adversarial legal system, NTPL coverage is offered by insurers for the required financial security amount ($450 million) and for the full scope of cover required[146], including claims made from incidents that may have occurred decades ago. The local insurers are represented by American Nuclear Insurers (ANI), the domestic nuclear insurance pool, which considers that the legal framework in the USA leaves insurers mainly exposed to 'catastrophic' losses only. The US NTPL framework has many unique features that result in it offering the highest financial security globally, when all the financial components are combined. This concept is designed primarily to increase insurer capacity provision by providing a buffer against certain losses that would

144 IAEA Safety Standards Series No. GSR Part 7 "*Preparedness and Response for a Nuclear or Radiological Emergency*" General Safety Requirements, International Atomic Energy Agency, Vienna, 2015.

145 The anecdotal experience in one EU MS is instructive. In the last decade risk-transfer insurers resisted covering the environmental and preventive measures heads of damage introduced in the revised Conventions, on the basis that the new heads of damage were too open. The insurers eventually took comfort from the guidelines that would be used to clarify nuclear damage for the courts; for example significant environmental damage was indicated to be when contamination was *X* mSv in excess of background radiation; loss of income from environmental damage could only be awarded for those *directly* affected and preventive measures could only be initiated by *statutory regulations* that qualify emergencies. The situation is that now, in 2019, none of the risk-transfer insurers has any difficulty with the environmental heads of damage.

146 The US NTPL policy scope of cover (the Facility Form) is limited to bodily injury or offsite property damage caused by nuclear material at a site or in transit to/from a site. Property damage includes environmental damage, but the cover generally excludes clean up arising from any government orders or directives. Radiation cover for workers on site is covered by a separate Facility Workers' policy. Cover under the policy is restricted to claims made up to 10 years after the accident; however, if an older claim materialises it is met out of the collected capacity made up of each of the previous 10 years' nuclear pool syndicates.

be allocated, by mutual agreement, to a fund that would build up to cover NTPL claims from all sources. The early stages of this fund's development would be the most challenging moment, but with political support such obstacles could be overcome. In the USA the fund now covers at least two losses and the insurers feel comfortable that their exposure is more distant from the difficult losses.

This solution would require agreement between operators and their insurers on a reallocation of exposure, leaving insurers with the largely catastrophic exposure; otherwise it appears to require minimal legal change and therefore can be recommended as a solution that is practical, achievable and that would encourage greater capacity provision.

This solution is analysed in more detail in the next section as a viable solution for the EC to consider.

9: Ensure all insurance policies offered single, lifetime limits for all insured sites

A key but apparently voluntary aspect of the insurance policy language is the lifetime limit of exposure and the previous section demonstrates that this is a material constraint on current NTPL capacity. Within the EU MS and indeed globally there is not consistency of temporal exposure accumulation, yet the Convention language is silent on this. If all EU MS insurers adopted at least a lifetime limit, perhaps also with clear reinstatement of cover conditions[147], there would be consistency in this respect; it is anticipated that this would immediately allow increased capacity commitment in some EU MS that currently don't have such policy limitations.

This solution is entirely achievable within the insurance market; the only material obstacle could be anti-trust issues, as ideally the insurers would need to cooperate to ensure this change is managed consistently.

Given its simplicity, **this solution is analysed in more detail in the next section as a viable solution for the EC to consider.**

10: Total homogeneity for scope of cover, financial security limits, policy language and reinstatement provisions; develop a standardised insurance policy for the EU.

In the 1950s, when the insurance market originally considered insuring nuclear risks, widespread insurer participation in the nuclear insurance pools was materially greater than today; typically, most non-life insurers participated knowing that the radioactive contamination exposure had all been channelled via the operator to the nuclear insurance pool. With the nuclear exposure removed from all domestic motor, homeowners and commercial polices, insurers provided small amounts of net-line capacity to the national insurance pools almost as a duty. This solution could range from a step further towards greater NTPL market integration than the previous solution, to creating a compulsory, full scope standardised NTPL insurance product[148] with participation by all general insurers in the market for a net line share across all EU MS. Such changes would achieve equality of cover throughout the EU, but inevitably agreeing on the scope of cover and policy design would be complicated and the final product may be based on the lowest common denominator of acceptability; moreover this solution would demand substantial legal changes[149] to enforce the mandatory elements of the proposal. Therefore, a standardised insurance cover, mandated throughout the EU would be more successful as a final step once the legal framework and nuclear regulatory environment were homogenised throughout the EU. If implemented, the benefits of standardised insurance policies would be more transparency of product and pricing for the operator clients, more certainty of outcome for all EU NTPL capacity providers and greater clarity for potential claimants anywhere within the EU. The disadvantages would be a loss of competitiveness in the insurance market for NTPL products and conceivably a reluctance from some insurers to participate in such a regulated market.

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147 For example, a single, annually 'rolling' policy could cover the lifetime of a nuclear facility; it could incorporate an automatic reinstatement for any undamaged units on a site with only the site suffering the loss being subject to claims assessment, payment & negotiation on any reinstatement of cover.

148 Such a standardised policy could provide: a single lifetime aggregate limit, agreed reinstatement terms for undamaged sites, scope of cover negotiated to a standard level (e.g. the full scope of the revised Conventions?), standard conditions, exclusions and other terms, even standardised premium rating.

149 It is envisaged that legislation would be necessary to enforce insurers to participate in providing compulsory nuclear cover on a standardised form, in return for the continuation of the radioactive contamination exclusion clause.

Ultimately markets could go a step further by mandating all non-life insurers to cover the radioactive contamination hazard in their normal policies on a standardised basis; this would remove the need for a specialist nuclear market altogether and would spread the exposure across all insurers, in a similar way to how catastrophe events are covered today. However, specific difficulties (such as the 10-30 year exposure for bodily injury) could remain and of course such arrangements would be contrary to the Convention principle of exclusive liability of the operator, which is already fully established in the national legislations of those EUMS with NPPs.

This concept is practical if associated with other standardisation measures, such as a harmonised NTPL regime, a harmonised insurance regulatory regime and an EU-wide nuclear regulatory regime. Standardisation, whether compelled or voluntary, will offer victims, operators and capacity providers a simple and clear framework for NTPL cover and compensation; the practical obstacles increase as the reach of standardisation increases. However, any effort at harmonisation needs broad political support to succeed; such support is not certain within the EU MS for subjects as contentious as nuclear.

With the legal changes that will optimise this solution likely to prove challenging, the research team considers that greater NTPL insurance policy standardisation across the EU is not an optimum solution at present.

11: Increase materially the use of mutualisation

Currently the mutual insurers are the principal providers of capacity for the full scope of the revised NTPL Conventions; therefore, it is logical to look at extending the mutual insurers' capacity as much as possible, to allow at least cover for the full scope of the Conventions up to €1.2 billion. Such expansion of capacity could be achieved through the greater use of traditional risk transfer reinsurance, new mutual solutions and the use of new markets; it also does not require any legal changes, being an insurance market led solution.

Given its obvious lack of complexity and legal complications, this solution is analysed in more detail in the next section as a viable solution for the EC to consider.

12: Change the insurance policy from a 'losses occurring' to a 'claims made' basis

These two insurance terms are described in **Technical Annex 6** and this concept is considered in the context of trying to increase capacity for the full scope of the Conventions and specifically for the extended period to bring a claim from 10-30 years.

Unfortunately, while helpful to the risk-transfer capacity providers, informal research amongst regulatory bodies suggest changing insurance policies to a claims-made basis will make them unacceptable as financial security. Nevertheless, claims made policies are now common in the insurance market and an understanding of this concept is important; a full description is provided in **Technical Annex 6**.

With likely rejection as non-compliant with NTPL Convention treaty obligations, the research team considers that introducing a claims made policy wording across all EUMS is not an optimum solution at present.

5.4.3 NEW PRODUCT SOLUTIONS

13: Create a new, catastrophe only, EU wide, single event, excess layer of insurance above the current legal regimes, provided by either or both operators and the insurers

This concept will maintain all the current legal frameworks and financial security amounts at national EU MS level. Above this the EC will mandate a new obligatory financial security limit for all nuclear damage, with specific triggers initiating cover. This will be designed to provide a consistent amount of cover up to a new level (e.g. €2.5 billion, €5 billion or more); this will offer both more and a consistent level of capacity across all EU MS. It can be provided either on a site-specific basis (with a single loss limit) or could cover all EU MS nuclear sites with one or two losses covered annually, to reduce costs. There are many variants to this concept, and it could be layered to offer different stakeholders the opportunity to participate.

There are some legal obstacles to such an arrangement, to ensure it fits around the various current regimes in force within the EU MS, not least a mechanism to enforce purchase of the additional financial security in each EU MS (or maybe from the EC). Despite these obstacles, a variant of this solution could deliver material

additional, full-scope NTPL capacity to either operators or state entities within the EU from private capital sources – thus fulfilling many of the objectives of this study.

This solution is analysed in more detail in the next section as a viable solution for the EC to consider.

14: Establish an EU-wide Protection Gap Entity

Protection Gap Entities (PGE) bring together market and non-market stakeholders to address significant protection 'gaps'; the term 'insurance protection gap' refers to the gap between the insured and actual economic losses caused by large-scale catastrophic events, as observed with the Fukushima accident and subsequent claims. The broad objective of PGEs is to transform uninsured risk into insurance-based products that can be transferred into global financial markets to provide capital for recovery following a disaster. In the nuclear sector, a PGE could act as an aggregator of several of the initiatives outlined elsewhere in this list of possible solutions, offering multiple stakeholder involvement to provide materially higher financial security limits with the exposure 're-packaged' and allocated to the most suitable and willing capacity provider.

PGEs have been established elsewhere successfully[150] and there is already considerable research into and interest in their development. Governments are looking at PGEs as a mechanism to bridge the gap between the state and the private markets to ensure all aspects of difficult risks and exposures can be optimally covered.

This solution is analysed in more detail in the next section as a viable solution for the EC to consider.

5.4.4 SUPPORT FOR NEW SOLUTIONS

The existing capacity providers were also asked under what circumstances they would consider providing capacity to new concepts outside of the current and proposed NTPL Convention arrangements. The objective of asking this question was to establish the circumstances which could allow capacity providers to consider concepts to increase capacity that might not be compliant with the existing or revised legal framework; for example liability cover initiated by a trigger rather than the existing strict and absolute liability. A summary of the responses is shown in Table 11. Those that would consider concepts outside the existing legal regime either wanted to see each offer individually or for there to be an equivalent legal arrangement that regulated the cover; some respondents were unsure of what might be offered or didn't comment (this is understandable given the open nature of the question) and some stated that under no circumstances would they look at new concepts outside of the existing legal arrangements. Overall the responses indicate that there is some appetite amongst some capacity providers to consider new concepts that are not strictly compliant with the existing legal framework, if any new concept also contains clear legal parameters.

[150] For example, The Caribbean Catastrophe Risk Insurance Facility (see: https://www.ccrif.org/)

Table 11: Capacity outside the current legal framework

Type of capacity provider	Would consider case by case &/or with legal framework	Unsure or no comment	Under no circumstances would consider new concepts
Nuclear Pools (EU)	***5***	***5***	***4***
MGA	***1***	-	-
Mutuals	-	***1***	-
Captive	***no response***	***no response***	***no response***
Op. Pooling	***n/a***	***n/a***	***n/a***

Some capacity providers have already explored new concepts outside the legal framework[151] and, given the known constraining factors around the revised Convention language, it is probable that more of the current reluctant risk-transfer markets may support a much simpler cover with a trigger, designed to sit outside the current regime.

5.4.5 LEGAL CONSIDERATIONS WITH REGARD TO THE SOLUTIONS SELECTED FOR FURTHER REVIEW

The main objective of this study can be captured in the following three questions:

1. Is there enough capacity in the market today to allow a significant increase of the financial security amount for NTPL?
2. Under what conditions could this capacity already available easily be released? Under what conditions could additional capacity be released?
3. Is there a mechanism or a scheme which would allow this release without a substantial increase in costs for the operator (i.e. electricity consumers)?

These three questions are answered in this study from the perspective of insurance and capital markets capabilities and mechanisms; in addition, the aim has been to avoid solutions which will require changes to the revised NTPL Conventions, or that will impede their ratification.

The research conducted by the team and the outcome of a workshop held during the research confirmed that there are positive answers to all three questions above:

- There is substantially more capacity on the market than currently demanded (the maximum calculated available capacity is €2.3 billion);
- There are methods that could provide for higher capacity, in addition to the capacity already available on the market;
- There are mechanisms which could deliver such additional capacity without substantially increasing the costs of NTPL financial security for the operators.

151 See content from: '*Taking nuclear third-party liability into the future; Fair compensation for citizens and level playing field for operators*.' A conference co-organised by the European Commission (DG ENERGY), the European Economic and Social Committee (EESC) and the Brussels Nuclear Law Association (BNLA). At this conference, some insurers presented the case for a 'catastrophe only' NTPL product, similar to that described in this study. Two of the main insurers involved in that work also contributed to this study.

Within the study's Terms of Reference, specific objectives D and E further requested an assessment of the relevance and effectiveness of the solutions. Hence, the Team has assessed the possible legal implications of the identified solutions and made this one of the criteria for their prioritisation.

The conclusion of this high-level legal analysis was that most of the solutions (insurance market changes and new products) could be implemented without the need to employ creative interpretations to circumvent the international NTPL regimes (in particular the definitions of the "nuclear damage" and "nuclear incident"), as the NTPL Conventions allow the state parties to choose the most appropriate mechanism to implement their financial security[152].

However, a more important conclusion was that the effectiveness of the proposed solutions could be maximised if they were implemented on an EU-wide level (or at least in all EU MS with NPPs). To achieve this there needs to be a legal intervention by the EC (or by the individual EU MS in unison) to cover all NPPs that will enforce one or all the following points:

- Increase the required amounts of financial security across the EU or all EU MS with NPPs;
- Require the operators and/or states with NPPs to buy additional financial security;
- Establish a supranational Protective Gap Entity (one of the solutions *per se*, not a prerequisite for other possible solutions) to implement and oversee the EU NTPL framework.

In fact, it was established that the lack of a real EU-wide nuclear third-party legal framework (in particular the wide range of financial security amounts) is probably the greatest obstacle to introducing of the various models and mechanisms for both using and increasing the existing capacity.

Although the research team was not mandated to elaborate the legal grounds and procedures for embedding these solutions in the EU legal framework, it did identify several avenues for such action.

The solutions mentioned above could be introduced by using the following legal interventions:

a) Adoption of a Directive based on Article 98 of the Euratom Treaty:
"*Member States shall take all measures necessary to facilitate the conclusion of insurance contracts covering nuclear risks.*
The Council, acting by a qualified majority on a proposal from the Commission, which shall first request the opinion of the Economic and Social Committee, shall, after consulting the European Parliament, issue directives for the application of this Article."
b) Legal action based on Article 203 of the Euratom Treaty:
"If action by the Community should prove necessary to attain one of the objectives of the Community and this Treaty has not provided the necessary powers, the Council shall, acting unanimously on a proposal from the Commission and after consulting the European Parliament, take the appropriate measures."
Here the question is less about the legal interpretation, rather it is about building up the political readiness to accept such an initiative.
c) The EC recommends to EU MS with NPPs to adopt nationally new limits and mandate the purchase of financial security to cover them.

It seems that a NTPL regime on an EU-wide level is the best way to achieve wide-ranging protection of potential nuclear accident victims and to ensure resources are available for their compensation and associated claims

[152] PC, Article 10 a) "To cover the liability under this Convention, the operator shall be required to have and maintain insurance or other financial security of the amount established pursuant to Article 7 and of such type and terms as the competent public authority shall specify...."; 2004 RPC, Article 10 a) "To cover the liability under this Convention, the operator shall be required to have and maintain insurance or other financial security of the amount established pursuant to Article 7*(a)* or 7*(b)* or Article 21*(c)* and of such type and terms as the competent public authority shall specify... "; VC, Article VII 1) "The operator shall be required to maintain insurance or other financial security covering his liability for nuclear damage in such amount, of such type and in such terms as the Installation State shall specify..."; 1997 VC, Article VII 1) "The operator shall be required to maintain insurance or other financial security covering his liability for nuclear damage in such amount, of such type and in such terms as the Installation State shall specify..."

management, which is arguably the greatest deficiency of the current legal patchwork. Until now the political will for such changes has been lacking; however, the interest demonstrated for this topic should not be disregarded. A recent study commissioned by the Policy Department for Citizens' Rights and Constitutional Affairs of the European Parliament states the following: "*Extensively interpreted, the obligation of Member States arising from Article 98(1) of the Euratom Treaty entails both the obligation to abolish any barriers with respect to the conclusion of insurance contracts to cover nuclear risks and the obligation to establish a nuclear liability legal framework. This is in line with two recommendations: Commission Recommendation 65/42/Euratom and Commission Recommendation 66/22/Euratom advocated a tendency to a broader interpretation, enabling the Commission to use Article 98 not only for insurance matters, but also in a more extensive manner*. "[153]

5.4.6 REVIEW OF THE SOLUTIONS SELECTED FOR FURTHER REVIEW

In this section a range of new solutions that could deliver this study's objectives have been reviewed. Not all are practical or realistic in the short term, nor within the current competence of the EC; therefore, some have been rejected whereas others will be subject to further analysis. Table 12 below shows a summary of those solutions selected for further review in the next section.

Table 12: List of new solutions selected for further review

#	Description	Category
8	RPC 1st tier amount or RPC full amount funded as USA for all EU MS	Insurance market changes
9	All policies have single, lifetime limits	Insurance market changes
11	Increase mutual participation with new mechanisms for reinsurance	Insurance market changes
13	Catastrophe only, EU wide, single event, cover excess of the current legal regimes	New product
14	Establish EU wide Protection Gap Entity	New product

153 Cross-border nuclear safety, liability and cooperation in the European Union, February 2019, Page 79, see: http://www.europarl.europa.eu/RegData/etudes/STUD/2019/608860/IPOL_STU%282019%29608860_EN.pdf

6 IDENTIFYING THE OPTIMUM NTPL ARRANGEMENTS FOR ALL STAKEHOLDERS

In the Inception Report for this project, the research team outlined the assessment criteria to be used when considering future options to increase NTPL capacity; the matrix proposed at that stage will be used without material amendment to review the new solutions described in the previous section.

In this section each of the new concepts/solutions selected will be described and assessed against the following criteria:

Criterion	Comment
Scope of cover	Will the solution provide the full scope of cover to include all HoDs and prescription periods as required under the revised Conventions?
Capacity	Will the solution provide material additional capacity for NTPL, so distancing governments and taxpayers further from financial loss caused by a nuclear accident?
Geographical scope	Will the solution provide the same cover/capacity in all EU Member States, whether they have NPPs or not?
Practicality	Will the solutions present any practical obstacles to its introduction?
Cost	Will the NTPL solution(s) identified be affordable for the nuclear industry?
Legal framework	Will the NTPL solution(s) identified require changes to the current national and/or international legal framework?

8: Facilitate the 1st tier financial security amount under the revised Paris Convention, or the revised Vienna Convention minimum amount, to be funded jointly by insurers and operators, similar to the US Industry Credit Rating Plan (ICRP) system

Rationale

In the USA, despite insurer perceptions of an adversarial legal system, NTPL coverage is offered by insurers for the required financial security amount ($450 million/€402 million)) and for the full scope of cover required, including claims made from incidents that may have occurred decades ago. The local insurers are represented by American Nuclear Insurers (ANI), the domestic nuclear insurance pool, which considers that the legal framework in the USA leaves insurers exposed to 'catastrophic' losses only. From the insurance perspective, there are two features that contribute to make the exposure of the insurers largely catastrophe only:

1. The common occurrence exclusion: this exclusion features on all NTPL site insurance policies and limits any NTPL common occurrences[154] to a single $450 million exposure, no matter how many sites are

[154] A common occurrence is defined in the US standard NTPL insurance policy as: *"Any occurrence or series of occurrences resulting in bodily injury, property damage or environmental damage arising out of the radioactive, toxic, explosive, or other hazardous properties of*

(a) nuclear material discharged or dispersed from the facility over a period of days, weeks, months or longer and also arising out of the properties of other nuclear material so discharged or dispersed from one or more other nuclear facilities insured under any Nuclear Energy Liability Policy (Facility Form) issued by Nuclear Energy Liability Insurance Association, or

(b) source material, special nuclear material, spent fuel, waste, or tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content in the course of transportation for which this insurance is afforded under this policy and also arising out of such properties of other source material, special nuclear material, spent fuel, waste, or tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content in the course of transportation for which this insurance is afforded under one or more other Nuclear Energy Liability Policies (Facility Form) issued by Nuclear Energy Liability Insurance Association,

shall be deemed a common occurrence resulting in bodily injury, property damage or environmental damage caused by the nuclear energy hazard."

involved in a generic (i.e. multi-site) loss scenario. This restricts insurers' exposure materially and ensures that similar claims occurring across multiple sites can only cost insurers up to one full limit[155].

2. The Industry Credit Rating Plan (ICRP): this scheme allocates about 75% of each NTPL site policy premium to an operator owned fund, with the residual 25% premium and the fund investment income passing to the insurers. The 75% of premium is accumulated and retained to meet any claims for 10 years after the policy inception date; at the end of that period the loss-free element of the fund is returned proportionately to the operator(s). With all the policy premiums in the fund, the total amount retained now exceeds the $450 million policy limit, so ensuring enough funds are available to meet at least one single site loss and its associated costs[156]. The fund is intended for non-catastrophic events and is not required by the US Price Anderson Act legislation; however, it does offer insurers the comfort of knowing any claim (but in particular any non-catastrophic claim as responding to these is its primary purpose) is already fully funded for at least one full site limit.

These two features effectively leave insurers with catastrophic loss exposure only, as the first claim will draw on the ICRP fund and if a claim arises from some generic issue and involves multiple sites, it is likely to be excluded by the common occurrence clause. With no temporal restriction on the liability exposure and equivalent full scope cover, other than the common occurrence exclusion, the US insurance arrangements are oversubscribed. Could some of these arrangements be transplanted to the EU MS, so providing more capacity?

Informal discussions with regulatory bodies suggest that a common occurrence definition would disqualify a financial security product from acceptance under the Paris/Vienna regime, as the liability for the operator is absolute and anything excluded by the insurers will remain the operator's liability (as is the case in the US); therefore, its introduction in Europe would be a unilateral act by insurers, leaving the residual exposure with the operators, and one that would increase insurance capacity at the cost of removing exposure and reducing full-scope risk-transfer insurance coverage. This is probably an unsatisfactory trade-off. However, the ability to build up funds in a joint exercise between operators and insurers will increase capacity over time and will offer a fund to pay for non-catastrophic losses to an agreed definition between insurers and operators. Capacity will increase because the fund will act as a buffer against insurers paying out immediately for certain types of claims.

The Conventions make it clear that each incident must be covered by financial security[157]; however, this language may offer relief from requiring the accumulation of funds to cover financial security for each site operated by multi-site operators. This would make this solution more palatable to operators such as EdF, which operates over 70 reactors across its sites in France and the UK. For example regulators may take the view that if EdF accumulated funds to cover at least two financial security amounts in each territory, this would be viewed as sufficient. Although restricting the amount of financial security required for multi-site operators in this way may appear non-compliant with the Convention obligations, there is some precedent already for offering more favourable financial security requirements for these sites[158]. This would imply there is an acceptable maximum number of full amounts of financial security and associated accumulated funds for multi-site operators.

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155 This means that any common cause occurrence across several sites will only be to claim for up to a single, full site limit (of $450 million in the US); the residual liability excess of this amount reverts to the operator.

156 In the USA NTPL arrangements, costs and expenses are included within the primary financial security limit of $450 million; this contrasts with the position under the Vienna/Paris regimes, where costs are not included in the financial security requirement and can be insured separately.

157 For example, see 2004 Protocol amending the Paris Convention, Art. 7 (a).

158 For example, see the UK's Nuclear Installations Act 1965 Sect.19.2E (http://www.legislation.gov.uk/ukpga/1965/57/section/19). Under the proposed revisions to the Act (to accommodate the changes to the Paris Convention introduced by the 2004 protocol), this section allows operators with more than 2 sites to hold only 2 financial security limits, no matter how many sites they have. Therefore, EdF operating 7 sites in the UK will only be obligated to provide for 2 financial security amounts.

Assessment

Criterion	Comment
Scope of cover	If fund accumulation was permitted by regulators and tax authorities, then the scope of liability covered by the fund could be negotiated between operators and insurers. This would allow the currently difficult elements within the RPC/RVC scope of cover to be covered by the fund by mutual agreement, so relieving insurers from immediate potential losses. This will encourage capacity commitment for the full scope of the revised Conventions, once the fund claims have been defined and priced to mutual agreement.
Capacity	Increased certainty of loss patterns will allow more capacity to develop over time.
Geographical scope	Permission to build up NTPL claim funds at a site or an operator level will apply to whatever Convention a country has ratified. Therefore, this arrangement does not impact the geographical scope in any way.
Practicality	There seem few practical problems with this concept as it largely depends on negotiations between operators and insurers[159], having established that tax-free funds can be built up. The funds would be built up by taking a fixed proportion of each operator's NTPL premium, therefore the relative lack of operator homogeneity in Europe (unlike the USA) should not be a problem; however the concept would be much easier to operate if a common financial security amount was agreed across all EUMS. The likely issue is during the early years, when funds allocated for the difficult aspects of cover will not cover the full financial limit; this may put off potential new insurers.
Cost	This concept will not see material premium changes, but with part of the premium being placed into a fund that could see refunds to operators in the event of no claims, overall the cost to operators would be less. The insurers gain a buffer against immediate loss payment, as the fund would meet claims and a closer working relationship with their clients, as they will co-manage the fund and any claims.
Legal framework	Subject to there being no restriction on building up NTPL loss funds free of tax, there are no other major legal obstacles. The arrangement to fund claims will be subject to private agreement between operators and insurers as to the allocation of liability, with total liability being unchanged. The arrangement will work with whichever Convention the EU MS is a party to.

Overview

This concept is designed primarily to increase insurer capacity provision by providing a buffer against certain losses that would be allocated, by mutual agreement, to the fund. The early stages of this fund's development would be the most challenging time, but with political support such obstacles could be overcome. In the USA the fund now covers at least two losses and the insurers are comfortable that their exposure is more distant from the difficult losses and will be focused on catastrophe events. Any legal concerns about the quality or depth of the financial security should be allayed because the allocation of liability between operators and insurers can be a private matter, with an associated financial cost allocation that could reduce premium for operators.

9: Ensure all insurance policies offer single, lifetime limits for all insured sites

Rationale

Some EU MS insurance providers already offer insurance policies that have a single, underlying time limit for the monetary exposure, but not all do. The research identified that greater capacity would be available from the risk-transfer markets if each NTPL site policy contained a single financial limit that is aggregated over the period of operation of the nuclear site[160]. Table 13 below indicates which capacity providers globally provide insurance

[159] In the USA the fund is not a requirement under the Price Anderson framework; it is a voluntary arrangement between insurers and operators.

[160] For example, this concept was considered essential for NTPL underwriting in the 1957 Report of the Advisory Committee to the British Insurance (Atomic Energy) Committee (BI(AE)C), the forerunner of the UK nuclear insurance pool. In part II, section 114 (e) of the study the following is noted: "*The limit of indemnity should apply to all claims aggregated over the period of operation of the*

policies with an aggregate time restriction to the limit of indemnity – either for the lifetime of the reactor or for some other specified period, such as an operating license period. It also shows the response when capacity providers were asked whether more capacity would be available if such an aggregate limit was introduced. Lastly, the table shows to which Convention each country is a party to; this shows that there are apparently no legal challenges to introducing this change, given the random selection of countries with such a limit.

Table 13: The spread and impact of a single long-period limit for the financial security amount

Type	NTPL capacity provider	Long-term single period for FS indemnity amount	More capacity if such single limit introduced?	Convention
RISK TRANSFER (incl Non EU)	BE POOL	NO	NO	PC/BSC
	BG POOL	NO	NO	VC/JP
	CZ POOL	NO	YES	VC/JP
	DE POOL	YES	UNSURE	PC/BSC/JP
	ES POOL	NO	YES	PC/BSC
	FI/SE POOL	NO	YES	PC/BSC/JP (both)
	FR POOL	NO	UNSURE	PC/BSC/JP
	HR POOL	NO COMMENT	NO COMMENT	VC/JP
	HU POOL	NO	NO	VC/JP
	NL POOL	NO	NO	PC/BSC/JP
	RO POOL	YES	UNSURE	VC97/CSC/JP
	SI POOL	YES	UNSURE	PC/BSC/JP
	SK POOL	NO	NO	VC/JP
	UK POOL	YES	YES	PC/BSC
	CH POOL	YES	UNSURE	PC04/BSC
	CN POOL	NO COMMENT	NO COMMENT	NONE
	JN POOL	YES	UNSURE	CSC
	US POOL	YES	YES	CSC
	MGA	YES	UNSURE	ANY
SELF INSCE	MUTUALS	YES	NO COMMENT	ANY
	CAPTIVES	NO COMMENT	NO COMMENT	N/A
	OP.POOLING	N/A	N/A	CSC (US)/PC (DE)

reactor, i.e. there would be no reinstatement of the limit of liability either after an accident or at the renewal date, except by agreement". This restriction remains in place today in the UK and in many other countries similar restrictions apply; see Table 13. Is the exclusion of reinstatement after an accident in compliance with the Conventions? A reinstatement is not excluded, it is just not universally available without agreement. In effect this gives the insurers an opportunity to discuss terms for cover reinstatement, which is normal insurance practice. It is understood that most NTPL insurance policies are silent on reinstatement cover or terms.

Assessment

Criterion	Comment
Scope of cover	This concept will not change the current situation with the scope of cover; therefore, reluctance of the majority of the risk-transfer market to commit capacity to the full scope of the revised Convention language will remain.
Capacity	The table above indicates that both insurance (from domestic policy issuers) and reinsurance (reciprocal risk exchange amongst insurance pools) capacity will increase immediately for those countries that currently don't have this policy limitation.
Geographical scope	This concept can be described as a tidying up exercise by insurers; with the variety of Conventions shown in the table above and no other obvious restrictions, this concept does not appear to have any geographical restrictions.
Practicality	This concept is largely an internal matter for the insurance and reinsurance market; there appear to be no obstacles to its introduction. Certainly where the concept is new, it will need careful explanation to the clients and the cover reinstatement by agreement only will need to be highlighted, but the issue of reinstatement of cover is one that the insurers should anyway discuss and clarify with the operators.
Cost	There is likely to be some cost reduction for those sites with annual limits.
Legal framework	This concept is not apparently ruled out by the NTPL legal framework; however, as the concept is assumed to be an internal matter for the insurance market, it will be important for both insurers and regulators to continue rigorous self-assessment for competition compliance to ensure that any additional cooperation amongst insurers resulting from implementing this concept is clearly understood and accepted as beneficial to consumers and the general public. If the insurers do not readily act to harmonise their policies with this concept, the Euratom Treaty Article 98[161] could be used to mandate such a change.

Overview

This concept will provide greater amounts of capacity from the risk-transfer market as it removes one of the key constraints on capacity, although it will not relieve the shortage of capacity for the full scope of the revised NTPL Conventions. There are no apparent legal, geographical or practical obstacles in the way of its introduction, and it is a change which could easily be incorporated by those insurers that do not offer it yet; therefore, it could easily be introduced across all EU MS.

11: Increase materially the use of mutualisation

Rationale

Currently the mutual insurers are the principal providers of capacity for the full scope of the revised NTPL Conventions; therefore, it is logical to look at extending the mutual insurers' capacity as much as possible, to provide at least cover for the full scope of the Conventions up to the revised Conventions' new minimum financial security amounts.

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161 Article 98 of the Euratom Treaty states: '*Member States shall take all measures necessary to facilitate the conclusion of insurance contracts covering nuclear risks*'; see https://www.consilium.europa.eu/media/29775/qc0115106enn.pdf

Assessment

Criterion	Comment
Scope of cover	The mutual insurers already provide the full scope of NTPL cover required by the revised Conventions; the purpose of increasing the mutualisation element of the insurance mix will be to extend this scope of cover to the full amount of financial security required.
Capacity	Using alternative reinsurance arrangements will allow enough capacity to cover the current site financial security amounts in full.
Geographical scope	The current geographical scope will not be altered by the use of more mutual capacity, as the mutuals are licensed to operate in all EU MS.
Practicality	Increasing the mutuals' capacity requires (i) greater insurance premium income underwritten (i.e. more mutual insurance purchased by operators) and/or (ii) extension of the mutuals' reinsurance arrangements. The former will allow the insuring mutual to offer more of its own capacity to operators and the latter will permit more gearing by greater use of the reinsurance markets. Increasing reinsurance will yield more immediate capacity; however, most reinsurers in the normal risk-transfer reinsurance market are reluctant to offer capacity for the long prescription periods (see section 5 for details of the capacity constraints), therefore they may not be able to offer material additional capacity. Instead, the mutuals will need to look to alternative markets; this will require a re-packaging of the exposure to make it more suited to the wider capital markets[162] and will require the creation of funds that can respond to losses; in the short term any shortfall of this funding can be protected by a financial insurance product[163].
Cost	Mutualisation offers material cost benefits to operators, as there is no need to generate profit for third-party (i.e. insurance company) shareholders; however increased reinsurance or retrocession capacity will add cost to operators. In time these costs will reduce, and funds could be built up sufficient ultimately to provide insurance at zero cost (if no losses occur). Also any financial obligations presented by a larger mutual will fall most heavily on the EU's dominant reactor operator in the EU (EdF).
Legal framework	There are no immediate legal implications if the expansion of mutual capacity is used to complete the full scope financial security requirements of the amended Conventions.

Overview

Increased mutual capacity within the existing NTPL framework offers a quick solution to fulfil the scope of NTPL cover required by the revised Conventions; there are no material legal obstacles and capacity provided by mutuals will be cheaper and probably more acceptable to the operators over time. Hitherto, the growth of the mutuals has been modest because of both limited member support and limited reinsurance cover[164]; however, more reinsurance could be accessed using new markets which will generate greater member support as the risk exposure is reduced through transfer to reinsurance markets. If the operators are required to participate in a new pooling arrangement excess of the current Convention financial security amounts, their exposure to a nuclear accident from such a scheme will accumulate with their mutual insurance obligations, which may discourage their desire to take on more exposure. The significant unknown is obtaining enough additional capacity to fulfil the financial security requirements; given the appetite amongst capital market players for new, non-correlating risk and with an innovative approach to securing the retrocession capacity for the mutuals, a

162 See Technical Annex 4 for more detail.

163 For example, the mutual reinsurer could take out a funded retrocession cover that would demand both a premium and a contribution to a fund that pays losses. The ultimate objective of the fund is to cover one (or more) full claims under the retrocession arrangement; if a claim occurs before the funds are sufficient, a separate product to protect any shortfall can be purchased from the financial product insurance markets, as the risk is no longer a nuclear risk, but a financial credit risk (i.e. a shortfall in funding). These products are already used for (e.g.) environmental bonds.

164 See Technical Annex 1 for more detail.

durable partnership between operators, their mutual and capital market capacity will quickly permit coverage for the full scope NTPL capacity as required by the revised Conventions.

13: Create new, catastrophe only, EU-wide, single event, excess layer of insurance outside (i.e. above) the current legal regimes, provided by either or both operators and insurers

Rationale

The gap between the nuclear damage compensation paid and the available financial security following the Fukushima accident has illustrated the inadequacy (except perhaps in the USA) of the global financial security amounts; within the EU only Germany can offer a financial security amount of more than €1.2 billion. A key objective of this study is to identify whether new capacity can be made available for NTPL. With the capacity constraints identified, the solution to unlocking greater capacity lies in adding triggers to or sub-dividing the liability obligations to allow new capacity to participate on a different basis – perhaps alleviating the constraints presented by the revised NTPL Conventions.

This is not as simple as it sounds, as the Conventions are not just about setting minimum financial security limits; they also describe and allocate liability for nuclear damage independent of the amount of financial security. Therefore, this concept may need to disentangle itself from certain aspects of the NTPL Conventions, allowing loss events defined by triggers or financial limits to be developed that will attract maximum capacity from new markets.

In its simplest form this concept's objective is to offer substantial new, unconstrained capacity for a single, defined catastrophic occurrence, covering all EU NPPs, during one calendar year. Technical Annex 4 describes the structure of this type of product in more detail, but it is likely that capacity will grow once markets become familiar with the NTPL exposure. Figure 1 below shows a possible, basic structure for this concept.

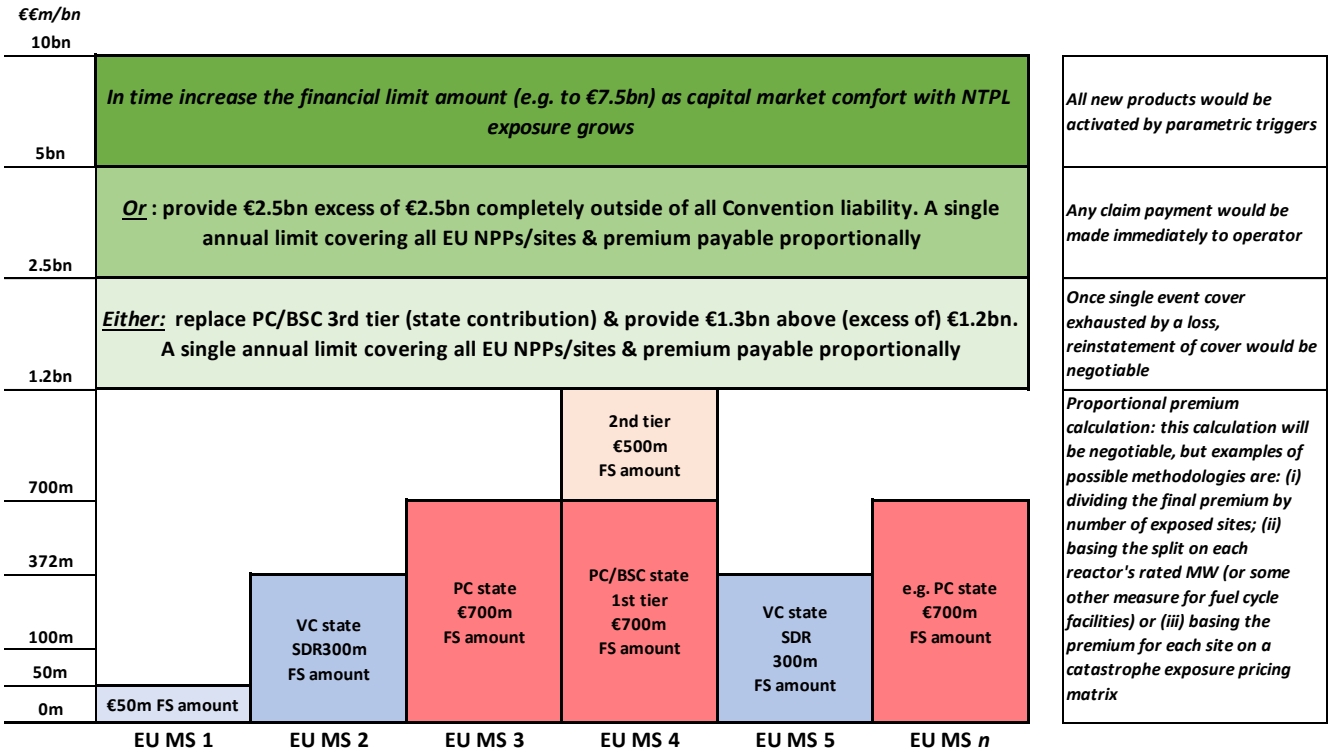

Figure 1: Possible structure for new catastrophe only single event EU-wide insurance

For this type of product the trigger mechanism which would initiate the coverage will be a critical consideration for the potential capacity providers; the next part of this section looks at different trigger options in more detail. Amongst these trigger options are:

1. Use of the IAEA's International Nuclear Event Scale[165]; for a catastrophe loss the event would need to exceed a Level 5 incident.
2. A specific defined catastrophic event, such as the US NRC's Extraordinary Nuclear Occurrence (ENO) definition[166].
3. The financial cost of an event, like an amount specified in an Insured Loss Warranty (ILW)[167] product, for example 'excess of €5 billion of damage'.
4. A series of environmental radiation readings from 2 to 5 geographically separate monitoring points in excess of a specified threshold (for example a specified reading above normal background radiation levels[168]).
5. The exhaustion of some underlying financial security (for example in a layered structure - where the layer/tranche below has been fully exhausted by a loss payment).

The choice of trigger will depend on the product type; triggers based on scientific and immutable values will attract more capacity than those that are potentially more fluid. From the list above, a parametric trigger based on radiation monitoring is likely to be the most favourable. Although the INES scale is a tool of the IAEA, the event scale reading can change as the event develops, which may not satisfy the capital markets. In addition, the regulatory body of the installation country decides on the categorisation of the event and in the case of a nuclear accident this adjudication may not be entirely objective.

Whatever trigger is chosen, its key feature must be to allow the markets to establish a clear distinction between a catastrophic event and a gradually occurring, latent event. Yet this sub-division of liability must also be acceptable and compliant with both the prevailing international NTPL Convention and national NTPL legislation. This compliance is looked at in more detail in section 6.1; however once accepted, there can be several variants to this new concept, but in time any of them will deliver materially more capacity for the full scope of damage (as currently defined).

Assessment

Criterion	Comment
Scope of cover	If the trigger is a measure of catastrophic loss, once activated any subsequent claim payment will be made by the insurer in full to the operator to use in whatever way it chooses
Capacity	Capacity will increase with comfort in the exposure, as explained elsewhere in this study. Previous EU workshops on this subject[169] have indicated that capacity of €2.5 – 5 billion could easily be assembled, provided the triggers and other conditions are acceptable to markets. Whatever the format, it is likely that multiples of current capacity could become available from the private sector for this concept.
Geographical scope	The concept envisages a single NTPL catastrophe policy covering the whole of the EU's NPP fleet; it could be extended to include other nuclear fuel cycle sites if desired but introducing a different category of exposure at the outset might hold back capacity.
Practicality	The practicality of the concept will be driven more by legal hurdles than financial or capacity constraints. No operator will buy more insurance unless mandated, therefore this obligation is the key practical consideration (see below)
Cost	A new insurance cover will cost operators more, but by mutualising the cost of the single limit across all EU NPPs/sites, the individual site cost should not be significant; this burden will fall

[165] See: https://www.iaea.org/topics/emergency-preparedness-and-response-epr/international-nuclear-radiological-event-scale-ines; see also the IAEA summary document in Annex I.

[166] See: https://www.nrc.gov/reading-rm/doc-collections/cfr/part140/part140-0083.html; see also the ENO criteria in Annex H.

[167] See Technical Annex 4.

[168] For example, the UK guidelines for radioactively contaminated land (see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718848/RCL_Statutory_Guidance_Final_220618.pdf) indicate an amount of > 3 mSv above background radiation could be considered contaminated. An agreed amount of this type could serve as a trigger for insurance policy attachment.

[169] See: January 2014 EC DG ENERGY workshop: '*Taking nuclear third-party liability into the future*', specifically the Munich Re presentation.

Criterion	Comment
	heavily upon EdF, with 73 of the 126 operating reactors. Obtaining accurate pricing information ahead of actual purchase is not possible.
Legal framework	There are three primary legal issues with this concept: (i) It will need to be a compulsory purchase for all EU sites. This will require some legal mechanism to enforce this. The use of Article 98 of the Euratom Treaty could provide a legal basis for introducing the necessary enforcement obligation. (ii) The disengagement of the Conventions. The major NTPL Conventions prescribe the extent of operator liability[170] and any new arrangement must either remain within the scope of the NTPL Conventions or risk encountering considerable legal difficulties and delays if the new product is viewed as falling 'outside' the NTPL Convention framework. (iii) The existing German Solidarity Agreement may prove a legal obstacle to the German operators' participation. Derogation from the provisions of the revised Paris Convention is permitted where financial security in excess of the minimum amount is considered and the Vienna Convention permits changes to the financial security when greater capacity is available[171]. This flexibility to allow materially greater financial security, perhaps without adherence to the full provisions of the Conventions, may offer a possible legal gateway to this solution.

Overview

This concept could achieve several of the objectives set out in the introduction of this study, although it will only deliver these if operators are obligated to purchase higher amounts of financial security; creating this obligation will require a legal change. Substantially greater private sector capacity for any type of nuclear damage emanating from a catastrophic accident will relieve EU states from some of the financial burden of a nuclear accident; as confidence builds so can the capacity, to the extent that operators themselves could also consider providing capacity.

An alternative variation of this concept could be for the EC or another state entity to become a buyer of this product. Any funds claimed under the insurance would be used to offset the state's obligation to pay NTPL compensation where insurance or other financial security is unavailable or insufficient and the premium paid could be recovered from operators[172]; this could simplify the implementation of this concept as there would only be a single state buyer.

14: Establish an EU-wide Protection Gap Entity (PGE)

Rationale

A PGE is not an individual solution that provides either more or wider scope capacity; instead it will provide a mechanism that enables several of the solutions described in this study to be linked together in a single management framework. A 2015 in-depth study described PGEs in the following terms: '*In their quest to address some of their social objectives in protecting their citizens from disaster, governments are increasingly turning to market solutions, such as innovative means of insuring for potential loss. They do so through the establishment*

[170] For example: 2004 Protocol revising the Paris Convention, Article 6 (c) (ii).

[171] See (i) 2004 amending Protocol to the Paris Convention, Art. 15 (b). Also note the *Exposé des motifs* of the RPC, paragraphs 104, 105 and 106. In particular, referring to Article 15, paragraph 104 states '*Where a Contracting Party takes measures to provide for compensation in excess of the 700 million EUR referred to in Article 7(a), such measures may be applied under special conditions which derogate from the provisions of the Convention, and in particular, need not be applied without discrimination to all victims*' and (ii) Vienna Convention as amended by the 1997 Protocol Art. (V) 1: '*the liability of the operator may be limited…*' and the arrangements to amend the financial security amounts in Art. V D, in particular Art. V D 3: '*when acting on a proposal to amend the limits, the meeting of the Contracting Parties shall take into account, inter alia….the capacity of the insurance market*'.

[172] See, for example, Article 10 (c) of the 2004 revised Paris Convention.

of Protection Gap Entities (PGEs) that operate between state and market in developing novel solutions/schemes that mobilize global (re)insurance capital in addressing the aftermath of disaster.' [173] PGEs aim to bridge the gap between the state's more social objectives and the often-conflicting objectives of the private markets, where the desired insurance cover is rendered unaffordable or unobtainable because of the perceived risk exposure. The same study[174] notes: '*PGEs are often formed through joint action between the government and/or intergovernmental organizations on the one side; and various market organizations on the other. Their mandate often requires them to pursue 'social' objectives through market means. PGEs sit at the nexus of a range of stakeholders, often coordinating or combining these market and social objectives. Therefore, the creation of PGEs introduces a new type of actor, operating on a market basis but with a clear social mission.'*

In the context of nuclear NTPL, the social objective is to ensure that nuclear accident victims are adequately and swiftly compensated, whereas at present many risk-transfer markets are unwilling to provide affordable insurance capacity to enable this objective to be met in full. In the EU a PGE could be established with a supra-national organisational and management framework[175] that would 'own' the nuclear risk at an EU-level and would be responsible for the segmentation and redistribution of the exposure to the optimum provider(s), so allowing the current NTPL market difficulties to be addressed and the risk allocated.

For NTPL exposure, the exposure can be segmented into the type of risk it presents, for example:

NTPL risk/exposure	Possible product	Potential capacity provider
Immediate preventive measures	Disaster liquidity product	Cat bond market
Economic loss and property damage	Conventional and catastrophe insurance	Risk transfer/mutual insurers
Authorised emissions, environmental damage and loss	Long-term funding for environmental damage	Retrospective operator pooling, perhaps supported by conventional insurance.
Long-term bodily injury	Funding for up to 30 years	Operator mutualised funding and/or redistributive (i.e. consumer charged) funding
Compensation and claims management	Resource infrastructure such as call centres etc.	Insurance market and nuclear site joint operation

Different types of exposure will demand different products to optimise outcomes for all NTPL stakeholders and the PGE would own this risk distribution process on behalf of (in the case of Europe) the public authority that has established it; as with other similar entities[176], a NTPL PGE would operate on a not-for-profit basis. It would be created to embody the necessary expertise and stakeholder credibility to enable it to optimise the capacity acquisition to protect the public and cost minimisation for the operators; subject to further legal analysis on the possibility of establishing such entity under the Euratom Treaty, the PGE could operate with a mandate from the Euratom Community or even from the Euratom Community and non-EU states in Europe, as the cross-border exposure from a serious nuclear accident may involve both EU MS and non-EU states. Sub-division of exposure and capacity allocation could also be structured in financial tranches, depending on the optimum market; again, the role of the PGE would be to manage this work with credibility, expertise and support from the stakeholders.

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[173] See: '*Between State and Market: Protection Gap Entities and Catastrophic Risk*' by Professor Paula Jarzabkowski, Dr Konstantinos Chalkias, Dr Eugenia Cacciatori and Dr Rebecca Bednarek – 2015, CASS Business School, London.

[174] Ibid.

[175] The Caribbean Catastrophe Risk Insurance Facility (CCRIF) was established by the World Bank and is a supra-national PGE; it operates as a protected cell company, with board representation from the Caribbean Community (CARICOM) and the Caribbean Development Bank. It offers catastrophe insurance policies throughout the Caribbean area. An EU based NTPL PGE could be structured in a similar way, with board representation from the EC and the European Central Bank alongside private sector members; its mandate would be set by the board and it would operate throughout the EU.

[176] See the example of CCRIF, in Section 6.4.3 of the report. This is a multi-sovereign entity, voluntarily established. Also see: https://www.ccrif.org/content/about-us. For another PGE example, see the California Earthquake Authority : https://www.earthquakeauthority.com/About-CEA

In whatever form it develops, it will need to be independent and to operate within specific parameters[177] to ensure its success and continued credibility as an acceptable outsourcer.

Assessment

Criterion	Comment
Scope of cover	As the entity which combines multiple solutions for all capacity shortages, a PGE will be charged with ensuring that capacity is found to cover the full scope of cover required.
Capacity	The primary purpose of the PGE will be to segment the exposure and seek the optimum capacity and capacity provider for each segment of risk, with the ultimate goal being to ensure the maximum available capacity is acquired.
Geographical scope	Again, the PGE's purpose will be to ensure capacity is found for all aspects of the cover, wherever it is needed. A PGE, if established, would operate across all EU MS.
Practicality	The establishment of a multi-sovereign entity is undoubtedly a practical challenge, but with precedent elsewhere globally of PGEs and the likely benefits of creating an independent 'owner' of the organisation of NTPL capacity, it should be possible for these challenges to be overcome.
Cost	A key purpose of the PGE is to optimise cost-effective capacity acquisition, balancing the needs of all the stakeholders. Minimisation of cost should be one key performance criteria for the PGE in acquiring capacity.
Legal framework	The Euratom Treaty may offer a legal vehicle for the establishment of a multi-state PGE in the EU; it is surely a facilitator for insurance arrangements. Otherwise obtaining sufficient legal and political impetus behind a PGE may be difficult. For example, Germany would need a clear incentive to break from or alter its existing arrangements in favour of something else.

This PGE proposal differs from the others proposed in that it proposes an infrastructure that could incorporate many of the other solutions proposed in this study; the task of a PGE, if established, would be to use the most suitable capacity provider to cover the part of the NTPL exposure to which it is most suited, this suitability being judged on indicators of cost and maximising capacity.

The study of PGEs is at an early stage, but multi-country risk pools have been established already; using these precedents with some further development could allow the creation of a tailor-made solution for NTPL exposure in the EU.

Overview

A PGE could be the entity that drives the creation of an EU-wide NTPL full scope capacity provider, using and managing the optimum providers for each segment of the exposure. If the obvious challenges of establishing such an entity can be overcome, the PGE will become an independent and credible source of expertise operating on a not-for-profit basis, mandated to obtain maximum capacity for the full scope and quantum required.

6.1 TRIGGERS

In section 4 the language of the NTPL Conventions was identified as a factor that constrains the deployment of adequate capacity; included within the description of this constraint was a reference to the lack of a trigger that could create a distinct point at which an insurance claim would be made. A recurrent theme in the research for this study was that a trigger added somewhere into a NTPL insurance policy or even in the Convention language would immediately increase NTPL capacity from most of the risk-transfer market. This part of the study looks in more detail at triggers that could be considered to increase NTPL capacity.

[177] A PGE mandate would establish the key objectives of the entity and its operational parameters. For example, the PGE could be set a long term (say 5 or 10 years) goal of achieving €5 billion of compliant NTPL capacity for all NPP sites in the EU MS with a maximum cost specified to the operator.

It is important to note that the introduction of a trigger into the language of the NTPL Conventions is extremely unlikely and as such, is not advocated by this study. In the previous Section (Section 5) new solutions for adding to capacity were described and the introduction of triggers was considered; those that required changes to the NTPL Conventions were rejected as impractical. Not only do such changes lie outside of the mandate of the EC but also, whether permissible or not, the timescale of introduction would be unacceptable[178]. Instead, the suggested use of these triggers here is to **sub-divide liability between capacity providers, whether they be operators, insurers or new capital markets**. Ultimately regulators need to have comfort that adequate financial security exists to cover the compensation obligations imposed by the NTPL Conventions[179]; **dividing the financial security obligation between different players is not embargoed if the financial security is adequate in scope and quantum**[180].

With such flexibility from the Conventions and using capacity enhancing solutions that are within the grasp of the EC, creating a patchwork of optimum financial security coverage is a plausible project for the EC and the need for triggers to activate certain types of that cover also becomes apparent.

6.1.1 TRIGGER QUALITIES AND TYPES

During the research work for this study, the team interviewed several entities involved in alternative and new capacity deployment, including brokers, analysts and insurers. To attract material additional capacity from these new markets to any new class of insurance, the common features of a successful trigger (i.e. one that can attract capacity) were identified as: simplicity, immutability, not subject to political interference and ideally scientifically based. Subjective or capricious triggers were not considered suitable and the need for credibility of the trigger 'judge' was also emphasised.

The research team also questioned new capacity stakeholders and established that in the insurance market there are many products already that rely on triggers[181] and the reliability of the trigger provider is a critical factor in attracting capacity. Using the information received, the research team reviewed the triggers listed below:

1. The International Nuclear Event Scale (INES);
2. A specific monetary amount;
3. A formal event description, such as the US NRC's description of an Extraordinary Nuclear Occurrence (ENO);
4. Multiple simultaneous radiation off-site monitoring point readings;
5. A state inspired trigger, such as when emergency procedures or evacuations are initiated;
6. A supra-national trigger, such as one for example based on selected values in the Basic Safety Standards Directive (BSSD) that identifies harm to individuals, property and/or the environment.

In reviewing these triggers, the research team specifically looked for a scientific evidence-based trigger that once initiated, remained certain and immutable. Below is a short review of each trigger and an overall review of their relative suitability.

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[178] The entry into force of any amendments to the international Conventions would indeed be subject to lengthy ratification process by the State Parties.

[179] The Exposé des Motifs of the Paris Convention p.34 paragraph 83 (referring to Article 10 (a) and (b)) states: 'It is for the competent public authority to determine the type and terms of the insurance or other financial security which the operator will be required to hold. The type and terms envisaged do not imply the establishment of a supervisory authority to control insurance activities in those countries where such an authority does not already exist, but only the control necessary to ensure compliance with the Convention'.

[180] Ibid; paragraph 82: 'Financial security may be in various forms: insurance coverage, conventional financial guarantees or ordinary liquid assets. A combination of insurance, other financial security and State guarantee may be accepted.'

[181] For example, Insured Loss Warranty (ILW) products – see technical annex 4.

1. The International Nuclear Event Scale (INES).

The INES was primarily designed as a communication tool to inform the public of a nuclear events significance in an easy to understand format; in the words of the IAEA[182] (the originator of the scale): '*The International Nuclear and Radiological Event Scale (INES) is a tool for communicating the safety significance of nuclear and radiological events to the public.' 'INES covers events at facilities and activities involving radiation sources. It is used for the rating of events that result in a release of radioactive material into the environment and in the radiation exposure of workers and the public.*'

The INES was first used in 1990 and has seven levels, with levels 1-3 labelled as incidents and levels 4-7 as accidents. The scale is logarithmic, thus each increase in level is about ten times as severe as the previous level; the objective is to measure each event in terms of its impact on (a) the environment and people, (b) radiological barriers and control (unplanned large releases on and off-site) and (c) defence in depth (where mitigation measures did not work as intended). The actual determining of the INES level is undertaken by national regulators[183].

To use the INES as a trigger for initiating a type of financial security, the focus needs to be on the higher levels; a level 5 event is categorised as 'an accident with wider consequences', a level 6 event as a 'serious accident' and level 7 as a 'major accident'. By way of reference, Fukushima (2011) and Chernobyl (1986) were both categorised as level 7 accidents; Three Mile Island (1979) and Windscale (1957) as level 5 accidents. Therefore, an INES trigger would most probably be set at a level 6 or 7 accident only – i.e. one that had off-site implications.

Advantages	Disadvantages
Simple and understandable by most.	Not scientifically based and not all assessments objective.
Credibility of IAEA (designer) and most nuclear regulators (as adjudicators) is strong.	A public-relations tool designed for public information and not for private capital.
Satisfactory distinction between initiating and non-initiating events (levels).	Although national regulators decide the INES score, without a unified regulatory system, inconsistencies of assessment could occur due to different regulatory approaches. Suspicion of state influence over state-run regulatory bodies may also adversely influence markets.
In widespread use, with IAEA and OECD NEA backing.	Inadequacy of scale: no differentiation between major accidents and nothing beyond 7.
Insurers aware of INES, with some already supportive of it as a trigger.	Conflates magnitude with intensity[184].
	Not immutable[185].

[182] See: https://www.iaea.org/topics/emergency-preparedness-and-response-epr/international-nuclear-radiological-event-scale-ines and a full description of INES in Annex I.

[183] For example, see (i) France: http://www.french-nuclear-safety.fr/Information/News-releases/ASN-Classifies-Melox-Incident-as-INES-Level-2 and (ii) UK: (page 20) http://www.onr.org.uk/documents/a-guide-to-nuclear-regulation-in-the-uk.pdf

[184] See 2011 Physics Today paper by David Smythe '*An objective nuclear accident magnitude scale for quantification of severe and catastrophic events*'.

[185] For example, the 2011 Fukushima accident was categorised as follows:

Date	Categorisation
11th March 2011	Fukushima accident date:
18th March 2011	Allocation of level 5 separately for Units 1,2,3; provisional level 3 for Unit 4
12th April 2011	Level 7 applied to Units 1,2,3 as a single categorisation; level 3 for Unit 4 remains

Source: Nucnet News

2. A specific monetary amount

A monetary trigger is a concept that is very familiar to the insurance market; the layering[186] of insurance policies is extremely common and is used in most types of insurance. A financial threshold of cover is included as an integral and distinctive part of the insurance contract and the insurers generally do not pay a claim until the underlying amount of loss (whether insured or not) has been exceeded.

It works particularly well for short-tail facultative and treaty insurances, such as 1st party property policies where the amount of loss can be quite quickly established. It is less used where the financial loss is difficult to assess and where liability may not become obvious for some time.

In the context of a nuclear event trigger, a 'catastrophe only' insurance could be designed to initiate coverage once NTPL claims exceeded (for example) €2.5 billion; this is similar to an Insured Loss Warranty type of cover that pays a claim in full if an independent assessment of the total insured value of all the losses arising from the nominated event (typically a natural catastrophe) exceeds a certain amount.

Advantages	Disadvantages
Simple & understood by most insurers	Requires credible independent assessor of the financial (insured) cost of the event.
Quick assessment of insurer involvement is possible	Not well suited to long-tail (liability) insurance types, where the cost of the event is not likely to be settled for some time.
	For nuclear, added complications such as prioritisation inconsistencies[187] make use of this trigger difficult.

3. A formal event description, such as the US NRC's description of an Extraordinary Nuclear Occurrence (ENO).

The Price Anderson Act is the main NTPL legislation in the USA and it contains many of the same basic principles contained in the international NTPL Conventions; however, there are also some differences. One such difference is the concept of the ENO and it is highly relevant to this review of trigger mechanisms.

The full technical description of the ENO definition can be found in Annex H; however, by declaring an ENO, the US regulator is signifying a material change in the route for victims to compensation and is moving the US NTPL regime from economic channelling of liability to legal channelling. Should the NRC find that an accident is an ENO, anyone indemnified under the Price-Anderson Act (Atomic Energy Act) waives certain legal defences, relieving the claimant of having to prove negligence by the operator and of having to disprove defences such as contributory negligence.

The US Atomic Energy Act defines an ENO thus: '*any event causing a discharge or dispersal of source, special nuclear, or by-product material from its intended place of confinement in amounts off-site, or causing radiation levels off-site, which the Nuclear Regulatory Commission or the Secretary of Energy, as appropriate, determines to be substantial, and which the Nuclear Regulatory Commission or the Secretary of Energy, as appropriate, determines has resulted or probably will result in substantial damages to persons off-site or property off-site.*'

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186 The International Risk Management Institute defines layering: 'The building of a program of insurance coverage using the excess of loss approach. Layered programs involve a series of insurers writing coverage, each one in excess of lower limits written by other insurers. Umbrella liability coverage is frequently structured in this manner, whereby a number of umbrella insurers write coverage at various levels, on an excess of loss basis, ultimately providing an insured with a high total limit of coverage.' See also Excess of Loss in the glossary in Annex A.

187 Both globally and amongst the EU nuclear power states, the position on prioritisation of NTPL compensation payments is not consistent. In summary within the EU nuclear power states, FR, HU, NL, SK, SI and ES have prioritisation rules and BE, CZ, FI, DE, SE and UK do not. Those states with prioritisation rules do not have consistent rules. These inconsistencies would make a financial trigger more difficult to set and assess. For more information on prioritisation rules see: https://www.oecd-nea.org/law/priority-rules-comp.pdf

Scrutiny of the above definition shows it contains two tests:

(i) The NRC must find that there has been substantial discharge or dispersal of radioactive material offsite or that there have been substantial levels of radiation offsite;
(ii) If (i) has occurred, then the NRC must also find that the event has resulted or will probably result in substantial damages to persons offsite or property offsite.

This dual test is the sort of trigger that new insurance and capital markets favour, as there is not just a single initiator but two. An illustration of the dual test is found with the Three Mile Island (TMI) accident in 1979; whilst there was significant damage on-site there was relatively little off-site discharge and the NRC decided not to declare the TMI accident an ENO. This position was challenged[188] but the definition and the decision following TMI was upheld.

In summary, the ENO offers a credible regulator-assessed dual test trigger that, when initiated, materially changes the NTPL financial compensation arrangements; these are all favourable elements for capital markets which makes the ENO a strong contender as an ideal trigger mechanism for consideration in the EC.

Advantages	Disadvantages
Established, understood and legally tested.	Regulatory independence is a standard requirement in all countries with regulated nuclear power and the US NRC is a leading example of an independent regulator. However, markets can remain sceptical of such independence everywhere, particularly when in extreme (i.e. accident) conditions. Thus there could be some suspicion that the regulator may be open to political pressure, being an arm of the state.
Contains dual test, which appeals to capital markets and a similar concept could work to establish triggers in the EU for the sub-division of liability.	The ENO concept and definition are part of the US NTPL legal regime; negotiating a similar arrangement in the EU will probably take time.
Credible administrator and adjudicator.	
Already established as a trigger that changes the NTPL financial arrangements, which further enhances its credibility.	

4. Multiple simultaneous radiation off-site monitoring point readings.

Careful monitoring of radiation levels in the surrounding of nuclear sites is almost universal and has been a key aspect of securing public acceptance for nuclear power. Regulatory oversight of nuclear sites generally requires multiple monitoring points to ensure any off-site releases are kept within accepted limits[189]; use of these monitoring points and the associated oversight would make an ideal arrangement as a trigger for financial security, given the emphasis new capacity providers have put on a more scientific assessment provided by an independent, credible entity.

This trigger would make use of the extensive monitoring stations already in place. The following examples illustrate the universality of these monitoring points:

188 See: Withdrawal of proposed rule and denial of petition for rulemaking submitted by the public citizen litigation group and the critical mass energy project: https://www.nrc.gov/reading-rm/doc-collections/commission/secys/2000/secy2000-0160/2000-0160scy.pdf

189 For example, see US NRC: https://www.nrc.gov/about-nrc/radiation/protects-you/radiation-monitoring.html or France's ASN: https://www.asn.fr/Informer/Publications/La-revue-Controle

- A nuclear site in the UK provides an annual report with full details of measurements and maps of marine and terrestrial monitoring stations for radioactivity around the nuclear site[190].
- In Finland the nuclear regulator monitors 600 samples around the 2 local NPPs[191] annually.
- At EU level, the Euratom Treaty has established cooperation amongst EU MS (and other neighbouring states) to share radiological data through the European Radiological Data Exchange Platform (EURDEP), which can show data from all over Europe in real time during an emergency[192].
- In the USA the NRC requires all nuclear sites to provide annual environmental reports that measure airborne, direct, waterborne and specific foodstuffs radiological data[193].
- In France, all radiation monitoring sites are mapped and the nuclear regulator (ASN) has made these available for all to see on a consolidated 'real-time' website[194].

The data are thus easily available and negotiating an acceptable trigger is feasible. The readings that form the trigger will need to demonstrate that a catastrophic event has occurred, are immutable and that any latent causes are eliminated. Currently monitoring occurs at all compass points (e.g. at 16 compass points or every 22.5° in the US) and takes measurements at indicator points relatively close to the nuclear site and at control points further away that would normally be beyond the scope of regular radiological influence from the site; typically operators report the readings from all these sites and show any differences between the control and indicator points to demonstrate the (normally) very limited releases from the site. Therefore there are already suitable mechanisms for establishing whether harmful amounts of radiation have been released and the creation of a trigger using these measurements would be subject to negotiation with markets, following close analysis of the scientific data available, but the main attractions of this trigger are immutability, easy assessment and credible, scientific basis. In the USA, the monitoring points' catastrophe 'credentials' are illustrated by the comment on the NRC website: '*Plants have been very effective in controlling their releases. To date, there have been no releases above the ALARA levels*.'[195] Therefore, any extreme reading can be considered a serious event. Overall a carefully selected value that is considered by the capacity providers a 'catastrophic' event trigger will attract material additional capacity and will provide a suitable sub-division point for liability.

Nuclear site readings are generally performed by the nuclear operators[196] themselves, which may be a concern for the capital providers; however, these readings are a regulatory requirement in most countries and sites need to provide truthful readings in order to secure a license[197], which should allay any concerns. Even if this is not satisfactory, there are reputable independent bodies that could be tasked with this work.

Advantages	Disadvantages
Scientific, objective and immutable.	Could be open to moral hazard as operators are currently providing many of the readings.
Quick to measure and establish.	Consensus on the exact values to be used as triggers of catastrophic harm will be required; this may take time to

[190] For full details see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/758942/Monitoring_Environmental_Discharges_2017.pdf

[191] See: https://www.stuk.fi/web/en/stuk-supervises/stuk-monitors-the-radiation-safety-of-the-environment/monitoring-of-environmental-radiation-in-nuclear-power-plants

[192] See: https://rem.jrc.ec.europa.eu/RemWeb/activities/Eurdep.aspx

[193] See: https://www.nrc.gov/reactors/operating/ops-experience/tritium/plant-info.html

[194] See: https://www.mesure-radioactivite.fr/#/

[195] See: https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/env-monitoring.html

[196] According to the 2017 discharges publication; see: https://www.gov.uk/government/publications/discharges-and-environmental-monitoring-annual-report-2017

[197] For example, see the UK practice: https://www.gov.uk/guidance/monitoring-radioactivity

Advantages	Disadvantages
	negotiate, especially if there are national inconsistencies in these values.
A credible administrator and adjudicator could be found if the current regimes of monitoring is found wanting.	
Trigger type could be 'tailor-made' to suit different types of capacity product.	
Already part of an established and trusted regulatory procedure across the EU and USA.	

5. A state inspired trigger, such as when emergency procedures or evacuations are initiated.

At EU level, a mechanism for swift exchange of information in the event of a radiological or nuclear emergency, is provided by the European Community Urgent Radiological Information Exchange (ECURIE), which has been set up under the Euratom Treaty; it covers all EU MS and some neighbouring states[198]. Under this mechanism, a participating country must promptly notify the EC if it is initiating its site emergency measures to protect the public, in the event of an emergency. The Commission must then make this notification available to all other members. This initiation of emergency measures could act as a trigger for an insurance product; such procedures are an EU-wide requirement, in compliance with Council Directive 2013/59/Euratom (the Basic Safety Standards directive – see also # 6 below).

Insurers already have offered full capacity for the preventive measures head of damage under the revised NTPL Conventions (see earlier sections); this is a difficult concept for insurers, as it is offering cover for a loss that may never occur (preventive measures can be triggered when there is a 'grave and imminent' threat of nuclear damage, as well as after an actual accident[199]). Normally insurance can only be provided for fortuitous events where an insurable interest exists, but in this case cover will be provided for merely the threat of loss; many insurers provided capacity for this head of damage only with the comfort of knowing that the implementation of state-authorised emergency measures acted as a trigger for this cover[200]. For example, the BSSD outlines the requirement for emergency response systems and their activation[201]; this activation could be used as a trigger for cover activation. With this precedent, it is likely that insurers could be encouraged to use the same trigger for other products, given that it can only be initiated by relatively trustworthy state actors.

Advantages	Disadvantages
Relatively trusted adjudicator (state).	Could be open to political interference where local government has more of a role in implementing emergency measures.
Precedent of using this trigger already established with some markets.	May be perceived as a subjective judgement by some who view politicians with scepticism.
Emergency measures are easily understood and widely accepted as an indicator of a real emergency.	Discouragement of capital providers if no loss occurs (i.e. measures implemented but threat does not materialise).
	Within the EU there are differences in triggers for the initiation of such measures.

198 See: https://rem.jrc.ec.europa.eu/RemWeb/activities/Ecurie.aspx

199 See the *Exposé des Motifs* of the Paris Convention p.25 paragraph 62.

200 This was the case in the UK.

201 See BSSD Chapter IX, Section 5 Article 97 on emergency management systems and Chapter VIII, Section 2 Article 69 on activation of emergency response systems.

6. A supra-national trigger, such as one created using values established in the Basic Safety Standards Directive (BSSD)

The EC's Basic Safety Standards directive (BSSD) was established as '*a set of basic safety standards to protect workers, members of the public, and patients against the dangers arising from ionising radiation*.'[202] As indicated by the EC in relation to the releases of radioactive effluents: '*Nuclear sites, in particular nuclear power stations and reprocessing sites, are entitled to discharge airborne and liquid radioactive effluents into the environment on condition that these discharge operations abide by conditions and restrictions set in their operating licenses.*

The radioactivity of discharges is measured and the results must be communicated to the European Commission. This helps the Commission to evaluate the exposure of populations and compare the levels of radioactivity in different EU countries.' [203]

Therefore (and as noted above) there are requirements to measure radioactivity around all EU nuclear sites and to report this information centrally. The difficulties with these data could be that national monitoring requirements differ, so rendering the data inconsistent However, this does not mean it is useless or unacceptable. Noted already is the BSSD's concept of 'reference levels', which are a good starting point to determine a sufficiently catastrophic event trigger. Chapter III Article 7 states '*Member States shall ensure that reference levels are established for emergency and existing exposure situations*' and Annex 1 indicates that reference levels for emergency exposure are set between 20 and 100 mSv. The setting of an acceptably catastrophic reference level exposure to the public using the BSSD framework could then be linked with some environmental readings (as suggested in # 4 above) to create a parametric trigger that would be readily acceptable by markets and which could thus unlock new capacity. Negotiation to set the appropriate trigger and pricing of the eventual product would be necessary before establishing the quantum of additional capacity, but indications from respondents taken during the research phase support this approach.

Advantages	Disadvantages
Trusted adjudicator (state).	Inconsistency of environmental and personal radiation monitoring standards across the EU.
Already established across the EU.	

Suitability of triggers

The six triggers reviewed in section 6.1.1 have been selected because they demonstrate some or all the characteristics necessary for a trigger to be suitable as an attachment point for liability; these are characteristics which have been identified by both new and existing capacity providers. The study has already opined that the introduction of a trigger into the legal framework is unlikely, given the lengthy negotiation required to change the international NTPL Conventions; however, it is assumed instead that these triggers can be used to sub-divide the liability either within the current financial security requirements or for new amounts of financial security beyond those currently demanded. No matter how they are used, the critical assessment is whether the trigger is fit for purpose and acceptable to the markets providing capacity; this part of the study now looks at the suitability of each trigger in more detail, to help identify the most effective and thus the most acceptable trigger.

To measure suitability the ideal qualities for any trigger already identified (being simplicity, clarity, immutability, not subject to political bias and ideally scientifically based – see section 6.1.1) are scored for each of the six triggers and the outcome of this exercise are shown in Table 14 below.

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202 See: https://ec.europa.eu/energy/en/topics/nuclear-energy/radiation-protection

203 See https://ec.europa.eu/energy/en/topics/nuclear-energy/radiation-protection/radioactivity-environment

Table 14: Trigger suitability matrix

Criteria	Trigger type: INES	Monetary amount	ENO type (parametric)	Multi-site rad.values	State declaration	BSSD or similar
Clear distinction between latent & catastrophic event	3	0	2	2	2	2
Immutability	2	1	3	3	1	3
Technical & scientifically based	1	0	3	3	1	3
No potential for political interference	2	3	2	3	1	2
Clarity & easily understood by markets	3	2	2	2	2	1
Easily understood by general public	3	2	2	2	2	2
Total score:	**14**	**8**	**14**	**15**	**9**	**13**
Scoring:	*0-3 inclusive, with 0 indicating least match and 3 indicating best match. Maximum score is 18.*					

This scoring mechanism, although perhaps subjective, shows that when measured against the market's indicated preferred trigger characteristics the INES, ENO type and triggers based on clear radiological readings are most suitable. A combination of two of these triggers, hinted at already, may work to provide an optimum parametric trigger mechanism that would serve to sub-divide liability between catastrophic and latent events and thus attract new capacity to consider providing NTPL insurance.

6.2 CONCLUDING REMARKS

This section has examined both a selection of new solutions as well as suitable triggers that could be used to activate additional capacity for these new solutions; the next section recommends the best of the reviewed solutions and any associated triggers that can deliver on the original objectives of this study – substantial, affordable additional private sector NTPL capacity for EU NPPs.

7 RECOMMENDATIONS AND CONCLUSIONS

Recommendations

The purpose of this final section is to select the best of the solutions already described that could work within a relatively short period and that after a limited legal review, seem to have the least legal obstacles to overcome; importantly in this section the cost of each solution is also considered. Obtaining reliable data on a future product cost in a highly competitive and uncertain market has proved difficult, with few players willing to commit to more than rough estimates; however, cost effectiveness of any new solution is paramount, and imposition of additional cost is a key concern of nuclear operators. Therefore, *indicative* costs are shown where possible.

The original EC tender document specified two general objectives for this study, the latter being '*to consider the best possible ways of developing additional capacity…with the view of increasing private coverage in this field*'[204]. When reviewing the possible new solutions, the research team has remained focused on increasing capacity; however, it has also been stressed consistently that practical delivery of any new solution is also important. Thus, the reviews have been accompanied by a general assessment of the practical challenges of introducing each of the chosen concepts, including a high level indication of those which do or do not appear to have legal implications that will affect the ability of Member States to adopt them.

Ultimately to deliver the laudable objective of more capacity for NTPL, the team must recommend from the solutions reviewed those that can deliver practically, cost effectively (for operators) and within the competence of the Euratom Community the greatest additional full scope capacity for the benefit of nuclear accident victims, as illustrated in figure 2 below. Any final recommendation must be able to work quickly, efficiently and fairly to ensure the maximum capacity can be available for compensation.

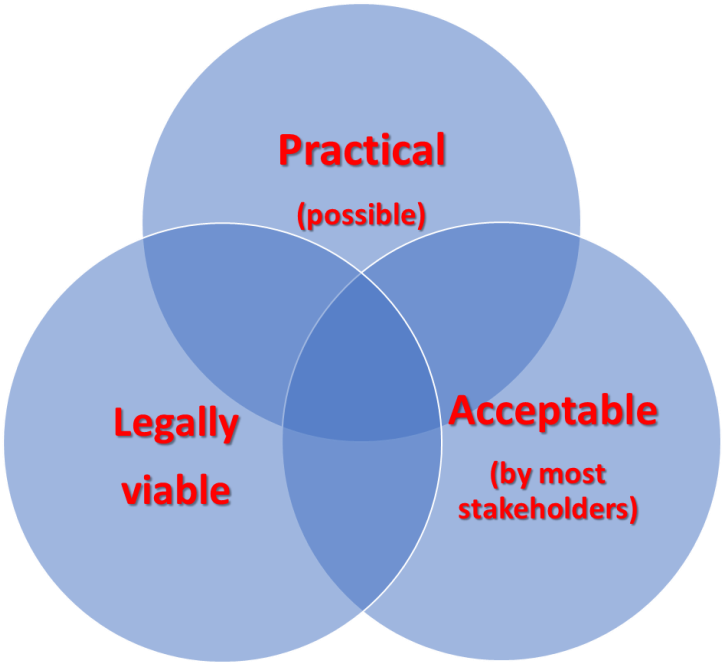


Figure 2: Finding the optimum solution

[204] See Terms of Reference (Annex 1) from the original EC tender document (May 2018) – contract 2017-562.

At this stage a short recap of the study's key findings will provide context for the final recommendations:

- Between the current players in the NTPL market there is more than enough capacity volume (or amount) for the obligatory financial security amounts currently demanded or proposed by the legal regimes; however, the full scope of the revised NTPL cover demanded remains unfulfilled at present.
- The risk transfer market is restrained from providing both this full scope and materially more capacity today because of the challenges of modelling and accounting for the long tail element of the revised Conventions' NTPL cover.
- Materially more capacity for NTPL from insurers is available, but only with triggers that identify the loss event and activate cover; also required is an obligation upon operators to purchase what additional capacity is available.
- Operators are nervous that any increased financial security obligations will cost them materially more premium than they already pay.

The optimum solution will recognise the strengths and weaknesses of the players and must exploit these to organise the capacity in the most effective way.

The recommended new solutions have been sub-divided into two groups:

(i) 'Quick wins' that will work within the current framework and status quo; if implemented they will provide more full scope capacity up to the revised NTPL Convention requirements in all EU MS.

(ii) 'Longer plays' that will deliver materially more capacity above the financial security minimum amounts required by the revised Conventions; if implemented these will require the compulsory purchase of additional financial security amounts as specified by the EC.

The team also considers how a combination of the recommended solutions could be used to optimise capacity increases; finally, the team considers which of the rejected solutions could be implemented if changes to the legal framework within the Euratom Community permitted a wider selection of solutions in future**.**

Quick wins

Recommended solution 1

Ensure all insurance policies offered single, lifetime limits for all insured sites

This solution is recommended because it only needs to involve the risk-transfer insurance market in a harmonisation exercise. The annual renewable financial limit in some EU MS is holding back reciprocal reinsurance capacity from other insurance pools as well as causing discomfort from the accumulation of the new exposures that will be introduced with the Convention revisions. Introduction of a single, annually renewable, lifetime limit for each nuclear site across the EU will ease these concerns and allow the deployment of more capacity, both in scope and amount.

Primary purpose	Increase amount and scope of insurance capacity
Practicality	For a voluntary introduction of this change the insurers need to cooperate; this can be achieved at policy renewal as insurers and reinsurers sign up to the new annual NTPL policy. Non-compliant policies could be rejected by the reinsurers, so forcing the insurer to adapt the policy.
Legality	There are no significant legal obstacles to this solution and the EC needs only encourage the insurers to cooperate in this way; this could be achieved within the scope of the Euratom Treaty Article 98.
Acceptability	This solution will result in lower NTPL premiums for those operators that currently have annually stacking policy limits, as the insurers' exposure accumulation will reduce. How much will this reduction be? It is not possible to be precise because each underwriter will have different rating criteria; however, a typical standard insurance market reduction for changing a multiple limit policy to an aggregated, single limit policy is about 30%. Policies that are already limited to a single lifetime limit will see no change.

Recommended solution 2

Increase materially the use of mutualisation

Again, this solution is achievable within the insurance market as it requires the mutuals to develop their reinsurance programmes, which would allow them to increase their current offering of full scope NTPL capacity. At present the mutual NTPL insurer is the main provider of capacity that covers the full scope of the revised NTPL Conventions; it can grow this coverage through higher gearing and greater use of new reinsurance markets and products. Although €1.2 billion will not be achievable immediately, the regulatory and market understanding and appetite for alternative capacity is growing and this will speed the nuclear mutual insurers' access to wider reinsurance and capacity growth.

Primary purpose	Increase amount of mutual full scope insurance capacity to help off-set the risk transfer market's reluctance to cover the full scope of the revised NTPL Conventions.
Practicality	The challenge with this solution rests with the mutual insurers and whether materially increased reinsurance capacity from current and new markets can be purchased; also the mutuals will need to consider new products from the capital markets (such as ILW or cat bonds) to allow their capacity to increase.
Legality	There are no legal obstacles to this solution, other than ensuring the reinsurance programme complies with the financial security requirements of the operators.
Acceptability	Mutual insurance premiums are generally lower[205] than risk-transfer market premiums; therefore, greater mutual participation in an insurance programme should reduce the cost of premium for operators, notwithstanding the increased use of reinsurance to achieve a higher capacity.

Longer plays

Recommended solution 3

Create new, catastrophe only, all sites, single event, excess layer of insurance above the current legal regimes, provided by either or both operators and insurers

The preceding sections and the Technical Annexes give a flavour of the scope of this proposal; the EC is also no stranger to the concept as a catastrophe only risk-transfer product was actively discussed at a workshop in 2014. For this solution there is no specific product blueprint that can be copied; instead a blend of capacity types could be assembled from both traditional reinsurance and alternative capital markets consisting of a single policy or series of layered policies that could deliver materially more capacity for NTPL insurance, with growth likely over time as financial institution gain comfort with the concept; the common denominator is that the cover needs to be initiated by some form of simple, objective and independent trigger that removes any exposure to gradually occurring third-party radioactive contamination. This implies sub-dividing the liability obligations presented by the Conventions and thus combining different sorts of financial security provision to ensure all aspects are covered compliantly, which is covered more in the next part of this section.

The scale of additional capacity generated from this solution will depend on three variables, being (i) the price of the product (the premium payable), (ii) the perceived quality of the triggering mechanism and (iii) the 'depth' of cover (i.e. how many times the indemnity limit is exposed). This solution is proposed as a single event cover that covers all EU NPPs for catastrophe events only, as initially it will be easier to obtain capacity for exposure with a simple and relatively limited indemnity; as the capacity provider's confidence in the nuclear sector and their own understanding of the product grows the capacity and depth of cover could be extended.

The research amongst new capital providers and existing markets established that available capacity for such a product ranges between €2.5 billion to €10 billion. For example, one leading European reinsurer indicated acceptance of a product providing €10 billion capacity with a single reinstatement of cover excess of €2.5 billion.

[205] The amount of this variation in premium is not fixed or universal, but driven by commercial realities; however, because mutuals do not have the same need as risk-transfer markets to deliver shareholder profit, typically premiums charged are at least 10% lower than risk-transfer premiums.

This was the highest capacity suggested and other ILS and new capacity providers suggested initially capacity of €1 billion could grow to € 5 billion.

Primary purpose	Increase materially the amount of insurance capacity available for NTPL at a high level.
Practicality	Assurance of the objectivity and simplicity of the trigger mechanism is a key factor in attracting capacity to the NTPL market; in the previous sections, various trigger options were reviewed and for the purposes of triggering this type of cover, the previous section indicated that three of the triggers could fulfil the acceptance criteria: (i) The INES trigger, establishing an indemnifiable event excess of (i.e.) level 5 on the INES. (ii) A trigger that would use multiple, clearly identifiable radiation monitoring points to establish a severe off-site event that is independently administered. (iii) An ENO-type formally defined trigger within the legal framework.
Legality	The primary legal challenge with this solution is mandating all NPPs in the EU to obtain additional financial security above the Convention minimum amounts. This could be achieved using Article 98 of the Euratom Treaty or possibly Article 15 (a) and (b) of the 2004 revision to the Paris Convention and Article V D of the 1997 Vienna Convention.[206]. Without an obligation to take additional financial security, the operators will not buy any extra cover. However, Article 6 (c) (ii) of the 2004 revision to the Paris Convention disallows any operator liability 'outside' of the Convention, therefore changes proposed may be compromised if it is considered that they introduce new liability outside of the Convention regime; debate on this point could delay the implementation of this solution. Should implementation prove challenging an alternative arrangement could be for the State to purchase the insurance cover, as the State has an obligation to pay NTPL compensation where any financial compensation is insufficient. The state(s) would then recover the cost of purchasing the insurance cover from their relevant site operators on the same basis used for the premium calculation. Such an arrangement could materially simplify the implementation of this solution because the number of buyers would be limited and these buyers would be governments (or the EC).
Acceptability	A new level of financial security inevitably will have a cost attached to it. Research indicated that the price range for a typical catastrophe only cover is as follows: • The above catastrophe only cover of €10 billion excess of €2.5 billion with a single reinstatement of cover (i.e. another €10 billion amount reinstated after a loss) has an initial indicative cost of €1 billion; spread across 126 reactors this amounts to about €8 million each. For EdF this could cost €584 million. • Lower amounts of capacity or single limits, without reinstatement, would cost less. Reinstatements can generally be provided by the traditional risk-transfer market, standing behind an ILS single event product. • A basic premium calculation, formula of two times multiple of the expected loss, with the expected loss being calculated from theoretical modelling of historical nuclear events is used for the ILS market. • With the low loss record of the nuclear sector providing a good indication of lower premiums, research indicates that, at the start, a rate on exposure of less than 4% is unlikely; this of course depends on the trigger's acceptability. • First of a kind risk exposure will cost more; this indicates that prices of products will reduce with exposure familiarity (and provided losses don't occur).

206 See footnote 170 and 178 elsewhere in this study for further references; however, in the opinion of the research team, flexibility over both the financial security amounts and the type of cover is possible within both revised NTPL Conventions. This flexibility would be derived from NTPL insurance capacity availability. Therefore, if a substantial new tranche of NTPL insurance capacity is demonstrably available, both Article 15 (a) and (b) of the revised Paris Convention and Article V D of the revised Vienna Convention appear to allow greater financial security amounts to be considered. Nevertheless it must be stressed again that legal analysis of this aspect is outside the scope of this study and has therefore not been considered in depth.

Primary purpose	Increase materially the amount of insurance capacity available for NTPL at a high level.
	• For an ILS product that attracts a credit rating, in the current market it can expect minimum pricing of 4.5% rate on exposure amount for a BBB credit rated entity and 3% minimum rate on exposure for an A rated entity[207]. • If a state entity contemplated purchase of this cover, cost (i.e. premium) optimisation would be achieved with the greatest number of NPPs under a single policy limit. The implication here is that the EC would achieve a more cost-effective premium buying a single policy for all EU MS NPPs than if each EU MS purchased a policy separately. It is important to note that all the prices referred to above are indications only and are subject to material change, especially as NTPL cover is new to the markets. Capacity providers of all types will not provide any more than vague indicative prices prior to cover negotiation and these are subject to material alteration once the full risk information is provided and negotiations have concluded.

Recommended solution 4

Facilitate the 1st tier financial security amount under the revised Paris Convention, or the revised Vienna Convention full amount, to be funded jointly by insurers and operators, similar to the US Industry Credit Rating Plan (ICRP) system

The previous sections examined this solution in detail and demonstrate the merits of permitting the build-up of funds that could be reserved to pay for latent exposures rather than catastrophe exposures; the optimum type of finance security could be selected for the different types of exposure to fulfil the existing financial security requirements with full scope cover. The amount of fund required can be determined by the Euratom Community (for example two full financial security limits) for each site and each operator, where they operate multiple sites.

Importantly, the solution can be achieved through negotiation between operators, insurers and regulators to ensure the fully compliant financial security is obtained from several providers without any gaps.

Primary purpose	Increase amount and scope of insurance capacity by blending and utilising the most appropriate capacity for each type of exposure.
Practicality	This solution can be achieved through discussion between insurers, operators and regulators. The objective of these discussions would be to separate the latent, long tail exposures that are currently difficult for most of the traditional risk-transfer market from the much easier to insure catastrophic events. Operators would be permitted to build up sufficient funds to cover a selected number of financial security requirements to pay compensation for the latent losses, leaving risk-transfer markets to provide catastrophe cover with a trigger.
Legality	Operators must be permitted to build up funds in a tax efficient manner for this solution to be most effective; otherwise there are no material legal obstacles to this solution. Again, if legal competence is required, the Euratom Treaty article 98 could be used, as this solution is little but a facilitation of improved insurance arrangements.
Acceptability	This solution will result in lower NTPL premiums for the existing insurance required to cover the revised financial security amounts, as the risk-transfer insurers would be released from providing for anything but catastrophe exposure, activated by a trigger (for example the INES or a series of radioactivity measuring point readings); the operators would cover the remaining exposure through an accumulated fund. This change should justify a material reduction in premium, given it will see the removal of exposure from the risk-transfer market that has concerned insurers so much. Precise values of this reduction are commercially sensitive and not available.

Combinations of solutions

If the Euratom Community can establish a wider competence in the field of NTPL, then the opportunities for it to intervene to increase NTPL capacity become more interesting; a broadening of the range of solutions will

[207] See technical annex 4 for details of how ILS products are structured. Of relevance for this solution is the information about the special purpose vehicle established as a bridge between the insurance and capital markets, which can attract a credit rating; if it does, it will be able to access a much wider selection of capacity providers from the capital markets.

allow the development of the optimum combination of solutions to allow the deployment of NTPL capacity best suited to each element of the exposure.

For example, the financial security amount required could be increased over time to allow a combination of operator pooling, funding of the amounts within the current financial security amounts specified as minimums in the revised NTPL Conventions, new catastrophe only insurances and traditional mutualised insurance arrangements, all blended to achieve full scope cover with a materially higher financial security amount than today. In the previous section the Protection Gap Entity concept was reviewed; it is this structure that is recommended here as an overarching entity operating at arms-length from the EC, that would manage the sub-division and allocation of liability for an increased financial security amount across the EU, as described below.

Recommended solution 5

Establish an EU-wide Protection Gap Entity (PGE)

The final solution recommended by this study is for the establishment of a PGE to manage the development and day-to-day stewardship of the NTPL arrangements. The previous section outlined how a PGE provides a mechanism for organising an optimum mix of capacity providers to take on difficult risks, such as nuclear. It would be used to organise a range of products that together would cover the full scope of the NTPL financial security requirement; the PGE would operate independently of the public entity that would establish it, with a mandate to organise full scope NTPL capacity up to an amount specified. For example, if an initial target of €5 billion for NTPL financial security is set, the PGE role would be to implement the target by organising the purchase of the most appropriate products and the sub-division of the NTPL exposure amongst the players; it would be responsible for managing the negotiations between the different capacity providers to ensure there are no gaps between the scope of what is required by the NTPL Conventions and the actual deployment of capacity, perhaps from multiple sources with some capacity activated only by a trigger. Figure 3 below gives an example of how a NTPL insurance programme could be structured using multiple types of capacity providers deployed according to the risk appetite of each and managed by the encompassing PGE.

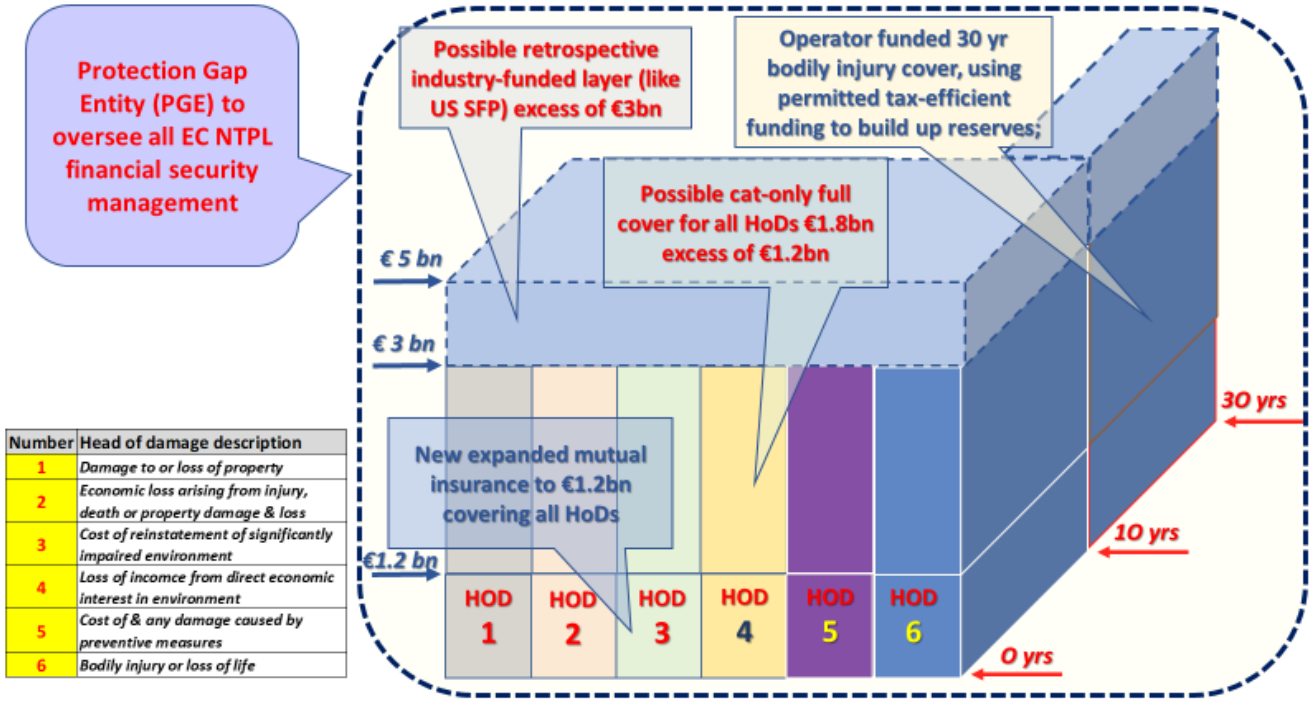


Figure 3: Combining multiple solutions under a PGE structure

Primary purpose	Improve the NTPL infrastructure to allow materially increased capacity sourced from the most appropriate capacity providers.
Practicality	As already described, today PGEs have been established in supra-national roles; therefore, with such precedence establishing a new PGE in the EU could be envisaged, subject to further legal analysis on the possibility of establishing such entity under the Euratom Treaty. If this is possible, it is envisaged that the EC establishes the new entity to operate independently but reporting to the Commission, with a specific mandate to develop, organise and administer the EU-wide NTPL arrangements. The PGE could be instructed to fulfil a financial security target amount within a specified period.
Legality	Establishing a PGE to facilitate the insurance arrangements and secure greater capacity is not legally challenging; however, for this EU-wide solution to be implemented, two separate mandates will be necessary: (i) a mandate from the EC to establish the PGE and, once established, (ii) the PGE could develop an EU-wide mandate requiring all NPP sites to purchase the financial products necessary to cover the operators' greater financial security.
Acceptability	Materially more insurance to cover greater NTPL obligations will cost operators more than current premium amounts; however, with operators able to develop funds to cover latent exposures and the insurance market restricted to catastrophe only losses, the organisation of the various capacity participations can be matched to risk appetites, which will have a positive impact on product pricing. The objective should be to achieve the widest scope of cover for the highest possible capacity deployment and for a limited increase in aggregate premium cost. In general, buying more capacity for high layers of insurance is not as costly as buying cover at low levels, with premiums more closely matching the cost of capital. The PGEs responsibility would be to maximise capacity and minimise premium spend.

Utilising a broader range of solutions

The USA has established a NTPL regime that (i) provides the highest global level of financial security, (ii) incorporates a trigger mechanism for altering the liability channelling and (iii) offers risk-transfer insurers exposure that is close to catastrophe only. This blending of capacity types to match risk appetites helps maximise capacity and it is the belief of this study's research team that a similar regime could bring greater NTPL capacity to the EU MS.

If the Euratom Community was to establish a broader competence for NTPL then it would be able to consider more options to build capacity; if a managing PGE is established, then it can become the organiser and manager of these schemes.

Under these circumstances solutions rejected in the previous section would become viable for consideration; for example widening the Paris Convention signatories within the EU will provide a harmonised legal regime that will facilitate the work of a PGE and will offer more certainty to severe accident victims.

Also, with continuing convergence of regulatory and nuclear safety standards, it is easy to contemplate a more benign environment for an EU-wide solidarity agreement, such as that operating in Germany in future.

Alterations to the NTPL Conventions will always remain challenging, not least because of the likely timeframe required to achieve any change; therefore, the EU needs to focus on what improvements in the NTPL provision can be achieved for EU citizens that are within the reach of its competence.

However, fulfilling the objective of developing additional capacity with the view of increasing private coverage in this field can be contemplated by taking a stepped approach:

- The first step could be to establish an aspirational NTPL financial security target for the whole EU - perhaps € 10 billion as being approximately equivalent to that available in the USA – to be reached by a target date.
- The EC could then consider the optimum legal environment necessary to achieve the objectives.
- The next step could see the establishment of an EU wide PGE to drive the negotiations with all major stakeholders.

- The final step would see the gradual implementation of an optimal capacity allocation, using a mix of the recommendations from this report, allowing the target capacity to be reached over time at reasonable cost to operators.

Achieving a substantially increased EU-wide NTPL financial security target will require a bold action on the part of the EC, but with political support and a realistic timescale, a strong financial commitment from the private financial markets could help deliver a more realistic financial security amount for the future.

Concluding Comments

It is important to remember that no matter what solution is adopted, some of the cost of a severe nuclear accident will inevitably fall upon the state. Fukushima's compensation payments to date amount to about €75 billion, on top of this are the costs of site stabilisation and regional clean-up. These numbers are beyond the resources of most private enterprises and are even challenging for the global insurance markets; however, to help the nuclear sector develop a stronger social license to operate and allow it to continue its vital contribution towards reducing global emissions, further internalisation of the cost of higher financial security must be achieved. We believe this study guides the EC towards the most appropriate mechanisms that can help achieve these outcomes at a reasonable cost to the operators and ultimately electricity consumers.

ANNEXES

A. Glossary
B. Objective and task index
C. Nuclear Power plants in the EU
D. Nuclear liability financial security requirements in the EU[208]
E. Nuclear third-party liability insurance capacity analysis
F. Nuclear insurance pools and other insurers – capacity detail
G. The radioactive contamination exclusion clause
H. The US Nuclear Regulatory Commission (NRC) ENO definition[209]
I. The International Nuclear Event Scale (INES)[210]

TECHNICAL ANNEXES

1. Self-Insurance - Nuclear insurance mutuals
2. Self-Insurance – Operator pooling arrangements
3. Risk-transfer - Nuclear insurance pools and MGAs
4. Risk-transfer - ILS and cat bonds
5. Capital, capacity and underwriting
6. Losses occurring and claims made policy language

208 Sourced from OECD Nuclear Energy Agency

209 Sourced from US NRC

210 Sourced from IAEA/OECD Nuclear Energy Agency

A. GLOSSARY

The definitions and annotations in this table were obtained from the open sources whose links are provided in the third column. In most cases the definitions were copied in their entirety. Changes that were occasionally introduced mainly fall in one of the following three categories: swapping of the Dollar sign ($) with the Euro sign (€), abbreviation of the full definition or addition of further explanation in brackets. None of them is intended to infringe the rights of their authors, who in most cases are not indicated on the websites themselves[211], but to achieve brevity and clarity considering the audience to which the Report will be available.

Definitions and clarifications in blue are written by the authors of the study.

Term	Definition	Annotations	Source
Actuary	An actuary is a professional statistician who calculates the risks associated with insurance coverage and the likelihood that claims will be filed or that benefits will have to be paid out. Using relevant statistical data, actuaries also compute dividends and decide premium rates.	Actuaries need expertise in mathematics, statistics, and economics to fulfil their responsibility of evaluating risks and returns associated with each insurance product offered. Crucial to an insurance company's operation and profitability, they help ensure premiums are offered at a rate that is not only competitive but also enough to cover the risks of the specific coverage offered. If the rate is set too high, then potential customers may not want to purchase policies. However, if premium rates are too low, then the insurance company may not be able to cover all the claims policyholders file.	Insuranceopedia https://www.insuranceopedia.com (retrieved on 20 March 2019)
Attachment Basis	A provision in reinsurance agreements that determines whether, and in what manner, a reinsurance agreement covers a specific loss.		International Risk Management Institute, Insurance and Risk Management Terms https://www.irmi.com/term/insurance-definitions/attachment-basis (retrieved on 13 March 2019)
Broker	Insurance broker or insurance agent is a person or firm which acts as an intermediary in bringing together clients seeking insurance cover and insurance companies offering suitable policies. In some cases, the agent may simply introduce the two parties to each other and receive a	Broker vs. Agent The main difference between a broker and an agent has to do with whom they represent. An agent represents one or more insurance companies. He or she acts as an extension of the	Collins Dictionary of Business, 3rd ed. © 2002, 2005 C Pass, B Lowes, A Pendleton, L Chadwick, D O'Reilly and M Afferson

211 Definitions from the website Investopedia were reviewed by Ms. Julia Kagan, while the authors are not named.

Term	Definition	Annotations	Source
	commission from the insurance company; or the agent may be employed by a particular insurance company to sell insurance policies on its behalf, partly on salary and partly on commission. Insurance brokers are usually independent intermediaries who are able to negotiate with a number of insurance companies on behalf of clients in order to secure for them the most advantageous cover and terms, as well as handling claims and offering general insurance advice.	insurer. A broker, on the other hand, represents the insurance buyer.	
Capacity	Underwriting capacity is the maximum liability that an insurance company is willing to assume from its underwriting activities.	An insurance company's potential for profitability depends on its appetite for risk. The more risk it assumes by underwriting new insurance policies, the more premiums it collects and later invests. When an insurer accepts additional hazards, through the issuance of policies, the possibility increases that it may become insolvent. A company's underwriting capacity, or the maximum amount of acceptable risk, is a crucial component of its operations. To protect policyholders, regulators prohibit insurance companies from underwriting an unlimited number of policies. How Insurers Increase Underwriting Capacity Over time, an insurer's underwriting capacity can change based on how the factors used to calculate its capacity change. An insurance company can increase its underwriting capacity by underwriting policies that cover less volatile risks. As an example, a company may refuse to write new property insurance coverage in a hurricane-prone zone, but will still cover hazards from fire and theft. Limiting the risk of policies written reduces the likelihood that the company will have to pay out claims.	Investopedia https://www.investopedia.com (retrieved on 13 March 2019)

Term	Definition	Annotations	Source
		Insurers are also able to increase underwriting capacity by ceding their obligations to a third party, as with reinsurance treaties. In a reinsurance contract, the reinsurer assumes some of an insurer's liability in exchange for a fee or a portion of the premiums paid by the policyholder. The liabilities assumed by the reinsurer no longer count against the ceding company's underwriting capacity, which allows the insurer to underwrite new policies.	
Captive Insurance Company	A captive insurance company is a wholly owned subsidiary company that provides risk-mitigation services for its parent company or a group of related companies. A captive insurance company may form if the parent company cannot find an outside firm to insure them against particular business risks; if the premiums paid to the captive insurer creates tax savings; or if the insurance provided is more affordable or offers better coverage for the parent company's risks.	A captive insurance company is a form of corporate "self-insurance." While there are financial benefits of creating a separate entity to provide insurance services, parent companies must consider the associated administrative and overhead costs, such as additional personnel. There are also complex compliance issues to consider. As a result, larger corporations predominantly form captive insurance companies	Investopedia https://www.investopedia.com (retrieved on 13 March 2019)
Claims made (policy)	Claims-made policies provide coverage for claims only when both the alleged incident and the resulting claim happen during the period the policy is in force. See additional information on claims made and losses occurring in TECHNICAL ANNEX 6.	Claims-made vs. Occurrence Coverage Claims-made Coverage Timing: Claims-made policies provide coverage for claims only when BOTH the alleged incident AND the resulting claim happen during the period the policy is in force. Claims made policies provide coverage so long as the insured continues to pay premiums for the initial policy and any subsequent renewals. Claims made to the insurance company after the coverage period ends will not be covered, even if the alleged incident occurred while the policy was in force. Limits: Claims-made limits DO NOT "restore" each year the way Occurrence Coverage limits do. The	International Risk Management Institute, Insurance and Risk Management Terms https://www.irmi.com/glossary?taxonomy=alphanumeric&propertyName=tags&taxon=a (retrieved 18 March 2019)

Term	Definition	Annotations	Source
		policy limits in place when the policy is purchased remain the single set of limits available to protect the insured from all claims that could arise from care provided during the years the policy is continuously in force. The insured does not have a separate set of limits for each year the policy is in force. Occurrence Coverage Timing: An Occurrence policy protects you from any covered incident that "occurs" during the policy period, regardless of when a claim is filed. An occurrence policy will respond to claims that come in – even after the policy has been cancelled – so long as the incident occurred during the period in which coverage was in force. Limits: Occurrence limits "restore" each year so that claims paid for incidents arising from one policy year do not deplete limits available to cover claims from other years. Each year an Occurrence policy is in force represents a separate set of limits. Ten years of coverage under a €1M/$3M Occurrence policy could provide the insured protection for up to €30MM in claims (ten year combined annual aggregate limit).	
Coinsurance	Coinsurance usually refers to the sharing of risk between the insurer and insured. In this sense, coinsurance is the amount, generally expressed as a fixed percentage, an insured must pay against a claim after the deductible is satisfied. It can also mean the sharing of risks between at least two title insurance companies.	Example – health coinsurance One of the most common coinsurance breakdowns in health insurance is the 80/20 split. Under the terms of an 80/20 coinsurance plan, the insured is responsible for 20% of medical costs, while the insurer pays the remaining 80%. However, these terms only apply	Investopedia https://www.investopedia.com (retrieved on 13 March 2019) Market Business News https://marketbusinessnews.com/financial-glossary/coinsurance-definition-meaning/ (retrieved on 13 March 2019)

Term	Definition	Annotations	Source
	In most of Europe's international insurance market, the term refers to the second meaning. Usually, one insurance firm will lead. That company will be responsible for various aspects of the insurance policy including the premium, claims. The lead company will also be responsible for the insurance documents. In such cases, the company levies a charge (*lead office commission*).	after the insured has reached the term's out-of-pocket deductible amount.	
Coinsurer	A coinsurer is one of the parties that provides additional insurance to the same person or policy. This party provides partial coverage along with other coinsurers. They are generally used when the amount of the policy being written is too large for a single insurer to cover by itself.		Investopedia https://www.investopedia.com (retrieved on 19 March 2019)
Credit rating	An insurance company credit rating is the opinion of an independent agency regarding the financial strength of an insurance company. An insurance company's credit rating indicates its ability to pay policyholders' claims. It does not indicate how well the insurance company's securities are performing for investors.		Investopedia https://www.investopedia.com (retrieved on 19 March 2019)
Excess of loss (reinsurance)	Excess of loss reinsurance is a type of reinsurance in which the reinsurer indemnifies the ceding company for losses that exceed a specified limit. Excess of loss reinsurance is a form of non-proportional reinsurance.	Excess of loss reinsurance takes a different approach. The reinsurance company is held responsible for the total amount of losses above a certain limit. For example, a reinsurance contract with an excess of loss provision may indicate that the reinsurer is responsible for losses over €500,000. In this case, if aggregate losses amount to €600,000 the reinsurer will be responsible for €100,000. Excess of loss reinsurance can also work a slightly different way. Rather than require the reinsurer to be responsible for all losses over a certain amount, the contract may instead indicate that	Investopedia https://www.investopedia.com (retrieved on 19 March 2019)

Term	Definition	Annotations	Source
		the reinsurer is responsible for a percentage of losses over that threshold. This means that the ceding company and the reinsurer will share aggregate losses. For example, a reinsurance contract with an excess of loss provision may indicate that the reinsurer is responsible for 50 percent of the losses over €500,000. In this case, if aggregate losses amount to €600,000, the reinsurer will be responsible for €50,000 and the ceding company will be responsible for €50,000.	
Facultative (reinsurance contract)	Facultative reinsurance is purchased by a primary insurer to cover individual risks held in the primary insurer's book of business. Facultative reinsurance is one of the two types of reinsurance, with the other type being treaty reinsurance.	Treaty vs. Facultative reinsurance An insurance company (ceding company) that enters into a reinsurance contract with a reinsurance company does so in order to pass off some of their risk in exchange for a fee. The primary insurer that cedes risk to the reinsurer has the option of ceding specific risks or a block of risks. Reinsurance contract types determine whether the reinsurer is able to accept or reject an individual risk, or if the reinsurer must accept all risks. Treaty reinsurance is a broad agreement covering some portion of a particular class or class of business, such as an insurer's entire *workers' compensation* or *property business*. Reinsurance treaties automatically cover all risks, written by the insured that fall within treaty terms defining the portion of a particular class or class of business. While treaty reinsurance does not require review of individual risks by the reinsurer, it demands a careful review of the underwriting philosophy, practice and historical experience of the ceding insurer. This is an indicator that the relationship between the ceding company and the reinsurer is expected to	Investopedia https://www.investopedia.com (retrieved on 13 March 2019)

Term	Definition	Annotations	Source
		be more long-term than if the reinsurer only dealt with one-off transactions, covering single risks. Facultative reinsurance covers individual policies and are written on a policy-specific basis. A facultative agreement covers a specific risk of the ceding insurer. Facultative reinsurance allows the reinsurance company to review individual risks and determine whether to accept or reject them. A reinsurer and ceding insurer must agree on terms and conditions for each individual contract. Facultative reinsurance agreements often cover catastrophic or unusual risk exposures. Facultative reinsurance is considered to be more of a one-off transactional deal while treaty reinsurance is more of a long-term arrangement.	
Gearing	The term used where an insurer's capacity is increased by buying reinsurance.	For example, an insurer has a net capacity of $1million for catastrophe risks; it decides it wants to increase its share of certain risks and therefore buys reinsurance for $4million excess of its retention of $1million. The insurer now has a capacity of up to $5million, thanks to gearing.	
Indemnity	Indemnity is compensation for damages or loss, and in the legal sense, it may also refer to an exemption from liability for damages. The concept of indemnity is based on a contractual agreement made between two parties, in which one party agrees to pay for potential losses or damages caused by the other party. A typical example is an insurance contract, whereby one party (the insurer or the indemnitor) agrees to compensate the other (the insured or the indemnitee) for any damages or losses, in return for premiums paid by the insured to the insurer.		Investopedia https://www.investopedia.com (retrieved on 13 March 2019)

Term	Definition	Annotations	Source
Leader/leading (re)insurer	The lead (re)insurer responsible for negotiating the terms and rates of a (re)insurance treaty that other (re)insurers participate in. The lead (re)insurer, also known as the lead underwriter, is the first party to sign the (re)insurance slip or contract. The choice of a lead (re)insurer usually depends on their level of expertise and experience. The other participating (re)insurers subscribing to the contract are known as followers.	See definition of the term coinsurance.	Investopedia https://www.investopedia.com (retrieved on 13 March 2019)
Limit(s)	The amount of insurance purchased.	In the context of NTPL, the financial security amounts required and fulfilled by insurance are often referred to as limits; the limit is the amount of financial exposure assumed by the insurer/reinsurer.	
Lloyd's (market)	Lloyd's of London is the leading global specialist insurance and reinsurance market.	Often referred to as simply 'Lloyd's' the market encompasses over 50 competing insurance entities (underwriters), over 200 competing brokers (which act as the intermediaries between the client – or buyer of insurance – and the underwriter) as well as the governance infrastructure. The insurers trade from an underwriting floor, in offices and increasingly electronically with the brokers who present underwriters with complex risks. The Lloyd's infrastructure consists of regulatory bodies, an agency network and several associations open to all market players. Lloyd's was founded in 1688, originally as a subscription marine underwriting venue.	https://www.lloyds.com/about-lloyds/what-is-lloyds
Losses occurring during	Loss occurring during (LOD): With the Loss occurring basis, the Reinsurer agrees to indemnify the reinsured for losses occurring	Loss occurring during vs. Risk Attaching During Risk Attaching During (RAD): The Reinsurer agrees to indemnify the reinsured for losses stemming from policies that are issued within	Simplified and adapted explanation from the article published by Mr. J. Iranya, Underwriting Officer at ICEA General Insurance Company ltd; available

Term	Definition	Annotations	Source
	during the period of reinsurance regardless of the issue date of the underlying insurance policy. For example: If a Reinsurance Contract Runs from 01/Jan/2017 to 01/Jan/2018, the reinsured will be covered for all losses that occur between those two dates, even if the underlying insurance policy was issued in 2016. See additional information on claims made and losses occurring in TECHNICAL ANNEX 6.	the Reinsurance Period, irrespective of the date of occurrence of loss. For example: A reinsurance contract runs from 01 /Jan/2017 to 01/Jan/2018 and an insurance policy is issued during that period (e.g. sometime July 2017). A loss covered by that insurance occurs on 5/June/2018. That loss will be covered since the insurance policy_for it was incepted within the reinsurance period. If the insurance policy was issued prior to 01/Jan/ 2017 then the loss wouldn't be covered.	https://www.linkedin.com/pulse/excess-loss-risk-attaching-rad-basis-vs-occurring-during-joseph/ (retrieved on 19 March 2019)
Managing general agent (MGA)	A specialized type of insurance agent/broker that, unlike traditional agents/brokers, is vested with underwriting authority from an insurer. Accordingly, MGAs perform certain functions ordinarily handled only by insurers, such as binding coverage, underwriting and pricing, appointing retail agents within a particular area, and settling claims. See additional information on managing general agents TECHNICAL ANNEX 3.	Typically, MGAs are involved with unusual lines of coverage, such as professional liability and surplus lines of insurance, in which specialized expertise is required to underwrite the policies. However, MGAs also write some personal lines business, especially in geographically isolated areas where insurers do not want to set up a branch office. MGAs benefit insurers because the expertise they possess is not always available within the insurer's home or regional offices and would be more expensive to develop on an in-house basis.	International Risk Management Institute, Insurance and Risk Management Terms https://www.irmi.com/glossary?taxonomy=alphanumeric&propertyName=tags&taxon=a (retrieved on 19 March 2019)
Occurrence Coverage	An Occurrence policy protects you from any covered incident that "occurs" during the policy period, regardless of when a claim is filed. An occurrence policy will respond to claims that come in – even after the policy has been cancelled – so long as the incident occurred during the period in which coverage was in force.	See "Claims made"	International Risk Management Institute, Insurance and Risk Management Terms https://www.irmi.com/glossary?taxonomy=alphanumeric&propertyName=tags&taxon=a (retrieved 18 March 2019)
Policy limit	A policy limit refers to the monetary amount that an insurance company will pay out in relation to a specific insurance policy claim. It refers to the maximum amount of money for which an insurance company is responsible.	Insurance policy limits are contractually agreed upon at the time an insurance policy is created. Policies specify either the individual limit (the most amount payable in one claim) or the aggregate limit (the highest amount that can be	Insuranceopedia https://www.insuranceopedia.com (retrieved on 14 March 2019)

Term	Definition	Annotations	Source
		paid in any policy year for all claims). For example, when you consider a policy with an individual limit of €1 million and an aggregate limit of €4 million, this policy will provide a maximum of €1 million per claim and €4 million for all claims during a policy term.	
Primary (insurance)	Primary insurance is a policy that pays for coverage first, even when the policyholder has other policies that cover the same risk. Those other policies will only be tapped when the primary policy has reached its financial limit.	Excess insurance is triggered when the primary insurance is exhausted.	Insuranceopedia https://www.insuranceopedia.com and Business Dictionary http://www.businessdictionary.com/definition/primary-insurance.html (both retrieved on 19 March 2019)
Quota-share (treaty)	A quota share treaty is a pro rata reinsurance contract in which the insurer and reinsurer share premiums and losses according to a fixed percentage. Quota share reinsurance allows an insurer to retain some risk and premium, while sharing the rest with an insurer up to a predetermined maximum coverage.	As an example, consider an insurance company looking to reduce its exposure to the liabilities it has created through its underwriting activities. It enters into a quota share reinsurance contract. The contract has the insurance company retaining 40 percent of its premiums, losses, and coverage limits, but ceding the remaining 60 percent to a reinsurer. This treaty would be called a 60 percent quota share treaty, because the reinsurer is taking on 60 percent of the insurer's liabilities.	Investopedia https://www.investopedia.com (retrieved on 19 March 2019)
Reinsurance	Reinsurance is also known as insurance for insurers. Reinsurance is the practice whereby insurers transfer portions of their risk portfolios to other parties by some form of agreement to reduce the likelihood of paying a large obligation resulting from an insurance claim.	The party that accepts a portion of the potential obligation in exchange for a share of the insurance premium is known as the reinsurer. The party that diversifies its insurance portfolio is known as the ceding party.	Investopedia https://www.investopedia.com (retrieved on 19 March 2019)
Reinsurer	A reinsurer is a company that provides financial protection to insurance companies. Reinsurers handle risks that are too large for insurance companies to handle on their own and make it possible for insurers to obtain more business (that is, underwrite more policies) than they		Investopedia https://www.investopedia.com (retrieved on 19 March 2019)

Term	Definition	Annotations	Source
	would otherwise be able to. Reinsurers also make it possible for primary insurers to keep less capital on hand to cover potential losses.		
Reserving	Insurance companies must hold a portion of their assets (statutory reserves) as either cash or marketable investments to remain solvent and attain partial protection against a substantial investment loss. In addition to these statutory reserves insurance companies may as well hold voluntary reserves. However, for insurers, reserves are a balancing act. They'll seek to keep the minimums required by state regulators but increasing reserves beyond that siphons away capital that could be used to create more value for stakeholders. For property and casualty insurers, various tax laws and accounting practices discourage them from setting aside excess money for contingencies such as catastrophes. Standard levels of reserves include 8 to 12% of the insurers' total revenues. These requirements are never really fixed since they depend on the type of risks a company has presently assumed.	Actuarial Reserve An actuarial reserve is used to account for the amount of money that an insurance company will be liable to pay (in the event of a claim) based on an estimate of the present value of all future income that is derived from a contingent event. The actuarial reserve is simply a sum of all the amounts that we need to invest today in order to meet our obligations under the policy. Calculating Actuarial Reserves In order to calculate an actuarial reserve, we need to make some simple assumptions; these involve how much we are likely to have to pay out and how much interest we can earn on our investments (from the premiums we collect). The more accurate our assumptions – the better our actuarial reserves can be calculated. Let's say that we expect to pay out €500,000 on a policy and that we expect to pay out €250,000 in Year 1, €150,000 in Year 2 and €100,000 in Year 3. The actuarial reserve should tell us how much money we need to put aside today to cover these payments. Now €1 today is worth more than €1 in 3 years' time. So in order to make for an insurer to make provision for these payments they need to determine what they need to invest today – to pay out in full when the payments are due. There is a reasonably simple formula to do this: Amount Required to be Paid x (1+the rate of interest)^$^{-years}$=The Amount Required to be Invested	*How to Calculate an Actuarial Reserve*, by Jed Gigeron, 7 November 2014, http://riskheads.org/calculate-actuarial-reserve/ Investopedia https://www.investopedia.com (retrieved on 19 March 2019)

Term	Definition	Annotations	Source
		Now this may look complicated but if we assume the rate of interest to be a steady 6% on our investments the example above can be worked out like this: In Year 1 we need to pay €250,000 so let's put the numbers into the formula: 250,000 x (1+0.06)^-1= €235,849 That means if we put €235,849 into our investment vehicle now; in 1 year it will be worth the €250,000 we need to pay out. In Year 2 we need to pay €150,000 so: 150,000 x (1+0.06)^-2=€133,499 And investing €133,499 now at that 6% will realize €150,000 in 2 years' time when we need to pay out. In Year 3 we need to pay €100,000 so: 100,000 x (1+0.06)^-3=€83,961 So in the example above this €235,849 + €133,499 + €83,961 = €453,309 is our actuarial reserve. If we invest this amount of money and get a 6% interest rate; it will be worth the full €500,000 we have to pay to meet our obligations under the claim on the policy. <u>Statutory Reserves</u> Statutory reserves are state regulated reserve requirements. <u>Voluntary Reserve (Excess Reserve)</u> Insurance companies hold voluntary reserves to appear to be more financially stable and improve their liquidity ratios. Such requirements are often internally agreed upon by the insurer and not decided by law.	

Term	Definition	Annotations	Source
		Claims reserve A claims reserve is the money that is earmarked for the eventual claim payment. The claims reserve funds are set aside for the future payment of incurred claims that have not been settled and, thus, represent a balance sheet liability. Valuation Reserve Valuation reserves are assets that insurance companies set aside per state law to mitigate the risk of declines in the value of investments they hold. These reserves protect the insurance company from losses from investments that may not perform as expected. This helps assure that policy holders are paid for claims and that annuity holders receive income even if an insurance company's assets lose value. Asset Valuation Reserve An asset valuation reserve is capital required to be set aside in order to cover a company against unexpected debt. The intent for an asset valuation reserve is to function as failsafe or safety net of capital that can be accessed in the event of credit or equity losses that might adversely affect an organization's ability to meet and fulfill its obligations. Actuarial calculations are used to find the amount of asset valuation reserve is necessitated to cover different assets. Interest Maintenance Reserve An Interest Maintenance Reserve is a reserve of funds and other assets that are held in order to offset fluctuations in the interest rate.	

Term	Definition	Annotations	Source
Retention	In reinsurance, the net amount of risk the ceding company keeps for its own account. In insurance, the amount of exposure the insured keeps for its own account.		International Risk Management Institute, Insurance and Risk Management Terms https://www.irmi.com/term/insurance-definitions/retention (retrieved 18 March 2019)
Retrocession	A transaction in which a reinsurer transfers risks it has reinsured to another reinsurer.		International Risk Management Institute. https://www.irmi.com/term/insurance-definitions/retrocession
Signing (down)	Where a risk is oversubscribed, which is when the underwriter's written lines (i.e. chosen shares) exceed 100%, those lines will be proportionally reduced ('signed down) until they total 100%.		https://www.lloyds.com/help-and-glossary/glossary-and-acronyms?Term=signing+down
Solvency II	The Solvency II Directive is a Directive in European Union law that codifies and harmonises the EU insurance regulation.	The risk-oriented and forward-looking approach of Directive 2009/138/EG, OJ No. L 335/1 of 17 December 2009 (Solvency II) introduces a fundamentally new approach for calculating insurance company capital requirements and changes the supervisory measures and tools available. The new rules are divided into three pillars: - Pillar 1: Quantitative requirements - Pillar 2: Qualitative requirements and supervisory rules - Pillar 3: Reporting and disclosure	Various European financial regulators, for example: https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii https://www.bafin.de/EN/Aufsicht/VersichererPensionsfonds/Aufsichtsregime/SolvencyII/solvency_II_node_en.html https://english.bmf.gv.at/financial-sector/solvency-II.html https://www.lloyds.com/market-resources/regulatory/solvency-ii/about/what-is-solvency-ii
Tail (long or short)	A colloquial expression used by underwriters to describe the duration of the exposure accepted under an insurance policy.	Generally 1st party property risks have an annual exposure with few if any claims expected after the policy expiry; this would be a short tail exposure. TPL policies, in contrast, are generally long tail as the exposure may extend well beyond the policy expiry date, due to prescription periods. A good example of a very long-tail exposure is the bodily injury NTPL exposure proposed by the revised NTPL Conventions. The bodily injury exposure will last for 30 years after the nuclear occurrence	

Term	Definition	Annotations	Source
		that causes the injury, notwithstanding the actual insurance policy period.	
Treaty reinsurance contract	**See annotations for the term Facultative reinsurance contract**		
Underwriting/ Underwriter	Underwriting is the process by which an individual or institution takes on financial risk for a fee. The risk most typically involves loans, insurance, or investments. The term underwriter originated from the practice of having each risk-taker write their name under the total amount of risk they were willing to accept for a specified premium. See additional information on underwriting in TECHNICAL ANNEX 5.	Underwriting involves conducting research and assessing the degree of risk in each applicant or entity before assuming that risk. This check helps set fair borrowing rates for loans, establish appropriate premiums to adequately cover the true cost of insuring policyholders, and create a market for securities by accurately pricing investing risk. Risk is the underlying factor in all underwriting. With insurance, the risk involves the likelihood that too many policyholders will file claims at once. Hence, underwriters seek to assess policyholder health and other factors and to spread potential risk among as many people as possible. A big part of the underwriter's job is to weigh the known risk factors and investigate an applicant's truthfulness to determine the minimum price for providing coverage. Underwriters help establish the true market price of risk by deciding on a case-by-case basis which transactions they are willing to cover and what rates they need to charge to make a profit.	Investopedia https://www.investopedia.com (retrieved on 19 March 2019)

B. OBJECTIVE AND TASK INDEX

	GENERAL OBJECTIVES	
	Present an in-depth qualitative and quantitative analysis of the insurance, private and financial markets in EU Member States in the field of nuclear third party liability	**Consider the best possible ways of developing additional capacity on these markets, within the framework of the CMU, with the view of increasing private coverage in this field.**
SPECIFIC OBJECTIVES	*Provide a description of the different actors from the insurance, private and financial markets which operate in the EU in the field of nuclear third-party liability* A	*Provide an estimate regarding the capacity of the insurance, private and financial markets to provide for increased coverage in the field of nuclear third party liability and identify possible solutions to be set up for that purpose, such as legal solutions to increase legal certainty for the insurers or other actors, or multiple layer schemes and mechanisms, including trigger mechanisms* D
	Provide an estimate of the capacity of the insurance, private and financial markets currently available for each respective head of damage, at the global and EU level, for third party liability in case of a nuclear accident and identify the constraints regarding the availability of this capacity B	*Assess the most relevant and important likely impacts of the different solutions and mechanisms identified and indicate which solutions/mechanisms would be more effective for covering the gaps of the insurance, private and financial markets in the field of nuclear third party liability and for providing an increased coverage in this field* E
	Identify currents gaps in the insurance, private and financial markets in the field of nuclear third party liability, as well as possible solutions to cover for these gaps including through the identification of possible multiple layer schemes and mechanisms, focusing on private solutions C	

WHERE TO FIND THESE IN THE STUDY REPORT….

	GENERAL OBJECTIVES	
	Present an in-depth qualitative and quantitative analysis of the insurance, private and financial markets in EU Member States in the field of nuclear third party liability	**Consider the best possible ways of developing additional capacity on these markets, within the framework of the CMU, with the view of increasing private coverage in this field.**
LOCATION IN STUDY REPORT	***MAIN STUDY: Section 3. ANNEXES: C,F. TECHNICAL ANNEXES 1,2, 3.*** A	***MAIN STUDY: Section 5, Section 7 (triggers). ANNEXES: H,I.*** D
	MAIN STUDY: Section 4. ANNEXES: D,E,F,G. B	***MAIN STUDY: Section 6, Section 7 (recommendations). TECHNICAL ANNEXES: 4,5,6.*** E
	MAIN STUDY: Section 4 (gaps), Section 5, 6 (new solutions). TECHNICAL ANNEX: 2,4,5. C	

C. NUCLEAR POWER PLANTS IN THE EU

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
Belgium (7)							
	Doel Nuclear Power Plant ***Kerncentrale Doel (KCD)***	On the bank of the Scheldt river, near the village of Doel in the East Flanders province	4 PWR		Doel 1 Doel 2 Doel 3 Doel 4	454 454 1056 1090	Engie Electrabel + EDF Belgium + EDF Luminus https://www.engie-electrabel.be/nl/ https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=874639
				4		3054	
	Tihange Nuclear Power Plant ***Centrale nucléaire de Tihange (CNT)***	In the town Tihange, near the city of Huy, along the right bank of the Meuse	3 PWR		Tihange 1 Tihange 2 Tihange 3	1009 1055 1089	Engie Electrabel
				3		3153	
Bulgaria (2)							
	Kozloduy Nuclear Power Plant ***АЕЦ „Козлодуй“***	In the northern part of the province Vratsa	2 PWR		KOZLODUY-5 KOZLODUY-6	1000 1000	Kozloduy NPP, Plc. http://www.kznpp.org/index.php?lang=en&p=about_aec&p1=company_profile https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=41323751
				2		2000	
Czech Republic (6)							
	Dukovany Nuclear Power Plant ***Jaderná elektrárna Dukovany (EDU/JEDU)***	Near Dukovany village in Třebíč District in the Vysočina Region	4 PWR		DUKOVANY-1 DUKOVANY-2 DUKOVANY-3 DUKOVANY-4	500 500 500 500	Cez Group, Cez a.s. https://www.cez.cz/en/home.html https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=8350267
				4		2000	
	Temelín Nuclear Power Plant **Jaderná elektrárna Temelín (JETE)**	Near town Temelín in South Bohemian Region	2 PWR		TEMELIN-1 TEMELIN-2	1080 1080	Cez Group
				2		2160	
Finland (4)							
	Loviisa Nuclear Power Plant ***Loviisan ydinvoimalaitos***	Near the town Lovissa in the Eastern Uusimaa region	2 PWR		LOVIISA-1 LOVIISA-2	531 526	Fortum Power and Heat Oy (former IVO) https://www.fortum.com https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=6427741
				2		1057	
	Olkiluoto Nuclear Power Plant ***Olkiluodon ydinvoimalaitos***	On Olkiluoto Island, on the shore of the Gulf of Bothnia in the municipality of Eurajoki in western Finland.	2 BWR 1 PWR (under construction)		OLKILUOTO-1 (BWR) OLKILUOTO-2 (BWR) OLKILUOTO-3 (PWR) (u.c.)	910 910 1720 (u.c.)	Teollisuuden Voima Oyj https://www.tvo.fi/home https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=875857
				2		1820	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
France (58)							
	Belleville Nuclear Power Plant ***Centrale Nucléaire de Belleville***	Located in Belleville-sur-Loire commune, in the Cher department in the Centre-Val de Loire region	2 PWR		BELLEVILLE-1 BELLEVILLE-2	1363 1363	Électricité de France https://www.edf.fr/en/meta-home https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=690392
				2		2726	
	Blayais Nuclear Power Plant ***Centrale nucléaire du Blayais***	Near Braud-et-Saint-Louis, department Gironde, region Nouvelle-Aquitaine	4 PWR		BLAYAIS-1 BLAYAIS-2 BLAYAIS-3 BLAYAIS-4	951 951 951 951	Électricité de France
				4		3804	
	Bugey Nuclear Power Plant ***Centrale nucléaire du Bugey***	Located in Bugey in the Saint-Vulbas commune, department Ain, region Auvergne-Rhône-Alpes,	1 PWR in permanent shutdown 4 PWR operational		BUGEY-1 BUGEY-2 BUGEY-3 BUGEY-4 BUGEY-5	permanent shutdown 945 945 917 917	Électricité de France
				4		3724	
	Cattenom Nuclear Power Plant ***Centrale nucléaire de Cattenom***	Located in Cattenom commune, Moselle department, Grand Est region	4 PWR		CATTENOM-1 CATTENOM-2 CATTENOM-3 CATTENOM-4	1362 1362 1362 1362	Électricité de France
				4		5448	
	Chinon Nuclear Power Plant ***Centrale nucléaire de Chinon***	Located in the town of Avoine commune in the Indre et Loire department, Centre-Val de Loire region	3 GCR in permanent shutdown 4 PWR operational		CHINON A-1 CHINON A-2 CHINON A-3 CHINON B-1 CHINON B-2 CHINON B-3 CHINON B-4	permanent shutdown permanent shutdown permanent shutdown 954 954 954 954	Électricité de France
				4		3816	
	Chooz Nuclear Power Station ***Centrale nucléaire de Chooz***	Located in commune Chooz, in the Ardennes department, region Grand Est	1 PWR in permanent shutdown 2 PWR operational		CHOOZ-A (ARDENNES) CHOOZ B-1 CHOOZ B-2	permanent shutdown 1560 1560	Permanently shut – previously operated by Societe D'energie Nucleaire Franco-Belge Des Ardennes Remaining operational operated by Électricité de France
				2		3120	
	Civaux Nuclear Power Plant ***Centrale nucléaire de Civaux***	Located in the commune of Civaux, department Vienne, region Nouvelle-Aquitaine	2 PWR		CIVAUX-1 CIVAUX-2	1561 1561	Électricité de France
				2		3122	
	Cruas Nuclear Power Station ***Centrale nucléaire de Cruas-Meysse***	Located in Cruas and Meysse communes, Ardèch e department, Auvergne-Rhône-Alpes region	4 PWR		CRUAS-1 CRUAS-2 CRUAS-3 CRUAS-4	956 956 956 956	Électricité de France
				4		3824	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
	Dampierre nuclear power plant ***Centrale nucléaire de Dampierre***	Located in the town of Dampierre-en-Burly, in Loiret department, Centre-Val de Loire region	4 PWR		DAMPIERRE-1 DAMPIERRE-2 DAMPIERRE-3 DAMPIERRE-4	937 937 937 937	Électricité de France
				4		3748	
	Fessenheim Nuclear Power Plant ***Centrale nucléaire de Fessenheim***	Located in the Fessenheim commune in the Haut-Rhin department in Alsace	2 PWR		FESSENHEIM-1 FESSENHEIM-2	920 920	Électricité de France
				2		1840	
	Flamanville Nuclear Power Plant ***Centrale nucléaire de Flamanville***	Located in commune Flamanville, department Manche, region Normandy	2 PWR operational 1 PWR under construction		FLAMANVILLE-1 FLAMANVILLE-2 FLAMANVILLE-3 (u.c.)	1382 1382 1650	Électricité de France
				2		4414	
	Golfech Nuclear Power Plant ***Centrale nucléaire de Golfech***	Located in the commune of Golfech, department Tarn-et-Garonne, region Occitanie	2 PWR		GOLFECH-1 GOLFECH-2	1363 1363	Électricité de France
				2		2726	
	Gravelines Nuclear Power Centrale nucléaire de Gravelines	Located near the commune of Gravelines, department Nord, region Hauts-de-France	6 PWR		GRAVELINES-1 GRAVELINES-2 GRAVELINES-3 GRAVELINES-4 GRAVELINES-5 GRAVELINES-6	951 951 951 951 951 951	Électricité de France
				6		5706	
	Nogent Nuclear Power Plant ***Centrale nucléaire de Nogent***	Located in the commune of Nogent-sur-Seine, in the Aube department, region Grand Est	2 PWR		NOGENT-1 NOGENT-2	1363 1363	Électricité de France
				2		2726	
	Nuclear power station Paluel ***Centrale nucléaire de Paluel***	Located in the commune Paluel, in the department Seine-Maritime, region Normandy	4 PWR		PALUEL-1 PALUEL-2 PALUEL-3 PALUEL-4	1382 1382 1382 1382	Électricité de France
				4		5528	
	Penly Nuclear power station ***Centrale nucléaire de Penly***	Lies on the border of two municipalities: Penly and Saint-Martin-en-Campagne in the département of Seine-Maritime, region Normandy	2 PWR		PENLY-1 PENLY-2	1382 1382	Électricité de France
				2		2764	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
	Saint-Alban Nuclear Power Plant ***Centrale nucléaire de Saint-Alban***	Located in the communes of Saint-Alban-du-Rhône and Saint-Maurice-l'Exil, in the Isère department, region Auvergne-Rhône-Alpes	2 PWR		ST. ALBAN-1 ST. ALBAN-2	1381 1381	Électricité de France
				2		2762	
	Saint-Laurent Nuclear Power Station ***Centrale nucléaire de Saint-Laurent-des-Eaux***	Located in the commune of Saint-Laurent-Nouan, in Loir-et-Cher, region Centre-Val de Loire	2 GCR in permanent shutdown 2 PWR operational		ST. LAURENT A-1 ST. LAURENT A-2 ST. LAURENT B-1 ST. LAURENT B-2	permanent shutdown permanent shutdown 956 956	Électricité de France
				2		1912	
	Tricastin Nuclear Power Plant ***Centrale Nucléaire du Tricastin***	Located near the commune Pierrelatte, n the Drôme department, region Auvergne-Rhône-Alpes	4 PWR		TRICASTIN-1 TRICASTIN-2 TRICASTIN-3 TRICASTIN-4	955 955 955 955	Électricité de France
				4		3820	
Germany (7)							
	Brokdorf Nuclear Power Plant ***Kernkraftwerk Brokdorf (KBR)***	Located close to the municipality of Brokdorf in Steinburg, Schleswig-Holstein	1 PWR		BROKDORF	1480	PreussenElektra GmbH https://www.preussenelektra.de/en.html# https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=12787298
				1		1480	
	Emsland Power Plant ***Kernkraftwerk Emsland (KKE)***	Located near Lingen in the district Emsland, region Lower Saxony	1 PWR		EMSLAND	1406	Kernkraftwerke Lippe-Ems GmbH https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=5531817
				1			
	Grohnde Nuclear Power Plant ***Kernkraftwerk Grohnde (KWG)***	Located in Grohnde in the Hamelin-Pyrmont district in Lower Saxony	1 PWR		GROHNDE	1430	Gemeinschaftskernkraftwerk Grohnde GmbH & Co. oHG https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=99490113
				1		1430	
	Gundremmingen Nuclear Power Plant ***Kernkraftwerk Gundremmingen (KRB)***	Located in Gundremmingen, district of Günzburg, region Bavaria	2 BWR permanently shut down 1 BWR in operation		GUNDREMMINGEN-A GUNDREMMINGEN-B GUNDREMMINGEN-C	permanently shut down permanently shut down 1344	Kernkraftwerk Gundremmingen GmbH http://www.kkw-gundremmingen.de https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=6463730
				1		1344	
	Isar Nuclear Power Plant ***Kernkraftwerk Isar (KKI)***	Located in Essenbach, Lower Bavaria.	1 BWR permanently shut down 1 PWR in operation		ISAR-1 ISAR-2	permanently shut down 1485	PreussenElektra GmbH
				1		1485	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
	Neckarwestheim Nuclear Power Plant ***Gemeinschaftskraftwerk Neckar (GKN)***	Located in Neckarwestheim, in the Heilbronn district, Baden-Württemberg	1 PWR permanently shut down 1 PWR in operation		NECKARWESTHEIM-1 NECKARWESTHEIM-2	permanently shut down 1400	EnBW Kernkraft GmbH https://www.enbw.com/unternehmen/konzern/energieerzeugung/kernenergie/ https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=5886241
				1		1400	
	Philippsburg Nuclear Power Plant ***Kernkraftwerk Philippsburg (KKP)***	Located in Philippsburg in Karlsruhe	1 BWR permanently shut down 1 PWR in operation		PHILIPPSBURG-1 PHILIPPSBURG-2	permanently shut down 1468	EnBW Kernkraft GmbH
				1		1468	
Hungary (4)							
	Paks Nuclear Power Plant ***Paksi atomerőmű***	Located near the town Paks, in Tolna county, central Hungary	4 PWR		PAKS-1 PAKS-2 PAKS-3 PAKS-4	500 500 500 500	Paks nuclear power plant, ltd. (Paksi Atomerőmű Zrt.) http://www.atomeromu.hu/en/Lapok/default.aspx https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=5532666
				4		2000	
Netherlands (1)							
	Borssele Nuclear Power Station ***Kernenergiecentrale Borssele***	Located near the town of Borssele, province of Zeeland.	1 PWR		BORSSELE	515	Elektriciteits Produktiemaatschappij Zuid-Nederland https://epz.nl https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=5547026
				1		515	
Romania (2)							
	Nuclear Power Plant in Cernavodă ***Centrala Nucleară de la Cernavodă***	Located near the town Cernavodă, in Constanța County, Northern Dobruja	2 PHWR		CERNAVODA-1 CERNAVODA-2	706 705	Societatea Nationala Nuclearelectrica S.A. http://www.nuclearelectrica.ro https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=28851418
				2		1411	
Slovakia (4)							
	The **Bohunice Nuclear Power Plant** ***Atómové elektrárne Bohunice (EBO)***	Located near the village of Jaslovské Bohunice in the Trnava District	1 HWGCR permanently shut down 2 PWR permanently shut down 2 PWR in operation		BOHUNICE A1 BOHUNICE 1 BOHUNICE 2 BOHUNICE 3 BOHUNICE 4	permanently shut down permanently shut down permanently shut down 505 505	Slovenské elektrárne, a.s. https://www.seas.sk/company https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=5478139
				2		1010	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
	Mochovce Nuclear Power Plant ***Atómové elektrárne Mochovce (EMO)***	Located between the towns of Nitra and Levice, on the site of the former village of Mochovce	2 PWR operational 2 PWR under construction (since 1987)		MOCHOVCE-1 MOCHOVCE-2 MOCHOVCE-3 (u.c.) MOCHOVCE-4 (u.c.)	470 470 471 471	Slovenské elektrárne, a.s.
				2		1882	
Slovenia (1)							
	Krško Nuclear Power Plant ***Jedrska elektrarna Krško, (Slovenian)*** ***Nuklearna elektrana Krško (Croatian)***	Located in Vrbina in the Municipality of Krško	1 PWR		KRSKO	727	Nuklerana elektrarna Krško https://www.nek.si
				1		727	
Spain (7)							
	Almaraz Nuclear Power Plant	Located in Almaraz, in Cáceres Province, Extremadura	2 PWR		ALMARAZ-1 ALMARAZ-2	1049 1044	Centrales Nucleares Almaraz-Trillo (Id/Ufg/Endesa/Hc/Nuclenor) https://www.cnat.es https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=46970513
				2		2093	
	Ascó Nuclear Power Plant ***Central Nuclear de Ascó***	Located in Ascó, Catalonia	2 PWR		ASCO-1 ASCO-2	1033 1035	Asociacion Nuclear Asco-Vandellos (ANAV) a.i.e. (ENDESA) http://www.anav.es/en/ https://www.endesa.com/en/sustainability/a201611-nuclear-assets-management.html
				2		2068	
	Cofrentes Nuclear Power Plant **Central nuclear de Cofrentes**	Located about 2 kilometers southeast of the town Cofrentes, in the province of Valencia	1 BWR		COFRENTES	1102	Iberdrola, S.A. https://www.iberdrola.es https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=517300
				1		1102	
	Trillo Nuclear Power Plant ***Central nuclear de Trillo***	Located near the town Trillo, Guadalajara	1 PWR		TRILLO-1	1066	Centrales Nucleares Almaraz-Trillo (Id/Ufg/Endesa/Hc/Nuclenor)
				1		1066	
	Vandellòs Nuclear Power Plant ***Central nuclear de Vandellós***	Located in in Vandellòs, (Baix Camp comarca) Catalonia	1 GCR permanently shut down 1 PWR in operation		VANDELLOS-1 VANDELLOS-2	permanently shut down 1087	Asociacion Nuclear Asco-Vandellos (ANAV)
				1		1087	
Sweden (8)							
	Forsmark Nuclear Power Plant ***Forsmarks kärnkraftverk***	Located near the village Forsmark, municipality Östhammar, on the east coast of the province Uppland	3 BWR		FORSMARK-1 FORSMARK-2 FORSMARK-3	1022 1156 1195	Forsmarks Kraftgrupp AB https://corporate.vattenfall.se/om-oss/var-verksamhet/var-elproduktion/forsmark https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=5510618
				3		3373	
	Nuclear Power Plant Oskarshamn	Located near the city Oskarshamn, Oskarshamn	2 BWR permanently shut down		OSKARSHAMN-1	permanent shutdown	OKG

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
	Oskarshamns kärnkraftverk	Municipality, in the Kalmar County	1 BWR in operation		OSKARSHAMN-2 OSKARSHAMN-3	permanent shutdown 1450	http://www.okg.se/ https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=5532929
				1		1450	
	Ringhals Nuclear Power Plant ***Ringhals kärnkraftverk***	Situated on the Värö Peninsula, in Varberg Municipality, in Halland County	1 BWR 3 PWR		RINGHALS-1 RINGHALS-2 RINGHALS-3 RINGHALS-4	910 963 1117 1171	Ringhals AB https://corporate.vattenfall.se/om-oss/var-verksamhet/var-elproduktion/ringhals/ https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapid=6461460
				4		4161	
United Kingdom (15)							
	Dungeness Nuclear Power Station	Located in Romney Marsh	2 GCR permanently shut down 2 GCR in operation		DUNGENESS A-1 DUNGENESS A-2 DUNGENESS B-1 DUNGENESS B-2	permanent shutdown permanent shutdown 615 615	EDF Energy https://www.edfenergy.com
				2		1230	
	Hartlepool Nuclear Power Station	Located in Hartlepool	2 GCR		HARTLEPOOL A-1 HARTLEPOOL A-2	655 655	EDF Energy
				2		1310	
	Heysham Nuclear Power Station	Located in Heysham, Lancashire	4 GCR		HEYSHAM A-1 HEYSHAM A-2 HEYSHAM B-1 HEYSHAM B-2	625 625 680 680	EDF Energy
				4		2610	
	Hinkley Point Nuclear Power Station	Located in Somerset	2 GCR: permanently shut down 2 GCR: in operation		HINKLEY POINT A-1 HINKLEY POINT A-2 HINKLEY POINT B-1 HINKLEY POINT B-2	permanent shutdown Permanent shutdown 655 655	EDF Energy
				2		1310	
	Hunterston Nuclear Power Station	Located in Hunterston in Ayrshire, Scotland	2 GCR: permanently shut down 2 GCR: in operation		HUNTERSTON A-1 HUNTERSTON A-2 HUNTERSTON B-1 HUNTERSTON A-2	permanent shutdown permanent shutdown 644 644	EDF Energy
				2		1288	
	Sizewell Nuclear Power Station	Located near the village of Sizewell in Suffolk	2 GCR: permanently shut down 1 PWR: in operation		SIZEWELL A-1 SIZEWELL A-2 SIZEWELL B	permanent shutdown permanent shutdown 1250	EDF Energy
				1		1250	
	Torness Nuclear Power Station	Located near Dunbar, East Lothian, on the east coast of Scotland	2 GCR		TORNESS-1 TORNESS-2	682 682	EDF Energy
				2		1364	

EU Member state (total number of operational reactors)	Site name	Location	Number of reactors per site	Operating reactor total	MWe Gross Capacity per reactor	MW_e	Operator(s) name
			Total EU 28 MS operating reactors:	**126**	***(Note. EdF operated: 73 reactors or 58% of total)***		

D. NUCLEAR LIABILITY FINANCIAL SECURITY REQUIREMENTS FOR THE OPERATING NUCLEAR POWER PLANTS IN THE EU MS

EU Member state *(total number of operational reactors)*	Liability Convention	Installation/Activity	Operator's liability amount	Funds available		
				Financial Security Limit to cover Operator's Liability Amount	Public funds	International funds established by the BSC, except for Romania where established by the CSC
Belgium (7)						
	PC BSC (RPC) (RBSC) (JP)	Nuclear installations	EUR 1.2 billion	EUR 1.2 billion		SDR 125 million ***Approx. EUR 153 millions***
		Transport activities	EUR 297 millions	EUR 297 millions		
		Low risk installations	EUR 70-297 million	EUR 297 millions		
Bulgaria (2)						
	VC JP	Nuclear installations	BGN 96 millions[1]	BGN 96 millions ***Approx. EUR 49 millions***		
Czech Republic (6)						
	VC (RVC) JP (CSC)	Nuclear installations used for power generation purposes, storage facilities and repositories of spent fuel assigned to these installations or nuclear materials generated by reprocessing of spent fuel	CZK 8 billions ***Approx. EUR 308 millions***	CZK 2 billions ***Approx. EUR 7,7 millions***		
		Other nuclear installations and transport activities	CZK 2 billions ***Approx. EUR 77 millions***	CZK 300 millions minimum ***Approx. EUR 11 millions***		
Finland (4)						
	PC BSC RPC RBSC JP	Nuclear installations	Unlimited liability (for damage suffered within Finland) SDR 600 million (for damage suffered outside Finland) ***Outside Europe approx. EUR 735 millions***	SDR 600 millions ***Approx. EUR 735 millions***		SDR 125 million ***Approx. EUR 153 millions***
		Low risk installations and transport activities	SDR 5-600 millions ***Approx. EUR 6-735 millions***			

EU Member state *(total number of operational reactors)*	Liability Convention	Installation/Activity	Operator's liability amount	Funds available		
				Financial Security Limit to cover Operator's Liability Amount	**Public funds**	**International funds established by the BSC, except for Romania where established by the CSC**
France (58)						
	PC **BSC** **(RPC)** **(RBSC)** **JP**	Nuclear installations	EUR 700 millions	EUR 700 millions	After depletion of the operator's liability amount and up to SDR 175 million ***Approx. EUR 214 millions***	SDR 125 million ***Approx. EUR 153 millions***
		Low risk nuclear installations	EUR 70 millions			
		Transport activities	EUR 80 millions			
		Transit across France	EUR 80 million (if covered by the Paris Convention) Unlimited (if not covered by the Paris Convention)	EUR 80 million (if covered by the Paris Convention) EUR 700 million (if not covered by the Paris Convention)		
Germany (7)						
	PC **BSC** **(RPC)** **(RBSC)** **JP**	Nuclear Power Plants	Unlimited	NPP EUR 2.5 billion	Up to EUR 2,5 billion	SDR 125 million ***Approx. EUR 153 millions***
		Other Nuclear installations		Up to EUR 2.5 billion [maximum depending on thermal capacity (for reactors); on type, amount, activity and nature of radioactive substances (for other installations)]		
		Transport activities		Up to EUR 70 million (maximum depending on type, amount, activity and nature of the radioactive substances)		
Hungary (4)						
	VC **(RVC)** **JP**	Nuclear installations	SDR 100 millions ***Approx. EUR 122 millions***	SDR 100 millions ***Approx. EUR 122 millions***	SDR 200 millions ***Approx. EUR 245 millions***	
		Transport or storage of nuclear fuel	SDR 5 millions ***Approx. EUR 6 millions***	SDR 5 millions ***Approx. EUR 6 millions***	SDR 295 million ***Approx. EUR 361 millions***	
The Netherlands (1)						
	PC **BSC** **(RPC)** **(RBSC)** **JP**	Nuclear Power Plants	EUR 1.2 billion	EUR 1.2 billion	After depletion of the operator's liability amount and up to EUR 2.3 billions	SDR 125 millions ***Approx. EUR 153 millions***
		Enrichment installations, research reactors, storage installations and closed nuclear power plants	EUR 22.7-100 millions	EUR 22.7-100 millions	After depletion of the operator's liability amount and up to EUR 1.5 billion	
		Transport activities	EUR 8-22.7 millions	EUR 8-22.7 millions		

EU Member state *(total number of operational reactors)*	Liability Convention	Installation/Activity	Operator's liability amount	Funds available		
				Financial Security Limit to cover Operator's Liability Amount	**Public funds**	**International funds established by the BSC, except for Romania where established by the CSC**
Romania (2)						
	VC RVC JP CSC	Nuclear installations	SDR 300 million (can be reduced to SDR 150 million if State provides for the difference up to SDR 300 millions) ***Approx. EUR 367 millions and EUR 183 millions respectively***	SDR 300 million (can be reduced to SDR 150 million if State provides for the difference up to SDR 300 millions) ***Approx. EUR 367 millions and EUR 183 millions respectively***	After depletion of the operator's liability amount, and up to SDR 300 million ***Approx. EUR 367 millions***	SDR 108 million ***Approx. EUR 132 millions***
		Research reactors, radioactive waste and spent fuel storage facilities	SDR 30 million (can be reduced to SDR 10 million if State provides for the difference up to SDR 30 million) ***Approx. EUR 36 millions and EUR 12 millions***	SDR 30 million (can be reduced to SDR 10 million if State provides for the difference up to SDR 30 million) ***Approx. EUR 36 millions and EUR 12 millions***	After depletion of the operator's liability amount, and up to SDR 30 millions ***Approx. EUR 36 millions***	
		Transport of nuclear fuel used in a nuclear reactor	SDR 25 million ***Approx. EUR 30 millions***	SDR 25 million ***Approx. EUR 30 millions***		
		Transport of nuclear materials	SDR 5 million ***Approx. EUR 6 millions***	SDR 5 million ***Approx. EUR 6 millions***		
Slovakia (4)						
	VC JP	Nuclear installations with nuclear reactor or nuclear reactors serving for energy purposes (during their commissioning and operation)	EUR 300 millions	EUR 300 millions		
		Nuclear installations with nuclear reactor or nuclear reactors serving exclusively for scientific, educational or research purposes (during their commissioning and operation), transport of radioactive materials, nuclear materials and spent fuel handling, storage, conditioning and treatment of radioactive waste, any nuclear installations in decommissioning	EUR 185 millions	EUR 185 millions		
Slovenia (1)						
	PC BSC JP (RPC) (RBSC)	Nuclear installations	SDR 150 millions ***Approx. EUR 183 millions***	SDR 150 millions ***Approx. EUR 183 millions***	SDR 25 millions ***Approx. EUR 30 millions***	SDR 125 millions ***Approx. EUR 153 millions***
		Research reactors		SDR 5 millions ***Approx. EUR 6 millions***	SDR 170 millions ***Approx. EUR 208 millions***	
		Transport Activities		SDR 20 million ***Approx. EUR 24 millions***	SDR 155 millions ***Approx. EUR 190 millions***	
Spain (7)						
	PC BSC (RPC) RBSC (VC) (JP)	Nuclear installations	EUR 700 millions	EUR 700 millions	After depletion of the operator's liability amount and up to SDR 175 million ***Approx. EUR 214 millions***	SDR 125 millions ***Approx. EUR 153 millions***
		Low risk installations	EUR 30 millions minimum	EUR 30 million minimum		
		Transport activities				

EU Member state *(total number of operational reactors)*	Liability Convention	Installation/Activity	Operator's liability amount	Funds available		
				Financial Security Limit to cover Operator's Liability Amount	**Public funds**	**International funds established by the BSC, except for Romania where established by the CSC**
Sweden (8)						
	PC BSC JP (RPC) (RBSC)	Nuclear reactors used for power generation purposes	SDR 1000 millions	SDR 1000 million	SEK 900 millions ***Approx. EUR 88 millions***	SDR 125 millions ***Approx. EUR 153 millions***
		Other nuclear installations than nuclear reactors used for power generation purposes and transport activities	SDR 300 million	SDR 360 million		
		Installations for production and storage of un-irradiated uranium and transport activities	SDR 10 millions	SDR 12 millions		
United Kingdom (15)						
	PC, BSC, (RPC), (RBSC), (VC), (JP)	Nuclear installations and operator transport activities	GBP 140 million	GBP 10 million		
		Low risk installations (e.g. research reactors and nuclear disposal installations)	GBP 10 million	GBP 10 million	After depletion of the operator's liability amount and up to SDR 175 million ***Approx. EUR 214 millions***	SDR 125 million ***Approx. EUR 153 millions***

[1] As the last update for Bulgaria in the OECD publication was from 2011, we double checked the legal requirements for the operators liability (Act on the Safe Use of Nuclear Energy) on the website of the Regulatory authority (http://www.bnra.bg/en/documents-en/legislation/laws/asune-2018.pdf)

The data presented in the table above are extracted from the OECD's publication Nuclear Operators' Third Party Liability Amounts and Financial Security Limits (last updated: April 2018) and, where possible, double checked with collocutors who took part in the research as well as against publicly available information. Conversion to EUR was made in November 2018 using the calculator available on the website of the Statistical Data Warehouse of the European Central Bank (https://sdw.ecb.europa.eu/curConverter.do).

ACRONYMS

BSC: 1963 Brussels Convention Supplementary to the 1960 Paris Convention ("Brussels Supplementary Convention").

CSC: 1997 Convention on Supplementary Compensation for Nuclear Damage

JP: 1988 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention

PC: 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy ("Paris Convention")

RPC: 2004 Protocol to amend the Paris Convention ("Revised Paris Convention"), **not yet in force**

RSBC: 2004 Protocol to amend the Brussels Supplementary Convention ("Revised Brussels Supplementary Convention"), **not yet in force**

RVC: 1997 Protocol to Amend the Vienna Convention ("Revised Vienna Convention")

VC: 1963 Vienna Convention on Civil Liability for Nuclear Damage ("Vienna Convention")

( ): When between brackets, it means that the country has signed but not yet ratified the convention

E. NUCLEAR THIRD-PARTY LIABILITY INSURANCE CAPACITY ANALYSIS

Explanatory Notes

#	Note
1	The information presented shows the responses received from nuclear pools and other insurers concerning each capacity provider's NTPL capacity.
2	Each insurer has provided its **MAXIMUM** NTPL capacity available for both domestic business and international business, which for the pools is usually offered by way of reinsurance. For an understanding of MAXIMUM capacity vs. actual or deployed capacity, see TECHNICAL ANNEX 5.
3	For all insurers, the **ACTUAL** commitment of capacity to an international site will generally be lower than the maximum commitment; this is because of numerous factors that include rate of exchange fluctuations, reciprocal business relationship, underwriting considerations (such as site quality, location, policy language) and demand. For example, in the case of demand, if an NTPL financial security limit is low (e.g. Bulgaria) the available capacity from the international pools is too much and only certain pools will be needed to provide limited NTPL capacity to that country. For an understanding of MAXIMUM capacity vs. actual or deployed capacity, see TECHNICAL ANNEX 5.

NTPL Conventions - heads of damage description

#	Head of damage summary description
1	Bodily injury or loss of life up to 10 years after incident
2	Damage to or loss of property
3	Economic loss arising from injury, death or property damage & loss
4	Cost of reinstatement of significantly impaired environment
5	Loss of income from direct economic interest in environment
6	Cost of & any damage caused by preventive measures
7	Bodily injury or loss of life from 10 years to 30 years after incident

HoDs = Heads of Damage

European Union: MAXIMUM NTPL available capacity by country & head of damage

Country	Capacity provider	Head of damage						
		1	*2*	*3*	*4*	*5*	*6*	*7*
BE	***Mutuals***	€ 240,000,000	€ 240,000,000	€ 240,000,000	€ 240,000,000	€ 240,000,000	€ 240,000,000	€ 240,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 64,000,000	€ 64,000,000	€ 64,000,000	€ 64,000,000	€ 64,000,000	€ 64,000,000	€ -
	International Pools	€ 1,815,001,930	€ 1,815,001,930	€ 1,815,001,930	€ 1,815,001,930	€ 1,815,001,930	€ 1,815,001,930	€ -
	Available total:	**€ 2,319,001,930**	**€ 2,319,001,930**	**€ 2,319,001,930**	**€ 2,319,001,930**	**€ 2,319,001,930**	**€ 2,319,001,930**	**€ 340,000,000**
BG	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 9,800,000	€ 9,800,000	€ 9,800,000	€ 9,800,000	€ 9,800,000	€ 9,800,000	€ -
	International Pools	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ -
	Available total:	**€ 2,215,801,930**	**€ 2,215,801,930**	**€ 2,215,801,930**	**€ 2,215,801,930**	**€ 2,215,801,930**	**€ 2,215,801,930**	**€ 255,000,000**
CZ	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 30,000,000	€ 30,000,000	€ 30,000,000	€ 30,000,000	€ 30,000,000	€ 30,000,000	€ -
	International Pools	€ 1,826,001,930	€ 1,826,001,930	€ 1,826,001,930	€ 1,826,001,930	€ 1,826,001,930	€ 1,826,001,930	€ -
	Available total:	**€ 2,211,001,930**	**€ 2,211,001,930**	**€ 2,211,001,930**	**€ 2,211,001,930**	**€ 2,211,001,930**	**€ 2,211,001,930**	**€ 255,000,000**
DE	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	Operators' Solidarity	€ 2,244,355,000	€ 2,244,355,000	€ 2,244,355,000	€ 2,244,355,000	€ 2,244,355,000	€ 2,244,355,000	€ 2,500,000,000
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 285,000,000	€ 285,000,000	€ 285,000,000	€ 285,000,000	€ 285,000,000	€ 285,000,000	€ -
	International Pools	€ 1,664,001,930	€ 1,664,001,930	€ 1,664,001,930	€ 1,664,001,930	€ 1,664,001,930	€ 1,664,001,930	€ -
	Available total:	**€ 4,548,356,930**	**€ 4,548,356,930**	**€ 4,548,356,930**	**€ 4,548,356,930**	**€ 4,548,356,930**	**€ 4,548,356,930**	**€ 2,755,000,000**
ES	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 140,000,000	€ 140,000,000	€ 140,000,000	€ 140,000,000	€ 140,000,000	€ 140,000,000	€ -
	International Pools	€ 1,796,001,930	€ 1,796,001,930	€ 1,796,001,930	€ 1,796,001,930	€ 1,796,001,930	€ 1,796,001,930	€ -
	Available total:	**€ 2,291,001,930**	**€ 2,291,001,930**	**€ 2,291,001,930**	**€ 2,291,001,930**	**€ 2,291,001,930**	**€ 2,291,001,930**	**€ 255.000.000**
FR	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives[2]	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 289,000,000	€ 289,000,000	€ 289,000,000	€ 289,000,000	€ 289,000,000	€ 289,000,000	€ -
	International Pools	€ 1,732,001,930	€ 1,732,001,930	€ 1,732,001,930	€ 1,732,001,930	€ 1,732,001,930	€ 1,732,001,930	€ -
	Available total:	**€ 2,376,001,930**	**€ 2.376.001.930**	**€ 2.376.001.930**	**€ 2.376.001.930**	**€ 2.376.001.930**	**€ 2.376.001.930**	**€ 255,000,000**
GB	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives[1]	€ 83,333,333	€ 83,333,333	€ 83,333,333	€ 83,333,333	€ 83,333,333	€ 83,333,333	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ -

Country	Capacity provider	Head of damage						
		1	*2*	*3*	*4*	*5*	*6*	*7*
	International Pools	€ 1,509,001,930	€ 1,509,001,930	€ 1,509,001,930	€ 1,509,001,930	€ 1,509,001,930	€ 1,509,001,930	€ -
	Available total:	**€ 2,289,335,263**	**€ 2,289,335,263**	**€ 2,289,335,263**	**€ 2,289,335,263**	**€ 2,289,335,263**	**€ 2,289,335,263**	**€ 255,000,000**
HU	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155.000.000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 12,763,000	€ 12,763,000	€ 12,763,000	€ 12,763,000	€ 12,763,000	€ 12,763,000	€ -
	International Pools	€ 1,845,561,930	€ 1,845,561,930	€ 1,845,561,930	€ 1,845,561,930	€ 1,845,561,930	€ 1,845,561,930	€ -
	Available total:	**€ 2,213,324,930**	**€ 2,213,324,930**	**€ 2,213,324,930**	**€ 2,213,324,930**	**€ 2,213,324,930**	**€ 2,213,324,930**	**€ 255,000,000**
NL	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 25,976,000	€ 25,976,000	€ 25,976,000	€ 25,976,000	€ 25,976,000	€ 25,976,000	€ -
	International Pools	€ 1,836,925,930	€ 1,836,925,930	€ 1,836,925,930	€ 1,836,925,930	€ 1,836,925,930	€ 1,836,925,930	€ -
	Available total:	**€ 2,217,901,930**	**€ 2,217,901,930**	**€ 2,217,901,930**	**€ 2,217,901,930**	**€ 2,217,901,930**	**€ 2,217,901,930**	**€ 255.000.000**
RO	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 500,000	€ 500,000	€ 500,000	€ 500,000	€ 500,000	€ 500,000	€ -
	International Pools	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ 1,851,001,930	€ -
	Available total:	**€ 2,206,501,930**	**€ 2,206,501,930**	**€ 2,206,501,930**	**€ 2,206,501,930**	**€ 2,206,501,930**	**€ 2,206,501,930**	**€ 255,000,000**
SE & FI	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 258,000,000	€ 258,000,000	€ 258,000,000	€ 258,000,000	€ 258,000,000	€ 258,000,000	€ -
	International Pools	€ 1,622,001,930	€ 1,622,001,930	€ 1,622,001,930	€ 1,622,001,930	€ 1,622,001,930	€ 1,622,001,930	€ -
	Available total:	**€ 2,235,001,930**	**€ 2,235,001,930**	**€ 2,235,001,930**	**€ 2,235,001,930**	**€ 2,235,001,930**	**€ 2,235,001,930**	**€ 255,000,000**
SI	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ -
	International Pools	€ 1,832,601,930	€ 1,832,601,930	€ 1,832,601,930	€ 1,832,601,930	€ 1,832,601,930	€ 1,832,601,930	€ -
	Available total:	**€ 2,206,001,930**	**€ 2,206,001,930**	**€ 2,206,001,930**	**€ 2,206,001,930**	**€ 2,206,001,930**	**€ 2,206,001,930**	**€ 255,000,000**
SK	***Mutuals***	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
	Captives	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	MGA	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 100,000,000
	Domestic Pool	€ 62,132,000	€ 62,132,000	€ 62,132,000	€ 62,132,000	€ 62,132,000	€ 62,132,000	€ -
	International Pools	€ 1,837,191,930	€ 1,837,191,930	€ 1,837,191,930	€ 1,837,191,930	€ 1,837,191,930	€ 1,837,191,930	€ -
	Available total:	**€ 2,254,323,930**	**€ 2,254,323,930**	**€ 2,254,323,930**	**€ 2,254,323,930**	**€ 2,254,323,930**	**€ 2,254,323,930**	**€ 255,000,000**

NOTE:

1 The UK captive has not yet decided whether to offer its capacity for 10-30 years for bodily injury.

2 No French captive capacity information was disclosed.

Available MAXIMUM NTPL capacity by country - all providers

	Belgium	Bulgaria	Croatia	Czech Rep.	France*	Germany	Hungary	Netherlands	Nordic (SE&FI)	Romania	Slovakia	Slovenia	Spain	UK
Provider														
Mutual	€ 240,000,000	€ 155,000,000	€ -	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000	€ 155,000,000
Captive	€ -	€ -	€ -	€ -		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 83,333,333
Operators	€ -	€ -	€ -	€ -	€ -	€ 2,244,355,000	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
MGA	€ 200,000,000	€ 200,000,000	€ -	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000	€ 200,000,000
Domestic Pool	€ 64,000,000	€ 9,800,000	€ -	€ 30,000,000	€ 289,000,000	€ 285,000,000	€ 12,763,000	€ 25,976,000	€ 258,000,000	€ 500,000	€ 62,132,000	€ 18,400,000	€ 140,000,000	€ 342,000,000
Belgium Pool		€ 36,000,000	€ -	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000	€ 36,000,000
Bulgaria Pool	€ -		€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
Croatia Pool	€ 5,481,000	€ 5,481,000		€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000	€ 5,481,000
Czech Republic Pool	€ 25,000,000	€ 25,000,000	€ -		€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000	€ 25,000,000
France Pool	€ 119,000,000	€ 119,000,000	€ -	€ 119,000,000		€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000	€ 119,000,000
Germany Pool	€ 187,000,000	€ 187,000,000	€ -	€ 187,000,000	€ 187,000,000		€ 187,000,000	€ 187,000,000	€ 187,000,000	€ 187,000,000	€ 187,000,000	€ 187,000,000	€ 187,000,000	€ 187,000,000
Hungary Pool	€ 5,440,000	€ 5,440,000	€ -	€ 5,440,000	€ 5,440,000	€ 5,440,000		€ 5,440,000	€ 5,440,000	€ 5,440,000	€ 5,440,000	€ 5,440,000	€ 5,440,000	€ 5,440,000
Netherlands Pool	€ 14,076,000	€ 14,076,000	€ -	€ 14,076,000	€ 14,076,000	€ 14,076,000	€ 14,076,000		€ 14,076,000	€ 14,076,000	€ 14,076,000	€ 14,076,000	€ 14,076,000	€ 14,076,000
Nordic Pool	€ 229,000,000	€ 229,000,000	€ -	€ 229,000,000	€ 229,000,000	€ 229,000,000	€ 229,000,000	€ 229,000,000		€ 229,000,000	€ 229,000,000	€ 229,000,000	€ 229,000,000	€ 229,000,000
Romania Pool	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -		€ -	€ -	€ -	€ -
Slovakia Pool	€ 13,810,000	€ 13,810,000	€ -	€ 13,810,000	€ 13,810,000	€ 13,810,000	€ 13,810,000	€ 13,810,000	€ 13,810,000	€ 13,810,000		€ 13,810,000	€ 13,810,000	€ 13,810,000
Slovenia Pool	€ 18,400,000	€ 18,400,000	€ -	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000	€ 18,400,000		€ 18,400,000	€ 18,400,000
Spain Pool	€ 55,000,000	€ 55,000,000	€ -	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000	€ 55,000,000		€ 55,000,000
UK Pool	€ 342,000,000	€ 342,000,000	€ -	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	€ 342,000,000	
Other non-EU Pools	€ 800,794,930	€ 800,794,930	€ -	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930	€ 800,794,930
Total:	€ 2,319,001,930	€ 2,215,801,930	€ -	€ 2,211,001,930	€ 2,376,001,930	€ 4,548,356,930	€ 2,213,324,930	€ 2,217,901,930	€ 2,235,001,930	€ 2,206,501,930	€ 2,254,323,930	€ 2,206,001,930	€ 2,291,001,930	€ 2,289,335,263
Total EU Pools (total capacity provided by EU MS pools only)	*€ 1,078,207,000*	*€ 1,060,007,000*	*€ -*	*€ 1,055,207,000*	*€ 1,220,207,000*	*€ 1,148,207,000*	*€ 1,057,530,000*	*€ 1,062,107,000*	*€ 1,079,207,000*	*€ 1,050,707,000*	*€ 1,098,529,000*	*€ 1,050,207,000*	*€ 1,135,207,000*	*€ 1,050,207,000*
Total non-domestic Pools (total capacity provided by reinsurance from other pools)	*€ 1,815,001,930*	*€ 1,851,001,930*	*€ -*	*€ 1,826,001,930*	*€ 1,732,001,930*	*€ 1,664,001,930*	*€ 1,845,561,930*	*€ 1,836,925,930*	*€ 1,622,001,930*	*€ 1,851,001,930*	*€ 1,837,191,930*	*€ 1,832,601,930*	*€ 1,796,001,930*	*€ 1,509,001,930*
Total Pools only	*€ 1,879,001,930*	*€ 1,860,801,930*	*€ -*	*€ 1,856,001,930*	*€ 2,021,001,930*	*€ 1,949,001,930*	*€ 1,858,324,930*	*€ 1,862,901,930*	*€ 1,880,001,930*	*€ 1,851,501,930*	*€ 1,899,323,930*	*€ 1,851,001,930*	*€ 1,936,001,930*	*€ 1,851,001,930*

Note: * French captive capacities were provided, so are missing from this analysis,

F. NUCLEAR INSURANCE POOLS AND OTHER INSURERS – CAPACITY DETAIL

Nuclear Insurance Pools

POOL		Location	Pool members		Type		Policy	Capacity (maximum)					Comment
Country	*Name/acronym*		*Number*	*Largest*	*Ins/Reins*	*Dom/Intl*	*(period)*	*Domestic*	*Foreign*	*CCY*	*RoEx*	*Foreign €*	
Belgium	SYBAN	EU	13	29.3%	Insurer	International	Annual	64,000,000	36,000,000	**EUR**	1.00	**€ 36,000,000**	
Brazil	Brazilian	Non EU			Reinsurer	International							Not contacted - no data
Bulgaria	BNNIP	EU	8	21.8%	Insurer	Domestic	Annual	9,800,000		**EUR**	1.00	**€ -**	No foreign reinsurance
Canada	NIAC	Non EU			Insurer	Domestic		425,000,000		**CAD**	1.47	**€ -**	No foreign reinsurance
China	CNIP	Non EU		unknown	Reinsurer	International	Annual		160,000,000	**USD**	1.12	**€ 142,857,143**	
Croatia	Croatian	EU	4	unknown	N/A	International	N/A	-	5,481,000	**EUR**	1.00	**€ 5,481,000**	No domestic business as no NPP
Czech Republic	CPOJ	EU	10	22.0%	Insurer	International	Annual	30,000,000	25,000,000	**EUR**	1.00	**€ 25,000,000**	
Finland	Nordic Nuclear Insurers (NNI)	EU	15	20.0%	Insurer	International	Annual	258,000,000	229,000,000	**EUR**	1.00	**€ 229,000,000**	Single pool for SE & FI
France	Assuratome	EU	34	14.5%	Reinsurer	International	Annual	289,000,000	119,000,000	**EUR**	1.00	**€ 119,000,000**	
Germany	DKVG	EU	25	various	Reinsurer	International	Rolling	285,000,000	187,000,000	**EUR**	1.00	**€ 187,000,000**	
Hungary	Hungarian	EU	7	40.0%	Insurer	International	Annual	12,763,000	5,440,000	**EUR**	1.00	**€ 5,440,000**	
India	Indian	Non EU			Reinsurer	Domestic							Not contacted - no data
Japan	JAEIP	Non EU	15	30.0%	Reinsurer	International	Rolling		116,000,000	**EUR**	1.00	**€ 116,000,000**	
Mexico	Mexican	Non EU			Insurer	International							Not contacted - no data
Netherlands	Assurpol	EU	12	23.0%	Insurer	International	Annual	25,976,000	14,076,000	**EUR**	1.00	**€ 14,076,000**	
Romania	Romanian	EU	1	100.0%	Insurer	Domestic	Rolling	500,000		**EUR**	1.00	**€ -**	No foreign reinsurance
Russia	Russian	Non EU			unknown	International							Not contacted - no data
S Africa	SAPINR	Non EU			Insurer	International							Not contacted - no data
S Korea	KAEIP	Non EU			Reinsurer	International							Not contacted - no data
Slovakia	Slovakian	EU	9	45.5%	Insurer	International	Annual	62,132,000	13,810,000	**EUR**	1.00	**€ 13,810,000**	
Slovenia	Slovenian	EU	6	54.6%	Insurer	International	Rolling	18,400,000	18,400,000	**EUR**	1.00	**€ 18,400,000**	
Spain	Espnanuclear	EU	29	19.0%	Reinsurer	International	Annual	140,000,000	55,000,000	**EUR**	1.00	**€ 55,000,000**	
Sweden	Nordic Nuclear Insurers (NNI)	EU	15	20.0%	Insurer	International	Annual	258,000,000	229,000,000	**EUR**	1.00	**€ 229,000,000**	Single pool for SE & FI
Switzerland	SPN	Non EU	19	50.0%	Insurer	International	Rolling		450,000,000	**CHF**	1.09	**€ 412,844,037**	
Taiwan	Taiwanese	Non EU			Reinsurer	International							Not contacted - no data
UK	Nuclear Risk Insurers (NRI)	EU	28	unknown	Insurer	International	Rolling	342,000,000	342,000,000	**EUR**	1.00	**€ 342,000,000**	
Ukraine	Ukrainian	Non EU			unknown	International							No response
USA	American Nuclear Insurers (ANI)	Non EU	14	13.0%	Insurer	International	Rolling		127,785,000	**USD**	1.12	**€ 114,093,750**	

TOTAL FOREIGN EU ONLY:	€ 1,044,726,000	
TOTAL CONTACTED NON EU:	€ 785,794,930	
ASSUMED OTHER NON EU	€ 15,000,000	Pools not contacted
ALL POOL CAPACITY:	**€ 1,845,520,930**	

NOTES

1 Largest pool member capacity as % of total pool capacity (where information provided).
2 Insuring or reinsuring pool. See Technical Annex 3 for more information.
3 Capacity offered is either for domestic sites only (domestic) or domestic and international sites (international) using reciprocal reinsurance with other nuclear insurance pools.
4 This shows whether the pool offers a new annual policy limit each year, or a rolling, single limit policy with multi-year duration (see chapter/section XX for more detail).
5 Capacity offered for domestic sites.
6 Where international capacity is offered, the capacity offered for non-domestic sites in other countries.
7 The maximum capacity available for use on any non-domestic nuclear site, generally as a reinsurance (see Technical Annex 3 for more information.
8 The maximum capacity offered is rarely the actual capacity offered, which will generally be a lower figure than the maximum capacity; see Technical Annex 5 for more information on capacity commitment.
9 Rate of exchange date: May 2019

Other NTPL capacity providers

INSURER NAME	Domicile	Type	Location	Capacity (max)				Comment
				Amount	*CCY*	*RoEx*	*Amount €*	
Northcourt	Malta	MGA	EU	200,000,000	**EUR**	1.00	**€ 200,000,000**	50% for HoD 7 (€100m)
NEIL Overseas	Ireland	Mutual	EU	85,000,000	**EUR**	1.00	**€ 85,000,000**	BE ONLY
ELINI/NIRA/Blue Re	Belgium/Luxembourg	Mutual	EU	155,000,000	**EUR**	1.00	**€ 155,000,000**	For all (BE add NEIL = €240m)
Wagram (EdF)	Ireland	Captive	EU		**EUR**	1.00	**€ -**	No capacity information provided
Oceane Re (EdF)	Luxembourg	Captive	EU		**EUR**	1.00	**€ -**	No capacity information provided
Rutherford (NDA)	Guernsey	Captive		75,000,000	**GBP**	0.90	**€ 83,333,333**	Undecided for HoD 7
German Solidarity	Germany	Op.pooling	EU	2,244,355,000	**EUR**	1.00	**€ 2,244,355,000**	DE ONLY (for HoD 7 €2.5bn)

MAXIMUM OTHER CAPACITY:	**€ 2,767,688,333**	
MAXIMUM CAPACITY:	**€ 355,000,000**	Normal max excl. BE/DE/UK specific

NOTES

1 Type of insurers. See the Glossary (Annex A) and Technical Annexes 1 and 3 for more information on these insurers.

2 The maximum capacity offered is rarely the actual capacity offered, which will generally be a lower figure than the maximum capacity; see Technical Annex 5 for more information on capacity commitment.

G. THE RADIOACTIVE CONTAMINATION EXCLUSION CLAUSE

Introduction

This annex provides details on the radioactive contamination exclusion clause (RCE), which is a key component of today's nuclear liability insurance market. Understanding the unique circumstances that brought about the development of the clause and subsequently that nurtured a specialist and limited insurance market to offer capacity to the nuclear sector will help with understanding the limitations and constraints that the insurers of today face when insuring nuclear risks.

Background

Insurers had been aware of the dangers of radiation exposure since the 1920s, however it was not until the 1950s when insurers began to consider more seriously how they would insure the nascent commercial nuclear industry. Minds were fresh with images of the destruction caused by the atomic bombs in Nagasaki and Hiroshima at the end of the 2nd World War; therefore, there was a recognition that nuclear exposure could present a destructive and widespread catastrophe exposure, certainly well beyond the means of an individual insurer and probably beyond the means of a national market.

In Europe and the USA committees were formed to study the exposure in more detail and to provide recommendations how to cover this new exposure. Governments and lawmakers worked alongside insurers, all keen to ensure this new energy source thrived in the private sector. The conclusion reached was that liability (and its insurance) should be focused on the operator to guarantee the insurers' capacity resources were concentrated on a single entity (the liability channelling principle) with certainty of exposure in the event of a severe accident with off-site consequences. This proposal would also prevent discrimination and differential premium charging for those nearer NPPs for their day-to-day property, motor and business insurances, as no radioactivity cover would be required on any general policies.

In 1957 a study paper[212] for the UK insurance market concluded that: *'having given the fullest consideration to all aspects of the problem and having regard to the overriding necessity of insurers and reinsurers knowing with certainty the maximum liability to which they may be exposed, the Committee recommends that insurers should agree:*

a) To make clear…that the risk of radioactive contamination arising from nuclear fission or nuclear fusion is not covered by any existing insurance or reinsurance covering property of any kind, or liability to third-parties for property damage or personal injury

And

b) Not to cover…the risk of radioactive contamination arising from nuclear fission or nuclear fusion, by any future insurance or reinsurance covering property of any kind, or liability to third parties for property damage, except in the case of:

i. Reactor installations

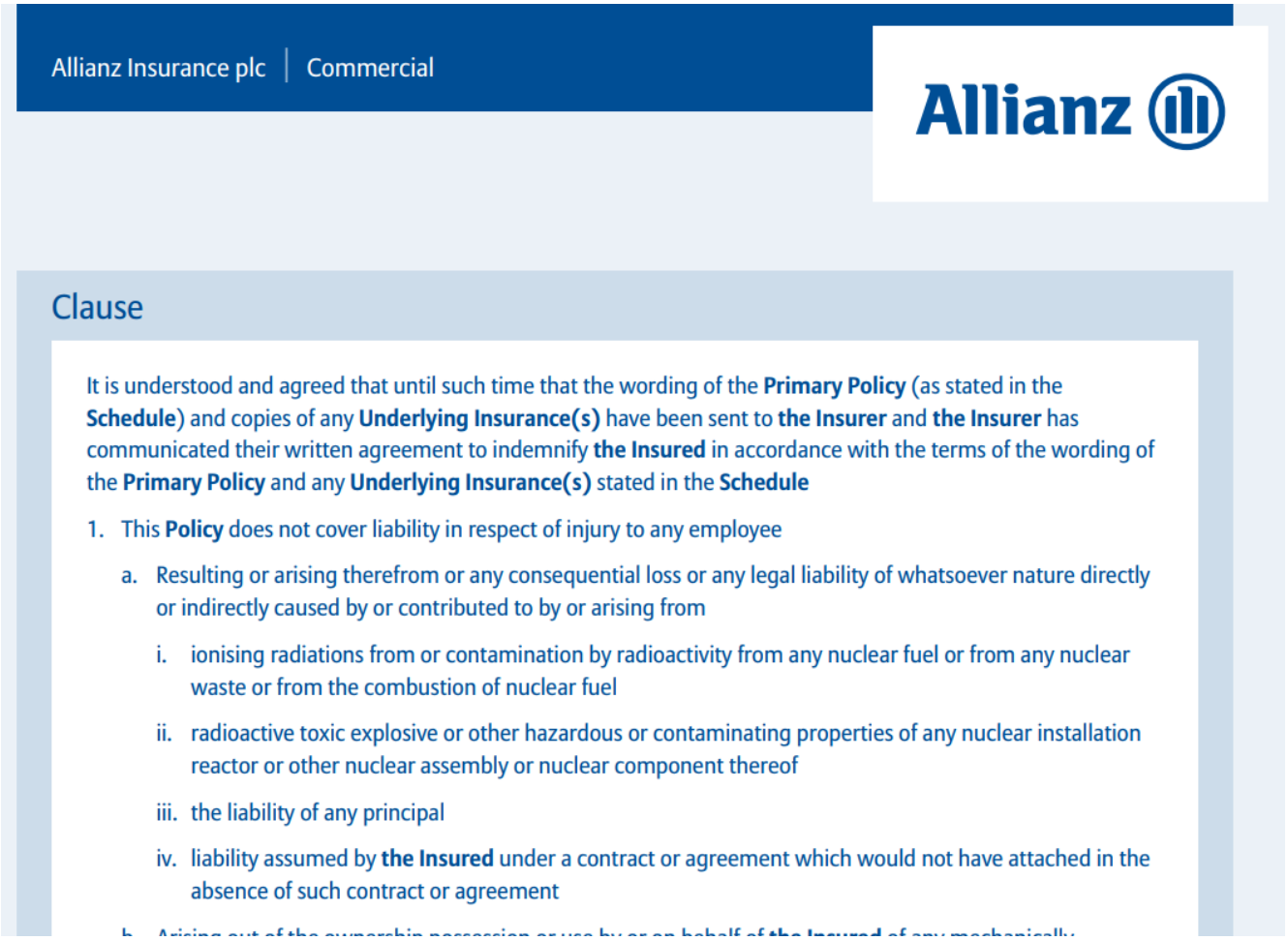
ii. Concerns engaged in the fabrication, processing and reprocessing of nuclear fuel…'

This recommendation was accepted throughout the insurance world at the time, and the nuclear insurance pools were formed to provide that concentrated capacity for the operators' property and third-party liability exposure; little has changed since then.

212 See: British Insurance (Atomic Energy) Committee Report of the Advisory Committee, April 1957; paragraph 129.

Effect of the RCE application

Almost all non-life insurance and reinsurance policies globally that do not cover nuclear installations will have a RCE embedded in the policy. The example shown in Figure 4: A typical RCE clause below is from an employer's liability policy provided by the insurer Allianz – it is a wholly random selection from the internet; policies for homes, home contents, motor cars, business premises, boats and industrial facilities will all have a similar clause contained within the policy.



Allianz Insurance plc | Commercial

Allianz

Clause

It is understood and agreed that until such time that the wording of the **Primary Policy** (as stated in the **Schedule**) and copies of any **Underlying Insurance(s)** have been sent to **the Insurer** and **the Insurer** has communicated their written agreement to indemnify **the Insured** in accordance with the terms of the wording of the **Primary Policy** and any **Underlying Insurance(s)** stated in the **Schedule**

1. This **Policy** does not cover liability in respect of injury to any employee
   a. Resulting or arising therefrom or any consequential loss or any legal liability of whatsoever nature directly or indirectly caused by or contributed to by or arising from
      i. ionising radiations from or contamination by radioactivity from any nuclear fuel or from any nuclear waste or from the combustion of nuclear fuel
      ii. radioactive toxic explosive or other hazardous or contaminating properties of any nuclear installation reactor or other nuclear assembly or nuclear component thereof
      iii. the liability of any principal
      iv. liability assumed by **the Insured** under a contract or agreement which would not have attached in the absence of such contract or agreement

Figure 4: A typical RCE clause[213]

The application of this exclusion means that all these general insurance policies will NOT cover any radioactive contamination; instead the policyholders for these policies will have to claim any damage due to radioactive contamination from the originator of the damage – in the case of the nuclear industry, the site operator; this is shown in Figure 5 below.

[213] Sourced from www.allianzebroker.co.uk

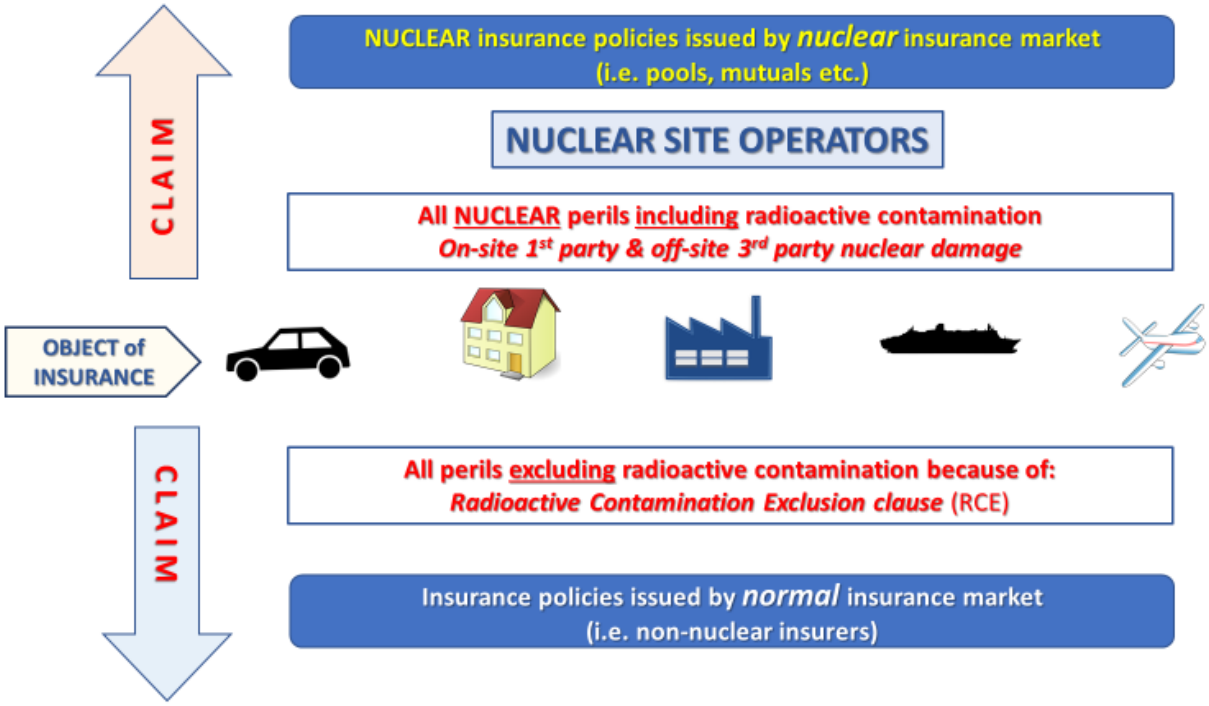


Figure 5: The RCE clause in the insurance market

With radioactive contamination excluded from the general insurance and reinsurance markets, only insurers with enough interest to form specialist nuclear teams, or to become members of a pool or MGA or reinsure a mutual are able to access the sector easily; however, as demonstrated elsewhere in the main study, the nuclear sector is relatively small and increasingly viewed as a volatile[214] exposure. This has resulted in a limited insurance market for nuclear risks and is thus a constraining factor for the whole insurance market.

Removing the RCE

The obvious reaction to such a restriction on wider market participation would be to remove the RCE from general policies; among the likely effects of this change could be:

1. Insurance market exposure to a nuclear catastrophe would no longer be focused on the operator's insurance policy; instead every policyholder affected would be able to claim from their individual insurances (e.g. motor, homeowner etc.) and all insurers across a wide area would suffer losses. This would see the loss spread across a wide selection of insurers, as with current natural catastrophe events.
2. The claims process for individuals affected could become more complex if multiple policies were claimed on (e.g. loss of business, home and motor contamination, evacuation etc.); the insurers would then seek redress for all these claims from the operator under normal tort law – this could take decades to be resolved. This contrasts with the current sole liability of the site operator for all claims.
3. With a new exposure on all general policies (radioactive contamination) premiums for many policies would probably rise a little.
4. With no RCE, to succeed each contamination claim would have to prove a causal link to the NPP for any lasting or gradual effects of radiation. This could diffuse somewhat the current

[214] See section 4 of the Study.

nuclear insurance market reluctance to cover the very long tail bodily injury or gradual exposure, as the problem would be fragmented amongst all insurers and each claim would need to be proven individually in court.

5. Differential and punitive pricing for any risks near NPPs and other nuclear sites (or even those perceived as radioactive).
6. If the liability channelling principle is eroded by the removal of the RCE, nuclear site contractors large and small will assume the radioactive contamination exposure, this might make them reluctant to work in the nuclear sector. At present they can work in the sector knowing any nuclear liability is the operator's responsibility.

H. THE US NUCLEAR REGULATORY COMMISSION (NRC) ENO DEFINITION

US Nuclear Regulatory Commission (NRC)

Trigger mechanism: definition of Extraordinary Nuclear Occurrence (ENO)215

§ 140.83 Determination of extraordinary nuclear occurrence.

If the Commission determines that both of the criteria set forth in §§ 140.84 and 140.85 have been met, it will make the determination that there has been an extraordinary nuclear occurrence. If the Commission publishes a notice in the Federal Register in accordance with § 140.82(a) and does not make a determination within 90 days thereafter that there has been an extraordinary nuclear occurrence, the alleged event will be deemed not to be an extraordinary nuclear occurrence. The time for the making of a determination may be extended by the Commission by notice published in the Federal Register.

[33 FR 15999, Oct. 31, 1968]

§ 140.84 Criterion I--Substantial discharge of radioactive material or substantial radiation levels offsite.

The Commission will determine that there has been a substantial discharge or dispersal of radioactive material offsite, or that there have been substantial levels of radiation offsite, when, as a result of an event comprised of one or more related happenings, radioactive material is released from its intended place of confinement or radiation levels occur offsite and either of the following findings are also made:

(a) The Commission finds that one or more persons offsite were, could have been, or might be exposed to radiation or to radioactive material, resulting in a dose or in a projected dose in excess of one of the levels in the following table:

Total Projected Radiation Doses

Critical Organ	Dose (rems)
Thyroid	30
Whole body	20
Bone marrow	20
Skin	60

Exposures from the following types of sources of radiation shall be included:

(1) Radiation from sources external to the body;

(2) Radioactive material that may be taken into the body from its occurrence in air or water; and

(3) Radioactive material that may be taken into the body from its occurrence in food or on terrestrial surfaces.

(b) The Commission finds that:

(1) Surface contamination of at least a total of any 100 square meters of offsite property has occurred as the result of a release of radioactive material from a production or utilization facility and such contamination is characterized by levels of radiation in excess of one of the values listed in Column 1 or Column 2 of the following table, or

(2) Surface contamination of any offsite property has occurred as the result of a release of radioactive material in the course of transportation and such contamination is characterized by levels of radiation in excess of one of the values listed in column 2 of the following table:

215 See NRC website page on ENO: https://www.nrc.gov/reading-rm/doc-collections/cfr/part140/part140-0083.html (header page with links to 140.83, 140.84 and 140.85).

Total Surface Contamination Levels[1]

Type of emitter	Column 1 Offsite property, contiguous to site, owned or leased by person with whom an indemnity agreement is executed	Column 2 Other offsite property
Alpha emission from transuranic isotopes.	3.5 microcuries per square meter.	0.35 microcuries per square meter.
Alpha emission from isotopes other than transuranic isotopes.	35 microcuries per square meter.	3.5 microcuries per square meter.
Beta or gamma emission.	40 millirads/hour @ 1 cm.[2]	4 millirads/hour @ 1 cm.[2]

[1] The maximum levels (above background), observed or projected, 8 or more hours after initial deposition.

[2] Measured through not more than 7 milligrams per square centimeter of total absorber.

[33 FR 15999, Oct. 31, 1968, as amended at 40 FR 8794, Mar. 3, 1975]

§ 140.85 Criterion II--Substantial damages to persons offsite or property offsite.

(a) After the Commission has determined that an event has satisfied Criterion I, the Commission will determine that the event has resulted or will probably result in substantial damages to persons offsite or property offsite if any of the following findings are made:

(1) The Commission finds that such event has resulted in the death or hospitalization, within 30 days of the event, of five or more people located offsite showing objective clinical evidence of physical injury from exposure to the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material; or

(2) The Commission finds that $2,500,000 or more of damage offsite has been or will probably be sustained by any one person, or $5 million or more of such damage in the aggregate has been or will probably be sustained, as the result of such event; or

(3) The Commission finds that $5,000 or more of damage offsite has been or will probably be sustained by each of 50 or more persons, provided that $1 million or more of such damage in the aggregate has been or will probably be sustained, as the result of such event.

(b) As used in paragraphs (a) (2) and (3) of this section, "damage" shall be that arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material, and shall be based upon estimates of one or more of the following:

(1) Total cost necessary to put affected property back into use,

(2) Loss of use of affected property,

(3) Value of affected property where not practical to restore to use,

(4) Financial loss resulting from protective actions appropriate to reduce or avoid exposure to radiation or to radioactive materials.

[33 FR 15999, Oct. 31, 1968]

I. THE INTERNATIONAL NUCLEAR EVENT SCALE (INES)

Source: IAEA/OECD

INES

THE INTERNATIONAL NUCLEAR AND RADIOLOGICAL EVENT SCALE

The INES Scale is a worldwide tool for communicating to the public in a consistent way the safety significance of nuclear and radiological events.

Just like information on earthquakes or temperature would be difficult to understand without the Richter or Celsius scales, the INES Scale explains the significance of events from a range of activities, including industrial and medical use of radiation sources, operations at nuclear facilities and transport of radioactive material.

Events are classified on the scale at seven levels: Levels 1–3 are called "incidents" and Levels 4–7 "accidents". The scale is designed so that the severity of an event is about ten times greater for each increase in level on the scale. Events without safety significance are called “deviations” and are classified Below Scale / Level 0.

IAEA
International Atomic Energy Agency
Atoms For Peace

OECD
Nuclear Energy Agency

For more information: *www-news.iaea.org*

INES classifies nuclear and radiological accidents and incidents by considering three areas of impact:

People and the Environment considers the radiation doses to people close to the location of the event and the widespread, unplanned release of radioactive material from an installation.

Radiological Barriers and Control covers events without any direct impact on people or the environment and only applies inside major facilities. It covers unplanned high radiation levels and spread of significant quantities of radioactive materials confined within the installation.

Defence-in-Depth also covers events without any direct impact on people or the environment, but for which the range of measures put in place to prevent accidents did not function as intended.

Communicating Events

Nuclear and radiological events are promptly communicated by the INES Member States, otherwise a confused understanding of the event may occur from media or from public speculation. In some situations, where not all the details of the event are known early on, a provisional rating may be issued. Later, a final rating is determined and any differences explained.

To facilitate international communications for events attracting wider interest, the IAEA maintains a web-based communications network that allows details of the event to immediately be made publicly available.

The two tables that follow show selected examples of historic events rated using the INES scale, ranging from a Level 1 anomaly to a Level 7 major accident; a much wider range of examples showing the rating methodology is provided in the INES Manual.

Scope of the Scale

INES applies to any event associated with the transport, storage and use of radioactive material and radiation sources, whether or not the event occurs at a facility. It covers a wide spectrum of practices, including industrial use

EXAMPLES OF EVENTS AT NUCLEAR FACILITIES

	People and Environment	Radiological Barriers and Control	Defence-in-Depth
7	*Chernobyl, 1986* — Widespread health and environmental effects. External release of a significant fraction of reactor core inventory.		
6	*Kyshtym, Russia, 1957* — Significant release of radioactive material to the environment from explosion of a high activity waste tank.		
5	*Windscale Pile, UK, 1957* — Release of radioactive material to the environment following a fire in a reactor core.	*Three Mile Island, USA, 1979* — Severe damage to the reactor core.	
4	*Tokaimura, Japan, 1999* — Fatal overexposures of workers following a criticality event at a nuclear facility.	*Saint Laurent des Eaux, France, 1980* — Melting of one channel of fuel in the reactor with no release outside the site.	
3	*No example available*	*Sellafield, UK, 2005* — Release of large quantity of radioactive material, contained within the installation.	*Vandellos, Spain, 1989* — Near accident caused by fire resulting in loss of safety systems at the nuclear power station.
2	*Atucha, Argentina, 2005* — Overexposure of a worker at a power reactor exceeding the annual limit.	*Cadarache, France, 1993* — Spread of contamination to an area not expected by design.	*Forsmark, Sweden, 2006* — Degraded safety functions for common cause failure in the emergency power supply system at nuclear power plant.
1			Breach of operating limits at a nuclear facility.

EXAMPLES OF EVENTS INVOLVING RADIATION SOURCES AND TRANSPORT

	People and Environment	Defence-in-Depth
7		
6		
5	*Goiânia, Brazil, 1987* — Four people died and six received doses of a few Gy from an abandoned and ruptured highly radioactive Cs-137 source.	
4	*Fleurus, Belgium, 2006* — Severe health effects for a worker at a commercial irradiation facility as a result of high doses of radiation.	
3	*Yanango, Peru, 1999* — Incident with radiography source resulting in severe radiation burns.	*Ikitelli, Turkey, 1999* — Loss of a highly radioactive Co-60 source.
2	*USA, 2005* — Overexposure of a radiographer exceeding the annual limit for radiation workers.	*France, 1995* — Failure of access control systems at accelerator facility.
1		Theft of a moisture-density gauge.

such as radiography, use of radiation sources in hospitals, activity at nuclear facilities, and transport of radioactive material.

It also includes the loss or theft of radioactive sources or packages and the discovery of orphan sources, such as sources inadvertently transferred into the scrap metal trade.

When a device is used for medical purposes (e.g., radiodiagnosis or radiotherapy), INES is used for the rating of events resulting in actual exposure of workers and the public, or involving degradation of the device or deficiencies in the safety provisions. Currently, the scale does not cover the actual or potential consequences for patients exposed as part of a medical procedure.

The scale is only intended for use in civil (non-military) applications and only relates to the safety aspects of an event. INES is not intended for use in rating security-related events or malicious acts to deliberately expose people to radiation.

What the Scale is Not For

It is not appropriate to use INES to compare safety performance between facilities, organizations or countries. The statistically small numbers of events at Level 2 and above and the differences between countries for reporting more minor events to the public make it inappropriate to draw international comparisons.

History

Since 1990 the scale has been applied to classify events at nuclear power plants, then extended to enable it to be applied to all installations associated with the civil nuclear industry. By 2006, it had been adapted to meet the growing need for communication of the significance of all events associated with the transport, storage and use of radioactive material and radiation sources.

The IAEA has coordinated its development in cooperation with the OECD/NEA and with the support of more than 60 Member States through their officially designated INES National Officers.

The current version of the INES manual was adopted 1 July 2008. With this new edition, it is anticipated that INES will be widely used by the Member States and become the worldwide scale for putting into the proper perspective the safety significance of nuclear and radiation events.

INES

THE INTERNATIONAL NUCLEAR AND RADIOLOGICAL EVENT SCALE

GENERAL DESCRIPTION OF INES LEVELS

INES Level	People and Environment	Radiological Barriers and Control	Defence-in-Depth
Major Accident Level 7	• Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures.		
Serious Accident Level 6	• Significant release of radioactive material likely to require implementation of planned countermeasures.		
Accident with Wider Consequences Level 5	• Limited release of radioactive material likely to require implementation of some planned countermeasures. • Several deaths from radiation.	• Severe damage to reactor core. • Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire.	
Accident with Local Consequences Level 4	• Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. • At least one death from radiation.	• Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. • Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure.	
Serious Incident Level 3	• Exposure in excess of ten times the statutory annual limit for workers. • Non-lethal deterministic health effect (e.g., burns) from radiation.	• Exposure rates of more than 1 Sv/h in an operating area. • Severe contamination in an area not expected by design, with a low probability of significant public exposure.	• Near accident at a nuclear power plant with no safety provisions remaining. • Lost or stolen highly radioactive sealed source. • Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.
Incident Level 2	• Exposure of a member of the public in excess of 10 mSv. • Exposure of a worker in excess of the statutory annual limits.	• Radiation levels in an operating area of more than 50 mSv/h. • Significant contamination within the facility into an area not expected by design.	• Significant failures in safety provisions but with no actual consequences. • Found highly radioactive sealed orphan source, device or transport package with safety provisions intact. • Inadequate packaging of a highly radioactive sealed source.
Anomaly Level 1			• Overexposure of a member of the public in excess of statutory annual limits. • Minor problems with safety components with significant defence-in-depth remaining. • Low activity lost or stolen radioactive source, device or transport package.
NO SAFETY SIGNIFICANCE *(Below Scale/Level 0)*			

Photo Credits: Chilean Nuclear Energy Commission, Genkai Nuclear Power Plant, Genkai, Japan/Kyushu Electric Power Co., J. Mairs/IAEA

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TECHNICAL ANNEXES

1. SELF-INSURANCE - NUCLEAR INSURANCE MUTUALS

Self-insurance - Mutual Insurance Entities (ELINI, NIRA & BLUE RE)

European Liability Insurance for Nuclear Installations (ELINI), Nuclear Industry Reinsurance Association (NIRA) and Blue Re together are the nuclear industry **mutual insurance entities**[216] through which the nuclear industry outside of the USA provides most of its self-insurance NTPL capacity. These entities provide the principal competition for the nuclear pools in Europe and today bring substantial nuclear third-party liability insurance capacity to the market; critically these entities are today the **largest source of capacity that is willing to provide the full scope of cover** required under the revised nuclear liability Conventions, i.e. cover for the extended prescription period for bodily injury (to 30 years).

ELINI

Background

ELINI is a Belgian mutual insurance association and was founded in 2002; it was created to provide insurance capacity **for nuclear third-party liability** for its Members. Today it provides nuclear liability capacity for Members globally, despite its European origins.

ELINI largely operates like an insurance company and it offers insurance policies to its Members and others with material capacity as a leader, coinsurer, reinsurer or as a stand-alone capacity provider where its capacity is sufficient.

It has its own risk rating model and can thus offer competitive terms in the nuclear liability market.

ELINI is permitted to buy reinsurance cover to supplement its capacity, subject to board approval.

ELINI is rated by A.M. Best[217] as A – (stable)[218].

Membership

Members of the Association can only be companies or authorities in the private or public sector (or their representatives) with an insurable interest in operating, controlling or owning a nuclear installation.

There are two main types of Members:

[216] A mutual insurance company is owned by its policyholders.

[217] A.M. Best is the only ratings agency that specialises solely in the insurance industry. Its rating system focuses on an insurer's claims paying ability and the credit quality of its obligations.

[218] On September 18, 2015, A.M. Best has assigned a financial strength rating of A- (Excellent) and an issuer credit rating of "a-" to ELINI. The outlook assigned to both ratings is stable. (source: https://www.elini.net/about/)

1. Non-insured Members[219] who do not take part in the constitution of the guarantee fund but pay an administrative fee (shown in red in the table below);
2. Insured Members who have an insurance policy and have contributed to the constitution of the guarantee fund.

Table 15: Current ELINI Members

Country	Operator/site - Member
Belgium	Belgoprocess NV
Belgium	Electrabel S.A.
Belgium	FBFC International BV
Belgium	SCK-CEN
Belgium	IRE
Belgium	Transrad
Belgium	Transnuclear
Canada	Bruce Power
Canada	New Brunswick Power
Canada	Ontario Power Generation
Czech Republic	CEZ a.s.
Finland	Fortum Power and Heat Oy
Finland	Teollisuuden Voima Oyj (TVO)
France	Eurodif
France	EDF
France	Orano
Germany	EnBW Kernkraft GmbH
Germany	PreussenElektra GmbH
Germany	RWE Power AG GmbH
Hungary	MVM PAKS Nuclear Power Plant Ltd.
Hungary	RHK Puram
Italy	ENEL
Italy	SOGIN
Netherlands	EPZ NV
Romania	SNN (Societatea Nationala Nuclearelectrica)
Slovak Republic	Slovenske Elektrarne a.s.
South Africa	ESKOM
Spain	ENDESA S.A.
Sweden	AB SVAFO
Sweden	Forsmark Kraftgrupp AB
Sweden	OKG Aktiebolag
Sweden	Ringhals AB
Sweden	Svensk Karnbranslehantering AB
Sweden	Studsvik AB
Sweden	Sydkraft Nuclear Power AB

[219] Non-insured members are those that have joined the mutual but have not yet taken an insurance policy. The ELINI membership rules state '*A new Member must take out or have the intention to take out at a later stage at least one insurance policy*' (see ELINI Report & Accounts 2017).

Country	Operator/site - Member
Switzerland	Axpo Trading AG
Switzerland	BKW Energie Ltd.
Switzerland	Kernkraftwerk Gösgen-Däniken AG
Switzerland	Kernkraftwerk Leibstadt AG
Switzerland	Zwischenlager Würenlingen AG
United Kingdom	British Energy Ltd
United Kingdom	Urenco Ltd.

Guarantee fund

Since starting in 2002, ELINI has built up a guarantee fund[220] and an equalisation reserve[221] that supports its underwriting capacity. By 2017 ELINI's own funds from these reached €101m.

At the close of each year, a proportion of the underwriting surplus[222] is moved to the guarantee fund to support further expansion of the capacity.

Paying for a valid claim

In the event of a large single claim, ELINI can draw upon its guarantee fund which is enough to cover its net retention[223]; thereafter it can claim from its reinsurers.

Should multiple losses occur that exhaust the funds available, ELINI can call upon its Members for additional funds.

Under this arrangement ELINI Members have a maximum liability of up to 20 'calls', covering up to 3 incidents in any annual period; a single call is equivalent to the Member's annual contribution (premium).

Capacity

For 2018 ELINI's maximum capacity for nuclear third-party liability is €155 million; in 2017 it was €130 million.

The net retention in 2018 was €87.3 million, as it was in 2017. For 2019 the net retention increased to €100 million.

Scope of cover

ELINI is unique amongst the current nuclear insurance market players as it offers the full scope of cover demanded by the revised nuclear liability Conventions, i.e. it offers coverage for the infamous 30 years' prescription period, which is not the case for most other market players.

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220 ELINI's guarantee fund is the equivalent of shareholders' capital and is made up of the annually accumulated surpluses.

221 An equalisation reserve is a long-term reserve that an insurance entity keeps to prevent cash-flow depletion in case of a significant unforeseen catastrophe. In ELINI's case, it is to '*smooth out claims*' and will cover '*exceptional risks*' (see ELINI annual reports)

222 Underwriting surplus is the difference between the total premium contributions paid during a certain period of time and indemnities paid in respect of claims, net of reinsurance and other expenses incurred during the same period.

223 In reinsurance, the net retention is the net amount of risk the ceding company (insurer) keeps for its own account. Exposure above this amount is ceded to the reinsurer(s).

Claims handling system

ELINI has developed a unique NTPL claims handling system, which is based on a web-based platform; the system is transboundary and available in many languages throughout Europe and the neighbouring countries.

NIRA

Background

NIRA is a Luxembourg domiciled mutual reinsurance association, founded in 2008.

NIRA provides treaty reinsurance[224] for NTPL to ELINI and property damage to EMANI[225] and other ceding companies, across Europe and worldwide.

NIRA is regulated by the CAA in Luxembourg[226] and does not currently hold a financial rating.

Membership

Members of the Association can only be companies or authorities in the private or public sector (or their representatives) that are operating, controlling or owning a nuclear installation.

Table 16: Current NIRA Members

Country	Operator/site - Member
Belgium	Belgoprocess NV
Belgium	SCK-CEN
Canada	Bruce Power
Canada	New Brunswick Power
Canada	Ontario Power Generation
P.R.o.China	China General Nuclear Corporation (CGN)
Czech Republic	CEZ a.s.
Finland	Fortum Power and Heat Oy
Finland	Teollisuuden Voima Oyj (TVO)
France	FRAMATOME
France	Socatri SARL
France	Orano
France	EDF
Germany	EnBW Energie Baden Württemberg AG
Germany	GNS (Gesellschaft für Nuklear-Service mbH)
Germany	Kernkraftwerk Obrigheim GmbH

[224] Treaty reinsurance occurs whenever a ceding company (insurer) agrees to cede **all risks** to a reinsurance company (reinsurance company accepts to reinsure these policies "in bulk"). It is usually a long-term contractual relationship. Treaty reinsurance differs from facultative reinsurance, which is reinsurance for a **single risk**. Under facultative agreements, each underwritten policy is considered a single transaction and reinsurer may accept or reject each individual policy, thus forcing the ceding company to retain only the riskiest policies. With treaty reinsurance the reinsurer is not performing individual underwriting for each policy, but is accepting all policies of the ceding company which pertain to the contractually defined class of risks. See Annex A – Glossary for detailed definitions.

[225] While ELINI was established with the aim to provide coverage for nuclear third-party liability, European Mutual Insurance for Nuclear Installations (EMANI) was founded to provide coverage for physical damage to nuclear installations.

[226] "Commissariat aux Assurances" (Insurance Commission) is the Luxembourg authority competent for the supervision of the insurance sector.

Country	Operator/site - Member
Germany	EnBW Kernkraft GmbH
Germany	PreussenElektra GmbH
Germany	RWE Power AG
Hungary	MVM PAKS Nuclear Power Plant Ltd.
Korea	KHNP
Slovak Republic	Slovenske Elektrarne a.s.
South Africa	ESKOM
Sweden	AB SVAFO
Sweden	Forsmark Kraftgrupp AB
Sweden	OKG Aktiebolag
Sweden	Ringhals AB
Sweden	SKB
Sweden	Studsvik AB
Sweden	Sydkraft Nuclear Power AB
Switzerland	Axpo Power AG
Switzerland	CNP – c/o Alpiq AG
Switzerland	Axpo Trading AG
Switzerland	BKW Energie Ltd.
Switzerland	Kernkraftwerk Leibstadt AG
Switzerland	Zwilag Zwischenlager Würenlingen AG
United Kingdom	British Energy Ltd
United Kingdom	Urenco Ltd.
United States	BWX Technologies, Inc
United States	Comanche Peak Power Cy. LLC
United States	Energy Solutions
United States	Northern State Power Company - Minnesota (NSP-M)
United States	South Carolina Electric & Gas (SCE&G)
United States	Union Electric Company d/b/a Ameren Missouri

Guarantee fund

Since starting in 2008, NIRA has built up a guarantee fund and equalization reserve that supports its underwriting capacity. By 2017 this fund amounted to €73 million.

At the close of each year, a proportion of the underwriting surplus is moved to this fund to support further expansion of the capacity.

Paying for a valid claim

In the event of a large claim, NIRA can draw upon its guarantee fund which is enough to cover its net retention; thereafter it can claim from its reinsurers.

Capacity

For 2018 NIRA's maximum capacity for nuclear third-party liability is €30 million, in 2017 it was €22 million. The net retention in 2018 is €20 million and in 2017 it was €22 million.

Scope of cover

NIRA provides reinsurance for its members that are ELINI policyholders as well as non-ELINI members it also provides reinsurance capacity for material damage exposure (not the subject of this study). Its

reinsurance policies match the underlying coverage, i.e. ELINI insurance policies, and therefore offer the full scope of cover demanded by the revised nuclear liability Conventions.

BLUE RE

Background

Blue Re is a Luxembourg domiciled mutual reinsurance association, founded in 2011.

Blue Re provides reinsurance for nuclear third-party liability to its Members.

Blue Re does not currently have a solvency rating.

Membership

Members of Blue Re can only be companies or authorities in the private or public sector (or their representatives) that are operating, controlling or owning a nuclear installation.

Table 17: Current Blue Re Members

Country	Operator/site - Member
Sweden	AB SVAFO
France	AREVA New Holding
United Kingdom	British Energy Ltd
Canada	Bruce Power
Czech Republic	CEZ AS
France	EDF
Belgium	Electrabel S.A.
Spain	ENDESA S.A.
Finland	Fortum Power and Heat Oy
Sweden	OKG Aktiebolag
Canada	OPG
Sweden	Ringhals AB
Belgium	SCK-CEN
Sweden	SKB
Slovak Republic	Slovenske Elektrarne / ENEL
Sweden	Studsvik AB
South Africa	Eskom
Sweden	Sydkraft Nuclear Power AB
Finland	Teollisuuden Voima Oyj (TVO)

Guarantee fund

Since starting in 2008, Blue Re has built up a guarantee fund and equalization reserve that supports its underwriting capacity. By 2017 this fund amounted to €9.8 million.

At the close of each year, a proportion of the underwriting surplus is moved to this fund to support further expansion of the capacity.

Paying for a valid claim

In the event of a large claim, Blue Re can draw upon its guarantee fund which is sufficient to cover its net retention; thereafter it can claim from its reinsurers. Should multiple losses occur that exhaust the funds available, Blue Re can call upon its Members for additional funds.

Under this arrangement Blue Re Members have a maximum liability of up to 20 calls per member, covering 3 incidents in any annual period; a single call is equivalent to the Member's annual contribution (premium).

Capacity

For 2018 Blue Re's maximum capacity for nuclear third-party liability is €23 million, as it was in 2017. For 2019 Blue Re's maximum capacity is €35 million.

Scope of cover

Blue Re provides NTPL reinsurance for its members that are ELINI policyholders. Its reinsurance policies match the underlying coverage and therefore offer the full scope of cover demanded by the revised nuclear liability Conventions. Blue Re only provides NTPL reinsurance capacity (not for property damage, as it is the case with NIRA).

Mutual Capacity Utilisation and Constraints

Utilisation of capacity

Figure 6 below illustrates how the three different entities provide nuclear third-party liability capacity together for up to €155 million (€ 160 million for 2019).

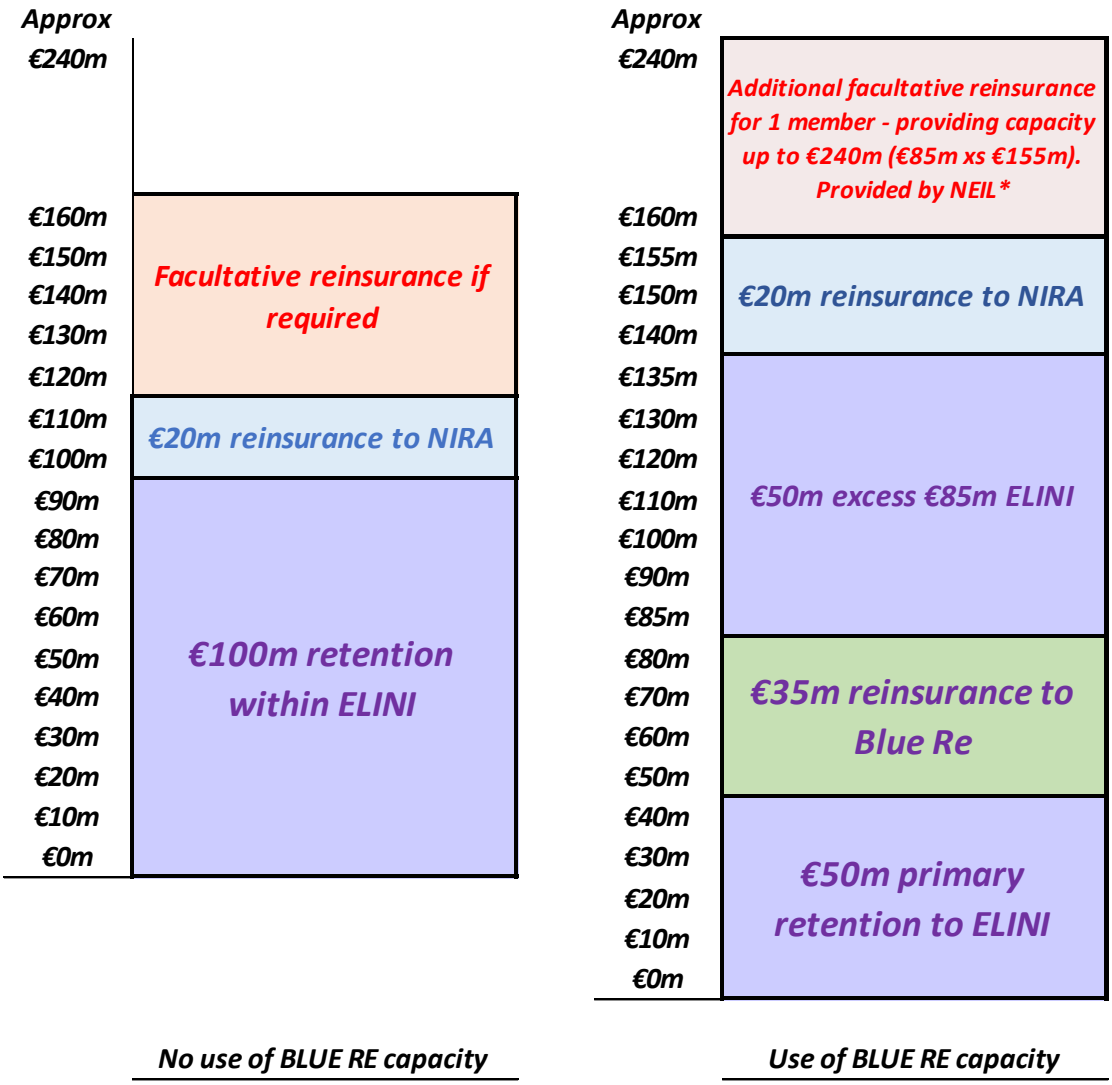

Figure 6: Capacity & inter-dependency (ELINI, NIRA & Blue Re)

* Nuclear Electric Insurance Limited (NEIL) is a mutual insurance company which insures all nuclear power plants in the United States as well as some facilities internationally. Its focus is 1st party material damage (property) insurance. It provided additional reinsurance support to ELINI during 2016 for Belgium only; it is unlikely to do so again.

All the capacity provided from NIRA, ELINI and Blue Re covers the full scope of the revised Conventions; this means it will cover all the heads of nuclear damage including bodily injury for claims up to 30 years after the triggering event.

Constraints

Scope of cover: ELINI, NIRA and Blue Re were all established as mutual insurers by nuclear industry site operators and, as such, the cover offered must match the operators' liability obligations; therefore, there are no constraints on capacity provision (in sense of covered heads of damage), other than the limited amount of capacity (€155 million) available.

It is interesting to note that Blue Re and NIRA are both able to provide full scope NTPL reinsurance capacity to other insurers, although currently such reinsurance is provided to a limited extent.

Period of cover: ELINI, NIRA and Blue Re all provide rolling annual contracts of insurance to their Members; this prevents the accumulation of annual policy limits and is thus not a constraint on capacity.

Multiple events: ELINI, NIRA and Blue Re provide up to 3 full capacity incidents per year. Like most insurers, the mutuals cannot provide inexhaustible cover for multiple events occurring within the same annual period. This represents the only material constraint on the capacity provided by these nuclear liability insurance mutuals. However, this group of mutuals can offer reinstatement[227] for up to 3 full losses and the Articles of Association allow for further calls to be made from the members if necessary.

Increasing mutual NTPL capacity

There is a circular relationship between the size of the Guarantee Fund and Equalization Reserve and the capacity of these mutuals. The Guarantee Fund is used to support the net capacity of each mutual; the Fund is built up by receiving contributions from the mutuals' underwriting surplus annually, as agreed by the Members at an annual meeting. Therefore, increases in the number of Members buying insurance, the amount of insurance the Members purchase from the mutual or the annual Fund contributions will all increase the size of the Guarantee Fund, so permitting greater capacity provision for nuclear third-party liability.

Despite this 'virtuous circle', many Members still opt to buy their nuclear third-party liability insurance from a mixture of capacity provided from nuclear pools and mutuals, to ensure they are not beholden to a single insurer.

227 A reinstatement clause is an insurance policy clause that states when coverage terms are reset after the insured files a claim.

2. SELF-INSURANCE – OPERATOR POOLING ARRANGEMENTS

Self-insurance - Operator Pooling Arrangements

1. The German Solidarity Agreement

Background

Germany's relationship with nuclear power can seem different to that in other EU member states; one of the reasons for this apparent difference is the national nuclear legislation, which offers materially greater financial security than other countries. This project is not concerned with the details of or reasons why such a legal framework exists, but a little background is instructive when considering the key aspect of the Agreement: this high level of financial security.

From the outset German nuclear legislation required a higher operators' financial security amount than was generally envisaged in the early days of the Paris Convention of 1960; the 1959 German nuclear law (Atomgesetz[228]) immediately required DEM 500 million. In 1975, Germany both ratified the Paris Convention and amended the nuclear legislation[229], increasing the operator's liability to DEM 1 billion, although the financial security amount remained at DEM 500 million. In 1985 the operator's liability limit was cancelled and ever since the liability of the operator's has been unlimited; at the time the operator's financial security amount remained at DEM 500 million.

In 1998, following the election of an anti-nuclear political coalition, further material changes to the law were discussed, resulting in the adoption in 2002[230] of the German nuclear-phase out plan and an increase in the financial security amount to €2.5 billion – the highest amount in Europe. This revision demanded new thinking on the deployment of so high an amount; the operators' mutual pooling arrangement was the outcome of this thinking and was introduced in 2001.

How it works

- Until 2002, the financial security obligation in Germany was fully provided for by insurance, up to DEM 500 million (about €256 million). When the financial security amount was raised to €2.5 billion in that year, the tenfold increase for the full scope of nuclear damage proved too great for the existing insurance markets to provide capacity for; therefore, the operators responded by splitting the €2.5 billion requirement into 2 layers – a primary €255,645,000, being equivalent to the 'old' financial security requirement, and a new second layer of €2.244 billion, for which they voluntarily accepted to provide the funding.
- The first tier (or primary layer) capacity is provided by the nuclear insurance market; in Germany this is the national nuclear pool (*Deutsche Kernreaktor Versicherungsgemeinschaft* – DKVG[231]) and the industry mutual (ELINI) for the full €255.655 million. The capacity for the second tier of €2.244 billion is provided by the four utilities that own the various NPP sites in Germany, in accordance with the 2001 Solidarity Agreement (*Solidarvereinbarung*).

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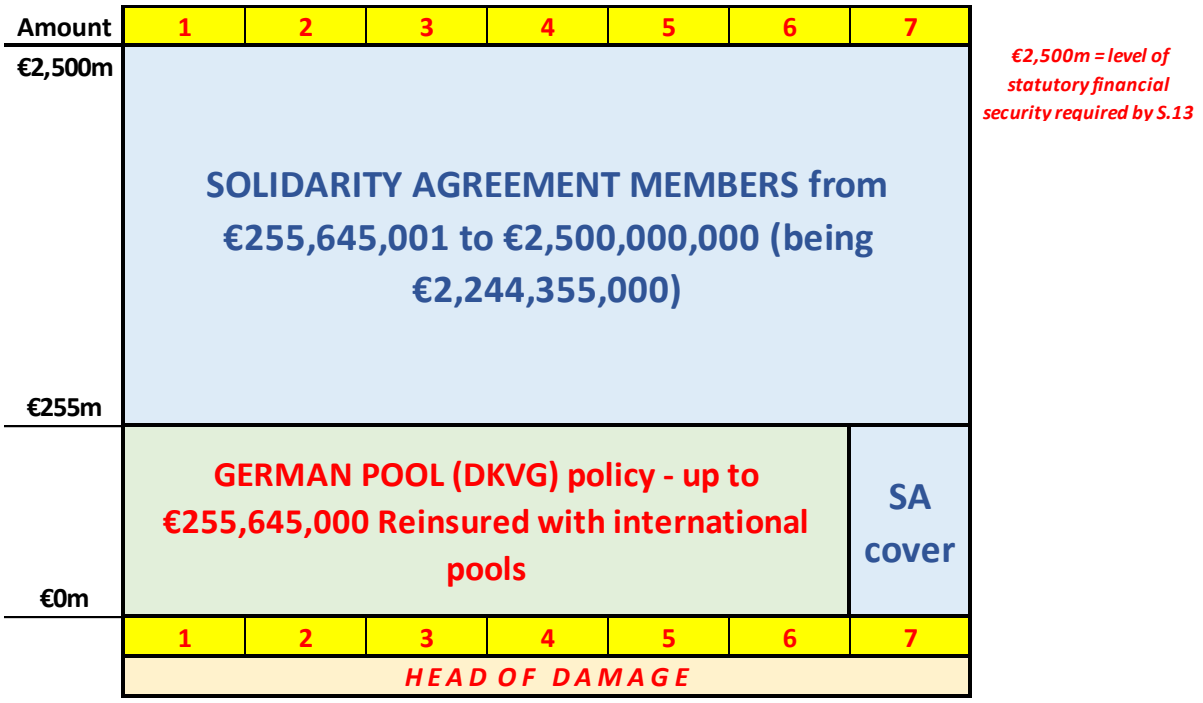
228 See: https://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl159s0814.pdf#__bgbl__%2F%2F*%5B%40attr_id%3D%27bgbl159s0814.pdf%27%5D__1557482956669

229 OECD NEA Legal Affairs Nuclear Law Bulletin #97 May 2016: '*Nuclear Third Party Liability in Germany*' by Christian Raetzke

230 See: https://www.cleanenergywire.org/factsheets/history-behind-germanys-nuclear-phase-out

231 See: https://www.versicherungsmagazin.de/lexikon/deutsche-kernreaktor-versicherungsgemeinschaft-dkvg-1985693.html

- The Agreement established a mutual guarantee between the owner/operators, with the capacity requirement (€2.44 billion) split amongst the owner/operators proportionally according to their share of the thermal capacity of the German NPPs. The Agreement covers both operating and decommissioning NPPs, until their nuclear fuel is removed. Each utility partner to the Agreement pledges to provide its share of the second-tier financial security amount to the liable operator, if for any reason the liable operator cannot meet its own compensation obligation.
- The diagram shown below in Figure 7 shows how the layers are structured.



Number	Head of damage description
1	Bodily injury or loss of life up to 10 years after incident
2	Damage to or loss of property
3	Economic loss arising from injury, death or property damage & loss
4	Cost of reinstatement of significantly impaired environment
5	Loss of incomce from direct economic interest in environment
6	Cost of & any damage caused by preventive measures
7	Bodily injury or loss of life from 10 years to 30 years after incident

Figure 7: German Solidarity Agreement (SA)

- The Agreement's obligations are retrospective as no premium is payable in advance; there is no accumulation of funds and nothing is payable by the operators until and unless a nuclear incident occurs.
- The evidence of this element of the financial security is provided annually by a certification prepared by a public accountant stating that each partner's balance sheet can provide for its share of the financial security amount. Each partner's calculated share of the financial security amount is doubled (to account for multiple events) and 5% is added to the amount for claims management expenses.

- In the event of an accident, it is envisaged that the insurers' claims mechanism would be initiated for the first tier, after which the operators' resources would be called upon jointly to deal with claims into the second tier and beyond.

Notable features

- **Operator identity**: Operator, co-operator and corporate parent are all considered operators of a single site and are thus jointly and severally liable in Germany[232]. This important element of the arrangement ensures that that multi-layered corporate structures cannot avoid ultimate parental responsibility for any nuclear liability.
- **Transfer agreements between 'parent' and 'child'** (being utility/corporate parent and site operator); Section 1(7) of the 2001 Solidarity Agreement states that utilities are required to furnish their site operators with all the necessary financial means to meet all the site liability obligations; the mechanism for this is a 'profit and loss' transfer between the entities and it forms the first line of financial defence before seeking mutuality funds from other utilities and sites.
- **Less hazardous or smaller nuclear sites** have lower financial security requirements; these are calculated proportionately using a formula based on hazard and thermal output.

2. The United States of America's Secondary Financial Protection

Background

The United States of America currently maintain the highest amount of financial security globally, using (as in Germany) a combination of private insurance markets and operator pooling. The federal framework for nuclear liability in the USA is provided by the Energy Act of 1954, specifically section 170, known as the Price Anderson Act, which was first enacted in 1957. The Price Anderson Act serves two purposes:

1. To provide compensation for victims of a nuclear incident;
2. To encourage the development of commercial nuclear energy by limiting the potential exposure site operators have to nuclear liabilities.

These two purposes explicitly demonstrate the nuclear liability 'bargain' whereby the nuclear sector's exposure to liability is limited in return for a specific amount of potential liability. This is familiar to us, as it offers a similar arrangement to the Paris and Vienna nuclear liability Convention regimes; therefore, as elsewhere, operators in the USA must maintain financial protection for potential liabilities. However the definition of financial protection is broader in the USA than elsewhere, as it encompasses '*the ability to respond in damages for public liability and to meet the costs of investigating and defending claims and settling suits for such damages*[233]'; the financial security requirements elsewhere do not include the costs of investigating, defending and settling claims[234].

The original source of US sites' financial protection was the insurance market; as in other nuclear countries, a nuclear pool commenced operation in 1956 to provide insurance to cover the required amount at that time of $60 million. The Act also authorised state indemnification (via the Nuclear

232 OECD NEA Legal Affairs Nuclear Law Bulletin #97 May 2016: '*Nuclear Third-Party Liability in Germany*' by Christian Raetzke

233 See: NRC Regulations Part 140.3 Definitions https://www.nrc.gov/reading-rm/doc-collections/cfr/part140/full-text.html#part140-0003

234 For example, see 1960 Paris Convention, Art.10 (c).

Regulatory Commission (NRC) or Department of Energy (DOE)) for damages that exceed any required financial protection; this amount was set initially at $500 million[235].

In 1975 Public Law 94-197[236] introduced a key amendment to the financial protection regime; it introduced an '*industry retrospective rating plan*'[237] which charged a deferred premium only triggered when the public liability from a nuclear event '*exceeds or appears likely to exceed the level of primary financial protection required.*'[238] This established another layer of financial protection that is retrospectively funded by the operators, that sits above the 'primary' layer of insurance, as provided by the nuclear insurers (in the USA American Nuclear Insurers, the local insurance pool).

The amount of this additional financial security has increased from the initial amount of $560 million established in 1975 to approximately $13 billion today (see below).

The US NRC implements the Price Anderson Act through its regulations set out in 10.CFR part 140.[239]

How it works[240]

- The secondary financial protection layer applies to all licensed reactors with a power output of 100 MW or greater; each reactor has a Master insurance policy issued by American Nuclear Insurers (ANI - the US nuclear insurance pool) that is triggered when the underlying $450 million (c. €401.8 million) of insurance cover is exhausted. Once triggered, each site is assessed equally by ANI for the retrospective premium identified in its policy.
- At present these retrospective premiums are set at $131.056 million (c. €117 million) in aggregate per reactor; however, the annual payment is capped at $20.496 million which gives each reactor a minimum payment period of about 6 years to pay its full obligation.
- In addition to the $131 million, a 5% surcharge is added to cover legal costs (being $6.5528 million), making the total assessment per reactor of $137,608,800 (€122,865,000).
- With 99 reactors operating, the total amount available today from this scheme is $13,623,271,200 (c. €12.164 billion).
- The ANI policy is a contractual document, which obliges each operator to pay the amount assessed and demanded. Each site owner has 20 days from the demand from ANI to pay its maximum annual 1st payment part of the aggregated total (the $20.496 million amount noted above).
- If the damages exceed both the primary insurance and secondary financial protection layer, the US Congress will review the incident and '*take whatever action is determined to be necessary (including approval of appropriate compensation plans and appropriation of funds) to provide full and prompt compensation to the public for all public liability claims resulting from a disaster of such magnitude*' [241]

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235 See: https://web.archive.org/web/20110707134037/http://www.amnucins.com/History.html

236 94th Congress Public Law 94-197 amendment to the Atomic Energy Act of 1954, December 31st 1975

237 Ibid: Sect 3 amendment - Liability Insurance 42 USC 2210

238 Ibid

239 See NRC website: https://www.nrc.gov/reading-rm/doc-collections/cfr/part140/

240 Information kindly provided by the US NRC in response to research team questionnaire

241 See 42 USC 2210 (e) (2)

- If an operator is unable to pay its share, ANI can pay up to $30 million for a single default, with a maximum payable of $60 million for 2 or more incidents of default. Separately, the NRC can pay the retrospective premium due from a defaulting operator and recover the amount plus interest from the operator.
- Operators must provide evidence annually of their financial ability to pay the deferred premiums, showing evidence of relevant loans, letters of credit surety bonds etc. It is not a NRC requirement to show the contingent liabilities created by the retrospective premium protection in the operator's report and accounts.

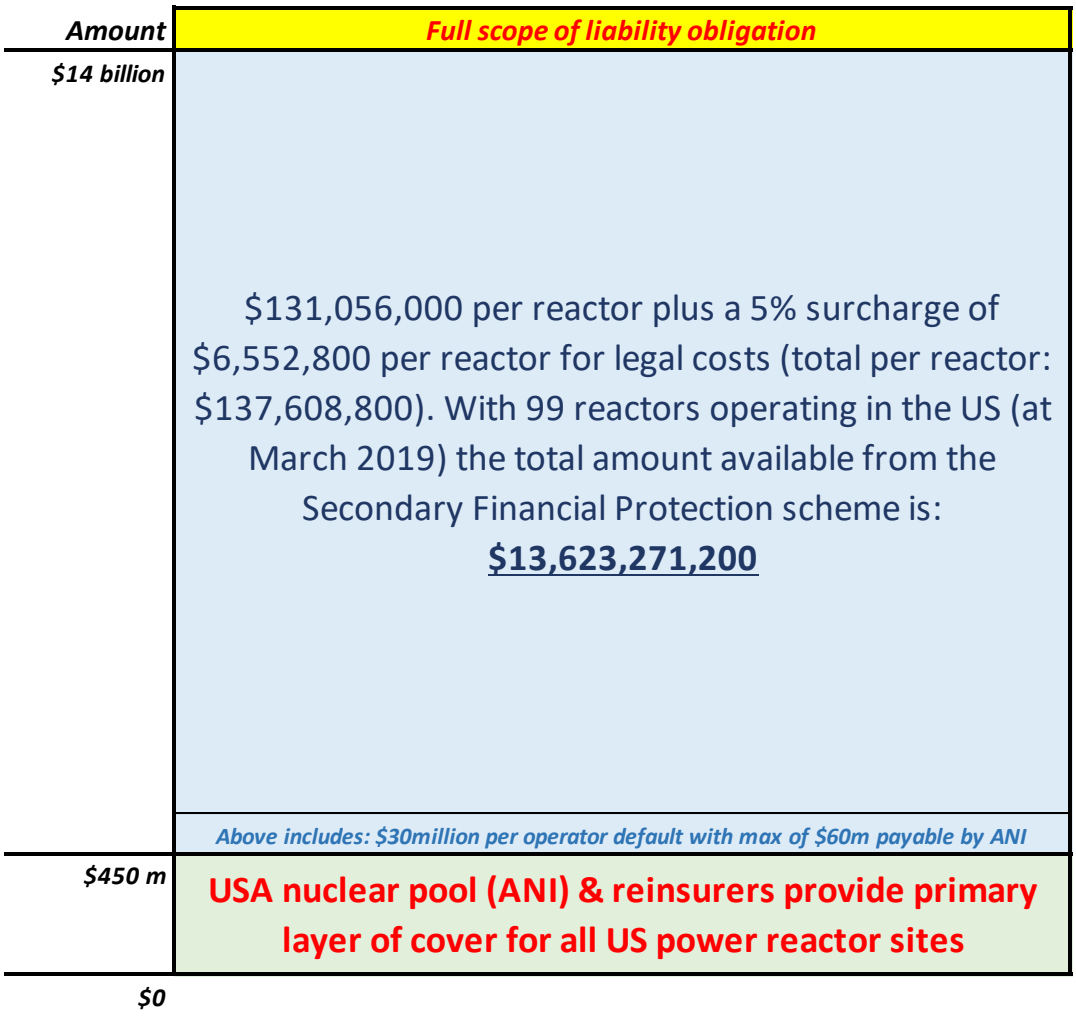

Figure 8: USA Secondary Financial Protection Scheme

Notable features

- The aggregate total financial security amount provided by the secondary financial protection layer across all 99 operating reactors in the US is $13,623,271,200 (c. €12.164 billion); the underlying primary layer of traditional insurance provided by ANI and its reinsurers amounts to a further $450 million (c. €401.8 million) per site. Thus, overall over $14 billion (c. €12.57 billion) is available for compensating third-party nuclear damages, which is the highest amount globally by a wide margin.
- The Price Anderson Act ensures that management of litigation of nuclear damages is a federal matter (as opposed to a state matter).

- Although the US system does not have a legal channelling system, it has instead a system of economic channelling. Suppliers and contractors can be liable under normal tort law under this arrangement and defence of a claim is permitted, but all claims must pass through the site operator, even when suppliers are found liable.
- Also, if an 'Extraordinary Nuclear Occurrence' (ENO) is declared by the US NRC, then operators are required to waive defences and strict operator liability will apply[242].
- The US is party to the CSC, which provides an additional amount for liability compensation in the US for the SDR equivalent of approximately $57 million; this amount sits above the primary $450 million insurance layer (equivalent to the SDR 300 million 1st tier amount).
- The secondary financial protection layer only applies to operating reactors, not those in decommissioning; therefore, the amount available under the scheme is currently shrinking. There are no plans at this stage to extend the scheme to include decommissioning sites; to do so would require a legislative amendment to the Price Anderson Act by the US Congress.

3. Japan's post-accident mutualisation scheme

After the accident at Fukushima in 2011, the responsible site operator Tokyo Electric Power Company (TEPCo) suffered substantial financial strain and government support was necessary to ensure compensation claims were processed and settled. In the context of operator pooling, a brief review of the financial scheme that has evolved since the accident in Japan is instructive.

Background

Until recently Japan was not a party to any of the international nuclear liability Conventions[243]; however, its legal framework follows the principles established by these Conventions. In 1961 Japan introduced 2 Acts that still govern the NTPL arrangements: the Act on Compensation for Nuclear Damage ('Compensation Act') and the Act on Indemnity Agreements for the Compensation of Nuclear Damage. Under these arrangements the operator's liability is strict, exclusive and unlimited, and the current financial security required to operate is set at ¥120 billion (about € 989 million); this must be covered by insurance or a government insurance cover for uninsurable elements of cover (such as earthquake or tsunami). The operator is exonerated from liability in the event of a 'grave natural disaster'; the accident at Fukushima was not designated a grave natural disaster, thus TEPCo was liable for nuclear damage resulting from the accident.

How it works

Section 16, paragraph 1 of the Compensation Act permits the state, with the Japanese Diet's[244] permission, to provide financial support as required to the operator should compensation payments exceed the financial security limit of ¥120 billion. The operator's unlimited liability exposure means the total resources of the company must be exhausted before any state help can be contemplated; this demands bankruptcy and/or corporate restructuring to maximise funds. As both a power generator and electric utility company, in TEPCo's case the compensation payments for nuclear damage were subordinate to its corporate bonds; therefore, liquidation of the company after Fukushima was not considered beneficial to victims of the accident who were due compensation.

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242 See annex H for the NRC definition of an ENO; see NRC website for further information: https://www.nrc.gov/reading-rm/doc-collections/cfr/part140/part140-0083.html

243 In January 2015 Japan signed and delivered its instrument of acceptance of the Convention on Supplementary Compensation (CSC). Three months later, the Convention entered into force.

244 The Japanese Diet is the national Parliament.

In June 2011 a new act, the Nuclear Damage Compensation Facilitation Corporation Act ('Corporation Act') was presented to the Diet and passed on 3rd August 2011[245]. This Act provides the framework for financial aid to be provided to an operator when its financial security limit is exhausted. The Act permits the support necessary to the nuclear operator to ensure prompt compensation is paid and it recognises that financial aid from the state is a priority and justified, given the government's social responsibility for nuclear energy policy.

The Corporation Act also established a Corporation that collects funds to allow nuclear operators to prepare for future accidents for which compensation payments could exceed the financial security amount. Article 38 of the Act requires operators and other fuel cycle facilities to pay an annual contribution into a fund, based upon criteria such as their electricity generation. The Corporation sets the amount of reserves for each operator and it collects and accumulates the funds[246]. After an accident that exhausts the financial security amount, the Corporation can assist the operator by providing funds to pay compensation; it can also offer financial assistance by issuing loans and bonds to ensure the site is safely decommissioned and disruptions to the supply of electricity are minimised.

If the funds available are insufficient, the Corporation Act permits the Corporation to seek further aid from the state, this being labelled Special Financial Assistance.

The Corporation is capitalised by the government and private entities; these being both nuclear power operators and other nuclear facilities, such as J-Power. The diagram in Figure 9 below shows a simplified view of how the Corporation is currently set up.

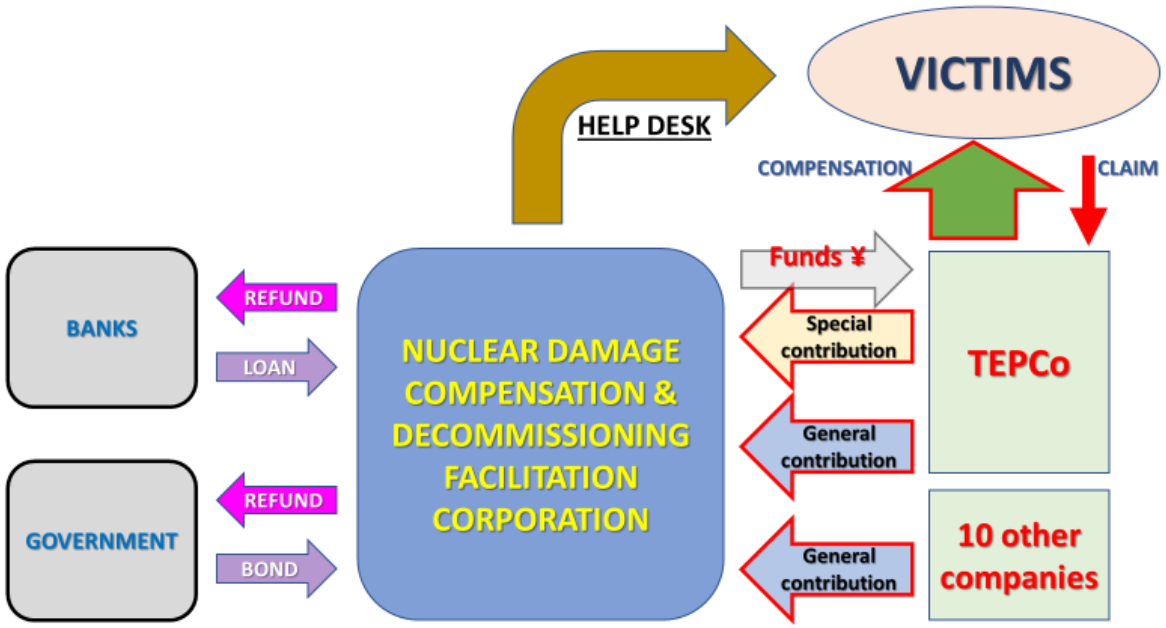

Figure 9: The Japanese post-accident funding mechanism

Afterword

Following the accident at Fukushima, the Japanese government's quick actions to implement additional legislation to complement its 1961 Compensation Act established the necessary framework

[245] For full details of the Japanese NTPL arrangements both before and since Fukushima, see '*Japan's Compensation System for Nuclear Damage*' published in 2012 by the OECD's Nuclear Energy Agency. The publication is available at: http://www.oecd-nea.org/law/fukushima/7089-fukushima-compensation-system-pp.pdf

[246] See Article 39 of the Nuclear Damage Compensation Facilitation Corporation Act.

that has ensured payment of compensation of over €70 billion to accident victims. This unique solution also looks ahead and begins to make provision for a future accident through the mutualised contributions from nuclear operators across Japan.

4. A review of operator pooling arrangements[247]

Introduction

Operator pooling appears an attractive method of addressing some of the perceived faults with the international nuclear liability regimes, such as limited financial security amounts and enshrining public funding for nuclear accidents. The operator pooling regimes in place today and described above offer greatly increased private funding for nuclear accident compensation for the full scope of nuclear damage suffered, when compared with the basic liability Convention offering; therefore operator pooling is a key component in any consideration of greater private finance participation in compensation for nuclear damage. This section summarises the advantages and disadvantages of operator pooling mechanisms.

Advantages

- Operator pooling could offer greater capacity than is currently available from the insurance market.
- This capacity will come from private (i.e. operator) sources, rather than public funds.
- The scope of cover provided for by operator pooling could match precisely the legal requirements of the revised nuclear liability Conventions (primarily for bodily injury with extended prescription period).
- The increased financial security resulting from operator pooling may be more cost-effective for operators, as they will not be funding risk-transfer insurers' costs and profits; retrospective premium charging would emphasise this aspect for operators.
- An operator pooling arrangement offers greater internalisation of the risks of nuclear power; this may increase public acceptance of nuclear power and enhance operators' social license to operate.
- Operator pooling would allow more diversification of capacity provision for nuclear liability.
- Operator pooling could contribute to greater harmonisation of regulatory and legal regimes for the sites and states that participate.

Disadvantages

- It is unlikely that even with substantial operator pooling capacity, enough capacity could be found to match the likely cost of compensation damage from a severe nuclear accident.
- Operator pooling would transfer risk between the participants, allowing more hazardous sites to offset their risk onto safer, less hazardous sites; this could be a substantial disincentive to participate in a pooling scheme.
- Operator pooling is only likely to work with closely harmonised legal and regulatory systems; such transboundary harmonisation is hard to envisage in the near term and may take considerable time and effort to achieve, notwithstanding some progress on EU-wide nuclear safety directives.

[247] For further reading, information and reviews of operator pooling, see (i) OECD NEA Nuclear Law Bulletin # 81 '*Perspective on the Pros and Cons of a Pooling-type Approach to Nuclear Third Party Liability*' by Simon Carroll and (ii) Discussion paper for the IAEA INLEX Group meeting, 2007: '*International Pooling of Operators' Funds: An Option to Increase the Amount of Financial Security to Cover Nuclear Liability*' by N Pelzer.

- An operator pooling scheme is unlikely to be able to offer the equivalent claims management and settlement infrastructure found within the traditional insurance market, although outsourcing this function is possible.
- On the EU level this would also require harmonisation of nationally established financial security limits.

Concluding remark

The advantages of operator pooling outweigh the disadvantages and certainly the current schemes operating nationally in the USA, Japan and Germany offer full scope cover with higher amounts of capacity than the risk-transfer insurers can currently provide; what weighs against operator pooling are the likely complexities involved in extending such schemes beyond national boundaries to create international arrangements, such as one for the whole EU. Consideration of such a concept is examined in section 5 of the Study.

3. RISK-TRANSFER - NUCLEAR INSURANCE POOLS AND MGAS

Risk Transfer Insurance

1. The Nuclear Pooling System

Background

In April 1957, the Advisory Committee to the British Insurance (Atomic Energy) Committee (BI(AE)C) reported that: "*The Committee has come to the conclusion that…some form of pooling is not only advisable but essential: firstly, in order to marshal the full capacity of the Market bearing in mind the net line feature and, secondly, to enable such risks as are insured to be spread in such a way as not to involve the risk of serious loss on too narrow a front*[248]" The report was commissioned to research and recommend the UK insurance market's approach to insuring the commercial nuclear industry, at that time in its infancy. The UK was not alone grappling with this problem; the German, American and Swedish insurance markets were having similar discussions in response to pressure from their respective Governments who all believed that the growth of the commercial nuclear industry would be constrained if private insurance could not be found for these new risks. However, along with the public, the insurers had still relatively fresh in their minds the destructive potential of an uncontrolled nuclear explosion from the bombs dropped on Nagasaki and Hiroshima. How could such a risk be insured when a loss event could cause widespread damage, possibly across borders?

The answer was a nuclear insurance pool; the BI(AE)C was the nascent Nuclear Pool for the UK which, as in most other nuclear countries, was created to cover the unique exposure presented by the nuclear industry. Today the 28 nuclear pools[249] in the EC and globally are the largest insurance capacity providers to the nuclear industry; their commitment to the industry probably has been the largest private market commitment in support of the nuclear sector, which could not have developed as it has without insurance.

How it works

Co-operation amongst insurers and insurance markets was the key to permitting insurance to be offered to the new and unknown nuclear risk; with few sites operating at the start of the nuclear industry's commercial development and an understanding amongst insurers that radiation was invisible and dangerous, the only route open to insurers was some form of cooperation to ensure a widespread participation in nuclear insurance by insurers. This cooperation is the base upon which the nuclear pooling system is constructed, and the mechanism has changed little since the late 1950s.

There were doubts about this cooperation[250], given the highly competitive nature of the insurance market and there was opposition from brokers, who considered the lack of competition to their (and their clients') disadvantage; however the inherent volatility of such a limited portfolio coupled with the possibility of extreme and widespread damage persuaded insurers that a pool was the only solution that could guarantee the nuclear industry the insurance capacity it needed. Thus, the nuclear pools aimed to balance the lack of competition with the desire for economic development; that they survive in such good health today is testament to the lack of a viable alternative model for providing the capacity now evidently required.

248 See: *BI(AE)C report of the Advisory Committee April 1957, para.150/p33.*

249 For a list of nuclear pools see Annex F.

250 See '*Nuclear Energy & Insurance*' by James Dow; published 1989 by Witherby, London; p.226

Each nuclear state generally has seen the development of a nuclear pool[251] which is a voluntary association of insurers that all desire to participate in the insurance of nuclear risks; the insurers group together in a single regulated entity that becomes the pool administration. The insurers that participate in the pool delegate their underwriting authority within strict limits to the pool. Thus, the pool becomes the national nuclear underwriting entity and issuer of the policies and the participating, or 'member' companies, provide the ultimate security that stands behind the policy. This offers an efficient and cost-effective underwriting mechanism for the member insurers.

The nuclear liability Conventions channelling principle is enforced through the application of the radioactive contamination exclusions (RCE – see Annex G) clause to all general non-life insurance policies issued to homeowners, businesses and car drivers globally; this exclusion prevents claims for radiation damage being made under these policies. The liability exposure for nuclear damage is channelled to the operator, who is strictly liable for nuclear damage – the operator in turn purchases an insurance policy for both on-site (first party) and off-site (third party) nuclear damage from the insurance pool (see Figure 10).

Nuclear Pools are open to all insurers that meet stringent security/solvency requirements. This is important not only because some pools have a mutuality agreement between members but also because of the long-tail nature of the existing nuclear liability exposure; insurers need to be able to ensure the ability to pay operators' claims in the future.

Insurers commit a capacity amount once the pool's management has accepted all the member companies, the capacity committed by each member is collectively used to underwrite nuclear risks; this accumulated amount is the individual pool's capacity with each member's share being its capacity as a proportion of the full, accumulated annual capacity. Pools generally provide both 1st and 3rd party capacity to nuclear sites, therefore each member's capacity is generally split between the two types of insurance, depending on demand and the pool members' risk appetite (see Figure 10). For most insurers, short tail 1st party property damage insurance is more attractive than long tail liability insurance, because the outcome of the former is known quickly, and minimal reserving is required; this allows insurers to declare their profits with more certainty and speed than with a portfolio dominated by liability insurance. The capacities in Annex E show the NTPL amounts available for the global pooling system; it should be remembered that these do not necessarily represent each pool's *maximum combined* capacity, as there will be capacity committed to 1st party property damage as well.

Critically each member is required to offer its net line capacity only. An insurer's net line is the amount it is prepared to retain without any form of reinsurance – effectively the amount per loss it will suffer to its underwriting account without being able to recover from reinsurers. Most insurers use reinsurance as a gearing mechanism[252] to offer greater capacity – an arrangement that spreads risk across the market and permits a wide variation of risk appetites. This net line restriction for nuclear pool risks is enforced because the pools themselves reinsure each other and thus must prevent inadvertent double reinsurance; it also helps to guarantee strong solvency, as reinsurance capacity is contractually less certain and harder to recover; it also can attract a capital loading (see **Technical Annex 5**).

When a nuclear site buys insurance it will normally use a broker to act as its agent for the purchase, whose objective is to find the best insurance for its client – in terms of cover scope and price. In the small nuclear market, the choice of insurer is limited to the pools, mutuals and the few other active participants (such as Northcourt or individual players). The broker presents the risk to the pool for consideration; the pool's underwriting team analyse, price and if acceptable issue a policy on behalf of

[251] For a list of nuclear pools see Annex F. Not all 'nuclear states' have nuclear insurance pools, for example Argentina, Iran and Armenia.

[252] See Annex A – Glossary.

the pool members, so committing their capacity to the nuclear site policy collectively on a co-insurance basis. Some pools within the EU operate in a different way: the nuclear site (or the broker) approaches a normal insurance company rather than the pool and that insurer will reinsure any nuclear exposure into a nuclear pool formed in the manner described above; the company offering the risk will normally be a member of the pool. These are known as reinsuring pools.

Once the nuclear risk has been underwritten and accepted, the national pool will issue a policy to cover the full demanded policy limit. In most circumstances the policy limit demanded will be beyond the capacity of the individual pool and to fulfil the demand, the pool will seek facultative reinsurance capacity from other pools around the world for each individual policy issued. Other pools are under no obligation to accept any risk from another pool and each pool will consider whether the exposure falls within their own pricing mechanisms and risk appetite. However, if the original risk is priced acceptably for the reinsuring pools, the global pool network provides a capacity commitment of up to about €2.5 – 3.0 billion (being the current maximum demanded) for a combination of 1st party property and NTPL insurance for an individual site. Although reinsurance contracts in the normal insurance market can be challenged, the nuclear pool reinsurance system is governed by Standard Rules that provide for quick and secure settlement; this is possible because of the small number of pools and close cooperation on administrative matters amongst the global pool network. With nuclear pools only reinsuring each other, their global reciprocal risk exchange network provides clients with strong policy security and quick access to substantial capacity (see Figure 10).

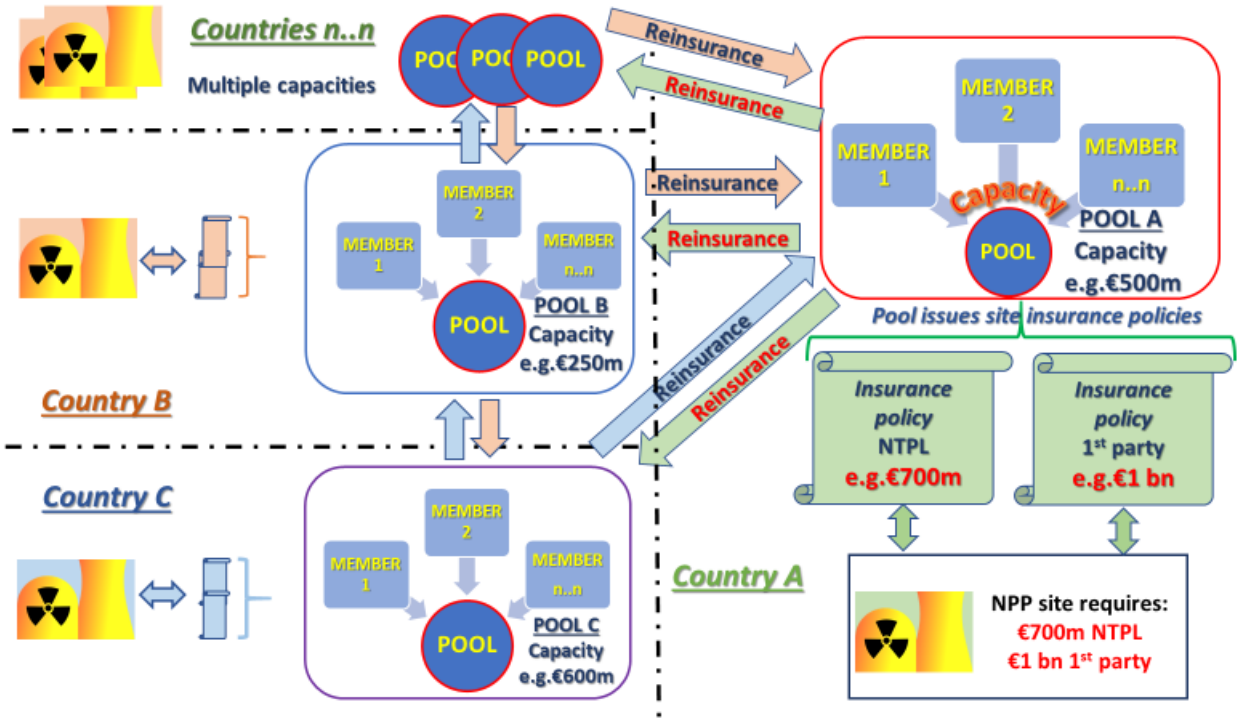

Figure 10: The global nuclear pooling system

Key features

- Annually renewable capacity: pool members renew their capacity commitment and delegated underwriting authority to the nuclear pool each year. The scale of participation by pool members is thus dependent on previous financial performance.
- Market wide: nuclear insurance pools are open to all adequately rated insurers in each national market. The objective is to attract as great a range of members as possible to ensure strong

market representation and thus spread the nuclear exposure across the whole insurance market.

- Net line commitment and overall solvency: individual pool members can only commit a net un-reinsured capacity to the pool; this offers clients better security because each member's exposure is limited to its own liquid funds and with many insurers participating on this basis, concentration of risk exposure on a small number of highly geared insurers is avoided. Some pools have the added security of mutualisation, thus if one pool member becomes insolvent, the other pool members will meet the insolvent insurer's pool obligations.
- Reciprocal risk exchange: the international network of pool reciprocal reinsurance provides clients with quick access to substantial, informed nuclear risk capacity; the Standard Rules of conduct that apply to all inter-pool reinsurances add a further layer of security to ensure quicker settlement of valid claims.
- Technical surveys and expertise: concentrating the nuclear underwriting into one specialist entity has enabled the pools to become centres of excellence in the field of nuclear insurance. The pools can also offer clients a global perspective of nuclear risk and strong technical expertise with a focus on the financial risk exposure.
- Claims handling: in theory Pools have available the full resources of the member companies, but in practice the claims handling ability has received limited testing. However, there is nothing to suggest that Pool members would not work together to provide a comprehensive claims handling and management system; after all the settling of claims is something insurers are extremely familiar with. Moreover, it appears a logical step to consider the insurers as the obvious choice for a universal post-accident claims handling system for all claims, whether made to operators, insurers or governments, given their experience, independence and collective resources.

Advantages of the pooling system

- Strong security offered to operators and accident victims provided by third-party (i.e. independent of operator) capital.
- Speed of access to substantial global capacity.
- Expertise on nuclear risk built up over decades of only insuring nuclear risks.
- Comprehensive claims handling infrastructure available from market participants.

Disadvantages

- Annual renewal could see quick fluctuations in capacity and results in less willingness to contemplate longer-term exposures.
- Net line reduces interest from some insurers – commitment either becomes too small or too volatile.
- Pools function with delegated authority from their members; the responsibilities that flow from delegated authority are becoming greater as regulatory oversight of insurers increase, particularly in classes of insurance that might pose a systemic risk.
- Constrained by general market conditions and risk appetite, which can slow reaction to nuclear sector specific requirements.

2. Other Capacity – Northcourt (MGA)

Background

Northcourt is an international insurance and reinsurance Managing General Agent (MGA) sponsored by the Lloyd's and company (i.e. non-Lloyd's) insurance markets. Northcourt can underwrite nuclear risks globally, offering competing capacity to the Nuclear Pools and supported by other, non-pool

insurers in the risk-transfer market. It was established in 2011 as a response to the perceived lack of nuclear insurance competition in the risk transfer market, with an initial capacity of $200 million (€178.6 million) for 1st party property risks only[253]; in 2015 it expanded its offering to include NTPL cover with an initial capacity of $100 million (€89.3 million)[254]; today the headline maximum NTPL capacity is €200 million. It is run by experienced nuclear insurance personnel and its mission is to bring additional capacity to the market, provide choice of insurer and spread of risks thus enabling insureds to have more flexibility in their programme design.

Northcourt is licensed by the Malta Financial Services Authority and thus can offer its insurance products throughout the EU; Northcourt's head office is in Malta with branch office in London. It is subject to the annual audit and regulation by the Lloyd's market, as most of its member insurers are based in Lloyd's as well as by UK's Financial Conduct Authority. Lloyd's regulatory framework offers certain benefits such as access to a global licensing network, which is why many insurers opt to establish in this famous market. Northcourt also has member insurers from outside the Lloyd's market, but these too are generally based in the London insurance market. Like the nuclear pools, Northcourt operates on a delegated authority basis, with the insurers permitting Northcourt to underwrite and manage the risks on their behalf.

The notable difference between Northcourt and the nuclear pools is that Northcourt is not a geographically limited entity; it is able to offer insurance in any country where its member insurers are licensed.

How it works

Most MGAs for any type of insurance operate with delegated authority from several insurers. In Northcourt's case 15 insurers have agreed as a group to delegate their underwriting, using a binding authority, to Northcourt for nuclear business on account of Northcourt's significant expertise in the nuclear sector; this delegation will be within strict parameters with a leading insurer(s) taking on the responsibility for greatest oversight of the scope of authority for underwriting and claims. Each of the insurer participants will commit a certain amount of capacity which, when accumulated with all the other member insurers, will provide the total Northcourt capacity; this mechanism is very similar to the nuclear pools, which are also MGAs but which are generally geographically limited to a single nation. The MGA management will operate within guidelines set by the largest (or larger) participating insurer(s). MGAs are typically regulated as intermediaries[255] rather than insurers, as the responsibility for regulatory capital remains with the participating insurers.

From its start Northcourt has emphasised its ability to work closely with insurance brokers, who act as representatives of the client buying the insurance – in the case of Northcourt, the nuclear site operators – and who will negotiate with the insurer to obtain the best terms for the client. With competition in the nuclear insurance sector previously restricted to the nuclear pools and the industry mutuals, the establishment and growth of Northcourt has been positive, as it offers more choice of insurer for nuclear operators; by working closely with brokers, Northcourt is able to publicise better its new place in this market.

Northcourt retains the necessary expertise in-house to enable it to offer a full suite of nuclear insurance products, covering both 1st party property and NTPL, to nuclear sites anywhere worldwide.

253 See various insurance press articles, for example: *News Insurances – January 2012*

254 See various insurance press articles, for example: *Business Insurance – February 2015*

255 Northcourt is licensed as an intermediary by the Malta Financial Services Authority, see: https://www.mfsa.com.mt/financial-services-register/?fsr=northcourt&cat=&subCat=&country=&years=

It can also offer a full technical inspection service. With Northcourt's assistance, lead insurers will handle and settle claims.

Today the accumulated capacity offered for NTPL exposures by the Northcourt member insurers amounts to €200 million; this amount is shown in the capacity tables in Annex E.

Notable features

- Northcourt is unique amongst the risk-transfer market as it is able to offer liability policies that cover the full scope of the revised Conventions – including the contentious 10-30 year period for making a claim for bodily injury as a result of nuclear damage. The capacity for this exposure is currently limited to 50% of the €200 million total, being €100 million, because the regulatory regime at Lloyd's has recently been amended to segregate the long-term nuclear liability using a separate risk coding; the purpose of this segregation is to identify what Lloyd's perceives as the more volatile exposure. Lloyd's considers that the 10-30 year bodily injury exposure is worthy of identification and additional capital loading primarily because of the uncertainty arising from judicial inflation (see section 4 of the main study) and the volatility caused by the insurers' net line participation arising from adherence to the radioactive contamination exclusion clause[256].

  Despite this restriction to €100 million for 10-30 bodily injury exposure, Northcourt's ability to offer any capacity for this exposure demonstrates that there are insurers in the risk transfer market willing to contemplate the extended bodily injury exposure. Why have Northcourt's insurers decided to offer such cover, when (at present) the insurers supporting the nuclear pools have refused to do so? The key reasons are:

  - Innovative approach permitted by independence (i.e. it is not reliant on a network of reinsurers, as the pools are);
  - Supporting insurers are outside of the Lloyd's regulatory regime.

  If the regulatory framework was relaxed by Lloyd's (and some other regulatory bodies), then Northcourt would be able to offer its full capacity for the whole scope of the revised Convention cover.

- Northcourt is a wholly independent, stand-alone insurer of nuclear risks, unlike the nuclear pools that need to reciprocally exchange risks amongst each other to enable them to offer maximum capacity; this independence enables Northcourt to be innovative in the products and services it offers to nuclear clients[257]. Thus, in addition to the usual 1st party and NTPL cover offerings, Northcourt also offers coverage specifically tailored to the CSC exposure for contractors, for nuclear project investors and for construction/site decommissioning.
- Northcourt's member insurers are all A.M Best 'A' rated as a minimum.

[256] Noted during an interview with the Performance Management team at Lloyd's - January 2019

[257] See Northcourt website: https://www.northcourt.eu/products.php

4. RISK-TRANSFER - ILS AND CAT BONDS

Risk-transfer - Insurance linked securities (ILS) and cat bonds

Introduction

Towards the end of the last century, traditional insurance and reinsurance capacity increasingly was inadequate to cope with some of the larger losses occurring at the time; for example, the insured cost of hurricane Andrew in 1992 comfortably exceeded the loss models[258] that provided insurers with an estimated cost of certain events. The ensuing shortage of capacity and some insurer insolvencies encouraged insurers to look for new capacity outside the traditional world of insurance; consequently, according to insurance broker Aon, the first cat-bond using capital from the capital markets was issued in 1996[259]. With investors hungry for capital growth that does not correlate with other global investments, the insurance linked securities (ILS) sector has grown strongly since, with estimates today putting capacity availability in excess of $100 billion (€89.3 billion)[260].

What are these new sources of capital and how do they work to provide additional capacity to the insurance sector? This section provides a short primer on the ILS market and its relevance to nuclear insurance.

Structure and vocabulary

The ILS market has developed quickly to provide substantial additional capacity for insurance products, while also offering diversified exposure for investors hungry for returns in the current low-interest environment. Its suitability to large binary events (a binary outcome is a prerequisite for so called all-or-nothing investments, which ILS are) at first glance makes it suitable as a provider of capacity for the NTPL market. It should be noted that the sector has developed a vocabulary that requires translation if the concepts are to be properly understood. Hence, the key phrases for the purposes of this study are described below:

Insurance Linked Security (ILS): ILS is a financial instrument, sold to investors by insurers/reinsurers, whose value is affected by insured loss event. ILS encompasses catastrophe bond and other forms of risk-linked securitization. It creates a collateral-supported source of contingent funding for an insurer or reinsurer, supported by investors. Figure 11[261] below illustrates the basic concept and how investors earn returns on both the collateral and the contingent funding obligation (premium and yield).

258 According to Business Insurance the modelled cost was c. $7bn, but the actual insured damage was $15.5bn. See: https://www.businessinsurance.com/article/00010101/NEWS06/912315310/Lasting-effects-of-Hurricane-Andrew

259 See: Aon Securities website.

260 Various sources have indicated capacity excess of $100bn, including Aon Securities, Guy Carpenter Securities, Artemis bm.

261 Derived from information provided by Swiss Re Capital Markets, Artemis.bm and Moody's.

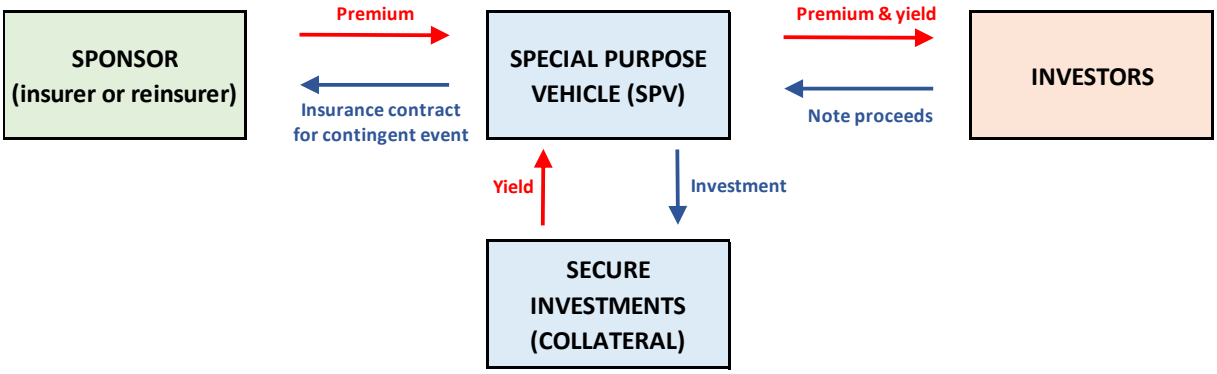

Figure 11: Insurance linked security - catastrophe bond

The sponsor (the insurer or reinsurer seeking the capacity) enters into a reinsurance contract with a newly formed Special Purpose Vehicle[262] (SPV); the SPV receives premium and provides reinsurance cover in the normal way. The SPV issues security notes to investors in return for principal (cash); the principal amount is then invested into highly rated money market funds, so providing collateralised security for the contingent reinsurance contract if required. During the contract's "lifetime" funds from both the collateral investment and the premium flow back to the investors. At the termination of the contract, if the reinsurance has not been triggered (i.e. the contingent event has not occurred), the investments (into money market funds) are sold, and the principal amounts are returned to the investors. The initiating event will generally have a trigger (e.g. earthquake or windstorm of greater than a specified intensity) which if exceeded will activate the cover (loss of principal provided by investors to the SPV).

The key element in the arrangement is the SPV, as this is the interface between the insurance and capital markets; the design of this 'transformer' must be an acceptable structure to suit both sides.

Catastrophe bond (cat-bond): a cat-bond is simply a liquid form of ILS.

Typically, it is linked to a non-proportional (see Annex A: the glossary) reinsurance. In figure 11 above the sponsor's (insurer/reinsurer) contract would be a layered product linked to a contingent event with a trigger.

Industry loss warranty (ILW): an ILW is a form of reinsurance contract that is triggered only when an event (e.g. windstorm, earthquake) exceeds an insurance market-wide financial loss, as observed by an official index-provider.

Protection gap entity (PGE): Protection gap entities are structures that bring together all stakeholders (such as governments, insurers, capital markets, insureds) to develop a holistic approach to providing complete coverage for difficult risks or exposures that maximise the advantages of each stakeholder. Therefore, they may contain elements of mutualisation, risk-transfer to traditional and new capital markets, operator risk retention and possibly some state involvement. A PGE can provide an independent infrastructure for marshalling financial resources to provide cover where market failure has left exposures uninsured.

[262] A special-purpose vehicle is a legal entity (usually a limited company of some type or, sometimes, a limited partnership) created to fulfill narrow, specific or temporary objectives, typically used by companies to isolate the firm from financial risk.

Tranches: one mechanism for maximising insurance capacity is to layer insurer participations in an insurance programme, allowing insurers to pick a monetary attachment point that best suits their individual risk appetites. Some insurers only like to participate on very high, remote layers where rewards are slim but risk very low; others like to participate at a low level and earn better returns for the much greater risk. The same applies to the ILS structures.

Triggers: Cat. bonds typically use triggers as the activating mechanism for loss payment under the arrangement. The types of trigger include:

1. Indemnity – the actual monetary loss sustained for the tranche insured.
2. Industry loss – typically for ILW cat. bonds, these triggers are activated when the reported market loss from the event exceeds a certain amount.
3. Parametric – triggers set around a formal measurement of the actual conditions experienced, such as wind speed or earthquake magnitude.

Credit rating

Alternate capital is sourced from 2 markets:

i. The private markets: consisting of private equity, hedge funds and other private capital. These markets are more selective than public markets, but these generally provide the starting point for new types of exposure. The team's research shows that available capacity from these markets is approximately $100 billion (€90 billion) for natural catastrophe products; the amount available for new risks, such as nuclear will be materially less than this.
ii. Public rated markets: consisting of, for example, credit rated securities and the bond markets.

If the SPV attracts a credit rating, then it will have access to this much wider pool of capital, which is estimated to offer 6 to 10 times more capital than the private capital markets. Once an NTPL product is familiar and well established, the respondents to the team's research suggested the SPV should seek a credit rating which will open up material additional capacity.

ILS and NTPL insurance

The attraction of ILS for nuclear exposure is the offer of orders of magnitude greater capacity than currently available, which could be linked to verifiable and credible triggers designed around some aspect of the nuclear industry's heavily regulated *modus operandi*. Consideration of possible structures for nuclear ILS are shown in section 5 and 6 of the Study, but research has indicated initial capacity of $1 billion for a possible un-rated nuclear ILS and the first nuclear liability ILS deal has already been concluded[263].

The main issue of concern about the use of ILS is likely to be cost; at present NTPL pricing knowledge is in its infancy, but several interesting points have emerged from the research conducted:

- A rule of thumb suggests that the price for a deal is currently approximately 2 times the actual loss cost; this multiple has dropped from over 5 times since 2011. For example, if an event had a return period of once every 100 years (1:100 or 1%) the cost to protect it currently using ILS should be in the region of 2% per annum (i.e. a €100 million 'policy' will cost about €2 million annually). However, these numbers must be used cautiously, as every deal is different and with minimal market knowledge of NTPL exposure, assuming these rules will apply to NTPL is premature.

263 See 2017 article in Artemis.bm newsletter: http://www.artemis.bm/news/nuclear-liability-risks-ils-deal-transacted-on-a-direct-insurance-basis/

- However, anecdotally ILS pricing is still regarded as 'expensive' compared to traditional reinsurance; some reports indicate the pricing multiple of ILS over traditional (re) insurance could be 1.5 times (i.e. ILS may cost buyers about 150% of the traditional reinsurance product).
- Pricing is driven by the cost of capital, competition and diversification; at present competition for nuclear capacity is low, but this can change once familiarity builds, as has been demonstrated by anecdotal evidence from the terrorism sector[264]. Diversification of any asset portfolio is generally attractive to investors and can make the product cheaper for sponsors if this element is viewed favourably. Non-correlation with stock markets is most favoured and it remains to be seen whether the capital markets consider NTPL exposure from a severe nuclear accident to be divorced from global or national stock market activity.
- Pricing for naturally occurring events is cheaper than for man-made losses; this is because actuarial calculation is easier for fortuitous events like earthquakes and hurricanes than it is for man-made accidents such as (most) train crashes, off-shore pollution and nuclear events. Long-tail risk also will attract a higher premium, although for NTPL re-packaging of exposure to eliminate the long tail legacy exposure will make it possible to mitigate this pricing disadvantage.
- Generally, indemnity triggered events are cheaper to buy than other triggered events; this is because the onus on reporting indemnity events falls upon the sponsor. However, parametric triggered events can attract greater capacity.
- All deals will be 100% collateralised with high grade (low risk) investments supporting each deal (see figure 11 above). However, the risk premium element of the deal is a critical as it is the majority component of the reward to the investors.
- Estimates of capacity for an ILS deal for NTPL exposure varied materially, with key variables being attachment point and trigger types. Amounts of between €100 million and €1 billion were suggested, with substantial co-(re)insurance participation required from traditional markets to help build confidence.
- With cover triggered by either high amounts of indemnity or specific parametric triggers and with fixed financial amounts as exposure, the use of ILS is likely to be limited to providing cover outside of the NTPL liability Convention regimes only (for example, to operators "above" the liability regime imposed on operators). However, over time the amounts of capacity available could develop to offer substantial amounts of capacity at a consistent level across all EU MS, in excess of that already provided within the national legal frameworks; this would fulfil the key EU objectives for NTPL cover.
- A credit rated SPV should be able to attract capacity at a price range of 3% rate on exposure for an 'A' rated entity to 4.5% rate on exposure for a 'BBB' rated entity. This would indicate a premium of € 35 million for a € 1 billion capacity offer, but this amount is obviously subject to a negotiation.

[264] See https://www.poolre.co.uk/pool-re-places-worlds-first-ever-terrorism-cat-bond/; the cost of this deal will probably reduce quickly, according to various sources.

5. CAPITAL, CAPACITY AND UNDERWRITING

Introduction

The main study refers frequently to both theoretical and actual capacity available for NTPL insurance; understanding why the amount of *theoretical* or *maximum* capacity is not always available as *actual* capacity 'on the ground' is important. The constraints on capacity provision are covered elsewhere in this study; however, other elements have a role in creating these capacity differences and the relationship between **capital**, **underwriting** and **capacity** is key to developing a better understanding of actual capacity deployment in the NTPL arena. This technical section aims to explain these three terms and their relationship.

Capital

Safeguarding the ability to pay valid claims when required is a factor that underpins confidence in the insurance market; therefore, it is axiomatic that policing the solvency of insurers and their ability to pay is a critical role for regulators. Since 2016, Solvency II has been the regulatory regime that controls this aspect of the EU insurance and reinsurance market, and it is obviously influential for participants in the nuclear liability insurance market.

The Solvency II directive was adopted in 2009 and finally came into force on January 1st 2016[265]. It has three pillars[266], being financial requirements, governance and supervision and reporting and disclosure. The latter two pillars cover insurers' obligations to manage their businesses prudently and to report their financial situation to the supervisory bodies; these are not immediately relevant to the understanding of the nuclear insurance market. However, the first pillar, financial requirements, is important to understand in the context of capacity provision for nuclear risks.

Whatever type of insurance an insurer decides to offer, under the Solvency II regime it will need to earmark enough capital to enable it to meet possible future claims. The adequacy of that capital amount is determined by modelling – for larger insurers these will probably be internal, regulator approved models and for smaller insurers, the models will probably be externally developed – perhaps by actuaries or the regulator itself. The models calculate the capital that is required to meet two ratios that underpin regulatory capital requirements:

- **Solvency Capital Ratio (SCR)**: this is the amount of capital the insurer is required to hold, and it is calculated annually to ensure all quantifiable risks, such as operational, counterparty[267], market and underwriting risk[268], are considered. The actual modelling is now largely specialised work for actuaries, who need to incorporate in the underwriting risk analysis the likely cost of future claims, expenses associated with claims, the impact these may have on premium (such as post-loss cover reinstatement premium) and a risk margin[269] in the

265 EC Directive 2009/138/EC - see European Insurance and Occupational Pensions Authority (EIOPA) website: https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii

266 See Lloyd's website: https://www.lloyds.com/market-resources/regulatory/solvency-ii/about/what-is-solvency-ii

267 Counterparty risk is the likelihood or probability that one of those involved in a transaction might default on its contractual obligation.

268 Underwriting risk refers to the potential loss to an insurer emanating from claims. The same may affect the solvency and profitability of the insurer in an adverse manner.

269 According to The Actuaries Profession (see: www.actuaries.org.uk) a risk margin is ' *Amount required to ensure the value of the technical provisions is increased from the discounted best estimate to an amount equivalent to the theoretical*

calculation. The objective of the SCR is to ensure that the insurer can meet its policyholder obligations for the 12 months ahead with a confidence level of 99.5% (equivalent to a 1:200-year failure)[270]. The models calculate the capital required for each class of insurance business and aggregate these together, permitting some capital relief for non-correlating classes spread across a risk portfolio; this obviously favours larger, diversified insurers with multiple insurance classes over insurers that are monoline (i.e. they insure only a single class of business). Insurance companies must report annually information about their risk assessment and capital, and they can express their modelled capital holding as a percentage of this SCR – for example AXA reports that for 2017 it held capital of 205% of its SCR[271].

- **Minimum Capital Requirement (MCR)**: this capital requirement must also be modelled; it represents the threshold below which an insurer will require regulatory intervention and may be deemed insolvent for regulatory purposes. Therefore, it is a safety net calculation that offers an 85% *probability of solvency adequacy* over any annual period and it must be between 25% and 45% of the SCR.

To calculate the capital required to achieve the SCR 99.5% confidence level, insurers need to evaluate the risks posed by the various types of insurance they offer. It is easy to appreciate how nuclear liability exposure compares unfavourably with other, easier types of insurance when modelling this calculation; for example, compare the broad definition of nuclear damage liability that includes a long bodily injury exposure of up to 30 years for relatively few nuclear sites with the short duration of exposure from motor car accident insurance for millions of policyholders. Motor insurance offers a simple capital calculation, but the same is not the case for nuclear where uncertainties over possible claims years into the future and the inherent volatility in relatively few, large sites will weigh the calculation of the required 99.5% of capital. Therefore, greater volatility and longer duration of exposure both contribute to increase materially capital required. Demonstration of this was offered by a large EU insurer, which explained that for 100 units of motor insurance premium accepted it requires 30 units of capital, whereas for excess of loss third-party liability (TPL) 100 units of premium requires 180 units of capital[272].

Insurers generally use the return on capital employed (RoCE) as a standard measure of profitability when assessing their performance. This ratio shows operating income (i.e. premium less expenses) against capital employed[273]; using the anecdotal example described above, we can compare the RoCE

level required to transfer the obligations to another insurance undertaking'. In other words, a commercial safety margin that would make the obligation sufficiently attractive to allow it to be sold on to another entity.

270 For example, see FT.com: https://www.ft.com/content/51bc0c08-aa38-11e5-9700-2b669a5aeb83

271 See: https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com%2F72f0d1a4-1aca-481a-9a83-949781f230b0_axa_sfcr_2017_va.pdf

272 Approximate numbers only, obtained by interview.

273 Formula:

$$\textbf{RoCE} = \frac{\textbf{Earnings before interest and tax}}{\textbf{Capital employed}} \quad \frac{[\text{Revenues} - (\text{cost of goods/services sold} + \text{operating expenses from revenues})]}{[\text{Total assets} - \text{current liabilities}]}$$

for a motor and an excess of loss TPL account. If we assume €100 premium for each class of insurance, the RoCE calculation is:

Component	Motor	Excess TPL
Premium	€ 1000	€ 1000
Claims (actual or predicted (i.e. reserved))	€ 600	€ 400
Expenses	€ 100	€ 100
Surplus	**€ 300**	**€ 500**
Capital employed (from example above)	€ 300	€ 1800
RoCE	1	0.277

From the example it is clear that more insurers will favour classes of insurance that offer greater certainty of return with low capital requirements and typically within most insurers and reinsurers each class of insurance must 'compete' for capital based on this measure. Considering this example, it is possible to understand why the nuclear liability insurance market capacity commitment is low compared to other sectors, because just the exposure from future bodily injury claims up to 30 years in the future will load both the underwriting risk and risk margin calculations. When combined with other elements of the analysis (for example volatility and reserving), the returns are modest, yet the capital requirement can be high.

In summary, insurers' profitability is driven by the returns achieved on the regulatory capital required to support their underwriting; that capital requirement is assessed using models that don't favour large exposure to volatile, long duration risks. This reduces the appetite and so the capacity available for such risks.

Capacity

Capacity is the financial liability an insurer is willing to assume from a specific class of business. The capacity amount committed is influenced by many factors, including the insurer's risk appetite, the availability of suitable reinsurance, the capital requirements and the profitability of the class of insurance under consideration; capacity is also a critical component in the SCR calculation, as the maximum liability amount assumed by the insurer will influence the capital required to support the liability.

After undertaking the necessary analysis and making a decision to underwrite a class of business, the insurer will calculate the maximum capacity amount it can commit to any one risk; as this indicates to the insurer's shareholders the maximum possible liability it will incur from a loss to a particular risk underwritten. Of course, each risk will be underwritten individually, and the insurer can exercise choice in the financial amount of liability committed to each risk, dependent on its qualities; therefore, the maximum capacity will normally only be committed to the best risks, where there is enough demand for capacity. With each new risk underwritten, the insurer will build up a portfolio of risks with varying amounts of capacity committed to each according to its circumstances, but never will the capacity commitment on any single risk exceed the maximum amount originally decided. These varying capacity commitments build up to create a picture of capacity utilisation for the portfolio; this is a key component in the insurer's profit calculation; if too many risks are underwritten with capacity commitments well below the maximum capacity available, the premium received will drop, which will affect the RoCE.

Lower than maximum capacity commitments can also happen where supply exceeds demand (insurers will be forced to take lower commitments than they want due to competition with other insurers – see *signing down* in the Glossary (annex A) and where demand is fixed (for example NTPL 'demand' is fixed, as the financial security amounts required are set by governments and do not readily change); this illustrates the difference observed in this study between *theoretical* maximum NTPL capacity available (the accumulation of all insurers' maximum commitments) and the *actual* NTPL capacity deployed (the

amount required from all insurers to fulfil the financial security amounts). In this study the research team asked the major NTPL insurers their available capacity and that amount, where disclosed, is generally a maximum possible commitment; actual commitments are lower because full utilisation of capacity is prevented by relatively low financial security limits.

For example, Insurer A decides it wants to consider participating in the NTPL insurance market. Firstly, it will review what sector information is available – the market size, the competitors, the loss record of the business, future loss reserving requirements and the perceived technical quality of the risks. It will model the capital required for taking on this new exposure for its SCR, finding that the capital requirement will be high because of the long duration of the exposure and the volatility resulting from the severe loss potential and relatively low number of actual sites. Knowing from the research the approximate premiums for NTPL risks and with the objective of a target return on the required capital, it can set the appropriate maximum amount it is prepared to lose from a single NTPL claim – this is its maximum capacity commitment. Insurer A's shareholders (or policyholders if a mutual) expect it to behave prudently; thus, the maximum exposure will be reserved for the best and most quantifiable NTPL risks (if demand permits), with the portfolio profile showing lower capacity commitments for smaller financial security amounts, worse or more uncertain NTPL risks, as determined by the underwriting process.

In summary, insurers present a headline maximum capacity for a class of business to signal their intent to be a viable player in that market; in this study this amount is the maximum theoretical capacity. The underwriting process applied to each individual risk, demand and competition will determine the actual capacity deployed**;** these will depend on the assessment of numerous variables such as capacity demand, risk quality, currency risk and counterparty exposure. The financial commitment to each risk will take account of these variables allowing the insurer's risk appetite to drive the final decision on the actual capacity committed.

Underwriting

With the parameters established by the actuarial modelling of the SCR and the maximum capacity commitment, the final decision on actual capacity commitment to each risk is made during the underwriting process. Underwriting is the receipt of a premium in return for willingness to cover a contingent liability risk, with the premium being calculated by the underwriter.

Even in the nuclear sector, no two risks are the same; therefore, underwriters will assess each risk to determine both the premium required and the capacity committed. Listed below are some of the variables that may influence the underwriter during the assessment of a nuclear risk:

- Reactor or plant age and type: the risk profile varies with age and type of reactor;
- Site location: population proximity and exposure to natural hazards;
- Reactor containment and risk management: what physical and process factors can mitigate exposure;
- Loss history: a poor loss record is an indication of a slack risk culture;
- Legal framework: despite the NTPL Conventions, there can be material differences between countries' NTPL legislation;
- Performance: key performance indicators offer clues about risk quality and management;
- Counterparty and currency: insurers need to be confident that a counterparty is reliable and that maximum exposure cannot be exceeded due to currency fluctuations.

The underwriter's skill and judgement will ultimately decide the actual capacity commitment to each risk, in accordance with the business risk appetite. Across a portfolio, the capacity profile will see the highest (perhaps a maximum) capacity committed to the very best risks, with the capacity commitment declining to low commitments to risks considered difficult.

On a portfolio basis, the underwriter wants to ensure the aggregated premiums calculated will be profitable for the shareholders (or if a mutual, that they deliver surplus to the policyholders), which means the claims and expenses together must be less than the premiums. In making the profitability calculation, underwriters must also consider future claims from policies issued; this aspect is known as reserving[274] and is a key factor of profitability. If a policy issued has a long duration (such as a 30-year period in which to make a bodily injury claim) some of the premium must be taken from the profitability assessment and set aside to pay potential losses in future. The calculation of these reserves is complex and will depend on actuarial input in addition to the underwriter's knowledge of the individual account and overall class performance. Obviously removing an element of premium for this purpose dents the profitability of the portfolio, which can act as a disincentive to commit capacity to complex risks with long duration; however, all the reserved policies will not have claims and any surplus income, coupled with investment income earned from the reserves over time can help offset the short-term loss of profitability caused by making reserves. In the case of NTPL, the low limits, few risks and resulting volatility will result in a material loading of reserves for future claims.

In summary, the underwriting process decides the final capacity commitment to each risk and is dependent on a qualitative assessment of the individual risk. With many variables to consider, underwriters commit the actual capacity within the set risk appetite parameters to generate a portfolio profit; as a result of this process almost invariably the actual capacity committed is less than the maximum possible commitment.

Case study[275]

A case study/example will help to understand the relationship between capital, capacity and underwriting.

The Sensible Insurance Company is based in Country Z.

At a board meeting a decision is made to enter the nuclear insurance market; research has shown it is a profitable class of insurance and it will complement the already diversified business portfolio of the company.

Sensible Insurance's regulatory approved capital model shows that some additional capital will be required to insure nuclear risks.

After consideration of the inability to buy reinsurance for the potential nuclear risks (see Annex G for more information on net line and RCE) and the additional capital requirement, Sensible Insurance decides to commit a maximum capacity of €10 million to nuclear risks.

It decides to split this evenly between 1st party property and 3rd party liability; thus, its ***maximum NTPL capacity is €5 million****.*

The ***first risk Sensible Insurance Company is approached to insure*** *is a modern, well risk-managed PWR power reactor located in Country A. The NTPL policy refers to the local nuclear legislation and the policy amounts are in US dollars.*

The underwriter observes that the Country A's NTPL legislation, whilst complex, is acceptable as it is based on the original 1960 Paris Convention; the insurance policy follows the legislation, which provides for a single lifetime financial security limit for the site of $500 million with a limited scope of nuclear damage, as defined in the 1960 Convention.

274 See Glossary in Annex A

275 This case study is entirely fictitious.

The underwriter considers possible currency fluctuations between euros and dollars after a loss and the attractive cap on exposure offered by the lifetime limit; after an assessment, Sensible Insurance commits an actual capacity of €4 million, being €1 million below its maximum.

*The **second risk Sensible Insurance Company is approached to insure** is a 35-year-old RBMK type power reactor, with reasonable risk-management and located in Country B. The NTPL policy refers to the local nuclear legislation and the policy amounts are in local currency.*

The underwriter observes that Country B's NTPL legislation is loosely based on the Vienna Convention; the insurance policy follows the legislation, but it provides an annually renewable financial security limit for the site of $200 million.

Once again, the underwriter considers possible currency fluctuations between euros and the relatively weak local currency after a loss; also, the annually renewable policy limit of $200 million which could see Sensible Insurance Company's exposure accumulate each year. The underwriter also viewed the site less favourably, as the reactor type is less attractive and in its final years of operation. After this assessment, Sensible Insurance Company commits an actual capacity of €1 million, being €4 million below its maximum.

*The **third risk Sensible Insurance Company is approached to insure** is a domestic, modern EPR type power reactor, with excellent risk-management. The NTPL policy refers to the local nuclear legislation that closely follows the 1960 Paris Convention, which also provides for a single lifetime financial security limit for the site of €400 million and limited scope of nuclear damage. The policy amounts are in Sensible Insurance's domestic currency, the euro.*

In considering this risk, the underwriter has no concerns about currency fluctuations, the risk is excellent with an attractive single lifetime policy limit that cannot accumulate over time; after this assessment, Sensible Insurance commits an actual capacity of €5 million – which matches its maximum capacity.

In summary, Sensible Insurance's maximum capacity of €5 million has only been utilised fully on one domestic risk; actual capacity deployed for the other risks presented to the underwriter has been less than the maximum capacity, after a risk assessment by the underwriter.

All insurers go through a similar process when committing capacity to risks of any type; insurer risk appetite is influenced by local risk variables that, once assessed, enable insurers to commit any amount of actual capacity, but always within the maximum available.

During the research for this study, insurers were questioned about available capacity; the amounts disclosed were maximum amounts and many showed wide discrepancy between the capacity they make available from this maximum amounts for domestic sites and international sites. In general, the actual capacity committed to non-domestic risks is materially lower than the maximum capacity.

6. LOSSES OCCURRING AND CLAIMS MADE POLICY LANGUAGE

Introduction

Liability insurers normally use two different policy structures to differentiate between temporal restrictions of liability; these two policies are known as **claims made policies** and **losses (**or **claims) occurring policies**. Each offers a distinctive profile of liability exposure for insurers.

Definitions

1. A **claims made policy** will pay out for any valid claim made during the policy period, regardless of when the incident or alleged breach of duty actually occurred; this means a current **claims made policy** could provide cover for claims made during the policy period which arise out of work performed over many years, or several years previously, subject to the **retroactive date**. **Claims made policies** normally contain a **retroactive date**; this date limits the amount of retrospective cover the insurers are prepared to offer.

   If an incident occurs during a current **claims made policy** period but damage is not discovered until after the policy expires, then any claim arising from the incident will not be covered by this current **claims made policy**, because the claim is made at a time after the policy has expired. If the policy has been renewed and a renewed policy is in force when the claim is made, then a valid claim arising from the incident would be covered by this future policy.

2. A **claims (or losses) occurring** policy will pay out for any valid claim that arises out of loss or damage that actually occurs during the policy period, regardless of when it manifests itself or is discovered; therefore a **losses occurring policy** will cover valid claims for loss or damage that occurred during the policy period, but which do not become apparent until much later.

   If insurers of **losses occurring policies** do not specify a termination date of discoverable events, then covered incidents that occurred decades ago and that are discovered today (e.g. industrial diseases with long latency periods, such as asbestosis) can still be claimed for under the **losses occurring policy** that was in force at the time of the incident occurrence.

   This is in direct contrast to the **claims made policy**, as a **losses occurring policy** issued today can provide cover for future discoveries of unrecognised incidents that occur now.

Today's market practice

Most liability insurers today opt to provide claims made policies with retroactive dates, as the policy only offers retrospective cover for a specified period – claims made today from damage that may have occurred years ago (but always after the retroactive date); although potentially exposing insurers to limited claims from old, historic incidents, it is not exposing insurers to future claims from current incidents. Claims brought against insurers today for incidents that occurred many decades ago under old losses occurring policies have frequently been judged and compensated under current social values; this has exposed insurers to more uncertainty of outcome.

The asbestosis experience has been the main reason for the move from losses occurring to claims made policies. Insurers have faced, are facing and will continue to face asbestosis claims that have been made against policies issued decades ago; policy records, insurers and causality have all been found wanting, with a significant but unexpected financial exposure falling upon the insurance market.

Example

Claims made & losses occurring

Claim event: an incident occurred on 13th March 2013 that caused damage; the damage was not discovered until 1st February 2019 & not reported to insurers until 1st March 2019.

LOSSES OCCURRING

Policy #	Policy 1	Policy 2	Policy 3	Policy 4	Policy 5	Policy 6	Policy 7	Policy 8	Policy 9	Policy 10	Policy 11	Policy 12
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**	2020	2021
Period	12m	12m	12m	12m	12m	12m	12m	12m	12m	**12m**	12m	12m
Start	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	**1st Jan**	1st Jan	1st Jan
										NOW		
Incident occurred:				*13-Mar*								
Manifested:										*01-Feb*		
Insurance claim made:										*01-Mar*		
				2013 policy responds								

The incident (loss) occurred on 13th March 2013 & the damage was noticed on 1st February 2019; a month later it was reported as a claim to the insurers. Under a LOSSES OCCURRING policy the 2013 insurers are liable for the loss & should pay the claim, if it is valid. LOSS OCCURRED in 2013

CLAIMS MADE

Policy #	Policy 1	Policy 2	Policy 3	Policy 4	Policy 5	Policy 6	Policy 7	Policy 8	Policy 9	Policy 10	Policy 11	Policy 12
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**	2020	2021
Period	12m	12m	12m	12m	12m	12m	12m	12m	12m	**12m**	12m	12m
Start	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	1st Jan	**1st Jan**	1st Jan	1st Jan
										NOW		
Incident occurred:				*13-Mar*								
Manifested:										*01-Feb*		
Insurance claim made:										*01-Mar*		
Retroactive date:	01-Jan											
										2019 policy responds		

The incident (loss) occurred on 13th March 2013 & the damage was noticed on 1st February 2019; a month later it was reported as a claim to the insurers. Under a CLAIMS MADE policy the 2019 insurers are liable for the loss & should pay the claim, if it is valid. CLAIM MADE in 2019

The RETROACTIVE DATE in a Claims Made policy limits the period for which claims can be made to AFTER the retroactive date, in this case 1st Jan 2010. If the retroactive date was 5 years before this year's policy (1st Jan 2014), the Insurers would not be liable to pay the claim from 2013.

Nuclear liability

Nuclear third-party liability insurance must follow the nuclear exposure obligation the operators assume from the nuclear liability Conventions; this exposure equates to a losses occurring type exposure. The Conventions require financial security to cover the full scope of the operator's liability[276] and specify the duration the operator is liable for[277]; this forward-looking exposure suits a losses occurring policy. A claims made policy would not allow the operator to guarantee that his 10 year

[276] For example, see: Paris Convention 1960 Art.10 (a) and Vienna Convention 1967 Art.7 (1) regarding financial security requirement.

[277] For example, see: Paris Convention 1960 Art.8 (a) and Vienna Convention 1967 Art. 6 (1) regarding the date of extinction of liability obligation.

exposure into the future (or soon to be 30 year for bodily injury) that could arise from incidents that occur today is covered beyond the expiry of his current claims made insurance policy. If the claims made policy is renewed each year, there is no problem, but consider the following scenario:

> *The insurance market heard a rumour that there was a strong causal link between living near a nuclear site and some form of bodily injury or disease; the natural reaction of insurers at the next insurance policy renewal would be either to not renew the policy or to charge materially greater premium. If the policy is cancelled by the insurer, the operator is not able to show the relevant authorities that he has cover in place for the full scope of his liabilities – including the obligation to compensate for up to 10 years into the future for property damage and 30 years into the future for bodily injury. He would need to seek new insurers - if such insurers could be found, of course.*

Introduction a claims made policy for nuclear liability

If a claims made policy is introduced for nuclear liability, the likely benefits are:

- The policy would be cheaper for operators to buy initially, as the retrospective cover would be limited by the previous, expiring losses occurring policy.
- More risk transfer insurers will offer the full scope of the revised Conventions, as there is no immediate 30-year exposure.
- The retrospective element would increase annually, but this would allow the market to develop comfort with the full exposures gradually; ultimately a policy could be issued with a 30-year retrospective date, so ensuring full retrospective cover in compliance with the revised Conventions' language.
- Most liability insurers today only consider offering claims made liability coverage; therefore, introducing this cover for nuclear exposure will attract more capacity from a wider market.

There would also be some challenges:

- The relevant authorities in each nuclear state would need to validate a claims made policy as acceptable financial security under their treaty obligations (if party to a nuclear liability Convention), despite its possible lack of future cover for incidents that occur now but remain undiscovered. If the insurance markets renew the policy annually, there is no deficiency in cover and an annual claims made policy will certainly offer satisfaction of cover for the immediate 12 months' period ahead.
- Retroactive dates under a policy would need to match the temporal exposure in the Conventions (i.e. 10 years or 30 years).

Indications from one regulatory body's legal team suggest that the introduction of a claims made policy would not be compliant with the requirements of the international NTPL Conventions, because of the assumed lack of insurance (financial security) cover provided initially for potential losses into the future; however, it is likely that the introduction of such policy language would materially increase market capacity and scope of cover, as it has become normal practice for liability underwriters in today's market.

Overall the attraction of greater capacity that could develop following the introduction of a claims made policy cannot overcome the difficulty presented by the probable rejection on the grounds of non-compliance by nuclear regulators of such a policy. For this reason, the research team decided to reject using claims made policies to encourage greater NTPL capacity.

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