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LEGAL AND INSTITUTIONAL ISSUES OF TRANSPORTABLE NUCLEAR POWER PLANTS: A PRELIMINARY STUDY

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

IAEA NUCLEAR ENERGY SERIES No. NG-T-3.5

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FOREWORD

One of the IAEA's statutory objectives is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". One way this objective is achieved is through the publication of a range of technical series. Two of these are the IAEA Nuclear Energy Series and the IAEA Safety Standards Series.

According to Article III.A.6 of the IAEA Statute, the safety standards establish "standards of safety for protection of health and minimization of danger to life and property." The safety standards include the Safety Fundamentals, Safety Requirements and Safety Guides. These standards are written primarily in a regulatory style, and are binding on the IAEA for its own programmes. The principal users are the regulatory bodies in Member States and other national authorities.

The IAEA Nuclear Energy Series comprises reports designed to encourage and assist R&D on, and application of, nuclear energy for peaceful uses. This includes practical examples to be used by owners and operators of utilities in Member States, implementing organizations, academia, and government officials, among others. This information is presented in guides, reports on technology status and advances, and best practices for peaceful uses of nuclear energy based on inputs from international experts. The IAEA Nuclear Energy Series complements the IAEA Safety Standards Series.

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) was launched in 2000 on the basis of a resolution of the IAEA General Conference (GC(44)/RES/21). INPRO activities have since been continuously endorsed by resolutions of successive General Conferences and by the General Assembly of the United Nations.

The objectives of INPRO are to help ensure that nuclear energy is available to contribute, in a sustainable manner, to the goal of meeting the energy needs of the 21st century, and to bring together technology holders and users so that they can consider jointly the international and national actions required for ensuring the sustainability of nuclear energy through innovations in technology and/or institutional arrangements.

A transportable nuclear power plant (TNPP) is a factory manufactured, transportable and relocatable nuclear power plant which, when fuelled, is capable of producing final energy products such as electricity and heat. Introducing a TNPP may require fewer financial and human resources from the host State. However, the deployment of such reactors will face new legal issues in the international context which need to be resolved to enable the deployment of such reactors in countries other than the country of origin.

The objective of this report is to study the legal and institutional issues for the deployment of TNPPs, to reveal challenges that might be faced in their deployment, and to outline pathways for resolution of the identified issues and challenges in the short and long terms. It is addressed to senior legal, regulatory and technical officers in Member States planning to embark on a nuclear power programme or to expand an existing one by considering the introduction of a TNPP.

The IAEA officers responsible for this publication were V. Kuznetsov and V. Lysakov of the Division of Nuclear Power.

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

1.1.1. Demand for innovative nuclear reactors

Energy requirements and the share of electricity in total energy consumption are increasing rapidly. The share of nuclear power in the energy mix is expected to increase significantly in the 21st century. According to the IAEA Power Reactor Information System (PRIS) [1], by mid-2012, 30 countries were operating 435 nuclear power reactors, with a total capacity of 370 009 GW(e), and another 65 nuclear power units were under construction. In addition to this, a growing number of countries are expressing interest in the introduction of nuclear power to meet their energy needs, with more than 30 countries actively considering it.

According to the latest issue of the IAEA Nuclear Technology Review [2], significant growth in the use of nuclear power, between 35 and 100%, is anticipated by 2030, though the Agency projections for 2030 are 7–8% lower than projections made in 2010.This drop reflects an accelerated phase out of nuclear power in Germany, several shutdowns and a government review of the planned expansion in Japan, and temporary delays of nuclear power programmes in several other countries. However, the factors that contribute to the continuing increase of interest in nuclear power have not changed and will most probably require a growing number of reactors between 2030 and 2050.The expected construction rates may become comparable with the historical building experience of the 1970s and 1980s.

Of the commercial nuclear power plants (NPPs) under construction, the majority are large sized units, with a capacity of more than 700 MW(e).There are also orders for the small (i.e. below 300 MW (e)) and medium sized (between 300 MW(e) and 700 MW(e)) reactors, which are of particular interest to countries with small electricity grids, insufficient infrastructure or limited investment capabilities [3–7]. Small reactors are being considered for energy supply to remotely located areas or for non-electrical applications, such as heat production for district heating, seawater desalination, or process steam production for a variety of industrial processes, including crude oil recovery and coal liquefaction. Currently, about 20 different innovative reactor concepts in the small and medium sized categories are at different stages of design and development worldwide [4–6].

Among the small sized reactors, the transportable reactor belongs to the category which allows for it to be transported on rail, truck or barge to an appropriately selected site. The entire power plant is factory built, either in one single module together with the balance of the plant, or with the balance of plant as a separate module. After pre-testing, the complete power plant is shipped to where the energy is needed, either in separate modules or as a whole unit. This site may be located within the reactor manufacturer’s country or in a foreign country. Depending on the design, the reactors may be factory fuelled, maintained and refuelled. In all cases, the plant will not operate during its transport and can be returned to the factory after its design life.

This category of reactors could present the appropriate answer for countries with energy needs on islands, with remotely located areas without interconnected electricity grids, or for countries with immediate needs for energy but without the full infrastructure required for stationary NPPs. Depending on the user requirements, the plant can be operated by the supplier or by an entity from the receiving country. The host State regulatory authorities may request information from the supplier when fulfilling their legal responsibilities on licensing of the plant.

Transportable reactors or transportable nuclear power plants (TNPPs) may have the advantage of considerably reducing the time-span between the government decision to introduce an NPP and the start of its actual operation, which, for stationary reactors, is typically 5–8 years for countries which already have experience with the construction and operation of an NPP. In the case of a first NPP in a country, this period would range between 10 and 15 years.

The TNPP concept is not new. Some designs have been manufactured and operated domestically, e.g. in the Russian Federation and the USA [8–10]. Some TNPPs being considered today, in particular for export, are innovative concepts, i.e. they may still need considerable time and effort for development and demonstration of their technical, safety and economic viability. The interest shown by a number of developing countries demonstrates a real possibility to develop a market in the future for this category of reactors. However, the idea of exporting such reactors is quite new and, in view of their innovative nature, may require innovative approaches in establishing the legal basis for their implementation.

For the export of TNPPs, different scenarios may be considered with notably different roles for the stakeholders in both the exporting and receiving countries in terms of ownership, licensing, transport and operation. In such cases, the interest of the third party countries through the territories or territorial waters of which the TNPPs would be transported should also be taken into account. This requires review, discussion and identification of the different responsibilities of stakeholders and a careful analysis of the existing international and national legal and institutional framework (e.g. nuclear safety, security, liability and safeguards for TNPPs) in order to identify possible innovative approaches and the efforts required to introduce them.

1.1.2. Related development programmes in Member States

Various designs have been developed in a number of countries that include reactors cooled by water, liquid metal, or even gas. Most of the transportable reactors are based on long term experience acquired with ship propulsion reactors and with larger, land based stationary reactors [4, 5, 11].

However, work still needs to be done in order to correctly characterize the categories of TNPPs according to their respective design and purpose. In particular, it might be useful to distinguish between mobile and transportable reactors (which can be of modular or integral design but still need on-site construction work and offer limited possibilities for further relocation). Consideration of different power scales will inevitably be a factor to consider for these categories and the power/weight ratio is important for the mobility aspect, which may also affect both infrastructural and legislative approaches.

The following designs are given as examples of small reactors under investigation and implementation in Member States.

In the Russian Federation, the KLT-40S (compact icebreaker type) design is based on the experience obtained with similar reactors used for Russian icebreakers. It was developed by OKBM (Experimental Design Bureau for Machine Building) and is a compact, modular pressurized water reactor for a barge mounted (floating) NPP (Fig. 1) [12]. The two reactors and a barge accommodating them are factory fabricated and then transported to the user's site in a coastal area. The barge mounted plant is intended for co-generation of electricity and heat, and can produce 58 MW(th) and up to 70 MW(e). The KLT-40S is not a factory fuelled reactor; it is refuelled in a conventional batch mode and the fresh and spent fuel storage areas are located within the barge within the reactor compartment. The first TNPP of this kind, named 'Academician Lomonosov', is under construction in the Russian Federation and is expected to be commissioned in 2016.

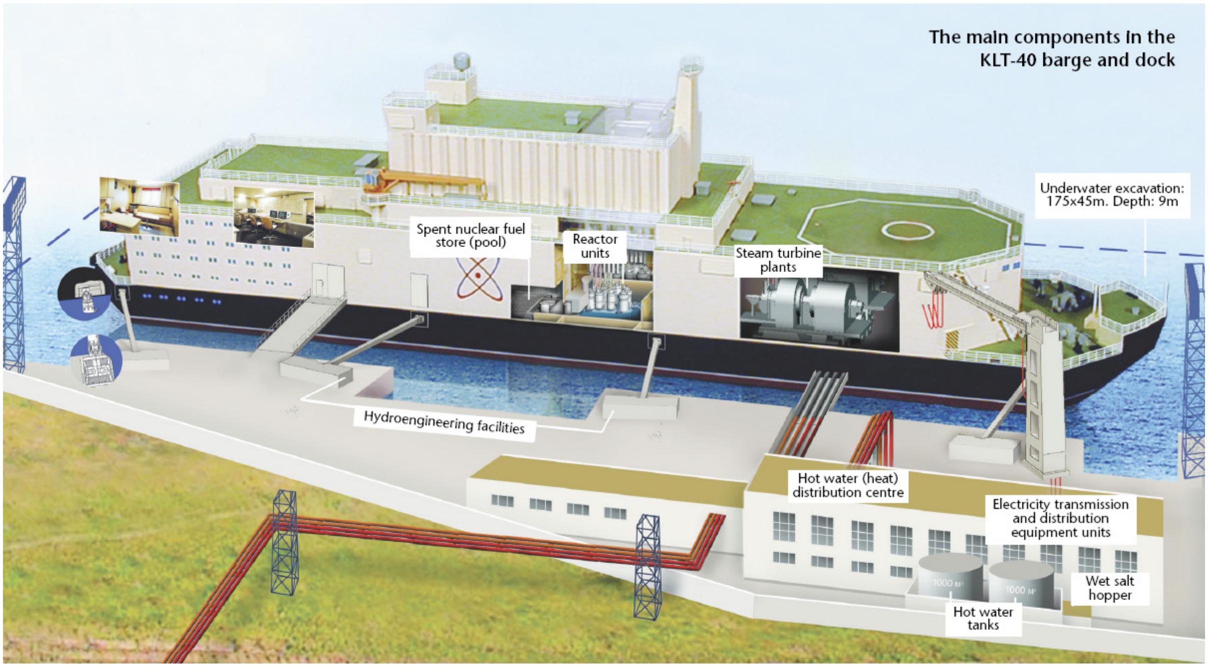

FIG. 1. General view of a floating NPP with the two KLT-40 reactors [12].

The Russian Federation marine propulsion reactor experience is also the basis for the development of another transportable reactor, the ABV-6M (autonomous module type NPP), under the leadership of OKBM. The ABV-6M is an integral type PWR with the reactor core and the steam generators housed in one vessel [5]. The reactor is very compact and has a power rating of 8 MW(e); it can also be used for the co-generation of heat and electricity. The ABV-6M is factory fabricated and factory fuelled, and can operate for about 10–12 years without refuelling. It is being designed for a barge mounted, co-generation plant (that would accommodate two such reactors), but could also be used within a land based plant.

Another example of the TNPP design could be the UNITHERM reactor (Fig. 2), developed by the Research and Development Institute of Power Engineering (RDIPE). It is an integral water–water natural circulation, three circuit type reactor with a power rating in the range of 5–10 MW(e). It features a 25 year lifetime with a load factor of 70%. Due to the implementation of the self-regulation principle based on a temperature effect and the use of burnable absorbers, maintenance work is necessary only once a year by a team of about eight people, which makes the TNPP quasi-autonomous and very convenient for operation in remote areas. The design is seismic-proof up to an estimated value of 9 on the MSK-64 scale. The weight of one unit together with shielding (see Fig. 2) is about 180 t.

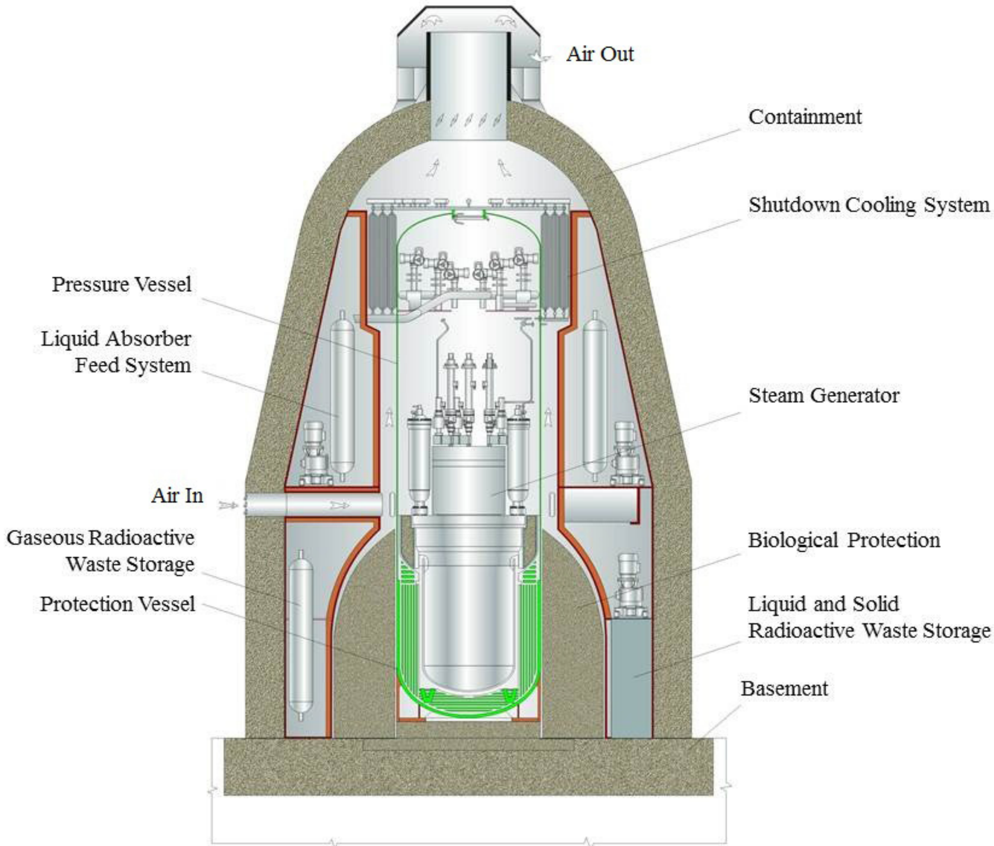

FIG. 2. TNPP module with UNITHERM reactor.

In France, the DCNS company, designer of the reactors for French nuclear submarines, in partnership with AREVA-TA and CEA, is developing a small, modular, underwater NPP based on a state of the art French water cooled marine propulsion reactor (Fig. 3) [13]. The plant, named Flexblue, is factory fabricated and fuelled and is transported to an operational (underwater) site by a surface ship. The reactor vessel appears as a torpedo resistant, 100 m long cylinder with a weight of about 12 000 t. The electric output is between 50 and 250 MW(e) for a single NPP module, which is anchored on a flat sea bottom at a depth of between 60 and 100 m several kilometres from the shore. The plant is remotely controlled and connected to the on-shore grid by an underwater, seabed embedded cable. An option of refuelling at a local refuelling base is being considered.

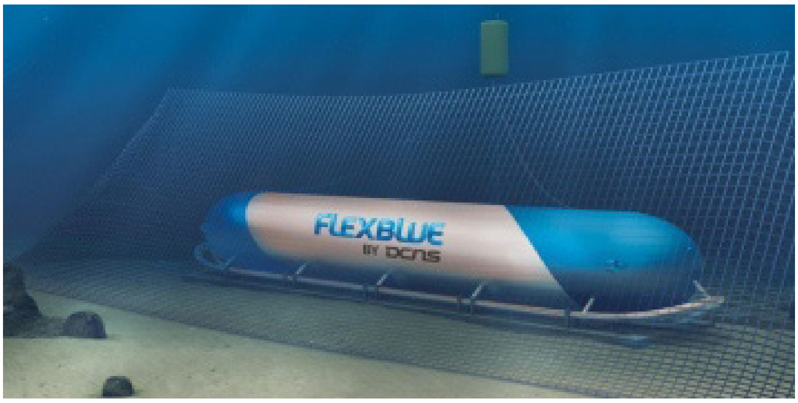

FIG. 3. Flexblue NPP module in its operational position on the sea bottom [13].

In the USA, the Babcock & Wilcox company, designer of the reactors for US nuclear submarines, in partnership with the Bechtel Corporation, is developing the design of a small modular reactor called mPower. The mPower is a 180 MW(e) integral type PWR intended for electricity generation within multi-module land based plants of a flexible overall capacity [14]. The reactor compartments are embedded underground, while the power circuit equipment is located above ground. The mPower uses an air cooled turbine condenser and the reactor module is assembled in full at the factory. Whole core fuelling and discharge are performed on-site. Future modifications of the mPower may use factory fuelling of the reactor modules.

Also in the USA, the NuScale Power Inc. is developing a detailed design for a small modular reactor called the NuScale. The NuScale is a 48 MW(e) per module integral type PWR intended for generating electricity within a multi-module land-based NPP. The design uses a compact vacuumed containment. The foreseen standard plant configuration incorporates 12 NuScale modules located in an ambient pressure water pool below ground level. The power circuit equipment is located above ground (Fig. 4) [15]. The reactor module/balance of plant can be assembled in full at the factory. Whole core fuelling/defuelling is performed on-site in a dedicated compartment located within an underground water pool. Future modifications of the NuScale may use factory fuelling of the reactor modules.

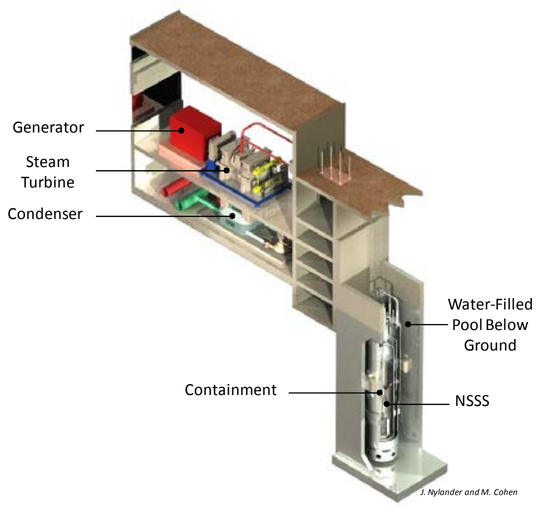

FIG. 4. Reactor module configuration of the NuScale [15].

The Russian Federation also has experience with marine propulsion reactors of another type, those cooled by lead–bismuth eutectics. Detailed design development for a civil application lead–bismuth cooled SVBR-100 (the abbreviation stands for the Russian term for lead–bismuth fast reactor) is being led by AKME Engineering, a joint venture company of the ROSATOM State Atomic Energy Corporation and the JSC EuroSibEnergo private company. The SVBR-100 of 101.5 MW(e) per module (Fig. 5), is based on experience in the design and operation of the propulsion reactors of the Russian Alpha class submarines. The experience in the operation of such reactors amounts to 80 reactor-years. The SVBR-100 is being designed for flexible plant configurations and applications. The reactor is factory fabricated, could be factory fuelled and can operate with various types of fuel, such as uranium dioxide, mixed oxide (MOX) or nitride fuel. The near term design configurations of the SVBR-100 allow for continuous operation without on-site refuelling for 7–8 years. The near term goal of AKME Engineering is to build an SVBR prototype by 2017.

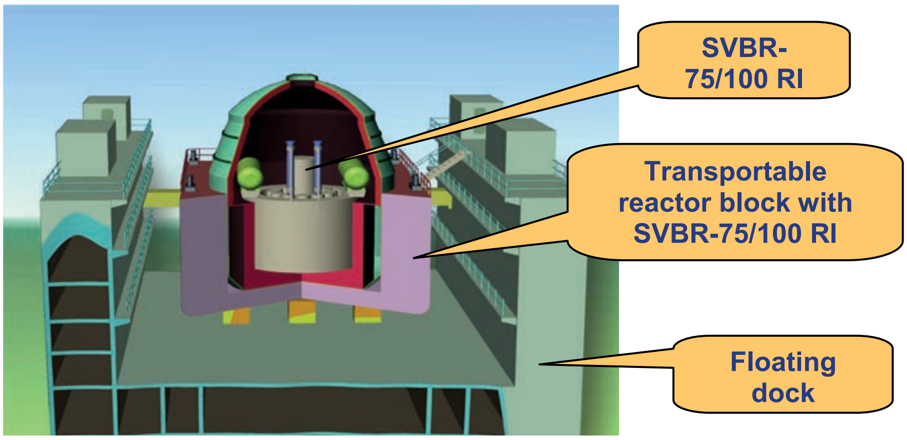

FIG. 5. The SVBR-100 reactor module — a floating dock delivery option [5].

In Japan, a detailed design of a 4S (super-safe, small and simple) reactor is being developed by the Toshiba Corporation. The 4S is a 10 MW(e) pool type sodium cooled fast reactor with a core lifetime of about 30 years (Fig. 6). The moveable reflector surrounding the reactor core gradually moves upwards in an axial direction, compensating for the burnup reactivity loss over the lifetime of the core. The reactor power is controlled exclusively by changing the water flow rate in the power circuit. The reactor can produce a core outlet temperature of up to about 500°C, part of which can be used for hydrogen production by high temperature electrolysis. There are plans to build a first of a kind 4S in the city of Galena in Alaska (USA).

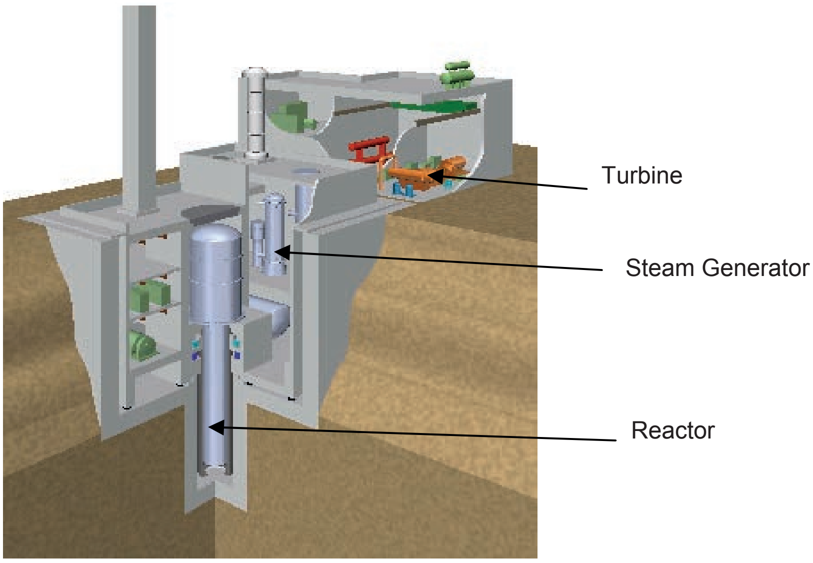

FIG. 6. The 4S plant of 10 MW(e) [5].

In India, the Bhabha Atomic Research Centre (BARC) is developing a compact high temperature reactor (CHTR) with a power output of 100 kW(th). The reactor is lead–bismuth cooled but has a thermal spectrum with beryllium used as the moderator. The reactor is designed to operate at temperatures of about 1000°C; thus, it can also be used for hydrogen production [5]. It uses tri-isotropic (TRISO) type coated particle fuel within prismatic fuel elements, and the core has a lifetime of about 15 years. The reactor, including the core, reflectors, fuel, reactor shell and cover plates, will weigh no more than 4.0 t to simplify its delivery to remote locations.

In the Republic of Korea, the system integrated modular advanced reactor (SMART) of standard design was certified in the summer of 2012. It is a small sized integral type PWR with a rated thermal power of 330 MW(th), which corresponds to a gross electric output of 100 MW(e). SMART aims to achieve improved safety and economics; better safety and reliability are to be effected by incorporating inherent safety features and reliable passive safety systems at the design stage. Improvement in economics is achieved through system simplification, component modularization, reduction of construction time, and high plant availability. The distinguishing feature of SMART is its compatibility with a desalination plant and process heat [4].

In Argentina, the Central Argentina de Elementos Modulares (CAREM), an Argentine nuclear reactor designed by INVAP for the National Atomic Energy Commission (CNEA), is currently being finalized for licensing and construction start to prepare for prototype deployment by 2015 This nuclear plant has an indirect cycle with distinctive characteristic features that simplify the design and have been selected to achieve a higher level of safety. High level design characteristics of the plant include an integrated primary cooling system, a self-pressurized primary system and safety systems relying on passive features. Different CAREM concept power modules are being considered: the higher power module, CAREM-300, is being designed to produce 900 MW(th), generating 300 MW(e). For power modules below 150 MW(e), the coolant flow in the primary reactor system is achieved by natural circulation [4].

All presented designs are either TNPPs (KLT-40S, ABV-6M, Flexblue), or could be used as TNPPs (SVBR-100), or share certain characteristics of the TNPPs. For example, they allow factory manufacturing, transportation of the assembled reactor modules and balances of the plant, and in several cases factory fuelling and defuelling. All of the reactors presented target factory production in series, short construction periods and operation in a base load or a load following mode with minimum or no reliance on the local grid.

Like any nuclear reactor, those used in TNPPs may release, during normal operation, liquid and gaseous effluents to the environment containing very small amounts of radionuclides. These releases are controlled to ensure that the public and the environment are protected, fulfilling the radiological principles of dose limitation and optimization. The national nuclear regulators in the host State should set the discharge limits on the basis of the annual dose limits and constraints.

1.2. OBJECTIVE

Because TNPPs are being considered by some Member States to meet their energy needs, this report has been prepared for the purpose of reviewing the specific legal and institutional issues associated with international deployment of such NPPs. The objectives of this publication are to:

- Examine legal and institutional issues and challenges — including those concerning ownership and contract — related to the deployment of TNPPs, considering several technological options and deployment scenarios;
- Identify challenges;
- Examine the implications of TNPPs on the infrastructure of the recipient countries.

The report considers other IAEA publications on infrastructure development [16, 17] which, so far, have focused on the deployment of conventional NPPs with stationary reactors. The guidance contained in these publications is, however, to a large extent also applicable to transportable reactors. The present report focuses essentially on the different legal and institutional issues that would specifically apply to TNPPs.

1.3. SCOPE

This report is addressed to senior legal, regulatory, and technical officials in Member States planning to embark on a nuclear option or to expand an existing nuclear power programme with a TNPP. The publication also provides a basis for further IAEA activities aimed at further elaboration of innovative infrastructure options to support the deployment and application of TNPPs.

This publication has been prepared in the framework of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and reflects the relevant aspects in the areas of nuclear energy and nuclear safety.

1.4. STRUCTURE

Excluding the Introduction (Section 1), this report is set out in nine sections and one appendix.

Section 2 lists the definitions used in the study. Section 3 elaborates on the different technological options and deployment scenarios considered for the TNPPs in this report. It includes a description of the different roles incumbent upon States, owners, operators and regulators, respectively. Section 4 reviews all infrastructure issues that a country wishing to acquire a TNPP needs to consider. The review focuses on the differences as compared to when a conventional NPP is acquired. This section describes the potential role of the national institutions, concerns of authorities and other stakeholders and highlights issues that may need to be addressed according to the suggested scenarios. Section 5 reviews the safeguards and verification issues for TNPPs with special reference to the case where a TNPP is produced in a nuclear weapon State (NWS) and exported to a non-nuclear-weapon State (NNWS). Section 6 describes the general legal issues that may arise during the deployment and operation of TNPPs. It includes a discussion of potential consequences for domestic law and the institutional/governmental framework of a host State related to compliance with the international obligations it has accepted. The purpose of this section is to provide an overview of the relevant international legal instruments that may apply to TNPPs, for either or both the supplier and the host State of a TNPP under the different scenarios/options envisaged. Section 7 outlines specific issues relating to nuclear safety. Section 8 outlines specific issues relating to nuclear security. Section 9 outlines specific issues relating to nuclear liability. Section 10 presents the conclusions.

The Annex considers the legal framework for the deployment and operation of TNPPs.

2. DEFINITIONS

A transportable nuclear power plant is defined as a factory manufactured, transportable and/or relocatable nuclear power plant which, when fuelled, is capable of producing final energy products such as electricity, heat and desalinated water. A TNPP includes the nuclear reactor (with or without fuel, depending on the TNPP option considered), the balance of the plant (e.g. turbine, generator) and fuel storage facilities, if necessary. The TNPP is physically transportable, but is not designed to either produce energy during transportation or provide energy for the transportation itself. The installed TNPP, land based or floating, is intended for use in the host State for different purposes such as electricity supply for remote areas, district heating, desalination of sea water and hydrogen production, while preserving its capability for relocation if necessary.

This report mainly addresses the legal and institutional aspects of the transportable nuclear reactors; however, the term *reactor* is replaced by the term *power plant*. A nuclear reactor is in general limited to energy production and this term, therefore, would seem to be insufficiently comprehensive. On the other hand, the term *nuclear power plant* is more comprehensive and includes temporary fuel or component storage and other ancillary activities on-site. At the same time, it was decided not to distinguish between the reactor power scales and mobile, integral or modular designs to provide a more generalized approach to address the legal and institutional issues.

A *supplier* is defined in the IAEA Safety Glossary [18] as "Any *legal person* to whom a *registrant* or *licensee* delegates duties, totally or partially, in relation to the *design*, manufacture, production or *construction* of a *source*. (An exporter of a source is considered a supplier of the source.)"

In this report, the *supplier of a TNPP* is understood to have additional responsibilities depending on the scenario considered and the contract concluded. This may include delivery and return of the TNPP and its operation if requested by the host State.

The *supplier State* is the State in which the TNPP is designed and fabricated.

The *host State* is the State in which the TNPP is operated.

In this report, *land based reactor* refers to a reactor that is operated on or is rigidly connected to the land.

3. REFERENCE CASES

3.1. REFERENCE TECHNICAL OPTIONS FOR TNPPs

Usually, all components or modular sections of a *stationary NPP sited on land* are shop fabricated and then delivered by truck, rail or barge to the construction site, where they are assembled into a plant. Some components are too large and cannot be transported in one piece, so the balance of the plant is prefabricated in separate parts and then brought to the site, where the parts are then assembled. All shop fabricated components are pre-tested at the factory before they are brought to the site. When the construction of the plant is finished, the plant is commissioned, which includes first thoroughly testing all components and systems and then testing the complete plant at various power levels. After these tests, the plant may be connected to the grid.

During plant operation, maintenance and refuelling are done during regular periods of outages. In order to reduce the time of the reactor outages, most of the work is done in parallel. At the end of the operating cycle, the fuel in some of the assemblies is ‘spent’ and is discharged and replaced with new (fresh) fuel assemblies, which may be stored at the site. Spent fuel is highly radioactive and the fuel rods are stored in shielded basins of water (spent fuel pools), usually located on site. After some time, the fuel becomes less radioactive and can then be transported for storage in dry casks or silos. After several decades, the fuel rods can then be transported for conditioning, final storage or reprocessing.

In the case of TNPPs, the complete plant is shop fabricated, pre-tested and then moved to the site by rail, truck, sea or river. The fuel may already be contained in the reactor or (depending on the design) may be transported separately and then loaded into the reactor core on the site. Before going into operation, the complete plant is tested on-site. There are different options for maintenance, repair and refuelling, either on-site, with similar procedures as for stationary reactors, or by bringing the plant back to the factory. Some of the TNPP designs allow for plant relocation to another site after a certain period of operation.

Two technical options for TNPPs have been selected for consideration in this report from the standpoint of possible legal and institutional issues associated with the TNPP deployment:

- **Option 1:** A TNPP, *factory assembled, supplier factory fuelled and tested, supplier factory maintained and refuelled or decommissioned,* complete with the balance of the plant on one barge (or platform, if transported by truck or rail) or with the balance of the plant on a separate barge (or platform), or the balance of the plant built on land in a conventional manner to which the reactor is then connected at the site.
- **Option 2:** A TNPP, *factory assembled, factory pre-tested (non-nuclear tested), maintained, fuelled and refuelled on-site*, with storage facilities for fresh and spent fuel located on board or at the site. Fuel is delivered to the site either overland in the conventional manner or by a dedicated fuel delivery ship. The balance of the plant may be on the same barge (or platform) as the fuel, on a separate barge (or platform), or built on land in a conventional manner with the reactor then connected at the site.

All TNPPs defined in these two reference options can be designed either to remain at the site until their final return to the factory or to be relocated after having been operated for certain period at a selected site.

A TNPP under either option may offer the following potential advantages for the user:

— The TNPP may reduce the infrastructure requirements, and thus reduce the associated costs.
— The host State of the TNPP is not obliged to install facilities for storage and management of fresh and spent nuclear fuel. Thus, the obligations of the host State for the management of fresh fuel and spent nuclear fuel are essentially eliminated.
— The site for a TNPP may be more easily selected and, after decommissioning, more easily restored to a non-nuclear condition.
— Production, delivery and commissioning of a transportable reactor, in particular of that produced in series, may be faster than the construction of a reactor on a site.
— The length of the investment cycle and the construction costs of a TNPP are expected to be lower in comparison with a conventional NPP of the same capacity, as the design of a TNPP may be standardized and factory produced in series with the assurance of high quality manufacturing in the shop conditions.
— In the long term, regional service centres may help to optimize TNPP maintenance (and refuelling, if selected as an option). In addition, national or regional centres may provide training for the staff of the host State.
— Decommissioning of a TNPP would be under the responsibility of the supplier.

3.2. REFERENCE SCENARIOS FOR TNPP DEPLOYMENT

In addition to the technical options, there are options as to ownership, operation and licensing that have been considered for TNPPs. These include different roles for the supplier and the host State, which have been simplified for this study.

The two reference technical options for TNPPs, as defined in Section 3.1, are considered for two different scenarios, i.e. implying different roles of the stakeholders regarding licensing, regulation and operation. In both scenarios the supplier remains the owner of the plant, which is typically leased to the user.

The scenarios are as follows:

— **Scenario 1:** *The supplier is operator/the host State is regulator.* The supplier provides, operates and takes back the entire TNPP, including the spent fuel. The TNPP is operated by the supplier. The TNPP is regulated and licensed by the host State.
— **Scenario 2:** *The host State entity is the operator/the host State is the regulator.* The supplier provides and takes back the entire TNPP, including the spent fuel. The TNPP is operated by an entity established by the host State, and regulated and licensed by the host State.

These scenarios can undergo different modifications depending on the conditions of the contractual agreement concluded between the supplier and the host State.

Another scenario could be where the regulation of the TNPP is ‘outsourced’ and the supplier is also the operator. This scenario might be the most profitable for a host State from the point of view of necessary infrastructural arrangements and also the time of deployment. However, the preliminary analysis has shown that the use of the existing legal basis for such a case would raise a number of major issues, notably with regard to nuclear liability and the governmental, legal and regulatory framework for safety. According to the presently applicable laws and regulations, there are a number of essential activities that, under this scenario, can only be performed by the host State. Taking this into account, this scenario becomes very similar to the two scenarios defined above and, therefore, was not considered separately in this study.

In the scenarios defined above, the host State is expected to execute surveillance of the construction at the supplier’s facility, procurement, installation, operation and return of the TNPP to the extent necessary, either on its own or under contracts with capable organizations. Furthermore, the host State is expected to provide the relevant authorizations needed for installation, operation and return of the TNPP, which must all be based on the relevant national regulatory standards, safety assessments and with the necessary inspection programmes for safety surveillance. At the same time, the host State is eligible to receive any kind of support needed from the supplier in infrastructure building for the TNPP deployment.

The considered scenarios are based on the following common assumptions:

- The supplier provides fresh fuel and then removes and takes back the spent fuel. Therefore, the host State should have no obligations with regard to refuelling and long term storage of high level waste.
- The supplier removes and takes back the entire reactor at the end of its operational lifetime, which minimizes or even eliminates post-operation contamination.
- Delivery, commissioning, operation and removal of the TNPP from the site do not require complex technological operations (such as primary circuit welding, instrument calibration or dismantling).

Each of the scenarios can include a variety of contracting options such as build, own and operate (BOO), build, own, operate and transfer (BOOT), annual contract for electricity supply, or lifetime contracts for the supply of electricity and non-electrical energy products. Most of these options are not TNPP specific and, therefore, they are not addressed in this report. The work on these options, including BOO and BOOT arrangements, is being carried out by the IAEA.

4. INFRASTRUCTURE ISSUES FOR TNPPs IN 19 AREAS DEFINED IN THE IAEA'S 'MILESTONES' PUBLICATION (IAEA NUCLEAR ENERGY SERIES No. NG-G-3.1)

4.1. INTRODUCTION

4.1.1. Background

As noted earlier, there is a growing interest in small reactors, and specifically TNPPs, because of their potential to facilitate the utilization of nuclear power for electricity generation or other applications in countries embarking on nuclear power programmes. TNPPs may also have advantages for countries already operating nuclear power plants that could use such TNPPs for remote areas without grid connections or for other applications. Advantages include the provision by the supplier of support services, including operation and training, which could reduce the need for complex operational human resource development in those countries, thereby theoretically reducing the infrastructure requirements. A further advantage for States that do not have operating reactors at present is the option to return all spent fuel and radioactive waste from the TNPP to the supplier State, which is expected to be an inherent feature of these arrangements. This would be attractive if it could be implemented, since it would eliminate the burden associated with disposition of high level waste in the host State.

However, there are issues associated with the international market of TNPPs that need to be considered before concluding that the option of exporting TNPPs for deployment in a foreign host State is indeed a viable option. These issues include the feasibility of manufacturing and licensing the complete installation in one State and its regulation, including authorization, inspection, enforcement (when applicable) and operation in another State, the commissioning of the reactor in the State where it is manufactured or following delivery, the transport of the reactor, either with fuel in the core or shipped separately, and the return transport of the irradiated TNPP after operation. Issues associated with operating a TNPP in the State where it is manufactured are not addressed in this report.

This section aims to provide advice for technology holders and technology users on the infrastructure development aspects of TNPPs, so that the suppliers, operators and other interested Member States and organizations, including carriers, may be able to identify actions that they may take (or need to take) in order to facilitate export transactions for the TNPPs.

4.1.2. Context of the study

The IAEA publication entitled Milestones in the Development of a National Infrastructure for Nuclear Power, also known as the 'Milestones' publication (IAEA Nuclear Energy Series No. NG-G-3.1) [16], addresses the infrastructure necessary to introduce nuclear power in the context of a conventional plant being constructed in a Member State. The Milestones publication has identified 19 issues that a State should consider when planning to develop its national infrastructure for nuclear power. The specific area of establishing the safety infrastructure for a nuclear power programme is addressed in detail in IAEA Safety Standards Series No. SSG-16 [19].

The 19 issues remain, in principle, relevant for TNPPs, but in many cases the specific features of TNPPs must be analysed. The potential ownership and responsibility scenarios will also affect this analysis.

If the decision of a State to have a TNPP is not driven by the idea of starting a national nuclear power programme, but is limited to TNPP use as an alternative source of energy for a limited period of time, then it must be recognized that this concept was not foreseen as a possible option during development of the Milestones approach. However, the Milestones approach can be sufficiently flexible to consider new institutional arrangements that might shorten the schedule for the introduction of this type of NPP. It is important to note that the basic issues associated with nuclear power remain and must be addressed by some combination of the host State, the supplier State, transit States, and certain international organizations. These new aspects need to be compared with those related to site constructed reactors in order to measure the impact of the TNPP introduction.

The reference options and scenarios for the introduction of TNPPs have been described in Section 3. Detailed consideration of the benefits of TNPPs and the infrastructure issues requiring further consideration for the different options and scenarios are presented later in this section. It is expected that the TNPP provided by a supplier to a host State would be of a proven design that is in operation and not a first-of-a-kind in a country with no previous experience of nuclear power. The provision of a first-of-a-kind TNPP may introduce several additional issues for consideration, but this is beyond the scope of this report.

The options all contain an important assumption, i.e. for a TNPP the delivery, deployment, commissioning, decommissioning and removal from the site do not require complex technological operations (such as primary circuit welding, dismantling or instrument calibration) at the operation site. Within this constraint, there are options for complete factory fuelling and commissioning before transport (Option 1), or transport of the completed TNPP separately from the fuel with fuelling and commissioning tests performed at the operational site (Option 2) (see Section 3). The scenarios addressed in this report recognize different commercial options for ownership and operation (Scenarios 1 and 2) (see Section 3).

4.1.3. Key comments

There are several initial remarks that have been drawn from the detailed analysis that could help in following the subsequent discussion of the infrastructure issues associated with TNPPs. Among the key comments that can be presented at the outset are the following:

(1) The host State will need to establish a national policy for safety and implement it in accordance with IAEA Safety Standards, particularly the Fundamental Safety Principles, General Safety Requirements (GSR) Parts 1 and 4, GSR Part 3 and GS-R-2 [20–23] covering authorization (i.e. siting, design, construction, commissioning, operation, etc.), regulatory review and assessment, inspection and enforcement, and, with suitable judgement, covering the safety design and operation requirements defined in IAEA Safety Standards Series Nos SSR-2/1 and SSR-2/2 [24, 25].

(2) The host State regulator will need to exercise responsibility for the licensing and operational oversight of a TNPP under all options and scenarios and cannot outsource this responsibility. This does not prevent the host State from obtaining advice and assistance, as at present, from any country, including the supplier country regulator.

(3) A TNPP has the potential to reduce the national resources needed to be committed by a host State, and hence could make it easier for a State to introduce nuclear power for electricity or other applications.

(4) Responsibility for safe operation will remain with the operator of the TNPP. The operator may be a host State organization, or a foreign organization contracted to operate the plant (which may include supplier organizations). The host State regulator will need to ensure that the operator is fully licensed in accordance with the host State requirements throughout the life of the TNPP.

(5) The transport of a TNPP with fuel in the core raises a number of concerns that need to be further addressed. These are discussed in detail in Sections 5 and 6 and summarized in Section 8. The issues may involve third States in addition to the supplier, carrier and host State if the TNPP transits through or near these third countries.
(6) If a TNPP is transported as a complete reactor, non-irradiated and with the fuel in separate storage arrangements (even if part of the same transportation vehicle), the arrangements for its delivery to the host State will be largely unchanged from the existing arrangements for transport of nuclear components and fuel.
(7) The transport of a TNPP after use, for maintenance, refuelling, relocation or decommissioning, requires the transport of irradiated components and will need special consideration and, if it includes transport with fuel in the core, the additional consideration of item (4) above will apply.
(8) The legal and institutional implications of the use of an unproven, first-of-a-kind design in a country without experience of nuclear power is not considered in this document.

4.2. REVIEW OF INFRASTRUCTURE ISSUES RELATED TO TNPPs

In this section, the options and scenarios previously described are analysed to determine their relevance to the issues presented in the Milestones approach [16, 19]. As one of the main issues related to TNPPs is their transportability, the safety, regulatory, safeguards and legal aspects of the transportation of TNPPs are discussed separately in this section.

Despite the fact that the storage of radioactive waste and spent fuel is limited in time and volume, the relevant IAEA Safety Requirements such as those in GSR Part 5 [26] and the associated Safety Guides should be considered by the host State. International instruments, including the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management should also be considered during the years when temporary storage of radioactive waste and spent fuel can take place in the host State.

Following this consideration of the options, scenarios and transportation issues, a summary of the benefits and also of items requiring further consideration in relation to the 19 infrastructure issues is included. The section then continues with a discussion of issues that a potential supplier will or may need to consider as a result of the assessment in the previous sections.

Similarly, discussions of issues that a host State may need to consider are also presented. As there are issues that may have implications for organizations and States that are neither supplier nor host, a discussion of issues that may be considered by other countries or the international community is presented. Section 4.3 summarizes the key issues arising for TNPPs in relation to infrastructure.

4.2.1. Consideration of TNPP options in relation to nuclear infrastructure

The two options described previously are analysed with regard to the 19 infrastructure issues defined in the Milestones approach [16].

Table 1 highlights the difference in the infrastructure needed in the host State when considering the technical options described in Section 3. It also considers the possible effects upon the suppliers. The table is not intended to be complete, but rather to highlight several important issues. An empty box means that there is no difference from what is already stated in the Milestones publication and IAEA Safety Standards Series No. SSG-16 [16, 19]. It is also anticipated that generic provisions of infrastructure requirements for nuclear safety (regulatory supervision during the TNPP lifetime, waste management and spent nuclear fuel (SNF) storage), legislative framework (applicability to safety, operation, inspection and enforcement), radiation protection (workers and public) and environmental protection (impact due to radioactive releases and prospective assessments of impacts both during normal operation and accidents) are implemented similar to land based NPPs.

It can be seen that Option 1 could be of the greatest benefit to the necessary infrastructure development in the host State, but that issues related to the transport of a reactor with fuel in the core, such as the potential for the reactor to become active, need to be resolved. Implications on transport liability could be different depending on the resolution found (see the discussion in Section 8.2.)

TABLE 1. TNPP OPTIONS IN RELATION TO NUCLEAR INFRASTRUCTURE

No.	Milestones area	Option 1 Factory assembled, fuelled, tested, maintained and refuelled. TNPP and spent fuel returned to supplier at end of life	Option 2 Factory assembled and maintained, fuelled and refuelled on-site. Storage for fresh and spent fuel in TNPP or independently. TNPP and spent fuel returned to supplier (separately) at end of life
1	National position.	No fuel handling requirements for the host State. No long term HLW storage for the host State. Additional bilateral/multilateral/ international agreements and considerations may potentially be required for the transportation of the reactor containing fresh and spent fuel. The transport of a TNPP requires special consideration (see Section 8.2 for details).[a] National resource (financial and human resource) commitment to achieve the necessary infrastructure can potentially be minimized for the host State.	No long term spent nuclear fuel and high level waste (HLW) storage for the host State. National resource (financial and human resource) commitment to achieve the necessary infrastructure is potentially reduced for the host State. For land based TNPPs, where the balance of plant is constructed on-site, the national resources required might be fewer than if a conventional reactor was being constructed on-site.
2	Nuclear safety.	Design, operational and waste safety issues related to floating NPPs must be considered. The host State must provide regulatory supervision in supplier State for fuelling and pre-commissioning tests. Design established on the basis of the safety regulatory framework of the supplier State. The nuclear safety and regulatory approach for a TNPP during transport need to be addressed.	Design, operational and waste safety issues related to floating NPPs must be considered. The host State must provide regulatory supervision and qualification in the supplier State, but fuelling and commissioning at the operating site.
3	Management.	Greater management responsibility for the supplier and reliance by the host State on the supplier and transport company.	
4	Funding and financing.	Potentially, payment only when the TNPP is delivered or payment only for product. Potentially upfront payment for fuel as part of contract for the supply of TNPPs.[b] This could be considered reactor leasing or fuel leasing.	Capital requirements are substantially less for an SMR/TNPP (similar to the BOO/BOOT arrangement). The site could more easily be returned to green field status, thus reducing decommissioning liabilities.
5	Legislative framework.	Legislation applicable to safety, including authorization (i.e. siting, design, construction, commissioning, operation, etc.) for regulatory review and assessment, inspection and enforcement needs to be examined. Legislation applicable to the transport of TNPPs needs to be examined, including the responsibilities and liabilities of operators/carriers during transit through third countries (see Section 8.2).	Legislation applicable to safety, including authorization (i.e. siting, design, construction, commissioning, operation etc.) for regulatory review and assessment, for operation, inspection and enforcement needs to be examined.

TABLE 1. TNPP OPTIONS IN RELATION TO NUCLEAR INFRASTRUCTURE (cont.)

No.	Milestones area	Option 1 Factory assembled, fuelled, tested, maintained and refuelled. TNPP and spent fuel returned to supplier at end of life	Option 2 Factory assembled and maintained, fuelled and refuelled on-site. Storage for fresh and spent fuel in TNPP or independently. TNPP and spent fuel returned to supplier (separately) at end of life
6	Safeguards.	It would be necessary to ensure design information verification in the NWS if the plant is designed, built and sealed in an NWS and operated in an NNWS. It may be possible for the IAEA to carry out such verification under the NWS voluntary offer safeguards agreement. The IAEA will need to confirm its ability to verify long life cores without access for remeasurement. If it is demonstrated as feasible that a sealed reactor can be verified by the IAEA, then the State system of accounting for and control of radioactive material (SSAC) requirements for the host State may be simplified. (For more details, see the discussion in Section 5.)	
7	Regulatory framework.	Responsibility for regulation rests with the host State even if the plant is designed, constructed, fuelled and pre-commissioned with a license delivered by the regulatory body of the supplier. Proof of operational and safety performance on delivery could be reasonably expected, and then the host State regulator will need to establish standards to be demonstrated in these site related tests. Responsibility for regulation of a fuelled reactor during transport through other States or territorial waters needs to be addressed further (see Section 8.2). Responsibility for the regulation of an irradiated reactor (with fuel in the core) needs to be addressed further (see Section 8.2).	Responsibility for licensing remains with the host State regulator, and hence the need to ensure the quality of TNPP manufacture. Fuelling and commissioning at the site need supervision as standard reactor designs. The TNPP is non-irradiated and hence would not require any radiation regulation during transport. Responsibility for regulation of an irradiated reactor without fuel in the core needs to be confirmed. Some major reactor components have been transported after irradiation under special agreement and it should be possible to arrange for the transport of irradiated components of a TNPP.
8	Radiation protection.	Radiation protection of the transport of a fuelled reactor needs to be addressed (see Section 8.2).	
9	Electric grid.	Of potentially less concern, in particular if the TNPP is designed for safe autonomous operation (without a grid).	Of potentially less concern, in particular if the TNPP is designed for safe autonomous operation (without a grid).
10	Human resource development.	Potentially no need for training of construction or nuclear commissioning and operating host State personnel (if the TNPP is supplier operated).	Potentially reduced human resource requirements due to modular design and simpler construction.
11	Stakeholder involvement.	Same as for a conventional NPP.	Same as for a conventional NPP.

TABLE 1. TNPP OPTIONS IN RELATION TO NUCLEAR INFRASTRUCTURE (cont.)

No.	Milestones area	Option 1 Factory assembled, fuelled, tested, maintained and refuelled. TNPP and spent fuel returned to supplier at end of life	Option 2 Factory assembled and maintained, fuelled and refuelled on-site. Storage for fresh and spent fuel in TNPP or independently. TNPP and spent fuel returned to supplier (separately) at end of life
12	Site and supporting facilities.	Specific conditions related to the siting of a floating nuclear power plant need to be considered. No need for additional high level waste and fuel storage facilities in the host State.	Specific conditions related to siting of a floating nuclear power plant need to be considered. Depending on the TNPP design, in some cases a site may need intermediate fuel storage facilities.
13	Environmental protection.	Environmental impact specific to floating nuclear power plants, including the radiological impact due to radioactive releases, needs to be considered. No fuel handling in the host State may reduce the potential environmental impact in that State. Environmental protection implications of the transport of operable reactor need to be considered.	Environmental impact specific to floating nuclear power plants, including the radiological impact due to radioactive releases, needs to be considered.
14	Emergency planning.	Emergency planning issues specific to floating nuclear power plants need to be considered (such as who is responsible for responding to external and beyond design basis accident events). No risk of nuclear accidents during refuelling. TNPP designs may offer reduced emergency planning requirements based on accident analysis. Emergency planning implications of transport of a fuelled reactor need to be considered (see Section 8.2)	Emergency planning issues specific to floating nuclear power plants need to be considered. TNPP designs may offer reduced emergency planning requirements based on accident analysis.
15	Security and physical protection.	Security and physical protection issues specific to floating nuclear power plants need to be considered. No fuel movements outside reactor core would reduce the potential security risk. Security during transport of a fuelled reactor needs to be considered.	Security and physical protection issues specific to floating NPPs need to be considered.
16	Nuclear fuel cycle.	Spent fuel removed without commitment to storage by host State.	Spent fuel stored until the entire TNPP is removed, similar to current interim storage arrangements. When the TNPP is removed, spent fuel is removed (separately) without commitment to storage by the host State.

TABLE 1. TNPP OPTIONS IN RELATION TO NUCLEAR INFRASTRUCTURE (cont.)

No.	Milestones area	Option 1 Factory assembled, fuelled, tested, maintained and refuelled. TNPP and spent fuel returned to supplier at end of life	Option 2 Factory assembled and maintained, fuelled and refuelled on-site. Storage for fresh and spent fuel in TNPP or independently. TNPP and spent fuel returned to supplier (separately) at end of life
17	Radioactive waste.	All waste removed as part of the TNPP's return to the supplier. Consideration of damage to TNPP resulting from an accident rendering it non-transportable.[c]	HLW could be removed along with the TNPP and spent fuel (under an appropriate contract arrangement). Consideration of damage to the TNPP resulting from an accident rendering it non-transportable.
18	Industrial involvement.	Reduced opportunity for national involvement.	
19	Procurement.	Potential for an all-encompassing contract from supply to removal of the TNPP.	Separate contract arrangements for supply/ return of fuel may be needed.

[a] Depending on the technology and consensus of the interested parties, a factory fuelled reactor could be considered an 'operable' reactor or, alternatively, a fuel transport pack. Both cases would have implications for transport liability and regulatory oversight (see Section 8.2).

[b] Options could be considered to avoid upfront payment for fuel, such as formal selling of the fuel load to a third party, who will then lease fuel to the TNPP user on a 'pay as you go' basis (see Ref. [5]).

[c] For example, if the reactor operates in an unexpected manner (e.g. if the cold critical rod positions are not as predicted), then it will probably be essential to open the reactor in situ because transport will no longer be feasible.

4.2.2. Considerations of TNPP scenarios in relation to nuclear infrastructure

The infrastructure issues arising from different scenarios of TNPP deployment are considered in relation to the 19 infrastructure areas defined in Ref. [16].

Table 2 identifies benefits and infrastructure issues based on the addressed scenarios of TNPP deployment as described in Section 3. It is not intended to be complete, but rather to highlight some issues. An empty box means that there is no difference from what is already stated in the Milestones publication and IAEA Safety Standards Series No. SSG-16 [16, 19].

In general, no different from the BOO/BOOT scenario with a conventional NPP where a supplier may operate the NPP, and even own it and sell the electricity to the host State. It can be seen that it is possible for the host State to obtain considerable benefit from the assistance of the supplier. However, it is noted that in both scenarios, the responsibility for the legal arrangements, operation, licensing and regulation of the nuclear plant remains with the host State and these issues cannot be outsourced, irrespective of the contractual arrangements proposed. In the future, it may be that some of these issues could be helped by international agreements, but in order for a TNPP to be implemented in the near future, it is necessary to recognize the host State's responsibility.

4.2.3. Potential benefits and liabilities requiring consideration

The infrastructure benefits and liabilities arising from the use of a TNPP are listed in Table 3 in relation to the 19 infrastructure areas defined in Ref. [16]. Areas where there is, or may be, a benefit of a TNPP as well as issues where consideration needs to be given to the liabilities involved with the use of a TNPP have been identified from the previous two sections.

TABLE 2. TNPP DEPLOYMENT SCENARIOS IN RELATION TO NUCLEAR INFRASTRUCTURE

No.	Milestones area	Scenario 1 Supplier is operator Host State is regulator	Scenario 2 Host State entity is operator Host State is regulator
1	National position and energy planning.	Potential for State to be able to introduce nuclear power more quickly because of the reduced need for training of all operational staff. If a TNPP is available, then the construction period could effectively be skipped.	
2	Nuclear safety.	The supplier would need to be licensed as an operator by the host State regulator.	The host State entity needs to be licensed by the host State regulator.
3	Management	Same as for conventional NPPs.	Same as for conventional NPPs.
4	Funding and financing.	The supplier may offer contracts to supply electricity or steam, rather than sell the TNPP, and the host State could commit to a long term agreement. This would reduce the upfront costs for the host State. Leasing of fuel, reactor modules or NPPs could be examined.	Leasing of fuel, reactor modules or NPPs could be examined.
5	Legislative framework.	Responsibility of the host State (as in IAEA Safety Standards Series Nos NG-G-3.1 and GSR Part 1).	Responsibility of the host State (as in IAEA Safety Standards Series Nos NG-G-3.1 and GSR Part 1).
6	Safeguards.	The host State must ensure that it has been provided by the supplier State with all necessary information to enable it to fulfill its safeguards obligations. (For more details, see discussion in Section 5).	
7	Regulatory framework.	The host State regulator remains responsible for setting national regulatory norms and approving operating licenses even if assistance from other regulatory bodies is obtained.	The host State regulator remains responsible for setting national regulatory norms and approving operating licenses even if assistance from other regulatory bodies is obtained.
8	Radiation protection.	Not different from Table 1.	
9	Electricity grid.	Not different from Table 1.	Not different from Table 1.
10	Human resource development.	The need for operator training is eliminated.	Potential development of skills which could be applied for later reactors.
11	Stakeholder involvement.		Need for the host State to demonstrate national competence to all stakeholders (as in IAEA Safety Standards Series No. NG-G-3.1).
12	Site and supporting facilities.	Responsibility for site supervision and management during operation rests with the supplier.	
13	Environmental protection.	Need for commitment from the supplier to meet national environmental protection laws and standards.	

TABLE 2. TNPP DEPLOYMENT SCENARIOS IN RELATION TO NUCLEAR INFRASTRUCTURE (cont.)

No.	Milestones area	Scenario 1 Supplier is operator Host State is regulator	Scenario 2 Host State entity is operator Host State is regulator
14	Emergency planning.	Responsibility for emergency planning remains with the host State.	Responsibility for emergency planning remains with the host State.
15	Security and physical protection.	Coordination of security and management within the site boundary is organized by the supplier. Compatibility with national security responsibility needs to be confirmed. Physical protection would remain the responsibility of the host State.	
16	Nuclear fuel cycle.	Supplier would be responsible for fuel supply.	
17	Radioactive waste.	Commitment by the supplier and supplier State to remove TNPP and spent fuel shall be formally agreed and included in the contracts with adequate provisions.	Even if the TNPP is operated by a host State entity, commitment by the supplier and the supplier State to remove TNPP and spent fuel shall be formally agreed and included in the contracts with adequate provisions.
18	Industrial involvement.	Other than the development of the host State regulator, little involvement for the host State industry, except in the case of TNPPs located on land where the host State could be involved in site preparation and building of the balance of plant.	
19	Procurement	Not different from Table 1.	Not different from Table 1.

TABLE 3. POTENTIAL BENEFITS OF TNPPs AND LIABIILTIES REQUIRING CONSIDERATION

No.	Milestones area	Potential benefit of a TNPP	Consideration needed for possible liabilities of TNPPs
1	National position.	The availability of a TNPP could: — Provide benefits of secure and economical energy to more Member States. — Eliminate the long term commitment to the management of spent nuclear fuel and high level waste. — Potentially reduce the national investment required for benefiting from nuclear power.	Mode of transport and liabilities and obligations of stakeholders need to be considered.

TABLE 3. POTENTIAL BENEFITS OF TNPPs AND LIABIILTIES REQUIRING CONSIDERATION (cont.)

No.	Milestones area	Potential benefit of a TNPP	Consideration needed for possible liabilities of TNPPs
2	Nuclear safety.	Manufacture and pre-testing of the entire reactor under workshop conditions could reduce risk during site construction and eliminate some variability. The experience of production in series may, as a result of experience, facilitate a reduction of the regulatory oversight during construction.	Responsibility of the host State regulator cannot be delegated. The host State regulator may require assistance from outside to fulfill its duties. The fact that a plant is licensable in its home country does not remove the obligations on the host State regulator to take responsibility and ensure TNPP licensability in the host State. The need to confirm safety responsibility is with the operator under the laws of the host State, and licensing is with the host State regulator. The responsibility for safety at different stages in the movement of the plant rests with the operator/owner, and how this is to be managed and regulated during transport will need to be considered on a case specific basis. The transport safety of a TNPP with fuel in the core needs special consideration (see Section 8.2), potentially resulting in amendments to the national legislation and bilateral or multilateral agreements.
3	Management.	The supplier may accept managerial responsibility for all design, construction and transport activities until the TNPP arrives in the host State. This could reduce the need for host State management during this phase. The benefit will depend upon who will own and operate the TNPP. The supplier country can provide information to support design approval and operational licensing in the host State.	Management responsibility has to be continuous throughout the transport and, if the responsibility changes from supplier to transport company and then to host, there needs to be a clear and continuous chain of responsibility It is noted that the issue of management of transport of the TNPP is not just between the supplier and the host State, but any other countries or territorial waters through which the TNPP is transported have a legitimate interest and may have significant concerns. It is noted that the International Maritime Organization INF code assigns responsibility for the carriage of nuclear material to the carrier. Information on the equivalent for land transport is not clarified. It is essential for the host State to have sufficient knowledge to be an informed and competent purchaser.
4	Funding and financing.	Costs can be redistributed between initial costs and lifetime costs. Upfront costs may be eliminated if the supplier remains the owner/operator and the host State agrees to purchase the product (electricity or steam).[a] Decommissioning costs may be included in the supply contract and the removal of the TNPP and spent fuel would eliminate long term decommissioning and spent fuel storage costs. Various options on finance may be available, which could reduce the commitment by the host State of resources and funds for many years before electricity is produced.	Financial considerations in the event of accidents or damage to the TNPP, making subsequent transport impossible, would need to be agreed upon.

TABLE 3. POTENTIAL BENEFITS OF TNPPs AND LIABIILTIES REQUIRING CONSIDERATION (cont.)

No.	Milestones area	Potential benefit of a TNPP	Consideration needed for possible liabilities of TNPPs
5	Legislative framework.	Option 2 could be implemented under existing legal arrangements.	Noting Section 6, the issues of liability — in particular during transport — need to be further considered. The liability risks of a TNPP with fuel in the reactor core might need to be distributed and passed on to the carrier/operator as the TNPP moves from one jurisdiction to another and through international waters.
6	Safeguards.	If the host State has the reactor without any refuelling, the SSAC responsibilities may be simpler than if the State were to have a traditional reactor in operation which would need refuelling. The host State must ensure that it has been provided by the supplier State with all necessary information to enable it to fulfill its safeguards obligations. (For more details, see the discussion in Section 5.)	It would be necessary to ensure adequate design information verification if the plant is designed, built and sealed in an NWS and operated in an NNWS. It may be possible for the IAEA to carry out such verification under the NWS voluntary offer safeguards agreement. The IAEA will need to confirm its ability to verify long life cores without access for remeasurement. (For more details, see the discussion in Section 5.)
7	Regulatory framework.	The experience of production in series may, as a result of experience, facilitate a reduction of the regulatory oversight during construction. Because of standardization associated with the modular design and factory manufactured nature of TNPPs, the host State regulator may be able to take advantage of international experience (once it is available) and, hence, achieve adequate supervision with a smaller organization.	Basic legislative and regulatory framework is necessary under all scenarios. The regulatory body should be established by law and may be empowered to carry out its duties as provided by the law. This could involve obtaining assistance and support from the supplier country regulator. The regulatory responsibility for a plant, with fuel in the core, passing through a third country, or territorial waters needs to be determined. If a TNPP is relocated to a third State, the regulatory body of the third State needs to issue the required licenses covering siting, design, etc., and also the licenses for transport and operation.
8	Radiation protection.		Normal standards would apply. When transporting a fuelled reactor, additional considerations need to be taken into account.
9	Electricity grid.	Potentially, a TNPP may be able to consist of a greater percentage of the grid if the TNPP safety case does not rely upon external grid supplies for post-trip cooling and safety. This may enable countries with a small grid to introduce nuclear power earlier than would be possible if the 10% guidance is followed.[b]	
10	Human resource development.	If the supplier becomes the operator, then human resource requirements for plant operation are potentially eliminated. Human resource requirements for construction are also significantly reduced. Human resource requirements for the host State regulatory body may be reduced.	Commitments to training by the supplier may be required. If the host State plans to operate the TNPP itself, certain requirements for training and maintenance of operating staff will be similar to a site constructed reactor. The regulatory body must ensure an adequate level of independence and competence.

TABLE 3. POTENTIAL BENEFITS OF TNPPs AND LIABIILTIES REQUIRING CONSIDERATION (cont.)

No.	Milestones area	Potential benefit of a TNPP	Consideration needed for possible liabilities of TNPPs
11	Stakeholder involvement.	If the TNPP is one of a series production, it may be advantageous to be able to refer to many existing examples of the use of the same technology.	States through which the plant transits may also be stakeholders.
12	Site and supporting facilities.	If the TNPP is located on land, no major change in siting criteria is needed. The potential ability to relocate the TNPP if the site characteristic changes (such as local demographics, or flood levels) may be an advantage. The site may be more easily restored for other use after the removal of the TNPP.	Need for siting criteria for floating NPP. Supporting facilities need to be considered, although there may be differences, the need for consideration of them remains unchanged. Siting arrangements should also include consideration of the necessary site and facilities for a replacement TNPP.
13	Environmental protection.	Some TNPPs aim to achieve higher standards of radiation fields or lower risk of accidents causing radioactivity release and, hence, may achieve a possible reduction of environmental impact and, if justified, this should be reflected in any environmental considerations. TNPPs which do not have fuel movements outside the reactor core may have some advantages in this respect.	The possibility of an accident during transport needs to be considered and this may involve international waterways and any third country passed through or near where the incident occurred. Environmental issues on management of spent fuel and returned TNPPs by supplier may be of concern to the host State.
14	Emergency planning.	Unique TNPP features should be considered in the development of emergency planning, and this may reduce the emergency planning requirements.	Accidents during operation and those related to waste management and temporary storage, including spent fuel, should be considered. Possible accidents during transport need to be considered.
15	Security and physical protection.	The absence of refuelling could reduce the security risk of handling fresh and spent fuel if a reactor without refuelling is available.	Definition of who is responsible for providing security during transport should be clear. Transport with fuel in the core may raise an additional security/safety concern.
16	Nuclear fuel cycle.	It is assumed that the suppliers will take the fuel back, which is actually reactor leasing. This could be an advantage over the current situation of no agreements on long term spent fuel management and distributed spent fuel storage. While other systems may also have fuel take-back options, the return of the fuel and the reactor together is unique.	If fuel remains in the reactor for return of fuel to the supplier country, then safety, liability and transport issues would need additional consideration. In the event of an accident, the options need to be considered. Specifically, it would be beneficial if the supplier agrees to accept the responsibility to take the TNPP back. The issue of how to transport a damaged TNPP needs to be addressed.
17	Radioactive waste.	HLW would be handled by return of the TNPP and fuel to the supplier. In some options all the intermediate level waste (ILW) and low level waste (LLW) could also be returned to the supplier and this would be advantageous. Otherwise, the LLW and ILW could be managed in host State as in many countries at present.	Transport of radioactive waste if TNPP is returned to the supplier.

TABLE 3. POTENTIAL BENEFITS OF TNPPs AND LIABIILTIES REQUIRING CONSIDERATION (cont.)

No.	Milestones area	Potential benefit of a TNPP	Consideration needed for possible liabilities of TNPPs
18	Industrial involvement.	There is no need to develop a national nuclear industry in order to obtain the benefits of a nuclear power programme for electricity, desalination or other applications.	If the design approval is for a highly standardized, factory assembled design, it is assumed that the supply chain would also be ‘standardized’. If national suppliers are to provide parts or services, it may require additional design approval. Generically, there is less potential for industrial involvement with shop fabricated and supplier maintained systems. Regional agreements may be considered for maintenance of TNPPs in order to have a close assistance to incidental need of repair. Long distance to the supplier’s country may recommend this action.
19	Procurement	Potentially, financial arrangements can be simplified. The procurement organization may be simplified. Better availability of spare parts could be an advantage of standardization.	

[a] A report on alternative contracting and ownership practices for nuclear power plants is being produced by the IAEA.

[b] In IAEA Nuclear Energy Series No. NG-G-3.1 [16, 17], it is suggested that no nuclear plant should comprise more than 10% of a grid system to which it is connected, in order to avoid an unacceptable risk of disconnection from external power supplies in the event of a reactor trip.

4.2.4. Issues for consideration by potential suppliers

The information provided in Tables 1–3 indicates there are several issues that a potential supplier may wish to consider to facilitate the use of a TNPP. A TNPP provides opportunities for innovative commercial arrangements, which can reduce the initial costs to a host. A TNPP supplier may consider several options, such as leasing the TNPP, selling it with payment on delivery, or operating it and selling the electrical output, the produced steam or any other products. Each of these options could facilitate a host State deciding that buying a TNPP is more appropriate than purchasing a reactor to be constructed on the site, with the associated potential for construction delays and related increases of the financing costs.

The financial arrangements would potentially also include all charges for fuel and subsequent removal of the fuel and TNPP, and this would also provide a benefit to a host State in that the long term costs of fuel, decommissioning and high level waste management could be identified and fixed from the outset.

It is assumed that proposals for TNPPs include the supply of fuel, either integrally with the TNPP or as a separate delivery, and also arrangements for return of the spent fuel to the supplier. Such arrangements can provide considerable confidence to the host State with regard to fuel supply security and also minimize the long term commitment of the host State to nuclear material management. The supplier needs to consider how the contractual arrangements can be implemented in relation to the supplier country’s national legal framework, and provide clear indications of the contractual commitments to potential host States. An issue that would need to be considered in relation to the return of the TNPP and spent fuel is what would be the contractual commitment in the event of an incident causing fuel damage and/or contamination of the TNPP, that might limit its ability to be transported and returned to the supplier State.

Recognizing the responsibilities of the host State regulator, the supplier will need to make a commitment to the host State regulator to enable access to the design details and safety case approved by the national regulator of the supplier country. The access might also be needed to enable all necessary safeguards requirements to be met, and probably to provide information to the host State to support stakeholder information within the host State.

The supplier would need to enable design information verification by the IAEA if the plant is designed, built and sealed in an NWS and operated in an NNWS. It may be possible to obtain IAEA verification through a voluntary offer (see the discussion in Section 5).

In order to enable TNPP use on a small national grid, the supplier may wish to demonstrate that the TNPP is not dependent for any safety function on external grid supplied electricity. This would help place the TNPP, to be used where it comprises a greater than 10% share of the total electricity generation or for applications fully isolated from electricity generation. In many countries, this would be a significant advantage for a TNPP and could assist the host State to decide upon the TNPP design.

A key issue is the very nature of the concept, i.e. the transportability of the plant. A TNPP transported as a complete factory built power plant, but with the fuel transported separately and loaded at the operating site, in terms of the infrastructure is not different from conventional NPPs built on-site. This is the simplest concept for the infrastructure associated with a TNPP to address and, hence, a supplier may consider that, in the short term, this is the easiest way to introduce a TNPP.

If a TNPP is commissioned with the fuel loaded at the factory, then any subsequent transport would require special consideration. Depending on the technology and consensus of the interested parties, a factory fuelled reactor could be considered either an 'operable' reactor or, alternatively, a fuel transport pack. Both cases would have certain implications for transport liability and regulatory oversight (for more details, see Section 8.2).

The issue of removal of a TNPP after use also requires assessment and it is likely to be simpler if the fuel is transported separately from the reactor, in a similar way to the spent fuel from any reactor operated at present.

A supplier would need to develop the requirements of a site where the TNPP would be located during its operating life, irrespective of the means of transport to the site.

It has been proposed that a supplier might also consider whether it is possible to provide an opportunity for the host State industry to supply components or to contribute to the manufacturing of the TNPP.

The supplier may also wish to offer training services for the host State regulatory body, and to provide a background of additional expertise in the host State.

4.2.5. Issues for consideration by potential host States

Introducing a TNPP may require fewer financial and human resources from the host State. A TNPP may better match a smaller electrical grid and be deployed faster than a conventional site-constructed NPP. There are, however, several issues that the host State will not be able to avoid and these need to be considered by all involved parties within the host State. The establishment of a group to consider all the implications of nuclear energy within the country remains important, and an organization similar to the proposed nuclear energy programme implementing organization (NEPIO) needs to be developed (see Ref. [27]).

Among the key topics that the host State needs to address are commitments to establish appropriate nuclear legislation, liability undertakings, and a regulatory body with the authority, responsibility, resources and competence to oversee a nuclear plant. The host State regulatory body needs to be capable of setting national standards (e.g. international standards could be used as a basis for this purpose) for the nuclear plant, of ensuring that the standards are met for siting and during design, manufacture and commissioning, and also during licensing of the operation, decommissioning and waste management. The host State regulatory body cannot outsource the responsibility for these actions, although it will be appropriate to obtain advice and guidance from other regulatory bodies, including the supplier's regulatory body.

The choice of options for the supply and scenarios for the ownership of a TNPP may influence many of the decisions of a host State. These should be considered by the NEPIO or equivalent.

The host State will need to consider when it will take responsibility for the TNPP. This may depend upon the transport or future ownership arrangements and will need to be fully consistent with the applicable legal and liability legislation that is in force.

The host State will need to ensure that a supplier who proposes to operate a TNPP has the capability of meeting national standards and is able to continue to meet these throughout the operational life of the TNPP, during its decommissioning and the period needed to ensure safe waste management.

It will be necessary for the host State to ensure that it is able to meet the safeguards requirements for inspection and material accountancy during the life of the TNPP. The issue of the TNPP being sealed at the supplier would need to be clarified with the safeguards authorities (see discussion in Section 5).

The host State will need to ensure that the regulatory body is adequately trained and that the skills needed by the regulatory body can be maintained throughout the life of the TNPP. It will also need to establish criteria for the site. These criteria should also include conditions for the site at the end of operation, when the TNPP is removed and returned to the supplier.

Arrangements for environmental protection, emergency planning, security and physical protection should (as for a land based NPP) consider all phases of the TNPP life cycle including, in particular, TNPP transport before and after installation.

Arrangements for fuel supply and removal are expected to be offered by TNPP suppliers, but the host State should also consider what would be the arrangement if a TNPP had an incident where fuel is damaged and the TNPP is contaminated.

The host State may also wish to negotiate the involvement of its own national industry in the manufacture or supply for the TNPP.

4.2.6. Issues for consideration by involved third countries

The transport of non-irradiated components for NPPs is a usual practice at present and the fresh and spent fuel is transported under clearly defined and agreed standards. On the other hand, third countries may consider that they have an interest if fuelled reactors are transported through their territory or territorial waters (see the discussion in Section 8.2). At the end of the operating life, the removal of a TNPP with the fuel in the core may also raise similar interests. In view of this, specifically for the factory fuelled TNPP, a consensus of not only the supplier and the host State, but of all involved third countries would need to be looked for and found regarding the transaction planned. A multilateral agreement between all involved countries would provide a solution in the near term, while international legal arrangements could be useful in a longer term. Third countries may have an interest in the radiological impact due to radioactive discharges during normal operation having transboundary implications.

4.3. CONCLUSION ON INFRASTRUCTURE ISSUES

TNPPs can provide potential benefits to countries embarking on nuclear programmes if they offer reduced infrastructure requirements and shorter implementation time frames. However, it should be recognized that the introduction of a TNPP in a host State does not remove the need for the host State to establish the necessary infrastructure, which includes a legislative and regulatory framework and a competent regulatory body, to ensure that all its national and international commitments to safety, security and safeguards are met. It should be noted that the host State regulatory body may rely on technical support from the supplier State's regulatory body to increase its competence and capacity, but this should in no way diminish its responsibilities, independence and authority as a national regulatory body.

The transport of a TNPP with fuel in the core requires careful consideration by all involved countries (the supplier State, the host State, and the countries whose territories or territorial waters the plant is to be transported through) and may require special arrangements. This issue is discussed in more detail in Section 8.2.

The initial legal arrangements for TNPP deployment might add additional time to the deployment schedule; however, it is expected that with the further expansion of the serial production of TNPPs this increased time issue could be essentially eliminated. Also, the time needed for the implementation of the special arrangements could be included in the original export deployment schedule for a TNPP.

5. SAFEGUARDS ISSUES RELEVANT TO TNPPs

5.1. INTRODUCTION

For the purpose of this section, a TNPP is assumed to consist primarily of a factory-built reactor, which could be loaded with fuel and transported to a fixed location for operation (Option 1 in Section 3). The TNPP might also include an associated fresh fuel store and spent fuel storage (Option 2 in Section 3). For purposes of analysing the safeguards implications of TNPPs, it is further assumed that the quantity of nuclear material involved exceeds one effective kilogram.

In this section, the deployment of TNPPs is addressed on the basis of two scenarios:

(1) A domestic scenario, in which the TNPP is designed, constructed, operated (using fuel of domestic origin) and decommissioned within one State;
(2) An export scenario, in which the State that constructs the TNPP exports it to another State, where it is operated in a fixed location.

5.2. DOMESTIC SCENARIO

5.2.1. Nuclear weapon States

An NWS, as defined in Article IX.3 of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)[1] [28], is under no legal obligation to accept safeguards on its nuclear material or facilities. However, each of the five NWSs has, on a voluntary basis, concluded a safeguards agreement with the IAEA[2] [29]. These agreements, referred to as 'voluntary offer agreements' (VOAs), differ in scope but basically operate on the basis that the NWS offers the IAEA a list of facilities from which the IAEA may select some, all or none of the facilities for the application of safeguards.

Should the NWS in question offer a TNPP for safeguards, the IAEA may or may not decide to select the facility. In the event that the IAEA selects the facility, the TNPP and the nuclear material produced, processed or used in the TNPP would be subject to safeguards. Notwithstanding, under a VOA, a NWS may at any time withdraw a facility and the material contained therein from safeguards, in accordance with the terms of the safeguards agreement.

Should an NWS offer a TNPP to the IAEA, and the IAEA selects it for the application of safeguards[3], the NWS would be required to provide the IAEA with design information about the TNPP, including:

(a) The identification of the facility, stating its general character, purpose, nominal capacity and geographical location, and the name and address to be used for routine business purposes;
(b) A description of the general arrangement of the facility with reference, to the extent feasible, to the form, location and flow of nuclear material and to the general layout of important items of equipment which use, produce or process nuclear material;
(c) A description of the features of the facility relating to material accountancy, containment and surveillance;

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[1] NPT, Article IX, paragraph 3, defines an NWS as a State which "manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January 1967".

[2] Agreement of 6 September 1976 between the United Kingdom of Great Britain and Northern Ireland, the European Atomic Energy Community and the IAEA in Connection with the NPT (INFCIRC/263); Agreement of 18 November 1977 between the United States of America and the IAEA for the Application of Safeguards in the United States of America (INFCIRC/288); Agreement of 27 July 1978 between France, the European Atomic Energy Agency and the IAEA for the Application of Safeguards in France (INFCIRC/290); Agreement of 21 February 1985 between the Union of Soviet Socialist Republics and the IAEA for the Application of Safeguards in the Union of Soviet Socialist Republics (INFCIRC/327); Agreement of 20 September 1988 between the People's Republic of China and the IAEA for the Application of Safeguards in China (INFCIRC/369 [29]).

[3] In the case of France and the United Kingdom, this obligation is incumbent upon the State regardless of whether the Agency actually selects that facility.

(d) A description of the existing and proposed procedures at the facility for nuclear material accountancy and control, with special reference to material balance areas established by the operator, measurements of flow and procedures for the taking of physical inventory.[4]

Under a VOA, design information provided to the IAEA may be used to:

(a) Identify the features of facilities and nuclear material relevant to the application of safeguards to nuclear material in sufficient detail to facilitate verification;
(b) Determine material balance areas to be used for IAEA accounting purposes and to select those strategic points, which are key measurement points and which will be used to determine the flow and inventory of nuclear material;
(c) Establish the nominal timing and procedures for taking of physical inventory of nuclear material for IAEA accounting purposes;
(d) Establish requirements for records and reports and procedures for record evaluation;
(e) Establish requirements and procedures for verification of the quantity and location of nuclear material;
(f) Select appropriate combinations of containment and surveillance methods and techniques at the strategic points where they are to be applied.[5]

All of the NWSs have also brought into force an additional protocol (AP), in connection with its VOA. While based generally on the 'Model Additional Protocol' set out in IAEA document INFCIRC/540 (Corr.) [30], the NWS APs vary in scope and application. Of the five, one AP applies to all of the State's nuclear fuel cycle, the other four are limited to those activities of the State which have some connection with an NNWS. Thus, unless the development/deployment of a TNPP in an NWS involved activities carried out in cooperation with an NNWS, under the NWS domestic scenario, these APs would not be relevant.

The relevant provisions of these APs could require the State concerned to provide the IAEA with information on the TNPP on nuclear fuel cycle related R&D not involving nuclear material; a declaration with regard to the site of a TNPP; and information on the movement or processing of waste containing plutonium, high enriched uranium or uranium-233, if safeguards have been terminated on such material.

There is nothing distinctive about the characteristics of a TNPP which would differentiate it from a non-transportable reactor, from the point of view of the safeguards situation of an NWS under this scenario.

5.2.2. Non-nuclear-weapon States

Pursuant to Article III, paras 1 and 4 of the NPT, an NNWS is obliged to conclude, with the IAEA, an agreement which provides for the application of safeguards on "all source or special fissionable material in all peaceful nuclear activities within its territory" under its jurisdiction or carried out under its control elsewhere. These agreements, commonly referred to as comprehensive safeguards agreements (CSAs), are based on INFCIRC/153 (Corr.) [31].

Should an NNWS decide to construct and operate a TNPP, it would be obliged, in accordance with paragraph 42 of INFCIRC/153 (Corr.)[6] [31], to provide design information to the IAEA as soon as the decision to construct or to authorize construction of the facility has been taken, and to provide updated design information during the project definition, preliminary design, and commissioning stages. The information required to be provided to the IAEA by such a State, and the purposes for which that information may be used, are the same as those referred to above.[7]

Pursuant to paragraph 48 of INFCIRC/153(Corr.), the IAEA would then be able to verify the design information on a continuous basis, with a view to establishing the safeguards approach for the facility and ensuring that the facility is in fact constructed, and operates, as contemplated in the design information. The facility would remain under safeguards until the IAEA verifies that it has been decommissioned, from the point of view of safeguards.

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[4] These details are given in Article 43 of each of the VOAs.
[5] These details are given in Article 46 of each of the VOAs.
[6] GOV/2554/Att.2/Rev.2 (1 April 1992).
[7] Paragraphs 43 and 46 of INFCIRC/153 (Corr.).

Another scenario would be the construction and fuelling of the reactor in one location in the State, and its subsequent transport to another location where the facility would operate. In such instances, both locations would need to be reported to the IAEA.

Under a CSA, all nuclear material in an NNWS is subject to safeguards. Hence, the nuclear material used or to be used in a TNPP would be required to be declared to the IAEA, and would be subject to ongoing reporting, recordkeeping and inspection requirements, unless and until the material was exempted from safeguards, or safeguards were terminated on such material, in accordance with the terms of the CSA.

An NNWS may also have an AP to its CSA with the IAEA. Unlike the VOA APs, the CSA APs are highly standardized, and contain all of the measures set out in the Model Additional Protocol.

Under an AP to a CSA, the NNWS is required to submit additional information to the IAEA, and provide broader access to locations within the State. Of particular relevance to the domestic scenario would be information on nuclear fuel cycle related R&D not involving nuclear material, a site declaration for the TNPP, information on certain activities associated with the construction of equipment for a reactor, the mining of uranium and inventories of source material, and ten year plans for the development of the nuclear fuel cycle.

There is nothing distinctive about the characteristics of a TNPP that would differentiate it from a non-transportable reactor, from the point of view of the safeguards obligations of an NNWS under such a scenario.

5.2.3. Other States

States not party to the NPT currently have no legal obligation to accept safeguards on indigenously manufactured facilities or fuel. So, if under the contemplated domestic scenario the reactor is built, fuelled and operated on the basis of indigenously produced material and equipment, safeguards would not be required in connection with the TNPP, nor in connection with the material produced, processed or used in the TNPP.

Should such a State require the assistance of other States in the construction of such a facility, or require imported material to fuel the reactor, the exporting State could insist on safeguards as a condition of supply. In this case, an agreement could be concluded between the importing State and the IAEA for the application of safeguards in connection with the supplied item, equipment or material. For a more detailed discussion on export requirements, see below.

For example, in the light of its Agreement with the IAEA for the Application of Safeguards to Civilian Nuclear Facilities (INFCIRC/754)[8] [29], if India were to construct a TNPP and place it on its list of facilities that are subject to safeguards under that safeguards agreement, both the TNPP and any nuclear material produced, processed or used in it would become subject to safeguards and would remain under safeguards until safeguards are terminated thereon.

There is nothing distinctive about the characteristics of a TNPP that would differentiate it from a non-transportable reactor from the point of view of the safeguards obligations, under the domestic scenario of a State which is not party to the NPT.

5.3. EXPORT SCENARIO

5.3.1. Exports by NWSs

5.3.1.1. Obligations of the exporting NWS

While the NPT contains obligations related to export controls, these measures do not apply to exports to an NWS. Therefore, under the NPT, safeguards would not be required as a condition of supply of a TNPP or fuel for the facility to an NWS.

However, in the VOAs of China, France, the Russian Fedration and the United Kingdom, the provisions concerning the reporting of international transfers of nuclear material, which require advance reporting of transfers

[8] The Agreement between the Government of India and the IAEA for the Application of Safeguards to Civilian Nuclear Facilities was approved by the Board of Governors on 1 August 2008, signed in Vienna on 2 February 2009 (GOV/2008/30) and entered into force on 11 May 2009 (INFCIRC/754 and Add. 1-3 [29]).

of nuclear material in quantities above one effective kilogram, are not limited to exports to NNWSs. While the VOAs with France and the United Kingdom provide for the reporting of exports of such material from any facility which has been offered to the IAEA for the application of safeguards, the VOAs with China and the Russian Fedration limit such reporting to exports coming from facilities that have actually been selected by the IAEA for the application of safeguards. Under its VOA, the USA has undertaken to provide the IAEA with information on exports of nuclear material "in accordance with arrangements made with the IAEA as, for example, those set forth in INFCIRC/207". As a matter of practice, although INFCIRC/207 [29] refers to exports only to NNWSs, the USA also reports, under INFCIRC/207, exports of nuclear material to NWSs (INFCIRC/207 is discussed further in Section 5.3.1.2). Thus, depending on the terms of the VOA of an exporting NWS, the export of nuclear material from one NWS to another NWS may or may not be required to be reported to the IAEA by the exporting NWS.

5.3.1.2. Obligations of importing NWSs

All five NWSs have voluntarily undertaken to inform the IAEA about imports of nuclear material which was, prior to its export, subject to safeguards under an agreement with the IAEA.[9] Thus, if an NWS were to import nuclear material loaded into or for use in a TNPP from another NWS, and the nuclear material had been subject to IAEA safeguards in the exporting NWS before its export (i.e. it had been in a facility selected by the IAEA for the application of safeguards), the importing NWS would be required, pursuant to INFCIRC/207, to provide information to the IAEA on its import of the nuclear material in question.

5.3.2. Exports to NNWSs

5.3.2.1. Obligations of the exporting NWS

In accordance with Article III.2 of the NPT [28], all State Parties to the NPT undertake not to provide to an NNWS "source or special fissionable material", or "equipment or material especially designed or prepared for the processing, use or production of special fissionable material", unless the source or special fissionable material is subject to Agency safeguards. The list of items the supply of which to a NNWS triggers safeguards under Article III.2 of the NPT includes nuclear reactors.[10]

In 1975, a group of nuclear suppliers that included non-NPT suppliers (the Nuclear Suppliers Group (NSG)) adopted its own list of nuclear material and single use items (INFCIRC/254) and, in 1992, a list of dual use items (INFCIRC/254/Part 2) [29].

In 1992, the NSG also decided to require full scope (comprehensive) safeguards agreements as a condition of supply to NNWSs.[11] Item specific safeguards agreements concluded on the basis of INFCIRC/66/Rev.2 [32] would no longer be considered sufficient. Pursuant to that decision, no nuclear material or reactor, whether stationary or transportable, would be exportable to an NNWS unless the NNWS had a CSA in force. This policy was modified in 2008, when the NSG agreed to a specific exception for exports to India.[12]

As indicated above, the VOAs contain specific provisions relevant to reporting to the IAEA certain exports of nuclear material (see Section 5.3.1). In accordance with those provisions, France and the UK would be obliged to report, in advance, exports of such material from any facility which it has offered to the IAEA for the application of safeguards, while the VOAs for China and the Russian Federation would limit such reporting to exports coming from facilities that had actually been selected by the IAEA for the application of safeguards. As regards the USA, INFCIRC/207, which is incorporated by reference into its VOA, would require advance reporting of such transfers to an NNWS regardless of whether the material came from a selected facility.

It would be useful for the exporting NWS to provide design information on the TNPP at an early stage of construction of the reactor, and offer the IAEA the possibility of verifying the design information while the

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[9] On 11 July 1974, the Director General of the IAEA received letters from the United Kingdom, the USA and the USSR informing him that they had decided to provide the Agency with information on certain exports and imports of nuclear material. The text of these letters is set out in IAEA document INFCIRC/207 [29]. The Director General received similar letters from France and China on 16 February 1984 and 29 November 1991, respectively (INFCIRC/207/Adds. 1 and 2 [29]).

[10] See INFCIRC/209/Rev.2/Mod.1 [29].

[11] The most current version of the list is published in INFCIRC/254/Rev.7/Part 2 [29].

[12] See discussion below under exports to other States.

facility is under construction, as would be required of an NNWS under a CSA if the facility were constructed in the NNWS. This would permit the IAEA to verify the design of the reactor prior to its shipment to the NNWS.

Under the export scenario, it is anticipated that the TNPP would eventually be returned to the State of origin, together with the spent fuel. Since the spent fuel would be subject to safeguards pursuant to the CSA of the State in which the TNPP had been operated, the NWS would be required, in accordance with its undertaking reflected in INFCIRC/207, to inform the IAEA of the import of the spent fuel after its receipt.

As indicated above, NWS APs provide for additional reporting and access in connection with activities carried out in cooperation with NNWSs. Thus, in addition to the elements referred to above under the domestic scenario for NWSs, an NWS constructing a TNPP for export to a NNWS may be required to provide the IAEA with information about, and access to, nuclear fuel cycle related R&D activities[13], and locations engaged in activities listed in Annex I of the Model Additional Protocol[14] where those are carried out for or on behalf of an NNWS,[15] and general plans for the future relevant to the development of the nuclear fuel cycle, including planned nuclear fuel cycle related R&D activities, in connection with such reactor and reactor development.

The exporting NWS would also be required to inform the IAEA of the export to an NNWS of non-nuclear material and equipment listed in Annex II of the Model Additional Protocol, which includes nuclear reactors.[16]

5.3.2.2. Obligations of the importing NNWS

NNWSs are required to provide the IAEA with preliminary design information for new facilities "as soon as the decision to construct or to authorise construction has been taken, whichever is earlier".[17] In the case of an NNWS which imports a pre-fabricated facility, it would be reasonable to extrapolate that the NNWS should inform the IAEA as soon as the decision to import the TNPP has been taken. Of course, as indicated above, it would be useful from the point of view of safeguards for the IAEA to have been able to observe and verify the construction of the reactor while it was being built, so that it could develop an appropriate safeguards approach which addresses possible undeclared irradiation/removal of nuclear material from such a reactor.

As regards nuclear material, CSAs require an importing NNWS to provide the IAEA with information on all nuclear material subject to safeguards under the CSA, and advance notification of imports in amounts greater than one effective kilogram,[18] which would certainly be the case if the TNPP were to include an entire reactor core.

If the importing NNWS also had an AP in force, the IAEA could seek confirmation from the NNWS of its receipt of the TNPP pursuant to Article 2.a.(ix)(b) of the Model Additional Protocol.[19]

5.3.3. Exports to other States

Under the NPT, the transfer of nuclear material and equipment to States other than those defined under the NPT as NWSs must be accompanied by a requirement that the importing State accept safeguards thereon. This, along with the 1992 decision of the NSG participating States to insist on full scope safeguards as a condition of

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[13] In the case of China, France and the United Kingdom, this obligation applies whether or not nuclear material is involved. In the case of the Russian Fedration and the USA, it applies to nuclear fuel cycle related R&D activities not involving nuclear material.

[14] Annex I includes activities such as: the manufacture of zirconium tubes; the manufacture or upgrading of heavy water or deuterium; the manufacture of nuclear grade graphite; the manufacture of flasks for irradiated fuel; and the manufacture of reactor control rods.

[15] The language in Article 2.a.(i) of the NWS APs differ from State to State: "conducted for or in cooperation with an NNWS" [China]; "carried out in cooperation with a NNWS" [France]; "carried out … for or in cooperation with, or otherwise relevant to, an NNWS" [United Kingdom]; "carried out for or jointly with an NNWS" [Russian Federation]. Under its Additional Protocol, the USA has undertaken to provide this information whether or not an NNWS is involved.

[16] Under Annex II, Item 1.1, a reactor is defined as a "nuclear reactor capable of operation so as to maintain a controlled self-sustaining fission chain reaction, excluding zero energy reactors, the latter being defined as reactors with a designed maximum rate of production of plutonium not exceeding 100 grams per year".

[17] See Section 5.2.2.

[18] NFCIRC/153 (Corr.), paragraph 95 [31].

[19] Article 2.a. of the Model Additional Protocol provides that: "[Name of the State] shall provide the Agency with a declaration containing:… (ix) The following information regarding specified equipment and non-nuclear material listed in Annex II: … (b) Upon specific request by the Agency, confirmation by [Name of the State], as importing State, of information provided to the Agency by another State concerning the export of such equipment and material to [Name of the State]."

supply, effectively precluded the export of nuclear material and nuclear related items to India, Israel and Pakistan. However, in light of the recent NSG exception made for India in this regard, on the basis of certain undertakings by India,[20] the supply by an NWS to India of a TNPP and the fuel for such a reactor would be permissible, so long as the reactor and the nuclear material are placed under IAEA safeguards pursuant to India's agreement for the application of safeguards to civilian nuclear facilities.[21]

5.3.4. Exports by NNWSs

5.3.4.1. Obligations of the exporting State

An NNWS is under no obligation to require safeguards as a condition of supply to an NWS of a TNPP, or the fuel for the reactor. However, if an NNWS were exporting a TNPP (with or without fuel) to any other State (whether party to the NPT or not), the exporting State would be obliged, under the NPT, to insist as a condition of supply on the acceptance of safeguards by the importing State. As indicated above, while the NPT does not specify whether the safeguards agreement of the importing State must be comprehensive in scope, it is the current practice and policy of all nuclear supplier States which adhere to the NSG Guidelines to insist on the existence of a CSA in the importing State, except in the case of India.

In accordance with its obligations under its CSA, an NNWS would be required to provide the IAEA with advance notification of intended exports of nuclear material in amounts exceeding one effective kilogram "at least two weeks before the nuclear material is to be prepared for shipping"[22]. If the material is to be exported to a State in which the nuclear material would not be subject to safeguards (i.e. an NWS), the NNWS would also be required under its CSA to make arrangements with the importing State for the IAEA to receive confirmation of the transfer by the importing State.[23]

In accordance with Article 2.a.(ix) of its AP, an NNWS exporting a TNPP would be required to provide the IAEA with a declaration containing information on the "identity, quantity, location of intended use in the receiving State and date or, as appropriate, expected date, of export"[24] for each export of equipment and non-nuclear material listed in Annex II of the AP. As indicated above, this annex includes "reactors and equipment therefore" and "non-nuclear materials for reactors".

5.3.4.2. Obligations of the importing State

NWSs

Nuclear material imported from an NNWS party to a CSA would have been subject to safeguards pursuant to that NNWS's CSA. Pursuant to the NWS's undertaking in INFCIRC/207, an NWS importing a TNPP from an NNWS party to a CSA would be required to inform the IAEA about the import of fuel, since that material would have been subject to IAEA safeguards in the exporting State. As a corollary of the requirement in paragraph 94 of INFCIRC/153 that an exporting NNWS make arrangements for the IAEA to receive confirmation by the host State of the transfer of nuclear material which would not be subject to IAEA safeguards in the host State, an importing NWS would, in accordance with the arrangements referred to in that provision, be obliged to provide the necessary confirmation.

In addition, if the nuclear material is imported in a quantity above one effective kilogram and designated to a facility or part of a facility that has been offered to the IAEA for the application of safeguards, the NWS may also be required, in accordance with their respective VOAs, to provide the IAEA with the name of the organization which will receive the nuclear material and the description, composition and quantity of the nuclear material.

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[20] NSG Statement on Civil Nuclear Cooperation with India, accessible at http://www.armscontrol.org.

[21] See footnote 8.

[22] INFCIRC/153 (Corr.), paragraph 92 [31].

[23] INFCIRC/153 (Corr.), paragraph 94 [31].

[24] INFCIRC/540 (Corr.), Article 2.a.(ix)(a) [30].

Except for China, all importing NWSs would also be required, in accordance with their respective additional protocols, to confirm the receipt of the TNPP if the IAEA were to so request.[25]

NNWSs

The obligations of an NNWS importing a TNPP are the same whether the exporting State is an NWS or an NNWS (see discussion above).

Other States

The obligations of any other State importing a TNPP would depend on the terms and conditions of the relevant safeguards agreement in accordance with which the State had agreed to accept safeguards, regardless of the status of the exporting State.[26]

5.3.5. Exports by other States

India, Israel and Pakistan are not members of the NSG. However, India has undertaken to harmonize its export control list and guidelines with those of the NSG and to adhere to the NSG Guidelines.[27]

The only other relevant safeguards obligations would be in connection with the export by such States of nuclear material/equipment which had been subject to an existing safeguards agreement. These three States currently have in force a number of item specific safeguards agreements concluded on the basis of IAEA document INFCIRC/66/Rev.2 [32]. The safeguards procedures under such agreements would generally require that safeguards be applied in the importing State to an item, if the item in question had been subject to safeguards under an INFCIRC/66-type agreement.[28]

5.4. CONCLUSION ON SAFEGUARDS ISSUES

From the above analysis, it may be concluded that there is nothing distinctive about the characteristics of the construction or operation of a transportable nuclear installation, which would differentiate it from the construction or operation of a non-transportable nuclear installation from the point of view of safeguards. However, it is clear that if the facility is to be constructed in an NWS and exported to an NNWS, it would be useful for the NWS to enter into an arrangement with the IAEA whereby the IAEA is able to verify the design information of the facility while it is under construction.

6. LEGAL ISSUES RELATING TO TNPPs

6.1. GENERAL LEGAL ARRANGEMENTS APPLYING TO ALL TNPP CONCEPTS

A TNPP will, in general, be under the same legal arrangements as any other reactor or nuclear installation. The Handbook on Nuclear Law [33] provides the major guidance as to the legal arrangements that need to be made for any nuclear installation. The objective of this section is then to identify those TNPP attributes that may result in somewhat different, TNPP specific, legal implications, as per reference options and scenarios defined in Section 3.

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[25] In the case of France and the United Kingdom, this obligation applies only if the information is provided by an NNWS outside Euratom. In the case of the USA, this obligation is not limited to information provided by an NNWS. China is solely required to "make every reasonable effort to provide, for the purpose of the resolution of an inconsistency, confirmation of information submitted to the Agency by an NNWS (INFCIRC/369/Add.1, Article 2.a.(vii)d.) [29].

[26] See discussion in Sections 5.3.2.2 and 5.3.4.2.

[27] See footnote 20.

[28] INFCIRC/66/Rev.2, paragraph 28 [32].

The major attributes of a TNPP (as defined in this report) that may result in specific legal implications are:

(1) The reactor's transportability;
(2) Operational scenarios;
(3) Fuel transport within the reactor.

All TNPP concepts include the potential for return of the spent fuel and the irradiated reactor and equipment to the supplier State at the end of the TNPP's lifetime. At present, most nuclear supplier States will not accept the return of spent fuel for permanent storage and disposal. It is, therefore, advisable that the host State and the supplier State provide for that explicitly in a treaty that would govern operations with a TNPP.

6.2. LEGAL IMPLICATIONS OF THE REFERENCE OPTIONS

The options described in Section 3.1 identify two technical approaches to the supply and operation of a TNPP. The options differ in that Option 1 includes innovative approaches to building, fuelling and commissioning a reactor and then transporting it to the country of operation. Option 2 involves the construction of the power plant at a site in one country (the supplier State) and then transporting the complete manufactured facility to the site of future operation in another country (the host State), where it is then loaded with nuclear fuel that has been separately transported to the host State. In Option 2, the fuel is only placed in the reactor when it is stationary in the host State.

6.2.1. Option 1

Option 1 presupposes legal clarity at all stages. Since a TNPP is fuelled in the supplier State, that State's legislation and applicable international laws (primarily international treaties to which this State is a party) would govern activities in relation to the TNPP in its territory. Once installed in the host State, the TNPP would fall under the jurisdiction of that State. Any specific details or modifications pertaining thereto could be the subject of an agreement between these States. That agreement is expected to specify how the responsibilities for nuclear liability, safety, and security are exercised. In the absence of such an agreement (e.g. purely commercial nature of transactions related to a TNPP), national laws and regulations will apply.

Should a TNPP transit through a territory of a third State on its way from the supplier State to the host State, a special arrangement should be reached with that third State. Sea transport, including passage through international straits, other maritime areas or the high seas will be governed by applicable rules of international law, including the law of the sea. In recent years, the transport of fuel or radioactive waste has revealed some problems and conflicts between States related to transit or innocent passage or navigation on the high seas. However, there is no reason to believe that sea transport of a TNPP should give rise to any additional problems or legal requirements.

It should be noted that issues related to the ability of the host State to comply with safeguards requirements, if the fuel is sealed within the reactor vessel in the supplier State, need to be addressed through negotiation with the IAEA.

6.2.2. Option 2

Option 2 has no new legal issues in that the transport of the reactor to the host State is in an uncontaminated condition, and is similar to the transport of components for existing reactors undertaken many times in the past. The fuel would be transported separately under the existing regulations for the transport of fresh fuel and hence, would raise no additional legal issues. At the end of life, or in order to relocate the TNPP, this option anticipates the removal of fuel from the core so that the fuel would be moved as spent fuel and the TNPP would be moved as an irradiated component, which would need special arrangements, but has been achieved for the transport of large irradiated components previously.

As in Option 1, it is advisable that the supplier State and the host State conclude an international treaty on the subject.

6.3. LEGAL IMPLICATIONS OF THE REFERENCE SCENARIOS

The two reference scenarios described in Section 3 reflect alternative operation[29] of the TNPP.

In the first scenario, the supplier is postulated to act as the operator of the installed TNPP. It would retain ownership of the TNPP and subsequently remove the TNPP, whereas the host State ensures regulation and licensing.

In the second scenario, the host State takes responsibility for operation of the TNPP while also retaining responsibility for regulation and licensing, in a similar manner to most NPPs operating today.

Each of these scenarios may have different commercial arrangements and the objective of this section is not to address the alternative commercial and contractual issues, but only to provide information on any legal implications of the possible scenarios.

6.3.1. Scenario 1

Operation of a TNPP by the supplier necessitates licensing, by the host State regulator, of a foreign operating company. The supplier will act according to its obligations under the contract with the host State and, subject to the host State determination, could be eligible to a special regime in its legal system (privileges, exclusions or limitations of application of certain rules to provide incentives). Overall, however, the supplier will act within the limits of the host State's legal system, with all the responsibilities and liabilities that would entail.

It is also possible that a domestically based company owned or co-owned by a foreign supplier will be created for the purpose of TNPP operation. The experience of Turkey and the United Arab Emirates, who selected a BOO approach for the deployment of their first (conventional) NPPs may be a case in point. However, the legal situation would be changed, as formally the operator would be a national juridical entity of the host State, rather than a foreign entity. In legal terms, that deviation would make this case similar to scenario 2, with obvious differences as to ownership.

6.3.2. Scenario 2

Legal arrangements will not surpass those applicable to any existing NPP projects. Adoption of a special regime with incentives for TNPP introduction and operation remains possible.

6.4. LEGAL ISSUES FOR THE SUPPLIER

For a supplier, the offer of supply under Option 2 appears to be legally consistent today. In fact, that supply would not differ from current commercial practice.

If an innovative design is developed that approximates Option 1, then there would be a need to find a consensus among the States involved on whether the particular factory fuelled reactor will be considered an operable reactor or as just a pack of nuclear fuel (fresh or spent).

If the consensus among the States involved (normally the supplier State and the host State) is to rate a transported reactor as a fuel pack, then the currently adopted legal norms for the transportation of fresh and SNF would apply (see discussion in Section 8). No special treaty between the supplier State and the host State is necessary, although it is advisable in order to provide legal certainty.

In the most innovative case (in fact, the genuinely mobile TNPP), a particular TNPP is regarded as an operable reactor. In that case, an agreement between all involved parties should be considered. Besides the supplier State (or States) and the host State, third States through the territory of which the TNPP would transit (transit States) could be considered involved States. A treaty between the supplier State and the host State, plus an agreement with the transit State, would address the issues of TNPP safety and security and material liability for nuclear damage before the TNPP becomes operational in the host State. All those operations will be also governed by relevant international conventions, where applicable.

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[29] Ownership, as such, is not essential for determining legal implications.

6.5. LEGAL ISSUES FOR THE HOST STATE

For a host State, obtaining a TNPP using Option 2 would currently be possible. The host State would need to ensure that it has the capability to regulate the siting, design, manufacture, commissioning and operation of this TNPP. It may be possible to obtain foreign or international assistance, including that from the supplier State, to help the regulator.

It is advisable for the host State to consider concluding a bilateral treaty with the supplier State that would govern all legal aspects of the project, including possible provisions on return of the TNPP and spent fuel to the supplier State.

6.6. LEGAL ISSUES FOR OTHER STATES AND THE INTERNATIONAL COMMUNITY

For Option 2, only the issue of transporting the irradiated TNPP without fuel at the end of life makes it different from existing legal arrangements. There are known precedents where large irradiated components of conventional reactors have been transported through the territories of several countries under special arrangements. This option is therefore legally clear.

Option 1 introduces issues of the transit of a TNPP, as a mobile nuclear installation, through the territory of third States. Specifically, a potential conflict is linked to possible sea transport of such a TNPP. Principles and rules of the law of the sea would provide guidance in that respect. However, experience shows that navigation through international straits and in the exclusive economic zones of certain coastal States does create conflicts. Consequently, it should be expected that such coastal States would wish to be invited to consider issues related to the transit and navigation of seaborne TNPPs. Besides environmental issues, nuclear liability issues could be the object of such consultations.

Option 1 also introduces the concept of design and manufacturing approval for the designs constructed and commissioned in one State before operating in another. In a longer perspective, this leads to consideration of international design certification and related liability issues for potentially operable reactors in transit.

6.7. CONCLUSION ON LEGAL ISSUES

The consideration of the current state of international regulation leads to the conclusion that legal certainty or predictability in the evolution of legal frameworks is not sufficient. Suppliers and operators of TNPPs are interested in operating under clear and predictable legal conditions, which can be achieved if the supplier State and the host State conclude an international treaty on the use of TNPPs. Such a treaty could contain provisions on safety regulation and liability for nuclear damage, starting with jurisdictional provisions. In case of involvement of third States (transit States), an international agreement with those third States should be envisaged.

In the absence of a special international treaty, suppliers and operators of TNPPs will have to abide by national laws and regulations and/or international conventions, as the case may be. If the expansion of the TNPP practice is foreseeable (normal commercial operations without direct State involvement), it would be relevant to place it in the framework of international regulation of nuclear energy issues with special rules and exemptions, as appropriate. Regarding the technical options and deployment scenarios considered (see Section 3), the main conclusions are as follows:

— Option 1 (where the reactor is factory fuelled and tested) may include transport of an operable reactor. This necessitates addressing issues of nuclear safety, security and liability. The best way to proceed is to conclude an international treaty between the supplier State and the host State. Issues of transit could be addressed through an agreement with transit States. It may also happen that States involved could reach a consensus on qualifying a TNPP of particular design with fuel in the reactor core as a pack of fuel. For the transport of a fuel pack, the regulatory norms currently in place may apply (see Section 9.2 for more details).

— Option 2 (where fuel is transported separately from the reactor) will not require any new legal regimes to be developed to cover transport. However, it is advisable for the supplier State and the host State to consider concluding a bilateral treaty that would govern the details of the implementation of that project. It may provide for special arrangements to ensure that the TNPP (as opposed to the fuel) can be transported back to the supplier State. There are examples of international transport of large irradiated NPP components under special arrangements.

- Despite the obvious difference in the status of TNPPs when supplied (nuclear facility under Option 1 and still a non-nuclear facility under Option 2 before being fuelled), there are no drastic legal discrepancies or differences in the overall legal nature of such TNPPs. In respect to operation, refuelling, relocation, decommissioning or removal, TNPPs under both options will enjoy the same status and will be be subject to identical requirements and regulation. Depending on the case, a particular option can be preferable in a host State in the light of the possible technical and financial advantages it could present under specific natural, geographical or economic conditions, but that would not entail variation in the legal regime.
- Scenarios 1 (supplier is the operator/host State is regulator) and 2 (the host State entity is the operator/host State is regulator) do not pose legal or institutional challenges. The important point is to ensure that commercial arrangements for TNPP supply address, in a comprehensive manner, the rights of supervision of the host State regulator, who in any case retains the authority to issue licences and permits at all stages of operation taking place in the host State.
- It remains a point for future consideration how the global application of innovative TNPPs may be facilitated by international certification of the designs, and international licensing of the equipment and components.

7. SPECIFIC LEGAL ISSUES RELATING TO NUCLEAR SAFETY AND RADIATION PROTECTION FOR TNPPs

7.1. INTRODUCTION

This section summarizes the applicability to TNPPs of international binding and non-binding instruments for safety and radiation protection, an in depth review of which is provided in Section A–4 of the Annex. The list of references includes links to the relevant conventions and safety standards.

International instruments related to the safety and radiation protection of nuclear material and radioactive waste transport are reviewed in the same way in Section A–7.2.1 of the Annex, and are also summarized in brief in this section.

This section also provides a preliminary list of safety and radiation protection issues related to the siting, design and operation of barge mounted TNPPs and, in particular, addresses issues related to licensing. It is noted that construction, commissioning and decommissioning of barge mounted TNPPs could also have specific issues, but their consideration is beyond the scope of this preliminary generic study.

7.2. GENERAL REMARKS

The question of applicability of the legally binding international conventions on safety and radiation protection to the deployment of TNPPs will be discussed in Section A–4 of the Annex. The international nuclear legally binding instruments related to nuclear safety and radiological protection (under IAEA auspices) include the following:

- Convention on Nuclear Safety [34];
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [35];
- Convention on Early Notification of a Nuclear Accident [36];
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [37].

Non-binding instruments establishing detailed requirements and guidelines, such as the IAEA safety standards [38], apply to activities undertaken both by the supplier and the host State. The Fundamental Safety Principles and Safety Requirements [20–26, 39–41] constitute the substantive basis of national nuclear laws and regulations and of safety related international instruments.

From the standpoint of TNPP transportation in Option 1 (factory fuelled and tested reactor, see Section 3.1) the important question is whether such a TNPP is to be considered as an 'operable' reactor or just as a 'fuel pack'. This question is discussed in more detail in Section 9.2. The existing safety standards do not address the specific case of transport of an 'operable' or 'operating' reactor. However, many provisions of the current safety standards will apply in this case. The case of 'fuel pack' transport is addressed in the current IAEA safety standards, as shown in more detail in the sections to follow.

7.3. APPLICABILITY OF THE IAEA SAFETY STANDARDS TO TNPP TRANSPORT: OPTIONS

7.3.1. Option 1: New reactor

If a factory fuelled and tested reactor could be considered as a 'particular fuel pack', the transport of Option 1 as defined in Section 3.1 would be, in essence, not different from the transport of fresh fuel in a standard fuel cask. In this, some features of such transportation may be easier to arrange in a safe way, while others, could pose more challenges. It is expected that the IAEA Transport Regulations [40] and relevant conventions [34–37] can be applied to such shipments. There are important transport related issues to be considered, such as:

- The potential for criticality always exists after the reactor has been tested. Subcriticality must be maintained during the transport and in transit stops, under any possible internal and external events and accidental conditions. Criticality prevention may involve checks which are difficult to perform anywhere other than at the manufacturing location;
- The reactor may be the transport package for the fuel or it may be enclosed in another package. In this case, the safety of the reactor during the testing of the transport package should not be affected.

7.3.2. Option 1: Reactor return

The difficult issue here is the need to specify the operating history and link it to the prediction codes. If the reactor has operated in more than one State, this could pose a difficulty.

The transportation of a TNPP containing irradiated nuclear fuel will almost certainly require the demonstration of secure control rod positions in the reactor core. If such a demonstration is not in line with the predicted positions of the control rods, then the possibility of transporting the core without access to the fuel becomes questionable. If the measured reactivity is higher than the predicted one, this leads to a concern about criticality, while the opposite case raises concerns about the release rates, so that the 'window' of acceptability would be rather narrow, particularly for a reactor that has operated for over ten years.

In addition, there would be a need to ensure that safety features are securely in place within the core before and during transport. This could be difficult to achieve with an irradiated core. The features include containment for radioactive protection, confinement for criticality safety, shielding, and a heat transfer system. The Transport Regulations [40] require the package, including the contents inside it, to withstand tests in normal and in accident conditions (e.g. the 9 m drop test onto an unyielding surface) without loss of radioactive material exceeding the limits defined. Since it is anticipated that TNPPs will be of serial production, a random selection could be made, in accordance with production procedures, for the testing. Also, the testing preceding the production should be in place. However, it seems that the testing procedure may depend greatly on the design of the TNPP (e.g. for a barge mounted TNPP).

From a preliminary consideration, the greatest problem for the TNPP might be the same as the problem faced in the radioactive source return/repatriation business. The return journey will be 10–30 years after the manufacture. Regulatory requirements over that period might change and make the transport of the reactor more difficult. Transport approvals normally have a validity of 3–5 years. Ensuring the validity of the transport approval for return will require continuous surveillance and record keeping.

Problems arising from losing conformance to the original design characteristics could be foreseen. This can be related to the material properties (if discovered after operation commences), or could result from an operational incident or accident. In such cases, it may be impossible for the reactor to be transported.

7.3.3. Option 1: Relocation of a partly used TNPP

In this case, the Transport Regulations [40] would also apply. The transport will be similar to that of a used reactor with one crucial difference: just as there will be a need to ensure that the safety of the reactor is not affected by the transport, there will also be a need to ensure that the TNPP can be relocated and operated after being transported.

7.3.4. Option 2: Fresh fuel

Current practices and regulations will apply in full for this case.

7.3.5. Option 2: Irradiated fuel

Current practices and regulations will apply to this option. There could be issues related to shipping large irradiated components, such as the reactor vessel, but there have been cases of such shipments being executed under special arrangements.

7.4. APPLICABILITY OF THE IAEA SAFETY STANDARDS TO TNPP TRANSPORT: SCENARIOS

The IAEA safety standards will apply to the transport of TNPPs as recommendations in all the scenarios defined in Section 3.2, but would be binding only if transport is international by sea or air (or by road, rail, or inland waterway for the ADR [42], RID [43] and ADNR [44] States Parties, or if they have been used as a basis for national regulatory norms in the supplier State, the host State or the transit countries. If any country involved in a TNPP transaction applies a safety standard for the transport of nuclear material and radioactive waste that differs substantially from the IAEA safety standards, this would pose a problem of compatibility. Adoption of amendments to national regulations would be required and this would need to be considered in the bilateral or multilateral agreements concluded between the countries involved in a TNPP transaction. Also, the differences in national standards may hamper receiving technical support from other countries or from the IAEA.

7.5. ISSUES RELATED TO THE SITING, DESIGN AND OPERATION OF BARGE MOUNTED TNPPs

Barge mounted TNPPs raise several issues in specific technical areas due to the unique features of the site and installation. The preliminary assessment concluded that for the siting, design and operation, the current IAEA safety requirements are fully applicable. However, a general review of all standards of each area is necessary to determine whether the existing requirements are sufficient and whether additional dedicated safety guides are necessary.

For this purpose, existing experience in design and operation of reactors mounted on ships (e.g. ice-breakers) and submarines can certainly provide useful information and should be collected.

7.5.1. Siting of barge mounted TNPPs

Siting safety requirements for conventional NPPs are defined by IAEA Safety Standards Series No. NS-R-3 [41]. The specific technical issues that may need further investigation regarding barge mounted NPPs are:

— Effects of external events associated to the particular site (including tides, waves; wind);
— Response to earthquakes and tsunamis;
— Impact of other floating ships;

— Possible fire due to dispersion of oil by tanks;
— Diffusion of radioactive substances released directly in the water;
— Radiological impact of radioactive discharges during normal operation.

7.5.2. Design of barge mounted TNPPs

Design safety requirements for conventional NPPs are defined by IAEA Safety Standards Series No. SSR-2/1 [24]. The specific technical issues that may need further investigation with respect to barge mounted NPPs are:

— Definition of the design basis associated with the site and special conditions of operation;
— Implication of the design basis for the actual design of TNPP systems, structures and components;
— Anchoring systems, recipient structures;
— Connection to a very small and unstable grid (or no grid at all);
— Emergency energy supply (current designs claim complete independence from land; supply);
— Protection against flooding;
— Modality and equipment for refuelling;
— Sinking of the floating reactor.

7.5.3. Operation of barge mounted TNPPs

Operational safety requirements for conventional NPPs are defined by IAEA Safety Standards Series No. SSR-2/2 [25]. The specific technical issues that may need further investigation with respect to barge mounted plants are:

— Radioactive waste treatment, controlled discharges to the environment and storage;
— Fresh and spent fuel storage;
— Refuelling;
— Shift turnover and staff motivation (if they have to stay on board);
— Staff retraining/simulators;
— Major maintenance and in-service inspections;
— Storage of consumable material.

In addition to what is mentioned above, accidental or malevolent releases of radioactive material from a floating reactor could occur directly into water (sea or river) and be quickly dispersed into very large areas. These could threaten the environment over a long time. These issues, including their implication on the preparation of the emergency planning, need to be considered thoroughly.

The specific issues that need to be investigated in this respect are:

— Extensive contamination of sea water or river water during transport;
— Extensive contamination of sea water or river water during operation;
— Effects on the environment;
— Effects on current and future generations.

Many, if not all of the above-mentioned issues may have already been addressed by the pioneering vendors of barge mounted NPPs (see Ref. [6]); however, any assessment of how this has been done is beyond the scope of the present report.

7.6. TNPP LICENSING ISSUES

A licensing approach to the deployment of TNPPs, in particular regarding Option 2 (fuel transported separately from the reactor), would not differ much from the existing procedures followed for conventional stationary NPPs.

However, certain specifics of TNPPs may require special considerations, in particular, as comes to Option 1 (reactor transported with fuel in the core), which represents the reactors with extended lifetime of a factory sealed core.

The IAEA has recently published IAEA Safety Standards Series No. SSG-12, Licensing Process for Nuclear Installations [45], that is applicable to the licensing of TNPPs, as well as for other nuclear installations.

Once a decision to acquire a TNPP has been made, the essential elements of the legal and regulatory framework of safety infrastructure should be implemented in order to complete/adjust the existing legal and regulatory arrangements of the host State (some of the current national requirements may be relevant for transportable reactors). Identification of the essential elements should be based on the requirements contained in IAEA Safety Standards Series No. GSR Part 1 [20]. Some legal and regulatory arrangements would depend on the specific option and scenario. Therefore, a dedicated analysis would be needed for each particular case (e.g. mode of fuel transport, duration of the refuelling cycle) to develop a complete set of relevant legal and regulatory requirements. Regarding radiation protection and the safety of radiation sources, the regulatory framework of the host State should consider the requirements in IAEA Safety Standards Series No. GSR Part 3 [21], and regarding the safety management of radioactive waste, the requirements established in IAEA Safety Standards Series No. GSR Part 5 [26].

In the host State, all steps of the licensing process should be clearly identified and established prior to signing a contract for the TNPP supply. In particular, the host State regulator should be ready to address safety issues related to the feasibility of the design, its manufacture and licensing of the complete installation in the supplier State, and its regulation and operation in another; the commissioning of the reactor in the State where it was manufactured or after delivery; the transport of the reactor, either with fuel in the core or shipped separately, and the return transport of the irradiated TNPP after operation.

As mentioned in Section 4, the key topics that the host State needs to address are establishing appropriate nuclear legislation, liability undertakings, and the existence of a regulatory body with the authority, responsibility, resources and competence to oversee a nuclear plant. The host State’s regulatory body needs to be capable of setting national standards (international standards could be used as a basis for this purpose) for the nuclear plant, and of ensuring that the standards are met for siting and during design, manufacture and commissioning, and during licensing and operation. The host State’s regulatory body cannot outsource the responsibility for these actions, although it will be appropriate to obtain advice and guidance from other regulatory bodies including that of the supplier.

To a large extent, licensing issues for TNPPs will depend on the degree of innovation implemented in the plant design. If TNPPs are subjects of export transactions, licensing will be carried out both in the supplier State (requirement of design probity) and in the host State. Innovative TNPPs, such as those using non-water-cooled reactors, those fuelled and tested at the factory and, irrespective of the reactor type, all barge mounted TNPPs include essential innovations that would require the development of necessary regulatory norms to support their licensing, first within the country of origin. Licensing issues may be associated with long core lifetime in operation without on-site refuelling or with new siting conditions and new external hazards faced by barge mounted (floating) NPPs, and also with how these new external hazards should be addressed together with the internal hazards. Ensuring the safety in transportation of a factory fuelled and tested reactor would also be an issue of licensing.

Specifically for barge mounted plants, licensing of the barge by the maritime regulator will be needed in all cases.

Host States may request assistance from the supplier State for the preparation of their national regulations to include the provisions enabling licensing of the design, construction (including siting), commissioning, operation and decommissioning of TNPPs.

With regard to the options considered, Option 1 (factory fuelled reactor) may require more issues in licensing to be addressed. Moreover, if a TNPP is barge mounted, issues related to non-conventional siting conditions and the associated new external hazards (e.g. sinking of a barge or a tsunami impact) would need to be resolved irrespective of whether the reactor is factory fuelled or fuelled on the site.

Scenarios 1 and 2 (see Section 3.2) are not much different with regard to licensing issues. In Scenario 1, where the supplier is the operator, the supplier should receive a license (a permit) from the regulatory authority of the host State to operate a TNPP on its territory. In legal terms, such a scenario does not differ too much from the BOO approach for conventional NPPs.

Similar considerations would be valid for any entity created by the host State to operate the TNPP (together with the supplier State or other States), the host State regulator remains responsible for setting national regulatory norms and approving operation licences even if major assistance from other regulatory bodies is obtained.

7.7. CONCLUSION ON INTERNATIONAL LEGAL INSTRUMENTS FOR SAFETY

The considerations expressed in this section indicate that non-binding instruments, such as the IAEA safety standards, will apply to TNPP activities undertaken both by the supplier and the host State. The common denominator would be the fundamental safety principles, which constitute the substantive basis of national nuclear laws and regulations and of the safety related international instruments.

The TNPP, which may have similarities to both land based NPPs and nuclear powered vessels, are nonetheless distinct and may possibly represent a new category for which nuclear safety norms, standards, or best practices will need to be developed. The available instruments may not address particular cases of TNPP deployment in detail, such as the transport of factory fabricated, fuelled, tested and ‘operable’ reactors.[30] In such a case, it is the spirit rather than the letter of the available norms that could help the countries develop national laws, rules and regulations, regarding transactions with such TNPPs.

An issue for the TNPPs may result from regulatory norms and rules changing, typically once over 10–20 years. Experience in transportation shows that changes in the regulations and laws over time may prohibit certain originally permitted procedures. In 25–50 years after deployment, some TNPPs might also face such problems. For example, in the event of non-conformance with new regulations, e.g. pre-return test failure, it might be impossible to transport back a reactor loaded with fuel. In this context, an option to remove fuel at the operating location might be necessary to ensure the return transport.

8. SPECIFIC LEGAL ISSUES RELATING TO NUCLEAR SECURITY FOR TNPPs

8.1. INTRODUCTION

This section summarizes the applicability to TNPPs of international legally binding and non-binding instruments concerning nuclear security (also referred to as physical protection of nuclear material and facilities). An in-depth review of the applicability of such instruments to TNPPs is provided in Section A–6 of the Annex along with a list of references identifying links from which texts of the relevant conventions and recommendations can be downloaded.

Binding and non-binding instruments related to the security of transport are reviewed in the same way in Section A–7.2.2 of the Annex, and are also summarized in brief in this section. Finally, this section lists the nuclear security issues for barge mounted TNPPs.

8.2. GENERAL REMARKS

The first principle of nuclear security is that responsibility for it within a State rests entirely with the State. In the exercise of their sovereignty, States establish, implement, and sustain their national nuclear security frameworks to ensure the security of nuclear material, other radioactive material, associated facilities, and associated activities under their jurisdiction. Therefore, the establishment of a competent and effectively independent regulatory body responsible for nuclear security (or the expansion of an existing regulatory body), to support the national decision making process, procurement, licensing and regulation of the design and operation of TNPPs, and provision of the adequate authority, staffing, equipment/tools and financial resources to monitor licensees to ensure they establish and maintain effective physical protection systems throughout the life cycle of the plant, is considered a primary prerequisite.

[30] The Fundamental Safety Principles would, however, apply in full in this case, as in all other plausible cases.

In addition, a State's legislative and regulatory framework governing the international transport of nuclear and other radioactive material should ensure that throughout its transport, including storage incidental to transport, the material is appropriately and effectively protected.

8.3. NUCLEAR SECURITY ISSUES IN TNPP TRANSPORT

Physical protection measures applied to the transport of nuclear material are generally considered to be distinct from those applied to fixed site facilities because of the additional complexities encountered during transport. These complexities arise from the need to transport the protection system along with the material, and from the changing physical and threat environment through which the transport moves. Though more complex than for a fixed site, the problem remains the same: to design and implement a system that protects the material, at the level required by the State's competent authority, from theft and sabotage, and which is based on an assessment of the threat. As such, the requirements and guidance provided by the IAEA Nuclear Security Series publications [46] apply fully to the transportation of TNPPs. Furthermore, in the absence of any specific issues that would require the development of a new guidance, the existing guidance is believed to be adequate for all options and scenarios.

As explained in Section A–7.2.2 of the Annex, any sovereign State from which, through or to which nuclear material (e.g. a TNPP) is transported is responsible within its own legal order for the security of that particular transport. TNPPs are transported from the territory of the supplier State to the host State, possibly transiting through the territories of third States (vice versa for the return of a TNPP either temporarily for refurbishing or final). Thus, nuclear security is a concern for all the involved States.

Furthermore, States involved in nuclear transport normally conclude agreements on a bilateral or multilateral level regarding the security of one or several transport operations covering transborder crossing and shipments through international waters or airspace (e.g. agreements concluded between two States regarding the international shipment for reprocessing, and for return of resulting radioactive waste to the waste generating State).

8.3.1. Option 1: Delivery of a new reactor

The two primary objectives of a physical protection system are to prevent the theft of nuclear material and to prevent radiological sabotage. Option 1 for TNPPs, as defined in Section 3.1, allows for both malicious intent scenarios, to remove the fuel or sabotage the reactor in such a way as to cause a radiological release. Evaluating the potential for these two malicious intent scenarios is beyond the scope of this publication but, if they can be shown to be credible, then prudence would require the protection and mitigation support systems based on a threat assessment and using key design elements, such as protection-in-depth, minimal exposure to threat, and established trustworthiness of the persons with access, authority, or special knowledge.

The transport of a reactor loaded with fuel (see Section 9.2) is sufficiently novel to generate concern. TNPPs, while having similarities to both land based NPPs and nuclear powered vessels, are nonetheless distinct and may possibly represent a new category for which nuclear security norms, standards or best practices will need to be developed. At this point, however, lacking any rationale to the contrary[31], it is believed that the application of existing physical protection recommendations, such as those presented in the IAEA Nuclear Security Series publications [46], remain valid and sufficient to address the known concerns. These recommendations, which are derived from the fundamental principles expressed in the Convention on the Physical Protection of Nuclear Material (CPPNM) [47], the 2005 Amendment to the CPPNM [48], and the IAEA Nuclear Security Fundamentals [49], continue to serve as the appropriate, internationally recognized, applicable guidance governing this option. Therefore, until shown otherwise, this option poses no additional security concerns which would require the development of new or revised guidance. However, given the novelty of this option, existing recommendations should perhaps be more stringently applied until more specific, experience based norms and best practices are established.

[31] The existing legally binding norms and recommendations on nuclear security (physical protection) are of a generic nature; they have been carefully developed by the States Parties (IAEA Member States in the case of the IAEA nuclear security recommendations) not to impede technological innovations of any kind.

8.3.2. Option 1: Return of a used reactor

The transport of a reactor loaded with irradiated fuel presents a fundamentally different security concern than the transport of a reactor loaded with fresh or low irradiated fuel. The main threat in the case of a used reactor is sabotage, where both external (in the form of explosives) and internal (residual heat and pressure) energies may be used by the adversary to expose or damage the core. This form of sabotage is relatively easier to accomplish than the type of sabotage considered in Section 8.3.1 and, thus, the physical protection measures used to prevent such an attack typically need to be more robust and timely in its response. Determining baseline security requirements for this option would require a detailed review of the reactor design and fuel properties, along with a clearly defined design basis threat. Again, as mentioned in Section 8.3.1, the existing physical protection recommendations remain valid and sufficient to address the known concerns.

8.3.3. Option 2: Delivery of a new reactor

Option 2 for TNPPs, as defined in Section 3.1, could be split into two sub-options. The first one would be where the delivery of the plant and the delivery of the fuel are separate and distinct activities. This sub-option is, then, not different from the current practice used for all conventional operating NPPs and, therefore, requires little additional consideration.

The second sub-option provides for the joint shipment of the plant and fuel, i.e. on a single barge or platform. In this second sub-option, the degree to which physical separation of the fuel from the plant is implemented may be an important concern. The location and number of targets and the consequences resulting from a malevolent attack need to be determined on the basis of the degree and means of separation of the plant and its fuel. Theft of the fuel is clearly a concern. However, whether there is also a potential for radiological sabotage needs to be evaluated.

In both of the cases highlighted above, no new or revised security guidance may be required. If that is the case, both Option 1 and Option 2, as defined in Section 3.1, will likely require new technical approaches or methods in order to effectively apply the existing guidance, specifically, to a barge mounted TNPP. The challenges, though not new (such challenges are faced by a nuclear navy), are considerable.

8.3.4. Option 2: Return of a used reactor

The security concerns for the return of irradiated fuel separately from the rest of the TNPP are the same as in current practice, even in the case when the fuel and the plant share a single barge or platform.

8.4. NUCLEAR SECURITY ISSUES IN TNPP SCENARIOS

The three scenarios considered in this study (see Section 3.2) are identical in defining the host State as the responsible party for the regulation and licensing of the facility. This responsibility is consistent with international standards and the fundamental principles of physical protection. For States where a regulatory framework does not yet exist or where it is not developed to the necessary levels, as mentioned earlier, the establishment of a competent and effectively independent regulatory body responsible for nuclear security (or the expansion of the existing regulatory body) is considered a primary prerequisite. Only through the efforts of a trained and competent regulatory body working within the established national nuclear security framework can the details of the various scenarios be equitably negotiated and the responsibilities of the State for nuclear security be met. Anything less would imply the abdication of a State's responsibility to the supplier or to some other non-State organization, including the case where existing international expertise is used for this purpose. No practice for such an approach ever existed and, therefore, there is no mention of it in current national legislation or in binding and non-binding international legal instruments[32].

[32] Of certain relevance could be a case when exterritorial status is granted to the TNPP, when all responsibilities could actually be attributed to a supplier State.

8.5. NUCLEAR SECURITY ISSUES FOR BARGE MOUNTED TNPPs

The security of barge mounted TNPPs is likely to pose certain technical and regulatory issues and will definitely attract a high level of attention. A reactor transported on a barge travels very slowly, it is recognizable, and it can become an easy target for malevolent attacks, if not guarded by a military convoy. The particular typology of a different set of sites (just off the coast) that are supposed to host a barge mounted nuclear plant can present security and physical protection vulnerabilities that need to be carefully addressed.

The specific issues that need to be investigated are:

— Malevolent attack on the reactor or fuel during transport (sea or river);
— Stealing or hijacking fuel or reactor during transport;
— Malevolent collisions;
— Stand-off attacks on the plant during operation;
— Physical protection of the plant during operation;
— Coordination of security arrangements by the operator, as supplier, with the national security organization of the host State.

It is recognized that many, if not all, of the above mentioned issues may have already been addressed by the pioneering vendors of barge mounted NPPs (see Ref. [6]); however, any assessment of how consistently this has been done is beyond the scope of the present report.

8.6. CONCLUSION ON NUCLEAR SECURITY

The basic principle of nuclear security is that responsibility for nuclear security within a State rests entirely with the State. In the exercise of their sovereignty, States establish, implement, and sustain their national nuclear security regimes to ensure the security of nuclear material, other radioactive material, associated facilities, and associated activities under their jurisdiction.

International transactions with TNPPs would include the transport of such plants from the territory of the supplier State to the host State, possibly transiting through the territories of third States and vice versa for the return of a TNPP. In such transactions, nuclear security will be a concern to all involved States. Responsibilities for nuclear security should be clearly assigned and mechanisms to pass on the responsibility and to coordinate security efforts during TNPP transport, commissioning, operation and decommissioning need to be clearly defined. At no time during the TNPP life cycle should the nuclear security of a plant be outside the responsibility of an involved State.

Furthermore, States involved in nuclear transport would normally be expected to conclude agreements on a bilateral or multilateral level regarding the security of one or several transport operations covering transborder crossings and shipments of a TNPP through international waters or land.

The TNPP, while having similarities to both land based NPPs and nuclear powered vessels, are nonetheless distinct and may possibly represent a new category for which nuclear security norms, standards, or best practices will need to be developed. Currently, however, lacking any rationale to the contrary, it is believed that the application of existing physical protection recommendations, such as those presented in the IAEA Nuclear Security Series [46], remain valid and sufficient to address the known concerns.

The CPPNM [47] and its 2005 Amendment [48] (provided it enters into force) will apply in full to the TNPP transactions executed by States Parties to these conventions.

Some TNPP options, e.g. transport of a reactor loaded with fuel (see also the discussion in Section 9.2), could be sufficiently novel to generate a concern. Until shown otherwise, this option poses no additional security concerns which would require the development of new or revised nuclear security guidance. Given the novelty of this option, existing recommendations should perhaps be more stringently applied until more specific, experience-based, norms and best practices are established.

9. SPECIFIC LEGAL ISSUES RELATING TO NUCLEAR LIABILITY FOR TNPPs

9.1. INTRODUCTION

There are different perceptions among liability experts on the applicability or non-applicability of any given liability convention, in view of the differences between regimes and the multiplicity of possible scenarios. This should not prevent a search for solutions for any given case, so long as the proposed activity is supported by the States concerned and is based on sound economic and market realities and economic development incentives.

Liability, insurance, and jurisdiction issues are essential preconditions for the planning of activities related to TNNPs. The legal basis should be established by agreements concluded between interested States — normally between the supplier State and the host State but, when a TNPP is transported through a third country, the third country too.

It would be prudent to take into account the principles embodied in relevant IAEA (and other) conventions in respect to those issues. Even if interested States are not parties to these conventions, they may become applicable in certain situations.

However, from a practical point of view, the conventions need not be considered as sole legal bases for transactions of TNPPs. In fact, at present, most of the potential host States are not Parties to any of the relevant conventions.

The following sections provide an overview of the current national and international legal instruments and explain their relevance to export/import transactions involving TNPPs, with a link to the reference technical options and deployment scenarios defined in Section 3. The Annex presents an in depth analysis of the applicability to TNPPs of certain provisions of the current international legal instruments.

9.2. OVERVIEW OF APPLICABLE NATIONAL AND INTERNATIONAL LEGAL INSTRUMENTS

9.2.1. General and special regimes

It should be emphasized that in no situation would there be a legal vacuum preventing the possibility to address issues of civil liability in the case of damage resulting from an incident involving a TNPP, and resulting in a release of radiation or a real or perceived threat thereof. The laws of the State where the incident has taken place would govern related claims for compensation and criminal investigation, even in the absence of any specific legislation on nuclear energy and nuclear liability adopted in that State, or any international law commitments assumed by it under international treaties or other international acts. These legal rules governing civil liability for damage (general tort law) would be the most common denominator in nuclear liability damage compensation cases. However, the finding of fault in such cases remains crucial, while the award of compensatory or punitive damages can be substantial; as a result, tort litigation can be time consuming and costly. Its defenders claim that tort litigation promotes safety and economic efficiency while critics argue that the process simply raises insurance premiums and becomes a disincentive for business.

These considerations alone could prompt the desire to create a special regime for nuclear liability. Apart from that, the characteristics of nuclear damage are a stimulus for a special regime to be developed, because nuclear damage could be of an extreme magnitude; moreover, its detrimental effects are likely to cross State borders. It may result in personal injury, damage to property, and/or damage to the environment of several States. Damage caused by ionizing radiation to living cells may be latent for a long time. It may be very difficult to prove that the damage suffered by an individual was in fact caused by the nuclear accident.

Despite the very low probability of a major nuclear accident, the potentially extreme magnitude of nuclear damage explains why special statutory provisions dealing with civil liability have been adopted in many States, beginning in the early days of nuclear power development. These special liability regimes intend to facilitate the compensation of victims.

The special nuclear liability regimes were adopted in order to address the concerns of nuclear suppliers, contractors, and the insurance industry. In the light of early concerns regarding potentially very significant damage associated with a nuclear accident, suppliers and contractors to the industry sought indemnification from liability for third party risks before participating in nuclear endeavours. In order to pursue the benefits of nuclear development, a special liability regime was needed to address these economic concerns.

Because of the potential cross-border effects of a nuclear accident, the need was soon felt to adopt international rules aimed at harmonizing national legislation on civil liability for nuclear damage, providing common rules on jurisdiction and ensuring the enforcement of foreign judgements. Special international conventions developed for that purpose are expected to bring stability, predictability and harmonization in international and State nuclear regulation.

9.2.2. International conventions

Special nuclear liability regimes have been developed in the national legislation of many States, especially those that favour nuclear energy development. Normally, they presuppose strict and exclusive liability of the operator, and limitation of its liability coupled with minimum obligatory financial security available for victims.

Similar principles provide the basis for the relevant international conventions, as well. The following international nuclear liability conventions have been concluded under IAEA auspices:

— The 1963 Vienna Convention on Civil Liability for Nuclear Damage [50];
— The 1997 Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage [51];
— The 1997 Convention on Supplementary Compensation for Nuclear Damage [52];
— The 1988 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (the Joint Protocol) [53].

The following regional nuclear liability conventions have been concluded through the Organisation for Economic Co-operation and Development (OECD):

— The 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy, amended in 1964, 1982 and 2004 [54];
— The 1963 Brussels Convention Supplementary to the Paris Convention (the Brussels Supplementary Convention), amended in 1964, 1982 and 2004 [55].

It has to be noted that not all of the listed conventions and their amendments have entered into force. These treaties have different scopes of application and different sets of States Parties. In the multinational environment of today's nuclear markets it is sometimes not easy to draw conclusions as to their application to specific situations.

All liability conventions are based on similar legal principles:

— Absolute (strict/no fault) liability of the operator of the nuclear installation;
— Exclusive liability of the operator;
— Possibility of limitation of liability in amount and time;
— Necessity for the operator to maintain financial security (insurance or otherwise);
— Jurisdictional certainty (single competent court and applicable law, recognition and enforcement of foreign judgments within the convention).

One particular element of these conventions, concerning the exclusion of reactors comprised in a means of transport from their scope of application, deserves special attention in view of its possible implications for the TNPPs. In this respect, the exclusion clause in the Paris Convention is wider and applies to all reactors "comprised in any means of transport", whereas the corresponding exclusion clauses in the liability conventions adopted under IAEA auspices merely refer to reactors "with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose". As pointed out in the Annex, these exclusion clauses could be interpreted in a way that would result in the exclusion of TNPPs from the scope of application of the international nuclear liability regime, even though a different interpretation, as regards the liability conventions adopted under IAEA auspices, could be based on the argument that, in the case of a TNPP, the reactor cannot be considered to be part of the equipment of the vessel and that the vessel merely ‘transports’ a TNPP and is built for that purpose.

Apart from the liability conventions, the carriage of TNPPs by ship or aircraft is subject to special precautionary measures established for such ships and aircraft by international agreements. At the level of implementation of TNPP projects, relevant legal instruments established within the framework of the International Maritime Organization (IMO) [56] and the International Civil Aviation Organization (ICAO) [57], or the International Air Transport Association (IATA) [58] would be taken into account. All of them uphold freedom of navigation on the high seas, including freedom of overflight and international airspace.

For the purpose of this report, it is not necessary to analyse other particularities of the above mentioned international conventions, adherence to which remains an advisable political option for every nuclear energy State. A considerable body of literature on the subject is available.

10. SUMMARY OF LEGAL AND INSTITUTIONAL CHALLENGES FOR TNPPs

10.1. INTRODUCTION

The analysis carried out in Sections 4–9 for reference technical Option 2 and reference Scenarios 1 and 2 defined in Section 3 has yielded the following findings:

— If the TNPPs are factory fabricated and transported in an assembled form to the site, with fuel being transported separately from the reactor (Option 2 as defined in Section 3), the current legal and regulatory norms and practices of exports for conventional NPPs with large reactors would remain fully applicable. Return of a plant with a defuelled irradiated reactor to the factory will require special arrangements, but practices of a transborder transport of large irradiated components exist and would also apply in the TNPP case in Option 1.
— Scenarios 1 (supplier is operator; host State is regulator) and 2 (host State entity is operator; host State is regulator) do not pose legal or institutional challenges. The important point is to ensure that commercial arrangements for TNPP supply comprehensively address the legal authority of the supplier and the host State and the right of supervision of the host State regulator, which in any case retains the authority to issue licenses and permits at all stages of operation taking place in the host State.

Yet another and, perhaps, the most attractive[33] scenario, when the regulation of the TNPP is ‘outsourced’ and the supplier is also the operator, was found to have no legal and institutional basis in current and previous practices. Analysis of the possibilities to implement this scenario would, therefore, require a separate, in-depth study.

The analysis carried out in Sections 4–8 for reference technical Option 1, which includes the transport of a factory fuelled and tested reactor, has identified this option as posing certain legal and institutional challenges. These challenges are summarized in Section 10.2.

10.2. SUMMARY OF CHALLENGES ARISING FROM TRANSPORTATION OF FUELLED TNPPs

10.2.1. Safety and regulation

If the reactors of a TNPP are factory fuelled and tested, and then transported to the operation site, it would be necessary to find a consensus on whether the particular factory fuelled reactor in transport should be considered

[33] This scenario might be the most profitable for a host State as it requires minimum infrastructural arrangements.

a part of the means of transport or could be rated as just a package of nuclear fuel (fresh or spent). The consensus needs to be found among all involved parties, which are the supplier State, the host State and all countries through the territories or territorial waters of which the fuelled reactor is transported.

Regarding transport safety, reactor criticality seems to be the most crucial case. This issue may be addressed as part of innovative design.

An example of particular design features to prevent reactor criticality in transport (including possible accidents), would be the use of the control rods designed for stepwise movement (the case with many advanced water cooled small and medium sized reactors (SMRs) [4, 5]) combined with disconnection of the control rod drives or even mechanical securing of all control rods for the entire period of reactor transportation.

Another example of some inherited features of design safety is the innovative SVBR-100 reactor [5], which uses lead–bismuth eutectics coolant which solidifies at 125°C. Transport of the reactor with solidified coolant practically excludes an option of inadvertent or deliberate control rod withdrawal. Because of the large thermal capacity of the reactor structure, the heating of the reactor to bring the coolant into liquid state and remove the control rods is a complex procedure requiring special equipment capable of providing extreme heat during quite a lengthy period of time, which may provide additional safety and security features during reactor transportation.

Assessment of the effectiveness of these and other possible measures to prevent reactor criticality in transport is beyond the scope of this report. In any case, such an assessment would need to be made by all parties involved in the export transaction with a TNPP and, most probably, would also need to be communicated clearly to the international community.

If the consensus is to rate the transported reactor as a fuel package, then the currently adopted legal norms and safety standards for the transport of fresh and spent nuclear fuel would apply [35, 40]. However, the recommendations of safety standards on the transport of fuel packs could be quite strict. For example, as noted in Section 7.3.2, the Transport Regulations (IAEA Safety Standards Series No. SSR-6) [40] require the fuel package and its contents to withstand tests in normal and in accident conditions, without a loss of radioactive material exceeding the limits defined, e.g. the 9 m drop test onto an unyielding surface. At the same time the requirements of the Transport Regulations specify that the package must be subject to a thermal test at 800°C, which may require additional safety measures from the reactor design.

10.2.2. Security

As stated in Section 8.3.1, the transport of a reactor loaded with fuel is sufficiently novel to generate security concerns. However, the existing legally binding norms and recommendations on nuclear security (physical protection) are of a generic nature, they have been carefully developed by the States Parties (IAEA Member States in the case of IAEA security recommendations) not to impede technological innovations of any kind. Therefore, lacking any rationale to the contrary, it could be concluded that the application of the existing legally binding and non-binding physical protection norms and recommendations remains valid to address the known concerns for transport of a TNPP with a factory fuelled and tested reactor. Given the novelty of this option, existing recommendations should perhaps be more stringently applied until more specific, experienced based, norms and best practices are established.

As noted in Section 6.4, supplying factory fuelled and tested TNPPs raises legal issues of how the responsibilities for nuclear security are exercised during TNPP commissioning, transport through other legal jurisdictions, and installation at the host State site.

10.2.3. Safeguards

As concluded in Section 5.5, if the TNPP is to be constructed in an NWS and exported to an NNWS, it would be useful for the NWS to enter into an arrangement with the IAEA whereby the IAEA is able to verify the design information of the facility while it is under construction. Additionally, as noted in Section 4.2.1, the IAEA will need to validate its ability to verify long life cores without access to fuel for re-measurement.

10.2.4. Liability for nuclear damage

As mentioned in Section 9.1, export supplies of factory fuelled and tested TNPPs raise legal issues of when the TNPP becomes subject to international liability requirements, and how the responsibilities for nuclear liability are exercised during TNPP commissioning, transport through other legal jurisdictions, and installation at the host State site.

11. CONCLUSIONS

The objective of this report was to study legal and institutional issues for the deployment of TNPPs, and to identify issues and challenges. The report focused on export deployment of TNPPs, and examined the implications of a TNPP option for the infrastructure of recipient countries.

A TNPP is defined as a factory manufactured, transportable and/or relocatable nuclear power plant which, when fuelled, is capable of producing final energy products such as electricity, heat and desalinated water. A TNPP includes the nuclear reactor (with or without fuel, depending on the TNPP option considered) and the balance of the plant (e.g. turbine, generator) and fuel storage facilities, if necessary. The TNPP is physically transportable, but is not designed either to produce energy during transportation or to provide energy for the transportation itself. The installed TNPP in its fixed location and when connected for use in the host State is intended to serve for the purposes of electricity supply for remote areas, district heating, desalination of sea water and hydrogen production, though preserving its capability for relocation, if necessary.

Two technological options for TNPPs have been considered in this report, from the standpoint of possible legal and institutional issues associated with export deployment of such NPPs:

— **Option 1:** A TNPP, factory assembled, supplier factory fuelled and tested, supplier factory maintained and refuelled or decommissioned, complete with the balance of the plant on one barge (or platform, if transported by truck or rail), or with the balance of the plant on a separate barge (or platform), or a balance of the plant built on the land in a conventional way to which the reactor is then connected at the site. This also includes a reactor which does not require refuelling during its whole lifetime.
— **Option 2:** A TNPP, factory assembled, factory pre-tested (non-nuclear tested), maintained, fuelled and refuelled on-site, with storage facilities for fresh and spent fuel located on board or at the site. Fuel is delivered to the site either overland in the conventional way, or by a dedicated fuel delivery ship. The balance of the plant may be on the same barge (or platform) as the fuel, on a separate barge (or platform), or built on land in a conventional way with the reactor then connected at the site.

Legal and institutional issues associated with TNPP deployment in recipient countries (host States) were examined for the following two scenarios:

— **Scenario 1:** Supplier is operator/host State is regulator. The supplier provides, operates and takes back the entire TNPP, including the spent fuel. The TNPP is operated by the supplier. The TNPP is regulated and licensed by the host State.
— **Scenario 2:** The host State entity is operator/host State is regulator. The supplier provides and takes back the entire TNPP, including the spent fuel. The TNPP is operated by an entity established by the host State, and regulated and licensed by the host State.

Infrastructure issues relevant to export deployment of TNPPs have been reviewed in the 19 areas defined in the IAEA’s ‘Milestones’ publication [16] and IAEA Safety Standards Series No. SSG-16 [19]. The review was centrally focused on the differences from when a conventional NPP is acquired.

It was found that export transactions with TNPPs may involve not only the supplier State and the host State but, depending on the technical option used, other countries too, i.e. third parties to the transaction. The transport of non-irradiated components for NPPs is current practice and the fresh and spent fuel is transported under clearly defined and agreed upon standards. In contrast, third parties may consider that they also have an interest if factory fuelled reactors are transported through their territory or territorial waters. At the end of its operating life, the removal of a TNPP with the fuel in the core may also arouse similar interest. In view of this, the transport of a TNPP with fuel in the core (Option 1) requires careful consideration by all involved countries (the supplier State, the host State, and the countries through the territories or territorial waters of which the plant is to be transported) and may require special legal arrangements.

The main conclusions of the review regarding the supplier States are as follows:

— A TNPP provides opportunities for innovative commercial arrangements that have the potential to reduce the initial costs to a host. A TNPP supplier may consider several options, such as leasing the TNPP, selling the TNPP with payment on delivery, operating the TNPP and selling the electrical output, the produced steam or any other products. Each of these options could facilitate a host State deciding that buying a TNPP is more appropriate than purchasing a reactor to be constructed on the site with the associated potential for construction delays and related increases of the financing costs.
— Recognizing the responsibilities of the host State regulator, the supplier will need to make a commitment to the host State regulator, to enable access to the design details and safety case approved by the national regulator of the supplier country.
— A key issue for TNPPs is the very nature of the concept, i.e. transportability of the plant. A TNPP transported as a complete factory built power plant, but with the fuel transported separately and loaded at the operating site, in terms of the infrastructure is not different from conventional NPPs built on-site. This is the simplest concept for the infrastructure associated with a TNPP to address and, hence, a supplier may consider that, in the short term, this is the easiest way by which the TNPP concept can be introduced.

The main conclusions of the review regarding the host States are as follows:

— Introducing a TNPP may require fewer financial and human resources from the host State. A TNPP may better match a smaller electrical grid and be deployed faster than a conventional site constructed NPP. There are, however, several issues that will need to be considered by all involved parties within the host State. The establishment of a group to consider all of the implications of nuclear energy within the country remains important, and an organization similar to the proposed NEPIO (see Ref. [27]), needs to be developed.
— Among the key topics that the host State needs to address are commitments to establish appropriate nuclear legislation, liability undertakings, and a regulatory body with the authority, responsibility and competence to oversee an NPP. The host State regulatory body needs to be capable of setting national standards (e.g. international standards could be used as a basis for this purpose) for the plant, of ensuring that the standards are met during manufacture, commissioning, licensing and operation. The host State's regulatory body cannot outsource the responsibility for these actions although it will be appropriate to obtain advice and guidance from other regulatory bodies, including that of the supplier.
— The host State will need to establish criteria for the site. These criteria should also include conditions for the site at the end of operation when the TNPP is removed and returned to the supplier. Arrangements for environmental protection, emergency planning, security and physical protection should (as for a conventional NPP) consider all phases of the TNPP life cycle including, in particular, TNPP transport before and after installation.

Safeguards and verification issues for export transactions with TNPPs have been analysed in detail. It was concluded that there is nothing distinctive about the characteristics of the construction or operation of a transportable nuclear installation which would differentiate it from the construction or operation of a non-transportable nuclear installation, from the point of view of safeguards. However, it is clear that if the facility is to be constructed in an NWS and exported to an NNWS, it would be useful for the NWS to enter into an arrangement with the IAEA whereby the IAEA is able to verify the design information of the facility while it is under construction. Additionally, in the case when TNPPs are based on factory fuelled reactors designed for operation without on-site refuelling, the IAEA may need to validate its ability to verify long life cores without access to fuel for re-measurement.

The international legal framework has been analysed explicitly (see the Annex) with a focus on its applicability to the deployment and operation of TNPPs. The main conclusions of this analysis are as follows:

— The applicability of the international legal instruments (conventions) on nuclear safety [33–40], nuclear security [47, 48] and liability for nuclear damage [50–55] to TNPP transactions conducted by the States parties to these instruments needs careful consideration in light of the provisions regarding the scope of each particular convention.
— International non-binding requirements and guidance established by the IAEA [21–23, 26, 38–41, 59] would apply to TNPPs. The flexibility of the Fundamental Safety Principles [39,] and also of the Safety Requirements [21–26, 39, 40] allows for their case-by-case application as required by the supplier and the host State and also makes them applicable to innovative technical developments that might not have been considered at the time of drafting.
— Option 2 (where fuel is transported separately from the reactor) will not require any new legal instruments to be developed to cover transport. It may require special arrangements to ensure that the TNPP (as opposed to the fuel) can be transported back to the supplier State. Examples of international transport of large irradiated NPP components under special arrangements exist and may be used as models.
— Scenarios 1 (the supplier is the operator/the host State is the regulator) and 2 (host State entity is operator/host State is regulator) do not pose legal or institutional challenges. The important point is to ensure that commercial arrangements for TNPP supply address, in a comprehensive manner, the legal authority of the supplier and the host State and the rights of supervision of the host State regulator, which in any case retains the authority to issue the licences and permits at all stages of operation taking place in the host State.

The analysis of the current state of the applicable international nuclear law and related regulations has shown that for the case when factory fuelled and tested reactors (Option 1) are to be used in a TNPP, there are obvious ‘gaps’ and an insufficient coverage of certain TNPP related activities. In addition to this, there is no sufficient legal certainty or predictability in the evolution of international legal frameworks. Then, suppliers and hosts of TNPPs interested in operating in clear and predictable legal realities can achieve this goal if the supplier State, the host State and all involved third countries conclude an international treaty among themselves on the use of TNPPs. In the absence of such a treaty, the supplier and operator of TNPPs will have to abide by the applicable national laws, regulations and international conventions.

International transactions with factory fuelled and tested TNPPs (Option 1) raise legal issues of when the NPP becomes subject to international safety, security (physical protection) and nuclear liability requirements, and how and by whom the responsibilities for safety, security and nuclear liability are to be exercised during TNPP commissioning, transport through other legal jurisdictions, and installation at the host State site.

Regarding nuclear safety, if the reactors of a TNPP are factory fuelled and tested (Option 1), and then transported to the operation site, it would be necessary to find a consensus on whether the particular factory fuelled reactor in transport should be considered an operable reactor, or could be rated as just a package of nuclear fuel (fresh or spent). Consensus needs to be found among all involved parties, which are the supplier State, the host State and all countries through the territories or territorial waters of which the fuelled reactor is transported. The decision would depend on the assessment of the technical measures implemented in a particular TNPP design to prevent criticality in transport and, most probably, would need to be communicated clearly to the international community.

If the consensus is to rate the transported reactor as a fuel package, then the currently adopted legal norms and safety standards for the transportation of fresh and spent nuclear fuel would apply [35, 40].

The specific case when the transported reactor is rated as an operable reactor is currently not addressed explicitly by international legally binding norms or non-binding recommendations (safety standards and security recommendations).

Regarding nuclear security, the transport of a reactor loaded with fuel (TNPP — Option 1) is sufficiently novel to generate security concerns. However, the existing legally binding norms [47, 48] and recommendations [59] on nuclear security (physical protection) are of a generic nature. They have been carefully developed by the States Parties (IAEA Member States in the case of IAEA security recommendations [59]) not to impede technological innovations of any kind. Therefore, lacking any rationale to the contrary, it could be concluded that the application of the existing legally binding and non-binding physical protection norms and recommendations remains valid to address the known concerns in the case of a transport of a TNPP with a factory fuelled and tested reactor. Given the novelty of this option, existing recommendations should perhaps be more stringently applied until more specific, experience based norms and best practices are established.

The study carried out has found that legal and institutional issues and challenges associated with the export deployments of TNPPs are related to Option 1, i.e. the case when the nuclear reactors of a TNPP are fuelled and tested at the factory, prior to transporting the plant to its operational site in the host State. Recommendations for the resolution in a nearer term are as follows:

— In a broader context, all States likely to be involved in the use of TNPPs should become, in due time, parties to the international conventions on nuclear safety [34–37], nuclear security [47, 48] and liability for nuclear damage [50–55].
— The supplier State, the host State, and all involved third countries could agree to conclude an international treaty or treaties among themselves to cover relevant innovative aspects regarding the use of TNPPs that are presently not the object of existing legal norms.
— Specifically, such treaties should legally define when the NPP becomes subject to international safety, security and nuclear liability requirements, and how and by whom the responsibilities for nuclear safety, security and liability are to be exercised (if necessary, transferred) during TNPP commissioning, transport through other legal jurisdictions, and installation at the host State site.
— On the basis of the provisions of the above mentioned treaties, the relevant safety, security and environmental requirements would need to be developed and emplaced as part of national regulations in all of the States involved in the export transaction.

Thoughtful application of the existing national regulatory norms and international safety standards [21–23, 26, 38–41] also provides a good starting point, as many of them would be applicable to innovative technical developments that might not have been considered at the time of drafting. It remains a point for future consideration that international certification of the designs, and international licensing of the equipment, components and even operators might greatly facilitate international transactions involving the innovative TNPPs.

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Annex

LEGAL FRAMEWORK FOR DEPLOYMENT AND OPERATION OF TNPPs AS REGARDS NUCLEAR SAFETY, NUCLEAR SECURITY AND LIABILITY ISSUES

A–1. SCOPE AND CONTENT OF LEGAL FRAMEWORK FOR TNPPs

A–1.1. General considerations

Nuclear law has evolved continuously over more than five decades to regulate nuclear activities, facilities and nuclear and radioactive material, though in different ways. Today, the existing comprehensive framework of nuclear law acts as a web of both binding and recommendatory norms, established and implemented at international, regional and national level. However, it is necessary to emphasize that this framework has been developed and emplaced mostly in view of the available nuclear technologies and activities.

Therefore, the question may be asked to what extent the legal framework potentially applicable to the deployment and operation of a transportable nuclear power plant (TNPP), which is based on innovative characteristics that determine its life cycle and deployment/decommissioning, can be found in the existing norms, both international legally binding instruments and advisory, i.e. non-binding norms that cover nuclear safety, nuclear security, safeguards, and liability.

Under a domestic scenario, the TNPP is designed, constructed, operated and decommissioned within one State, pursuant to the domestic laws and regulations. This option is not addressed in the following study, as the legal framework applicable would be based entirely on the laws of the supplier State where the TNPP is designed, constructed, licensed, operated, and decommissioned. In such a case, the legal framework depends exclusively on the domestic legislation and the international treaties and conventions adhered to by that supplier State.

Under an export scenario, the supplier State designs, constructs and exports a TNPP to a host (importing) State, under different technical options, where the TNPP is thereafter temporarily sited and operated on either land or territorial waters.

This study reviews the deployment of TNPPs under the export scenario. The deployment of TNPPs under the domestic scenario is not the subject of this report.

The outsourcing scenario, which has been briefly described in the report, is somewhat similar to the export scenario in that the supplier State exports the TNPP. However, it also operates the TNPP and provides additional services to the host State, where the TNPP is located. The outsourcing scenario is based on the hypothesis that the supplier State is granted full rights of sovereignty over the site of the TNPP, or acts as if it were ultimately responsible for a TNPP located in the territory of another sovereign State.

The outsourcing scenario is highly hypothetical under the parameters of existing international law. The legal framework that might be applicable would combine elements under the domestic and export scenarios mentioned above. It would assume that full legal responsibility over the TNPP can be maintained by the supplier State outside its territory after the TNPP is deployed in the host State. The available treaties and conventions of nuclear law (covering peaceful uses), however, are based on the concept of responsibility of the sovereign State for nuclear activities conducted only on its territory. That is why this hypothetical scenario is not specifically addressed in this Annex.

A–1.2. Legal aspects of TNPPs reflected in the international framework of nuclear law

What are the specific legal consequences of the deployment a TNPP in the light of its innovative characteristics? The first, outstanding set of legal consequences apply to the ‘transportability’ of the installation and, as an element thereof, to the ‘double’ national location whereby design and construction of the TNPP, (possibly also fuelling, spent fuel and radioactive waste management) are separated (dislocated) from the TNPP siting and operation.

Certain technical options envisaged may also have direct consequences regarding the applicable law. This may apply in particular to the selection between Option 1 and Option 2 of the report, i.e. to the cases when nuclear fuel is transported in the core of a factory assembled reactor or separate from the core, respectively.

The option to ship and supply a TNPP to a host State either with or without fuel may have direct consequences, e.g. for the licensing of such TNPP pursuant first to the laws of the supplier State, then to the laws of the host State, and to legislation applicable to transport (including transport licences, applicable packaging regulations).

The option regarding the mode of shipment selected, i.e. by sea, road or rail, would have direct legal consequences on the applicability of instruments of international transport law (modal laws, routes, transit provisions).

The option of a barge mounted versus land based TNPPs would have a direct impact on applicable law of the sea norms (location/site in territorial/coastal waters), on environmental laws in the host State, and also on safety, radiation protection and related emergency procedures, and on norms relating to nuclear security and physical protection.

Options regarding the return of a TNPP to the supplier State: (i) at the end of its life cycle, i.e. as a decommissioned reactor and also at any earlier time as a shutdown reactor for refuelling or maintenance; or (ii) as a reactor that has suffered a major nuclear accident resulting in core damage, will have direct legal consequences on transport law, and on applicable norms of nuclear safety, physical protection and security.

Further, the international and national legal framework that applies to deployment and operation of a TNPP may be linked to the decision as to whether the purpose of a TNPP is: (a) production of power (electricity) in the context of a nuclear power programme of the host State; (b) production of energy to serve other industrial uses as further specified; or (c) whether both options need to be considered.

As an example, regarding Option 1 assuming TNPP transport with fuel factory loaded in the reactor core, the main issues are related to:

(1) The international transport of such TNPPs, including fresh fuel in the reactor core;
(2) The number of licenses required in that process;
(3) Decommissioning at the site and return of the TNPP to the supplier.

In this option, the TNPP is first licensed in the country of origin (the supplier State). Transport may require relicensing by transit State(s) and by the host State. Alternatively, it could be hypothetically envisaged to conclude a bilateral or multilateral international agreement on licensing. Before such an agreement is concluded, with details of the particular technical features of a TNPP (see the discussion in Section 9.2), a consensus would need to be found on whether the TNPP in transport would be viewed as a potentially operating reactor or just a fuel pack. Depending on this, different sets of provisions may need to be included in the agreement.

In Option 2, when a TNPP (without fuel) is shipped to the host State as [nuclear] industrial equipment/facility, as would be the case for imported industrial components/elements (e.g. vessels) of a non-transportable land based NPP, the main necessary steps would be:

(1) Licensing the TNPP by the supplier State (as required);
(2) Licensing at the site under the licensing laws of host State (as required) (fuelling, initial authorization, commissioning, operation);
(3) Initial shipment of nuclear fuel to the site of the TNPP, which would not differ in terms of legal arrangements from a non-transportable NPP;
(4) Shipment and return of fuel thereafter as for a non-transportable NPP (i.e. shipment of fresh fuel, return of spent fuel).

Accomplishing these steps for a TNPP would not be much different from accomplishing them for a conventional NPP. The remaining issue would be the return shipment of a decommissioned TNPP containing irradiated structures and, potentially, other waste.

A–1.3. Role of bilateral agreements

In addition to the norms of national and international law that are directly or indirectly applicable to the supplier State, to the host State, or to both, a number of binding bilateral (possibly also multilateral) agreements[1] will have to be concluded at an early stage between the States involved. Such agreement can be understood as an overarching long term framework agreement covering nuclear cooperation in general, supplemented by one or several detailed agreements or memoranda of understanding specifically related to the technical and legal requirements of the supply of a TNPP. More detailed agreements may cover specific aspects of transport/liability, fuel supply, radioactive waste management, and return shipment of a TNPP.

A–1.4. Link to scenarios and technical options

In the following, certain technical characteristics and related options highlighted in the report are reviewed in terms of the applicability of international binding instruments, and transposition of international norms into the national laws of the host State.

With reference to the report, the following special features of the TNPP, as described therein, are considered of legal relevance:

— **A TNPP, factory assembled, supplier factory fuelled and tested:** There is no requirement for legal norms to be enacted by the host State at the site of a TNPP (e.g. licensing, safety regulations) that apply to design, construction and initial testing at the site (barge or land) of the installation.

— **The TNPP is physically transportable, but is not designed either to produce energy during transportation or provide energy for the transportation itself:** The reactor is not self-propelled but is transported on a specific vehicle at sea, or land (road, rail). This, however, does not imply that there is no need for national/international approval/endorsement of the 'vehicle' (e.g. specifications of the ship/container IMO standards [A–1], IAEA safety standards for transport [A–2]).

— **The installed TNPP will be considered…for use in the host State for various purposes such as electricity supply for remotely located areas, district heating, desalination of sea water and hydrogen production…:** The term *transportable nuclear power plant* covers different (industrial) types of installations designed and operated for different purposes. It is important to note that some international conventions and existing national laws apply to 'power reactors' (e.g. the reactors for electricity generation) only. It should also be noted that the TNPP is not a research reactor.

— **The host States of TNPPs are not obliged to install facilities for the storage and management of fresh and spent nuclear fuel and thus the obligations of the host States for fresh fuel storage and spent nuclear fuel management are essentially eliminated:** Fuel is imported either together with or separately from the reactor. The spent fuel is not reprocessed nor (permanently) disposed of, but only temporarily stored at a site of the host State. Radioactive waste management activities are exclusively those required at the site and installation.

— **A TNPP is factory maintained….**

— **The supplier takes back the whole TNPP, including the spent fuel:** The return of the 'reactor' and the relevant modalities, time frames, liabilities, etc., would necessarily be included in the basic bilateral agreement. Here, the TNPP option (Option 1 versus Option 2) may have an impact on the legal framework applicable to the (return) transportation of a TNPP (i.e. operable reactor or spent fuel pack, see the discussion in Section 9.2).

[1] Examples are: general 'nuclear cooperation agreements' on a State to State level; fuel supply, reprocessing, waste return, etc., specific agreements either as stand-alone agreements/contracts or covered by overarching long term bilateral nuclear cooperation between supplier State and host State.

A–1.5. Applicability of the 'Milestones' and other IAEA guidance to the TNPP host State

Three relatively recent IAEA publications address measures of a technical, economic, regulatory and legal nature that States are advised to adopt when considering and implementing new nuclear energy programmes[2] [A–3 to A–5]. All of them set forth a number of basic considerations, including legal requirements that are relevant to the host State of a TNPP.

These publications focus primarily on the development of a national infrastructure meant to include all activities and arrangements needed to set up and operate a nuclear programme. This covers a comprehensive strategy, including compliance by the State with specific international legal obligations in addition to international nuclear safety standards, security guidelines and safeguards requirements. The essential requirements or infrastructure milestones relate to the phased establishment of a regulatory and legislative framework for all aspects of NPP siting, design, construction, commissioning, operation, decommissioning and radioactive waste management. A number of these binding requirements are derived from the obligations of the States Parties to the Convention on Nuclear Safety (CNS) [A–6] and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [A–7], which apply to non-transportable NPPs and to radioactive waste and spent fuel facilities.

In the introductory explanations regarding infrastructure milestones, it is stated that "it should be noted that decisions early in the process, such as turnkey purchase versus indigenous construction, can greatly influence the resources necessary to create the required infrastructure". In this, the term resources is not referring only to financial resources.

Such a turnkey scenario might indeed be applicable to a TNPP. Therefore, the *infrastructure issues* (term used in Refs. [A–3] and [A–4]) might be ab initio different from a non-transportable NPP.

The Milestones publication [A–4] addresses infrastructure issues related exclusively to land based civil NPPs as defined in the Convention on Nuclear Safety [A–6], and does not envisage transportability, sea based siting or other inherent innovative features possible for a TNPP. Therefore, for example, the list of "relevant international instruments"[3] provided in the context of the Legislative Framework would not automatically apply to TNPPs.

However, the general advice given to States that intend to launch a nuclear energy programme for power or for other uses would seem to be equally valid in the context analysed in this Annex. Moreover, the initial approach to be followed and the recommended sequences of decision-making therein are useful tools for States to consider when embarking on a TNPP project (see, for instance, Table 1, Infrastructure Issues and Milestones, in Ref. [A–4])[4]).

Due to the fact that radioactive waste from TNPPs, including spent fuel, are managed as any other radioactive waste generated in the nuclear industry, no radioactive waste coming from a TNPP will be disposed of at sea, neither during its operation, decommissioning or transport. This means that the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and 1996 Protocol Thereto in principle does not apply to TNPPs [A–8].

Radioactive discharges may result during the normal operation of TNPPs or during certain activities like maintenance or refuelling. If radioactive discharges would occur, not only should they be regulated and controlled by the host State, but any regional convention to prevent pollution of the marine environment covering radioactive discharges from land based installations should need consideration. As examples, the North-East Atlantic has the Convention for the Protection of the marine Environment of the North-East Atlantic (the 'OSPAR Convention') [A–9] and the Baltic Sea has the Convention on the Protection of the Marine Environment of the Baltic Sea (the HELCOM Convention) [A–10].

A–1.6. General approach to nuclear safety, physical protection and security, safeguards and liability

In the following, the legal framework applicable to TNPPs is examined following the cross-cutting concepts of nuclear safety, nuclear security, safeguards and liability for nuclear damage. From a legal standpoint, the technical

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[2] Considerations to Launch a Nuclear Power Programme, IAEA, Vienna (2007) [A–3], Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1, IAEA, Vienna (2007) [A–4] and Establishing the Safety Infrastructure for a Nuclear Power Programme IAEA Safety Standards Series No. SSG-16 [A–5].

[3] Reference [A–4], paragraph 3.5, Table 2, page 29.

[4] Reference [A–4], page 8.

options and deployment scenarios defined in the report, and briefly referred to above, are taken into consideration within each of these substantive thematic segments, rather than being treated separately so as to avoid repeating common ground for each option or scenario considered.

The essential legally relevant, non-optional features of the TNPP, which distinguish this innovative type of installation from a conventional non-transportable NPP, are its inherently ‘international’ character and its ‘transportability’. Both determine the issues of jurisdiction and of applicable legal regimes.

Three distinct legal regimes apply in different degrees to TNPPs:

(1) The national laws and international obligations of the supplier State;
(2) The national laws and international obligations of the host State;
(3) The laws applicable to the international transport of nuclear material.

These three regimes reflect the legal consequences of the nuclear properties of a TNPP (i.e. nuclear material, nuclear activities, nuclear facility) which determine the analogies, differences and references to legal norms applicable to non-transportable, i.e. to conventional land based civil NPPs or to other types of comparable installations as set forth in the applicable IAEA safety standards and the provisions of relevant international treaties and conventions.

A–1.6.1. Laws of the supplier State[5]

Mention has to be made, though not in terms of a comprehensive legal analysis, of international treaty obligations and the ensuing domestic obligations contained in the laws of the supplier State, in as much as they may have direct legal consequences on the export of TNPPs, their transport and deployment in another State.

The domestic legal framework is of relevance to:

— The initial phases of design, construction and pre-export licensing;
— The export, transport, and deployment;
— The fuel supply and return of spent fuel and radioactive waste, including final disposal (if the spent fuel and radioactive waste are not kept in or returned to the host State).

The international instruments of particular importance to both the supplier and the host State include:

— IAEA safeguards agreement and protocols thereto;
— Nuclear safety related conventions [A–6, A–7, A–11, A–12];
— The Convention on the Physical Protection of Nuclear Material [A–13];
— Liability regimes, the UNCLOS [A–14], and other relevant instruments of maritime law and applicable modal transport laws (road, river, rail).

In the absence of an international licensing agreement*,* the initial license(s) granted by the supplier State are relevant for the export of TNPPs in cases of specific licensing requirements for, e.g. maritime transport or transit through third States, import license by the host State, and operating licenses requirements at the site of operation.

As regards the norms applicable to international transport by any mode, it is also relevant whether the TNPP, i.e. the reactor, has been pre-tested prior to its export or not. International transport of reactor equipment (‘non-nuclear material’, i.e. non-contaminated, prior to fuelling/testing), and the separate transport of fresh fuel are legally different operations from the transport of a reactor that has been tested, fuelled, or even shut down in a ‘non-operable’ way.

[5] The option of an exclusively national design, construction, deployment and operation of a TNPP is outside the scope of this study.

A–1.6.2. Laws of the host State

The host State, where the TNPP is to be located and operating, has to assume a number of nuclear legal responsibilities regardless of the terms of bilateral agreements concluded with the supplier State and regardless of the 'turnkey' character of the acquisition of the installation.

In particular, the host State is bound by provisions of conventions to which it is a party to establish an appropriate legislative and regulatory framework within its jurisdiction. This includes the responsibility for licensing and control, as appropriate and specific provisions for the 'prime' responsibility of the operator to be established under the laws of the host State.

In relation to that, the host State will also need to establish or designate one or several governmental regulatory authorities.

The host State will probably be encouraged by the supplier State or by the IAEA, if the organization provides and finances legislative or technical assistance, to adhere to a number of international binding instruments of nuclear law, possibly also of international environmental law and law of the sea.

As stated above, the 'infrastructure issues and milestones' listed in Table 1[6] of the Milestones publication [A–4] constitute a useful checklist for the host State, although TNPPs do not conform to the same technical and legal characteristics as non-transportable NPPs and, therefore, do not necessarily require the same legislative and regulatory provisions and authorities.

A–1.6.3. Law of international transport

Transport is an essential and permanent feature of TNPPs, and thus a cross-cutting issue. Both in a separate part and in a number of other contexts as it relates to the jurisdiction of both the supplier and the host, to safety and security, physical protection, safeguards and, in particular, to liability for nuclear damage. A large number of international binding and non-binding norms regulate different aspects of the transport of nuclear material.

A–2. ISSUES OF JURISDICTION

A–2.1. Application of two national jurisdictions

As distinct from a non-transportable nuclear installation, which is sited, constructed, and operated within the same State, a TNPP moves from one national jurisdiction to another through national and international waters or by air/land from one national to another national territory.

General international law and international nuclear law are based on the concepts of national sovereignty and control over all nuclear activities, facilities and material; on the existence of a national legal and institutional framework and a national regulatory authority.

All applicable international instruments of nuclear law affirm the ultimate responsibility of the State for nuclear activities on its territory or under its control.

As formulated in the Preamble of the CNS [A–6], paragraph (iii) "Reaffirming that responsibility for nuclear safety rests with the State having jurisdiction over a nuclear installation."

The Amendment to the Convention on the Physical Protection of Nuclear Material [A–13], 2005, under Article 2A, paragraph 3, provides for a number of Fundamental Principles of Physical Protection of Nuclear Material and Nuclear Facilities generally applicable to TNPPs:

— Fundamental Principle A. Responsibility of the State: "The responsibility for the establishment, implementation and maintenance of a physical protection regime within a State rests entirely with that State."

In the present case, jurisdiction over the TNPP is transferred to the host State after leaving the territory, land or territorial waters, of the supplier State, after transit through international waters or through third States. At the end of its life cycle, or for other reasons, the TNPP returns to the supplier State. These transfers of jurisdiction are

[6] IAEA Nuclear Energy Series No. NG-G-3.1, Table 1, page 8 [A–4].

not the same as a once-and-for-all export of a nuclear installation, but take place in the course of the three phases of the life cycle of a TNPP:

— **First phase:** Jurisdiction of the supplier State: design, construction, testing, fuelling (if before shipment), liability for nuclear damage (for details, see Section A–8), direct transport or transport involving transit through States other than the host State;
— **Second phase:** Jurisdiction of the host State: site selection, deployment and operation (safety, security, safeguards), liability for nuclear damage (for details, see Section A–8) of the TNPP during the time span of its operation;
— **Third phase:** Return to the supplier State of the TNPP and related spent fuel and radioactive waste (the issue of final disposal of radioactive waste is open).

The following issues are to be considered as a consequence of the plurality of applicable jurisdictions:

— Responsibility of the supplier State for all activities undertaken under its jurisdiction and control (i.e. the design, construction, licensing, exporting/transporting State). Applicable national law; licensing of nuclear installations, export controls, return/import of radioactive waste and of spent fuel originating from the exported TNPP, for reprocessing, temporary storage or final disposal. Applicable safeguards provisions.
— Responsibility of the host State for the TNPP (nuclear installation, activities, nuclear material) undertaken under its jurisdiction or control, regardless of selected technical option, i.e. for both land based and barge mounted TNPPs (in the territorial waters of the host State). These responsibilities include the setting up of a national framework for nuclear safety and security, safeguards and liability for nuclear damage.

These responsibilities are a key factor in determining the scope and content of the legislative and regulatory framework required to be established by the host State. In this context, it is relevant whether both the supplier and the host State are contracting Parties to the same international instruments, as international instruments apply only to their respective contracting Parties.

A–2.2. Jurisdiction during TNPP transport

Jurisdiction during transport includes the issue of responsibility/liability of the transport operator (carrier, shipper). Transport is initially of exclusive concern to the supplier State, but will be of concern to the host State, the sender, for the return of the TNPP after completion of its life cycle, and also the return of spent fuel and radioactive waste for final disposal (if applicable). The following legal issues require specific consideration:

— The supplier State, presumably in cooperation with the host State, determines the mode of transport (i.e. rail, river, road or sea) and conforms, as applicable, to the requirements of each mode of transport. This may include approval of vessels, casks, etc. (by the IMO [A–1]), and transit authorizations (as, for instance, when transiting through the territory of the European Union). For the State having jurisdiction regarding a given transport, all provisions apply as set forth in UNCLOS [A–14], the Safety of Life at Sea (SOLAS) Convention [A–15] and IAEA Safety Standards Series No. SSR-6 [A–16];
— The provisions of the Convention on the Physical Protection of Nuclear Material(CPPNM) apply in principle to the supplier State and to the host State, as set forth in its Articles 3, 4, 5, and 6 [A–13];
— The relevant provisions of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [A–7] (Article 27[7], Transboundary Movement of Spent Fuel and Radioactive Waste) also apply in principle to both the supplier State and the host State.

[7] Reference [A–7], Article 27: "1. Each Contracting Party involved in trans-boundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this convention and relevant binding international instruments".

A–3. LEGISLATIVE FRAMEWORK

A–3.1. General considerations

Both the supplier State and the host State need a legislative and regulatory framework commensurate with the legal requirements for TNPP deployment, siting, operation, safety, security, safeguards and relevant transport that reflect the obligations of each State, respectively, under the international treaties and conventions it has ratified.

A–3.2. National legislative and regulatory framework of the supplier and host State

The supplier State (as relevant), will have a legal regime applicable to TNPP design and construction, export of nuclear material and equipment (international nuclear export requirements), return of spent fuel and, in some States, radioactive waste resulting from TNPP operation, and storage and disposal of returned spent fuel and radioactive waste, as applicable.

Regarding the host State, without prejudice to the specificity of the technical options selected, including ‘turnkey’ arrangements, any national nuclear power or energy programme requires the setting up or designation of an appropriate independent, competent and adequately staffed nuclear regulatory body. Effective separation of the regulatory body from the promotional and implementing organization(s) is also required. The tasks, powers and competences of such a regulatory body will, however, differ considerably from those required for a non-transportable NPP.

In this context, there are general principles but no detailed mandatory provisions that apply equally to the regulatory framework of all States, regardless of the scope of their national nuclear programme. However, as stated above, all relevant international instruments, both legally binding and advisory, obligate or strongly encourage States establishing and operating a nuclear programme to avail themselves of an appropriate legislative and regulatory framework. In today’s State practice, model provisions as recommended by relevant IAEA publications, such as GSR Part 1 [A–17], are adopted in domestic legislation.

Therefore, some of the fundamental elements of a regulatory framework[8] listed and described in the Milestones publication [A–4] seem to be flexible enough to apply, as a matter of principle, to the regulatory needs of a TNPP host State (see Section A–1.5).

On the legislative side, the State is obligated to enact specific nuclear legislation that corresponds to its international legal obligations, a consequence of its jurisdiction over the TNPP, taking into account the State’s existing relevant national laws (e.g. laws on radiation protection, on environmental matters, coastal zone, territorial waters).

The host State will further need to adopt a comprehensive or several national nuclear laws which provide for a national commitment to peaceful use of nuclear energy, a commitment to implement all obligations contained in treaties and conventions ratified by the State, and those resulting from other relevant bilateral and multilateral agreements. The basis of such a legislative framework could be established following, as appropriate, the elements set out in the Milestones publication [A–4] (Milestone 1).[9]

A–4. NUCLEAR SAFETY AND RADIATION PROTECTION

A–4.1. General considerations

Safety norms, principles, standards and the binding provisions of the relevant conventions are of relevance during the entire life cycle of a TNPP. This includes all phases of design and construction, deployment[10]/transportation, siting, installation/deployment, and operation. Safety norms are also relevant to the return shipment of the spent fuel and radioactive waste originating from the TNPP, and to final disposal.

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[8] Reference [A–4], paragraph 3.7 and 3.7.1, pages 34 and 35.

[9] Reference [A–4], paragraph 3.5.1, page 30.

[10] Issues of transport safety, including applicable international instruments are covered separately in Section A–7.

Nuclear safety is of concern to the governments of both the supplier[11] and the host States; to the operators (including transport operators) and the stakeholders in general. Also, the norms include environmental protection (as applicable, protection of the marine environment). For the host State, safety requirements apply when the TNPP enters national/coastal waters or national territory (i.e. the jurisdiction of the host State).

However, a turnkey type purchase or similar form of acquisition of a TNPP raises different legal nuclear safety related questions for the host State than does a locally constructed NPP. This applies mainly to the scope of the regulatory infrastructure and legislation required and, more generally, to the preparatory (pre-deployment) phases of the TNPP (e.g. design, site preparation, construction at the factory).

A–4.2. Relevant norms

Two different sets of norms address nuclear and radiation safety:

(a) International legally binding instruments, notably the four nuclear safety related conventions adopted under the auspices of the IAEA. These conventions [A–6, A–7, A–11, A–12] are binding upon the States Parties to these conventions as regards matters set forth in their respective scope of application;
(b) 'Soft law' instruments, primarily the IAEA safety standards, are non-binding, but may become binding for IAEA assisted projects, when adopted as an integral part of national legislation (e.g. regulatory provisions included in a comprehensive national nuclear law), or of an international instrument.

Both sets of norms are addressed primarily to the State. As a general principle, responsibility for establishing a legal framework and the regulatory infrastructure, including the regulatory authority for licensing or authorizing all nuclear facilities or activities undertaken within the jurisdiction of a State, rests with that State. However, within the national legislative system, prime responsibility for safety rests with the operator.[12]

A–4.2.1. International legally binding instruments: Conventions related to nuclear safety

As a rule of international law, conventions apply to their contracting Parties[13], and to the subject matters laid out in the provisions regarding the scope of the convention. These are usually further specified under the definitions of terms used, as provided in each convention. The relevance and applicability of the conventions related to nuclear safety to TNPPs is discussed in brief below.

A–4.2.1.1. Convention on Early Notification of a Nuclear Accident 1986 [A–11]

The convention establishes the obligation for its States Parties to provide notification, in a prescribed manner, of nuclear accidents with actual or potential transboundary effects.

The broad scope of application set forth in Article 1 makes this convention applicable in the present context to both TNPP supplier States and host States and to all related transport operations.

In addition to the general rule of applicability established in paragraph 1, subparagraphs (a), (c) and (d) of paragraph 2 are of specific relevance:

> "1. This Convention shall apply in the event of any accident involving facilities or activities of a State Party or of persons or legal entities under its jurisdiction or control, referred to in paragraph 2 below, from which a release of radioactive material occurs or is likely to occur and which has resulted or may result in an international transboundary release that could be of radiological safety significance for another State.
> "2. The facilities and activities referred to in paragraph 1 are:
> (a) Any nuclear reactor wherever located;
> (b) Any nuclear fuel cycle facility;
> (c) Any radioactive waste management facility;

[11] As stated in the Introduction, this study does not include detailed references to the laws and regulations of the supplier State.
[12] See definition in the IAEA Safety Glossary [A–18], page 137.
[13] The term 'States Parties' is also used synonymously.

(d) The transport and storage of nuclear fuels or radioactive waste;
(e) The manufacture, use, storage disposal and transport of radioisotopes for agricultural, industrial, medical and related scientific and research purposes; and
(f) The use of radioisotopes for power generation in space objects.”

Both the supplier States and the host States of the TNPP should be encouraged to adhere to the convention. In that case, both States would be bound by the provisions of Article 7 that provide for the establishment or designation of a competent authority and points of contact required to comply with the obligations of the convention. Both States might, with reference to Article 9, consider concluding a bilateral arrangement relating to the subject matter of the convention or include these matters in a relevant bilateral agreement.

A–4.2.1.2. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency 1986 [A–12],

This convention establishes a system of cooperation among its State Parties and with the IAEA; it provides for the right of a State Party to request assistance from the IAEA and/or from another State Party in the case of a ‘nuclear accident’ or a ‘radiological emergency’[14] subject to certain conditions and procedures.

The convention would presumably be applicable in the event of an accident involving a TNPP, and both the supplier and the host State should be encouraged to adhere thereto.

A–4.2.1.3. Convention on Nuclear Safety, 1994 [A–6]

General remarks

The question of applicability or non-applicability of the Convention on Nuclear Safety (CNS) to TNPPs by Contracting Parties to that convention cannot be answered by a clear yes or no[15]. The first relevant question is whether or not TNPPs are necessarily ‘nuclear power reactors’. The scope of this convention is narrowed by its definitions, not to apply generically to ‘nuclear safety’. In fact, the precise wording of the provision regarding the scope of application of the convention would appear to limit its applicability exclusively to land based civil nuclear power plants.

However, there may be room for arguments that could support, under certain circumstances, the inclusion of TNPPs in the scope of application of the CNS as set forth in Article 3, notably if and when a TNPP can be assimilated to a nuclear installation as covered by that convention.

The following provisions of the CNS are relevant to this question:

— Preamble, paragraph (viii) states:

“Recognizing that this Convention entails a commitment to the application of fundamental safety principles for nuclear installations rather than of detailed safety standards and that there are internationally formulated safety guidelines which are updated from time to time and so can provide guidance on contemporary means of achieving a high level of safety;”

This phrase is meant to reflect the fact that the Fundamental Safety Principles [A–19] — published first in 1993, just before the convention was formally adopted —are a basic source for the substantive provisions of the CNS. It also means that safety guidelines, as all technical documents, are updated from time to time so as to provide current and relevant advice.

[14] These terms are not defined in the convention to allow for broad definition.

[15] Interpretation of the provisions of any convention is a prerogative of the Contracting Parties only. Conventions normally contain dispute settlement procedures.

— Preamble, paragraph (x):

"Recognizing the usefulness of further technical work in connection with the safety of other parts of the nuclear fuel cycle, and that this work may, in time, facilitate the development of current or future international instruments."

This phrase reflects the intention of the drafters to limit the scope of the CNS to matters laid out in Article 3 and defined in Article 2, paragraph (i).

— Article 3: Scope of application of the CNS: "This Convention shall apply to the safety of nuclear installations."
— Article 2, paragraph (i): The term *nuclear installation* is defined "for the purpose of the convention" as follows:

"'Nuclear installation' means for each Contracting Party any land-based civil nuclear power plant under its jurisdiction, including such storage, handling and treatment facilities for radioactive material as are on the same site and are directly related to the operation of the nuclear power plant..."

This definition unambiguously reflects the fact that the provisions of this convention cover no other installation of the fuel cycle, notably no waste management related or reprocessing plant, as had initially seemed desirable to some States during the negotiations.

Applicability of the CNS to TNPPs when located/sited in a Contracting Party

In the light of the provisions cited above, the CNS, which is carefully formulated in a restrictive manner, would not seem to be applicable ipso iure to TNPPs. This is without prejudice to the fact that the IAEA Fundamental Principles and Requirements [A–2] are fully applicable to both the exporting (TNPP designing and constructing) State and to the importing State (see above, Preamble, paragraph (viii)).

The specific obligations of each contracting Party under the CNS, notably the substantive safety provisions, i.e. as different from the reporting obligations under the convention laid out in Articles 5 and 20, are based on and are, thus, analogous to the safety standards. In the convention, however, these 'fundamental principles' are formulated in terms of binding obligations addressed to the States Parties for implementation within the framework of their respective national law (Article 4).

Moreover, if the TNPP is not designed for nuclear power but for non-power applications, the primary purpose of such a TNPP being to produce energy to serve industrial/chemical applications other than electrical power, there does not appear to be any common denominator between a TNPP and a land based civil NPP according to the definition of a 'nuclear installation' provided by the CNS.

A–4.2.1.4. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, 1997 [A–7]

The Joint Convention was drafted after the adoption of the CNS [A–6] for the main purpose of developing international binding norms to cover the safety of spent fuel and of radioactive waste management, matters that had been specifically excluded from the scope of the CNS. The question as to whether the Joint Convention is applicable to TNPPs is, therefore, somewhat different from the question of applicability of the CNS.

Pursuant to Article 3: Scope of Application, the Joint Convention applies to "the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors" (paragraph 1) and also to the "safety of radioactive waste management when the radioactive waste results from civilian applications" (paragraph 2).

The definitions of the terms as used in the Joint Convention, notably Article 2 (i) and (j), radioactive waste management and radioactive waste management facility, and (o) and (p) spent fuel management and spent fuel management facility exclude off-site transportation and cover only relevant 'primary purpose' facilities.

The main obligations of the Joint Convention are of concern to Contracting Parties that are responsible for "the safety of spent fuel management" resulting from the operation of civilian nuclear reactors, and for "the safety of radioactive waste management" under the same conditions. Other Contracting Parties, notably those located in the vicinity of such radioactive waste/spent fuel management facilities are entitled to be consulted, provided with general relevant data, and more generally, the "contracting Parties shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other contracting Parties" (see Articles 13.1(iv) and 13.2, Siting of Proposed Facilities).

In the present case, and in the light of the preferred technical options, the supplier State will be in charge of the reprocessing, of the radioactive waste management and if agreed, of the radioactive waste and spent fuel disposal. Therefore, the supplier State is bound by the obligations of the Joint Convention.

The host State, in accordance with the technical options of TNPPs laid out in of the report, is concerned with obligations for the safe management of the radioactive waste and spent fuel located on the site. As noted in the previous subsection (CNS), however, all general safety recommendations provided by the relevant safety standards are applicable.

Nevertheless, the Joint Convention is not irrelevant to the TNPP project as the convention addresses a number of international legal issues that may have a bearing on the deployment of TNPPs. This is notably the case for the Preamble and the provisions of Article 27.

The Preamble of the Joint Convention reads:

— Paragraph (vi), "Reaffirm[ing] that the ultimate responsibility for ensuring the safety of spent fuel and radioactive waste management rests with the State";
— Paragraph (vii), "Recognizing that the definition of a fuel cycle policy rests with the State";
— Paragraph "(xi), "Convinced that radioactive waste should, as far as is compatible with the safety of the management of such material, be disposed of in the State in which it was generated, whilst recognizing that, in certain circumstances, safe and efficient management of spent fuel and radioactive waste might be fostered through agreements among contracting Parties to use facilities in one of them for the benefit of the other Parties, particularly where waste originates from joint projects."

As in the case of the CNS, the Preamble to the Joint Convention (in paragraph (xiv)) refers to the principles contained in the IAEA Safety Fundamentals, the Principles of Radioactive Waste Management [A–19] and in the international standards relating to the safety of transport of radioactive material.

The Joint Convention also bears relevance on issues related to the transport of radioactive waste and spent fuel. Article 27, paragraph 1 (i)–(v), of the Joint Convention sets forth a number of obligations incumbent upon contracting Parties involved in 'transboundary movement' (including the State of origin, the State of transit and the State of destination of such transboundary movement).

Article 27, paragraph 3, uniquely protects the rights of each Contracting Party "to export its spent fuel for reprocessing" (3.iii) and the rights of a Contracting Party to which radioactive waste/spent fuel is exported for (re) processing, to return the radioactive waste and other products after treatment to the State of origin (3.(ii) and (iv).

Summing up, in the case of TNPPs the Joint Convention applies mostly to the supplier State. Regarding the host State, it should in any case be encouraged to adhere to the Joint Convention in view of the conventions' exclusive competence for matters of safe management of radioactive waste and spent fuel, and in case the final disposal site of the waste and spent fuel is located in the host State.

A–4.2.2. 'Soft law' instruments: General relevance

Non-binding instruments setting forth detailed requirements and guidelines apply to activities undertaken both by the supplier and the host States. The common denominator is the set of Fundamental Safety Principles and Safety Requirements, which constitute the substantive basis of national nuclear laws and regulations as well as of the safety related international instruments.

The flexibility of the Fundamental Principles and also of the Safety Requirements allows for their case-by-case application, as required, by the supplier and the host State, and also makes them applicable to innovative technical developments that might not have been considered at the time of drafting.

These are, notably:

- Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1, 2010 [A–17];
- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR – Part 3 (Interim), 2011 [A–20];
- Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, 2006 [A–19];
- Regulations for the Safe Transport of Radioactive Material, 2012 Edition, IAEA Safety Standards Series No. SSR-6; Safety of Nuclear Power Plants: Design, Specific Safety Requirements, IAEA Safety Standards Series No. SSR-2/1; and Safety of Nuclear Power Plants: Commissioning and Operation, IAEA Safety Standards Series No. SSR 2/2 [A–16, A–21, A–22];
- Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-R-2, 2002 [A–23].

In the context of TNPPs, there do not seem to be obstacles to the application of selected[16] provisions of safety standards by supplier and host States as appropriate to the technical requirements of TNPPs. IAEA Safety Standards Series No. GSR Part 1 [A–17] states:

> "The government shall establish a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety principles established in the Safety Fundamentals"[17].

This flexibility of case-by-case application of individual safety norms is, however, not legally permissible as regards international legally binding instruments (i.e. treaties and conventions).

A–4.2.3. 'Soft law' instruments: Relevance of specific IAEA publications

A–4.2.3.1. Fundamental Safety Principles, SF-1, 2006 [A–19]

The scope of the IAEA Fundamental Safety Principles is defined as follows:

> "The safety principles are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes…".

As concerns TNPPs, these Fundamental Safety Principles and their objectives apply to the supplier State within its existing national legal framework, and to the host State within a national legal framework to be established as needed for a TNPP. The Fundamental Safety Principles are[18]:

- Principle 1: "The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks";
- Principle 2: "An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained";
- Principle 3: "Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks";
- Principle 4: "Justification of facilities and activities" — "Facilities and activities that give rise to radiation risks must yield an overall benefit";
- Principle 5: "Optimization of protection" — "Protection must be optimized to provide the highest level of safety that can reasonably be achieved";

[16] It is important to select the provisions which are applicable and not the ones one would like to choose.
[17] Reference [A–17], Requirement 1: National policy and strategy for safety.
[18] Reference [A–19], pages 6 to 14.

— Principle 6: “Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm”;
— Principle 7: “Protection of present and future generations” — “People and the environment, present and future, must be protected against radiation risks”;
— Principle 8: “Prevention of accidents” — “All practical efforts must be made to prevent and mitigate nuclear or radiation accidents”;
— Principle 9: “Emergency preparedness and response” — “Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents”;
— Principle 10: “Protective actions to reduce existing or unregulated radiation risks must be justified and optimized”.

A–4.2.3.2. Governmental, Legal and Regulatory Framework for Safety, General Safety Requirements Part 1, 2010 [A–17]

In Ref. [A–17], the following main provisions are relevant to the host State:

— Legislation: “Where several authorities have responsibilities for safety within the regulatory work for safety, the responsibilities and functions of each authority shall be clearly specified in the relevant legislation” (paragraph 2.4);
— Regulatory functions: “The performance of regulatory functions shall be commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach”;
— Inspection and enforcement: “Inspections of facilities and activities shall be commensurate with the radiation risks associated with the facility or activity, in accordance with a graded approach. The regulatory body shall record the results of inspections and shall take appropriate action (including enforcement actions as necessary”.

A–5. ISSUES RELATED TO THE NUCLEAR FUEL CYCLE

The desirability of expanding the fuel cycle on a multilateral basis, ranging from enrichment and reprocessing to the setting up of regional repositories for spent nuclear fuel and radioactive waste, has reentered the international agenda since the beginning of the 21st century. In 2005, the IAEA published a report by an international expert group on multilateral approaches to the nuclear fuel cycle [A–24] and other publications on the topic [A–25]. In particular, the subject of assurance of the nuclear fuel supply and international nuclear fuel cycle centres has been further developed through a number of specific proposals submitted by individual States, groups of States and non-governmental organizations.[19] These mechanisms, as might be available in the foreseeable future, could also be considered by the supplier and host States, parties to a TNPP deployment and operation agreement. The concept of ‘fuel leasing’ is also under discussion and may be relevant for the fuel supply of TNPPs.

[19] See, notably, INFCIRC/659, 2005, USA Proposal for Reserve of Nuclear Fuel; INFCIRC/667, 2006, Statement on the Peaceful Use of Nuclear Energy, Proposal by the Russian Federation; Concept for a Multilateral Mechanism for Reliable Access to Nuclear Fuel, France, Germany, Netherlands, Russian Federation, UK and USA (GOV/INF/2006/10, June 2006); IAEA Standby Arrangements System for the Assurance of Nuclear Fuel Supply, by Japan, INFCIRC/683, 2006; Nuclear Threat Initiative: Contributions to Create a LEU Stockpile Owned and Managed by the IAEA (September 2006); for all INFCIRCs see Ref. [A–26]. For a detailed analysis of the proposals and relevant IAEA statutory mandates, see Ref. [A–27]; for the IAEA Fuel Bank see: http://www.iaea.org/OurWork/ST/NE/NEFW/Assurance-of-Supply/iaea-leu-bank.html

A–6. NUCLEAR SECURITY ISSUES: PHYSICAL PROTECTION OF NUCLEAR MATERIAL AND NUCLEAR FACILITIES

A–6.1. General considerations

International legal norms, both legally binding conventions and ‘soft law’, i.e. recommendations, notably INFCIRC/225/Rev.5 [A–28] as amended[20] from time to time, are now of quasi-universal validity as regards physical protection of nuclear material and nuclear facilities. The CPPNM [A–13] results from the early recognition of the need for worldwide cooperation between States to ensure adequate physical protection of potentially hazardous nuclear material during international transport.

In the present context, the CPPNM and INFCIRC/225/Rev.5 are of immediate relevance to the supplier State, the host State and the transport of TNPPs, i.e. the initial transport of a TNPP, transport of fresh fuel, as applicable, and spent fuel, and return of the spent fuel, radioactive waste and, as applicable, the decommissioned TNPP to the supplier State.

At present, the CPPNM and its 2005 Amendment [A–29] are the essential international legally binding instruments[21] that provide, in addition to specific norms regarding the physical protection of defined nuclear material, for *nuclear security* as defined by the IAEA, i.e. “the prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, or other radioactive substances or their associated facilities.”[22]

The provisions of the CPPNM, of its the 2005 Amendment and of INFCIRC/225/Rev.5 apply to TNPPs regardless of technical or other options. Applicability of the first two instruments is, however, subject to both the supplier and the host States being contracting Parties thereto.

A–6.2. Convention on the Physical Protection of Nuclear Material: Applicability to TNPPs

A–6.2.1. Convention on the Physical Protection of Nuclear Material, 1980 [A–13]

Contrary to the safety conventions discussed above that have a limited scope and apply to certain activities or facilities only, defined in a restrictive manner, the provisions of the CPPNM [A–13] relating to physical protection apply without restriction, pursuant to its Article 2, to *nuclear material* (as defined in the CPPNM in Article 1 (a) and (b)) used for peaceful purposes while in international nuclear transport (as defined in the CPPNM, Article1 (c)). Nuclear material is defined in Article 1 (b) as “uranium enriched in the isotope 235 or 233”.

The CPPNM also provides specific requirements regarding the levels of protection corresponding to the Categorization of Nuclear Material (see Annex II of the CPPNM). Nuclear material is categorized as I, II and III for the purpose of the requirements of physical protection during transport. Specified requirements are established for the three categories of nuclear material as related to the mode of transport. The categorization is based on the following approach:

> “The primary factor for determining the physical protection measures against unauthorized removal of nuclear material is the nuclear material itself” (see INFCIRC/225/Rev.5, Section 5.2.1).

The scope of application of the provisions of the CPPNM relating to physical protection is limited to international transport. Certain provisions, however, also apply to nuclear material used for peaceful purposes while in domestic use, storage and transport[23].

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[20] INFCIRC/225/Rev. 5 has been published as IAEA Nuclear Security Series No. 13, http://www-pub.iaea.org/MTCD/publications/PDF/Pub1481_web.pdf

[21] See also the International Convention for the Suppression of Acts of Nuclear Terrorism, 2005 [A–30].

[22] See IAEA GOV/2005/50 [A–31], and the IAEA Safety Glossary [A–18], p. 133.

[23] Though physical protection of nuclear material while in domestic use, storage or transport was considered a strictly national responsibility, not subject to international binding rules, Article 2, paragraph 2 of CPPNM provides that, with exception of Articles 3 and 4, the convention also applies to nuclear material used for peaceful purposes while in domestic use storage and transport. This provision is, however, again restricted by paragraph 3 stating that “nothing in this Convention shall be interpreted as affecting the sovereign rights of a State regarding the domestic use, storage and transport of such nuclear material.”

A–6.2.1.1. Obligations of States Parties

The CPPNM provides for two different types of obligations for the State Party. Regarding TNPPs, the following provisions would apply to both the supplier State and the host State:

(a) Provisions of Article 3 and 4 on the protection of the nuclear material, conditions for export, import, transit of the material (to ensure that during international transport, nuclear material is protected at "levels described in Annex I");
(b) The provisions of Article 5 ("cooperation of States Parties in the event of an unlawful act and response operations") and of Articles 7 to 13, which set forth in terms of criminal law, the definition of offences (Article 7.1 (a) to (g) and Article 7.2) and oblige the State Party to make the offences . . ."punishable by appropriate penalties";
(c) Article 8 obliges the State to establish jurisdiction over the offence (both territorial jurisdiction and personal jurisdiction), relevant in a case of non-extradition of an alleged offender; in addition, when the State Party is involved in international nuclear transport as the exporting or importing State, it may also establish its jurisdiction.

A–6.2.2. Amendment to the CPPNM, 2005 [A–29][24]

A–6.2.2.1. General remarks

Since the first Review Conference of the CPPNM [A–13] in 1992, the need has been discussed to amend the convention in order to broaden its scope to physical protection of nuclear installations and during domestic transport so as to further strengthen the international physical protection regime. Work on the Amendment began in 2001, and it was adopted in 2005.

A–6.2.2.2. Objectives of the 2005 Amendment[25]

The Preamble of the convention recalls the Declaration on Measures to Eliminate International Terrorism, annexed to United Nations General Assembly resolution 49/60 of 9 December 1994 [A–33][26] and thereby establishes the link between physical protection, safety, non-proliferation objectives and counter-terrorism measures.[27] The Preamble also refers in substance to INFCIRC/225 [A–28]:

- "Physical protection is of vital importance for the protection of public health, safety, the environment and national and international security;
- Physical protection plays an important role in supporting nuclear non-proliferation and counter-terrorism objectives;
- There are internationally formulated physical protection recommendations that are updated from time to time which can provide guidance on contemporary means of achieving effective levels of physical protection."
- Excluded from the scope of the convention is "effective physical protection of nuclear material and nuclear facilities used for military purposes" which is "a responsibility of the State possessing such material and nuclear facilities."

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[24] Adopted on 8 July 2005, not yet in force (needs ratification by two thirds of the States Parties to the CPPNM).

[25] The Physical Protection Objectives and Fundamental Principles were prepared by the Secretariat in cooperation with experts from Member States pursuant to a recommendation of the Working Group of the Informal Open-ended Expert Meeting, 1999, to "discuss whether there is a need to revise the convention". In 2001, the Objectives and Fundamental Principles were endorsed for publication as a Security Fundamentals publication [A–32]. They do not replace INFCIRC/225 (Rev. 4 (corrected)) [A–28] or its current revision.

[26] Later, United Nations General Assembly resolution 51/210 adopted 17 December 1996 [A–34] urged all States. "to consider as a matter of priority becoming parties to ... the Convention on the Physical Protection of Nuclear Material, signed in Vienna on 3 March 1980".

[27] The Preamble supports herewith the cross-cutting approach to nuclear security adopted by the IAEA.

Article 2A, paragraph 3 lists a number of Fundamental Principles of Physical Protection of Nuclear Material and Nuclear Facilities[28] which each State Party "shall apply insofar as is reasonable and practicable.…"

A–6.2.2.3. Applicability[29] of the 2005 Amendment to TNPPs [A–29]

Compared to the CPPNM [A–13], the scope of the 2005 Amendment [A–29] has been expanded to include 'nuclear facilities' and domestic use, storage and transport. The new provisions added and the expanded scope does not affect CPPNM applicability to TNPPs.

The convention stresses the sovereign rights of States Parties and their concomitant responsibilities*:* "The responsibility for the establishment, implementation and maintenance of a physical protection regime within a State Party rests entirely with that State." (Article 2, paragraph 2):

— "Apart from the commitments expressly undertaken by States Parties under this Convention, nothing in this Convention shall be interpreted as affecting the sovereign rights of a State" (Article 2, paragraph 3).

In the TNPP context, responsibility for physical protection would be incumbent upon the supplier State and the host State within the limits of their respective sovereignty.

The Amendment expands the scope of the convention (Article 2) to include nuclear material used for peaceful purposes in use, storage and transport (Articles 3 and 4 and paragraph 4 of Article 5 apply only to nuclear material while in international transport) and adds *nuclear facility[ies]* (defined in Article 1), to which the Amendment also applies.

The definition of the term *nuclear facility* is of special relevance to TNPPs*:*

— "(d) nuclear facility means a facility (including associated buildings and equipment) in which material is produced, processed, used, handled, stored or disposed of, if damage to or interference with such facility could lead to the release of significant amounts of radiation or radioactive material."

This term does not refer to the activity conducted in the facility (in technical terms, e.g. electricity production) but is determined by the material used in such a facility that, under certain circumstances, could "lead to the release of significant amounts of radiation or radioactive material".

It is, therefore, applicable to the TNPP, for States that adhere to the 2005 Amendment.

Also, a number of new elements of criminal law have been added: definition of extraditable offences and further details on extradition rules, mutual assistance and increased cooperation of the States Parties in law enforcement (Article 7, paragraph 1).

The offence of *sabotage* is also added (Article 1):

— "(e) "Sabotage" means any deliberate act directed against a nuclear facility or nuclear material in use, storage or transport which could directly or indirectly endanger the health and safety of personnel, the public or the environment by exposure to radiation or release of radioactive substances."

A–6.3. Non-binding international documents: The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev. 5 [A–28]

Published since 1975 and regularly reviewed, this document is addressed to States and recommended for their use as required in their physical protection systems. It refers to the CPPNM [A–13] and sets forth the principles of physical protection to be realized through administrative and technical measures, including physical barriers.[30]

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[28] See, notably, Fundamental Principles [A–32]: A: Responsibility of the State; B: Responsibility During International Transport; C: Legislative and Regulatory Framework; D: Competent Authority; E: Responsibility of the Licence Holders; F: Security Culture; G: Threat; H: Graded Approach; I: Defence in Depth; J: Quality Assurance; K: Contingency Plans; L: Confidentiality.

[29] Note: The 'applicability' of the Amendment to TNPPs is discussed here without prejudice to the fact that the 2005 Amendment has not yet entered into force.

[30] INFCIRC/225/Rev. 5, page 1 [A–28].

As a non-binding document, INFCIRC/225/Rev.5 can be applied, as required, to the physical protection system of a State. It can also be incorporated into national law or bilateral or multilateral agreements covering physical protection of nuclear material. It is, therefore, applicable to both the supplier and the host State of a TNPP, notably, of course, in the context of international transport[31].

A–6.4. Agreements between States

INFCIRC/225/Rev. 5 [A–28] envisages the establishment of agreements and conventions on cooperation between States for the protection of international (and national) transport of nuclear material, the transfer of responsibility for physical protection from the sending State to the receiving State and assistance in the recovery of that material if needed. This recommendation could be applied, as appropriate, by the supplier and the host States of a TNPP.

A–7. LEGAL FRAMEWORK FOR TRANSPORT OF TNPPs

A–7.1. General considerations

Most legal issues related to transport of the TNPPs are interconnected with other legal aspects of the entire life cycle of TNPPs. Transport of nuclear material is covered by a network of laws, regulations, technical norms, international treaties and agreements that apply to a particular mode of transport, (air, sea, rail transport) or to the legal requirements of a particular State or group of States (e.g. transport from or to, or transit through the European Union). To a large extent, nuclear transport is also regulated by bilateral intergovernmental or inter-company (transport) agreements concluded between the parties for single or multiple transports, and subject to the provisions of applicable binding international law.

A–7.2. Safety of transport versus security of transport

A–7.2.1. Safety of transport

The safety of international transport of nuclear material in general and in the TNPP context raises different legal and technical questions from those related to the security of transport. Safety is achieved and maintained by compliance by the consignor/operator (compliance assurance is given by the competent authority) with certain, strictly defined technical conditions regarding packages and containment systems to be established from the start of a particular transport and maintained to the end of the international transport regardless of national territories or international space crossed (e.g. open sea, international air space, international rivers, straits) and regardless of the mode of transport. For transport of a TNPP, in as much as it is nuclear material, the IAEA Transport Regulations [A–16] are valid and apply to all modes.

The initial transport of a non-fuelled, non-tested (and non-contaminated) TNPP from the supplier State to the host State will not constitute a nuclear material transport, but rather the transport of further defined industrial equipment. In this case, the provisions of the IAEA Transport Regulations [A–16] would not necessarily apply.

The IAEA safety standards [A–2] and the Class 7[32] United Nations Economic and Social Council (ECOSOC) standards [A–36] are incorporated into national laws and adopted as binding norms for carriers through the International Civil Aviation Organization (ICAO) [A–37], the International Air Transport Association (IATA) [A–38], and the International Maritime Organization (IMO) [A–1] conventions, as well as the rail and road regional transport treaties and agreements. They apply regardless of the mode of transport applicable to the deployment of a TNPP.

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[31] See also the Handbook on the Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, IAEA, Vienna (2002) [A–35].

[32] Class 7 radioactive material in the UN transport related classification of dangerous goods (9 items) [A–38].

A–7.2.2. Security of transport

Nuclear security is also a function of the properties of the nuclear material transported and depends on the law(s) applicable to the given national territory(ies), to international airspace or sea transited by the transport, and the mode of transport used (international air law, law of the sea, etc.).

In general terms:

— Any sovereign State from which, through or to which nuclear material (e.g. a TNPP) is transported is responsible within its own legal order for the security of that particular transport. TNPPs are transported from the territory of the supplier State to the host State, possibly transiting through the territories of third States (vice versa for the return of a TNPP, either temporarily for refurbishing or final). Nuclear security is a concern to all the involved States.

— Transport through open seas, international waterways, open airspace, is regulated by general international law.

— Transport through coastal zones, straits, lakes or inland waterways belonging to different States is regulated, in addition to general international law, by treaties and agreements concluded between those States (e.g. Convention on the Navigation on the Rhine[33], Danube Commission[34]).

— States involved in nuclear transport normally conclude agreements on a bilateral or multilateral level regarding the security of one or several transport operations covering transborder crossing and shipments through international waters or airspace (e.g. agreements concluded between two States regarding the international shipment for reprocessing, and for return of resulting radioactive waste to the waste generating State).

However, the scope for generally applicable binding security norms is rather limited, as opposed to that of the safety standards. The specificity of each type of transport, or even each individual transport of nuclear material has to be taken into account.

As analysed above, the only system of international norms applicable exclusively to the security — in addition to the physical protection of nuclear material — are set forth in the CPPNM [A–13], its 2005 Amendment [A–29] and the recommendatory INFCIRC/225/Rev.5 [A–28]. In view of the large number of States Parties to the CPPNM, these norms have quasi-universal validity.

The *physical protection* prescribed by the CPPNM and its 2005 Amendment applies to material as defined in the CPPNM[35].

The recommendations for the physical protection of nuclear material issued as INFCIRC/225/Rev. 5 [A–28] contain specific Requirements for Physical Protection of Nuclear Material During Transport, covering also material in use or storage. As a non-binding instrument[36], this set of recommendations is applicable to all States that decide to apply it.

A–7.2.2.1. Security at sea

Law of the sea has historically been concerned with maintenance of the safety and security of international navigation and has created a system of norms, controls and law enforcement mechanisms. Nuclear and other hazardous material is specifically addressed in some instruments.

In this context, the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation of 1988 [A–39] and its complement, the Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf of 1988 [A–40] are instruments concerned with security at sea in general terms. The 2005 revisions of the Convention and its Protocol, which entered into force on 28 July 2010 include ‘nuclear material’ (defined with reference to the IAEA Statute [A–41]) covered under the scope of application, and are thus of direct relevance to the transport of TNPPs.

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[33] Revised Convention for Rhine Navigation: http://www.ccr-zkr.org/Files/convrev_e.pdf

[34] Donaukommission: http://danubecommission.org/

[35] CPPNM [A–13], Article 1 (a) “nuclear material”; (b) “uranium enriched in the isotope 235 or 233”; (c) “international nuclear transport”.

[36] INFCIRC/225/Rev. 5, Section 3.2(a) [A–28].

The original purpose of these instruments is to ensure that appropriate action is taken by the competent State or in cooperation between several States concerned, against persons committing specified unlawful acts against ships (and fixed platforms). Offences include seizure of ships by force, acts of violence against persons on board ships, the placing of devices on board a ship that are likely to destroy or damage it. The Preamble to the 2005 Protocol to the Convention of 1988 [A–42] recalls UN Security Council resolution 1540 (2004) [A–43], which assigned States the responsibility of taking "additional effective measures to prevent the proliferation of nuclear, chemical or biological weapons and their means of delivery". The Convention of 1988 obligates States Parties to make such crimes punishable under their national laws, to establish relevant jurisdiction and to prosecute or extradite alleged offenders. The Convention of 1988 also provides for specific modes and detailed procedures of cooperation between its States Parties.

The Protocol of 2005 [A–42] to the convention of 1988 [A–40] was adopted by the IMO's International Conference on the Revision of the Suppression of Unlawful Acts (SUA) Treaties in November 2005 for the purpose of expanding the coverage so as to include nuclear material in peaceful and non-peaceful uses. The national authorities concerned with the implementation of the convention/protocol are those responsible for law enforcement in the maritime context rather than national nuclear authorities or regulators.

A–7.2.2.2. Other relevant international binding instruments

The following international instruments include security of transport of nuclear material.

International Convention for the Suppression of Acts of Nuclear Terrorism 2005 [A–30][37]

This convention [A–30] covers broadly defined categories of nuclear material ('radioactive material'; 'nuclear material'; 'uranium enriched in the isotope 235 or 233', 'nuclear facility' and 'device'). It covers also 'conveyance' used for transport of nuclear material (see Article 1.3 (b)) The main purpose of the convention is to obligate States Parties to establish as criminal offences under its national law, the offences set forth in Article 2[38] of the convention and to make these offences punishable; to prosecute or extradite alleged offenders, and to cooperate in matters related to the implementation of the convention. The convention does not cover physical protection and does not define security of the material covered, but is limited to the implementation by the States Parties of specific measures of national and international criminal law. Other provisions address the need for cooperation between interested States, cooperation with the IAEA and adherence to the IAEA's security publications.

International Convention for the Suppression of Terrorist Bombings, 1997 [A–44][39]

The relevance of the International Convention for the Suppression of Terrorist Bombings, 1997 [A–44] to TNPPs needs to be carefully examined. The convention covers such 'terrorist' acts (i.e. Article 2) as discharge or detonation of an explosive or other lethal device when committed during transport (Article 1, paragraph 2 defines 'infrastructure facility' so as to include 'communications'). The convention covers *explosive or other lethal device(s),* including a weapon or device capable of causing damage through the release of radiation or radioactive material.

The main purpose of the convention is to obligate States Parties to enact legislation establishing the offences set forth in Article 2 of the convention as criminal offences, to establish jurisdiction over these offences, to

[37] The convention [A–30] was adopted by the UN General Assembly in 2005 and entered into force 2007.

[38] Article 2 lists the offences committed in relation to the material defined.

[39] The convention [A–44] was adopted in 1997, entered into force in 2001, and has over 160 States Parties. It was elaborated under UN auspices. The issue of terrorist bombing as a threat to the international community was first presented by the United States at the Ministerial Conference on Terrorism convened in July 1996 in Paris under the auspices of the Group of Seven. Thereafter, a group of national experts prepared for submission to the UN General Assembly a draft international convention on the Suppression of Terrorist Bombings. This text became the substantive basis of the Ad Hoc Committee's negotiations. The convention sets forth certain defined criminal offences, including crimes committed with the use of an "explosive or other lethal device" that can cause death through the "release, dissemination or impact of radiation or radioactive material", which are to be prosecuted by the States Parties to the convention. By international agreement, these crimes are considered 'international' crimes.

cooperate between the States Parties in matters of exchange of information on criminal procedure, or on extradition procedures of alleged offenders.

A–7.2.3. Main issues[40] of the maritime transport of nuclear material

The main international binding legal instrument applicable to the transport of TNPPs is the United Nations Convention on the Law of the Sea, 1982 (UNCLOS) [A–14]. As an instrument of general international law it is, therefore, of general applicability to TNPPs.

The instruments of specific applicability to nuclear material are the International Maritime Dangerous Goods Code (IMDG Code) [A–45] of the IMO [A–1], which includes the IAEA Transport Regulations [A–16]. And, attached thereto, is the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code), 1999 [A–46].

Regarding the norms of international law set forth in UNCLOS [A–14], a number of basic principles are of relevance to TNPP transport. The international principle of 'freedom of the high seas' as expressed in Article 87: "The high seas are open to all States, whether coastal or land-locked", and the "Right of navigation" in Article 90: "Every State, whether coastal or land-locked, has the right to sail ships flying its flag on the high seas."

Freedom of navigation on the high seas is completed by the regime applicable to the territorial sea and to contiguous zones, which protect the interests of the coastal States, but at the same time also protect the right of 'innocent passage'. Again, there are general rules and norms specific to nuclear transport/vessels:

UNCLOS

— Article 2 provides as a general rule: "1. The sovereignty of a coastal State extends, beyond its land territory and internal waters …to an adjacent belt of sea, described as the territorial sea".
— Article 17: " Subject to this Convention, ships of all Sates, whether coastal or land-locked, enjoy the right of innocent passage through the territorial sea".
— Article 19, paragraph 1,"Meaning of Innocent passage": "Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State".
— Article 26 defends the principle of innocent passage, by providing that: "1. No charge may be levied upon foreign ships by reason only of their passage through the territorial sea."

As regards the rules presumably applicable to TNPPs, the convention establishes a lex special is, which sets forth exceptions to the general rule that amount to specific restrictions:

— Article 23, Foreign nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances: "Foreign nuclear-powered ships and ships carrying nuclear or other inherently dangerous or noxious substances shall, when exercising the right of innocent passage through territorial sea, carry documents and observe special precautionary measures established for such ships by international agreements."

Mention must also be made of the provisions of the UNCLOS [A–14] regarding the concept of 'contiguous zone' (see Article 33); the rules applicable to straits used for international navigation (see Article 34); the right of transit passage (see Article 38); the duties of ships and aircraft during transit passage (see Article 39); and exceptions to the rule of innocent passage (see Article 45).

[40] See also Section A–8, Nuclear liability aspects.

A–8. NUCLEAR LIABILITY ASPECTS

A–8.1. General remarks

From the early days of the industrial use of nuclear energy, it was recognized that the ordinary rules of civil liability would not be appropriate to protect the public and the environment effectively against the specific hazards associated with this new source of energy. Accordingly, most governments concerned adopted a series of international conventions or domestic legislation with a view to ensuring adequate compensation for damage likely to result from the operation of nuclear installations or occurring during the transport of nuclear material.

This special regime of liability, financial security and indemnification applies generally to land based (stationary) nuclear reactors and other large installations within the nuclear fuel cycle and also to transport operations. While the rules governing the liability of nuclear operators are described in detail in the specialized legal literature, they have been summarized for the purpose of this study in Section A–8.2.

As they clearly belong to the family of nuclear installations, there is no doubt that TNPPs should be subject to the nuclear liability regime. However, their design and intended mode of operation present several original features which deserve particular attention and will be examined in this study, in particular in light of the scope of application of the applicable international conventions.

A first step will be to consider the particular technical and operational features of TNPPs from the angle of this regime and to determine to what extent they are relevant for its implementation. Then, on the basis of this preliminary analysis, selected aspects of the nuclear liability regime will be reviewed, with special attention paid to those which may affect the operation of TNPPs.

Besides the application of the nuclear liability regime, the question of the insurability of TNPPs will be a key factor for their future operation and, for this reason, it will also be addressed in brief. This aspect may, however, need to be further studied at a later stage.

This analysis starts from the general assumption that a special system of liability of nuclear operators should apply to TNPPs as opposed to the ordinary law of tort, and that it should be based on either existing relevant international conventions or domestic legislation in line with the basic principles of these conventions.

A–8.2 General principles underlying the international nuclear liability regimes

One important characteristic of this regime is that it was established by a series of international conventions, the first concluded in the 1960s at the time of the development of the peaceful uses of nuclear energy and later, following the Chernobyl accident, in a second phase of modernization and consolidation of the regime[41]. The nuclear liability regime is intended to reconcile two distinct objectives:

— To provide adequate compensation to victims for damage caused by a nuclear accident;
— To avoid imposing an excessive financial burden on the operators of nuclear installations.

This explains why this special liability regime derogates whenever necessary from the ordinary rules of civil law.

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[41] In chronological order of their adoption, these instruments are the:
- 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy (amended in 1964 and 1982; in force since 1968) [A–47].
- 1963 Brussels Convention Supplementary to the Paris Convention (amended in 1964 and 1982; in force since 1974) [A–48].
- 1963 Vienna Convention on Civil Liability for Nuclear Damage (in force since 1977) [A–49].
- 1971 Brussels Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material (in force since 1975) [A–50].
- 1988 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (in force since 1992) [A–51].
- 1997 Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (in force since 2003) [A–52].
- 1997 Convention on Supplementary Compensation for Nuclear Damage (not in force) [A–53].
- 2004 Protocols amending respectively the Paris Convention and the Brussels Supplementary Convention on Nuclear Third Party Liability (not in force) [A–54, A–55].

A–8.2.1. Strict liability

Considering the significant hazards associated with large nuclear installations, a license to operate such installations cannot be granted unless the nuclear operator concerned has assumed a strict (no fault) liability for damage resulting from their operation. Strict liability means that potential victims are relieved of the need to prove any fault or negligence on the part of the operator concerned, provided simply that there exists a suitable causal link between the damage suffered and the nuclear accident.

A–8.2.2. Exclusive liability

Further to the rule of strict liability, the liability of the nuclear operator is exclusive. In other terms, such liability is 'channelled' entirely on the nuclear operator, to the exclusion of any other person (including contractors, suppliers, etc.). This rule is also meant to facilitate the access by victims to compensation. It also simplifies the provision by the operator of the mandatory financial security which the applicable legislation requires to cover nuclear risks.

A–8.2.3. Nuclear damage

Under the original provisions of the Paris [A–47] and Vienna [A–49] Conventions, the nuclear operator is held liable for physical injuries or loss of life of any person, and for damage to or loss of any property.

Under the revised Paris and Vienna Conventions and under the Convention on Supplementary Compensation for Nuclear Damage (CSC) [A–53], in addition to the above mentioned damage, the definition of nuclear damage also covers, to the extent determined by the law of the competent court:

— Costs of measures to reinstate significant environmental impairment;
— Certain categories of economic loss, including loss of income sufficiently related to environmental damage;
— Costs of preventive measures and any damage caused by such measures.

A–8.2.4. Damage excluded from liability

Nuclear damage caused by an accident to the nuclear installation of the liable operator or to any other nuclear installation on the same site or to any property on the site used in connection with the nuclear installation cannot be compensated under the special liability regime. The purpose of this rule is to restrict the use of the funds available for the indemnification of 'real' third parties.

Regarding exoneration of liability of the nuclear operator, it is limited to damage caused by war or other forms of hostilities and by an irresistible and unforeseeable natural disaster. It should be noted, however, that the second case of exoneration is no longer foreseen by the Vienna and Paris Conventions as revised, respectively, in 1998 and 2004 [A–52, A–54].

A–8.2.5. Limitation of liability and financial security

When the Paris [A–47] and Vienna [A–49] Conventions were adopted, it was acknowledged that to avoid potentially ruinous claims, a limitation of the amount of the operator's liability could be justified, considering also the rather drastic regime of liability imposed on the operator. For example, the original Vienna Convention [A–49] provides that the liability may be limited by the Installation State to an amount which is not less than US $5 million (1963 dollars). The limits are per nuclear accident and the national legislation can fix a higher limit if financial coverage is available.

The main reason for such a low amount was the difficulty at the time to find enough capacity on the insurance market; this capacity has, however, substantially increased since then. Under the revised Paris Convention [A–54], the liability of the operator shall not be less than €700 million. Under the 1998 revised Vienna Convention [A–52], the new minimum limit is, in principle, set at 300 million IMF special drawing rights[42] (SDRs). One purpose of the CSC [A–53] is to provide additional funds through contributions of its contracting Parties, above the minimum national compensation amount set at 300 million SDRs.

A–8.2.6. Time limits

Under the provisions of the 1960 Paris Convention [A–47] and the 1963 Vienna Convention [A–49], actions for compensation must be brought within ten years after the date of the nuclear accident, which is a shorter period than the usual 30 year prescription period under ordinary civil law. This difference finds its explanation in the difficulties for nuclear insurers in covering nuclear risks susceptible to manifest after extended periods (delayed damage). In addition, when the victim is both aware of the damage and of the liable operator, the (‘discovery’) period can be limited to three years.

Under the revised Paris and Vienna Conventions [A–52, A–54] and the CSC [A–53], the time limit in respect of physical injuries and loss of life has been extended to 30 years. It remains ten years for other damage unless extended by the law of the competent court.

A–8.2.7. Competent courts

The principle established by the special nuclear liability regime is that the competent court is designated by the Contracting Party in whose territory the nuclear accident took place. However, where the accident occurred outside the territory of a Contracting Party (for example, a case of transport), jurisdiction lies with the courts of the Contracting Party in whose territory the installation of the liable operator is located.

Under the revised Vienna and Paris Conventions [A–52, A–54], as well as under the CSC [A–53], the jurisdictional competence of a Contracting Party has been extended in the case of an accident occurring during maritime transport, to cover the situation where the accident occurs within its exclusive zone.

A–8.3. Operational features of TNPPs relevant to nuclear liability issues

A–8.3.1. Mobility of TNPPs

A major characteristic of the TNPPs, whether they are intended for electricity generation or other purpose (for example, co-generation), is their transportability with an option of relocation, i.e. the mobility.

TNPPs could be either barge mounted installations able to be moved to their destination from their site of manufacture or as land based ones, again able to be moved by waterway, rail or road. While transportable, i.e. on board a given means of transport, TNPPs are not designed to be used to provide power for their transportation. They may be moved to and from their destinations carrying their fuel load or they can be fuelled/defuelled at their destinations.

The following three scenarios for the use of TNPPs could be identified:

— Domestic;
— Export (under which the supplier or the foreign recipient entity is likely to act as the operator);
— Export (where the exporting supplier is meant to both operate and regulate the operation of the installation, including its transport).

Each case would have a particular bearing on the mode of application of the nuclear liability regime.

Under the ‘domestic’ case, the TNPP is meant to be constructed, operated and ultimately decommissioned within a single country. Independently of whether the reactor will be operated by one unique operator or by several during its life cycle, its operation will be governed by the particular nuclear liability (and licensing) regime of one country alone.

Under the ‘export’ case, the transfer of the TNPP from a given supplier State to a host (and user) State presupposes the passage from the liability regime in place in the supplier State to that applicable in the host State

[42] International Monetary Fund Special Drawing Rights [A–56].

(same for the eventual return of the TNPP), it being understood that the special international regime is precisely intended to facilitate such movements.

Finally, the ‘outsourcing’ scenario, to the extent that it implies a form of extension within the host State of the regulatory system and operational responsibilities belonging to the supplier, would result in quite a new situation from the viewpoint of nuclear liability. Indeed, under that special regime, it is normally for the competent authorities of the ‘installation State’ (that is the State within whose territory the nuclear installation is situated) to decide to whom the potential liability is assigned and to regulate it.

All cases are determined by the notion of national ‘territoriality’. However, a special case would occur when a TNPP is established on a fixed platform outside the boundaries of territorial waters.

The transport aspects require a little further elaboration. In the report, Option 1 for a TNPP is defined as a facility able to be transferred from the construction/assembly site to the site of its operation with the nuclear fuel load inside the reactor and to be eventually returned with its fuel load to the original supplier. The insistence on the nuclear fuel comes from the fact that the implementation of the nuclear liability regime is generally activated, as far as reactors are concerned, by the arrival of the fuel on the site or the loading of the reactor. A reactor alone that has not yet started to operate (meaning without any radioactive contamination) is not yet considered a nuclear installation in the meaning of the nuclear liability regime. Theoretically, four distinct phases could be identified:

(1) Loading and testing at assembly site;
(2) Transport (with fuel in the core) to operation site;
(3) Phase of operation;
(4) Return to assembly site.

Each particular phase might imply the assignment of liability to different persons, which would require effective coordination to avoid disruption in the application of the nuclear liability regime.

The case of the separate transport of the nuclear fuel and its loading at the operation site (and its separate return after unloading), defined as Option 2 of the report, would also trigger the application of the nuclear liability regime, but again under different conditions, as will be explained later.

Further, in the instance where a TNPP is loaded with fuel and tested at the manufacturing site prior to transport, a consensus among all involved Parties (the supplier, the host and the transit States) would need to be found, based on actual design features of a particular TNPP, whether such plant in transport to the site of destination should be considered a ‘fuel pack’ or an ‘operable reactor’ (see the discussion in Section 9.2), irrespective of the quantity and nature of the fission products contained in the reactor. A consensus that the TNPP is an operable reactor could present a special situation in which a reactor in transport is considered as ‘operating’ while not being involved in the propulsion of the means of transport, such as a ship. This case would require further study.

The transit of a TNPP through the territory of another country would also raise the question of whether that country is satisfied with the liability and financial coverage arrangements under which the transit is to take place. The possibility for a TNPP to be considered as an operable reactor during transit could further complicate the situation.

A–8.3.2. Nuclear fuel for TNPPs

During the operation of a reactor, the fuel elements contained in the core are not subject to liability rules distinct from the reactor itself since all liability is ‘channelled’ to the operator of the reactor. The same situation applies when nuclear fuel (fresh) is stored at the site of the reactor pending its loading or when the fuel (spent) has been discharged from the reactor for the time it remains on the same site.

As noted, the conditions would be different if the fuel elements were to be stored outside the reactor site or carried independently to or from the site of operation because, again, specific transport liability rules would then come into play in respect of their transport, as will be explained later.

A–8.3.3. Decommissioning of TNPPs

It is generally accepted that during the decommissioning phase of a reactor (even after the fuel has been removed from the site), its operator continues to be subjected to the same liability obligations as during operation, at least until the reactor has been 'declassified' by the competent national authorities. It is assumed that the same regime would apply to a TNPP.

It is also understood that in the planned operation of a TNPP, the reactor would, in principle, be returned at the end of the active phase to the supplier rather than decommissioned in situ. In either case, the decommissioning phase does not seem to create a special liability problem for TNPPs.

A–8.3.4. Transfer of liability concerning TNPPs

TNPPs are meant — in certain planned circumstances (export and outsourcing cases) — to be placed successively under the responsibility of distinct legal entities in different countries: constructor/supplier on one side, and host/user on the other. As already noted, the return of the TNPP to the supplier is possible and even in the domestic case, the supplier and the user may not be the same legal persons.

Having this in mind, one must underline a fundamental principle of the nuclear liability system: in no event does it allow the liability of the operator to be interrupted other than in accordance with prescribed conditions. It may be that the liability is reassigned to another operator or that it is terminated by express decision of the competent national authority. One objective of the Vienna Convention [A–49] and other relevant instruments is that this principle is being observed internationally.

A practical consequence for TNPPs is that in the situations described above, their physical movements from construction site to operation site will require a transfer of liability, except in the case where the operator remains one and the same person (this would also happen in the instance of the separate transport of the nuclear fuel intended for the TNPP).

In this respect, most prospective host States are not likely to accept the entry of a TNPP on their territory, or the connected transfer of liability, unless they have agreed beforehand with the supplier on a suitable arrangement concerning liability and compensation with a view to covering damage which could result from the transport and operation of that TNPP.

On the basis of these general considerations, the following chapter proceeds with the analysis, item by item, of selected elements of the nuclear liability regime which are found to be particularly relevant for the deployment of TNPPs.

A–8.4. Key provisions of the nuclear liability regime applied to TNPPs

For the sake of simplicity, the discussion in this section is conducted mostly with reference to the 1963 Vienna Convention [A–49] as a standard provision of the international nuclear liability regime.

A–8.4.1. Technical scope

An essential question to address is whether and how a TNPP would come into the scope of application of the nuclear liability regime. This is first a matter of definition, being it understood that a TNPP is, in substance, a transportable installation consisting of a nuclear reactor. The definition of a nuclear reactor as any structure containing nuclear fuel in such an arrangement that a self-sustaining chain process of nuclear fission can occur (see Ref. [A–49], Article I.1.i) does not seem to raise a particular problem.

The definition of a *nuclear installation* (which is used as a substitute for *nuclear power plant* in a TNPP) may prove to raise a more complex case, in particular as regards the Vienna Convention and the Annex to the CSC, since it refers, inter alia, to "any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose" (see Refs [A–7, A–52], Article I.1.j and Article 1.1.b [A–53]). Besides the elimination of nuclear propulsion from the scope of the convention ,which in itself is not a problem since TNPPs are not intended to be used for this purpose, the exclusion of reactors which are otherwise part of such a means of transport could affect the legal status of TNPPs when they are integrated in, for example, a barge (arguably, the case could be made that it is in fact the TNPP which is equipped with its own means of transport, not the other way round and, therefore, allow this difficulty to be overcome). The similar exclusion under the Paris Convention [A–47] is even broader, since it excludes all reactors "comprised in any means of transport".

Should this provision of the Vienna Convention [A–49] (or the corresponding provisions of the Paris Convention [A–47] or of the CSC [A–53]) be interpreted in a way resulting in the exclusion of TNPPs from its scope of application, this would obviously be a serious drawback. At the same time, the possibility of amending the definition of *nuclear installation* does not appear realistic. However, there could be ways to resolve this problem that are worth exploring.

For example, under the domestic case, nothing would oppose the State concerned (supplier/host) to extend the scope of application of its own nuclear liability legislation to TNPPs. An inevitable difficulty would remain that the other States likely to be affected by a TNPP accident would not be bound by such an extension. Yet, their best interest could be to accept it.

Under the export/outsourcing scenarios, which imply international movements of TNPPs, the host State should, like the Supplier State, similarly extend the scope of its nuclear liability legislation to TNPPs. Again, the question of other potentially affected State would be raised but it could be resolved likewise by way of the conclusion of a bilateral/multilateral agreement ensuring the recognition of TNPPs as *nuclear installations* in the meaning of the international nuclear liability regime.

In any circumstances, this question should be further examined in the light of better information on the intentions of the promoters of TNPPs[43].

The definition of *nuclear material* (see Ref. [A–49], Article I.1.h), which reads as "nuclear fuel…capable of producing energy by….nuclear fission outside a nuclear reactor…" is relevant because it applies to the transportation of nuclear fuel (and radioactive products or waste) whenever the fuel would not be contained in the TNPP and, therefore, confirms the application of the nuclear liability regime.

The *operator* is defined in relation to a nuclear installation as "the person designated or recognized by the installation State as the operator of that installation" (see Ref. [A–49], Article I.1.c). In practice, the operator is at the same time the holder of the construction/operation licence and identified as potentially liable in the event of a nuclear incident. For this reason, the operator is also responsible for providing the required financial security.

A–8.4.2. Transport

Different from a land based nuclear installation where the designated operator has to bear liability for any nuclear damage occurring in its installation, in the case of transport of nuclear material between two operators (it is a prerequisite that nuclear operators are involved), there is a need to determine how and at which point the liability is transferred from one operator to the other (usually from the consignor to the consignee).This circumstance would normally apply to a TNPP which carries its own fuel (as if it were a container of nuclear material) and which would be shipped from the construction site to the operation site, and return.

In practice, the liability can be transferred by a contract between the operators concerned at the time of their choice or, in the absence of such a contract, when the receiving operator effectively takes charge of the nuclear material (see Ref. [A–49], Article II). In addition, contracting Parties to the CSC [A–53] or to the Paris Convention [A–47] may subject the transport through their territories to the condition that the liability of the operator concerned be increased to an amount not to exceed, however, that applicable to their domestic operators.

An important objective of the Vienna Convention [A–49] and other relevant instruments is to ensure that these arrangements for the transfer of liability are recognized by contracting Parties, which both facilitates economic cooperation and ensures the protection of potential victims' vis-à-vis the transport of nuclear material. In addition, there are special provisions which apply where a transport originates from, or is intended to, a non-contracting State (to the relevant convention). Another special case is when the nuclear fuel is sent to, or comes from, a means of transport equipped with a reactor used for propulsion, although here it constitutes a case of interruption of the special regime of liability rather than of transfer (this provision is consistent with the definition of *nuclear installation* under the Vienna Convention [A–49]).

One more special case is where, by exception, the carrier itself rather than the operator concerned is designated as liable for the transport (see Ref. [A–49], Article II).This arrangement, however, is rarely used for major transport operations and can probably be discarded.

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[43] This particular exclusion was motivated at the time of the adoption of the Vienna Convention [A–49] by the existence of another earlier convention dealing with nuclear propelled ships (Convention on the Liability of Operators of Nuclear Ships, 1962 [A–57]) which, in fact, has never come into force. The problem is that, unfortunately, the language of the Vienna Convention ("for any other purpose") is broader than that would have been required for the sole exception of nuclear propulsion.

The application of these provisions to the transport of TNPPs raises the question of how such installations should be qualified in this particular context. As already noted, the application of the nuclear liability regime during transport is triggered by the presence on the means of transport of nuclear material, whether nuclear fuel, radioactive products or waste. Accordingly, the movement of a TNPP empty of nuclear fuel and which has never been in operation would not be considered as nuclear transport within the meaning of the nuclear liability regime. On the other hand, as from the moment such a TNPP is loaded with fuel and, further, after it has started to operate (albeit for testing purposes), it would come under the scope of the nuclear liability regime on account of its radioactive contamination (fission products), independently of whether or not it is equipped with a nuclear fuel load. The question could be raised as to whether a TNPP could be assimilated to a container of nuclear material, remembering that TNPPs are not meant to operate during their transportation and assuming that their design features exclude criticality during transport.

A–8.4.3. Financial obligations of the operator

In order to guarantee that funds would actually be available to meet claims for compensation in the event of a nuclear incident, the nuclear operator is required to provide and maintain financial security (usually in the form of a liability insurance) up to an amount determined by the applicable domestic legislation. In most countries, it corresponds to the fixed limit of liability of that operator. The terms and conditions of the financial security must be approved in advance and are closely supervised by the competent national authorities. For example, an insurer cannot suspend or terminate the insurance coverage without giving a two months advance notice or, in the case of transport, before the nuclear material has reached its point of destination. The funds provided as financial security can be used for the compensation only of damage covered by the nuclear liability regime (see Ref. [A–49], Article VII).

For transport operations, as national authorities are entitled to verify the existence of a financial cover before national borders are crossed, the carrier must present an international certificate of insurance given by the operator concerned, detailing the nature of the nuclear cargo and the conditions of the insurance. This is in fact meant to allow for the recognition of the validity of the financial security by foreign authorities and, therefore, facilitate international movements of nuclear material (see Ref. [A–49], Article III).

Under the nuclear liability regime, the State, when acting as the operator of a nuclear installation, has no obligation to maintain financial security for its own operations. On the other hand, the installation State, in the event that the financial security would somehow fail to cover an operator's liability, would have to ensure the payment of claims up to the limit of liability established by the applicable legislation for that operator (see Ref. [A–49], Article VII).

A–8.4.4. Compensation for nuclear damage

As explained, the nuclear operator is liable to indemnify both physical injuries and loss of, or damage to, property resulting from a nuclear incident, and also any other damage so resulting, as determined by the law of the competent court (see Ref. [A–49], Article I.1.k). The scope of the nuclear damage has since been expanded and clarified in the revised Vienna Convention [A–52] and other relevant instruments.

Otherwise, the nuclear liability regime refers to ordinary civil law for the determination of the nature, form and extent of the compensation of victims (see Ref. [A–49], Article VIII). Also, in many countries, the national social insurance schemes and workmen's compensation systems cover nuclear damage, subject to possible recourse action against the liable operator (see Ref. [A–49], Article IX).

Finally, if provided by the applicable legislation, direct action of the claimants against the insurer is possible (see Ref. [A–49], Article II.7).

A–8.4.5. Damage to means of transport

In the context of TNPP operation, the question of damage caused to the means of transport itself may be of particular importance since, in the absence of an appropriate guarantee that compensation for such damage can be obtained; it could have a negative impact on the availability of transport for this category of equipment.

On the other hand, the authors of the 1963 Vienna Convention [A–49], in order to guarantee that the larger part of the funds available be reserved for the indemnification of 'ordinary' victims, either excluded the damage to the means of transport or restricted their compensation to a given amount (see Ref. [A–49], Articles IV.5 and IV.6). The revised Vienna Convention [A–52] now covers this category of damage explicitly but continues to restrict the volume of funds likely to be devoted to their compensation.

A–8.4.6. Prescription, jurisdiction, applicable law, non-discrimination

As explained, one original feature of the nuclear liability regime is that the period of prescription or extinction of claims for compensation against a nuclear operator starts not from the time the victims find they have suffered damage but from the date of the nuclear incident (and the likely exposure of the victims).

Also different from ordinary civil law, the basic rule concerning jurisdictional competence provides that the court where the nuclear incident occurred has sole jurisdiction on claims for compensation. (see Ref. [A–49], Article XI). This rule covers both land-based installations and transport operations, subject in the case of transport to special arrangements when the incident occurs in a territory where the nuclear liability regime cannot apply. The competent court will use the provisions of the relevant convention and also its own national law in all matters not covered by that convention, without any discrimination between victims with regards to nationality, domicile or residence (see Ref. [A–49], Articles I.1.e and XIII).

A–8.5. Issues to be addressed

The below analysis is based on the assumption, which cannot be given for granted (see above under Section A.8.4.2), that the transport of a TNPP loaded with fuel but not in operation during the transport can be assimilated to the transport of nuclear material under the nuclear liability regime.

A–8.5.1. Domestic scenario

This is, comparatively, the simpler case. It is necessary to ascertain that:

— TNPPs are effectively covered by the applicable national legislation governing the liability of nuclear operators or by an equivalent legislation dealing specifically with TNPPs;
— Both the supplier and the host entities are recognized as nuclear operators by the competent authority and are equipped with suitable financial security (i.e. approved by the competent authority) covering both stationary operation and transport of the installation;
— The arrangements for the transfer of liability during transport operations meet the requirements of the applicable nuclear liability legislation.

A–8.5.2. Export scenario

In addition to the above, as appropriate, it is necessary to ascertain that:

— Both the supplier States and the host States are party to international agreement(s) ensuring compatibility between their respective obligations concerning nuclear liability.
— TNPPs are effectively covered in both the supplier and host States by the applicable national legislation dealing with the liability of nuclear operators or equivalent legislation.
— Both the supplier and host entities are recognized as nuclear operators and are equipped with a suitable and mutually accepted financial security.
— In the case of transit through the territory of a third country, such country is willing to accept the legal and financial cover conditions provided for the passage of the nuclear shipment.

A–8.5.3. Outsourcing scenario

For the reasons explained earlier, the case of the transposition/application in a third country (recipient) of the regulatory system of a supplier State is not presently envisaged in the conventions on nuclear liability. The legal implications of this particular scenario as regards nuclear liability need, therefore, to be further studied.

A–8.6. Insurance

So far, and except where the host (installation) State itself assumes liability for the likely results of a nuclear incident, mandatory financial security has generally been provided by nuclear operators in the form of third party liability insurance. That insurance is subscribed from national insurance companies regrouped for that purpose within 'nuclear insurance pools'. Above this level of co-insurance, national pools usually share part of their financial commitments with other foreign pools. This is creating a market of international nuclear reinsurance without which the financial capacity necessary to cover nuclear risks would be very difficult to obtain.

The main reason why insurance is generally the most current form of financial security for nuclear risks is that it is comparatively more economical and practical. Another important reason is that, professionally, insurers are better equipped to deal with that sort of risk and with the settlement of a potentially large number of complex claims.

As noted, the legal obligations of nuclear operators under the nuclear liability regime are very strictly defined and the provision of insurance, which is under close public supervision, must match the nature and scope of the operator's liability exactly. On the other hand, nuclear insurers, like all other insurers operate as an industry and are under no obligation to accept coverage of a particular risk which they find, for technical or other reasons, to be not 'insurable'. This is the case today for certain types of nuclear reactors or for nuclear installations in certain countries.

Therefore, concerning the development of TNPPs and their possible international market, it would be important to ascertain that nuclear insurers would be prepared, after a detailed technical review, as is the rule, to cover the liability of operators of this new class of reactors. It should also be noted that the suitability of the legal framework (i.e. the applicable domestic legislation and international conventions) is another major element in their final determination to accept the coverage of a particular risk. It is recommended that this question be raised with nuclear insurers at some future stage.

A–8.7. Liability of operators of TNPPs in an international context

One of the main reasons for the adoption of the international nuclear liability conventions, besides the imperative of protecting potential victims and also the need to consolidate the legal and financial regime applicable to the nuclear industry, has been to promote the international harmonization of such a regime, particularly for transport operations.

Without the application of this special regime, the international movements of nuclear material (or here, of TNPPs containing their own fuel) could be confronted with significant difficulties resulting from the lack of recognition of the domestic rules governing the liability of a nuclear operator by another country the territory of which is the destination of a transport or simply used for transit purposes. Such difficulties would, in particular, concern the limitation of liability of the nuclear operator concerned, the choice of the competent court, the applicable legislation and the adequacy of the financial cover, and could result in complex conflict of laws.

This Annex has assumed that the liability of the operator of a TNPP would be regulated by the international nuclear liability regime which, for the reasons explained above, cannot be given for granted. Unfortunately, none of the conventions constituting this regime currently enjoy universal adherence[44] and this has to be taken into consideration for the future deployment of TNPPs. Moreover, the exclusion clauses contained in the liability conventions and relating, in the case of the Paris Convention [A–47, A–54], to reactors comprised in any means of transport and, in the case of the Vienna Convention [A–49, A–52] and of the Annex to the CSC [A–53], to reactors with which a means of sea or air transport is equipped, might result in the exclusion of TNPPs from the scope of the international nuclear liability regime.

In this respect, the potential liability for damage caused by a nuclear incident occurring during the movement or operation abroad of a TNPP could be affected by a variety of factual or legal elements, which include the:

— TNPP shipment route — origin and destination, transit through countries, storage during transport;
— Location (abroad) of the operating site — land based; if at sea, in territorial waters, in an exclusive economic zone (EEZ), on the high seas;
— Location of the incident and of the damage suffered (whether or not covered by any of the relevant international instruments);
— Nature of the damage (whether or not covered by the special nuclear liability regime);
— Nationality and residence of the victims;
— Competent court and the applicable law.

This explains why it cannot be ensured in advance that the special regime of nuclear liability would apply in all circumstances to the transfer and operation of a TNPP. In some instances, victims could prefer seeking compensation outside this regime and make, therefore, the legal situation of the operator of a TNPP even more unpredictable. A further complication is that so far there are many countries outside the Vienna Convention and other relevant instruments, and there are no universal regulations concerning tort liability, which results in a risk of conflicts of laws and jurisdictions. While a (theoretical) country-by-country analysis would be necessary to explore this complex issue, it is beyond the scope of this study.

[44] Ratification of the nuclear liability conventions:
- 1963 Vienna Convention on Civil Liability for Nuclear Damage [A–49]: 38 Parties as of August 2011.
- 1997 Protocol to Amend the Vienna Convention [A–52]: 9 Parties as of August 2011.
- 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy [A–47]: 16 Parties as of August 2011.
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ABBREVIATIONS

CHTR	compact high temperature reactor
CNS	Convention on Nuclear Safety
CSC	Convention on Supplementary Compensation for Nuclear Damage
CSA	comprehensive safeguards agreement
MW	megawatt
NPP	nuclear power plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NSG	Nuclear Suppliers Group
NWS	nuclear weapon State
NNWS	non-nuclear-weapon State
PWR	pressurized water reactor
SMRs	small and medium sized reactors
SMART	system integrated modular advanced reactor
SSAC	State system of accounting for and control of nuclear material
TNPP	transportable nuclear power plant
UNCLOS	United Nations Convention on the Law of the Sea
VOA	voluntary offer agreement

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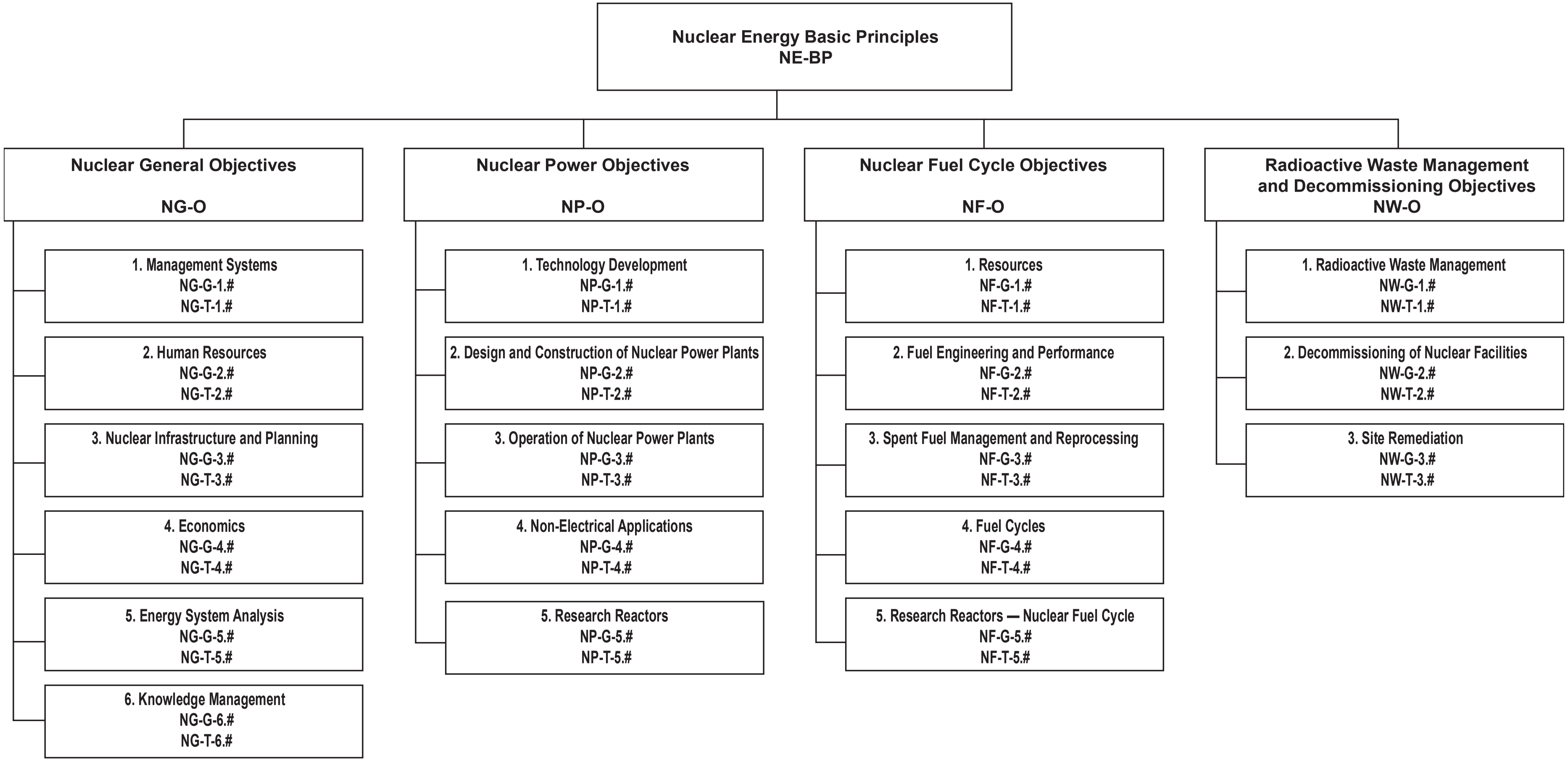

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