A World’s Dilemma ‘Upon Which the Sun Never Sets’ – The Nuclear Waste Management Strategy: Western European Nation States and the United States of America

Part II

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Due to the length of the paper and editorial requirements of atw, this paper is published in three successive parts. The authors and editor hope that you will enjoy and look forward to reading the entire paper, as each division is published. Part I, includes Sections 1 – 5, discusses the background, overview of the world nuclear waste dilemma, as well as the international nuclear legal framework. Part II, includes Sections 6.0 – 6.3, discusses the European Union framework, as well as the specific nations: The Republic of France and The United Kingdom. Part III, includes Sections 6.4 – 8, discusses the specific nations: Republic of Germany, Republic of Finland, Kingdom of Sweden, and The United States of America. It also provides the conclusive statements to the paper and the reference section."

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6 European Continent

6.1 The European Union (E.U.)

6.1.1 Historical overview & E.U. Law

Just as the dawn of the nuclear age finds its roots in the Second World War, the solidarity of the European Nations is born from the ashes of this war. This being the second major conflict within the first half of the twentieth century, the various nation states desire to establish a system of cooperation to prevent further conflict, and the Council of Europe21 is created in 1949. Based on the Schuman plan22, six countries sign a treaty to run their heavy industries (i.e., coal and steel) under a common management. The thesis presented is that through common control of the coal and steel industry a limitation is now placed on these nation states in their ability to

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21 The Council of Europe is the continent’s leading human rights organization. It includes 47 member states, 28 of which are members of the European Union. All Council of Europe member states have signed up to the European Convention on Human Rights, a treaty designed to protect human rights, democracy, and the rule of law.

22 The Schuman Declaration was presented by the French foreign minister Robert Schuman on May 9, 1950. The Schuman Declaration presents a path for the creation of “pooling of coal and steel production (which) will change the destinies of those regions which have long been devoted to the manufacture of munitions of war” by creating a “de facto solidarity” through a “higher authority” that will be built upon “concrete achievements”. The aim of the Schuman Declaration is to raise the standard of living among the European nations. Although customs duties disappeared in 1968, trade is not flowing freely across EU borders. The main obstacles are differences in national regulations. The Single European Act of 1986 launches a vast six-year programme to sort these out. The Act also gives the European Parliament more say and strengthens EU powers in environmental protection. The Treaty on European Union is signed in Maastricht. It is a major EU milestone, setting clear rules for the future single currency as well as for foreign and security policy and closer cooperation in justice and home affairs. Under the treaty, the name ‘European Union’ officially replaces ‘European Community’. The single market and its four freedoms are established: the free movement of goods, services, people and money is now reality. More than 200 laws have been agreed since 1986 covering tax policy, business regulations, professional qualifications, and other barriers to open frontiers. The free movement of some services is delayed. In 1995, The Schengen Agreement takes effect in seven countries — Belgium, Germany, Spain, France, Luxembourg, the Netherlands and Portugal.

Travelers of any nationality can travel between all these countries without any passport control at the frontiers. Other countries have since joined the passport-free Schengen area. In 1999, The EU countries coordinate these national economic policies so that they can act together when faced with challenges such as the current economic and financial crisis. Nineteen countries have pushed coordination even further by adopting the euro as their currency (it is introduced in 11 countries) for commercial and financial transactions only. Notes and coins will come later. The euro countries are Belgium, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland. Denmark, Sweden and the United Kingdom decide to stay out for the time being.
make the weapons of war to turn against the other, as in the past.

It is thought by each party understanding exactly the intent and projects being undertaken by the counter-party, then each party will have advanced foresight in how to respond and how to limit the party who is taking actions which would be detrimental to the others. The six nation states are Germany, France, Italy, the Netherlands, Belgium and Luxembourg. Following the successful implementation of the Coal and Steel Treaty, the six countries expand cooperation to other economic sectors. The Treaty of Rome is signed on 25 March 1957, creating the European Economic Community (EEC), or ‘common market’. Its basic overarching concept is for people, goods, services and trade to move freely across borders.

6.1.2 E.U. Law
On December 13, 2007, the 27 EU countries sign the Treaty of Lisbon, which amends the previous Treaties. It is designed to make the EU more democratic, efficient and transparent, and thereby able to tackle global challenges such as climate change, security and sustainable development. The Treaty of Lisbon is ratified by all EU countries before entering into force on 1 December 2009. This modernization of the institutions seeks to provide optimized working methods to tackle both efficiently and effectively the present challenges being faced. Europeans look to the EU to address issues such as globalization, climatic and demographic changes, security and energy. The Treaty of Lisbon reinforces democracy in the EU and its capacity to promote the interests of its citizens on a day-to-day basis. The aim of the treaty is to promote further harmonization among the Member States (MS).

A challenge in the harmonization process for the E.U. is in the fact that where the United States of America was a nation created by states, the E.U. is a transnational organ made up of nations attempting to function as states. The stabilizer of this body is found in the European Court of Justice (ECJ). The ECJ through its exercise of competence under the treaties has radically transformed both the constitutional nature of the (now) EU, and the breadth and depth of the substantive rights protected within that constitutional space.

By the very nature of its purpose in origination to be that of an interpretative court, the ECJ claimed the ideas laid for it in the Treaty of Rome and assumed a powerful role in assisting with the development of EU law. In this way, the Court has transformed the European political and legal landscape by means of its “ensuring that in the interpretation and application [of this Treaty] the law is observed.”

The ECJ therefore stays on the path originally prepared for it by the Schuman Declaration. This is that the harmonization process of the Member States of the E.U. must proceed in incremental steps. Thus, the ECJ may be said to be following in the footsteps of Geijer that in order to provide ‘stability through linkage’, it necessitates a thoughtful incremental forward approach to ensure that the customs, traditions and law making regimes of the Member States is harmoniously incorporated among the whole by means of a top-down apparatus.

This overarching concept in design was succinctly accomplished by the Court through establishing and asserting the principle of direct effect and the primacy of EU law within national legal systems through the process of judicial review and the preliminary reference procedure. In the Costa v Enel decision (which one must view as an Activist decision by claiming to it powers delegated to it) the Court through determining the “working of the question” of a complaint as presented, acted in order to obtain a “ruling of the compatibility of a national law with the treaty” through Article 177. “Its lack of

25) For instance: the founding Treaties contain no specific provisions on fundamental rights. The idea was developed through the ECJ by gradually developing a system of guarantees for fundamental rights throughout the EU. The rulings given by the ECJ have been essentially based on Article 267 TFEU giving the European Court the power to interpret the Treaty, the latter apply that interpretation to the facts of a particular case."


27) The first expansion of the E.U. takes place on 1 January 1973 – The six become nine when Denmark, Ireland and the United Kingdom formally enter the E.U. 1 January 1981 – Membership of the EU reaches double figures when Greece joins. It has been eligible to join since its military regime was overthrown and democracy restored in 1974. 1 January 1986 – Spain and Portugal enter the EU, bringing membership to 12.

1 January 1995 – Austria, Finland and Sweden join the EU. The 15 members now cover almost the whole of western Europe. In October 1990, Germany was unified and therefore former East Germany became part of the EU. 1 May 2004 - Eight countries of central and eastern Europe – the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia and Slovakia – join the EU, finally ending the division of Europe decided by the Great Powers 60 years earlier at Yalta. Cyprus and Malta also become members. 1 January 2007 - Two more countries from eastern Europe, Bulgaria and Romania, now form the EU, bringing the number of member states to 27 countries. Croatia, the former Yugoslav Republic of Macedonia and Turkey are also candidates for future membership.

28) For instance: the founding Treaties contain no specific provisions on fundamental rights. The idea was developed through the ECJ by gradually developing a system of guarantees for fundamental rights throughout the EU. The rulings given by the ECJ have been essentially based on Article 267 TFEU giving the European Court the power to interpret the Treaty, the latter apply that interpretation to the facts of a particular case."

29) “Challenging by way of a claim to review the lawfulness (judicial review) of decisions” (https://www.lexisnexis.com/uk/legal/search/homesubmitForm.do). Also see Halsbury’s Laws of England Volume 61 (2010) 5th addition: “601. General principles – The courts have an inherent jurisdiction to review the exercise by public bodies or officers of statutory powers imposing on legally recognized interests.”

In addition, as regards specifically to the EU, judicial review is the fundamental means by which the actions of the applicable decision making bodies of the EU can be controlled. “This enables the Court to consider whether a legally binding measure violates procedural or substantive rules of law. Binding acts of the Community institutions are subject to review through a number of routes, and the most direct way of reviewing is to challenge the legality of a particular measure. Article 267 Treaty of the Functioning of the European Union (TFEU) provides the mechanism for a direct challenge to the legality of Community acts.” (Steiner and Woods, Textbook on EU law, 2006, p. 244).

The preliminary reference procedure is an original feature of the EU system. This allows for the private enforcement of EU Law. In the EU, private actions begin in national courts where private litigants assert their directly effective EU Law rights against the State or other private persons. This remedy which is specific to the EU system provides a view into the importance of the role of individuals being vital in the development of EU Law. See Craig and De Burca, EU Law (Oxford, 2003), p. 472: “Article 267 TFEU gives the European Court the power to interpret the Treaty, but does not specifically empower to apply the Treaty to the facts of a particular case. Indeed the very distinction between interpretation and application is meant to be one of the characteristic features of the division of authority between the EU and national courts: the former interprets the Treaty, the latter apply that interpretation to the facts of a particular case.”
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Decommissioning and Waste Management

Following this laying of a solid foundation upon which to act, the ECJ further asserted its role in the EU framework continued to declare the supremacy of EU law finding that the idea of supremacy gives it powers to actively engage in this [EU] “body of law which binds both [their] nationals and themselves”.

The ECJ continued on a progressive journey of activism by developing the principle of direct effect in the Van Gend en Loos case. The ECJ is to provide a determination of the treaty, article 12 having “direct application in national law in the sense that nationals of member states may [on the basis of this article] lay claim to rights which the national court must protect”.

The ECJ left no doubt in the matter that this lies solely within its prerogative to adjudicate on an active basis by means of ascertaining the effects of provisions in relation to the treaty by “consider[ing] the spirit, the general scheme and the wording of the provisions”. In light of this, it may be said that the Court itself determined the manner in which it would set its ‘activist role’.

Having thus established itself to be an activist court in the role of ‘interpreter’ in the EU legal framework, the ECJ continued to radically expand the scope of the treaty provisions in many divergent areas. A review of the ECJ’s approach through the exercise of interpretative competence does not show a movement of the ECJ in a straight upward linear movement, but shows that the ECJ is keenly aware of the need to move forward in a manner sometimes showing restraint.

6.1.2.1 Treaty establishing the European Atomic Energy Community (Euratom) (28)

To tackle the general shortage of “conventional” energy in the 1950s, the six founding States (Belgium, France, Germany, Italy, Luxembourg and the Netherlands) looked to nuclear energy as a means of achieving energy independence. Since the costs of investing in nuclear energy could not be met by individual States, the founding States joined together to form Euratom.

The Euratom Treaty initially arose to coordinate the Member States’ research programmes for the peaceful use of nuclear energy. The major purpose and objective is to pool knowledge, infrastructure and funding of nuclear energy. A further primary goal is to ensure the security of atomic energy supply through creating a framework of a centralised monitoring system.

The major purpose for the creation of Euratom is to contribute to the formation and development of Europe’s nuclear industries. In so doing, it is devised so all the Member States can benefit from the development of atomic energy, which in turn will ensure security of the energy supply. Another overarching goal of Euratom is to guarantee high safety standards for the public are met as well as the prevention of nuclear materials intended principally for civilian use being diverted to military use. As with most international documents, Euratom’s powers are limited to peaceful civil uses of nuclear energy, being the states do not wish to relinquish sovereignty from the military sector.

6.1.2.2 EU Directive on Waste Management

Directive 2011/70/EURATOM establishes a Community framework for the responsible and safe management of SNF and radioactive waste within the E.U. For most nation states, the management of SNF and radioactive waste is governed by national legislation and the international conventions. However, with the E.U. being a supra-national body, this framework is being supplemented by an EU Directive. It was adopted by the Council of the European Union on 19 July 2011. Being a directive and as provided under the E.U. legal framework the directive provides binding legal force to the main internationally agreed principles and requirements in this field.

The aim of the Directive is to ensure a high level of safety in the waste management programs of the MS. It seeks to avoid undue burdens on future generations as well as the enhance transparency within the MS waste management programs. It supplements the basic standards referred to in the Euratom Treaty as regards the safety of SNF and radioactive waste without prejudice to the Basic Safety Standards Directive.

This Directive reaffirms the ultimate responsibility of MS for management of the SNF and radioactive waste generated in them. The prime responsibility of the licence holder for the safety of SNF and radioactive waste management is maintained and is to be under the supervision of its national competent regulatory authority. The role of the national...
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regulatory authorities is reinforced and their independence strengthened.

Each MS remains free to define its nuclear fuel cycle policy. The SNF can be regarded either as a valuable resource that may be reprocessed or as radioactive waste to be directly disposed of. MSs are obliged to establish and implement national programmes for management of SNF and/or radioactive waste from generation to disposal. Member States are under obligation to notify the Commission of their national programmes by August 2015 and any subsequent significant changes.

MS are under obligation to provide any necessary information on the management of SNF and radioactive waste be made available to workers and the general public. The public is to be given the necessary opportunities to participate effectively in the decision-making process regarding SNF and radioactive waste management in accordance with national legislation and international obligations. MSs are obliged periodically, and at least every 10 years, to invite international peer reviews of their national framework, competent regulatory authority and/or national programme with the aim of ensuring high safety standards.

6.2 The French Republic

France possesses a nuclear arsenal for military defense of approximately 300 warheads. France is now into its fifth Republic, and the French government feels more represents this sentiment. France is now into its fifth Republic (34).

Since Becquerel’s discovery, French scientists (for example Marie Curie) have developed the technology for creating artificial radioactivity and for harnessing the power of nuclear fission (32). After the Second World War, in 1945, under the leadership of General de Gaulle, the French government founded the French Atomic Energy Commission, or the CEA (Commissariat à l’Energie Atomique). In 1956, a joint project between the CEA and state-owned Electricité de France (EDF) was launched to develop the first all-French commercial nuclear reactor based on natural uranium gas-graphite technology (9). Less than 10 years later, in 1964, the first power reactor, EDF1, was operational at Chironon (on the Loire river) (32).

6.2.2 Government & Legislative Regime

The French citizen has a say in the running of the affairs of state and in matters relating to the nation’s nuclear power program through their government structure (35). Since the French Revolution of 1789, with a few exceptions, the power of government has rested within the hands of the people. With its banner of Liberty, Equality & Fraternity (36) as the mainstay of the revolution, the French National Assembly declared “so that by being liable at every moment to comparison with the aim of any and all political institutions the acts of the legislative and executive powers may be the more fully respected” (33). The sentiment is engrained within the psyche of the French People. When the people feel that the government no longer represents their interest and are no longer able to respect the acts of the legislative and executive powers, the French on a number of occasions since 1789 have started anew with a new government that it feels more represents this sentiment.

France nuclear law is created in France through the parliament in which the government is a semi-presidential system, centered on the French
Constitution of the Fifth Republic [34]. The Prime Minister of France is always elected from the majority party of the lower house of the Parliament and it is he who sets the direction for the government on matters involving France’s nuclear power program [34]. The Parliament is made up of the National Assembly and the Senate with its various functions to be that of passing of statutes, such as in matters relating to nuclear law, and votes on the budget to name a couple [34]. Therefore, matters relating to the French nuclear program reflect the will of the people through the decisions made by members elected to the French parliament.

Under the direction of the French parliament, the use of radioactive elements (natural or artificial) in France is mainly governed under the purview of the Public Health Code, which provides France with its general framework for legislative and regulatory needs. In addition, there are specific legal rules and provisions applicable based upon origin of certain substances, activities or installations [44]. France put in place comprehensive legislation in 2006 regarding nuclear transparency and safety with the passage of Act No. 2006-686 of 13 June 2006 (TSN Act) [35]. This act provided for the Nuclear Safety Authority (Autorité de sûreté nucléaire-ASN) to become an independent authority. The TSN act is considered an important piece of legislation as it provides certainty in the nuclear sector, which France lacked before this time [35]. Hitherto, legislation in France on nuclear matters was passed in a piecemeal fashion and with a change of technology (as needed) [35].

6.2.2.1 Legislative Framework

Nuclear waste disposal is undertaken in line with the 1991 Waste Management Act [45] (updated 2006) which established The Agence Nationale pour la gestion D échets Radioactifs (ANDRA) and which set direction of research [46] for 15 years [36]. Based on the findings of the research undertaken during the 1991 fifteen year mandate (and after strong support in France’s National Assembly and Senate), the Nuclear Materials and Waste Management Program Act [47] was enacted in June 2006. Operators are responsible for financing the management of their waste and the decommissioning of their nuclear installations. Therefore, it is important that operators have access to funds to fulfill their statutory and legal obligations when needed. Further, the ability to have dedicated funds set aside provides a stable environment for operators in which to act, especially by ensuring a satisfactory safety level of their future operations. To this end, in January 2005, the French Court of Accounts specifically provides recommendations to operators in its report “the decommissioning of nuclear installations and management of radioactive waste” [35]. Each nuclear operator (e.g., EDF, AREVA, CEA) manages its fund which stays inside the company [35].

6.2.3 Nuclear Waste Management

SNF from French reactors (and other nation states) is sent to Areva NC’s La Hague plant in Normandy for reprocessing. This has the capacity to reprocess up to 1700 tonnes per year of SNF [29]. Due to France having a program and facilities in place for reprocessing of SNF, SNF storage in pools at reactor sites in France is relatively brief. As of late 2011, 70% of EDF’s SNF was in

42 Constitution of October 4, 1958
43 Title IV Parliament, Article 24 – Parliament shall pass statutes. It shall monitor the action of the Government. It shall assess public policies. It shall comprise the National Assembly and the Senate. Members of the National Assembly, whose number shall not exceed five hundred and seventy-seven, shall be elected by direct suffrage. The Senate, whose members shall not exceed three hundred and forty-eight, shall be elected by indirect suffrage. The Senate shall ensure the representation of the territorial communities of the Republic. French nationals living abroad shall be represented in the National Assembly and in the Senate.
44 Installations are divided into 3 categories: (1) Basic nuclear installations (Installations nucléaires de base – INB); (2) Installations classified for environmental protection purposes (installations classes pour la protection de l’environnement) where activities using radioactive substances is carried out; and (3) defense related nuclear installations and activities (installations et activités nucléaires intéressant la défense – IAND).
45 Act No. 91-1381 30 December 1991
46 ANDRA’s origins began in the year 1979 as a “unit” of the CEA. It was established by the December 1991 Waste Act as a public body with responsibility for the long-term management of radioactive waste, under the supervision of the Ministry of Ecology, Energy, Sustainable Development and the Sea (formerly the Ministry of Industry and the Ministry of Environment), and the Ministry of Research. ANDRA has three basic missions (which were extended and its funding secured through the 2006 Planning Act). These missions are: 1. Research & Development - (a) to propose safe long-term solution for radioactive waste (without current disposal system); (b) this includes long-term storage, since the 2006 Planning Act, in order to propose interim solutions while final ones are being studied (the long-term storage issue was initially entrusted to the CEA according to the December 1991 Waste Act). 2. Industrial Mission – to establish waste acceptance criteria and control, as well as siting, construction, operation, closure and monitoring of repositories. 3. Information Mission – by way of regular publication of the National Inventory of radioactive materials and waste. This mission includes an active policy of dialogue with stakeholders both at national and local level. [38]
47 ANDRA is France’s national radioactive waste management agency.
48 The three research objectives for radioactive waste management established by this legislation were: (1) partitioning and transmutation; (2) repository in deep geological formations; and (3) long-term storage. [36].
49 Planning Act No. 2006-739, 28 June 2006. It supersedes the Waste Management Act of 1991 and is also valid for a 15 year timeframe. The 2006 legislation provides for the sustainable management of radioactive materials and waste. It makes the means for disposal for high-level and long-lived radioactive wastes and sets a target date of 2015 for the licensing of a repository with an opening slated for 2025 [37]. The 2006 Planning Act establishes a program on the sustainable management of radioactive wastes. This program of investigation for long-lived high-level and intermediate level wastes is in-line with its predecessor [39].
51 The main purpose and intent of such a financing scheme is that by these funds remaining autonomous (i.e., outside of the control) of the government, it provides for security in the financing process for nuclear power generating plants. More specifically, this is accomplished by limiting politicians’ desire (i.e., ability) to intermix these funds with other projects for which it was not intended. That being said, the situation differs from one company to the other. For instance, AREVA has already earmarked assets totaling its estimated future expenses. Following recommendations of the 2005 report by the French Court of Accounts, EDF made moves from the fall of 2005 through 2010 to accelerate its Collections each year to guarantee the funds needed would be obtained. Finally, CEA manages two funds (one for its civilian centers and the other for centers linked to the deterrent force) which will need to be developed in the future. [35]
SNF pools, mostly at La Hague, 19% was in dry casks and 11% had been reprocessed [29].

In 2008, Areva and EDF announced a renewed agreement to reprocess and recycle EDF's SNF that is to last through 2040 [29]. By contracting such an agreement with a long-range view commitment, the future of both the La Hague and MELOX (owned by Areva and situated in the regional department of Gard (France) plants are secured. Furthermore, such long term planning provides stability within the nuclear community in France in that nuclear power generating plants know and can better plan for onsite storage needs. France's back-end strategy in the handling and disposal of SNF is to evolve progressively in line with future needs and technological developments. The existing plants at La Hague (commissioned around 1990) have been designed to operate for at least forty years [29].

6.2.3.1 Permanent Disposal

VLLW in France comes mainly from the operation and decommissioning of nuclear facilities. Currently, it is stored above ground in the Collection, Storage and Disposal Facility (Centre Industriel de Regroupement, d'Entreposage et de Stockage – Cires), opened in 2003 [32]. Low and intermediate level, short lived radioactive waste is produced either by the maintenance and operation of nuclear facilities (clothing, tools, filters, etc.), or by research or healthcare activities in laboratories and hospitals [41]. Since 1992, it has been disposed of in the Aube disposal facility (CSA), which took over from the Manche disposal facility [32], operational from 1969 to 1994.

Since 1991, ANDRA has launched a major research program on the study of disposal in a clay formation. A key element of this study, in eastern France (the Meuse/Haute-Marne site), is of the stiff clay rock (argillite) which is approximately 155 million years old and sits in the Callovo-Oxfordian area [42]. This clay rock is found at a depth from 400 to 600 meters [42]. The work on the site and in the Meuse Haute-Marne laboratory sector has allowed for the collection of scientific information and the acquiring of an in-depth understanding of this site’s geological environment to ensure that the clay layer of the Callovo-Oxfordian provides the desired favorable properties for a waste repository and to assess its long-term behavior [32]. Furthermore, scientific activity has been going on in 40 m of drifts at a depth of 445 m since November 2004; over 300 m of drifts have been excavated at a depth of 490 m, of which some 120 m are dedicated to scientific experiments [32] [42].

Integrated as of the repository design phase, the reversibility requirement leads to privileging durable materials and to the implementation of systems for package retrieval [43]. Waste package retrieval is possible through simple inversion of the emplacement process over various centuries [43].

Since no site was available, studies on the granite medium were not meant to assess the feasibility of a repository designed to satisfy the specific aspects of a particular location [44]. The objective of this line of inquiry was to assess the interest of the granite medium for use in developing a repository. Thus, ANDRA has identified and dealt with the major issues concerned by a repository in a granite medium, in order to check that granite medium is not ruled out and to examine possible technical options [44]. The approach has been to study generic architectural designs for a repository, based on the properties of the granite medium [44]. These proposed options have formed the basis for analyses to understand the long-term conditions of a repository and to assess safety requirements. This information serves as the basis for France’s development strategy for moving forward with the development of a deep geological repository [57]. A review of the various waste management sites in France is provided in Table 1.

52] Upon arrival at the Cires facility, 30% of the waste received undergoes specific processing before disposal: (1) some plastic waste or scrap metal is compacted in order to reduce its volume; (2) liquid waste (polluted water, sludge) is solidified and made chemically inert. The waste is then placed in drums or big bags. Once prepared, these waste packages are labeled and stacked in vaults dug out of the clay layer, a few meters below the surface. Once the vault is full, it is roofed over with a covering containing sand, a waterproof membrane and clay [41].

53] Prior to disposal, some of the waste packages are compacted or solidified and then mixed with concrete before being placed in a concrete or metal container. A low and intermediate level package comprises 15 to 20% waste and 80 to 85% packaging material (epoxy resins) [44,45,46]. It is placed in reinforced concrete surface structures 25 meters long and 8 meters high, built over two superposed geological layers: one of sand, the other of clay [46]. These structures are then closed by a concrete slab, made watertight by a layer of impermeable resin [46]. Finally, a clay cap several meters thick is placed on the structures to provide long-term protection [46].

54] The ANDRA approach taken was not to determine a specific site for a possible repository, as the issue of where to locate a repository was determined to be premature when the studies began in 1991. Therefore, ANDRA’s objective was to assess only the transposability of the results obtained on the laboratory site to a larger zone. Through this transposability approach, the results will not depend on the specificities of any particular location. Therefore, deep bore-holes have been drilled since 1994 and 2300 m of argillite core samples extracted (from 4200 m of cored samples). ANDRA has taken over 30 000 samples (including 7300 fluid samples) and analyzed 5300 rock samples to date. Direct survey of the Callovo-Oxfordian host formation started in the shafts in March 2004 [42].

55] In all, over 1000 sensors have been installed for measurement in the rock and in situ observation of its behavior. Data are also acquired from many additional studies conducted in surface laboratories in France or abroad, or in underground research laboratories such as Mont Terri (Switzerland), where the argillaceous rock presents similar characteristics to that of Bure, or at Mol (Belgium) [42].

56] An observation program has been developed to ensure the technical feasibility of the backward process. The studies have shown that reversibility could be ensured for a minimum period of two to three centuries, with no intervention other than standard maintenance and monitoring operations [43].

57] On May 16, 2013, it was announced that the plans for the Cigéo facility to dispose of radioactive waste at Bure in France reached the stage where final public consultations could be held. A suitable site with local support for underground disposal has been identified at Bure, to the east of Paris in the Meuse/Haute Marne area. Industrial design work on the Centre Industriel de Stockage Géologique (Cigéo) facility was contracted in January 2012. Although Cigéo will be designed to accommodate the wastes permanently. French law requires that storage can be reversible for at least 100 years. As mentioned earlier, ANDRA has conducted research to make sure that its design applies with this law. A range of documentation on the project has been made available for a consultation period. Public comments will be considered ahead of ANDRA’s license application for permission to build and operate Cigéo, which could be submitted to the ASN next year. Given permission, ANDRA would hope to begin construction of Cigéo in 2019 and bring it into operation by 2025. In its central accounts, EDF has around €40 billion ($51 billion) set aside for waste management and decommissioning of power plants. Both a secure financing mechanism and public involvement are crucial in providing the public a sense of ease regarding the repository process. It should be noted that France involving the public in this matter is in line with international nuclear law, [47].
6.3 The United Kingdom of Great Britain and Northern Ireland (U.K.)

6.3.1 Historical Overview & Law

In 1946, under then Prime Minister Clement Attlee’s Labour government, it was decided to continue with a British atomic energy program with Parliament passing an Act "to provide for the development of atomic energy and the control of such development and for purposes connected therewith". This act laid out the powers of the Minister of Supply to promote and control the development of atomic energy. Various facilities for the production of uranium and plutonium, including Windscale, were constructed in the UK at this time. This activity on the part of the UK led to it exploding its first atomic bomb at Monte Bello, off the North West coast of Australia, in October 1952. However, the government was also increasingly interested in the civilian use of nuclear power, particularly for its use in generating electricity. To ensure government oversight and control, a senior cabinet minister would be responsible for the corporation and the related policy decisions. Under the Atomic Energy Authority Act of 1954, the UK Atomic Energy Authority was established to research and produce atomic energy.

By the late 1990s, nuclear power generating plants contributed approximately 25% of total annual electricity generation in the UK. However, this has gradually declined as old plants have been shut down. In 2011, the Department of Energy and Climate Change issued "Planning our electric future: a White Paper for secure, affordable and low carbon electricity" due to concerns that current power generation will not be able to keep up with demand.

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Tab. 1.

<table>
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<th>Site</th>
<th>Description</th>
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<tr>
<td>CSM Waste Disposal Facility</td>
<td>The CSM waste disposal facility located in the Manche district is the first repository to be built in France for low- and intermediate-level radioactive waste. It was created by a decree on 19 June 1969 and authorizing the CEA to modify its facilities at the La Hague Plant by adding a disposal facility for solid radioactive waste. Its operation was entrusted upon ANDRA by decree on 24 March 1995. The facility is officially in post-closure monitoring phase since 2003.</td>
</tr>
<tr>
<td>CSFMA Waste Disposal Facility</td>
<td>As the CSM waste disposal facility located in the Manche district was planned to be closed, a decree dated September 4 1989 CEA/ANDRA to create, within Souchains-Dhuys and La Ville-aux-Bois municipalities (Aube district), a disposal facility for solid- and intermediate-level short-lived radioactive waste, the CSFMA. Commissioned in 1992 as a CEA facility, the CSFMA has been officially operated by ANDRA since a March 24 1995 decree.</td>
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<td>CSTFA Waste Disposal Facility</td>
<td>The prospect of dismantling industrial nuclear facilities, as scheduled in the early 2000s, led the government and the Parliamentary Office for the Selection of Scientific and Technological Options (Office parlementaire d'évaluation des choix scientifiques et technologiques – OPECST) to require the nuclear industry and ANDRA to study a specific management system for very-low-level waste. Supported by public opinion and environmental associations, the approach led ANDRA to create the CSTFA, a new facility dedicated to the disposal of very-low-level radioactive waste, as authorized by Order No. 02-3138A of the Prefect of the Aube district, issued on 9 August 2002.</td>
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<tr>
<td>Meuse/Haute-Marne Centre (CMHM)</td>
<td>ANDRA's major research facility is the Meuse/Haute-Marne Centre with its two components: (1) the LSMHM Underground Research Laboratory sited at Bure in the Meuse district and aiming at studying the feasibility of the reversible geological disposal of high-level and long-lived intermediate-level radioactive waste in the Callno-Oxfordian clay formation. This facility was licensed on August 3 1999 and its construction as such (access shafts, basic drift network with underground ventilation) has been achieved in 2006. Nevertheless, more drifts and niches are due to excavated for the ongoing geological surveys and experimental programme or the engineering technological demonstrations. (2) Apart from this underground research laboratory, ANDRA works on the technological and engineering feasibility of geological disposal, and has built at Saumur in 2007 (in the Haute-Marne district near the LSMHM) a Technological Exhibition Facility (ETe), in order to design and operate prototypes and demonstrators.</td>
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pace with future demands. Rt. Hon. Chris Huhne MP Secretary of State for Energy and Climate Change stated, “Around a quarter of our existing capacity – mainly coal and nuclear power stations – will close in the next decade”[51]. In 2011, the Government announced the introduction of a Carbon Price Floor (CPF). The CPF will be introduced by removing from the Climate Change Levy the current exemption for supplies of fossil fuel, which are used to create electricity in the UK[51]. The White paper acknowledges that while this will be the first step in a package of reform for the UK electricity market to support low-carbon investment, it alone will not be sufficient to drive the required investment that will be needed in the UK[56].

The United Kingdom’s history link- age with atomic physics is through the work of New Zealand-born physicist Ernest Rutherford[66] and well predates the Second World War. In 1911, he proposed the Rutherford atomic model, a description of the structure of atoms. The model described the atom as a tiny, dense, positively charged core called a nucleus, in which nearly all the mass is concen-
trated, around which the light, negative constituents, called electrons, circulate at some distance, much like planets revolving around the Sun[57]. The Rutherford atomic model has been alternatively called the nuclear atom, or the planetary model of the atom[ibid]. Rutherford’s work, as well as those of his colleagues in the United Kingdom, laid the foundation to allow for atomic fission’s discovery, and to the efforts achieved during the Manhattan project.

6.3.2 Government & Legislative Regime
The British subject does have a say in matters relating to the UK nuclear program through the election of members to the House of Commons[69]. The involvement of the populace in affairs of the government, to allow them a say with matters of state, go back to the 15th of June 1215 in which the “Articles of the Barons” were sealed into what is known as the Magna Carta. It is important to note that the Magna Carta does not mention ‘parliam-
ent’ or the representation of the people, except the baronial class. In spite of this, the Magna Carta must not, though, be dismissed lightly[58]. The securing themselves of their privileges, “the barons of Runnymede were in fact establishing the rights of the whole landed class, great and small”[58]. The Magna Carta’s impor-
tance is secured in UK history and constitu-
tional law due to that it was the first time that the King himself is bound by the law. Therefore, in the 13th century, the great age of parlia-
mentary development and experiment began that directly impacts on today’s parliamentary democracy[59]. This is that the government is voted into power by the people to act in the interests of the people[59]. To this end, government policy is that the siting process for a geological disposal facility will be based upon voluntarism and partnership[59]. This means that any geological sites available for the disposal facility will depend on the locations of sites identified through discussions with local communities involved in the process[59].

6.3.2.1 Legislative Framework
Nuclear waste disposal in the UK falls under the 1993 Radioactive Substan-
ces Act[51]. The UK has full fuel cycle facilities including major reprocessing plants. In addition to these facilities, the Nuclear Decommissioning Authority (NDA) has established the Radio-
active Waste Management Directorate
Evaporites These rocks, for example rock salt, may contain water that has been trapped in them. This geological repository is defined by the RWMD as “burial underground (200-1,000 m) of radioactive waste in a purpose built facility with no intention to retrieve…” [59].

Higher strength rocks These rocks, for example granite, themselves generally have a very low permeability to water flow so that any water flow that does occur is in open cracks, or fractures, that have formed in the rock mass. This type of rock is planned to be used in Finland and Sweden at the sites chosen for their geological disposal facilities for used nuclear fuel.

Lower strength sedimentary rocks These rocks are generally physically uniform and any flow of water occurs through the overall rock mass. The Swiss Opalinus Clay geological disposal concept is designed for this type of rock.

Evaporites These rocks, for example rock salt, may contain water that has been trapped in them ever since they were formed, but they are isolated from water flow that could dissolve them. In the USA, this type of rock is used for the Waste Isolation Pilot Plant, where waste has been disposed of for more than a decade, in New Mexico; Germany has also developed a concept for this type of rock.

### 6.3.3.1 Permanent Disposal

One option that is being considered for the management of SNF and other materials, notably HLW, involves the use of multi-purpose containers (MPCs) [36]. In general terms, MPCs are containers that are designed to meet requirements for safe containment of radioactive waste during storage, transport and disposal [36]. Work has been undertaken to develop an understanding of the feasibility of using MPCs for SNF/HLW management and disposal. The MPC concept has the advantage that the waste is not handled again directly once it has been placed in the MPC [36].

Most MPCs designed to date have been developed for storage and transport of SNF overseas and their SNF loading capacities have been maximised in order to minimize the number of package movements and to minimize storage areas [36]. Until a geological repository is realized, the UK has various means for the handling and disposal of nuclear waste for its waste management scheme. To be continued: Part III in atw 1 (2017).

### References


### Tab. 2

<table>
<thead>
<tr>
<th>Broad (Generic) Host-Rock Types (UK) [59].</th>
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<tr>
<td>Higher strength rocks</td>
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<tr>
<td>Lower strength sedimentary rocks</td>
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<tr>
<td>Evaporites</td>
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74. The MRWS White Paper sets out what is known as the Baseline Inventory of the higher activity radioactive waste that is a legacy from nuclear activities that have been undertaken or committed to up to now [34]. This includes radioactive materials which have not yet been classified as waste, such as used nuclear fuel from power stations which has not yet been reprocessed; plutonium and uranium extracted from used fuel that has been reprocessed; and uranium from the nuclear fuel manufacturing process [33].

75. Higher strength rocks – the UK IUW/LW concept and KBS-3V concept for SNF were selected due to the availability of information on these concepts for the UK context (Report # NDA/RWMD/013).

76. Lower strength sedimentary rocks – the Opalinus Clay concept for disposal of long-lived IUW, HLW and SNF was selected because a recent OECD Nuclear Energy Agency review regarded the Nagra (Switzerland) assessment of the concept as state of the art with respect to the level of knowledge available. However, it should be noted that there is similarly extensive information available for a concept for a conceptual that has been developed for implementation in Callovo Oxfordian Clay by Andra (France), which has been accorded strong endorsement from international peer review. Although we will use the Opalinus Clay concept as the basis of the illustrative example, we will also draw on information from the Andra programme. In addition, we will draw on information from the Belgian super container concept, based on disposal of HLW and SNF in Boom Clay [ibid].

77. The concept for the disposal of transuranic wastes (TRU) (long-lived IUW) in a bedded salt host rock at the Waste Isolation Pilot Plant (WIPP) in New Mexico, USA was selected because of the wealth of information available from this licensed, operating facility. The concept for disposal of HLW and SNF in a salt dome host rock developed by DEB Technology (Germany) was selected due to the level of concept information available [ibid].