EU Non-Proliferation Consortium

The European network of independent non-proliferation think tanks

Non-Proliferation Papers

No. 44 April 2015

NUCLEAR SECURITY IN EUROPEAN UNION MEMBER STATES

MARCY FOWLER AND ALISA CARRIGAN*

I. INTRODUCTION

The international community's involvement in, and awareness of, nuclear security has grown significantly in the past fifteen years. In the wake of the terrorist attacks on the United States of 11 September 2001, governments acknowledged the need to increase nuclear security. Although the September 2001 attacks were not nuclear or radiological in nature, there was a fear that future attacks might be, especially if non-state actors were able to access nuclear material. Growing numbers of both potential threats and nuclear facilities around the world led the international community to seek greater security measures and ensure that states are equipped to implement those measures.

Since the beginning of the nuclear age, the term 'nuclear security' has evolved significantly in both how it is defined and how states respond to it. At present, the International Atomic Energy Agency (IAEA) defines nuclear security as, 'the prevention and detection of, and response to, theft, sabotage, unauthorised access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities'.[1]

It is generally accepted that the responsibility for ensuring the security of civilian nuclear material and facilities lies with the individual states that possess them. Nevertheless, states are aware that if nuclear security were to fail in one state, the implications of an incident would probably extend beyond that state's national borders. Therefore, in order to ensure

[1] International Atomic Energy Agency (IAEA), 'Meaning of nuclear security', Concepts and terms, <http://www-ns.iaea.org/standards/concepts-terms.asp>. This paper uses the IAEA's definition of 'nuclear security' and does not cover dual-use items and export controls.

*This work benefited from the research assistance of Morena Priori, which the authors gratefully acknowledge.

SUMMARY

The international community's awareness of the need for nuclear security has grown significantly in the past fifteen years, during which members of the European Union (EU), and the EU itself, have emerged as leaders in the field. In an effort to assess the efficacy of EU member states' nuclear security arrangements, this paper examines four areas that are integral to a robust nuclear security system.

1. Domestic legislation and programmes.
2. Participation in the international nuclear security regime.
3. Transparency regarding arrangements and incidents.
4. Threat assessment and response.

The paper finds that EU member states have generally fulfilled their responsibilities well, demonstrating an awareness of the importance of nuclear security and dealing with threats appropriately within their domestic systems. Nonetheless, there is further action that they could take in order to improve nuclear security, such as: (*a*) reducing nuclear material stocks and sites; (*b*) increasing physical nuclear security measures; and (*c*) increasing activity in international agreements and cooperation.

ABOUT THE AUTHORS

Marcy Rutan Fowler is a PhD student at the Department of War Studies, King's College London, and worked as a research fellow at the Vienna Center for Disarmament and Non-Proliferation during the preparation of this report.

Dr Alisa L. Carrigan is a consultant in non-proliferation and nuclear security and has a PhD from the Department of War Studies, King's College London.

its own security, a state must also look outside of its own borders. Currently, there is no overarching authority for nuclear security. While the IAEA issues nuclear security guidelines and best practices, as well as offering legal and other types of assistance to member states, it neither enforces the adoption of those guidelines nor has the ability to penalize states that do not conform to its standards.

In an effort to fill the existing gaps, several other international and non-profit organizations have been active in the realm of nuclear security, including the Nuclear Energy Agency, the World Institute for Nuclear Security and the Nuclear Threat Initiative.[2] These organizations have provided assistance, information and guidance in specific areas of nuclear security where states may wish to improve. The US Government's Global Threat Reduction Initiative (GTRI) actively assists states in eliminating highly enriched uranium (HEU) and plutonium from their territories. Additionally, there are several international agreements—some legally binding and some politically binding—that cover various aspects of nuclear security. These include the International Convention on the Suppression of Acts of Nuclear Terrorism (ICSANT), the Global Initiative to Combat Nuclear Terrorism (GICNT), the Convention on the Physical Protection of Nuclear Material (CPPNM) and its 2005 amendment, and United Nations Security Council Resolution (UNSCR) 1540 on preventing nuclear terrorism.[3] All of these, taken together, form a patchwork nuclear security regime, under which states can pick and choose the recommendations and guidelines that suit them best.

In the absence of an international nuclear security authority, the European Union (EU) has stepped in as one of the leading organizations in the field.[4] The EU sets standards for all member states to follow and also invests in various nuclear security projects in the region. In fact, investment in nuclear security is a growing priority for the EU, as demonstrated by increased investment in the 2014–20 funding for nuclear security via the Instrument for Stability and the Instrument for Nuclear Safety Cooperation (the latter being the primary EU funding instrument for nuclear security projects).[5] However, while the EU does set some regulatory and nuclear security standards for its existing and incoming member states, these EU-wide efforts are limited by the huge variation in nuclear facilities and technologies, making comprehensive EU-wide legislation difficult to achieve.

However, although such EU-level programmes are vital, nuclear security ultimately remains the responsibility of national governments. In an effort to assess whether EU member states are fulfilling their national nuclear security responsibilities, this paper examines four areas that are integral to a robust nuclear security system.

1. Domestic legislation and programmes (including engagement with industry, where appropriate). Since the state is the primary actor in the nuclear security regime, strong domestic nuclear security frameworks are vital.
2. Participation in the international nuclear security regime. International cooperation in the form of participation in the regime enhances domestic security arrangements, as states can give and receive assistance.
3. Transparency regarding arrangements and incidents. This builds trust both domestically and internationally.
4. Threat assessment and response (including issues of equipment, personnel and funding). These represent the execution of nuclear security plans—they are how states provide physical security and prepare to respond to incidents.

Section II of this paper provides an overview of those civilian nuclear materials and facilities within the EU member states that are at risk. Section III then examines how member states are performing in the four areas identified above. Sections IV and V

[2] See e.g. Nuclear Threat Initiative (NTI), Nuclear Threat Index, <http://ntiindex.org/>. The NTI and the Economist Intelligence Unit created an index of states around the world and gave them a nuclear security rating, including e.g. the number of facilities, the amount of direct-use material in the country, personnel vetting, legislation, international cooperation and political stability.

[3] UNSCR 1540 is the only nuclear security agreement whose participation and adherence is required of UN member states, under Chapter 7 of the UN Charter.

[4] For initiatives undertaken by the EU, see e.g. Anthony, I., 'The role of the European Union in strengthening nuclear security', EU Non-proliferation Consortium, Non-proliferation Paper no. 32, Nov. 2013, <http://www.sipri.org/research/disarmament/eu-consortium/publications>.

[5] Under the Seventh Project Framework Programme for Research (FP7), the EU has set aside dedicated funds for research in the field of security for the first time. Approximately €54 million is available for security-related projects, <http://ec.europa.eu/research/fp7/understanding/fp7inbrief/structure_en.html>.

conclude by offering an overall situation analysis and recommendations.[6]

II. RISK OVERVIEW

Civilian nuclear material and facilities in EU states

EU member states are some of the most technologically advanced in the world. Just under half of the operating power reactors in the world are in Europe, as are half of the world's operational research reactors.[7] Together, EU member states possess the entire nuclear fuel cycle; manufacture a significant percentage of the world's nuclear fuel; reprocess spent fuel from around the world; and make medical isotopes used by countries around the world—to name but a few applications of nuclear technology in the region. Below is a brief overview of the civilian nuclear material and facilities in EU member states that present a nuclear security risk, and descriptions of the risk presented by each type of facility (see appendices A and B for further information on nuclear material and facilities in the EU).

Direct-use nuclear material

Direct-use nuclear material refers to uranium enriched in the U-235 isotope to 20 per cent or greater, uranium 233, or any isotope of plutonium. Unirradiated direct-use material (separated HEU, plutonium or fresh nuclear fuel) presents a unique security threat, due to the fact that, if stolen, it could be directly utilized for nuclear weapons without further enrichment or processing. Spent (irradiated) nuclear fuel containing HEU or plutonium is also considered direct-use material, however, it is not as attractive for theft because it requires further complex processing and contains highly radioactive fission products that make handling hazardous.

There are several initiatives throughout the EU working to minimize the use of HEU in civilian applications, mainly through the conversion of reactor fuels and isotope targets to use low-enriched uranium (LEU), while plutonium is still used in mixed-oxide (MOX) fuel in several reactors. Large stocks of civilian HEU and unirradiated plutonium remain in France, Germany and the United Kingdom. Smaller stocks of civilian HEU remain in Belgium, Italy, the Netherlands and Poland. Belgium also has a small unirradiated plutonium stock (see appendix A for more details about stocks of nuclear material in the EU).

Nuclear facilities[8]

Nuclear facilities present various nuclear security risks depending on the presence of nuclear material, the form of such material, the nature of the items and the processes present at the facility. The following types of civilian nuclear facility present the highest nuclear security concern in the EU:

1. *Uranium enrichment*. Enrichment facilities are sensitive because the end product can be HEU. At larger commercial facilities the bulk nature of the material is a challenge, since the numerous cascades that are necessary for commercial production might present a target for theft of the enriched uranium. Attacks or sabotage are also possible. There are uranium enrichment facilities in France, Germany, the Netherlands and the UK (see appendix B).
2. *MOX fuel fabrication*. The fabrication of MOX fuel requires plutonium oxide to be combined with LEU, fabricated into fuel pellets and inserted into fuel rods. Because of the use of plutonium, MOX fuel fabrication plants demand high levels of security, as they are possible targets for theft of either the separated plutonium or of the MOX fuel pellets. Attacks or sabotage are also possible. MOX fuel fabrication facilities can be found in Belgium, France, Germany and the UK (see appendix B).
3. *Research reactors*. Research reactors can be fuelled with HEU or use targets containing HEU and many of these facilities are in difficult-to-secure areas, such as universities or city centres. Research reactors, and critical and sub-critical assemblies, are possible targets for attack or sabotage. Theft of material is also possible,

[6] This paper does not deal with nuclear arsenals, military nuclear material or military nuclear facilities. Such items are viewed by states as even further outside the purview of the international community and, to date, there are few international efforts to improve such security. Neither does it directly address the security of radioactive materials other than nuclear materials.

[7] International Atomic Energy Agency (IAEA), Power Reactor Information System (PRIS), <http://www.iaea.org/pris/>. 185 of 437 power reactors (42%) are located in Europe (including non-EU member states such as Russia and Ukraine). IAEA, Research Reactor Database, <http://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx>. 133 of 266 research reactors (50%) are located in Europe (including non-EU member states such as Russia and Ukraine).

[8] International Atomic Energy Agency (IAEA), Nuclear Fuel Cycle Information System, <https://infcis.iaea.org>; IAEA, Research Reactor Database (note 7); IAEA, PRIS (note 7); and IAEA, Country Nuclear Power Profiles, <https://cnpp.iaea.org>.

but the material would require further processing as it typically comes to the reactor in a finished form—such as in fuel assemblies or targets. The IAEA's Research Reactor Database (RRDB) lists 133 operational or temporarily shut down research reactors in Europe. Research reactors fuelled with HEU can be found in Belgium, Denmark, France, Germany, Italy and the UK. Research reactors using HEU or plutonium in targets can be found in Belgium, the Czech Republic, France, the Netherlands and Poland (see appendix B).

4. *Nuclear power plants*. Nuclear power plants are possible targets for sabotage. Attacks are also possible, but most commercial reactors in the EU have extraordinary shielding in place to prevent contamination and damage in such cases. Theft of material is also possible, but unlikely as most material comes to the reactor in a finished form (fuel assemblies) and leaves the reactor in a highly-radioactive form (spent fuel), requiring careful further processing in order to extract the uranium or plutonium. The IAEA's Power Reactor Information System (PRIS) lists 131 nuclear power reactors operating in EU member states, the majority of which are LEU fuelled. Additionally, reactors in Belgium, Germany and France use MOX fuel. France also operates power reactors that use HEU fuel.

5. *Spent fuel storage*. Spent fuel contains unseparated irradiated uranium and plutonium in differing amounts of isotopic content, depending on the burn-up and type of fuel. However, spent fuel also contains highly radioactive fission products, which make handling and transporting it very difficult. Additionally, spent fuel requires careful further processing in order to extract the uranium or plutonium. It is, therefore, less attractive as a target for theft. However, attacks or sabotage of spent fuel assemblies are possible. In EU member states, spent fuel is generally stored onsite at nuclear power plants—in total, there are 33 spent fuel storage facilities at nuclear power plant sites (16 of which are located in Germany). Some exceptions are France, which stores spent fuel in five storage facilities at reprocessing sites, and Sweden, which has one central spent fuel storage facility (see appendix B).

6. *Reprocessing*. Like enrichment facilities, reprocessing facilities are particularly sensitive because the processes result in separated direct-use material—in this case, plutonium. Reprocessing facilities deal with bulk handling of material and processes, making them possible targets for theft of plutonium. Attacks or sabotage are also possible (see appendix B).

III. MEMBER STATE PERFORMANCE

Domestic nuclear security frameworks

Nuclear security frameworks—regulations, legislation and programmes—are unique to each state's domestic situation, and this can be important as each state's security needs differ based on the material and facilities they possess. France, for example, requires far greater levels and types of security for its large amounts of direct-use material and numerous facilities than, for example, Cyprus, which possesses no material or high-risk facilities. Nevertheless, it is important for all states (including those that possess neither material nor facilities) to understand the potential threats and be prepared to respond to them—so that the EU, as a region, can also maintain a robust nuclear security system.

Therefore, the EU mandates certain regulations to which every member state must adhere. For example, the EU has common dual-use export control regulations, lists and implementation policies—including a 'catch-all' clause that controls the export of items not specifically on export control lists but which are suspected of being intended for use in a weapons of mass destruction (WMD) programme.[9] The EU has also developed an action plan for chemical, biological, radiological and nuclear (CBRN) security, which calls on all EU member states to be prepared to deploy detection systems within states and at EU borders in order to reduce the possibilities for trafficking of nuclear material.[10] Outside of these few areas, however, there is relatively little that is EU-mandated for member states; the bulk of nuclear security measures are merely recommendations. Similarly, the European Atomic Energy Community (Euratom), which has the

[9] Dual-use items are those that might be used for both peaceful purposes (nuclear fuel cycle, medical isotopes, etc.) and military purposes. European Commission, 'EU efforts to strengthen nuclear security', Joint staff working document, SWD (2014) 107 final, 13 Mar. 2014, <https://ec.europa.eu/jrc/sites/default/files/swd-2014-107-nuclear-security-final.pdf>.

[10] European Commission, Communication from the Commission to the European Parliament and the Council of 24 June 2009 on strengthening chemical, biological, radiological and nuclear security in the European Union—an EU CBRN Action Plan, 18 Dec. 2009, <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1411762389983&uri=URISERV:jl0030>.

same membership as the EU, does not mandate nuclear security practices for its member states but rather encourages adherence to 'international norms'.[11]

Some of the first steps that many EU member states have taken to improve domestic nuclear security are to (*a*) strengthen domestic legislation and (*b*) empower a government entity to oversee such legislation. Poland, for example, updated its legislation in 2011 to include new security mandates for agencies tasked with other types of nuclear oversight (e.g. regulatory affairs and safeguards). Several other EU states have amended their domestic legislation to incorporate international best practices, such as those recommended in the IAEA's guidance on the physical protection of nuclear material and facilities (INFCIRC/225), or to be in line with international treaties such as the CPPNM.[12] Belgium, the Czech Republic and Finland are a few of the states that have recently made such modifications to existing laws. Finland has expanded its nuclear regulatory laws to allow for the prosecution of criminal acts that are nuclear security-related, including allowing for the prosecution of nuclear-trafficking incidents, nuclear terrorism and cybercrime related to nuclear installations or material. Lithuania is following suit and adding illicit trafficking incidents related to nuclear or radioactive material to its criminal code, and Spain has amended its anti-smuggling legislation and export control regulations to better respond to illicit nuclear trafficking.[13]

One of the most important parts of a domestic nuclear security system is securing the transport of radioactive (including nuclear) material—security at facilities matters little if the trucks, trains, airplanes and ships that transport material are not also secured. Transport is one of the major areas where states need to be aware of potential threats and need to look for ways—legislative and physical—to improve security. In recent years, several states have modified legislation in order to further secure nuclear transport: Germany, for example, is implementing a regulatory framework aimed at enhancing nuclear transport security.[14] Many companies involved in the transport of nuclear material in EU member states are members of the World Nuclear Transport Institute (WNTI). The WNTI, based in the UK, provides guidance to members regarding best practices for the safe and secure international transport of radioactive (including nuclear) material, and acts as a voice for the industry to communicate with national and international authorities in nuclear security. By fostering communication between the major actors in nuclear transport, the WNTI helps to strengthen EU member states' domestic nuclear security systems.

By now, most states have realized that providing a robust domestic security system should naturally involve members of several different agencies, including technical and regulatory nuclear officials, industry representatives, state security and local police. Enhancing communication and cooperation between all of these entities is an important part of a nuclear security framework, as each entity may possess information that is crucial to preventing security incidents or responding should an incident occur. To that end, several EU states are working to create a more seamless exchange of information: in 2013 Denmark introduced a new national database that provides information on people and facilities that are linked to nuclear or radiological material, in order to enable better information dissemination between nuclear regulators, customs officials and law enforcement.[15] Similarly, in 2012, Germany implemented a CBRN incident reporting scheme for police and customs, in order to improve communication between the two authorities regarding nuclear security.[16] In order to improve communication between different entities in Sweden, several authorities, including the nuclear regulatory agency and the state security service, joined together to form a national physical protection coordination group, which also brings in nuclear facility operators and licensees.[17]

[11] James Martin Center for Nonproliferation Studies, 'Euratom: Euratom supply agency and nuclear safeguards', Inventory of international nonproliferation organizations and regimes, 17 Dec. 2012. <http://cns.miis.edu/inventory/pdfs/euratom.pdf>.

[12] International Atomic Energy Agency (IAEA), *Nuclear Security Recommendations on Physical Protection of Nuclear Materials and Nuclear Facilities,* IAEA Nuclear Security Series no. 13 (IAEA: Vienna, 2011).

[13] Arms Control Association, 'The Nuclear Security Summit: Progress report', July 2013, <http://www.armscontrol.org/files/Nuclear_Security_Summit_Report_2013.pdf>.

[14] Nuclear Security Summit 2014, 'National progress report: Federal Republic of Germany', 20 Feb. 2014, <http://www.nss2014.com/en/nss-2014/reference-documents>.

[15] Nuclear Security Summit 2014, 'National progress report: Denmark', Feb. 2014.

[16] Nuclear Security Summit 2014, 'National progress report: Federal Republic of Germany' (note 14).

[17] Nuclear Security Summit 2014, 'National progress report: Sweden', 24–25 Mar. 2014.

Participation in the international regime

Among those actors leading the response to the global nuclear security threat has been the US Department of Energy's National Nuclear Security Administration (NNSA), which has cooperated extensively with EU member states. In 2004 the NNSA started the Global Threat Reduction Initiative (GTRI), which EU member states have been actively involved in since its inception. The initiative has worked in three major areas in order to enhance nuclear security around the world: (*a*) the conversion of research reactors that use HEU (e.g. medical isotope production using HEU targets and/or fuel); (*b*) the removal of 'excess' nuclear material, such as spent and fresh HEU fuel; and (*c*) further physical protection of nuclear facilities. Under the GTRI, research reactors in nine EU states have undergone conversion (or been shut down) and no longer use HEU fuel: Bulgaria, the Czech Republic, France, Germany, Hungary, the Netherlands, Portugal, Poland and the UK.[18] Additionally, the GTRI has removed all HEU from a further seven countries in the EU: Austria, Bulgaria, the Czech Republic, Greece, Latvia, Portugal and Romania (as well as from neighbouring Turkey, Serbia and Ukraine).[19]

EU member states are also cooperating with the GTRI to develop technologies that facilitate further reductions in the use of HEU. Belgium and the Netherlands are working with the GTRI to convert medical isotope production from using HEU to LEU. Belgium and France are working with the GTRI to develop a high-density LEU fuel that can replace HEU fuels in research reactors for medical isotope production. EU member states are also involved in other US-led nuclear security programmes, such as the Proliferation Security Initiative, which deals with interdiction of WMD-related trafficking, and the Megaports Initiative, which assists states that have large international commercial shipping ports by enhancing their capabilities to detect and respond to nuclear trafficking.

Beginning in 2010, the US Government started a series of high-level meetings called the Nuclear Security Summit. The first was held in Washington, DC, in the USA; the 2012 Summit was held in Seoul in South Korea; and the 2014 Summit was held in The Hague in the Netherlands. EU member states have used the Summit process to work with other states on security issues and to offer public commitments on how they plan to increase their own, and global, nuclear security. For example, at the 2014 Summit, the Netherlands announced that it was developing four instruments that would further help the field of nuclear forensics worldwide: (*a*) a nuclear forensics knowledge platform (accessible as a website); (*b*) a lexicon of internationally accepted definitions at the interface between nuclear and forensic science; (*c*) a compendium of good practices for the nuclear forensics field; and (*d*) a training curriculum for the nuclear forensics field.[20]

In addition to participating in these US-led initiatives, EU states have started to lead their own multilateral or bilateral nuclear security initiatives; in part, as a result of efforts to meet UNSCR 1540 Committee reporting requirements and, in part, due to the momentum from the Nuclear Security Summits. Germany initiated the Wiesbaden Process in order to improve communication between the German Government and industry on nuclear security (specifically concerning UNSCR 1540 implementation), which is a series of conferences aimed at strengthening their partnership. The German Government has noted that the potential for cooperation with industry can be enhanced further and has offered to continue the process by hosting or co-hosting conferences with other interested states and industry representatives. Similarly, the French Government is working to repatriate French-origin fuels and sources to reduce the amount of 'loose' nuclear material around the world, by working bilaterally with states. France has also announced that it continues to support and offer its expertise to EU Centres of Excellence that are devoted to CBRN risk mitigation throughout the region.[21]

Other states have also begun to offer assistance on a bilateral level: at the 2012 Nuclear Security Summit, Romania offered technical assistance in the conversion of research reactors from HEU to LEU and in the repatriation of HEU—taking its own experiences and the assistance it has received and making that available to other states. Additionally, at the 2014 Nuclear

[18] National Nuclear Security Administration (NNSA), 'GTRI: Reducing nuclear threats', Fact sheet, 29 May 2014, <http://nnsa.energy.gov/mediaroom/factsheets/reducingthreats>.

[19] National Nuclear Security Administration (note 18).

[20] Nuclear Security Summit 2014, 'National progress report: The Netherlands', Mar. 2014.

[21] Nuclear Security Summit 2012, 'National progress report: France', 14 Mar. 2012; and Nuclear Security Summit 2014, 'National progress report: France', 24–25 Mar. 2014.

Security Summit, Hungary reported that it would establish a Nuclear Security Support Centre under the auspices of the Hungarian Academy of Sciences Centre for Energy Research.[22]

Similarly, the IAEA's involvement in nuclear security has increased since the mid 1990s, and especially since 2001. EU member states have been involved with the IAEA's work in nuclear security in a variety of ways, the first being financial. Half of all EU states have independently contributed to the IAEA's Nuclear Security Fund and more than 80 per cent of the IAEA's nuclear security activities are paid for by the fund—making it crucial to the IAEA's ability to carry out its work.[23] However, half of EU states have never independently contributed to the IAEA's nuclear security work or have not contributed in the last five years, even though several of them are recipients of IAEA or bilateral security assistance (see appendix D for further information on contributions). While some of these states may support the Nuclear Security Fund via the EU budget, an independent monetary contribution is one way that an EU member state can increase its impact on global nuclear security—even small pledges help to demonstrate the universal importance of nuclear security.

EU member states also cooperate by sending technical experts to the IAEA and by receiving nuclear security missions from the IAEA. Numerous states assist the IAEA's work by sending experts on short-term missions, for example, taking part as an expert on an International Physical Protection Advisory Service (IPPAS) mission, or for longer periods of time on more intricate projects, for example, in the development of the Nuclear Security Plan. IPPAS missions are essentially physical security peer-review missions led by the IAEA. Experts review a state's physical protection system and compare it with international guidelines (namely the IAEA's INFCIRC/225) and other recognized best practices. Recommendations for strengthening security are made based on this review, including ways that the IAEA or other states might be of assistance. For example, upgrades in physical protection systems might be provided with bilateral assistance or changes to the legal framework might be carried out with the assistance of the IAEA's legal experts.[24] As noted, several EU states supply experts to assist in carrying out IPPAS missions. Additionally, half of EU states have received at least one IPPAS mission and several have received more than one mission to assess their security arrangements and to assist with follow-up measures (see appendix C for a list of EU member state IPPAS missions).

Finally, international treaties help to cement cooperation among states and make up the backbone of the nuclear security regime. However, unlike the nuclear non-proliferation field, which has one primary treaty (the Non-Proliferation Treaty), the nuclear security field has several agreements, including some that have opened for signature since 2001. The majority of EU states have joined all of these treaties, with only a few exceptions (see appendix C for the full list of EU membership to key nuclear security agreements). The most notable exceptions are the states that have not yet accepted or ratified the CPPNM 2005 amendment (only Italy) and those that have signed but not yet ratified ICSANT (Bulgaria, Estonia, Greece, Ireland and Italy). Moreover, even in those member states that have signed and ratified all major nuclear security agreements, implementation of the agreement provisions varies.

Transparency

Nuclear security transparency refers to a state's willingness and ability to communicate with its stakeholders, the public and the international community about nuclear security preparation and response. Such transparency can be demonstrated by reporting fissile material stocks or security measures to national authorities or international bodies (e.g. Euratom or the IAEA), or by allowing access for such bodies to visit or inspect nuclear sites or to review nuclear security regulations or policies (e.g. IPPSAS missions and Euratom inspections). Transparency is key to strong security because it can enable increased accountability—a state and its public can be reassured that they and their neighbours are working towards a common goal (securing sites and material and preparing appropriate responses) and that any measures taken will be effective.

[22] Nuclear Security Summit 2014, 'National progress report: Hungary', 24–25 Mar. 2014.

[23] International Atomic Energy Agency (IAEA), 'Nuclear Security Report 2012', Report by the Director General to the Board of Governors and General Conference, GOV/2012/41-GC(56)/15, 31 July 2012.

[24] International Atomic Energy Agency (IAEA), International Physical Protection Advisory Service, <http://www-ns.iaea.org/security/ippas.asp>.

Transparency in nuclear security within the EU is generally quite high. Several EU states voluntarily report to the IAEA on their civilian stockpiles of direct-use material and make these declarations public. Doing so allows the international community to track the amounts of material in a state over time and to question why sudden changes may have occurred (e.g. large losses or gains). Belgium, France, Germany, the Netherlands, Poland and the UK have all declared stocks of HEU or plutonium (or both), usually annually, and have taken the time to explain changes in their inventory. This helps to keep these states accountable for the security of their material and helps to keep their neighbours informed about potential incidents involving that material. However, four EU member states with small stocks of HEU—Belgium, Italy, the Netherlands and Poland—have not made declarations to the IAEA regarding those stocks (see appendix A).

Every EU member state participates in the IAEA's Incident and Trafficking Database (ITDB), which commits states to share information about radiological (including nuclear) security incidents or illicit trafficking that may have occurred on their territory. In turn, states receive information from the ITDB when incidents occur, so they can be better prepared to respond to, or prevent, similar incidents in the future.

Further, every EU member state has submitted national reports to the UNSCR 1540 Committee, detailing steps that they have taken to prevent nuclear material from being obtained and used by non-state actors. However, it should be noted that several states have not submitted updated reports for several years (see appendix C for a list of UNSCR 1540 report years). Many of the actions that are reported to the UNSCR 1540 Committee overlap with other security treaties that are also focused on preventing nuclear terrorist acts, as well as with national-level security strategies that are in place. One of the hallmarks of the UNSCR 1540 reporting is that, where possible, it calls on states to offer expertise to other states that require it, thus further encouraging cooperation. Both Finland and Germany have made their expertise available to other UN member states in order to assist with various aspects of UNSCR 1540 reporting and implementation.[25]

[25] Nuclear Security Summit 2014, 'National progress report: Federal Republic of Germany' (note 14); and Nuclear Security Summit 2014, 'National progress report: Finland', 24–25 Mar. 2014.

Threat identification and response

Threat identification and response capability refers to a state's ability to recognize potential threats to nuclear material and facilities, and to secure sites and borders in response to identified threats. It is important to note that 'response' in nuclear security terms typically refers to reversing the immediate consequences of unauthorized actions, for example, recovering material. Response to uses of that material—for example, setting off a radiological dispersal device—is usually considered nuclear safety, not security. To ensure threat identification and response capabilities, a state must have (*a*) the proper financial resources dedicated to security; (*b*) the proper legal instruments to allow for response and a regulatory infrastructure to maximize awareness; and (*c*) the proper execution of security policies (to include physical security). A state can enhance its threat identification and response capabilities by working domestically and with international partners to find and respond to deficiencies in its current nuclear security setup. Determining whether facilities or transport links are vulnerable to theft, attack or sabotage is important for states—this is a key part of any threat assessment. Yet designing a response scenario for different types of facility, material and threat is also important.

One of the initial tools for identifying potential threats is a threat assessment process, the outcome of which can be used to define a Design Basis Threat (DBT). A DBT is a description of the attributes and characteristics of potential internal and/or external adversaries that might attempt unauthorized removal of nuclear material or sabotage, against which a physical protection system is designed and evaluated. Creating a DBT for a state (or for specific nuclear sectors within a state) can help to ensure appropriate levels of security for various facilities. Once a DBT has been defined for a given state, security measures can be planned more easily because the state has a clear idea of where threats might emerge and what shape they may take. Several EU states have completed threat assessments and defined DBTs. Some of these states have also completed updates of their DBTs or have created DBTs for specific sectors of their nuclear complex—Germany has a DBT for its transport links and the Netherlands has completed a DBT for potential cybercrime.

In the EU as a whole, the majority of security incidents that have taken place have been limited to trafficking of nuclear or radiological material and, very occasionally, physical protection incidents. Nuclear trafficking incidents include those reported incidents involving the illegal import, export, transfer or possession of radioactive (including nuclear) material. While reports of nuclear material trafficking and security incidents involving nuclear facilities can be used to gauge the existing threat, such reports do not necessarily indicate a low level of nuclear security in a state. In fact, such reporting could indicate a functioning nuclear security system or high levels of transparency. According to information located in the James Martin Center for Nonproliferation Studies (CNS) Global Incidents and Trafficking Database, the majority of trafficking incidents in the EU have involved radioactive material from industrial or medical usage, such as cobalt-60.[26] Further, the number of trafficking incidents involving nuclear material is quite low and such incidents have involved only relatively small quantities of material. Two known incidents have involved larger quantities, one involving the unauthorized use of nearly 5 kilograms of uranium in a home physics laboratory and another involving the theft of 74 kilograms of uranium (the isotopic composition of the uranium was not reported in either case).

Notably, the majority of trafficking incidents in the EU involving nuclear material either took place in, or the material was reported as probably originating from, former Soviet states, with several other cases involving other former Warsaw Pact countries. To reiterate, it may be that these incidents are known to the public because of the robust security or transparency of the EU member states involved—that they were able to find the material and respond to the incidents—and not that the incidents took place because security was lax. However, the trends observed in the reported incidents can be used by EU member states in order to adjust their nuclear security efforts accordingly.

Incidents involving physical security breaches are serious but extremely rare in the EU. Whether this is because they are rarely reported or because they rarely happen cannot be determined with publicly available information. One known incident happened in 2013, when more than 24 Greenpeace protesters infiltrated the Tricastin Nuclear Power Plant in France, clearing the perimeter fencing in a move aimed at revealing the site's susceptibility to potential attack. The French utility company Electricity of France (EDF) said the intruders had not reached any 'sensitive areas'.[27] France launched an investigation into the break-in shortly afterwards.[28] Incidents such as this can serve to demonstrate the importance of being both vigilant and flexible in physical security, and transparency regarding such incidents can assist other states through lessons learned. However, these incidents also highlight the delicate balance between transparency and threat assessment and response. While transparency is important, some information regarding nuclear security should stay closely guarded: publicly releasing amounts of HEU and plutonium in a state can build confidence, but publically releasing how much is stored at which sites, or the specifics of site security, can damage the ability to prevent incidents and respond appropriately.

IV. ANALYSIS AND RECOMMENDATIONS

Strengths

EU member states are aware of the importance of nuclear security and are dealing with the threats within their domestic systems. The majority of states have comprehensive domestic legislation that deals with nuclear security and most states have at least one organization that is tasked with overseeing threat assessment and response within the state. The EU member states with the most material and/or facilities to secure generally have the highest levels of nuclear security. EU member states have demonstrated their willingness to invest in developing strong nuclear security systems and technologies both within individual states (i.e. the Centres of Excellence working on nuclear security measures) and EU-wide (i.e. the European Commission's Joint Research Centre's development and implementation of nuclear security technologies). Several states are working on increasing

[26] Nuclear Threat Initiative, CNS Global Incidents and Trafficking Database, <http://www.nti.org/analysis/reports/cns-global-incidents-and-trafficking-database/>.

[27] 'Protestors storm French atomic power site', Global Security Newswire, 15 July 2013, <http://www.nti.org/gsn/article/protesters-storm-french-atomic-power-site/>; and 'Greenpeace protests inside French nuclear plant', BBC News, 15 July 2013, <http://www.bbc.co.uk/news/world-europe-23312611>.

[28] 'France launches investigation of nuclear plant break-in', Global Security Newswire, 16 July 2013, <http://www.nti.org/gsn/article/france-launches-investigation-nuclear-plant-break-/>.

communication and information sharing between domestic and international stakeholders in order to assist in the prevention of, and response to, incidents.

In the international realm, there is high to universal participation among EU member states in international organizations and treaties. All EU member states participate in the IAEA's ITDB. There is universal membership in the Nuclear Suppliers Group (NSG), in which members work to ensure that exports are in line with international export control lists. Additionally, all EU member states participate in the GICNT, and the Netherlands and Spain have hosted GICNT plenary meetings and taken on additional leadership roles within the GICNT in working groups and implementation groups. EU countries have also successfully responded to the UNSCR 1540 reporting requirement, with all member states having submitted reports. Numerous states have carried out threat assessments, completed DBTs and hosted IAEA IPPAS missions.

Overall, EU member states have been highly successful in adopting and promoting standards for nuclear security. This grouping is exemplary in terms of cohesiveness and for the assistance that has taken place within the EU in developing and maintaining member state regulations and guidelines. For this, EU member states should be lauded and encouraged to continue their outstanding work on nuclear security.

Areas for improvement

There are twenty-eight sovereign states in the EU, each with distinct national regulations and viewpoints, thereby complicating the complete standardization of nuclear security guidelines and policy. Needs for security frameworks differ immensely because of differences in a state's nuclear material and facilities—and so the EU and its members might be wise to pursue a graded approach to nuclear security regulations and systems. Encouraging universality in the security regime is less important than encouraging universal efficacy. It is also important to ensure that states with little to no nuclear infrastructure are still allowed a voice in nuclear security, as ultimately nuclear security incidents would affect all EU member states. These states with less material and fewer facilities should be encouraged to take an active part in nuclear security initiatives. Some steps toward universal nuclear security efficacy in the EU include ensuring that (*a*) every EU state has a comprehensive domestic nuclear security framework that establishes transparency, communication, threat awareness and response; (*b*) every EU member state takes part in at least one international nuclear security initiative annually—be it a Nuclear Security Summit, or an IAEA meeting on the subject, or bilateral exchanges with neighbouring states; (*c*) IPPAS missions, or a similar assessment process, are the norm for any state that has even small quantities of material or a single nuclear facility to secure; and (*d*) every nuclear security treaty is signed and ratified by all EU member states.

Perhaps the biggest issue that remains, however, is the sheer complexity of the security of nuclear material and facilities in the region: significant amounts of direct-use material are in use or stored, and numerous nuclear facilities contribute to nuclear industry and research. There is, in short, much ground for nuclear security to cover in the EU region, and with fewer sites and/or smaller stockpiles of material, nuclear security in EU member states could be dealt with more effectively and with fewer resources. Some steps that can be taken to improve this situation are detailed below, including: (*a*) reducing nuclear material stocks and sites; (*b*) increasing physical nuclear security measures; and (*c*) increasing activity in international agreements and cooperation.

Reducing nuclear material stocks and sites

EU member states with stocks of unirradiated direct-use material and direct-use material in spent nuclear fuel should continue to reduce such stocks; continue to work to minimize the usage of such material; and consolidate the storage of such material. Several EU member states are already working in this direction, for example, to create high-density LEU research reactor fuels that will replace HEU fuels and still allow reactors to achieve high flux. There are also projects underway to replace HEU-based medical isotope targets with LEU-based targets. Such positive steps should be encouraged and, where possible, assistance should be offered to states working to minimize this material.

At present, there are seven states in the EU that are in possession of unirradiated direct-use material: Belgium, France, Germany, Italy, the Netherlands, Poland and the UK (see appendix A), and many more that have irradiated spent fuel storage. Unfortunately, only two of those states—Poland and Italy—might be seen as 'low hanging fruit', meaning removal of all unirradiated direct-use material would be a relatively straightforward process involving a reactor core conversion or decommissioning of sites and repatriation of spent fuels to either the USA or Russia. The other five states all have some level of nuclear industry within their territories—outside of simply operating power plants or research reactors—such as, enrichment, fuel fabrication (including MOX fuel), isotope target production, fuel reprocessing or spent fuel storage. Since the elimination of these material stocks and sites in the short to medium term is impractical, the EU should encourage these five states to find ways to consolidate or repatriate the material in their possession. Repatriating some material to Russia and the USA may be an option. Alternatively, the number of sites where material is stored could be decreased and security at the remaining sites could be heightened. One example of this would be consolidating spent fuel storage from 16 operating sites in Germany to a single site within the country, with maximized security.

Increasing physical nuclear security measures

Within individual member states, the focus on increasing security seems to be in two main areas: (*a*) border protection (including ports); and (*b*) information sharing. Regarding ports, several EU states have taken part in the Megaports Initiative and all have participated in the Proliferation Security Initiative, both of which seek to provide better radiological detection equipment on land and at sea borders, as well as training for border patrols and customs agents that are on the front lines of combating illicit trafficking. Both of these initiatives could be expanded and Megaports could be widened to include all relevant EU member states.

Regarding information sharing, several EU member states, including Denmark and Germany, have created national databases that provide information on people and facilities linked to nuclear or radiological material, in order to enable better information dissemination between nuclear regulators, customs officials and law enforcement. This is a model that could be implemented across other EU states and that could increase communication between various government departments. Additionally, these member states could consider sharing the information contained in these databases with other EU member states or internationally, for example, through the IAEA.

Lastly, more EU member states should complete threat assessments and DBTs—if only to be assured that their current security setups and levels are adequate. Member states that have already completed statewide or sector DBTs could assist other member states that have yet to do so, and the EU should encourage such assistance and incentivize the development of DBTs in all member states.

International agreements and cooperation

Although the EU can claim almost universal participation of its member states in major international nuclear security agreements, there are still a few outliers that need to continue working towards the ratification of both the CPPNM 2005 amendment and ICSANT (see appendix C). Additionally, over the past five years, France, the Netherlands and the UK are the only three member states that have annually made independent monetary contributions to the IAEA's Nuclear Security Fund; the remaining EU member states could make independent monetary pledges and all states could ensure multi-year pledges (see appendix D).

Additionally, much has been accomplished through international cooperation, whether bilateral, with industry, under the auspices of the EU, or through organizations like the IAEA. Increasing the participation of industry in nuclear security within EU member states would also benefit domestic nuclear systems. As such, EU member states should provide incentives for nuclear industry to increase involvement in standard-setting, voluntary organizations such as the World Institute for Nuclear Security or the WNTI.

Lastly, as EU member states continue to progress in developing the strongest possible nuclear security frameworks, they could partner with the USA, or lead the way themselves, in assisting other states and regions to implement stronger nuclear security measures. Building up EU participation in international Centres of Excellence or Nuclear Security Centres through offers of training or assistance in nuclear security implementation would help to raise the standard of nuclear security practices globally.

Topics for further study

As nuclear security is a national issue with regional and global implications, one area that needs further study is how to engage with EU neighbours and prospective

EU members. Although countries located inside of the general EU area, such as Norway and Switzerland, and those neighbouring the EU area, such as Belarus, Serbia and Turkey, are not EU members, their nuclear security measures potentially impact on the EU as greatly as arrangements in member states. While the standard of domestic nuclear security legislation is consistently high throughout EU countries, newly acceded EU member states have been required to make significant upgrades to their nuclear security regulation and legislation before acceding. These processes have, in each case, been quite complicated for the incoming member states, requiring comprehensive reviews of existing legal systems and, in most cases, utilizing the assistance of the IAEA or other states' expert legal advisors. This should be troubling to the EU because it indicates that, before these member states joined, it had countries with sub-standard nuclear security systems on its borders. It is likely that this insecurity remains on the borders of the EU, with neighbouring states (including prospective EU member states) operating nuclear security systems that would not meet EU standards. The EU could, therefore, offer to assist such states in improving their nuclear security systems, through training or assistance in a nuclear security legislative review, with the goal of raising the standard of nuclear security both in the EU and beyond.

V. CONCLUSION

As noted throughout this paper, while nuclear security is primarily a national responsibility, it is an international concern that can have regional or global implications. Overall, EU member states, in cooperation with the EU and international partners and institutions, have risen to meet these challenges with transparency, high levels of awareness and response, and the funding and actions required to execute the necessary policies. In many respects, EU members lead the way globally when it comes to nuclear security as they have (*a*) some of the most advanced technology available and the ability to develop further technology as needs arise; (*b*) the financial resources and commitments necessary to secure material and sites; and (*c*) respect for the rule of law and international norms and treaties. EU member states have also demonstrated their commitment to the international nuclear security regime. Member states have made substantial contributions to international organizations such as the IAEA and have taken part in EU-funded research projects; most have ratified international nuclear security treaties; and most have implemented EU-wide security policies and measures.

Nonetheless, this paper has identified several actions that EU member states could take to further improve nuclear security. Due to the large amounts of nuclear material and the many (and various) nuclear facilities, several EU member states are faced with significant nuclear security challenges. Major areas for improvement would be: (*a*) reducing nuclear material stocks and sites; (*b*) increasing physical nuclear security measures; and (*c*) increasing activity in international agreements and cooperation. Additionally, EU member states could increase their contributions to the IAEA's security efforts and offer assistance to states in areas where improvement is needed. Taking best practices from both states with and without direct-use material, and developing EU-wide guidelines for both categories, could be another step to increasing nuclear security. Finally, as the EU considers further expansion and fully integrates newer members, the region as a whole (and its neighbours) would benefit from further standardization of nuclear security systems and from working together across state boundaries in order to fully implement nuclear security guidelines in every state in the region.

ABBREVIATIONS

CBRN	Chemical, biological, radiological and nuclear
CPPNM	Convention on the Physical Protection of Nuclear Material
DBT	Design Basis Threat
Euratom	European Atomic Energy Community
GICNT	Global Initiative to Combat Nuclear Terrorism
GTRI	Global Threat Reduction Initiative
HEU	Highly enriched uranium
IAEA	International Atomic Energy Agency
ICSANT	International Convention for the Suppression of Acts of Nuclear Terrorism
ITDB	Incident and Trafficking Database
IPPAS	International Physical Protection Advisory Service
LEU	Low-enriched uranium
MOX	Mixed oxide
UNSCR	UN Security Council Resolution
WMD	Weapon(s) of mass destruction
WNTI	World Nuclear Transport Institute

APPENDIX A. DIRECT-USE MATERIAL IN EUROPEAN UNION MEMBER STATES

Civilian HEU	> 1000 kg	France[a]	4717 kg (down from 4743 kg in the previous report), including unirradiated HEU at fuel fabrication or processing plants.
		Germany[a]	1230 kg (up from 1200 kg in the previous report), contained in research reactors, irradiated HEU held in storage, and elsewhere.
		UK[a]	1398 kg (up from 1396 kg in the previous report), primarily at reprocessing facilities or other locations not including civilian reactor sites.
	< 100–1000 kg	Belgium	Belgium declared the removal of all excess fresh HEU, however, it still maintains a stock of uncertain size.
		Italy	Italy has not made a declaration to the IAEA of its civilian HEU stocks (mainly HEU in fresh fuel).
		Netherlands	The Netherlands has not made a declaration to the IAEA of its civilian HEU stocks.
		Poland	Poland has not made a declaration to the IAEA of its civilian HEU stocks.
Civilian unirradiated plutonium	> 10 000 kg	France[a]	78 100 kg (down from 80 600 kg in the previous report) of civilian unirradiated plutonium (of which 17 000 kg is foreign owned), of which 27 700 kg is unirradiated separated plutonium (down from 30 600 tonnes in the previous report) and the remainder is unirradiated MOX fuel.
		UK[a]	123 000 kg (up from 120 200 kg in the previous report) of civilian unirradiated plutonium (of which 23 400 kg is foreign owned), of which 121 100 kg (up from 118 300 kg in the previous report) is unirradiated separated plutonium and the remainder is unirradiated MOX fuel.
	1000–10 000 kg	Germany[a]	3000 kg of fresh MOX fuel (up from 2400 kg in the previous report), with no unirradiated separated plutonium.
	100–1000 kg	Belgium[a]	1400 kg of unirradiated plutonium in MOX fuel or other fabricated products at reactor sites or elsewhere (1300 kg of which is foreign owned, up from 800 kg in the previous year); less than 50 kg of unirradiated separated plutonium for fuel manufacture or fabrication; less than 50 kg unirradiated separated plutonium elsewhere.

HEU = Highly enriched uranium; IAEA = International Atomic Energy Agency; kg = kilogram; MOX = mixed oxide.

[a] The figures are as of 31 Dec. 2013.

Sources: International Panel on Fissile Materials, 'Materials: Highly enriched uranium', 4 Nov. 2013, <http://fissilematerials.org/materials/heu.html>; International Atomic Energy Agency (IAEA), Communication received from France concerning its policies regarding the management of plutonium, INFCIRC/549/Add.8/17, 15 Aug. 2014; IAEA, Communication received from Germany concerning its policies regarding the management of plutonium, INFCIRC/549/Add.2/17, 21 Aug. 2014; IAEA, Communication received from the United Kingdom of Great Britain and Northern Ireland concerning its policies regarding the management of plutonium, INFCIRC/549/Add.8/17, 15 Aug. 2014; and IAEA, Communication received from Belgium concerning its policies regarding the management of plutonium, INFCIRC/549/Add.3/13, 8 Dec. 2014.

APPENDIX B. NUCLEAR FACILITIES IN EUROPEAN UNION MEMBER STATES

Enrichment	France	1 operational centrifuge enrichment plant, Georges Besse II (full capacity planned for 2016), used only for production of LEU. 1 closed diffusion enrichment plant, Georges Besse I.
	Germany	1 operational centrifuge-based plant, Gronau, capable of enriching some 4500 tonnes of UF6 annually.
	Netherlands	1 operational centrifuge enrichment plant, Almelo.
	UK	1 operational centrifuge enrichment plant, Capenhurst.
MOX fuel fabrication	Belgium	1 MOX fuel fabrication facility, Dessel, which is being decommissioned.
	France	1 operational MOX fuel fabrication facility, Melox.
	Germany	1 decommissioned fuel fabrication facility, Hanau, which was intended for MOX fuel fabrication.
	UK	1 MOX fuel fabrication facility, Sellafield, which closed in 2011 due to lack of orders after the Fukushima nuclear accident in Japan (the Nuclear Decommissioning Authority is overseeing the decommissioning).
Research reactors		
Fuelled with HEU	Belgium	1 operational HEU-fuelled research reactor, the 100 mW BR-2 at SCK•CEN, used primarily for production of the medical isotope molybdenum-99 (Mo-99) using HEU targets. 1 HEU-fuelled critical assembly, Venus-F, operated by SCK•CEN.
	Denmark	1 closed HEU-fuelled research reactor, Riso DR-1, which is in the process of being decommissioned.
	France	8 operational HEU-fuelled reactors; 2 operational pulsed reactors, Caliban and Silene; 2 HEU-fuelled operational critical assemblies, Masurca and Minerve; 1 HEU-fuelled reactor under construction, Jules Horowitz (JHR), which will run on HEU fuel until high-density LEU fuel is developed and qualified; and 16 closed reactors and critical assemblies, some of which housed HEU or plutonium.
	Germany	1 operational HEU-fuelled reactor, the 20 mW FRM-II at the Technical University of Munich.
	Italy	1 operational HEU-fuelled research reactor, Tapiro 5 kW in Rome, which uses 93% enriched fuel.
	UK	1 operational HEU-fuelled critical assembly, Neptune.
Using HEU or plutonium in targets	Belgium	The National Institute of Radioelements (IRE) processes irradiated targets made of HEU to extract medical isotopes.
	Czech Republic	The LEU-fuelled LVR-15 research reactor irradiates HEU targets for medical isotope production, although no target manufacture or processing takes place in the Czech Republic.[a]
	France	Areva manufactures reactor fuel and isotope targets using HEU and LEU.
	Netherlands	HEU-based targets are used for medical isotope production. The Netherlands has committed to converting to LEU-based targets by 2015, although delays until 2017 are possible.
	Poland	The Maria research reactor irradiates HEU-based targets for production of Mo-99. Poland is working with other irradiators and processors to convert isotope production to LEU by 2015.

Spent fuel storage sites	Germany	16 sites are in operation at 16 different nuclear power plants, with 1 additional site being decommissioned, 1 planned and 2 temporarily closed. It has been reported that Germany is considering shipping 288 161 spent fuel pebbles from interim storage in Julich to the US Savannah River Site.
	Netherlands	In December 2013 the last HEU spent fuel was removed from the low flux reactor (LFR) site at Petten and sent to a central radioactive waste storage facility.
	Poland	Although Poland has no spent fuel facilities, it has HEU in the form of spent fuel from its research reactors. This fuel is planned for repatriation to Russia in 2015–16, at which point all HEU and plutonium in Poland will be eliminated.
Reprocessing	Belgium	1 reprocessing plant, Eurochemic, which ceased operation in 1974 and is undergoing decommissioning.
	France	2 operational PUREX process spent fuel-reprocessing plants, La Hague UP 2 and UP 3, which extract uranium and plutonium for use in MOX fuel.
	Italy	1 decommissioned enriched uranium extraction pilot plant, CNEN Eurex, which operated from 1970–83.
	UK	2 facilities at Sellafield that separate out uranium and plutonium: the B205 Magnox plant, processing uranium metal Magnox fuel, and the Thermal Oxide (Thorp) facility, processing spent uranium oxide fuel from light water reactors and advanced gas-cooled reactors. The first-generation reprocessing plant closed in 1973 and is being decommissioned.

HEU = Highly enriched uranium; LEU = low-enriched uranium; kW = kilowatt; mW = megawatt; MOX = mixed oxide.

[a] The LVR-15 research reactor was converted to use LEU fuel, although it still uses HEU targets to produce medical isotopes, possibly including targets utilizing US-origin HEU.

Sources: International Atomic Energy Agency (IAEA), Integrated Nuclear Fuel Cycle Information Systems, <https://infcis.iaea.org>; IAEA, Research Reactor Database, <http://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx>; IAEA, Power Reactor Information System, <http://www.iaea.org/pris/>; IAEA, Country Nuclear Power Profiles, <https://cnpp.iaea.org>; International Panel on Fissile Materials, 'All HEU removed from Czech Republic', 5 Apr. 2013, <http://fissilematerials.org/blog/2013/04/all_heu_removed_from_czec.html>; US Department of Energy, 'United States, international partners remove last remaining weapons-usable highly enriched uranium from Hungary, set nuclear security milestone', 4 Nov. 2013, <http://energy.gov/articles/united-states-international-partners-remove-last-remaining-weapons-usable-highly-enriched>; 'Dutch unlikely to meet Nuclear Security Summit promise on reactor conversion', Global Security Newswire, 14 Mar. 2014, <http://www.nti.org/gsn/article/dutch-unlikely-meet-nuclear-security-summit-promise-reactor-conversion/>; International Panel on Fissile Materials, 'HEU spent fuel removed from LFR reactor at Petten', 10 Dec. 2013, <http://fissilematerials.org/blog/2013/12/heu_spent_fuel_removed_fr.html>; 'LFR fuel removed from Petten', World Nuclear News, 6 Dec. 2013, <http://www.world-nuclear-news.org/WR-LFR-fuel-removed-from-Petten-0612134.html>; Nuclear Security Summit 2014, 'National Progress Report: Poland', 24–25 Mar. 2014, <http://www.nss2014.com/en/nss-2014/reference-documents>; and 'German nuclear fuel to USA?', *Deutsche Welle*, 8 July 2014.

APPENDIX C. INTERNATIONAL COOPERATION

Member state	ITDB	NSG	CPPNM (EIF)	CPPNM 2005 amendment	UNSCR 1540 reports	ICSANT	NSS	GICNT	PSI	IPPAS mission receieved
Austria	x	x	21 Jan. 1989	Ratified	2004, 2005	Ratified	–	x	x	–
Belgium	x	x	6 Oct. 1991	Ratified	2004, 2006, 2007	Ratified	2010, 2012, 2014	x	x	Request sent 2014
Bulgaria	x	x	8 Feb. 1987	Ratified	2004, 2006, 2008	Signed	–	x	x	1996, 2002
Croatia	x	x	8 Oct. 1991	Approved	x	Ratified	–	x	x	–
Cyprus	x	x	22 Aug. 1998	Accepted	x	Ratified	–	x	x	–
Czech Republic	x	x	1 Jan. 1993	Accepted	2004, 2006	Ratified	2010, 2012, 2014	x	x	1998, 2002
Denmark	x	x	6 Oct. 1991	Approved	2004, 2005, 2013	Ratified	2010, 2012	x	x	–
Estonia	x	x	8 June 1994	Ratified	x	Signed	–	x	x	–
Finland	x	x	22 Oct. 1998	Accepted	2004, 2005, 2006, 2007, 2011	Accepted	2010, 2012, 2014	x	x	2009, 2012
France	x	x	6 Oct. 1991	Approved	2004, 2005, 2007	Ratified	2010, 2012, 2014	x	x	2011
Germany	x	x	6 Oct. 1991	Ratified	2004, 2005, 2010, 2013	Ratified	2010, 2012, 2014	x	x	–
Greece	x	x	6 Oct. 1991	Ratified	2004, 2006	Signed	–	x	x	–
Hungary	x	x	8 Feb. 1987	Ratified	2004, 2005, 2006, 2008	Ratified	2012, 2014	x	x	1997, 2013
Ireland	x	x	6 Oct. 1991	Ratified	x	Signed	–	x	x	–
Italy	x	x	6 Oct. 1991	–	2004, 2005, 2007	Signed	2010, 2012	x	x	–
Latvia	x	x	6 Dec. 2002	Accepted	2004, 2005, 2007	Ratified	–	x	x	–
Lithuania	x	x	6 Jan. 1994	Ratified	2004, 2005, 2007	Ratified	2012	x	x	1999, 2002
Luxembourg	x	x	6 Oct. 1991	Ratified	x	Ratified	–	x	x	–
Malta	x	x	15 Nov. 2003	Ratified	x	Ratified	–	x	x	–
Netherlands	x	x	6 Oct. 1991	Accepted	2004, 2005, 2008	Accepted	2010, 2012	x	x	2005, 2008, 2009, 2012
Poland	x	x	8 Feb. 1987	Ratified	2004, 2006, 2007	Ratified	2010, 2012	x	x	1997
Portugal	x	x	6 Oct. 1991	Ratified	2004, 2005, 2010	Ratified	–	x	x	1997, 2002, 2012
Romania	x	x	23 Dec. 1993	Ratified	2004, 2005, 2007, 2011	Ratified	2012	x	x	–
Slovakia	x	x	1 Jan. 1993	Ratified	2004, 2005, 2007	Ratified	–	x	x	2006
Slovenia	x	x	25 June 1991	Accepted	2004, 2005, 2012	Ratified	–	x	x	1996, 2010
Spain	x	x	6 Oct. 1991	Accepted	2004, 2006, 2008, 2014	Ratified	2010, 2012	x	x	–
Sweden	x	x	8 Feb. 1987	Ratified	2004, 2005, 2008	Ratified	2010, 2012, 2014	x	x	2011
UK	x	x	6 Oct. 1991	Ratified	2004, 2005, 2007, 2013	Ratified	2010, 2012, 2014	x	x	2011

CPPNM = Convention on the Physical Protection of Nuclear Material; EIF = entry into force; GICNT = Global Initiative to Combat Nuclear Terrorism; ICSANT = International Convention for the Suppression of Acts of Nuclear Terrorism; IPPAS = International Physical Protection Advisory Service; ITDB = Incident and Trafficking Database; NSG = Nuclear Suppliers Group; NSS = Nuclear Security Summit; PSI = Proliferation Security Initiative; UNSCR = United Nations Security Council Resolution.

Source: US Department of State, 'Proliferation Security Initiative participants', 4 June 2014, <http://www.state.gov/t/isn/c27732.htm>.

APPENDIX D. MONETARY CONTRIBUTIONS TO THE IAEA'S NUCLEAR SECURITY FUND

Specific contribution amounts were only provided in the 2006 report.

Contributor	2002–FY06 ($)	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14
European Commission	9 000 000	x	–	–	–	–	x	x	x
European Community	–	–	x	x	–	–	–	–	–
European Union	–	–	–	–	–	x[a]	–	–	–
Austria	–	–	–	–	–	–	–	–	–
Belgium	54 000	–	–	–	–	x	x	x	x
Bulgaria	15 000	–	–	–	–	–	–	–	–
Croatia	–	–	–	–	–	–	–	–	–
Cyprus	–	–	–	–	–	–	–	–	–
Czech Republic	147 000	x	x	x	–	–	–	–	–
Denmark	–	–	x	x	x	x	–	x	–
Estonia	–	–	–	–	–	x	x	–	x
Finland	24 000	x	x	x	x	x	x	–	x
France	667 000	x	x	–	x	x	x	x	x
Germany	1 743 000	x	–	–	–	x[a]	x	–	–
Greece	30 000	–	–	–	–	–	–	–	–
Hungary	70 000	–	–	–	–	–	–	–	–
Ireland	227 000	x	x	x	x	–	–	–	–
Italy	217 000	x	–	–	x	x	x	–	x
Latvia	–	–	–	–	–	–	–	–	–
Lithuania	–	–	–	–	–	–	–	–	–
Luxembourg	–	–	–	–	–	–	–	–	–
Malta	–	–	–	–	–	–	–	–	–
Netherlands	2 184 000	x	–	x	x	x[a]	x	x	x
Poland	10 000	–	–	–	–	–	–	–	–
Portugal	–	–	–	–	–	–	–	–	–
Romania	127 000	–	x	x	–	–	–	–	x
Slovakia	–	–	–	–	–	–	–	–	–
Slovenia	37 000	–	–	–	–	–	–	–	–
Spain	80 000	x	x	x	x	x	x	–	x
Sweden	91 000	x	x	x	x	x	x	–	–
UK	3 082 000	x	–	x	x	x	x	x	x

FY = Financial year; IAEA = International Atomic Energy Agency.

[a] Multi-year

Sources: International Atomic Energy Agency (IAEA), Director General, 'Nuclear security: Measures to protect against nuclear terrorism', GOV/2006/46-GC(50)/13, 16 Aug. 2006; IAEA, Director General, 'Nuclear Security Report 2007', GOV/2007/43-GC(51)/15, 15 Aug. 2007; IAEA, Director General, 'Nuclear Security Report 2008', GOV/2008/35-GC(52)/12, 22 Aug. 2008; IAEA, Director General, 'Nuclear Security Report 2009', GOV/2009/53-GC(53)/16, 21 Aug. 2009; IAEA, Director General, 'Nuclear Security Report 2010', GOV/2010/42-GC(54)/9, 12 Aug. 2010; IAEA, Director General, 'Nuclear Security Report 2011', GOV/2011/51-GC(55)/21, 5 Sep. 2011; IAEA, Director General, 'Nuclear Security Report 2012', GOV/2012/41-GC(56)/15, 31 July 2012; IAEA, Director General, 'Nuclear Security Report 2013', GOV/2013/36-GC(57)/16, 6 Aug. 2013; and IAEA, Director General, 'Nuclear Security Report 2014', GOV/2014/36-GC(58)/14, 22 July 2014.

EU Non-Proliferation Consortium

The European network of independent non-proliferation think tanks

A EUROPEAN NETWORK

In July 2010 the Council of the European Union decided to create a network bringing together foreign policy institutions and research centres from across the EU to encourage political and security-related dialogue and the long-term discussion of measures to combat the proliferation of weapons of mass destruction (WMD) and their delivery systems.

STRUCTURE

The EU Non-Proliferation Consortium is managed jointly by four institutes entrusted with the project, in close cooperation with the representative of the High Representative of the Union for Foreign Affairs and Security Policy. The four institutes are the Fondation pour la recherche stratégique (FRS) in Paris, the Peace Research Institute in Frankfurt (PRIF), the International Institute for Strategic Studies (IISS) in London, and Stockholm International Peace Research Institute (SIPRI). The Consortium began its work in January 2011 and forms the core of a wider network of European non-proliferation think tanks and research centres which will be closely associated with the activities of the Consortium.

MISSION

The main aim of the network of independent non-proliferation think tanks is to encourage discussion of measures to combat the proliferation of weapons of mass destruction and their delivery systems within civil society, particularly among experts, researchers and academics. The scope of activities shall also cover issues related to conventional weapons. The fruits of the network discussions can be submitted in the form of reports and recommendations to the responsible officials within the European Union.

It is expected that this network will support EU action to counter proliferation. To that end, the network can also establish cooperation with specialized institutions and research centres in third countries, in particular in those with which the EU is conducting specific non-proliferation dialogues.

http://www.nonproliferation.eu

FONDATION pour la RECHERCHE STRATÉGIQUE

FOUNDATION FOR STRATEGIC RESEARCH

FRS is an independent research centre and the leading French think tank on defence and security issues. Its team of experts in a variety of fields contributes to the strategic debate in France and abroad, and provides unique expertise across the board of defence and security studies.
http://www.frstrategie.org

PRIF HSFK
Peace Research Institute Frankfurt
Hessische Stiftung Friedens- und Konfliktforschung

PEACE RESEARCH INSTITUTE IN FRANKFURT

PRIF is the largest as well as the oldest peace research institute in Germany. PRIF's work is directed towards carrying out research on peace and conflict, with a special emphasis on issues of arms control, non-proliferation and disarmament.
http://www.hsfk.de

IISS

INTERNATIONAL INSTITUTE FOR STRATEGIC STUDIES

IISS is an independent centre for research, information and debate on the problems of conflict, however caused, that have, or potentially have, an important military content. It aims to provide the best possible analysis on strategic trends and to facilitate contacts.
http://www.iiss.org/

sipri

STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE

SIPRI is an independent international institute dedicated to research into conflict, armaments, arms control and disarmament. Established in 1966, SIPRI provides data, analysis and recommendations, based on open sources, to policymakers, researchers, media and the interested public.
http://www.sipri.org/