CoRWM

Committee on Radioactive Waste Management

PRELIMINARY POSITION PAPER: RADIOACTIVE WASTES FROM FUSION ENERGY

November 2021

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RADIOACTIVE WASTES FROM FUSION ENERGY

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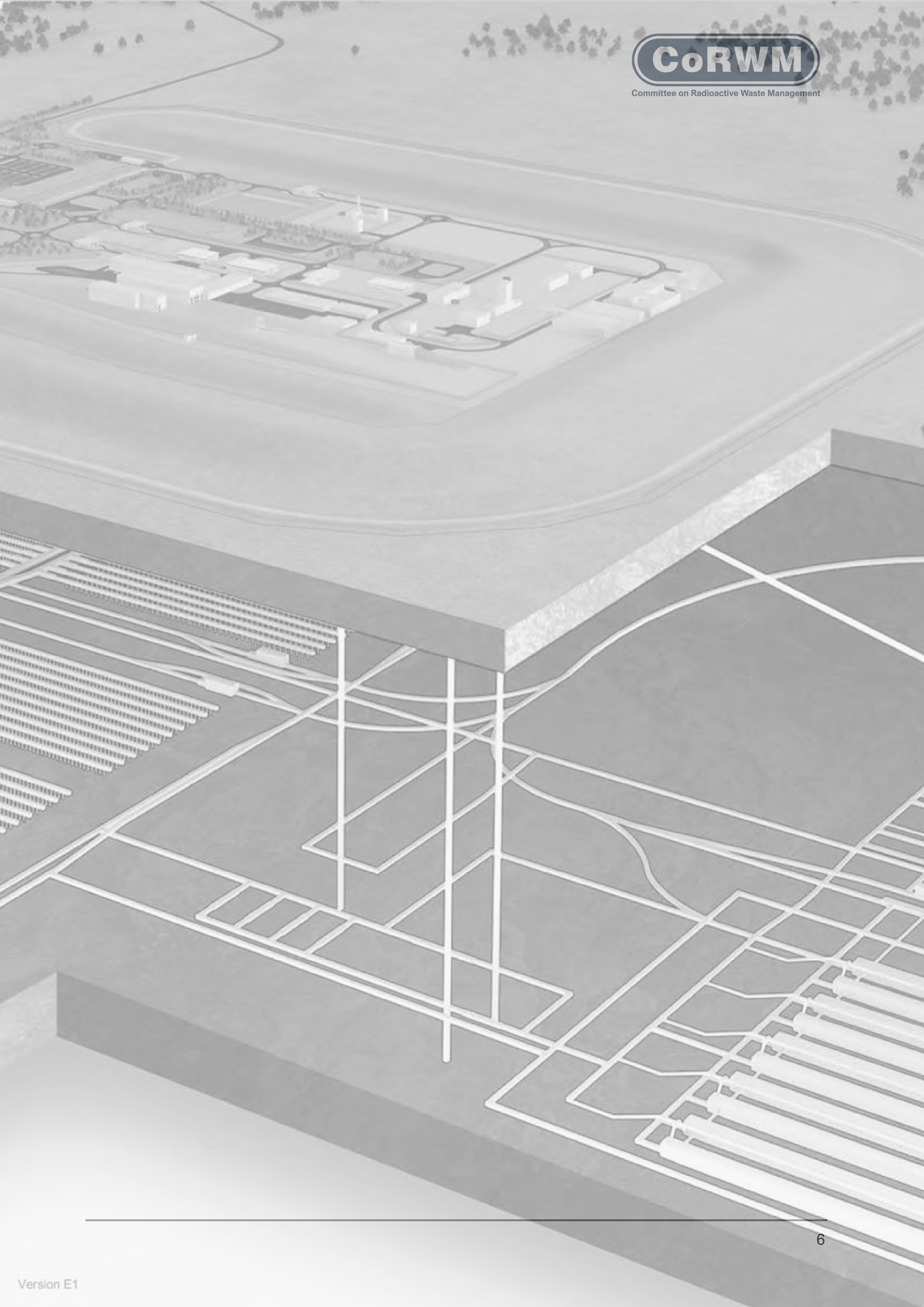
1 Overview

CoRWM has considered the implications for decommissioning, radioactive waste management, and radioactive waste disposal associated with fusion energy and has reached a preliminary position as set out in this paper. Consideration of this topic will continue and CoRWM will produce a further consolidated position paper in due course.

2 CoRWM Recommendations

No	Recommendation
1	**BEIS and CoRWM should engage to amend the CoRWM Framework Document to formalise consideration of decommissioning, radioactive waste management, radioactive waste disposal associated with fusion power.**
2	**Following consultation with BEIS, CoRWM should provide appropriate scrutiny and advice of radioactive wastes from fusion power, through its annual work plan.**
3	**Following conclusion of the current Green Paper consultation, CoRWM should produce a consolidated position paper on decommissioning, radioactive waste management, radioactive waste disposal associated with fusion power.**



3 Prior CoRWM consideration of radioactive wastes from fusion energy

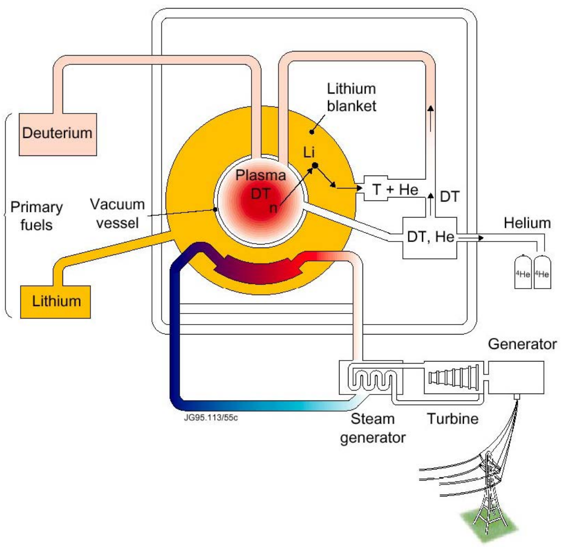
The original CoRWM recommendations on Managing Radioactive Waste Safely make no explicit reference to radioactive waste arising from nuclear fusion. A search of the CoRWM archive has not identified any briefing notes or record of discussion on radioactive wastes arising from nuclear fusion. CoRWM therefore has no specific position, at the current time, on the management of radioactive wastes from future nuclear fusion power systems. This paper was developed, originally, as an advisory note for CoRWM to assist the Committee in framing its consideration of radioactive wastes from nuclear fusion and to advise BEIS in its development of the recent Green Paper: Towards fusion energy: the UK fusion strategy, and consultation on regulation of fusion energy [1,2]. Engagement with CoRWM stakeholders further identified an opportunity for this paper to inform a wider audience of the nature of radioactive wastes arising from nuclear fusion, pending a formal position paper from the Committee. CoRWM has therefore published this paper with minor amendment, following feedback from stakeholders, as a Preliminary Position Paper. Publication of the Green Paper was accompanied by a UKAEA Technology Report – Safety and Waste Aspects for Fusion Power Plants, which postdates this paper [3]. Following conclusion of the Green Paper consultation, CoRWM will produce a consolidated Position Paper on radioactive wastes from fusion power.

4 Introduction to nuclear fusion

Nuclear fusion is an attractive source of low carbon electricity generation for the future; however, it has so far proven extremely challenging to achieve controlled and continuous release of energy in fusion reactor systems. The preferred nuclear reaction for exploitation is deuterium – tritium or DT fusion [4]:

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n $$

The high energy (14.1 MeV) neutron produced by this nuclear reaction transfers energy to the reactor vessel, which is cooled by high pressure water, liquid metal, molten salt or helium gas as the primary coolant. A heat exchanger raises steam from the primary coolant for electricity production, as in a nuclear fission reactor and gas fired combined cycle power plant, see Figure 1.



To achieve fusion and release energy, the DT gas mixture must be heated to around 200 x 10^6 ^{o}C (i.e. two hundred million Celsius), to form a plasma, or ionised gas, in which the electrons are stripped off the atomic nuclei. The plasma is confined by a magnetic field, in a tokamak device, to maintain a density and temperature sufficient to propagate the fusion reaction. The helium-4 nucleus produced by DT fusion transfers its energy (3.5 MeV) to the plasma, to maintain the temperature. An alternative approach to plasma confinement is inertial confinement achieved by rapid compression and ignition of the DT fuel, achieved by laser heating of a small volume.

Note that the principle of a nuclear fusion reactor is the release of energy from combining (i.e. fusing) two light nuclei, to produce a heavier product nucleus, with release of a neutron. In contrast, nuclear fission involves the splitting of fissile atoms (e.g., uranium-235) by low energy neutrons, to produce unstable, i.e. radioactive, fission products and further neutrons. Capture of neutrons by uranium, followed by radioactive decay, produces long lived actinides, e.g. plutonium and neptunium. An immediately apparent advantage of nuclear fusion, therefore, is the absence of long-lived fission and actinides, which constitute challenging radioactive waste constituents. Nevertheless, nuclear fusion systems will produce radioactive wastes, albeit of a different nature and bounding assumptions of management, as summarised below, which may challenge current radioactive waste management policy.

In the preferred DT fission reaction, tritium is a short-lived heavy isotope of hydrogen, whereas deuterium is stable. Tritium is a low energy (soft) β-emitter and therefore poses minimal external hazard, with a half life of 12.3 years. In humans, the biological half life is estimated to be 10 days, in the form of tritiated water (HTO), which is therefore considered to have relatively low radio-toxicity [6,7]. However, for tritium incorporated in organic compounds, the biological half life is estimated to be 40 days, which is of increased radio-toxicity compared to tritiated water [6,7]. To provide some context with regard to radiotoxicity, drinking 2 litres of water each day for a year at the highest permissible level of tritium at 10,000 Bq / litre would result in a dose of 0.1mSv per year, equivalent to two weeks of exposure to natural radioactivity in the UK. Tritium is a particularly mobile radionuclide due to substitution hydrogen in water, inorganic and organic compounds.

The natural abundance of tritium is very low, it is produced by the reaction between cosmic rays and nitrogen or oxygen in the upper atmosphere. Therefore, for consumption in fusion reactors, tritium is produced by breeding from lithium:

$$ {}^{6}_{3}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{3}_{1}H $$

$$ {}^{7}_{3}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He + {}^{3}_{1}H + {}^{1}_{0}n $$

This is achieved by surrounding the fusion reactor with a breeder blanket containing pebbles of a lithium oxide, molten lithium metal or molten lithium salt, within which the above reactions take place. A proportion of the fast neutrons produced by fusion are utilised for the breeding reaction, and, clearly, the objective is to achieve a net production of tritium slightly greater than consumption, to ensure a constant supply of nuclear fuel in a closed fuel cycle. Tritium extraction, separation and purification facilities will therefore be an integral component of the nuclear island of a fusion power plant.

5 The UK position in fusion energy

The UK has historically held a position of strength in the development of nuclear fusion technology, under the auspices of the UK Atomic Energy Authority, UKAEA [8]. Research was initiated in the late 1940s, leading to the Zero Energy Thermonuclear Assembly (or ZETA) at Harwell, under direction of the Atomic Energy Research Establishment, which entered operation in 1957. UKAEA established the nearby Culham Laboratory in 1965 to lead development of nuclear fusion research. In 1977, Culham was selected as the site to host the Joint European Torus, JET, a prototype tokamak device, which produced its first plasma in 1983. JET was the first machine in the world to achieve controlled DT fusion in 1991. Over the last two decades JET has been utilised to refine the design parameters for its successor the 500 MWth International Thermonuclear Experimental Reactor, ITER, located in Cadarache, France, and due to commence operation in 2035. ITER will be the first system to achieve break even, where the energy output from the fusion reaction exceeds the energy input. DEMO, a 1 – 2 GWth DEMOnstration power plant is planned for the 2050s, see Figure 2. Over the last three decades UKAEA has pioneered development of the spherical tokamak design as a smaller, lower cost, fusion power reactor. The first such experimental system, START (Small Tight Aspect Ratio Tokamak), operated from 1991-1998, followed by the more advanced MAST (Mega Amp Spherical Tokamak) from 2000-2013, with the MAST Upgrade entering service in 2020. UKAEA launched a nationwide siting competition in 2020 for the STEP facility (Spherical Tokamak for Energy Production), the first prototype fusion power plant of its kind, targeting operation by the 2040s [9]. In the Ten Point Plan for a Green Industrial Revolution, Government reaffirmed its commitment of £222 million for the STEP programme and £184 million for allied facilities, infrastructure and apprenticeships in nuclear fusion [10]. The commercial nuclear fusion market is developing in the UK, and overseas, with several vendors aiming to develop and deploy commercially viable power plants, such as Tokamak Energy, First Light, and General Fusion.

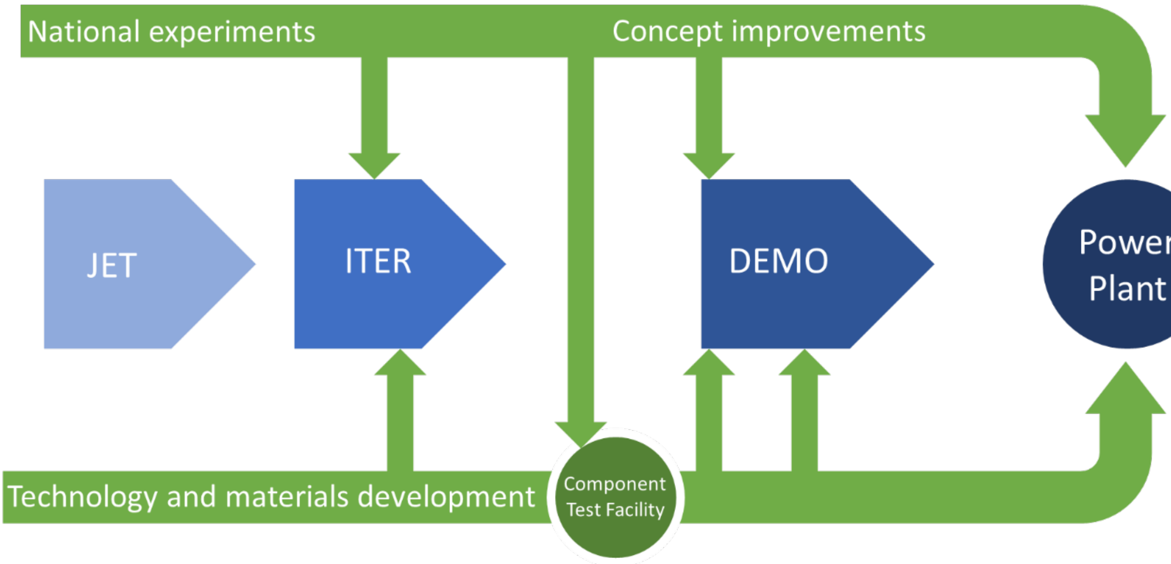


Figure 2: Road map to achieve commercial nuclear fusion power plant, adapted from EUROfusion / CCFE [11].

6 Radioactive wastes from fusion energy

Although nuclear fusion does not produce long lived fission products and actinides, neutron capture by the reactor structural materials and components forms short, moderate and some long lived activation products. Thus, in addition to tritium emissions and contaminated materials, there will be a need to manage radioactive materials and wastes produced by neutron activation, within regulatory controls, over the whole life cycle of a fusion reactor [3].

It is important to appreciate that the technological approach to nuclear fusion was historically predicated on avoiding the generation of long lived activation products, by eliminating the parent element, or reducing the concentration as far as practicable, in materials design [12]. Indeed, the ITER project continues to express this aim as: “No long-lived radioactive waste: Nuclear fusion reactors produce no high activity, long-lived nuclear waste. The activation of components in a fusion reactor is low enough for the materials to be recycled or reused within 100 years.” [13]. In its recent Green Paper, the UK Government committed to apply the principles of the waste hierarchy to all wastes from nuclear fusion, whether radioactive or not [1]. Minimising the generation of long lived activation products, and tritium inventory at source, is therefore of fundamental importance in achieving the primary objective in the waste hierarchy of waste prevention. However, it is to be recognised that future generations will be committed to managing wastes arising from decommissioning and waste management plans that are predicated on extended decay storage, such as those discussed herein.

The conceptual approach to managing wastes from nuclear fusion power is well founded on the currently applied waste hierarchy, with objectives of:

- Prevention of waste by release of material from regulatory control, for reuse and recycle.
- Reuse and recycling of radioactive materials, under regulatory control.
- Minimisation of radioactive waste for disposal.

However, historically, in the context of nuclear fusion power there has been a fundamental objective to avoid disposal of radioactive wastes in a deep geological disposal facility, which would afford isolation for a geological timespan [3, 5, 12]. In practical terms, the fusion community has adopted the position that radioactive waste produced from the first generation of commercial fusion reactors should be classified as low-level waste (LLW) within 100 years after the end of life (EOL), i.e. after cessation of commercial power generation [14]. Implicit within this approach is, presumably, a period of in situ decay-management, prior to dismantling, and a potential requirement for some decades of interim decay-storage prior to disposal. It is noted that an assumption of any such decay storage requirement will require justification to regulators, evidence to demonstrate confidence in managing wastes and stores for several decades, and acceptance of a local host community. The experience of the Magnox decommissioning programme is that the effort and cost of keeping facilities safe and structurally sound during the decay period such that it can be safely dismantled and decommissioned, may prove prohibitive and early reactor dismantling may be preferable. The fusion programme has the opportunity to benefit from these lessons, by design of infrastructure for end of life decay-management, care and maintenance, and minimisation of interim storage. This should include design with decommissioning in mind to enable the waste hierarchy to be applied, improve waste packaging efficiency, and achieve standardisation of practice across the fleet, for example by use of standardised containers and centralised / regional storage.

Radioactive wastes arising from operation and decommissioning of the JET experimental nuclear fusion reactor, located at Culham, are already factored into the UK radioactive waste inventory. Forecast LLW and ILW packaged volumes are 4,120 m^3 and 480 m^3, respectively [15]; activated steels and alloy plant and equipment, including the JET vacuum vessel, are a major contributor to the ILW arising. Development of the future ITER and DEMO reactors is incorporating the experience of radioactive waste management developed in the context of JET, in particular detritiation technology [16].

6.1 Prevention of waste by materials design

At present, there are no detailed engineering designs or specifications for nuclear fusion power plants. Fusion research programmes are taking a critical perspective on the elimination of problematic elements from the structural materials of the reactor breeder blanket, and other components, which would lead to moderate to long lived activation products under the operational neutron flux and pose a challenge to disposal as LLW at 100 years after EOL [14, 17-20].

The primary structural materials in the breeder blanket will be high performance steels, however, elements commonly utilised in alloying such as Ni, Nb and Mo, are problematic from an activation perspective and must either be substituted by alternatives or reduced as far as tolerable [14, 17-20]. Nevertheless, these materials must satisfy the structural performance requirements under neutron irradiation, be compatible with required manufacturing technology (e.g. welding), show satisfactory embrittlement and swelling characteristics, and be compatible with the coolant. In contrast to the operational philosophy of nuclear fission reactors, components of the nuclear fusion reactor vessel will require replacement during the operational lifetime [3]. These components will be highly activated and require shielding and remote handling.

From an activation perspective, the key nuclides of potential concern, as identified from recent activation modelling studies [14, 17-20], are summarised in Table 1. However, there are many other nuclides produced by activation which, depending on the final materials selection, may also need consideration. Table 1 also summarises CoRWM's interpretation of the behaviour and importance of the key nuclides of concern within the current generic Post Closure Safety Assessment for a Geological Disposal Facility (gPCSA) [21]. Note that the inventory considered in the gPCSA is different from that expected from a future nuclear fusion power programme. However, the occurrence of ^{14}C and ^{94}Nb, through activation of structural steels and alloys has some commonality. From a radiological perspective, it is reasonable to consider that, conceptually, wastes from a nuclear fusion power programme should be compatible with geological disposal, however, they may prove challenging for disposal in a near surface facility, given the long half life and potential mobility of ^{14}C and ^{94}Nb.

Nuclide	**Half life**	**Production route**	**Comments**
^{3}H	β^-, 12.3 y	$^{2}H(n,\gamma)^{3}H$ $^{6}Li(n,\alpha)^{3}H$, $^{7}Li(n,n\alpha)^{3}H$	Unlimited solubility, no sorption. Could be managed by extended decay storage. Currently managed by nuclear industry through "dilute and disperse" approach.
^{63}Ni	β^-,100 y	$^{62}Ni(n,\gamma)^{63}Ni$	High solubility, strongly sorbing. Decays within engineered barriers of a GDF system.
^{14}C	β^-, 5,700 y	$^{14}N(n,p)^{14}C$	High solubility and moderately sorbing as carbonate species, may be released as methane gas from corroding metal. In post closure DSSC for GDF, migration of ^{14}C, and radiological risk, depends on speciation and geological environment.
^{94}Nb	β^-, 20,000 y	$^{93}Nb(n,\gamma)^{94}Nb$	Low solubility, strongly sorbing. In generic post-closure DSSC for GDF, ^{94}Nb migrates through lower strength sedimentary host rock, but calculated mean radiological risk is insignificant.

Table 1: summary of key nuclides of concern for management of wastes from nuclear fusion.

6.2 Expected radioactive waste arising from nuclear fusion reactors

Management of radioactive waste arising from nuclear fusion reactors will depend on the availability of disposal routes, regulatory standards and practice in the country of origin. The development of nuclear fusion systems, however, is a uniquely collaborative international effort due to the technical challenge and cost. The natural misalignment of standards and practice between such international collaborators may result in different classification and management of otherwise identical conceptual wastes in the respective nations [14]. This is no different from the management of radioactive wastes from current fission reactors, with the exception that such wastes are rarely directly comparable between nation states. The radioactive waste inventory is expected to include:

Activated bioshield. The reactor bioshield will be of reinforced concrete construction and will be mildly activated. The bioshield is assumed to be suitable for free release at 100 y after EOL or will otherwise increase the LLW volume for disposal by several fold.

Activated reactor components. The extent of activation of reactor components will depend on the neutron exposure and the composition of the material. In-vessel, plasma facing first wall, blanket, back wall, divertor, and possibly some vacuum vessel components will likely be classified as ILW at 100 y after EOL. Some components such as the plasma facing wall tiles will require frequent replacement over the reactor lifetime and contribute a continuous waste stream during operation. In principle, replacement schedules could be optimised to manage activation and achieve LLW 100 y after EOL, though this is evidently a tension against waste volume. However, the content of toxic metals, such as beryllium, may mean that such wastes do not meet LLW Waste Acceptance Criteria on non-radiological grounds.

Tritiated wastes. All in vessel reactor components and some external reactor vessel components such as the fuel recycle and cooling system will be contaminated by tritium, including the potential ILW arisings highlighted above. Detritiation of such components may be necessary to allow free release, reuse or recycle, or to meet requirements for disposal at the time of waste emplacement. Existing surface decontamination technologies (e.g. laser scabbling or shot blasting) or bulk decontamination techniques (e.g. smelting) may be applicable. Tritium handling operations are likely to produce significant but unquantified volumes of tritium contaminated materials, from which tritium recovery may be uneconomic. This could realise the need for very significant decay-storage capacity with a lifetime of at least 100 years. UKAEA is developing detritiation technologies to support the nuclear fusion fuel cycle and decommissioning of the

JET reactor, but that considerable further development is required to fully mature such approaches [22-25].

Note fusion power systems will produce heat generating wastes in the form of highly activated plasma facing tiles, however, the intention is for decay storage to ILW in shielded facilities. Therefore, fusion power systems will not produce HLW that requires disposal.

6.3 Reuse and recycle

Materials of sufficiently low radioactive inventory, arising from decommissioning of fusion reactors, may be amenable to release from regulatory control and may be reused (noting that non-radiological properties will also be a determining factor), recycled or disposed as waste, according to the prevailing market conditions. Management of such wastes should not attract any additional requirements than those arising from any other part of the national economy. Experience from the nuclear fission decommissioning programme has shown that the commercial sector will respond with waste treatment technologies, e.g. surface decontamination, to enable free release of material otherwise to be consigned as waste, if the commercial environment and incentives are conducive. In particular, an integrated LLW treatment and disposal ecosystem have been recognised as crucial to achieving waste minimisation in nuclear decommissioning. It would not be too early for the nuclear fusion industry to consider the commercial environment and waste treatment technologies required to maximise free release of materials.

Reuse or recycle of radioactive materials from decommissioning of fusion reactors in subsequent systems, within regulatory control, has been proposed, with the intention of waste minimisation [3, 18]. Remote handling and fabrication techniques will be needed if the dose rate or inventory of the materials demand. It is recognised that there is considerable experience and capability in remote handling developed through operation and maintenance of the JET platform [26], however, it will be necessary to further innovate and optimise such technology for deployment in waste recycle and reuse applications, which may require considerable innovation and prove uneconomic. Moreover, the materials and design considerations of future nuclear fusion systems have yet to be conceived, and it would be reasonable to assume they will evolve in an effort to improve performance. In the absence of enabling technologies and even a conceptual market, reuse and recycle of materials must be considered hypothetical. It would therefore be prudent and transparent to plan a baseline scenario of disposal of such materials as waste, if free release cannot be reasonably assumed. Reuse and recycle within regulatory control should only be considered as a viable alternative waste minimisation strategy when any necessary enabling technology is sufficiently mature and there is confidence of uptake as a feedstock for future fusion reactors.

6.4 Radioactive wastes requiring disposal

The primary components of the fusion reactor system are likely to require disposal, including the activated front wall, blanket, divertor and vacuum vessel materials. As noted above, material design considerations seek to minimise activation and enable these components to be managed as LLW where possible, or otherwise as low-risk ILW, within 100 y after EOL. Government is now considering whether future fusion power plants should be encouraged to produce radioactive wastes that would be suitable for a surface disposal facility (similar to LLWR at Drigg) or a near surface disposal facility (similar to the NSD concepts being explored by NDA) for ILW [1]. Consideration will need to be given to the issue of near surface disposal of discrete items, in terms of waste acceptance criteria in the context of human intrusion scenarios, since design for decommissioning could produce a substantial waste inventory of this nature. Disposal of fusion wastes could not necessarily rely on the availability of these facilities, certainly in the long term, and consideration should be given at this stage as to the disposal facility requirements needed to underpin both prototype and fleet scale deployment of fusion reactor systems. Furthermore, some key activation products of concern, such as ^{14}C and ^{94}Nb, which are long lived, should be limited in near surface disposal facilities, given the reliance on engineered barriers to assure containment [27].^{14}C poses a particular challenge given its potential mobility in the near subsurface. It would be appropriate to undertake early performance assessment using existing LLWR post closure models, combined with model waste inventories, to develop confidence in disposability of potential LLW wastes. This would need to be supported through a wider consideration of the potential numbers of fusion reactors that may require disposal. Consideration should also be given to issues of future human intrusion given the potential economic attractiveness of disposed materials, which may be a differentiation from current LLW.

Recent modelling studies have highlighted that currently envisioned structural steels for the reactor blanket will fail to meet LLW criteria at 100 y after EOL, along with the best performing steels for the vacuum vessel [14, 17-20]. It is also acknowledged that some in-vessel (and possibly vessel) materials, particularly from highly activated plasma facing and near plasma components, may fail to meet current LLW criteria even 1000 y after EOL. Classification of such waste as ILW would not necessarily preclude near surface disposal, if it could be demonstrated that the isolation afforded by containment in a geological disposal facility was not required. Geological disposal of such ILW should not prove problematic. In considering and planning the facility requirements for disposal of radioactive wastes arising from the nuclear fusion programme, a graded approach should be taken, to achieve disposal of the waste according to the risk posed.

There are no reliable estimates of LLW and ILW waste volumes arising from commercial scale fusion reactors. However, a recent waste assessment of DEMO reactor designs, based on modelled materials activation, provides some insight [3, 17]. Depending on materials selection, several thousands of tonnes of ILW and tens of thousands of tonnes of LLW could be generated over a 20 year operational life span, associated with the fusion reactor components and vacuum vessel. Decay storage will reduce the quantity of radioactive waste requiring disposal by 100 y after EOL, and it is expected that some of the inventory may only just exceed the threshold for LLW and ILW classification. Development of a graded risk based approach to management of such boundary wastes, rather than a classification based approach, would be appropriate.

Clearly, there is a need to ascertain the extent to which radioactive wastes arising from future fusion systems can be confidently expected to meet LLW criteria at 100 y after EOL, and to understand whether any ILW can be plausibly managed in near surface disposal facilities. There is also a need for consideration of the other hazardous or non-radiological properties of the radioactive wastes from nuclear fusion, which may be the determining factor for acceptance as LLW and near surface disposal.

6.5 Need for an integrated waste management planning strategy

The development of an integrated radioactive waste management strategy has enabled the development of more robust and cost effective decommissioning plans for nuclear fission reactors, through lifecycle management that accounts for the radiological, chemical and physical properties of the waste [28]. This approach has also enabled development of the commercial environment to implement waste treatment technologies required to enable implementation of the waste hierarchy. The development of a such a holistic planning strategy for management of waste from future expansion of nuclear fusion power would be advisable, such that the required waste treatment and disposal facilities can be planned and costed according to the projected volumes of waste arising, and the feasibility of reuse and recycle of activated materials assessed. This could function as a projected radioactive waste inventory, periodically updated as uncertainties in fleet size, disposition and materials are constrained.

6.6 Public perception

A clear and transparent dialogue will be required to maintain public confidence in development and management of nuclear fusion technology. Nuclear fusion technology is advocated as not being compromised by the burden of generating long lived nuclear wastes. It is evident that this claim is challenged by the expected generation of some significant volumes of LLW and likely ILW arisings. It may be noted that the recent call for expressions of interest to accommodate siting the STEP facility makes no mention of management of the arising radioactive waste. Future dialogue with local communities needs to ensure it is as open and transparent as possible on such matters.

Materials of sufficiently low radioactive inventory, arising from decommissioning of fusion reactors, may be amenable to release from regulatory control and may be reused (noting that non-radiological properties will also be a determining factor), recycled or disposed as waste, according to the prevailing market conditions. Management of such wastes should not attract any additional requirements than those arising from any other part of the national economy. Experience from the nuclear fission decommissioning programme has shown that the commercial sector will respond with waste treatment technologies, e.g. surface decontamination, to enable free release of material otherwise to be consigned as waste, if the commercial environment and incentives are conducive. In particular, an integrated LLW treatment and disposal ecosystem have been recognised as crucial to achieving waste minimisation in nuclear decommissioning. It would not be too early for the nuclear fusion industry to consider the commercial environment and waste treatment technologies required to maximise free release of materials.

7 Conclusion

The future radioactive waste arisings from deployment of nuclear fusion power are uncertain as a result of the early stage of technology development. Nevertheless, HM Government commitment to nuclear fusion power and the siting process for the STEP fusion power plant are likely to increase public and stakeholder interest in the allied radioactive waste management strategy. It may therefore be timely for CoRWM to begin early scrutiny and consideration of these issues, so as to be in a position to provide effective advice, on matters including:

- Development of an integrated radioactive waste management strategy in nuclear fusion, potentially aligned to the current implementation of such a strategy by the NDA.
- Planning and assumptions for a baseline radioactive waste inventory.
- Disposability of long lived ILW from fusion in near surface facilities and the need for GDF availability to mitigate waste that does not meet near surface acceptance criteria.
- Consideration of the other potentially hazardous, non-radiological properties of the radioactive wastes from nuclear fusion.
- Requirements and capacity for decay storage of radioactive wastes.
- Credibility for free release of waste material and reuse / recycle under regulatory control.
- Compatibility of the approach to radioactive waste management with regulation.
- Specific issues of fit with radioactive waste policies of the devolved governments.
- Public and stakeholder engagement to develop a better understanding of the radioactive wastes issues associated with fusion technology.

This work would extend across all CoRWM sub groups. CoRWM will need to engage with BEIS to amend its Framework Document to formalise consideration of decommissioning, radioactive waste management, radioactive waste disposal associated with fusion energy. This will enable CoRWM to develop its consideration within its annual work plan. This work will be informed and guided by the outcome of the current Green Paper consultation: Towards fusion energy: the UK fusion strategy, and consultation on regulation of fusion energy [1,2]. After conclusion of this consultation, CoRWM will be in a position to develop a consolidated position paper on the issues of decommissioning, radioactive waste management, radioactive waste disposal associated with fusion power.

Recommendation 1
BEIS and CoRWM should engage to amend the CoRWM Framework Document to formalise consideration of decommissioning, radioactive waste management, radioactive waste disposal associated with fusion power.

Recommendation 2
Following consultation with BEIS, CoRWM should provide appropriate scrutiny and advice of radioactive wastes from fusion power, through its annual work plan.

Recommendation 3
Following conclusion of the current Green Paper consultation, CoRWM should produce a consolidated position paper on decommissioning, radioactive waste management, radioactive waste disposal associated with fusion power.

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