Department for
Business, Energy
& Industrial Strategy

UK STRATEGY FOR RADIOACTIVE DISCHARGES

2018 Review of the 2009 Strategy

June 2018

UK STRATEGY FOR RADIOACTIVE DISCHARGES

2018 Review of the 2009 Strategy

Any enquiries regarding this publication should be sent to us at parisbrussels@beis.gov.uk

This publication is available for download at www.gov.uk/government/publications.

This document is available in large print, audio and braille on request. Please email enquiries@beis.gov.uk with the version you require.

Contents

EXECUTIVE SUMMARY

1. The Government of the United Kingdom of Great Britain and Northern Ireland published a Radioactive Discharges Strategy for the period 2001-2020 in 2002. This Strategy was updated in 2009 to broaden its scope.
2. The UK Strategy for Radioactive Discharges 2009[1] (after this point called UKSRDS09) laid out the UK Government policy on radioactive discharges: that the unnecessary introduction of radioactivity into the environment is undesirable, even at levels where doses to humans and other species are low and, on the basis of current knowledge, are unlikely to cause harm.
3. The UKSRDS09 stated the UK Government's intent to review its outcomes and discharge profiles every five years. This publication marks the fulfilment of the UK's intent to conduct this review. This document is not a revision of the overall approach to radioactive discharges contained in the UKSRDS09, nor is it a new strategy.
4. This review takes account of developments in UK Government policy, commercial decisions within the nuclear industry, technological advances and improvements in our knowledge of the impacts of radionuclides in the marine environment.
5. This review demonstrates the clear evidence of progress being made by the UK in meeting the outcomes (not to be misinterpreted as targets) of the UKSRDS09 and contributing towards the objectives of the OSPAR Radioactive Substances Strategy.
6. This review will be submitted to the OSPAR Convention Secretariat and other Contracting Parties for their consideration.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249884/uk_strategy_for_radioactive_discharges.pdf

INTRODUCTION

7. The United Kingdom is a signatory to the Convention for the Protection of the Marine Environment of the North East Atlantic (hereafter referred to as the "OSPAR Convention"), which came into force in 1998 replacing the original Oslo and Paris Conventions; the contracting parties to which are a number of European countries and the European Union. The OSPAR Convention identifies threats to the marine environment and organises programmes and measures designed to ensure effective national action to combat them. One of the key work areas of OSPAR is on radioactive substances: the Radioactive Substances Committee meets annually.

8. To implement the provisions of the OSPAR Convention, and subsequent OSPAR meetings on radioactive substances, the UK produced a Radioactive Discharges Strategy for the period 2001-2020 in 2002. The Strategy was updated in 2009 to update the scope to include aerial as well as liquid discharges, decommissioning as well as operational activities, and the non-nuclear sector as well as the nuclear sector. It accounted for actual radioactive discharges of total alpha, total beta and (where appropriate) tritium for 2001-2005, and projections for discharges up until 2030.

9. The UKSRDS09 laid out UK Government policy on radioactive discharges: that the unnecessary introduction of radioactivity into the environment is undesirable, even at levels where doses to humans and other species are low and, on the basis of current knowledge, are unlikely to cause harm. The UKSRDS09 is based on the use of Best Available Techniques (in England and Wales – equivalent to Best Practicable Means and Best Practicable Environment Option in Scotland and Northern Ireland) to prevent and, where this is not practicable, minimise waste generation and discharges to the environment. In England and Wales, radioactive discharges are regulated under the Environmental Permitting Regulations 2016 (Scotland and Northern Ireland still use the Radioactive Substances Act 1993) to ensure that dose levels to members of the public remain well below internationally agreed limits and to protect both human health and the environment.

10. The UKSRDS09 committed the UK to its review and to issue an updated version "about every five years" (though work has been delayed due to capacity constraints). This publication marks the fulfilment of the UK's voluntary commitment to conduct this review.

11. This does not consist of a revision of the overall approach to radioactive discharges contained in the UKSRDS09. It is not a new strategy document. As the chapter titled 'Government Policy, Legislative and Regulatory Framework' shows, the UK Government remains committed to the principles laid out in the UKSRDS09. Instead, it provides an update with regard to the situation of radioactive discharges in the UK. It first provides an update as to the legislative and regulatory framework in the UK related to radioactive discharges, and then supplies updated actual discharge figures

(for the same sectors and categories of discharge – unless otherwise explained – as for the UKSRDS09) for 2015 and new forecast projections of discharges up to 2030.

12. The chapter titled ‘Government Policy, Legislative and Regulatory Framework’, lays out the changes to the legislative and regulatory framework concerning radioactive discharges in the UK, both from changes in domestic policy and international requirements.

13. The chapter titled ‘Uncertainties and Assumptions’ puts the new discharges data in context by providing the assumptions behind the data and forecast projections, and the uncertainties and caveats that should be taken into account when reading the data. These cover the different sectors reviewed by this publication, both nuclear and non-nuclear.

14. The chapter titled ‘Summary of Data and Analysis’ provides a summary of the liquid discharge data provided by operators for the main nuclear sectors (nuclear fuel manufacturing and enrichment, nuclear energy production, spent fuel reprocessing and decommissioning, research and defence), and an analysis of the trends revealed by the data. Aerial discharges are not considered in this chapter, as the main focus of OSPAR is liquid discharges.

15. Annex I updates Part 2 (chapters 7 to 14) of the UKSRDS09, with full data (where possible) on liquid and aerial discharges for all nuclear and non-nuclear sectors, and an update on main developments since 2009 in all sectors.

16. This review shows that the UK is making good progress in reducing radioactive discharges. The vast majority of UK radioactive discharges from all sectors in 2015 are below the OSPAR baselines (baseline years 1995-2001), showing there is clear evidence of progress being made by the UK in contributing towards meeting the objectives of the OSPAR Radioactive Substances Strategy. In about half of cases involving liquid discharges, discharges in 2015 were already below the discharge levels forecast in the UKSRDS09 for 2020.

17. This review will be submitted to the OSPAR Convention Secretariat and other Contracting Parties for their consideration.

GOVERNMENT POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

Introduction

18. This document provides an update to the UKSRDS09 and is not intended to replace it. Therefore, this chapter will note only changes in Government policy and in legislation or the regulatory framework that governs radioactive discharges in the UK.

Restatement of Government Policy

19. Government policy continues to recognise those principles as stated at 1.6 of the UKSRDS09 (Page 6) as a means of governing unnecessary introduction of radioactivity into the environment.

20. This review will focus on progress in implementing the UKSRDS09 and changes in the nuclear industry and policy since 2009.

Changes in UK Legislation and Regulation

21. This section notes the changes made to both UK and international legislation and regulation concerning the management of radioactive discharges in the UK since 2009. Any substantial changes in industry practices that relate to radioactive discharges will be discussed in the chapter titled ‘Uncertainties and Assumptions’.

Changes in UK Legislation

The Energy Act 2013

22. In December 2013 the Energy Act 2013 (EA13) was enacted. It included measures to establish the Office for Nuclear Regulation (ONR) as a statutory public corporation.

23. Establishment of ONR as a public corporation, with responsibility for holding the nuclear industry to account on behalf of the public in a fully transparent way, was seen by the UK Government as important to address the anticipated regulatory demands of an expanding nuclear sector. The creation of ONR brought regulation of nuclear safety, regulation of the transport of civil radioactive materials, regulation of security compliance and the UK Safeguards Office into a single body.

24. The ONR’s main purposes are:

    - protecting people from the risks of harm from ionising radiation from UK nuclear sites;

- protecting people from risks to health and safety from work activities on UK nuclear sites, including risks from the storage of dangerous substances;
- ensuring the security of civil nuclear premises, the nuclear materials used there, and sensitive information, equipment and technology;
- ensuring compliance by the UK with its international safeguards obligations; and
- protecting against risks relating to the civil transport of radioactive material in Great Britain by road, rail, or inland waterway.

25. The EA13 did not affect the standards of safety or associated regulatory requirements that the ONR places upon the UK nuclear industry.

Natural Resources Wales 2013

26. The Natural Resources Body for Wales (Establishment) Order 2012 established Natural Resources Wales (NRW) as a new statutory body. From 1 April 2013, NRW took over the functions of the Countryside Council for Wales together with the Welsh operations of the Environment Agency and the Forestry Commission.

The Environmental Permitting Regulations 2010/2016

27. The Environmental Permitting Regulations 2010 (EPR10) superseded the Radioactive Substances Act 1993 (RSA93) in England and Wales. Under EPR10, the Environment Agency (England) (EA) and Natural Resources Wales (NRW, Wales) as the environmental regulators are required to regulate disposals of radioactive waste (including discharges). This includes site inspection, maintaining public registers and providing information relating to environmental permitting, and undertaking formal consultations on major regulatory decisions. A consolidated version of the Environmental Permitting Regulations (EPR16) came into force on 1 January 2017 superseding EPR10. On 2 May 2018 amendments to EPR16 are expected to come into force to transpose aspects of the Basic Safety Standards Directive 2013. The RSA93 still applies in Scotland and Northern Ireland. In Scotland, as part of the Better Environmental Regulation Programme, the Scottish Government and Scottish Environment Protection Agency (SEPA) are working together to develop an integrated authorisation framework. The aim of the framework is to integrate the authorisation, procedural and enforcement arrangements relating to water, waste management, radioactive substances and pollution prevention and control. As part of this work, the Environmental Authorisations (Scotland) Regulations 2018 (EA(S)R), are expected to come in to force in later 2018.

The Conservation of Habitats and Species Regulations 2017

28. The Conservation of Habitats and Species Regulations 2010, is consolidated and updated with subsequent amending instruments. Minor modifications reflecting changes to related legislation are also made.

29. Aspects of the Marine and Coastal Access Act 2009 are also implemented. These changes also transpose EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

30. The changes provide, among other things:

    - that public bodies must exercise their nature conservation functions so as to comply with the Habitats Directive and the Wild Birds Directive
    - for the selection, designation, registration and notification of sites to be protected under the Habitats Directive, and provide for management agreements for European sites
    - for the protection of certain wild animals and plants, in particular making it an offence to deliberately capture, kill or disturb those animals or to trade in them.

Changes in UK Regulation

Generic Design Assessment

31. The Generic Design Assessment (GDA) was developed by the Office for Nuclear Regulation and the Environment Agency in response to a request from the Government following its 2006 Energy Review. The GDA robustly assesses potential new nuclear power station designs allowing the UK regulators to assess the safety, security and environmental implications (including minimising radioactive discharges to the environment) of new reactor designs.

32. The GDA process therefore enables UK Government to closely scrutinise new nuclear power station designs before they are built. Potential design or technical issues can be identified early and the reactor designer will have to address them.

33. The GDA's technical assessments are primarily carried out by ONR and the Environment Agency. The Environment Agency and NRW work as partners on environmental aspects of the scrutiny process. Any prospective operator that wants to operate a nuclear power station has to show that it can build, operate and decommission it safely, protect people and the environment and manage radioactive waste in compliance with UK standards and regulations.

34. As well as undergoing the strict and robust GDA process, prospective operators of an assessed design must obtain permission from regulators and Government in the form of:

- a site licence and relevant consent to begin nuclear-related construction from the ONR;
- environmental permits from the Environment Agency, NRW or SEPA; and,
- a development consent order from the Department for Business, Energy and Industrial Strategy, or Scottish Ministers (at present there is no intention for new nuclear build in Scotland).

The Regulators' Code

35. The Regulators' Code came into statutory effect on 6th April 2014 under the Legislative and Regulatory Reform Act 2006, replacing the Regulators' Compliance Code. It provides a clear, flexible and principles-based framework for how regulators should engage with those they regulate.

36. Nearly all non-economic regulators – including the Environment Agency, SEPA, NRW, ONR and Health and Safety Executive - must have regard to the Regulators' Code when developing policies and procedures that guide their regulatory activities.

37. Built upon the five principles of regulation noted at 2.3.9 of the UKSRDS09, the new Code sets out a clear framework for transparent and accountable regulatory delivery and establishes clear principles for how local authorities should interact with those they are regulating. The Code is underpinned by the statutory principles of good regulation, which provide that regulatory activities should be carried out in a way which is transparent, accountable, proportionate and consistent and should be targeted only at cases in which action is needed.

Guidance on the scope of and exemptions from the radioactive substances legislation in the UK – Guidance Document, September 2011

38. The legislative means by which radioactive substances are regulated in the United Kingdom are different between the various devolved administrations; however, the effects of the legislation are consistent. The 2011 guidance (to be amended in the near future to reflect EURATOM Directive 2013/59) sets out the rationale underpinning the exemptions regime, the Government's intentions for the legislation, and how Government intends the regime to be interpreted and implemented. It provides information to the environmental regulators and users on the means by which the objectives of the exemptions regime should be delivered.

Changes and Updates to International Legislation, Regulation and Reporting Procedures

39. This section notes the changes and updates to international legislation, regulation and reporting procedures concerning the management of radioactive discharges in the UK.

40. As a result of the referendum vote on 23 June 2016 to leave the European Union, the UK will also be leaving the Euratom Treaty, as the two treaties are uniquely legally joined. The UK retains its commitment to maintain the highest standards in nuclear safety, security and safeguards, and wants to see continuity of these standards and to maintain mutually successful civil nuclear cooperation with Euratom.

41. As a consequence of leaving Euratom, some of the technical legislative instruments and administrative structures for implementing international standards may change. The content of this document reflects the status quo in the UK as of early spring 2018, prior to leaving Euratom.

EURATOM Directive 2013/59 - Basic Safety Standards (BSSD)

42. European Council Directive 2013/59/Euratom establishes safety standards for protecting workers, the public and medical patients from the effects of ionising radiation. The UK transposed the 2013 Basic Safety Standards Directive as fully as possible by the transposition deadline of 6 February 2018. Our transposing legislation covering occupational radiation exposures came into force on 1 January 2018, and our legislation covering medical radiation exposures came into force on 6 February 2018. Those covering public radiation exposures and the justification of practices are now in force and were formally notified to the European Commission on 22nd May. The remaining parts of our transposition will be completed later. We expect the Air & Space Crew work stream to complete in December 2018 and Emergency Planning & Response to lay their legislation in early 2019.

EURATOM Directive 2011/70 – Spent Fuel and Radioactive Waste

43. The UK submitted a National Programme in August 2015, as required under Directive 2011/70/EURATOM. The National Programme implements national policies to ensure the responsible and safe management of spent fuel and radioactive waste.

44. The UK and all Member States were also required to submit a National Report[2] at the same time (and every three years thereafter) detailing progress made with implementing the Directive and providing an inventory of radioactive waste and spent fuel.

OSPAR

45. OSPAR is the mechanism by which 16 Contracting Parties cooperate to protect the marine environment of the North-East Atlantic. There are 5 committees focussing on different work areas - one of which is the Radioactive Substances Committee (RSC) and its Radioactive Substances Strategy (RSS). Aiming to address an OSPAR strategic objective the RSC/RSS aim to prevent pollution of the OSPAR maritime area

[2] The UK's National Report can be accessed here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457893/UK_National_Report_-_final.pdf

from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances. This objective is further developed by a RSS interim objective by 2020. The RSS will be implemented progressively by making every endeavour, through appropriate actions and measures, to ensure that by the year 2020 discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.

OSPAR Convention – defining historical and legacy waste discharges

46. In 2014, the OSPAR RSC agreed on a definition for 'historical and legacy waste' discharges. This facilitated allocating discharges to this category by the nuclear industry, increasing transparency regarding the source and nature of such discharges. OSPAR Contracting Parties have the option to report discharges within this category as part of the annual OSPAR reporting process.

47. There are also a number of RSC workstreams of interest to this review. These are listed below.

Radioactive Substances Committee: 3rd and 4th Periodic Evaluations

48. The OSPAR RSC published its 3rd Periodic Evaluation in 2009[3] and the 4th in 2016[4]. Periodic Evaluations analyse the progress made by Contracting Parties (including the UK) towards reducing discharges, concentrations and doses of radioactive substances to the North-East Atlantic in accordance with the objectives of the OSPAR Radioactive Substances Strategy.

Radioactive Substances Committee: UK Best Available Techniques Report 2013 and 2018 Intersessional Correspondence Groups - Best Available Techniques (ICG-BAT)

49. The UK submitted BAT reports in 2013 and 2018 as required by PARCOM Recommendation 91/4 and Agreement 2004-03. All Contracting Parties are required to submit such reports on a rolling cycle. The two UK reports cover the periods:

    - 2008-11, this BAT report[5] was submitted to, and published by, OSPAR in 2013.

    - 2012-16, this report was submitted to OSPAR in early 2018 and is expected to be published shortly.

[3] https://www.ospar.org/documents?v=7135
[4] https://www.ospar.org/work-areas/rsc/evaluation
[5] https://www.ospar.org/documents?v=7321

- In each case RSC agreed that the UK had fulfilled the reporting requirements, the report was in line with submission guidelines, the information indicated BAT had been applied in UK nuclear facilities, and the RSC would recommend its publication.

Radioactive Substances Committee: ICG-Close to Zero

50. The UK is contributing to the ICG developing a methodology to assess whether any additional concentrations in the marine environment above historic levels are ‘close to zero’.

International Atomic Energy Agency - Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

51. As a Contracting Party the UK is required to provide a report[6] every three years for peer review under the auspices of the International Atomic Energy Agency. Since the UKSRDS09, there have been three such reports: the fourth in September 2012, the fifth in October 2014, and the sixth in October 2017.

Further Information

52. Further information on the UK’s performance with regard to the management of radioactive discharges can be found in the series of Radioactivity in the Food and Environment (RIFE) Reports.

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65508/6363-fourth-uk-joint-convention-report.pdf
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/398558/uk_fifth_national_report_compliance_obligations_joint_convention_safety_spent_fuel_radioactive_waste_management.pdf
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/672640/20171020_-_UK_Sixth_National_Report_to_the_Joint_Convention.pdf

UNCERTAINTIES AND ASSUMPTIONS

Introduction

53. It is important to note that all the discharge forecasts presented and analysed in this review are based on the best available knowledge at the point in time of writing. As with all forecasting, there are uncertainties and assumptions. This chapter updates the information about uncertainties set out in Chapter 6 of the UKSRDS09 and notes the uncertainties and assumptions associated with the radioactive discharge forecasts up to 2030.

54. The assessments described in the chapter titled ‘Summary of Data and Analysis’ include comparisons between previous forecasts, actual discharges since those forecasts were made and also with the latest forecasts relating to future discharges. Meaningful evaluation of discharges is ideally based on longer term trends and comparisons of averages over multi-year periods, rather than year on year data which may fluctuate according to routine operational factors. Assessments and evaluation should also be considered alongside the bigger picture of the overall good progress the UK has made towards meeting, or contributing towards, the outcomes of the UKSRDS09 and the objectives of the OSPAR Radioactive Substances Strategy.

55. Despite potential for year-on-year variation, all radioactive discharges from civil nuclear facilities in the UK are required to be within limits as strictly specified by UK regulators. In addition to limits on discharges, operators are also required to use the Best Available Techniques (BAT) in England and Wales or Best Practicable Means (BPM) and Best Practicable Environmental Option (BPEO) in Scotland and Northern Ireland to avoid or minimise their discharges. The regulation of radioactive discharges ensures that radiation doses to people living around nuclear licensed sites from such discharges continue to be well below the UK national dose limit. Further information on assessments made regarding the impact of UK discharges, can be found in the annual Radioactivity in Food and the Environment (RIFE) reports complied by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) on behalf of the Environment Agency, FSA, Food Standards Scotland, NRW, Northern Ireland Environment Agency and SEPA. Alternatively, more information can be found on the progress OSPAR Contracting Parties have made in reducing radioactive discharges in the North East Atlantic in the 4th Periodic Evaluation in 2016[7] and the Intermediate Assessment 2017[8].

[7] https://www.ospar.org/work-areas/rsc/evaluation
[8] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/

Update on Uncertainties and Assumptions set out in the UKSRDS09

56. This section provides an update on the key assumptions and main areas of uncertainty in discharge forecasts described in the UKSRDS09. However, it should be recognised that operators' plans may continue to change and such changes may impact on future projections and forecasts.

57. For the nuclear and non-nuclear sectors, the main areas are:

- UK Nuclear New Build programme
- Plant Life Extensions (PLEX) of Advanced Gas Cooled reactors
- Decommissioning programme
- Magnox reprocessing
- THORP reprocessing
- Industries that generate NORM wastes.

UK Nuclear New Build programme

58. New nuclear power is a key part of the Government's policy to build a secure, affordable and low carbon energy supply.

59. New nuclear power stations that are expected to start generating power in the mid 2020s, and therefore feed into our forecasts and analysis are noted below:

- Hinkley Point C (Somerset) – expected to become operational around 2025
- Wylfa Newydd (Anglesey, North Wales) – expected to become operational mid 2020s
- Moorside (Cumbria) – expected to become operational mid 2020s.

60. Government is considering the planning framework for nuclear power generation for the long term. Government finished consulting (15 March 2018) on the arrangements for the siting of nuclear power above 1GW single reactor capacity for the period beyond 2025. The proposal is to carry forward existing sites into the new National Policy Statement (NPS), subject to them meeting the updated siting criteria and environmental assessments. Government will publish a response to the consultation with the draft NPS including the list of potentially suitable sites.

61. As with the current fleet of UK nuclear reactors, the operators of new nuclear reactors will be subject to the legal requirement to apply BAT to the management of radioactive discharges and to comply with limits set by environmental regulators on discharges.

As set out in the 2009 Strategy reactor design vendors also need to demonstrate that BAT have been incorporated into the design.

Plant Life Extensions (PLEX) of Advanced Gas Cooled reactors

62. Advanced Gas Cooled Reactors (AGR) reactors continue to produce electricity at seven of the eight operating nuclear power stations in the UK. The discharge forecasts set out in this review are based on EDF's latest Plant Life Extension (PLEX) programme.

63. To ensure the security of the UK energy supply it is possible that these reactors may be granted life extensions. Before an extension is granted, the UK regulators will need to be satisfied that operations at a site can continue to meet all relevant safety and environmental requirements.

64. This review has therefore forecast radioactive discharges for all seven AGR reactors based on the latest shutdown dates:

    - Hinkley Point B – 2023
    - Hunterston B - 2023
    - Hartlepool – 2024
    - Heysham 1 – 2024
    - Dungeness B - 2028
    - Heysham 2 – 2030
    - Torness – 2030

Decommissioning programme

65. Decommissioning activities provide a challenge for accurate forecasting of radioactive discharges both in terms of those expected in total over entire decommissioning projects and those made over shorter periods (e.g. 1 year). The reasons for this challenge are primarily two-fold:

    - Decommissioning activities are of a different nature relative to normal site operations as they are typically complex and can be unpredictable. This can therefore make it difficult to forecast the levels of radioactive discharges from a specific decommissioning activity; and,
    - Scheduled decommissioning activities can be brought forward or moved back depending on changes in priority

Magnox fuel reprocessing

66. The NDA Strategy is to reprocess all Magnox fuels in line with the Magnox Operating Programme (MOP). The UKSRDS09 noted that Magnox reprocessing would end in 2016 or later. The NDA now anticipate that if the past operational performance can be maintained, then Magnox fuel reprocessing is expected to complete around 2020. This recognises the operational and throughput uncertainties associated with Magnox reprocessing due primarily to the age of the plants involved which has led to variable performance. Performance below historic norms could result in extending reprocessing operations beyond 2020, although this is unlikely. However, it is important to note that in the event operations extend beyond 2020 it would not result in discharges to the environment that are inconsistent with the obligations of the UKSRDS09. Discharges will continue to be minimised through the use of BAT. The discharge forecasts set out in this review reflect the latest assumptions and further detail on NDA's approach to the completion of Magnox reprocessing is set out in its 2016 strategy.

THORP reprocessing

67. The NDA strategy is to reprocess Oxide fuels in line with the Advanced Gas Reactor Operating Plan (AGROP). Following publication of an options study in 2011, including a period of public consultation, the decision to cease reprocessing in THORP once existing contracts have been completed was published by the NDA in June 2012. This is in line with and supported by Government policy. Discharges are consistent with the obligations of the UKSRDS09 and will continue to be minimised through the use of BAT. THORP is scheduled to cease reprocessing by the end of 2018. Discharge forecasts in this review reflect the latest assumptions and further detail on NDA's approach to the completion of THORP reprocessing is set out in its 2016 strategy.

Industries that generate NORM wastes

68. In 2014, the UK Government produced the first Strategy for the Management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom. An extensive data collection exercise was carried out during 2013 in support of the development of this strategy. The aim of the data collection exercise was to identify those industries in the UK that generate NORM waste along with information on the quantities of waste that is produced now and that is expected in the future. The data collection exercise confirmed that the majority of the UK's NORM waste originates from the oil and gas industry as stated in the UKSRDS09. It also identified that it is very difficult to predict future NORM waste arisings.

69. The main factors affecting the quantity of NORM waste that will be generated from the offshore oil and gas industry are dependent on the type of hydrocarbon produced, subsurface geology, reservoir characteristics, and the age of the installation. Therefore it will be difficult to meaningfully predict NORM waste arisings. Similarly, how much NORM waste will be generated during decommissioning is also difficult to

predict as it will be different for each installation and may not be known accurately until decommissioning has occurred.

70. It is also possible that developments in onshore unconventional oil and gas production may result in additional NORM waste being generated. However, there is a high level of uncertainty about both the size and the pace of such developments along with a lack of detailed information on potential arisings. Accordingly, it is not possible to provide any robust estimates.

Horizon Scanning

71. As technology advances and policy positions are reassessed, there may be new sources of authorised radioactive discharges or the development and use of techniques which reduce discharges. Future reviews and/or strategies before or after 2030 will need to reflect these activities.

Summary

72. The purpose of this chapter was to make readers aware of the assumptions made and uncertainties that will affect the accuracy of this review's forecasting of radioactive discharge data up to 2030. It should be recognised that operators' plans can and do change and such changes may impact on projections and forecasts. The following chapters which analyse the historic trends and forecasts up to 2030 should be viewed in the context of these assumptions and uncertainties. A future review of the UKSRDS09 may amend the operational outcomes forecast in this document as changes or policy decisions impact radioactive discharges from nuclear sites between 2016 and 2030.

SUMMARY OF DATA AND ANALYSIS

Introduction

73. This chapter presents a summary of the analysis of the discharge data submitted by operators as part of this review. The aim of this chapter is to provide an overview of the UK's radioactive discharges past, present and future. Annex 1 contains a more detailed and technical update.

74. As with the UKSRDS09, this review presents data from all operators across all nuclear sites in the following sectors:

- Nuclear fuel manufacturing and uranium enrichment
- Nuclear energy production
- Spent fuel reprocessing
- Nuclear research
- Defence

75. It should be noted that the sector referred to as 'Spent Fuel Reprocessing' is used largely for consistency with the terminology used in the UKSRDS09, noting however that figures for this sector increasingly relate to discharges arising from clean-up of legacy wastes and decommissioning, particularly post 2020.

76. The UKSRDS09 also addressed discharges from the following sectors:

- Isotope production and radiolabelling, medical, pharmaceutical and academic uses
- Naturally occurring radioactive materials (NORM)
- The waste and incineration sector

77. Discharges from these sectors are discussed in more detail in Annex 1.

78. There are a number of improvements to the way the Department for Business, Energy and Industrial Strategy is presenting the data in this review relative to the UKSRDS09. These amendments have been made to clarify aspects of the presentation of the data. These amendments are explained below.

Amendments to data forecasting

Total Forecast Outcomes

79. The opportunity has been taken to clarify that the forecasts previously expressed as ‘expected outcomes’ within the UKSRDS09 are not intended to be targets, since the UKSRDS09 does not set targets or individual site limits for radioactive discharges. It does however describe total forecast outcomes across sectors which, based on best knowledge at that time, are expected to be achieved by 2020 and by 2030, and incorporates a strategic framework for addressing radioactive discharges over the next 20 years. It is the responsibility of the relevant regulatory authorities to ensure that Government policy on radioactive substances is implemented, in particular through the setting of individual site discharge limits and through the conditions requiring that radioactive discharges are minimised below those limits by using the Best Available Techniques (Best Practicable Means and Best Practicable Environmental Option in Scotland and Northern Ireland). This is done through the granting of permits to nuclear operators under the EPR16 (England and Wales) and the RSA93 (Scotland).

80. ‘Total Forecast Outcomes’ can therefore be defined as the total radioactive discharges expected by site operators in one of the five nuclear sectors. Therefore, as seen in Figure 5.1, the forecast operational outcome for total alpha discharges in the nuclear fuel manufacturing sector for 2020 is expected to be 0.04 TBq. This is a forecast made with the best available information at the time of writing and therefore performance for any forecasts is subject to variability.

81. Therefore Total Forecast Outcomes refers to the sum of forecast operational outcomes and forecast decommissioning outcomes within the five nuclear sectors as set out in Table 1.

Revised forecasting of future discharges 2016 – 2030

82. We have used updated forecasts from the site operators to carry out this review. The forecasts are based on an expected case, which represents the likely discharges from a site based on a combination of past performance, anticipated shutdown (for reactors), and scheduled waste management and decommissioning activities. It should be recognised that operators’ plans can and do change, as illustrated by both new build operators proposals, and EDF’s plans to extend the life of their operating reactors since the UKSRDS09 was published.

Overview

83. The Executive Summary of the UKSRDS09 listed three outcomes (not to be misinterpreted as targets):

- progressive and substantial reductions in radioactive discharges, to the extent needed to achieve the expected sectoral outcomes set out in detail in part 2, whilst taking into account the uncertainties described at chapter 6;
- progressive reductions in concentrations of radionuclides in the marine environment resulting from radioactive discharges, such that by 2020 they add close to zero to historic levels;
- progressive reductions in human exposures to ionising radiation resulting from radioactive discharges, as a result of planned reductions in discharges.

84. Strong progress has been made towards achieving the first outcome. The chapter titled 'Summary of Data and Analysis' provides a summary of the liquid discharge data provided by operators for the main nuclear sectors. Table 1 shows that the sectoral discharges in 2015 were already below the discharge forecast outcomes in the UKSRDS09 for 2020 in just under half of cases. In nearly all of the other cases the discharges were within a factor of 2-3 of the UKSRDS09 forecast outcomes.

85. Progress against the second outcome will not be formally assessed by OSPAR until 2022. OSPAR, with the assistance of the UK, is developing the methods to assess progress against the OSPAR Radioactive Substances Strategy. The UK, and the other OSPAR contracting parties, will ensure that the assessment methods are transparent and robust. In the mean-time the indications are that the reductions in radioactive discharges made by the UK, along with the results from routine environmental monitoring programmes, do provide some confidence that this objective will be met.

86. With respect to the third outcome, evidence provided in the annual Radioactivity in Food and the Environment (RIFE) reports show that human exposures to ionising radiation resulting from discharges continue to be very low and much less than the public dose limit.

87. On the whole, the UK is performing well with mean 2015 radioactive discharges and latest forecasted data being below the OSPAR baseline. This is reflected in the dashboard (Table 1) on UK performance, indicating how actual liquid discharges made in 2015 compare with the sectoral, forecast outcomes set out in the UKSRDS09. Table 1 is purely for illustrative purposes, since it shows comparisons between single year annual discharges against the forecast outcomes quoted in the UKSRDS09. The data refers to liquid discharges only, consistent with the main focus of OSPAR.

88. Table 1 shows that the discharges in 2015 were already below the discharge forecast outcomes in the UKSRDS09 for 2020 in just under half of cases. Nearly all of the other cases are currently within a factor of 2-3 of the UKSRDS09 forecast outcomes, which

in part reflects the current status of work programmes and the normal variability of discharges with operational status. In these cases, based on current understanding, the latest forecasted discharges are expected to be below those forecast in the UKSRDS09, and show progressive and substantial reductions of discharges since the original UK Strategy was published in 2002.

Table 1: Liquid Discharges in 2015 vs 2020 and 2030 Forecast Outcomes from UKSRDS09 (TBq)

Sector	Total alpha		Total beta		Tritium		Technetium-99	
	Forecast Outcome	Actual 2015	Forecast Outcome	Actual 2015	Forecast Outcome	Actual 2015	Forecast Outcome	Actual 2015
Nuclear fuel manufacture and uranium enrichment	0.04 (2020) 0.004 (2030)	0.024	0.7 (2020) 0.005 (2030)	1.8	-		-	
Nuclear energy production	0.0003 (2020) 0.00006 (2030)	0.0014	1.5 (2020) 0.1 (2030)	3.7	850 (2020) 75 (2030)	1730	-	
Spent Nuclear Fuel reprocessing	0.10 (2020) 0.05 (2030)	0.19	20 (2020) 10 (2030)	9.5	100 (2020) 10 (2030)	1540	1.0 (2020) 0.1 (2030)	1.7
Nuclear Research Facilities	0.025 (2020) 0.020 (2030)	0.0002	0.8 (2020) 0.2 (2030)	0.0022	-	23.0	-	
Defence	0.0001 (2020) 0.0001 (2030)	0.00005	0.002 (2020) 0.001 (2030)	0.00005	-	0.08	-	

Key

(dark blue)	Below forecast outcome from the UKSRDS09
(medium blue)	≤10x difference
(light blue)	>10x difference
(grey)	No Forecast Outcome applies

Introduction to the Graphs

89. The graphs below provide an update to the radioactive discharge data presented in the UKSRDS09.

90. As with the UKSRDS09, and where appropriate this review, the graphs include illustrative 'OSPAR baselines' for wider context and to assist understanding. The OSPAR baseline is represented by the blue horizontal dotted line. This helps to demonstrate and assess the UK's progress in achieving the objectives of the Radioactive Substances Strategy.

91. In order to take account of the normal variability of discharges from year to year, the baseline period for the nuclear sector was agreed as the averages of the discharges between 1995 and 2001 (the seven years which straddle the 'Sintra year' of 1998, in which the OSPAR Strategy was agreed and signed in Sintra, Portugal). The illustrated OSPAR Baseline dashed lines do not therefore represent a limit by which anything above is harmful to either human health or marine life. Instead, they provide a useful illustration against which subsequent and future progress can be measured.

92. Consistent with the OSPAR approach, these illustrations show baselines for liquid discharges of total alpha and total beta, but not for tritium. There are no OSPAR baselines for the defence sector.

93. OSPAR considers that it has collected sufficient data to now be able to agree a baseline period for oil and gas non-nuclear data (2005-2011). This period was chosen to ensure a similar approach as for the nuclear sector i.e. a 7 year baseline period and because reporting of discharge data from this sub-sector only commenced in 2005. Further information is contained within the OSPAR Radioactive Substances Committee Fourth Periodic Evaluation.

94. The following graphs (Figures 5.1 to 5.3) show annual data (2015) for liquid discharges (purple bars), alongside the revised annual forecast discharges for 2020 and 2030. The forecasts are a combination of both operational and decommissioning discharges. The 'OSPAR baseline' (where shown) and the previous 2020 and 2030 outcomes as forecast in the UKSRDS09 (orange dotted lines) are also shown. The tables in this chapter show declared forecasts from the UKSRDS09 along with the latest estimates of future discharges, noting that the UKSRDS09 figures were based on 5-year averages, whilst the updated figures are individual forecasts for 2020 and 2030, noting that the provisions detailed in the chapter titled 'Uncertainties and Assumptions' apply.

95. Table 1 shows that discharges from the defence and research sectors are low compared to those from the fuel manufacturing, energy production and reprocessing sectors. Therefore, for this review we have not updated the summary graphs 5.4 – 5.5 from the UKSRDS09, although annual actual discharges to 2015 and future forecasts up to 2030 (in five year annualised averages) for all sectors are shown in Annex 1.

Sectoral Data

Nuclear fuel manufacturing and uranium enrichment sector

Figure 5.1: Nuclear fuel manufacturing and uranium enrichment sector (**total alpha**): evaluation of progress

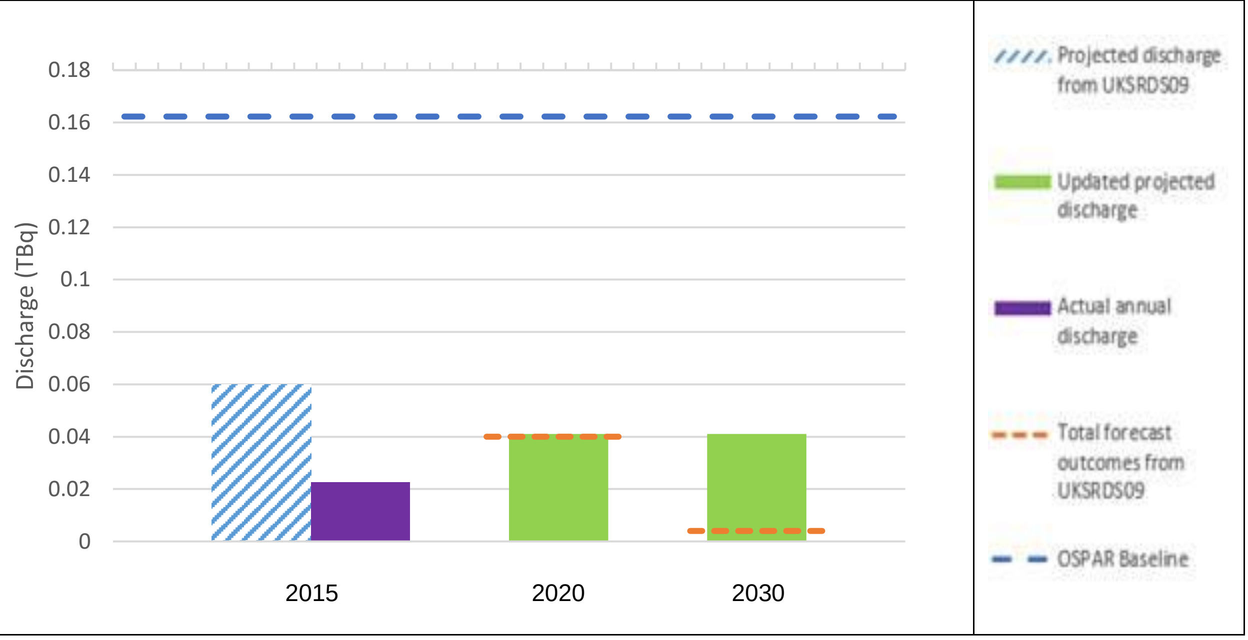
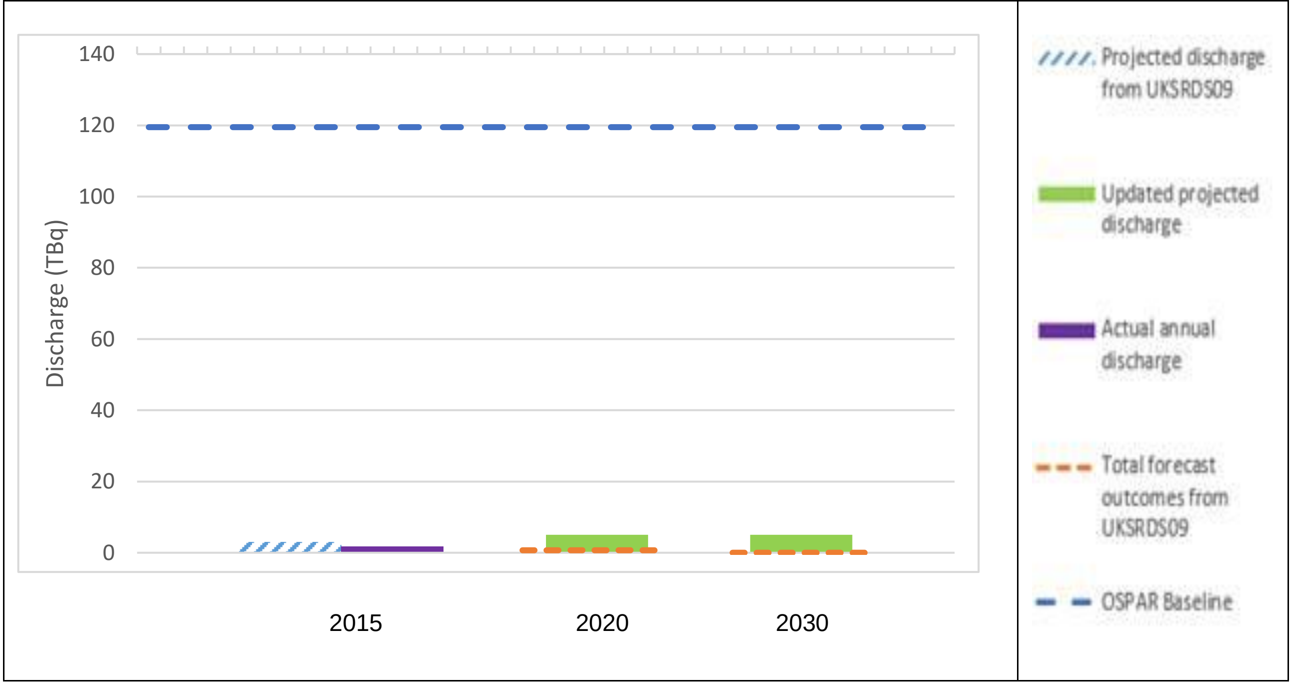


Figure 5.1: Nuclear fuel manufacturing and uranium enrichment sector (**total beta**): evaluation of progress



96. As can be seen from Table 1, liquid discharges of total alpha from this sector are approximately one order of magnitude less than the total discharges from the nuclear sector which are dominated by the spent nuclear fuel reprocessing sector.

97. Figure 5.1 illustrates that actual liquid discharges of total alpha and total beta from the nuclear fuel manufacturing and uranium enrichment sector have been consistent with forecasts in the UKSRDS09, and low compared to the OSPAR baselines. The figure also indicates that the revised forecast for 2020 and 2030 will be close to, but above, the expected outcomes forecast in UKSRDS09. The increase over the UKSRDS09 forecast is due to the continued operations of the uranium recovery plants which have stayed operational to deal with other sites' liabilities (recovering the uranium and returning it to the fuel cycle), and manufacturing fuel for the new nuclear power plants across Europe. As a result of this review, we propose revising the Forecast Operational Outcomes as follows.

Table 2: Revised Forecast Outcomes for the Nuclear Fuel Manufacturing and Uranium Enrichment Sector (TBq)

	2020		2030	
	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)	Total Forecast Outcome from UKSRDS09 (TBq)	Revised total Forecast Outcome (TBq)
Total alpha	0.04	0.04	0.004	0.04
Total beta	0.7	5.0	0.005	5.0

98. A more detailed presentation of actual liquid discharges from this sector to 2015 and future forecasts up to 2030 (in five year annualised averages) is shown in Annex 1, Figures 7.2 and 7.3. Aerial discharges are shown in Figures 7.4 – 7.6.

Nuclear energy production sector

Figure 5.2: Nuclear energy production sector (**total alpha**): evaluation of progress

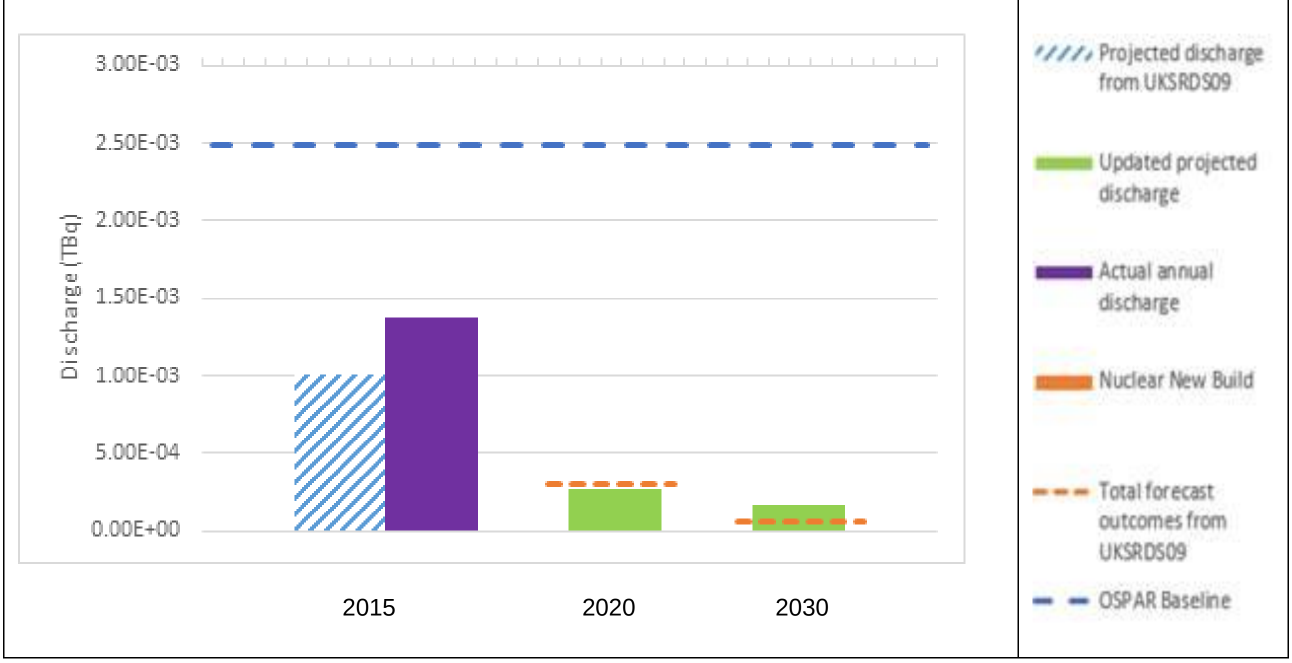


Figure 5.2: Nuclear energy production sector (**total beta**): evaluation of progress

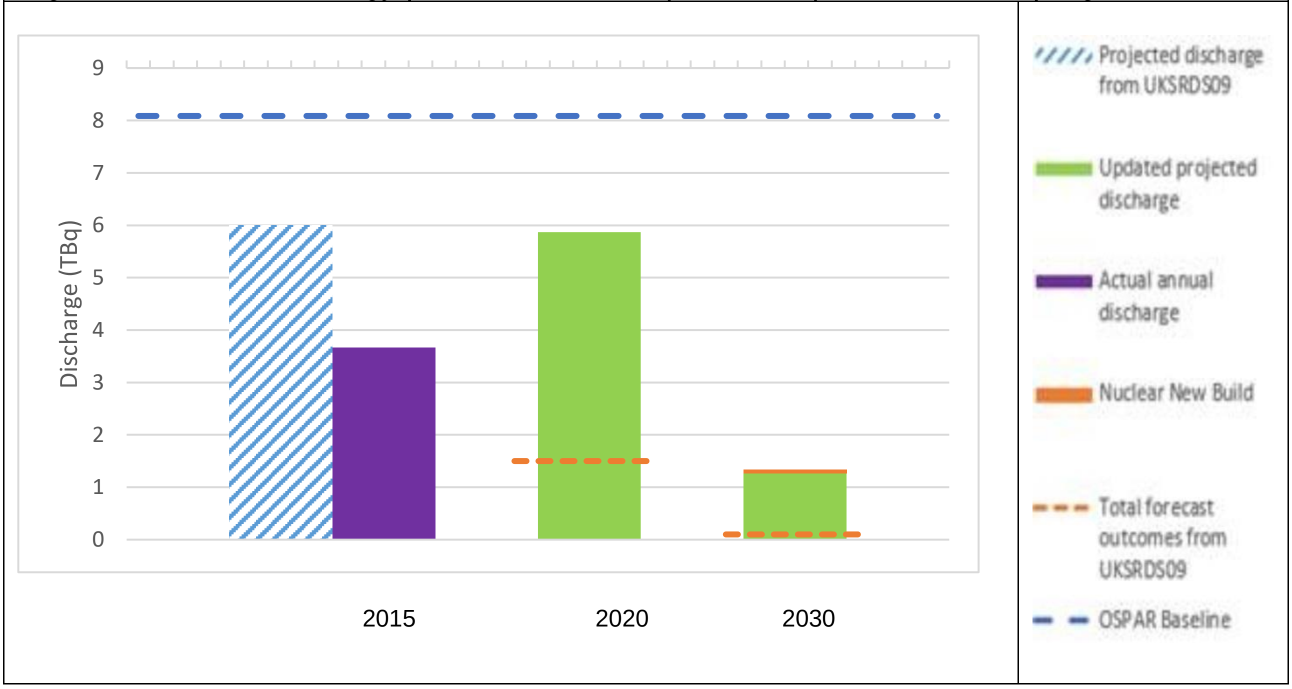
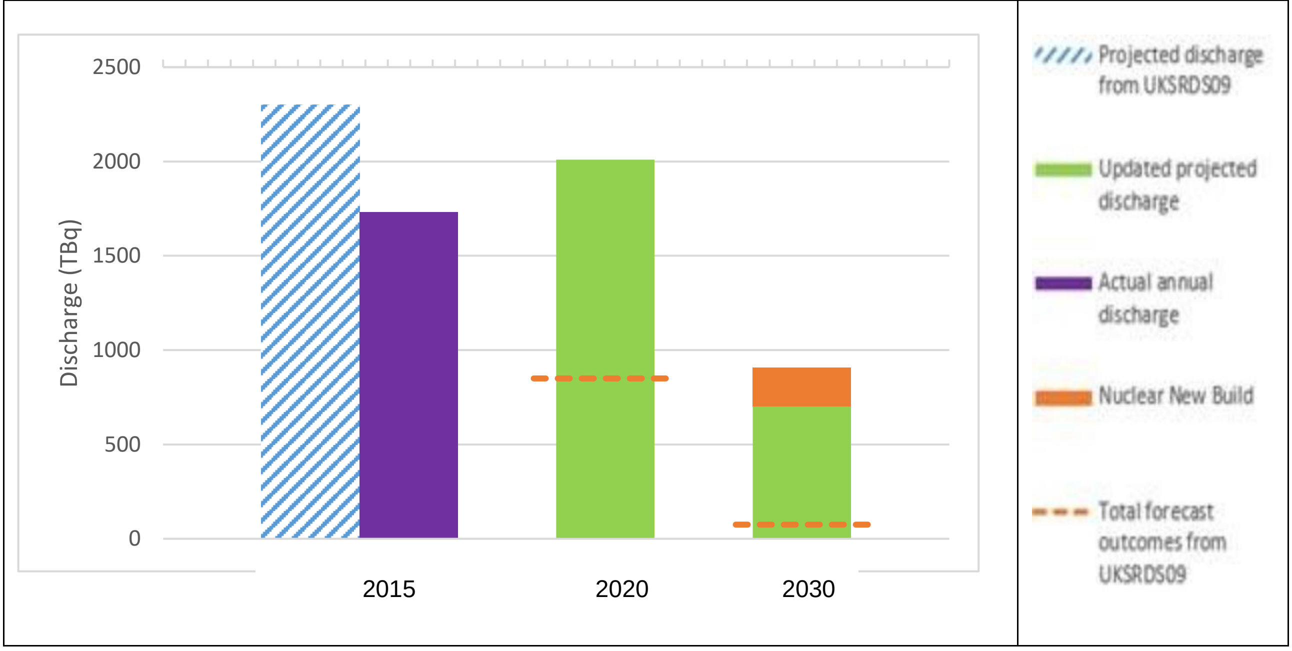


Figure 5.2: Nuclear energy production sector (**tritium**): evaluation of progress



99. As can be seen from Table 1, liquid discharges of total alpha from this sector are approximately two orders of magnitude less than the total nuclear sector discharges which are dominated by the spent nuclear fuel reprocessing sector. Similarly, liquid discharges of total beta from this sector are also approximately one third of the total discharges from the spent nuclear fuel reprocessing sector. Liquid tritium discharges from the nuclear energy production sector are of a similar order to those from the spent nuclear fuel reprocessing sector.

100. Figure 5.2 illustrates total alpha, total beta and tritium discharges were broadly consistent with forecasts. The figure also indicates that the revised forecast outcomes in 2020 and 2030 will be higher than forecast in the UKSRDS09 for total beta and tritium. Total alpha discharges are expected to be broadly consistent with the total forecast outcomes set in the UKSRDS09. Both the construction of new reactors and AGR life extension have had a significant impact on the forecast of tritium discharged to sea (over 90% of the tritium generated by an AGR is discharged to sea). Similarly, the life extensions for the AGRs will have had a significant impact on the discharge of gross beta activity excluding tritium.

101. Expected discharges from the proposed nuclear new build programme are included in Figure 5.2, and are not generally expected to increase discharges above current levels. As a result of this review, we propose revising the Total Forecast Outcomes as follows.

Table 3: Revised Forecast Operational Outcomes for the Nuclear Energy Production Sector (TBq)

	2020		2030	
	Total Forecast Outcome from UKSRDS09 (TBq)	Revised total Forecast Outcome (TBq)	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)
Total alpha	0.0003	0.0003	0.00006	0.0002
Total beta	1.5	6.0	0.1	1.5
Tritium	850	2000	75	1000

102. A more detailed presentation of actual liquid discharges from this sector to 2015 and future forecasts up to 2030 (in five year annualised averages) is shown in Annex 1, Figures 8.1 to 8.3. Aerial discharges are shown in Figures 8.4 – 8.5.

Spent fuel reprocessing sector

Figure 5.3: Spent fuel reprocessing sector (**total alpha**): evaluation of progress

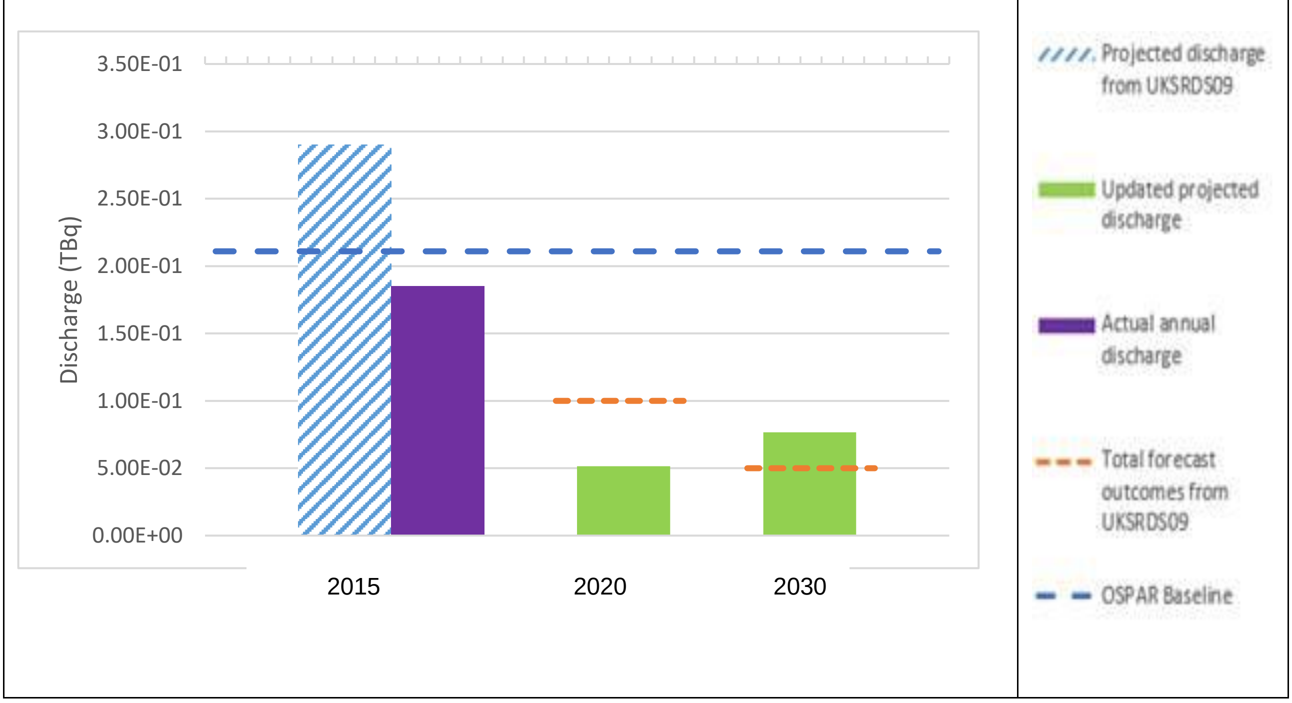


Figure 5.3: Spent fuel reprocessing sector (**total beta**): evaluation of progress

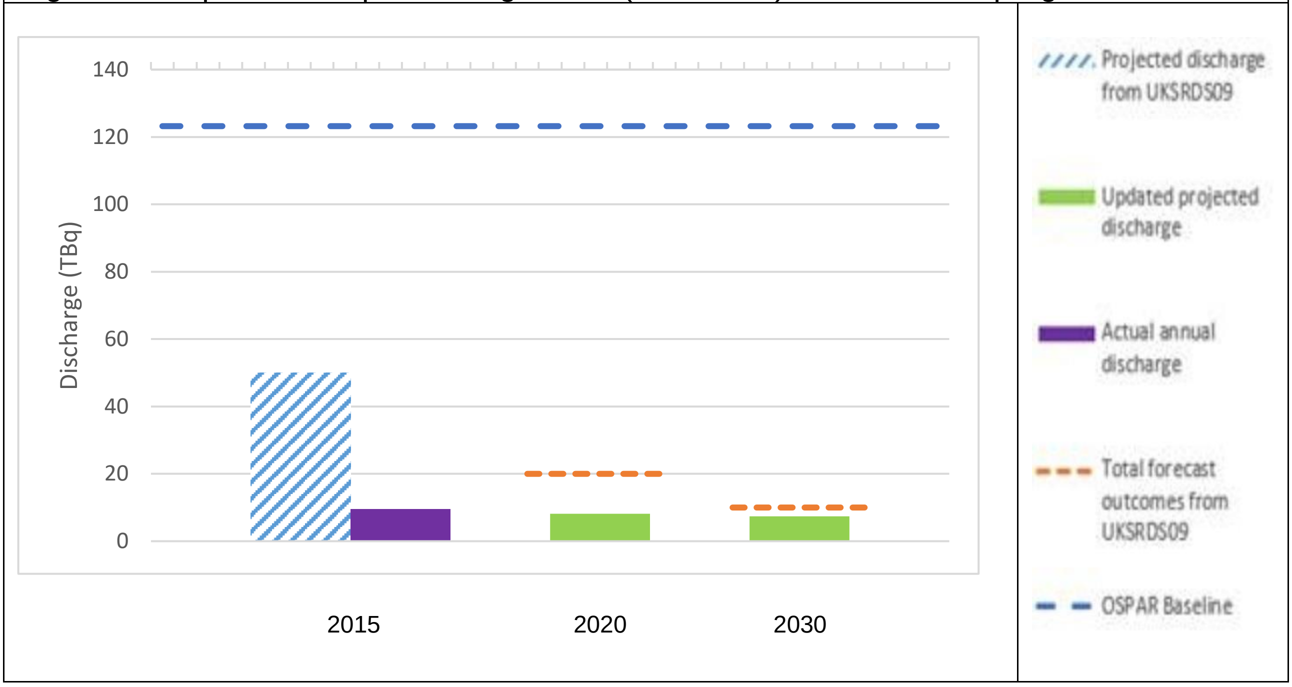
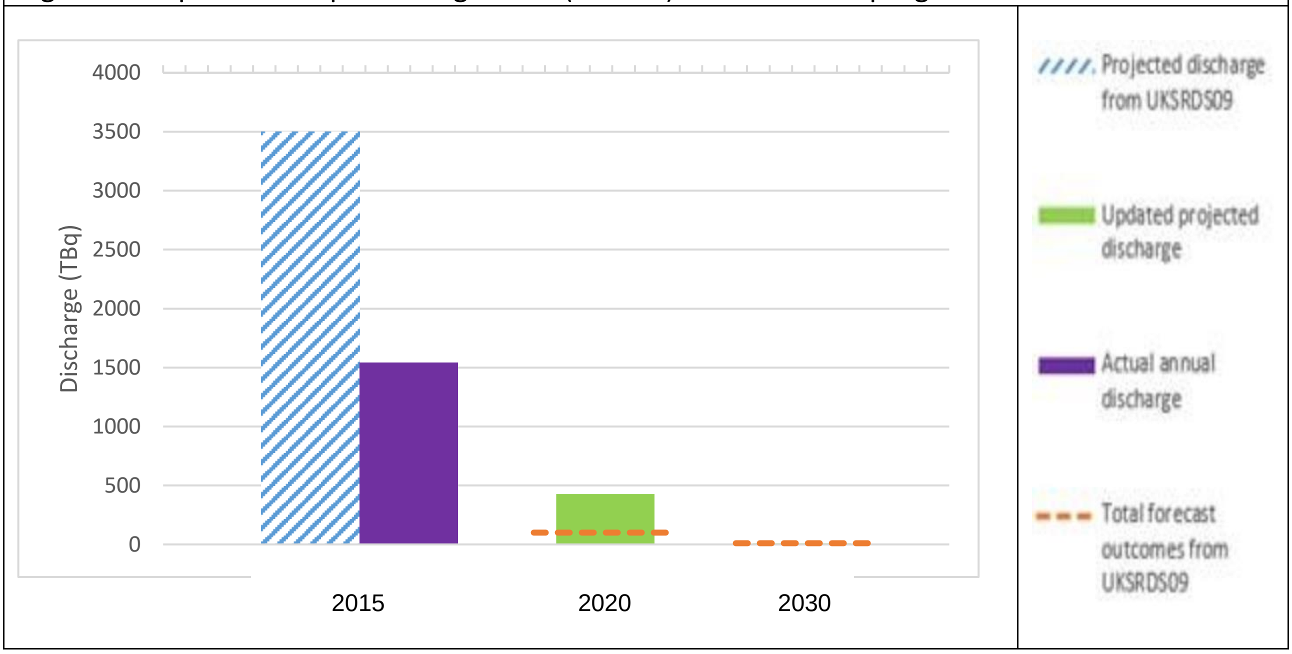


Figure 5.3: Spent fuel reprocessing sector (**tritium**): evaluation of progress



103. Table 1 shows that liquid discharges of total alpha and total beta from this sector are the largest within the nuclear sector. Liquid tritium discharges from this sector are of a similar order to those from the nuclear energy production sector, but are expected to decrease significantly when fuel reprocessing ends.

104. Figure 5.3 illustrates that actual liquid discharges of total alpha, total beta and tritium from the spent fuel reprocessing sector have been below forecasts in the UKSRDS09, and below the illustrative OSPAR baselines for total alpha and total beta. There has

been significant and continual improvement in quality of forecasts for this sector. Forecast outcomes are based on assumptions about future activities contained within detailed plans for Sellafield work programmes, which contribute to differences between these forecasts and those from the UKSRDS09. The figure also indicates that forecast discharges in 2020 and 2030 will be broadly consistent with the UKSRDS09 expected outcomes for this sector. It is expected that both reprocessing facilities will cease operations around or before 2020, which are significant contributors to discharges. Discharges associated with decommissioning activities, although of a lesser magnitude, will become more significant in the future.

105. As a result of this review and based on the latest information, including improved understanding of the planned legacy clean-up and decommissioning plans for Sellafield, the updated Total Forecast Outcomes are shown in Table 4. All revised figures include appropriate rounding and, in several cases, provide an indication of a potential upper estimate encompassing future discharges, noting that the provisions detailed in the chapter titled ‘Uncertainties and Assumptions’ apply. It should be noted that as further clarity is obtained on timescales and arisings from decommissioning activities, these figures may change in future.

Table 4: Revised Forecast Outcomes for the Spent Fuel Reprocessing Sector (TBq)

	2020		2030	
	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)
Total alpha	0.1	0.1	0.05	0.1
Total beta	20	18	10	10
Tritium	100	700	10	10
Tc-99	1.0	3.0	0.1	1.0

106. A more detailed presentation of actual liquid discharges from this sector to 2015 and future forecasts up to 2030 (in five year annualised averages) is shown in Annex 1, Figures 9.1 to 9.4. Aerial discharges are shown in Figures 9.5 – 9.7.

Nuclear research sector

107. Table 1 shows that liquid discharges of total alpha, total beta and tritium from this sector are approximately three orders of magnitude less than the discharges from the spent nuclear fuel reprocessing sector.

108. Actual liquid discharges of total alpha, total beta and tritium from the nuclear research sector have been well below forecasts in the UKSRDS09, and below the OSPAR baselines that apply for total alpha and total beta. The revised forecast discharges in 2020 and 2030 will be below the UKSRDS09 expected outcomes set for total alpha and total beta for this sector. As a result of this review, we propose revising the Total Forecast Outcomes as follows.

Table 5: Revised Forecast Outcomes for the Nuclear Research Sector (TBq)

	2020		2030	
	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)
Total alpha	0.025	*see below	0.020	*see below
Total beta	0.8	*see below	0.2	*see below

**Data not provided because forecast outcomes from the Research Sector are very low, in these circumstances the value of setting revised forecast outcomes is limited*

109. A more detailed presentation of actual liquid discharges from this sector to 2015 and future forecasts up to 2030 (in five year annualised averages) is shown in Annex 1, Figures 10.1 to 10.3. Aerial discharges are shown in Figures 10.4 – 10.6.

Defence sector

110. As can be seen from Table 1 liquid discharges of total alpha, total beta and tritium from the defence sector are less than the discharges from all the other sectors, and at least four orders of magnitude less than the discharges from the spent nuclear fuel reprocessing sector.

111. Liquid discharges of total alpha, total beta and tritium from the defence sector have been below forecasts in the UKSRDS09. There are no OSPAR baselines for the defence sector. Revised operational forecasts in 2020 and 2030 are broadly consistent with the UKSRDS09 expected outcomes for total alpha and total beta. Tritium discharges are forecast to continue at current levels. As a result of this review, we propose revising the Forecast Operational Outcomes as follows.

Table 6: Revised Forecast Outcomes for the Defence Sector (TBq)

	2020		2030	
	Total Forecast Outcome from UKSRDS09 (TBq)	Revised total Forecast Outcome (TBq)	Total Forecast Outcome from UKSRDS09 (TBq)	Revised Total Forecast Outcome (TBq)
Total alpha	0.0001	0.0001	0.0001	0.0001
Total beta	0.002	0.001	0.001	0.0005

112. A more detailed presentation of actual liquid discharges from this sector to 2015 and future forecasts up to 2030 (in five year annualised averages) is shown in Annex 1, Figures 11.1 to 11.3. Aerial discharges are shown in Figures 11.4 – 11.6. H-3 discharges from Chapelcross are shown in Figures 11.7-11.8.

EVALUATION OF PROGRESS TOWARDS THE OBJECTIVES OF THE OSPAR RADIOACTIVE SUBSTANCES STRATEGY – OSPAR 3RD AND 4TH PERIODIC EVALUATION

113. The OSPAR Commission has recently published the Fourth Periodic Evaluation of progress against its Radioactive Substances Strategy focussing on discharges of radioactive substances to the North-east Atlantic waters by Contracting Parties. The Fourth Period Evaluation concluded:

    - During the baseline period of 1995-2001, the main contributors to the total activity discharged from the nuclear sector were the reprocessing and nuclear fuel manufacturing and enrichment sub-sectors.
    - In the assessment period for the fourth periodic evaluation (2007-2013) the discharges from all the sub-sectors have reduced and the relative contributions have changed. For example, the relative reduction in discharges from the fuel fabrication and enrichment sub-sector has been greater than that for the other sub-sectors due to the operational changes in that sub-sector.
    - While discharges from the reprocessing sub-sector are much reduced, it remains the dominant source of discharges from the nuclear sector contributing approximately 90% of the total alpha, and approximately 80% of the total beta (excluding tritium), discharges over the assessment period.

114. The Third Period Evaluation concluded in relation to discharges from the nuclear sector that:

    - There had been a 38% reduction in total beta (excluding H-3) discharges during the assessment period compared with the baseline value and the statistical tests indicated that this change was statistically significant.
    - There had been a 15% increase in total alpha discharges during the assessment period compared with the baseline value, but the statistical tests indicated that this change was not statistically significant.
    - Since 2002, reductions had been achieved in discharges of Tc-99, a radionuclide to which both the 1998 and 2003 OSPAR Ministerial Meetings

drew special attention, and that discharges of Tc-99 were expected to be reduced further and maintained at low levels.

115. The Fourth Periodic Evaluation has confirmed that in relation to discharges from the nuclear sector:

- OSPAR Contracting Parties are continuing to make good progress in meeting the objectives of the OSPAR Radioactive Substance Strategy, and that
- OSPAR Contracting Parties have achieved substantial reductions in discharges in many cases, as required by the OSPAR RSS.

116. Furthermore, the overall situation for the nuclear sector has improved since the Third Periodic Evaluation. In particular, the following achievements should be noted:

- There has now been a 2.5 fold reduction in discharges of total alpha since the baseline period.
- There has now been a 12 fold reduction in discharges of total beta (excluding tritium) since the baseline period.
- Discharges of Tc-99 have continued to decline with a reduction of 38-fold in the discharges since the baseline period.

117. Exceptional discharges associated with decommissioning and the management of legacy wastes at nuclear sites are reported separately to operational discharges, but these were summed to give a total discharge for a site where applicable for the purposes of this evaluation. While relatively low when compared to overall operational discharges, the contribution of exceptional discharges from decommissioning activities is growing and this is expected to continue as essential work to reduce hazards and decommission redundant nuclear installations increases.

Environmental concentrations and radiation doses around the UK

118. The distribution of radionuclides in coastal seas away from nuclear licensed sites in the UK continues to be monitored. This supports the UK's marine environmental policies and international treaty commitments. Government research vessels are used in the sampling programme and the results have been used to show trends in the quality of the UK's coastal seas. These surveys, together with the results of monitoring at nuclear licensed sites, contribute to the data collected by the OSPAR Commission. They also help to measure progress towards the UK Government's objectives for improving the state of the marine environment.

119. The UK's environmental monitoring data (published annually in the RIFE report series) indicate that there has not been a significant increase in environmental concentrations since 1998 and the levels of most radionuclides in the environment have decreased in

response to decreases in discharges (i.e. there are no additional concentrations above the historic/baseline levels). The monitoring programme also shows that the radiological impacts of these discharges are low and well below statutory limits.

ANNEX I

Introduction

120. This chapter updates Part 2 (Chapters 7 – 14) of the UKSRDS09. It provides updated graphs, showing actual discharges for the period 2009 – 2015. The forecasts for the period 2016 – 2030 are also updated.

121. It does not repeat information from the UKSRDS09 about the different sectors in terms of sources, types of radionuclides or abatement technologies.

122. As with the UKSRDS09, it is unavoidable that there are a number of different scales for the graphs, reflecting the different levels of discharges from the various sectors. The chapter titled 'Summary of Data and Analysis' provides context as to how the discharges from the different sectors compare.

123. For ease of comparison, the same figure numbers are used in this update to allow comparison with the UKSRDS09 figures.

Nuclear Fuel Manufacture and Uranium Enrichment Sector

124. The main changes in the sector since the UKSRDS09:

- Fuel manufacturing on the Springfields site is no longer expected to cease in 2024. Revised forecasts also take into account the extended lifetime of AGR stations and the agreed decommissioning dates (with NDA) for some facilities (these dates have changed since the UKSRDS09 was published).

- The Sellafield MOX Plant (SMP) closed in 2011.

Discharge Projections

125. The projected liquid and aerial discharge profiles to 2030 for the nuclear fuel production and uranium enrichment sector are shown in Figures 7.2 to 7.6 below.

UKSRDS09 total forecast outcomes: The outcomes described below were predicted on the basis that the Springfields site will cease operation in 2024. Should operations continue on the site beyond that date, operational discharges are expected to be consistent with those projected in the period 2020-2025.

By 2020:

- total-alpha (liquid) discharges are expected to have reduced from 0.08 TBq/yr to below 0.04 TBq/yr.
- total-beta (liquid) discharges are expected to have reduced from around 20 TBq/yr to below 0.7 TBq/yr.

By 2030:

- on the assumption that Springfields will no longer be operational, total-alpha (liquid) discharges are expected to have reduced to below 0.004 TBq/yr.
- on the assumption that Springfields will no longer be operational, total-beta (liquid) discharges are expected to have reduced to below 0.005 TBq/yr.
- Otherwise discharges are expected to be consistent with those projected in the period 2020 to 2025.

Overall Comments

126. As noted in the chapter titled ‘Summary of Data and Analysis’, liquid discharges of total alpha from this sector are approximately one order of magnitude less than the total discharges which are dominated by the spent nuclear fuel reprocessing sector. Similarly, liquid discharges of total beta from this sector are also approximately one fifth of the total discharges from the spent nuclear fuel reprocessing sector.

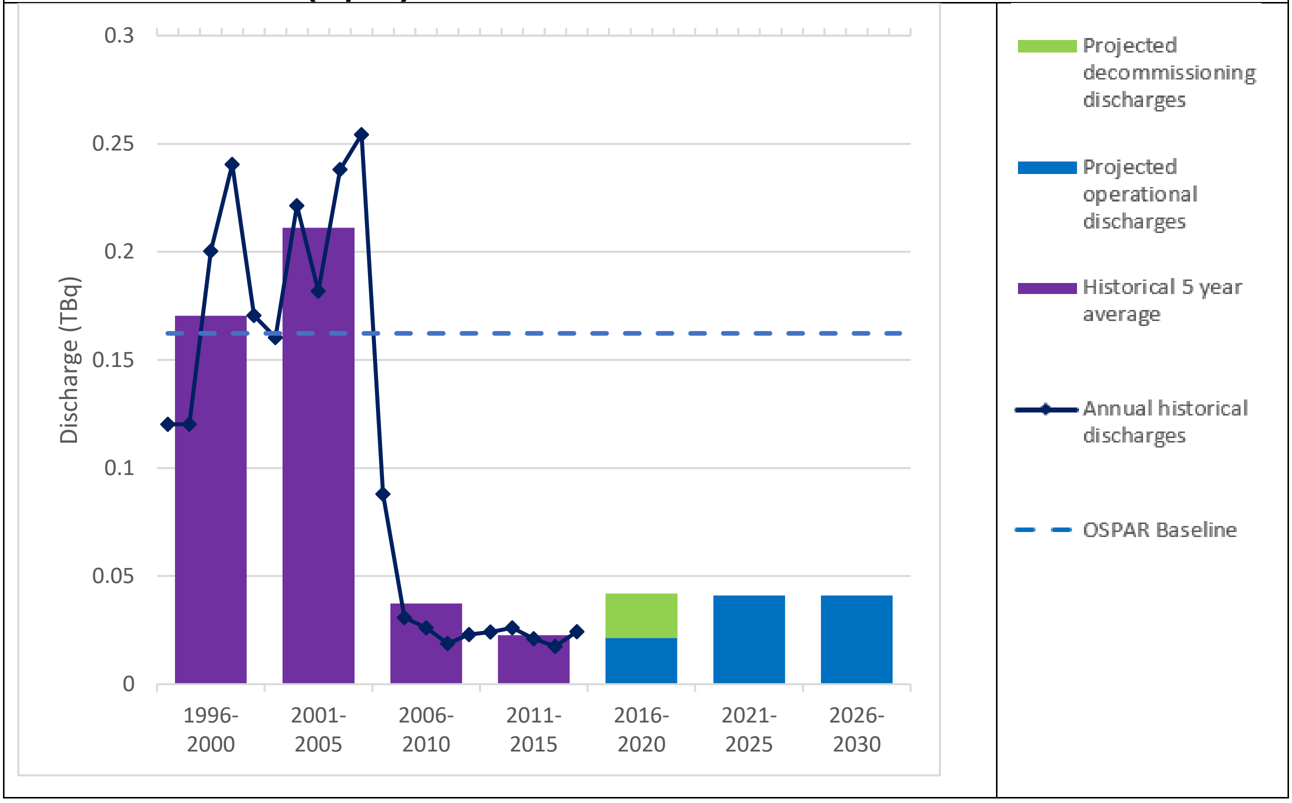
127. Figures 7.2 and 7.3 indicate liquid discharges from the nuclear fuel production and uranium enrichment sector have declined substantially since 1995, particularly with the cessation of uranium ore conversion at Springfields in 2006 but also the cessation of Magnox fuel manufacture in 2007.

128. With the exception of total beta discharges from the nuclear energy production sector, and tritium from the fuel reprocessing and energy production sectors, aerial discharges are many orders of magnitude less than the liquid discharges. This is illustrated by the scale of total alpha aerial discharges in Fig 7.4 being 100 times less than the scale of total alpha liquid discharges in Fig 7.2.

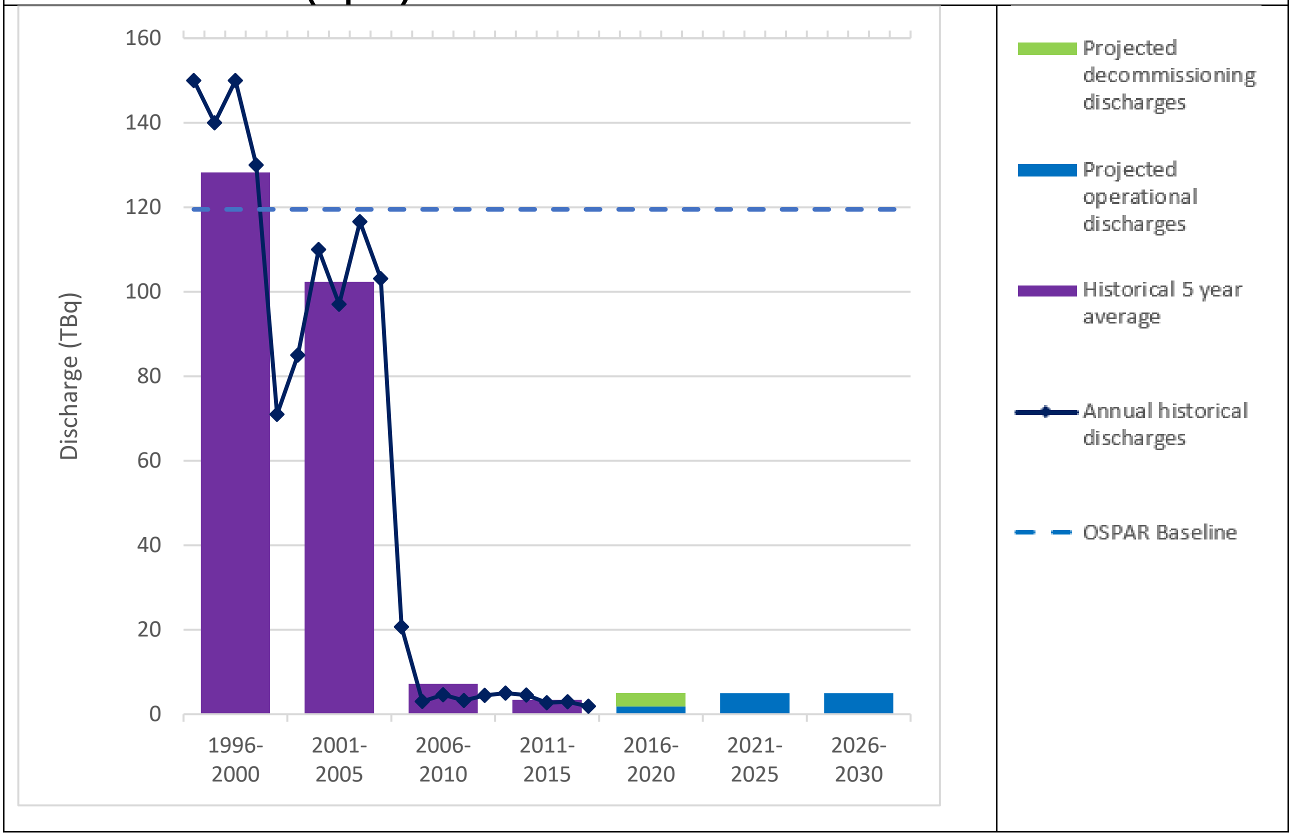
129. Figures 7.4 – 7.6 indicate aerial discharges from the nuclear fuel production and uranium enrichment sector have also declined substantially since 1995. One exception is noted in Figure 7.5 where there was an increase in aerial beta discharges in 2011, due a temporary 12 month increase in limit to allow Kr-85 discharges from the National Nuclear Laboratory's facilities on the Springfields site. Future forecasts assume that from 2017 Kr-85 will be discharged to allow historic material from Dounreay to be processed (subject to a permit variation by the Environment Agency). Whilst numerically the discharge is significant, the radiological impact is very low (less than 1 nanoSievert).

130. Future discharges from the nuclear fuel production and uranium enrichment sector will depend on the demand for nuclear fuels. Uranium hexafluoride production is expected to continue at the Springfields site into the future as part of the process of fuel manufacture for AGRs, and potentially fuel for new reactors, but will continue to use imported UO3 to avoid the need for on-site ore conversion.

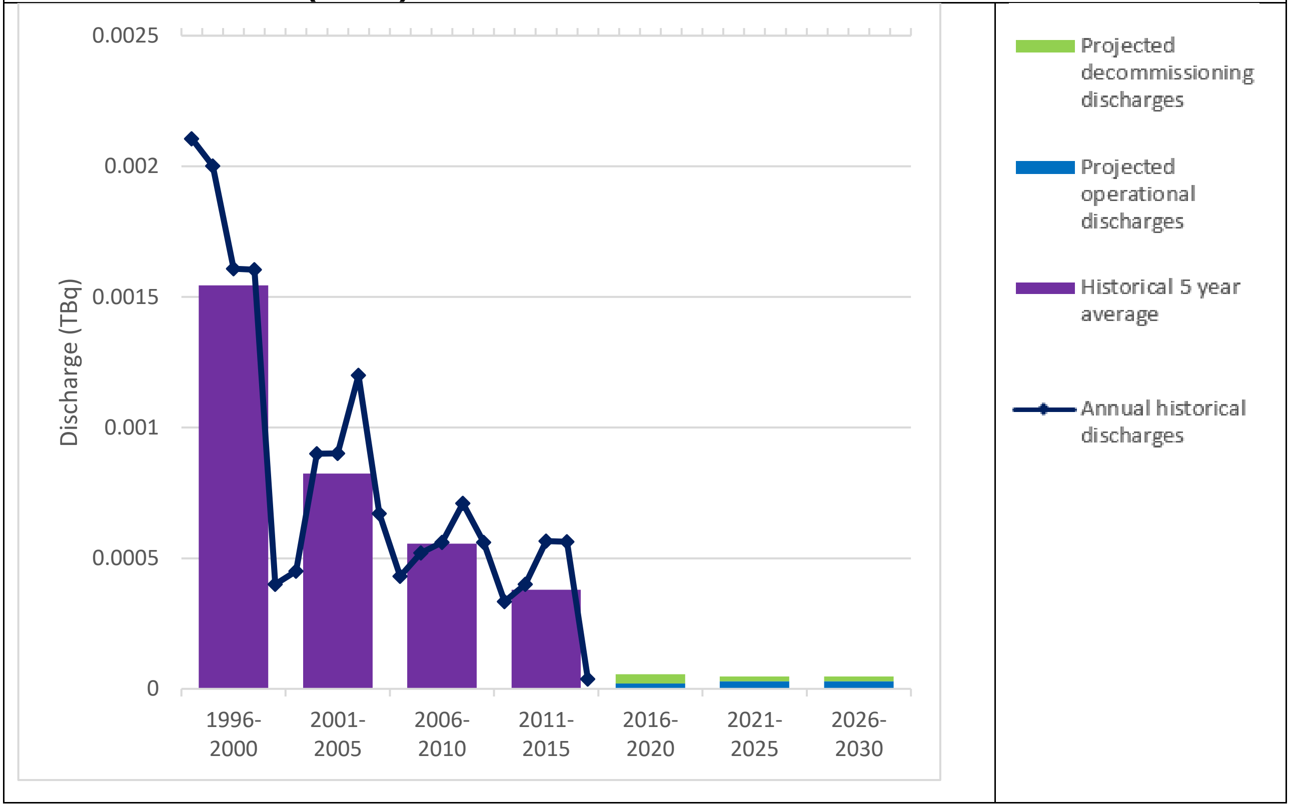
New Figure 7.2: Total alpha discharges from nuclear fuel production and uranium enrichment sector (liquid)



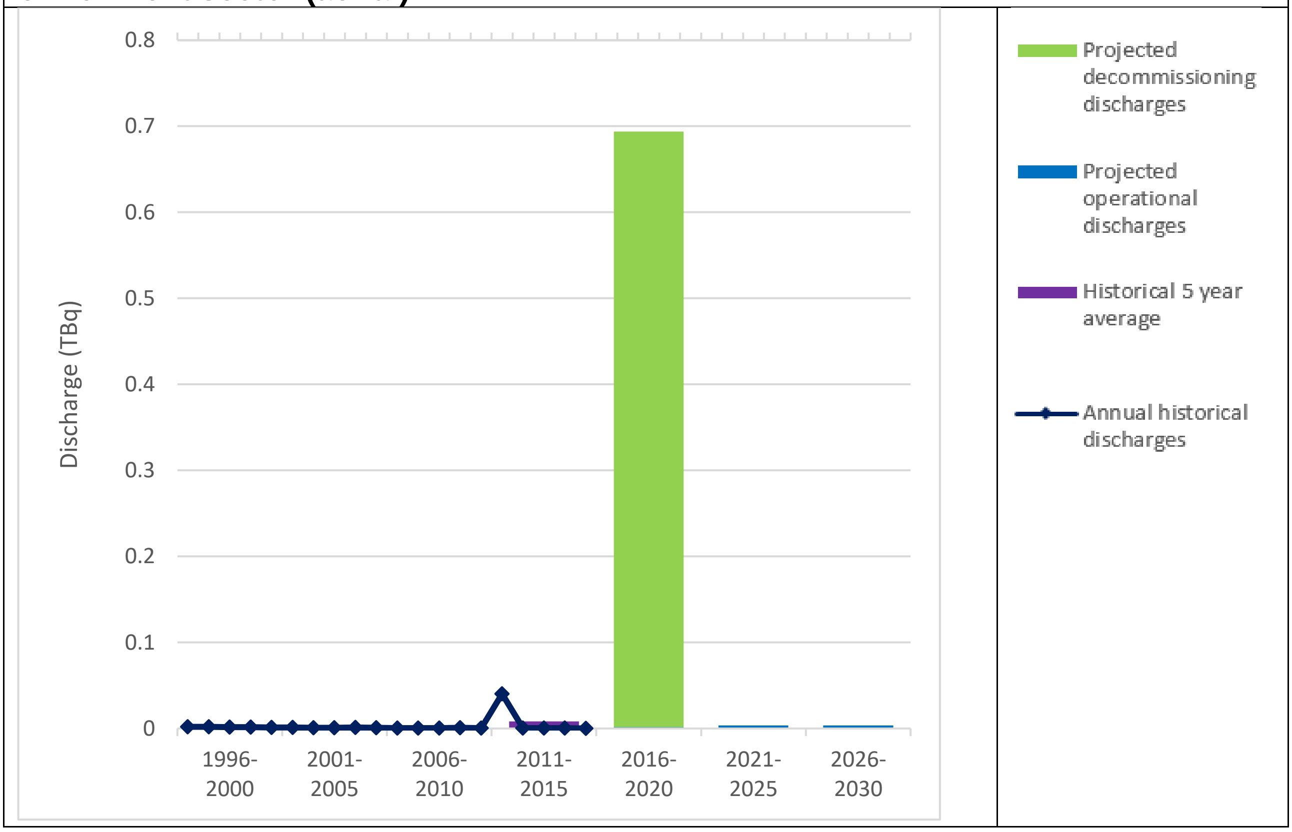
New Figure 7.3: Total beta discharges from nuclear fuel production and uranium enrichment sector (liquid)



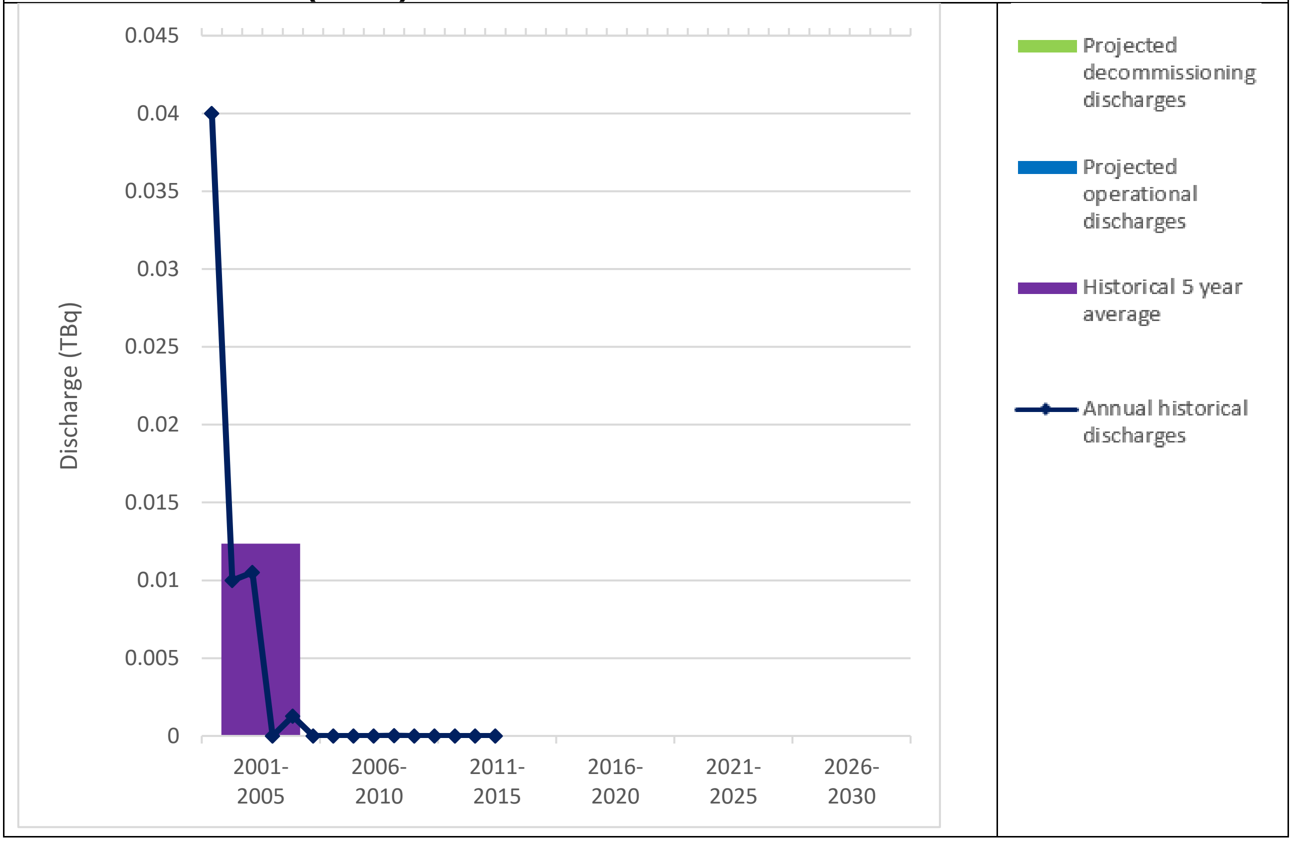
New Figure 7.4: Total alpha discharges from nuclear fuel production and uranium enrichment sector (aerial)



New Figure 7.5: Total beta discharges from nuclear fuel production and uranium enrichment sector (aerial)



New Figure 7.6: H-3 discharges from nuclear fuel production and uranium enrichment sector (aerial)



Nuclear Energy Production Sector

131. The main changes in the sector since the UKSRDS09:

- Cessation of electricity generation at Oldbury and Wylfa
- All Magnox sites except Wylfa have been defueled, Wylfa defueling is underway and expected to complete in 2019
- Plant extensions announced for the AGR fleet
- New power stations proposed for the mid to late 2020s

Discharge Projections

132. The projected liquid and aerial discharge profiles to 2030 for the nuclear energy production sector are shown in Figures 8.1 to 8.5 below.

UKSRDS09 total forecast outcomes: These outcomes of the UKSRDS09 were projected on the assumption that there will be no further extension of power station lifetimes and no new build of nuclear power stations: the revised forecasts of this review have taken these scenarios into account. The potential impact of these scenarios is discussed in the chapter titled ‘Summary of Data and Analysis’.

By 2020:

- total-alpha (liquid) discharges will be reduced from around 0.00002 TBq/yr to below 0.0003 TBq/yr.
- total-beta (liquid) discharges will be reduced from around 4.5 TBq/yr to below 1.5 TBq/yr.
- H-3 (liquid) discharges will be reduced from over 2000 TBq/yr to below 850 TBq/yr.
- C-14 (aerial) discharges will be reduced from around 14 TBq/yr to below 3 TBq/yr.

By 2030:

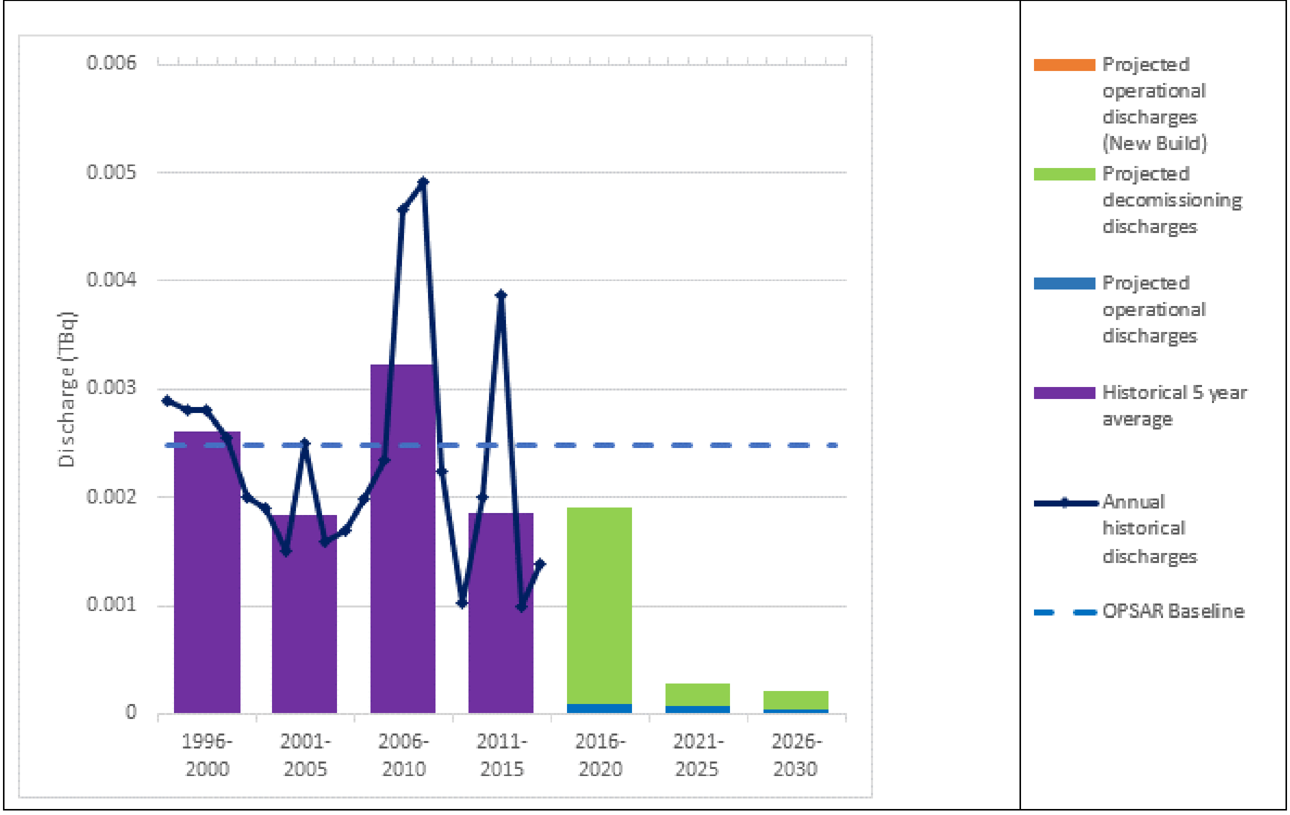
- total-alpha (liquid) discharges will be reduced to below 0.00006 TBq/yr.
- total-beta (liquid) discharges will be reduced to below 0.1 TBq/yr.
- H-3 (liquid) discharges will be reduced to below 75 TBq/yr.
- C-14 (aerial) discharges will be reduced to below 0.3 TBq/yr.

Overall Comments

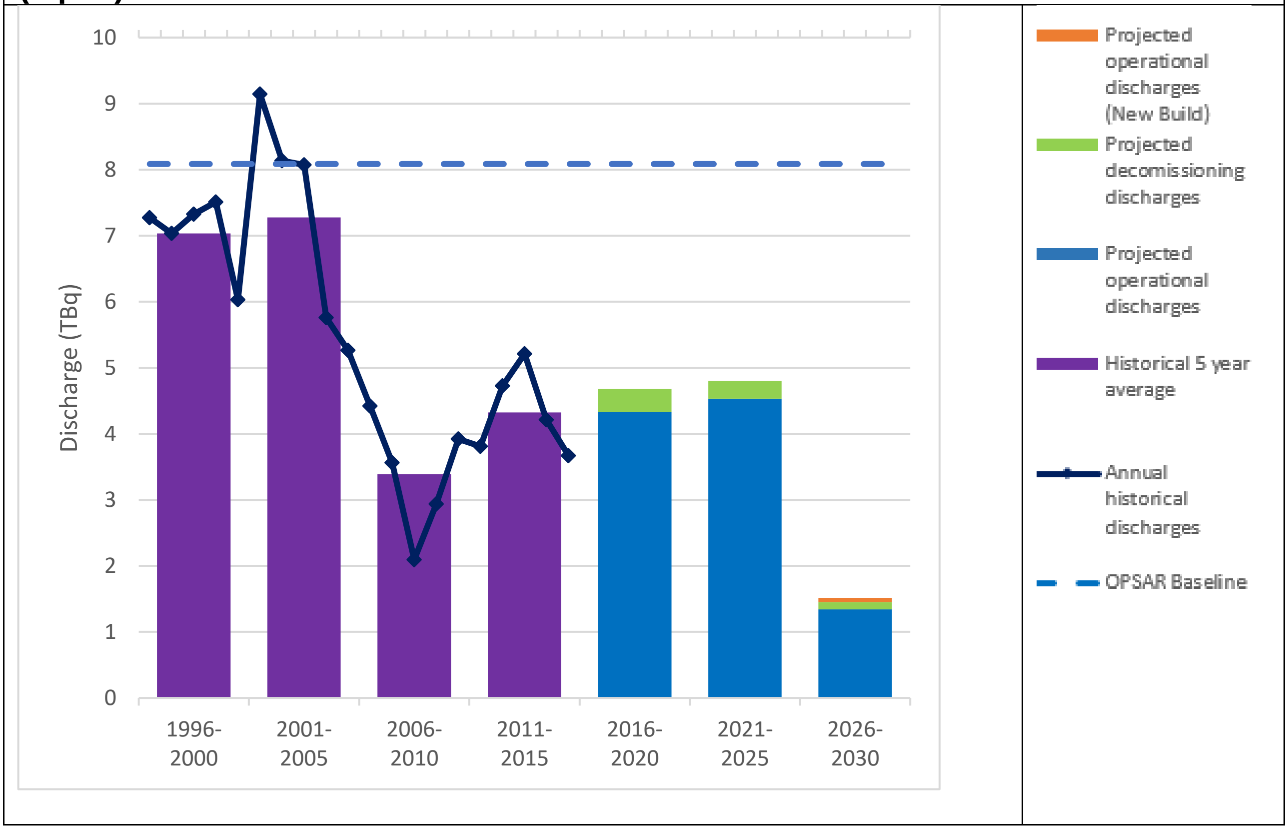
133. As noted in the chapter titled ‘Summary of Data and Analysis’, liquid discharges of total alpha from this sector are approximately two orders of magnitude less than the total discharges which are dominated by the spent nuclear fuel reprocessing sector. Similarly, liquid discharges of total beta from this sector are also approximately one third of the total discharges from the spent nuclear fuel reprocessing sector. Liquid tritium discharges from the nuclear energy production sector are of a similar order to those from the spent nuclear fuel reprocessing sector.

134. Figures 8.1 – 8.5 show that the progressive reduction of radioactive discharges from the nuclear energy production sector will slow as the proposed commissioning and operation of new nuclear power stations from ~2025 begins to replace the capacity of the current operating AGR fleet.

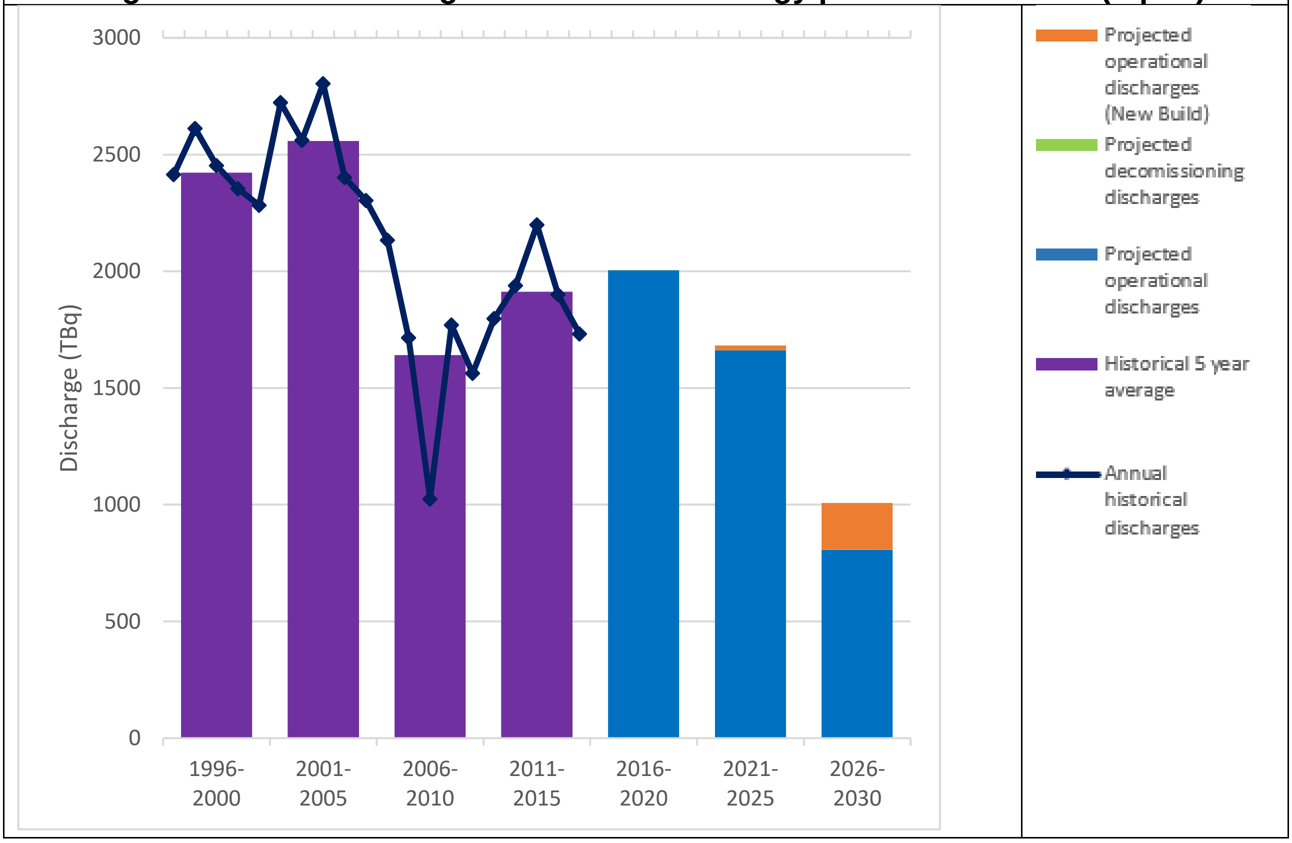
New Figure 8.1: Total alpha discharges from nuclear energy production sector (liquid)



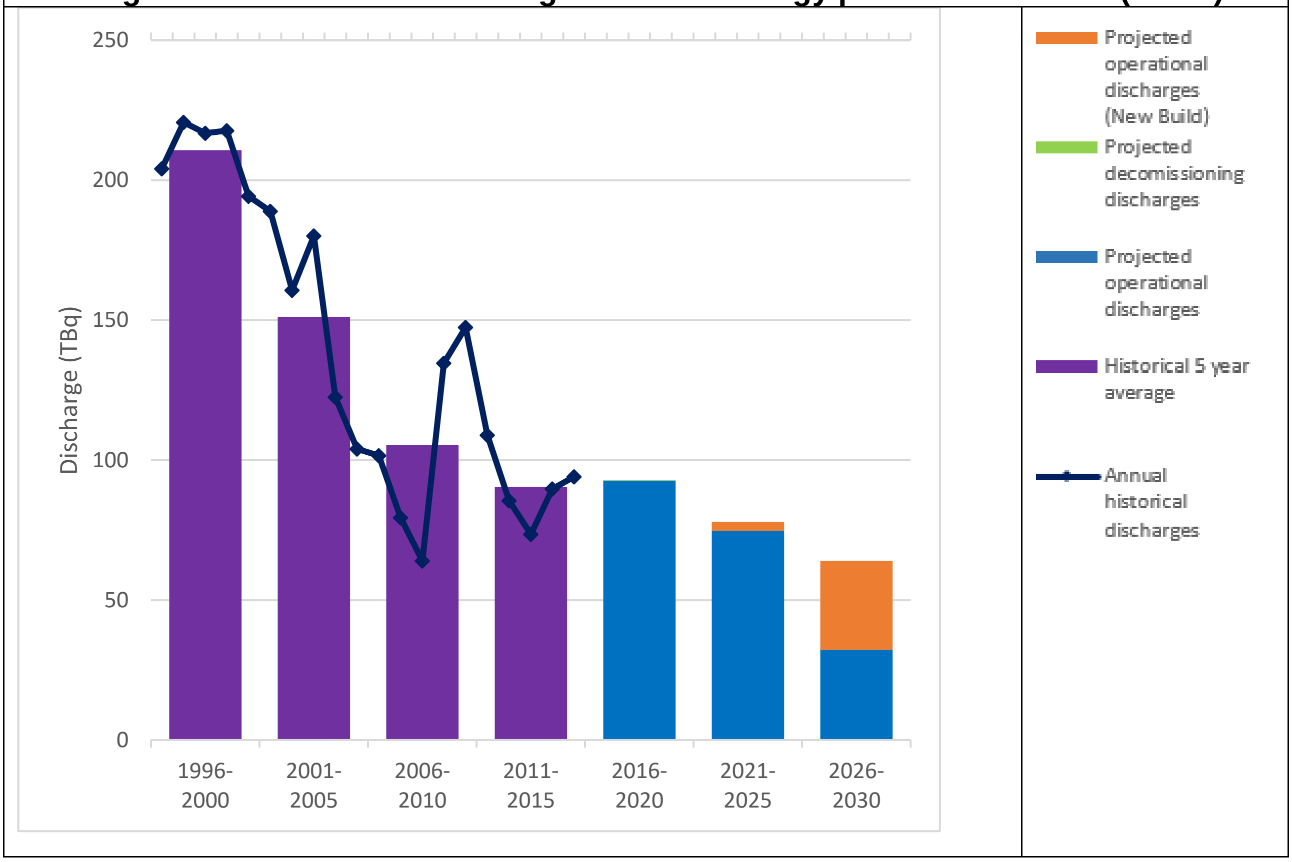
New Figure 8.2: Total beta discharges from nuclear energy production sector (liquid)



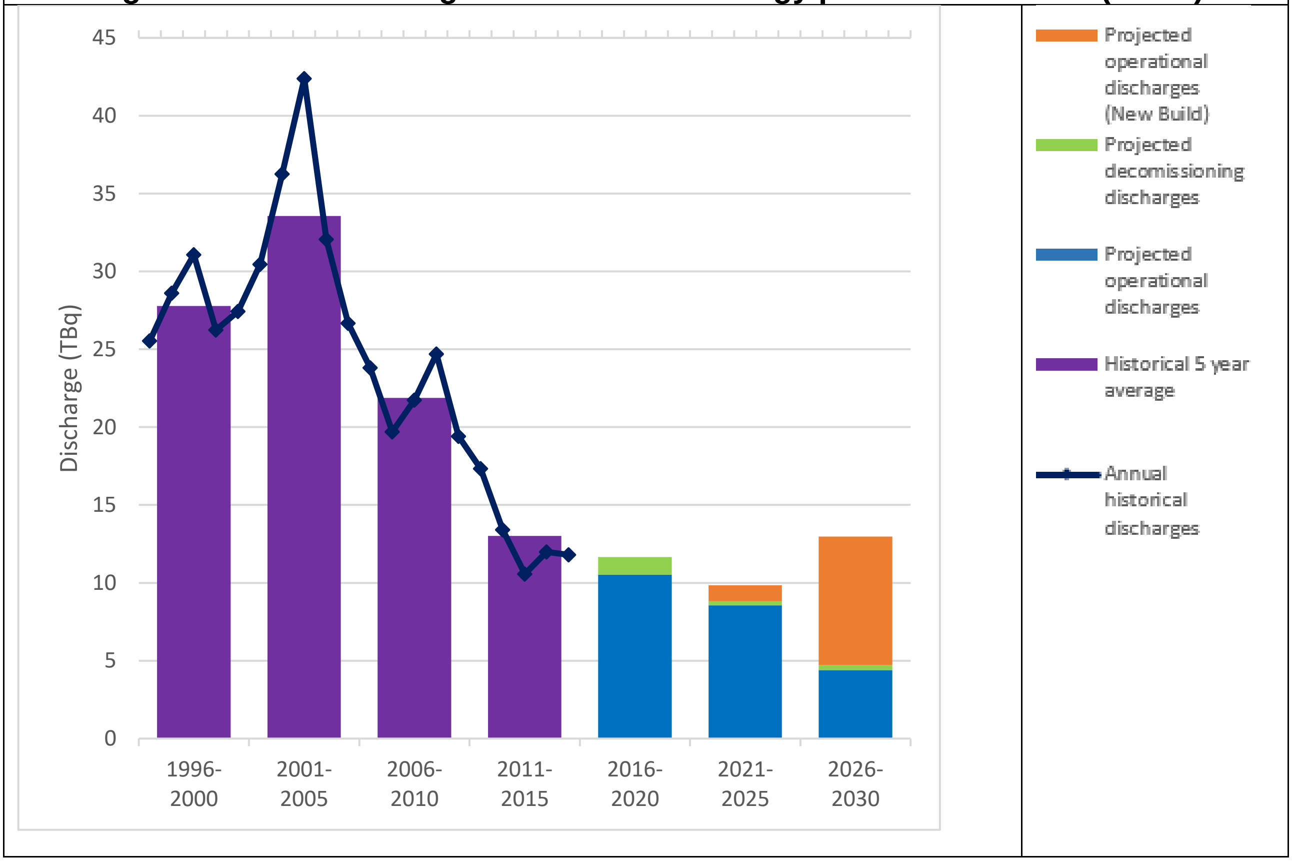
New Figure 8.3: H-3 discharges from nuclear energy production sector (liquid)



New Figure 8.4: Total beta discharges nuclear energy production sector (aerial)



New Figure 8.5: H-3 discharges from nuclear energy production sector (aerial)



Spent Nuclear Fuel Reprocessing Sector

135. The main changes in the sector since UKSRDS09:

- THORP and Magnox reprocessing operations have been extended. THORP reprocessing is scheduled to end in 2018 and Magnox reprocessing is anticipated to conclude around 2020 on completion of the reprocessing programme.

Discharge Projections

136. The projected liquid and aerial discharge profiles to 2030 for the spent nuclear fuel reprocessing sector are shown in Figures 9.1 to 9.7 below. Uncertainties associated with these projections are discussed in the chapter titled ‘Uncertainties and Assumptions’.

137. The predicted discharges for Sellafield do not include effluents resulting from the very last stage of preparing plants for recycling or disposal (i.e. during the final phase of decommissioning), or future radioactivity associated with groundwater and land remediation discharges.

UKSRDS09 total forecast outcomes: The outcomes set out below were based on the assumptions that THORP reprocessing operations would cease in 2015 and Magnox reprocessing would end in 2016 or later.

By 2020:

- total-alpha (liquid) discharges will be reduced from around 0.25 TBq/yr to below 0.1 TBq/yr.
- total-beta (liquid) discharges will be reduced from around 40 TBq/yr to below 20 TBq/yr.
- H-3 (liquid) discharges will be reduced from around 1000 TBq/yr to below 100 TBq/yr.
- Tc-99 (liquid) discharges will be reduced from around 6 TBq/yr to below 1 TBq/yr.

By 2030:

- total-alpha (liquid) discharges will be reduced to below 0.05 TBq/yr.
- total-beta (liquid) discharges will be reduced to below 10 TBq/yr.
- H-3 (liquid) discharges will be reduced to below 10 TBq/yr.
- Tc-99 (liquid) discharges will be reduced to below 0.1 TBq/yr.

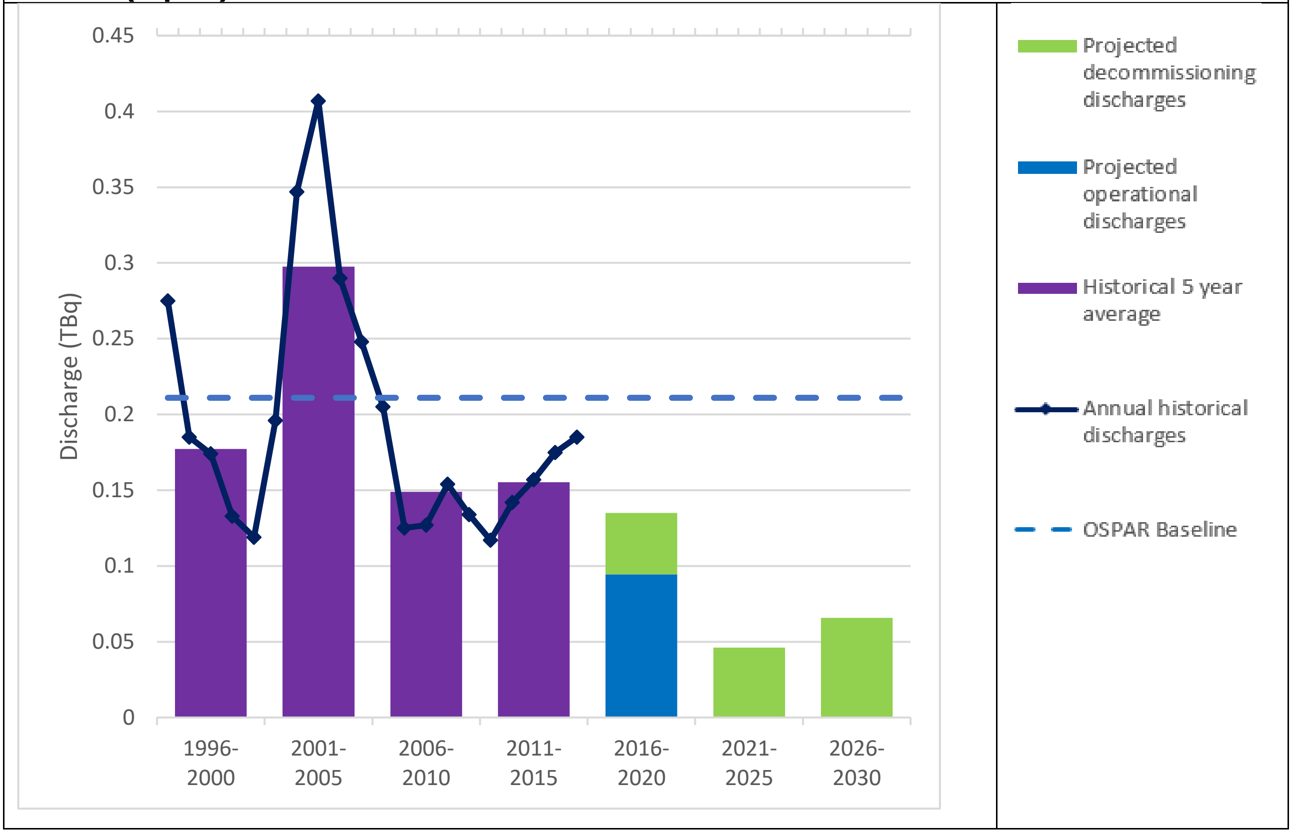
Overall Comments

138. As noted in the chapter titled ‘Summary of Data and Analysis’, liquid discharges of total alpha and total beta from this sector are larger than discharges from all nuclear sectors. Liquid tritium discharges from this sector are of a similar order to those from the nuclear energy production sector, but are expected to decrease significantly when fuel reprocessing ends. After reprocessing ends, discharges will be primarily from decommissioning activities on the Sellafield site, and are forecast to be close to 2030 total forecast outcomes from the UKSRDS09.

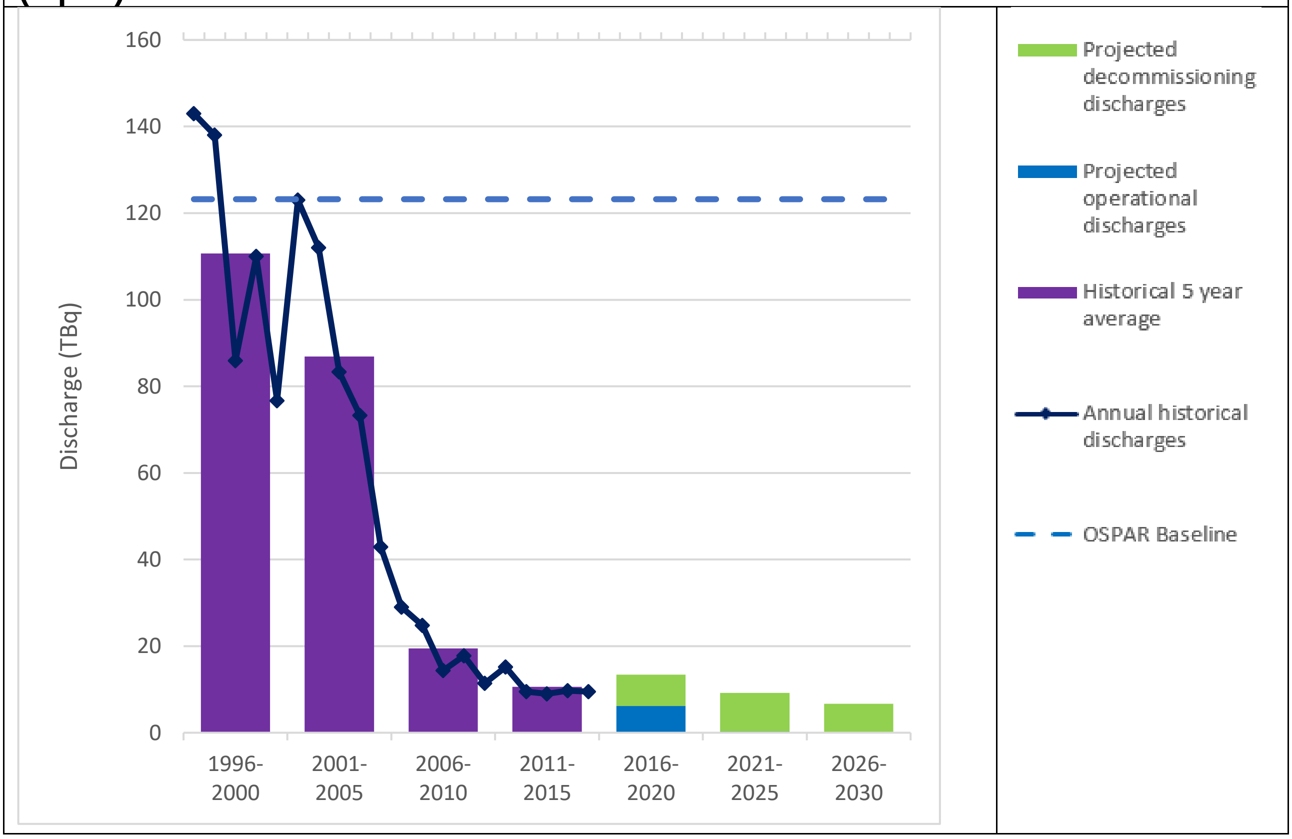
139. Aerial discharges of total alpha and total beta up to 2030 from planned decommissioning activities do not show the same decreases as liquid discharges, but are many orders of magnitude less than the liquid discharges. Aerial tritium discharges also show decreases, with levels approximately 10 times less than forecast liquid discharges.

140. Figure 9.6 includes some revised historical figures to those presented in the UKSRDS09.

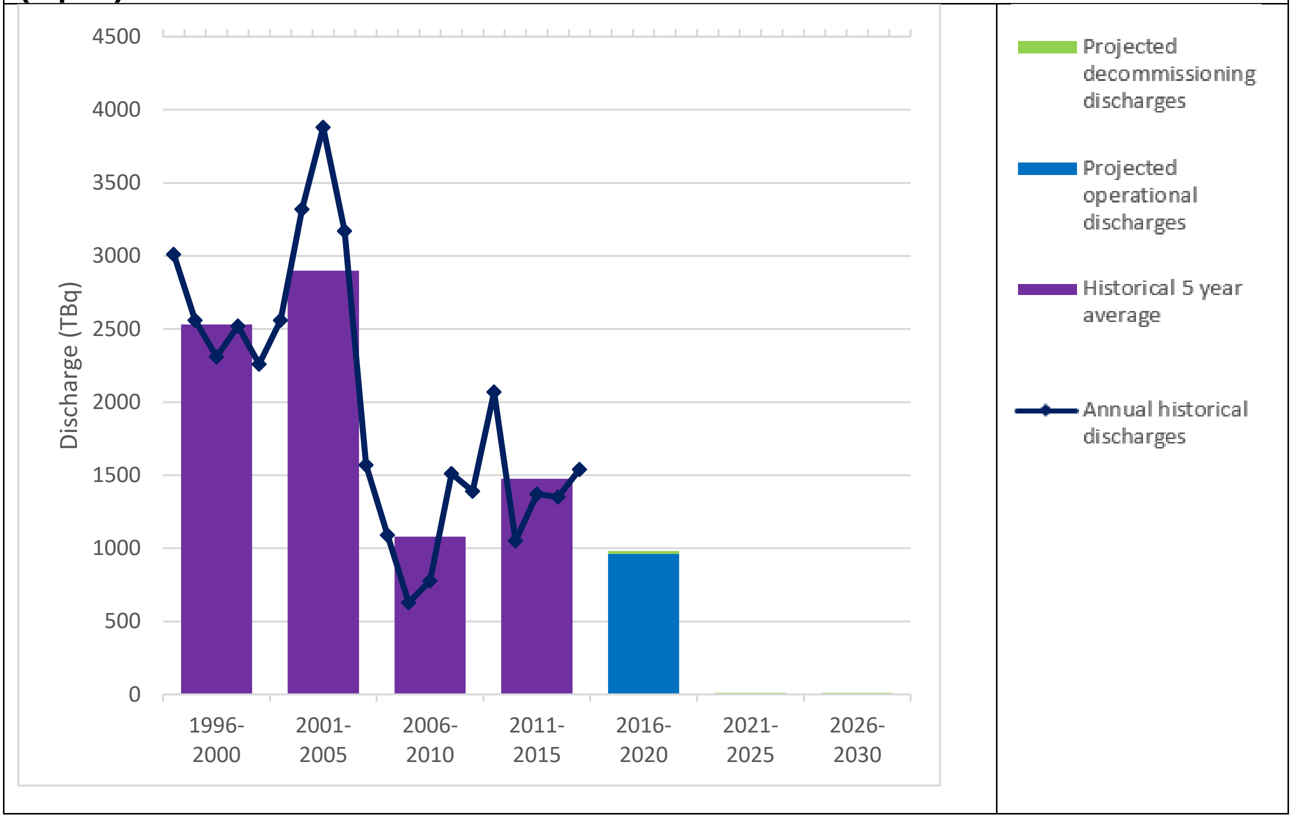
New Figure 9.1: Total alpha discharges from spent nuclear fuel reprocessing sector (liquid)



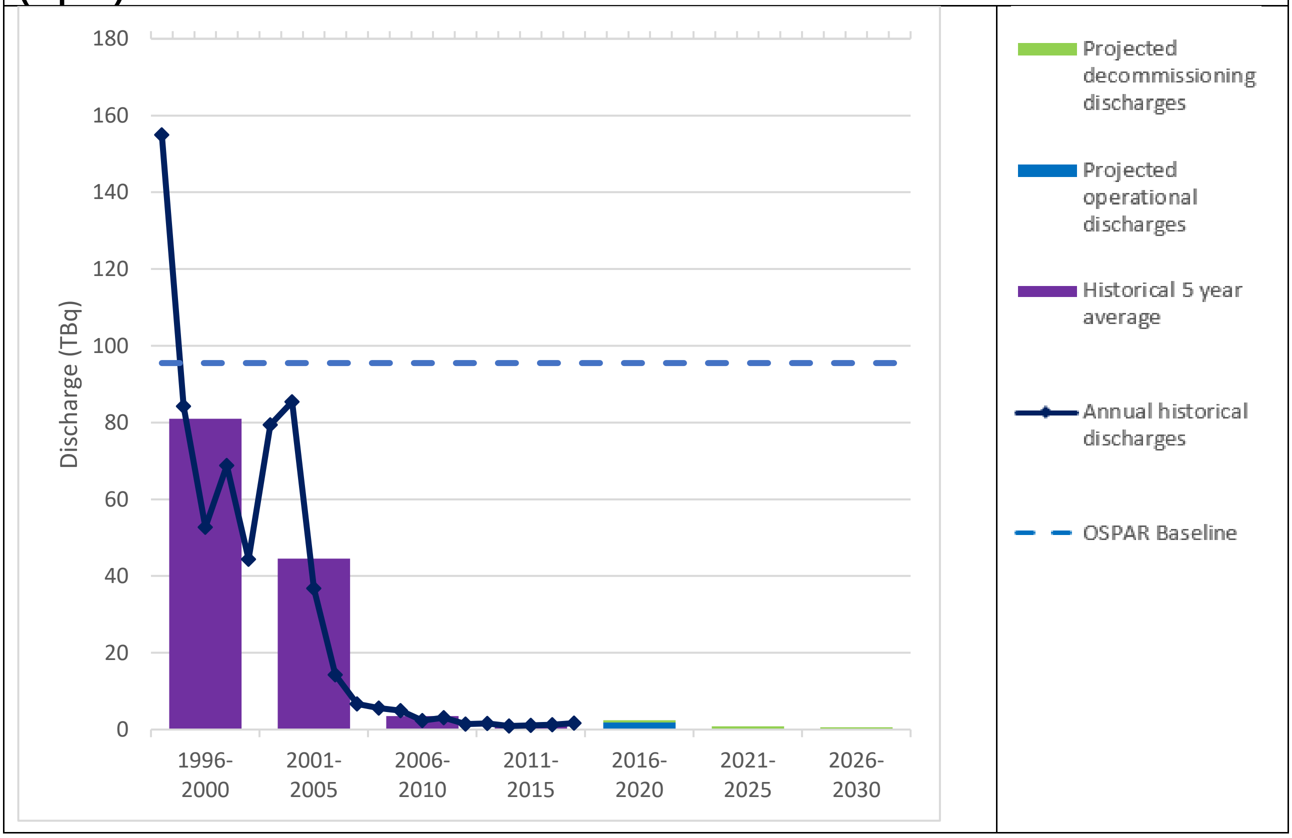
New Figure 9.2: Total beta discharges from spent nuclear fuel reprocessing sector (liquid)



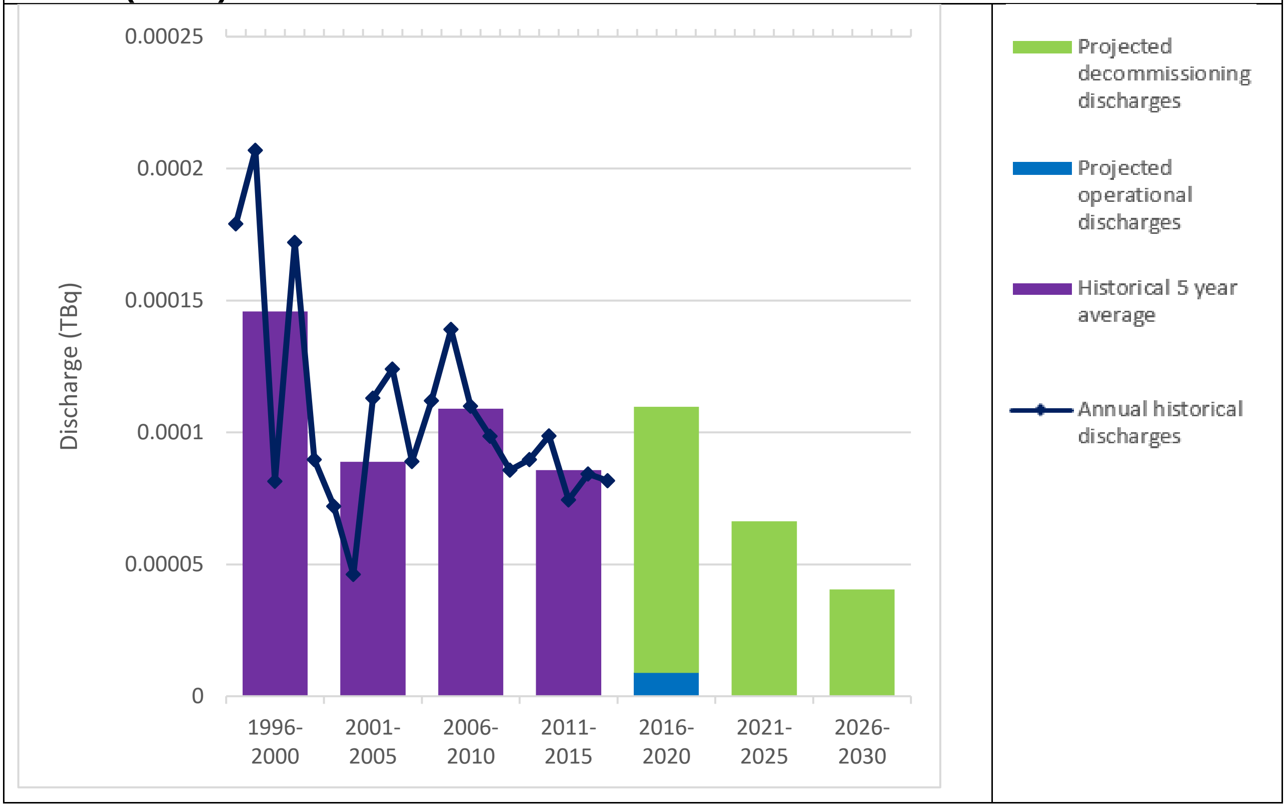
New Figure 9.3: H-3 discharges from spent nuclear fuel reprocessing sector (liquid)



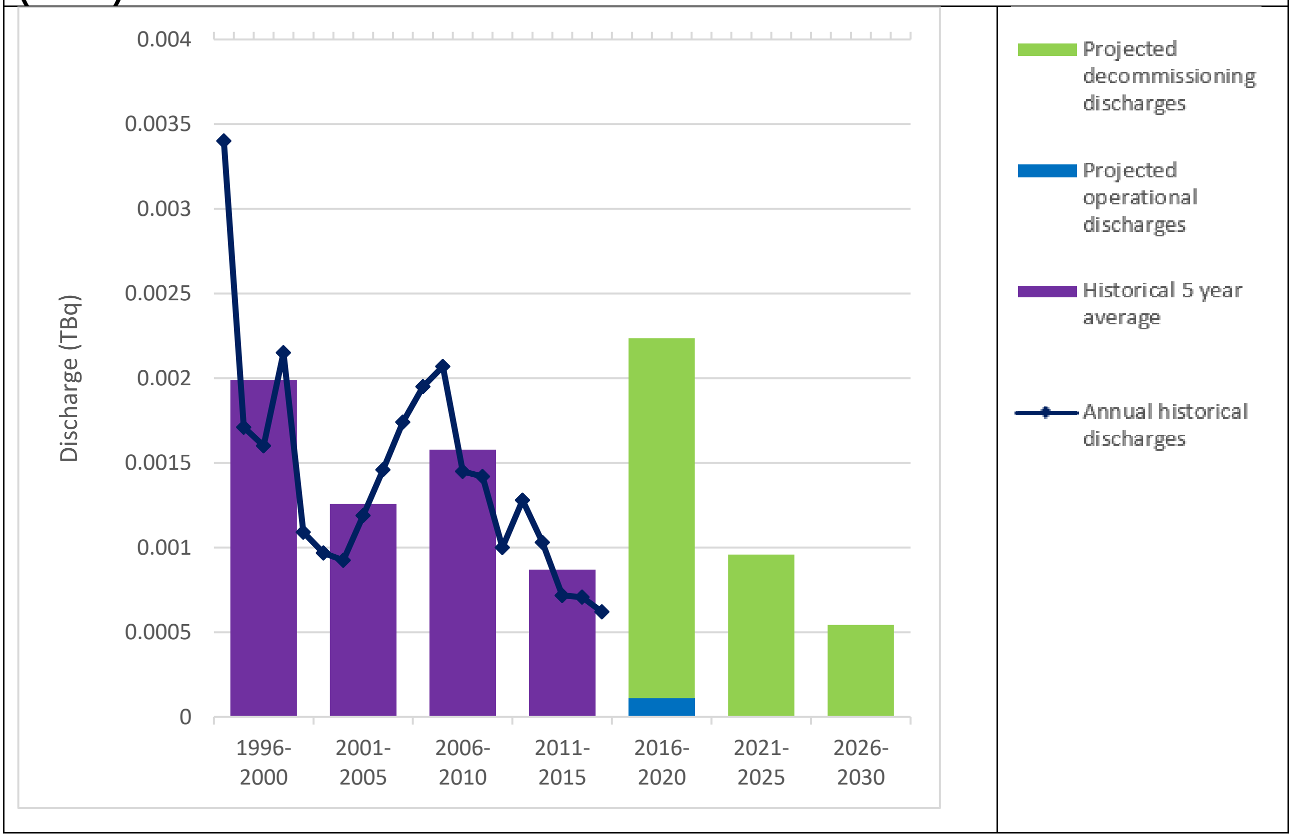
New Figure 9.4: Tc-99 discharges from spent nuclear fuel reprocessing sector (liquid)



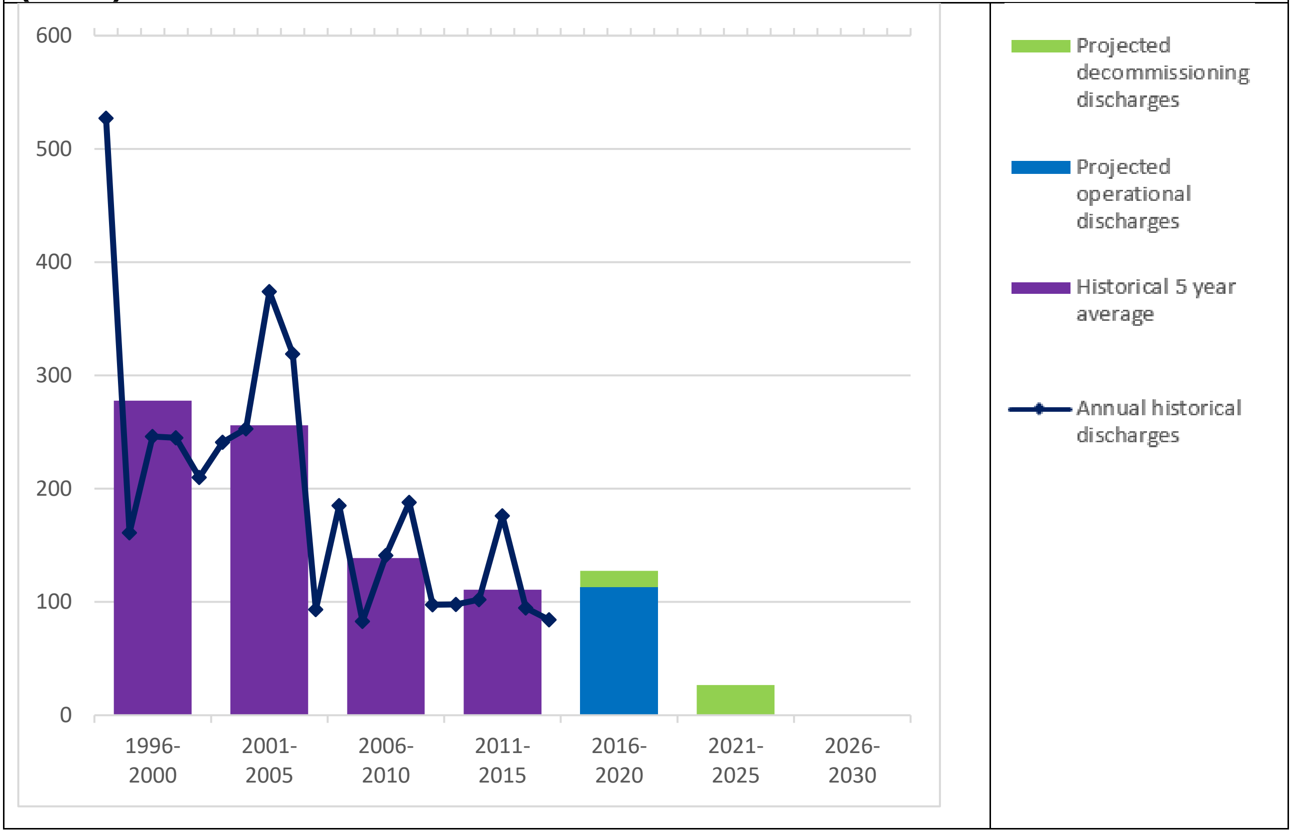
New Figure 9.5: Total alpha discharges from spent nuclear fuel reprocessing sector (aerial)



New Figure 9.6: Total beta discharges from spent nuclear fuel reprocessing sector (aerial)



New Figure 9.7: H-3 discharges from spent nuclear fuel reprocessing sector (aerial)



Nuclear Research Facilities

141. The main changes in the sector since the UKSRDS09:

- Waste retrievals, site decommissioning and remediation activities are ongoing at both Winfrith and Harwell sites. At Harwell, parts of the site have been completely cleared and made available for their next use. Both sites are now managed by Magnox Limited.
- Dounreay has completed the removal and treatment of the highly active liquid metal coolant which is a significant hazard reduction for the site. Also the raffinate from the Dounreay Fast Reactor has been encapsulated for long term storage.

Discharge Projections

142. The projected liquid and aerial discharge profiles to 2030 for the research sector are shown in Figures 10.1 to 10.6, below.

143. While some research activities have continued since the UKSRDS09, discharges from the research sector are dominated by the decommissioning of research and prototype reactors and associated waste processing and ancillary plant.

144. There may be periods when decommissioning discharges will increase from current levels, as specific decommissioning operations are undertaken. The timing of these predicted peaks in discharges will be governed by the timing of these decommissioning activities, which is dependent, amongst other factors, on NDA funding and the allocation of funding across NDA sites.

> **UKSRDS09 total forecast outcomes**: The outcomes set out below were based on decommissioning programmes for Harwell, Winfrith and Dounreay in place in 2009.
>
> By 2020:
> - total-alpha (liquid) discharges will have reduced to below 0.025 TBq/yr.
> - total-beta (liquid) discharges will have reduced to below 0.8 TBq/yr.
>
> By 2030:
> - total-alpha (liquid) discharges will have reduced to below 0.020 TBq/yr.
> - total-beta (liquid) discharges will have reduced to below 0.2 TBq/yr.

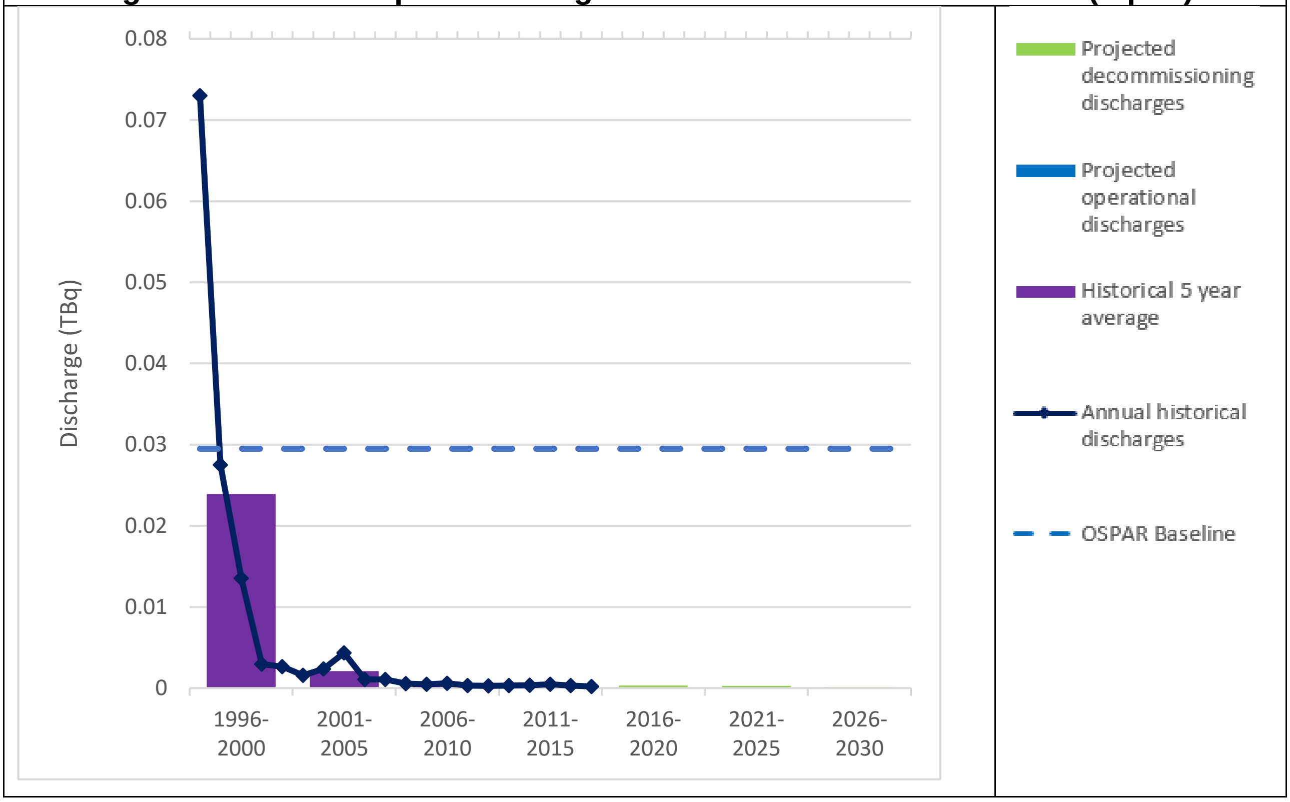
Overall Comments

145. As noted in the chapter titled ‘Summary of Data and Analysis’, liquid discharges of total alpha, total beta and tritium from this sector are approximately three orders of magnitude less than the discharges from the spent nuclear fuel reprocessing sector.

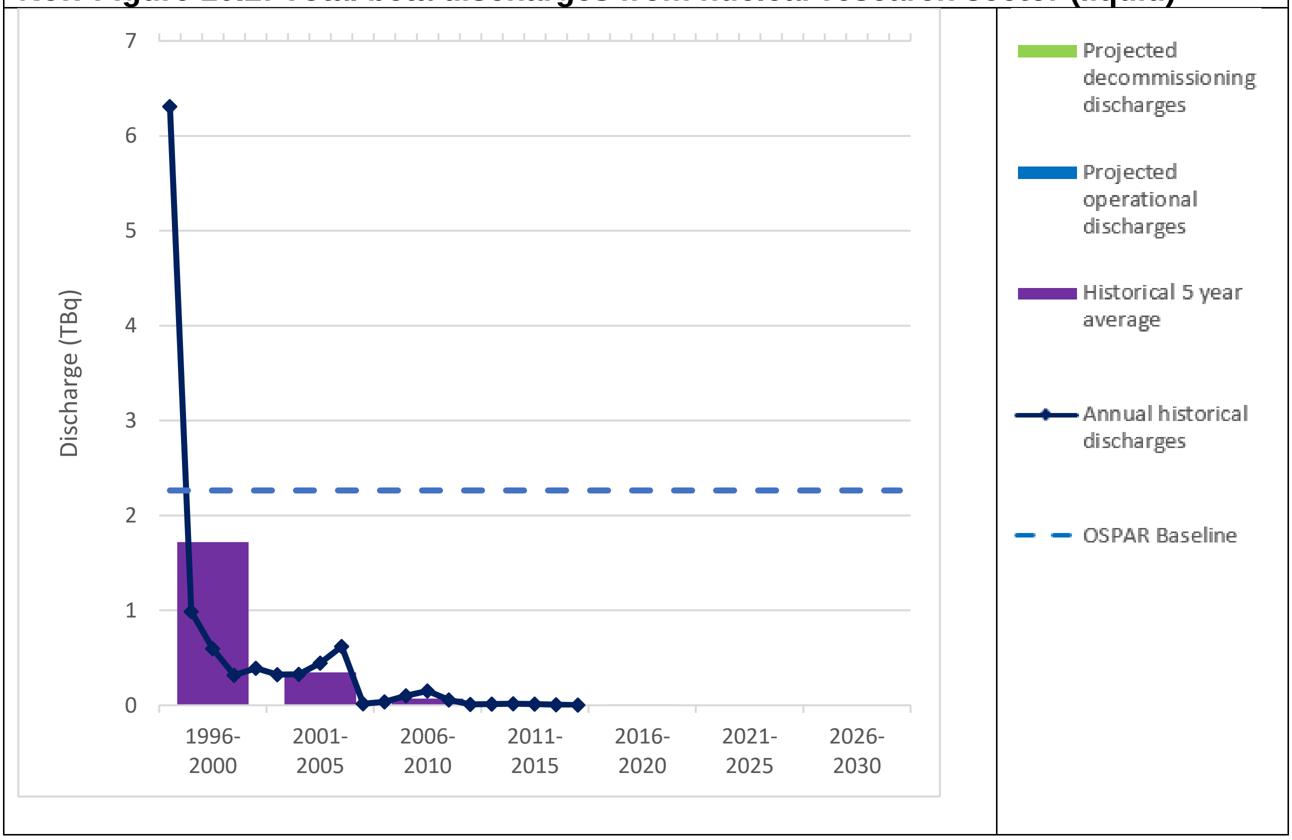
146. Liquid discharges from the nuclear research facilities sector have remained well below forecasts, and have met both the 2020 and 2030 total forecast outcomes set in the UKSRDS09.

147. Changes in decommissioning programmes will have a significant influence on actual decommissioning discharges in the short term, although current forecasts do not indicate any increases in liquid discharges up to 2030. Aerial discharges are forecast to increase as a result of the proposed decommissioning of research and prototype reactors at Harwell and Winfrith, although levels are significantly less than those from the both the reprocessing and energy production sectors.

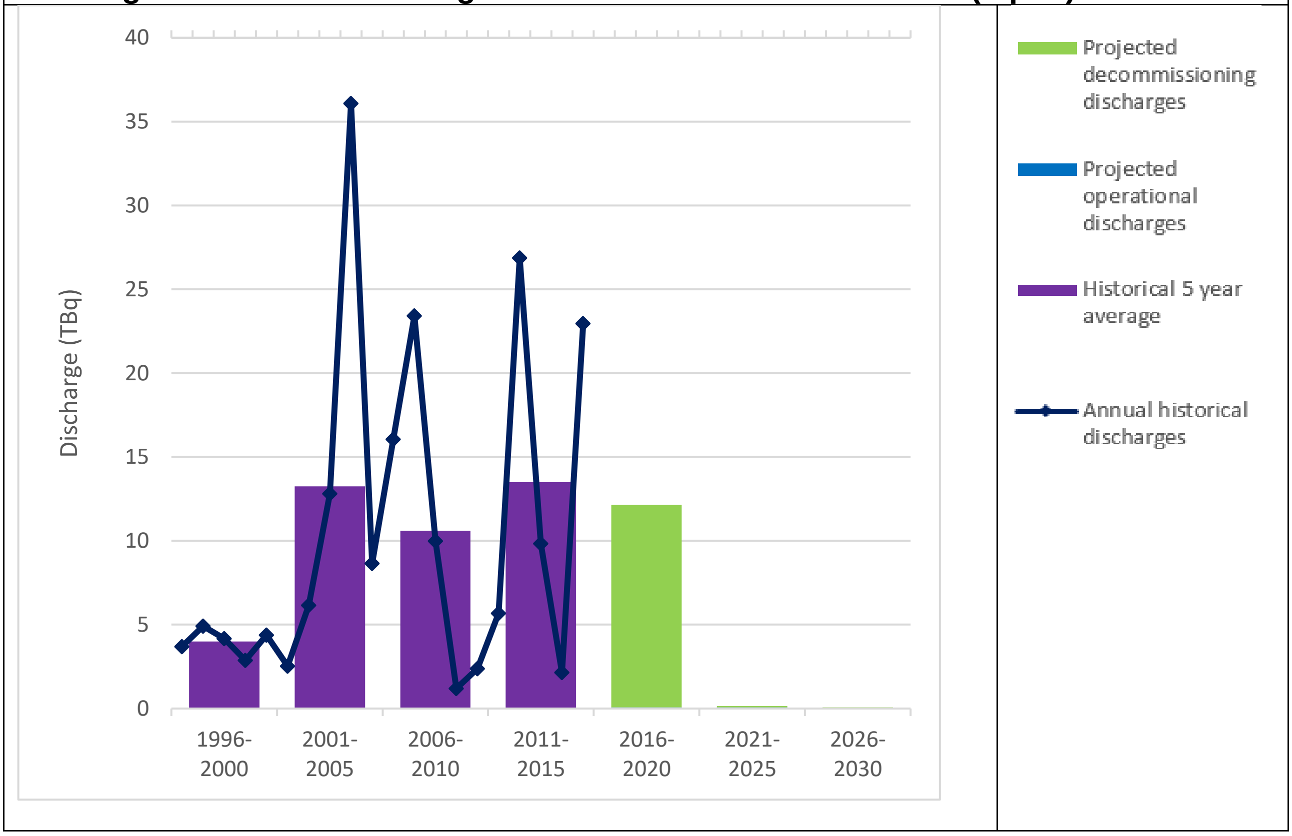
New Figure 10.1: Total alpha discharges from nuclear research sector (liquid)



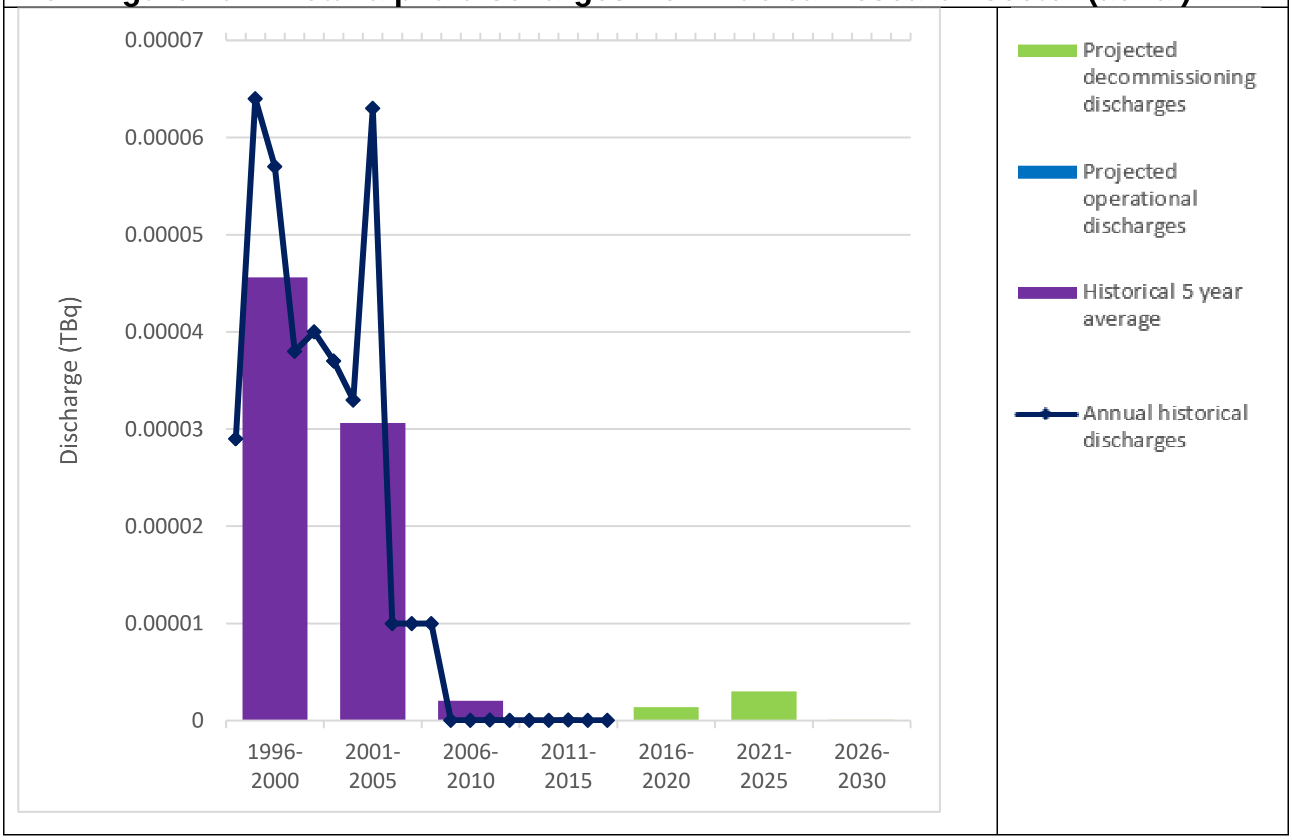
New Figure 10.2: Total beta discharges from nuclear research sector (liquid)



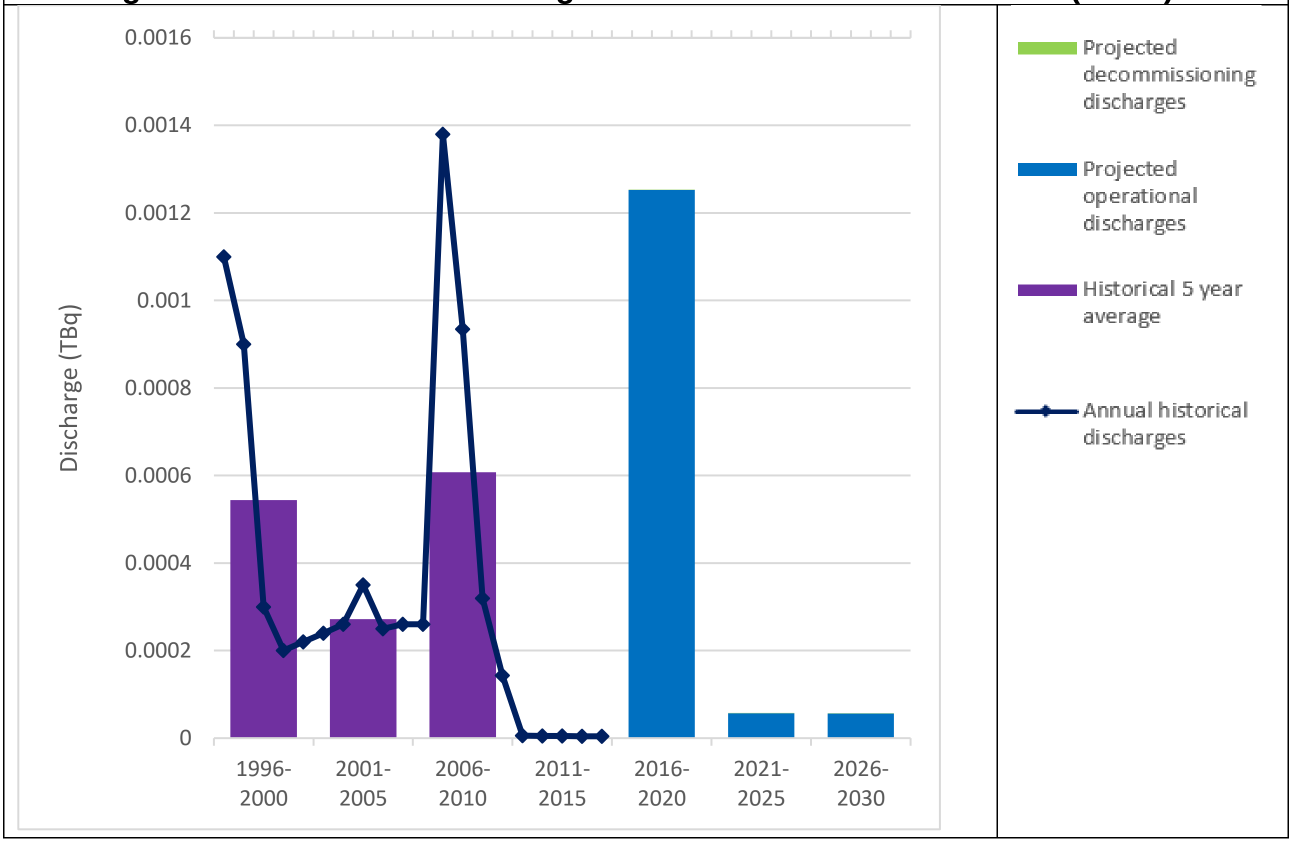
New Figure 10.3: H-3 discharges from nuclear research sector (liquid)



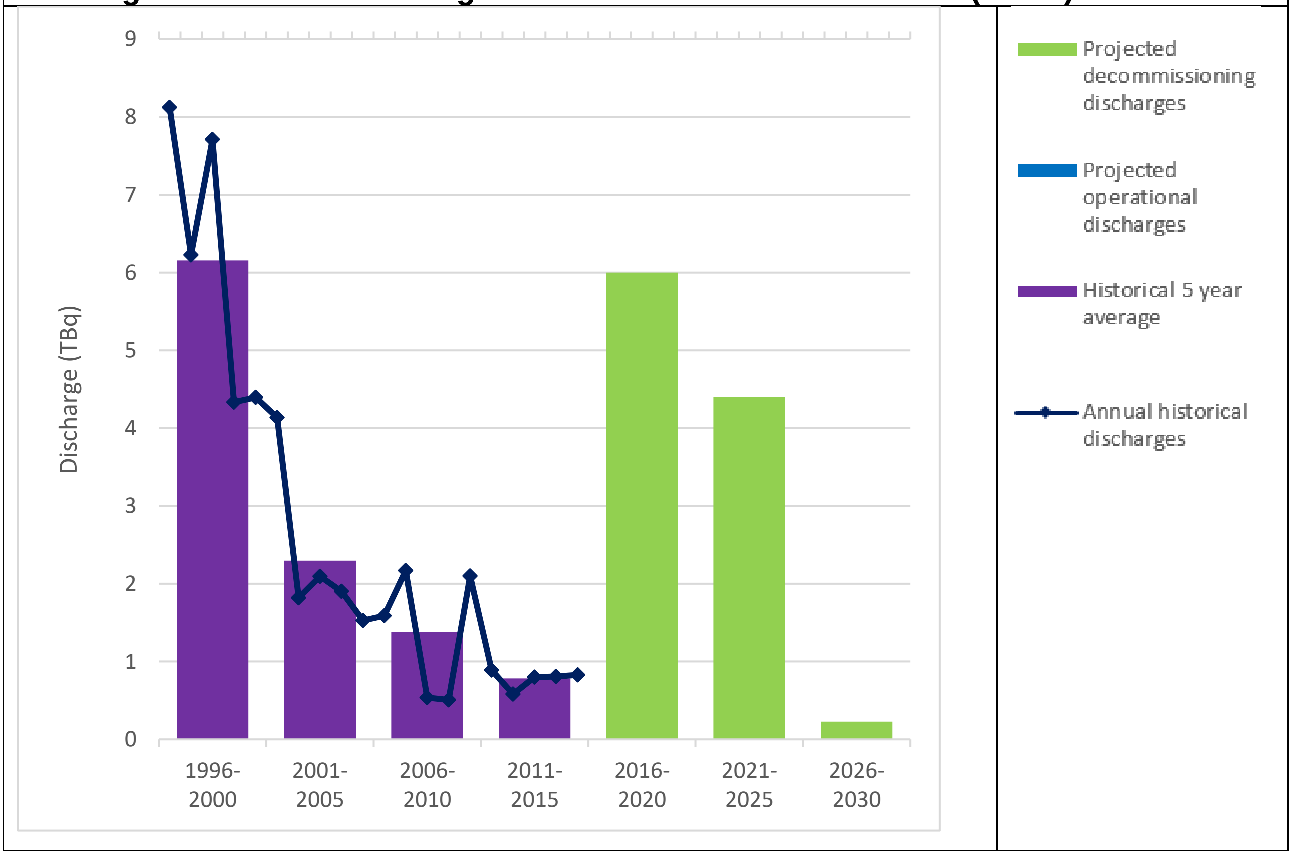
New Figure 10.4: Total alpha discharges from nuclear research sector (aerial)



New Figure 10.5: Total beta discharges from nuclear research sector (aerial)



New Figure 10.6: H-3 discharges from nuclear research sector (aerial)



Defence Sector

148. The main changes in the sector since the UKSRDS09:

- VULCAN NRTE has ceased operation as of 2015. The VULCAN Defuel and Decommissioning (VDAD) project is planning the decommissioning of the site.
- A Submarine Dismantling Project (SDP) has been stood up to dismantle the redundant submarines in Rosyth and Devonport. The initial phase of the dismantling project is on-going.
- There have been a number of submarines entering and retiring from service. Since the UKSRDS09 three submarines have left service and have been replaced.
- Discharges from the sector have remained below forecasts.

Discharge Projections

149. The projected liquid and aerial discharge profiles to 2030 for the defence sector are shown in Figures 11.1 to 11.8 below.

150. The projections provided are best estimates based upon present knowledge and activity levels. Discharges from the defence sector are determined by operational requirements; therefore levels have the potential to increase as well as decrease.

UKSRDS09 total forecast outcomes:

By 2020:
- total-alpha (liquid) discharges will have reduced to below 0.0001 TBq/yr.
- total-beta (liquid) discharges will have reduced to below 0.002 TBq/yr.

By 2030:
- total-alpha (liquid) discharges will have reduced to below 0.0001 TBq/yr.
- total-beta (liquid) discharges will have reduced to below 0.001 TBq/yr.

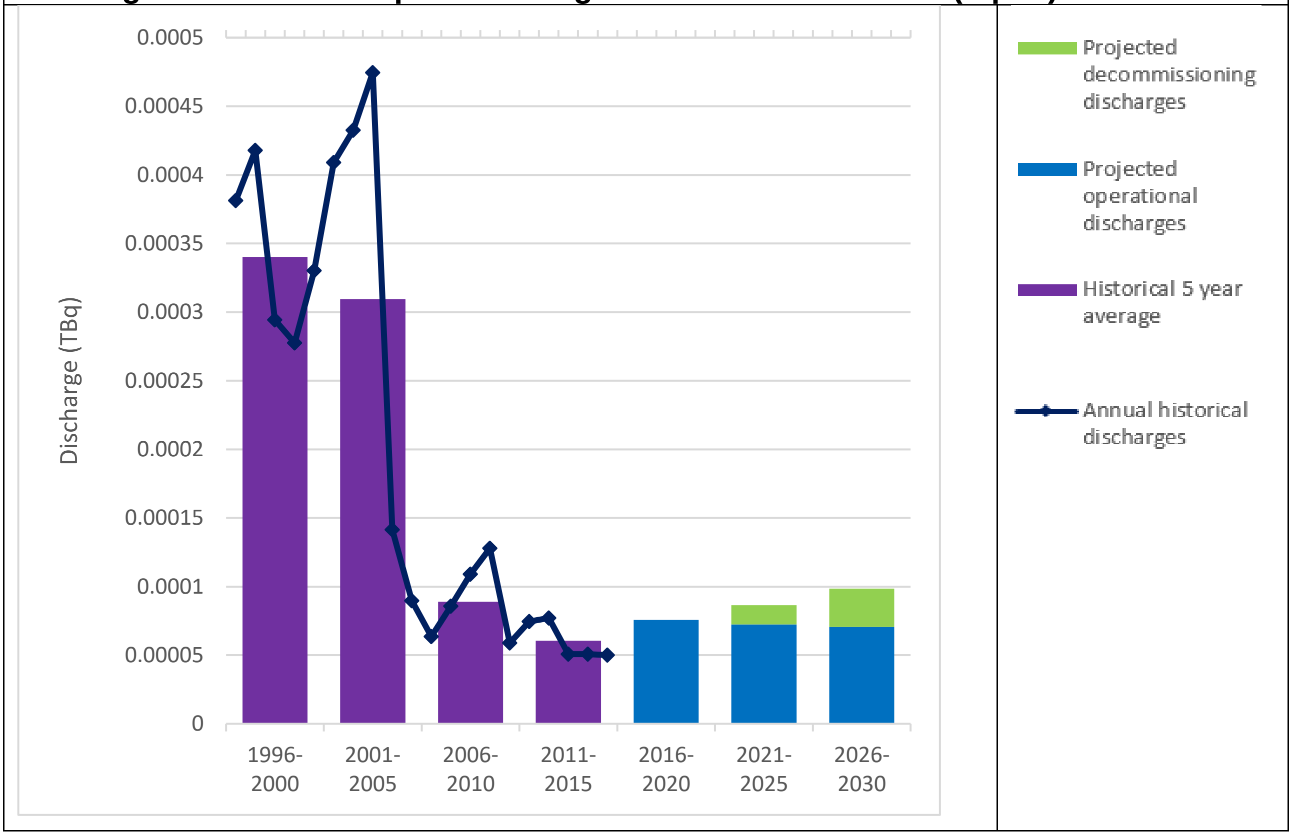
Overall Comments

151. As noted in the chapter titled ‘Summary of Data and Analysis’, liquid discharges of total alpha, total beta and tritium from the defence sector are less than the discharges from all the other sectors, and at least four orders of magnitude less than the discharges from the spent nuclear fuel reprocessing sector. Aerial discharges are also generally lower than other sectors.

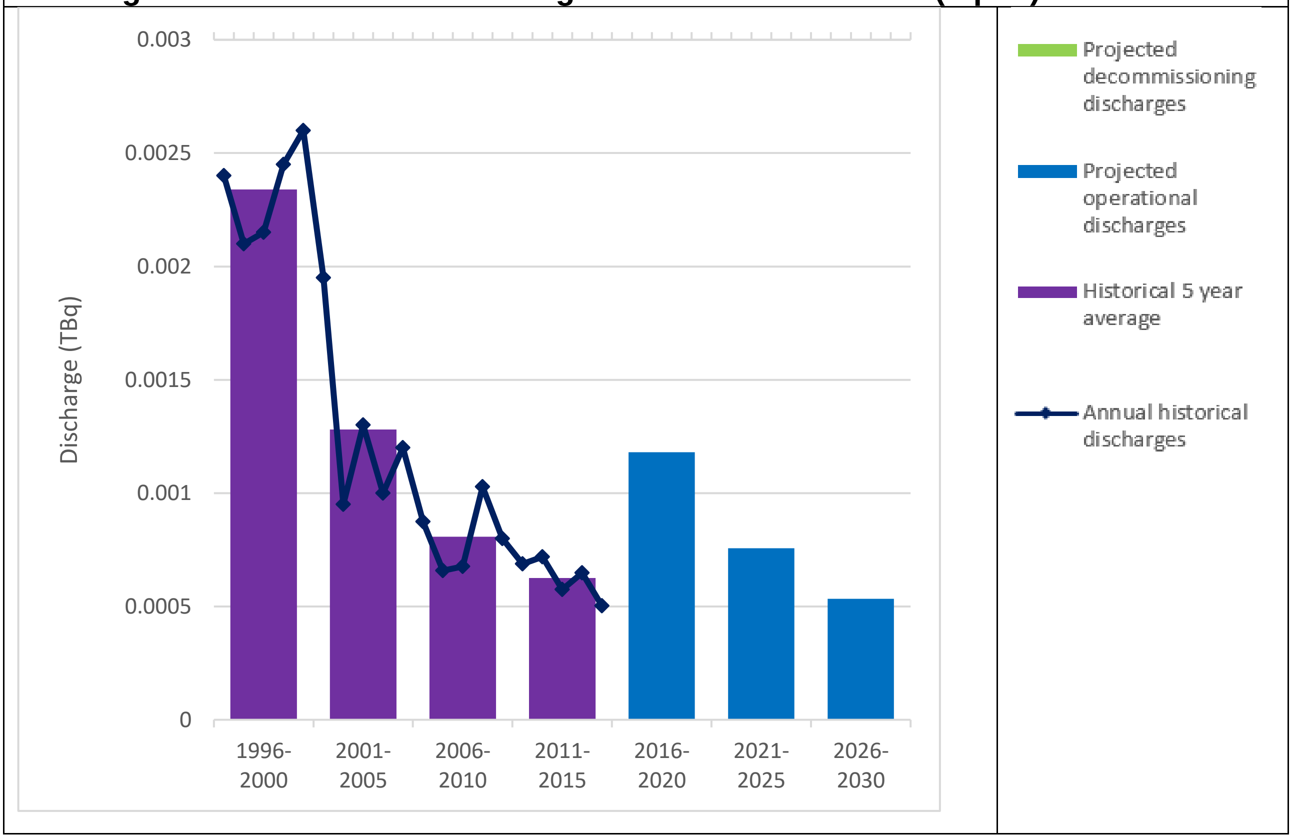
152. Liquid discharges from the defence sector have remained below forecasts and have met both the 2020 and 2030 total forecast outcomes set in the UKSRDS09. Forecasts of both liquid and aerial discharges up to 2030 are expected to remain at current levels.

153. The apparent spike in the UKSRDS09 Figure 11.3 was due to an error in the 2009 data and has been corrected in the new Figure 11.3.

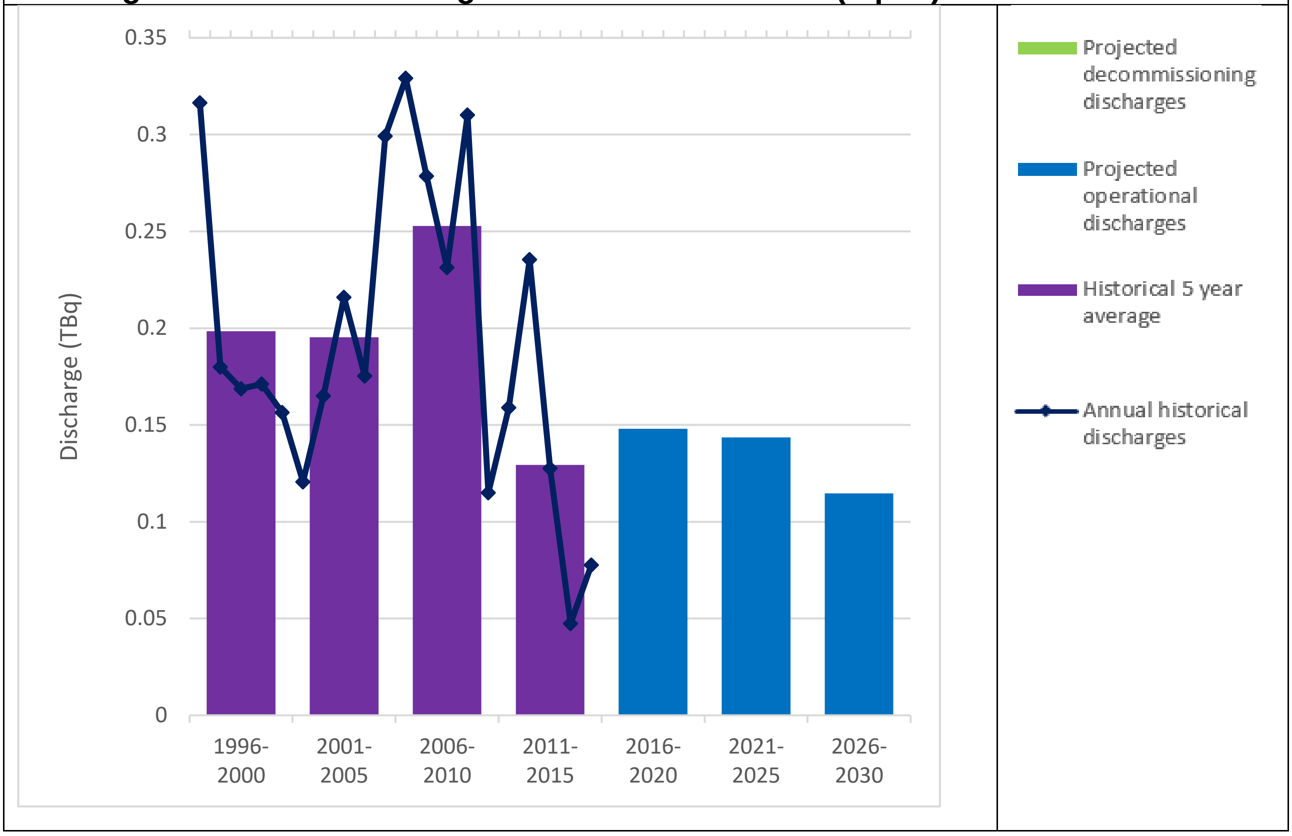
New Figure 11.1: Total alpha discharges from defence sector (liquid)



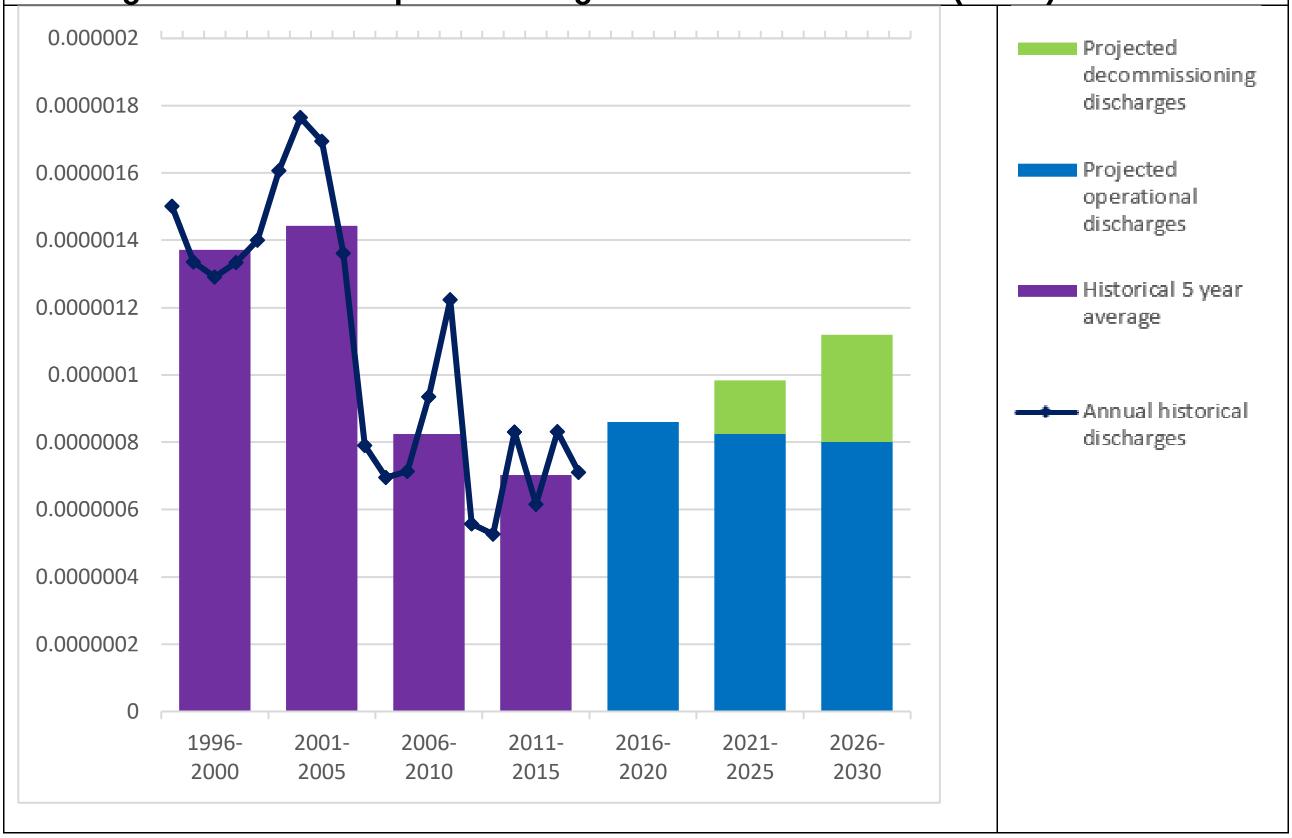
New Figure 11.2: Total beta discharges from defence sector (liquid)



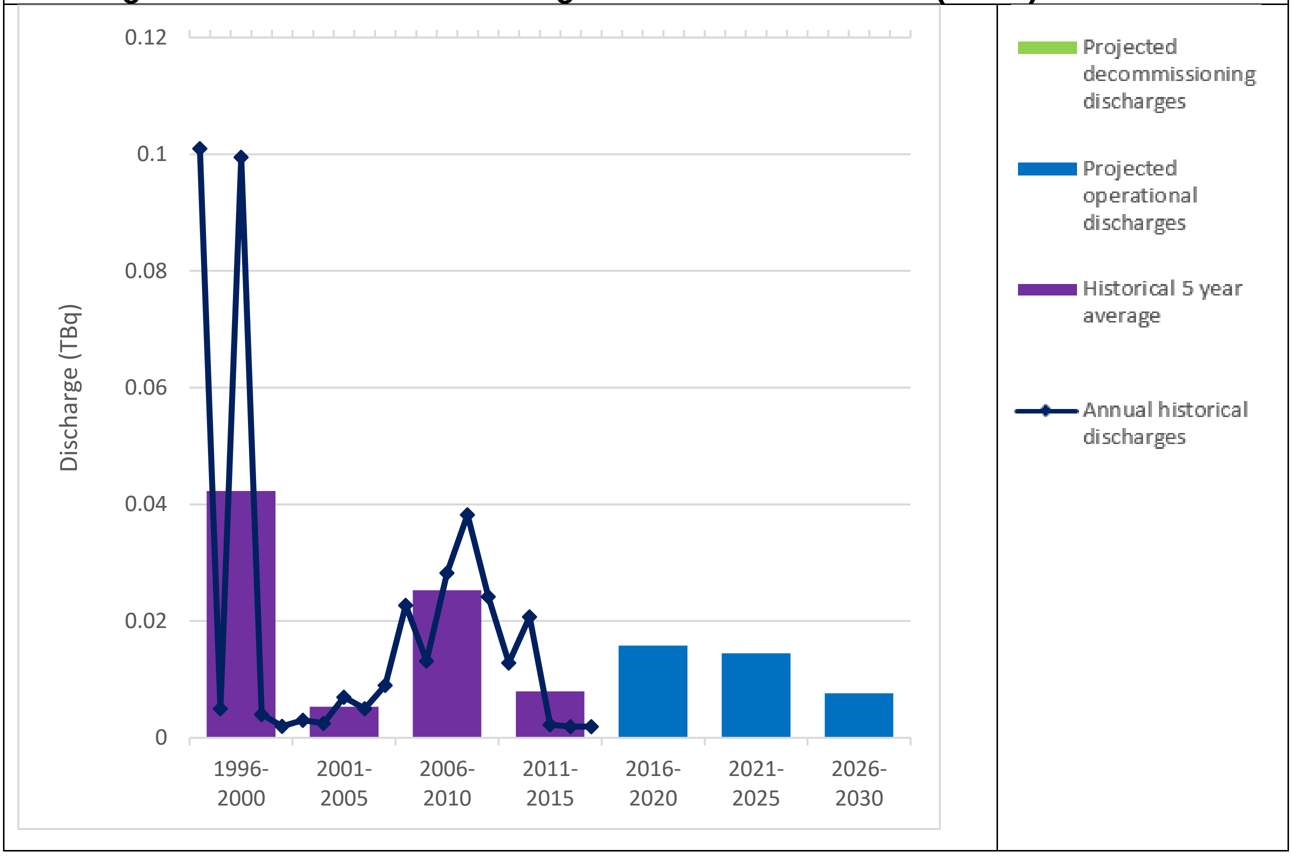
New Figure 11.3: H-3 discharges from defence sector (liquid)



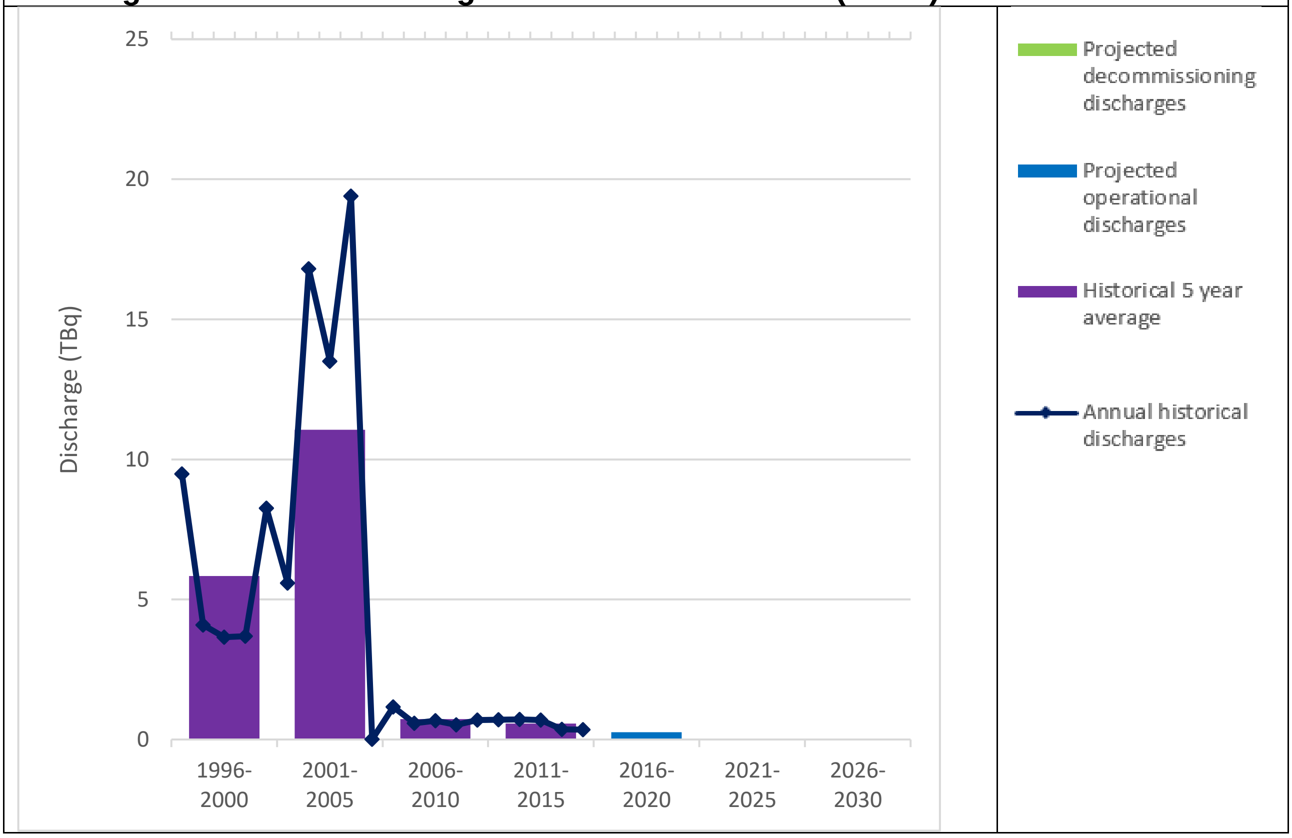
New Figure 11.4: Total alpha discharges from defence sector (aerial)



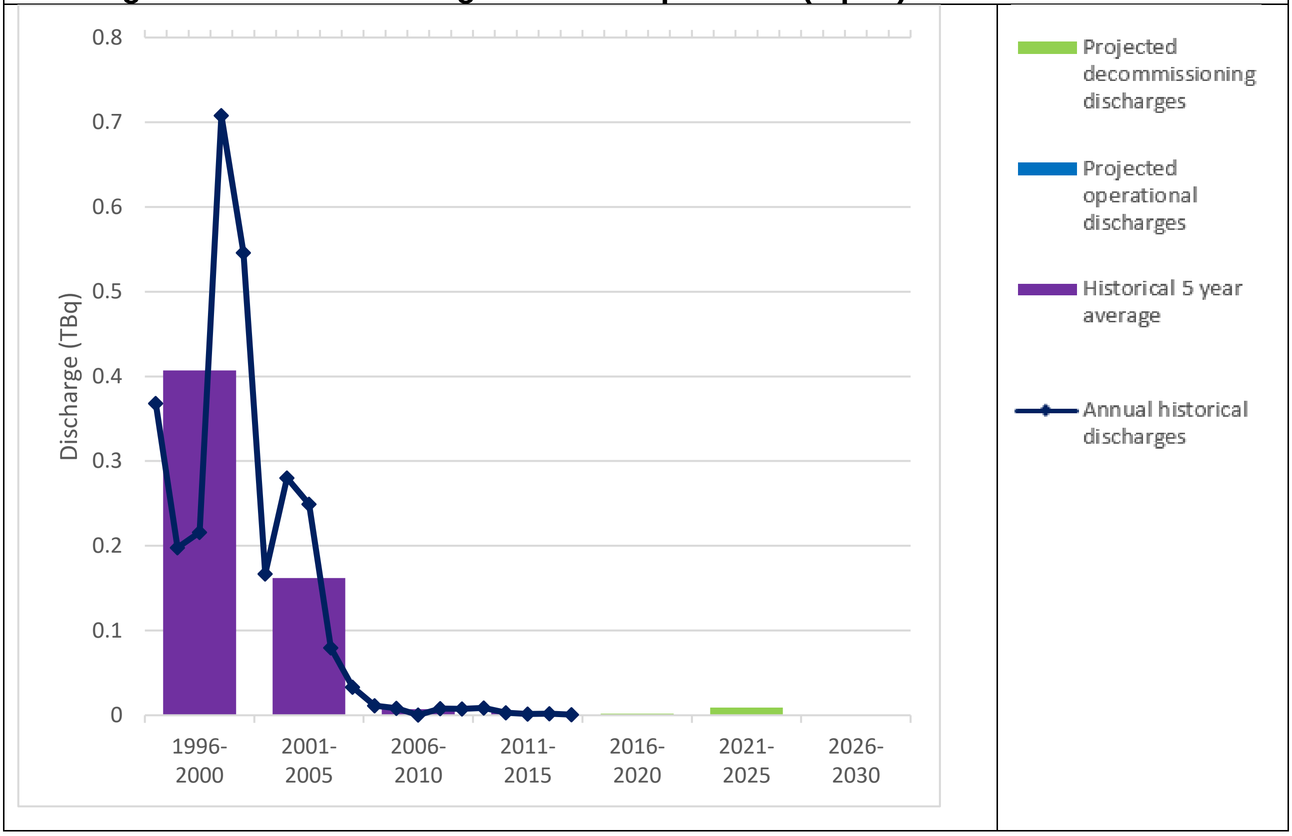
New Figure 11.5: Total beta discharges from defence sector (aerial)



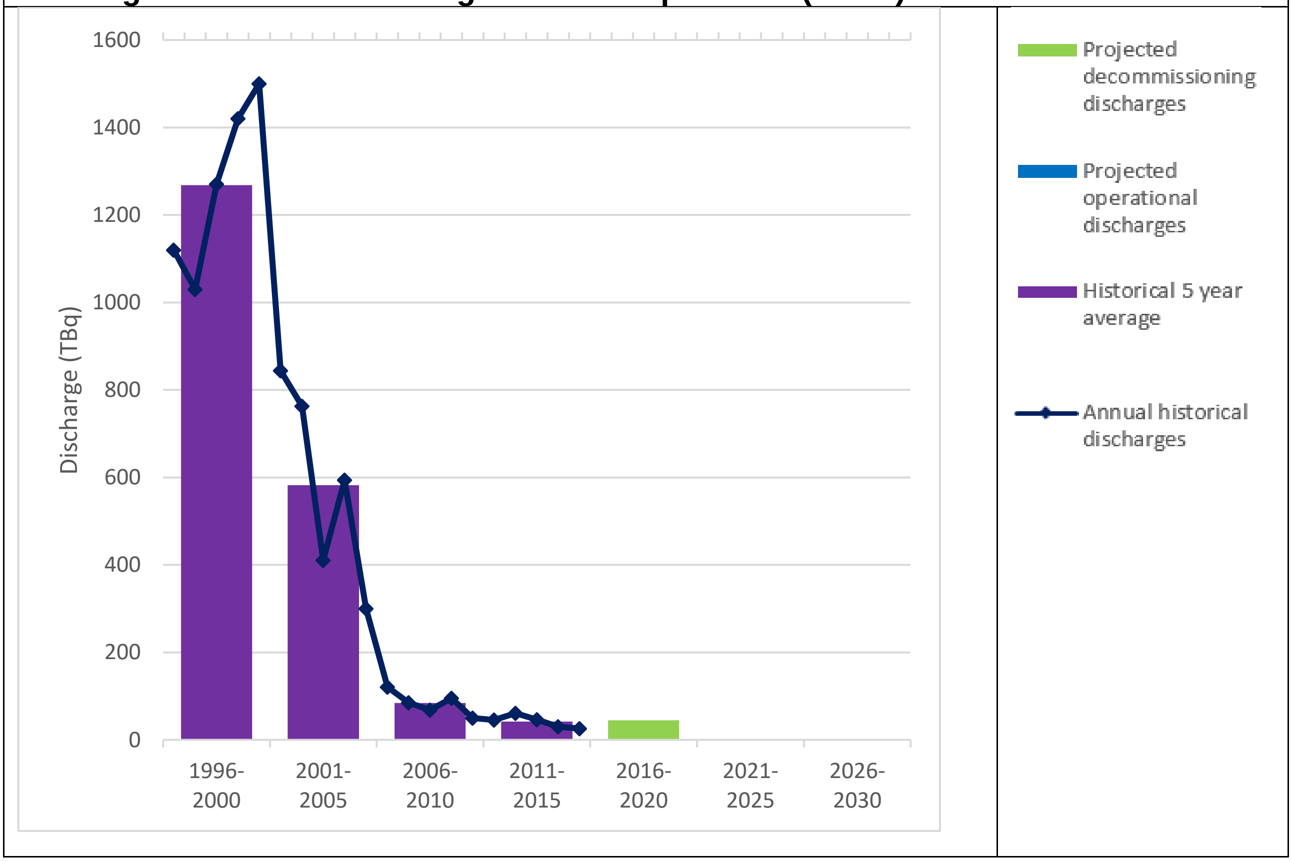
New Figure 11.6: H-3 discharges from defence sector (aerial)



New Figure 11.7: H-3 discharges from Chapelcross (liquid)



New Figure 11.8: H-3 discharges from Chapelcross (aerial)



Discharges from the Non-Nuclear Sector - Isotope Production and Radiolabelling, Medical, Pharmaceutical and Academic uses

154. The main changes in the sector since the UKSRDS09:

- GE Healthcare has two nuclear sites in the UK, the Grove Centre in Amersham and the Cardiff Nuclear Licenced Site in Cardiff. The Amersham site manufactures radiopharmaceuticals, and manages a decommissioning programme of legacy facilities. The Cardiff site comprises of a waste management operation; with the radiolabeling operations having ceased in 2010 followed by a reduction in the nuclear site footprint.

- As forecast in the UKSRDS09, the use of Positron Emission Tomography Scanning (PET) imaging as a medical research tool has increased, along with the associated cyclotrons to produce the necessary isotopes.

Discharge Projections

155. The projected liquid and aerial discharge profiles to 2030 for this sector are shown in Figures 12.1 to 12.11 below.

UKSRDS09 total forecast outcomes: Not applicable

Overall Comments

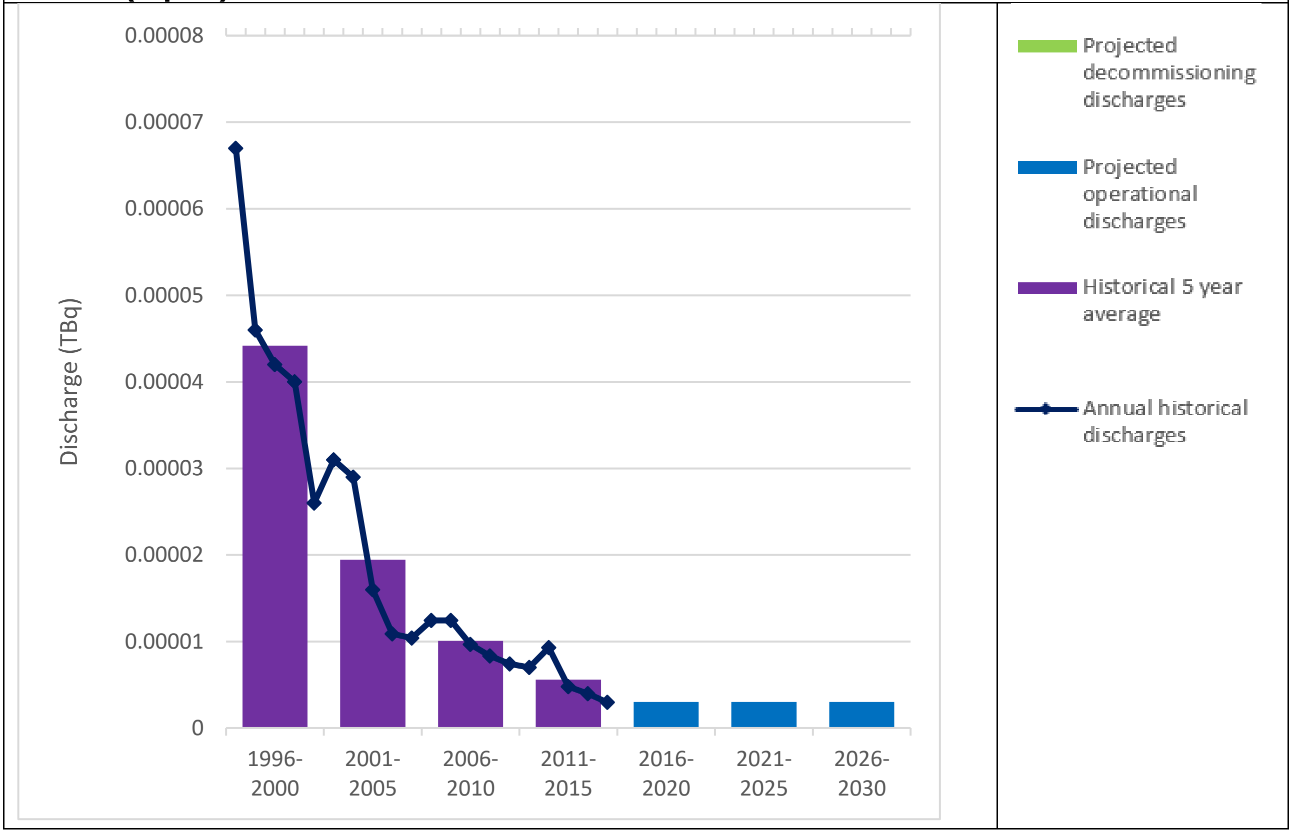
156. Discharges from this sector are many orders of magnitude less than the other sectors and have been below forecasts.

157. Figure 12.5 shows an increase between 2004 and 2007 of total beta aerial discharges due to the permitted discharge of a category of noble gases (Xe-133) from the Grove Centre Amersham; this operation ceased in 2007.

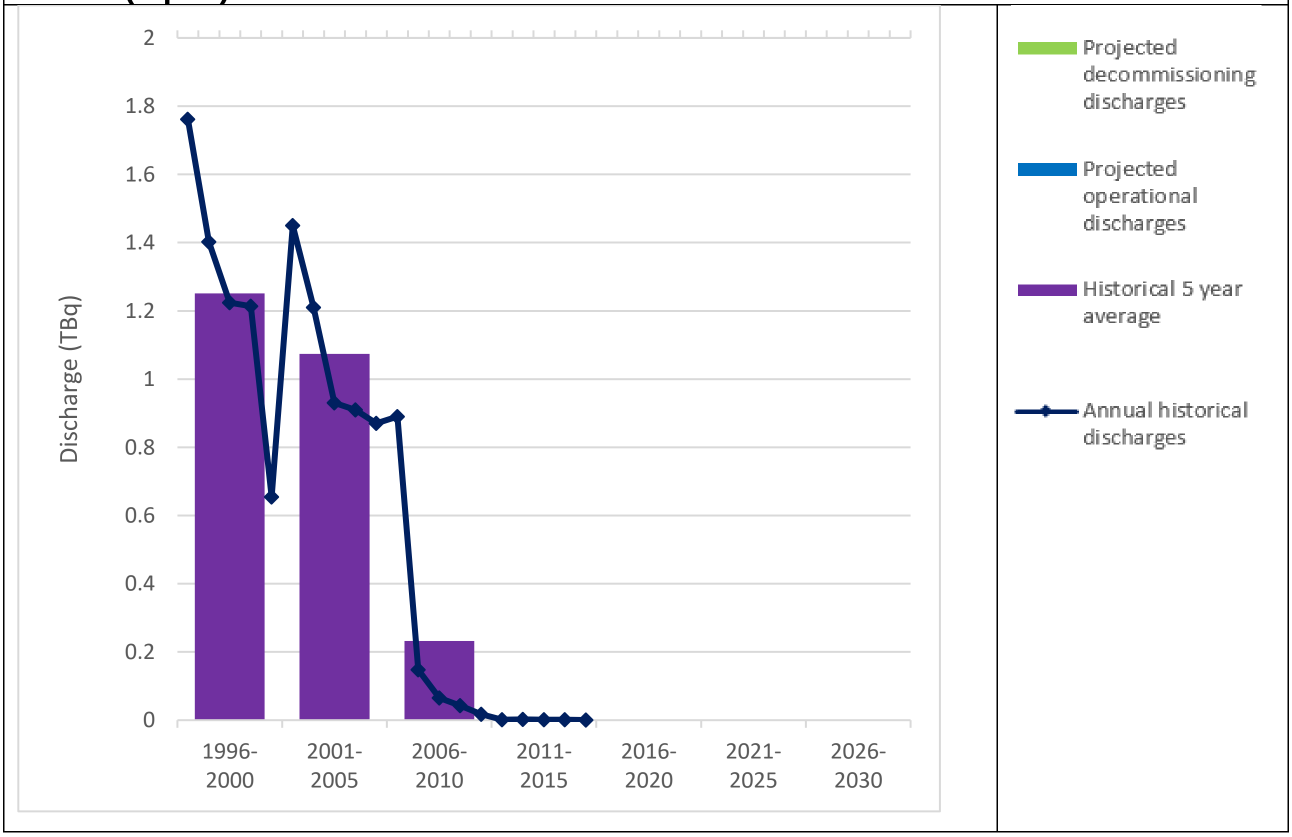
158. Figure 12.8 indicates that discharges of short-lived iodine-131 as a result of its use in hospitals have remained broadly constant at around 10 TBq per year.

159. It should be noted that the tritium discharges in Fig 12.10 duplicate those shown in Fig 12.3.

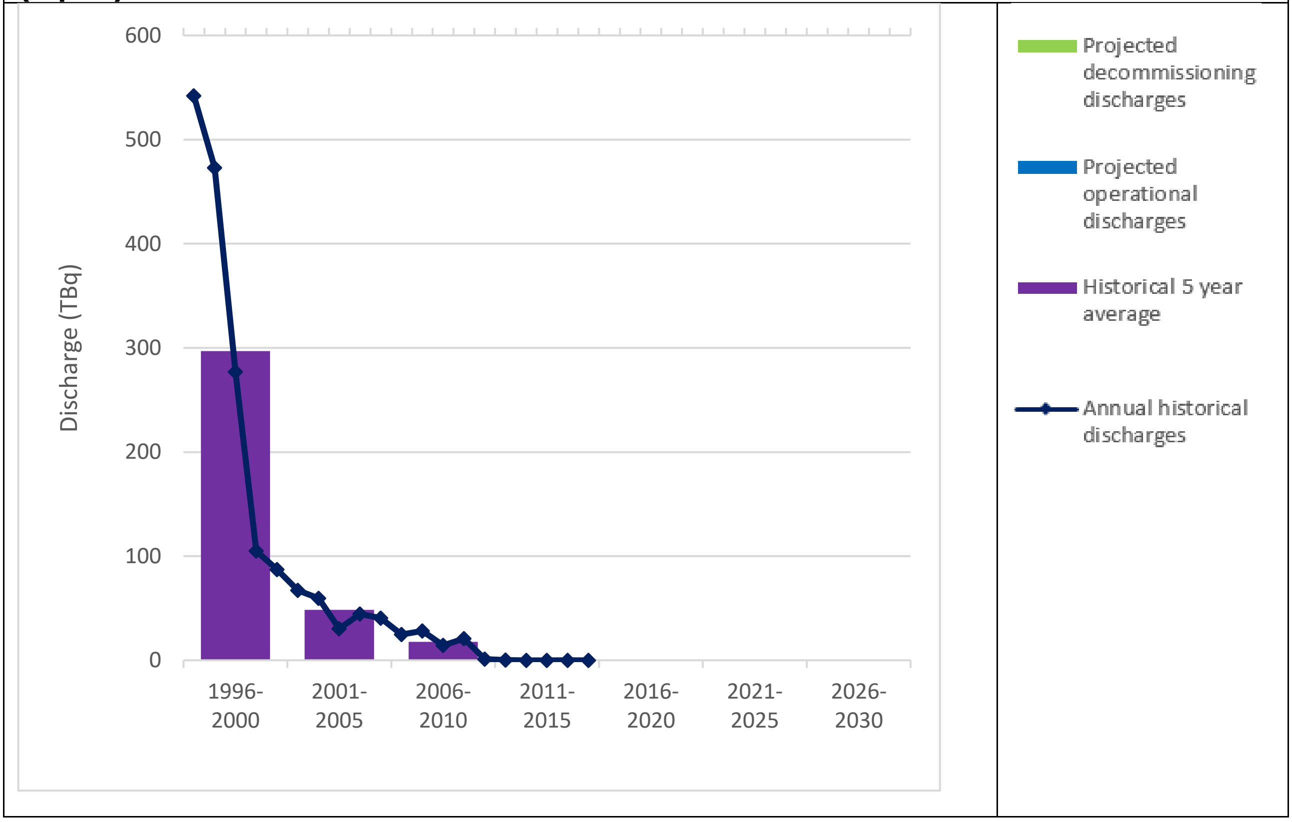
New Figure 12.1: Total alpha discharges from isotope production & radio-labelling sector (liquid)



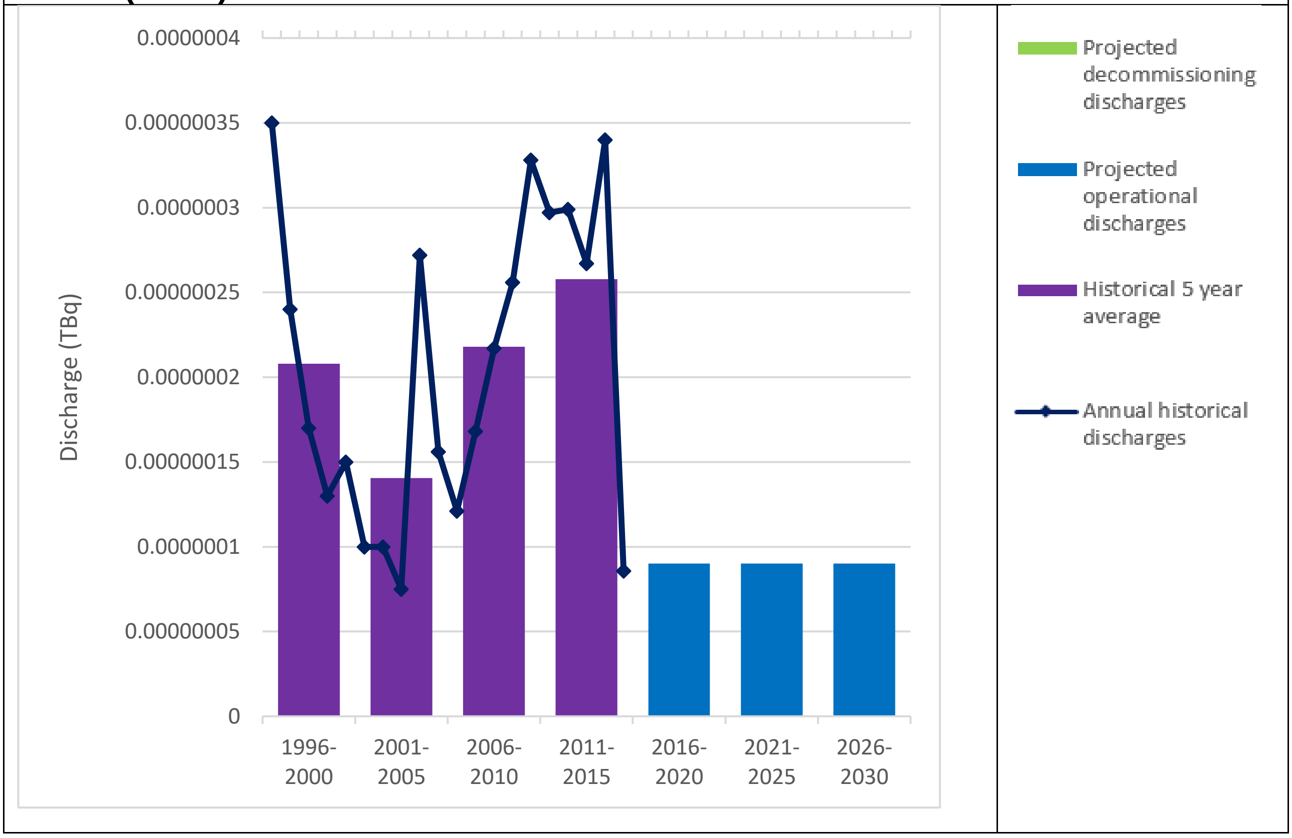
New Figure 12.2: Total beta discharges from isotope production & radio-labelling sector (liquid)



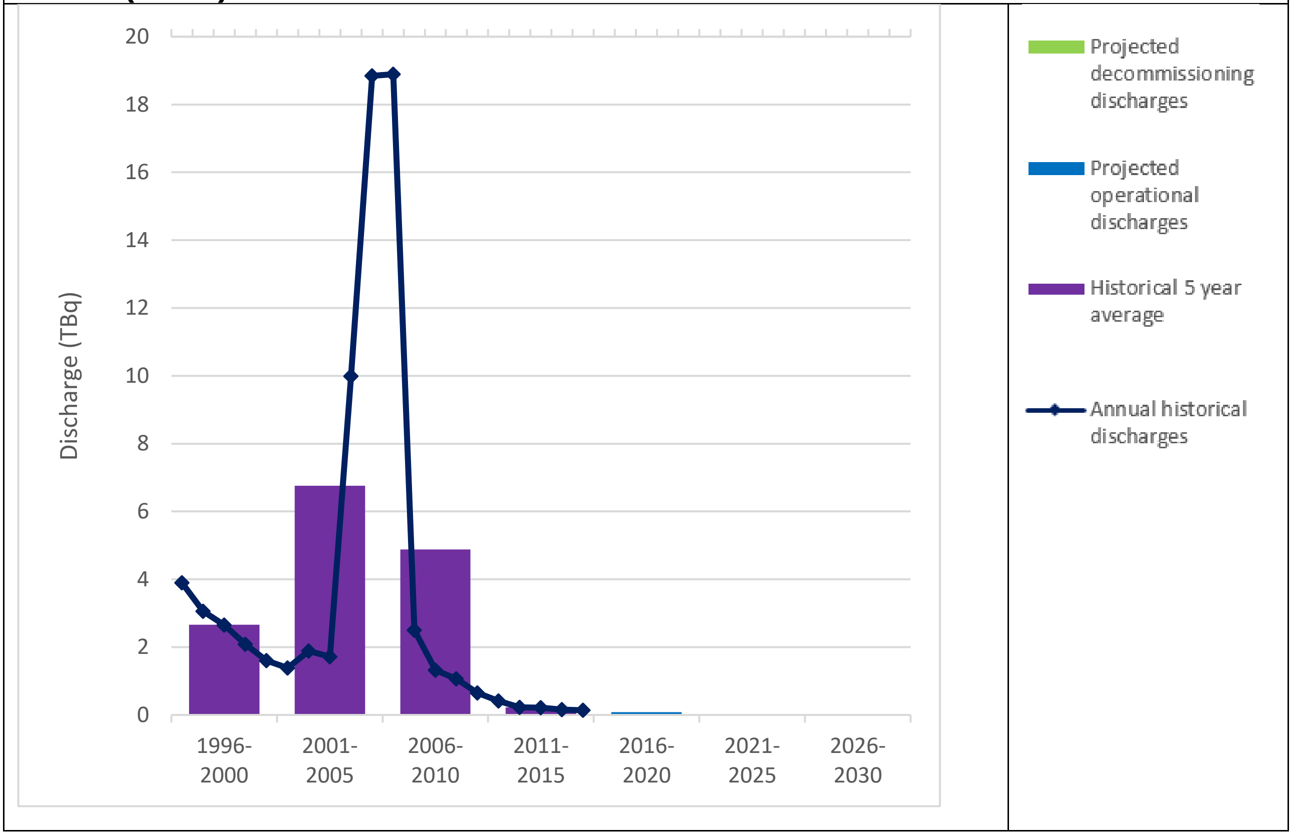
New Figure 12.3: H-3 discharges from isotope production & radio-labelling sector (liquid)



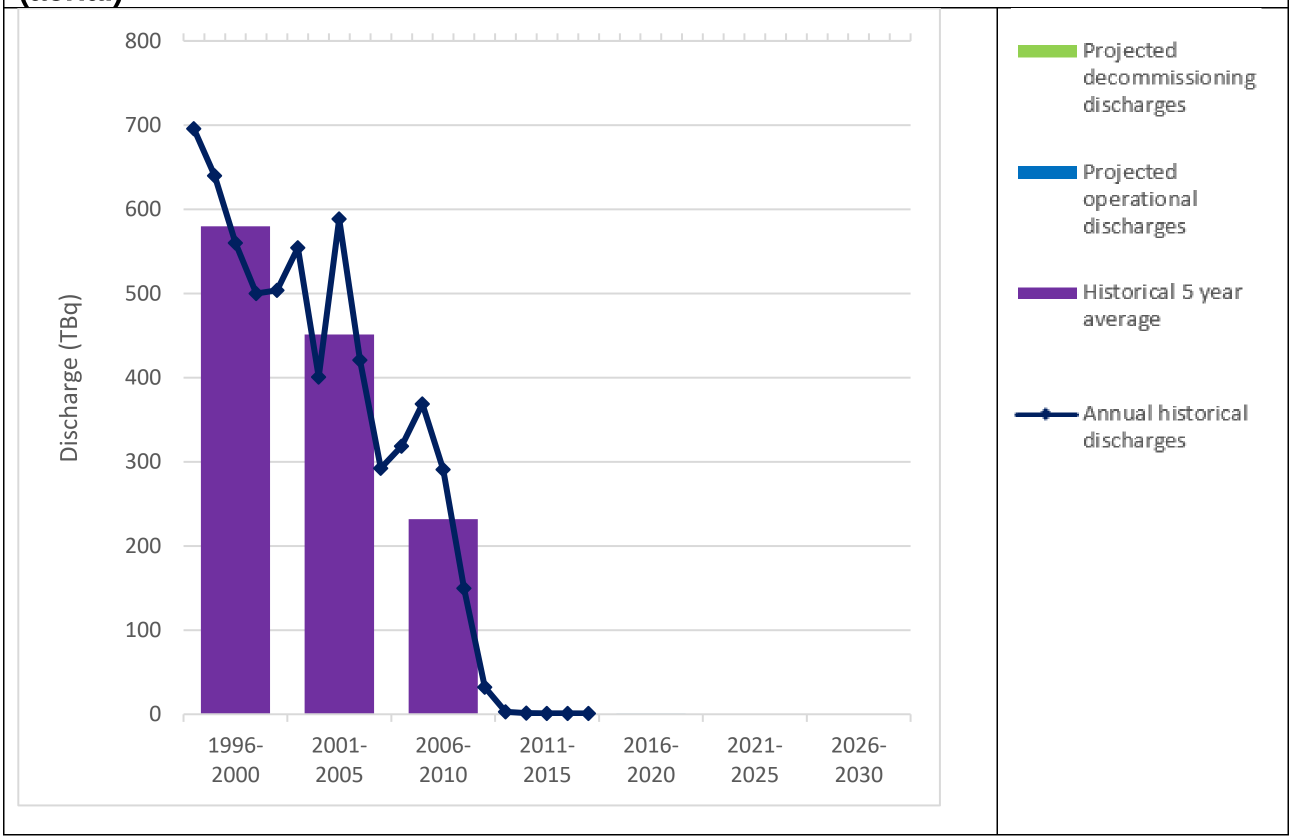
New Figure 12.4: Total alpha discharges from isotope production & radio-labelling sector (aerial)



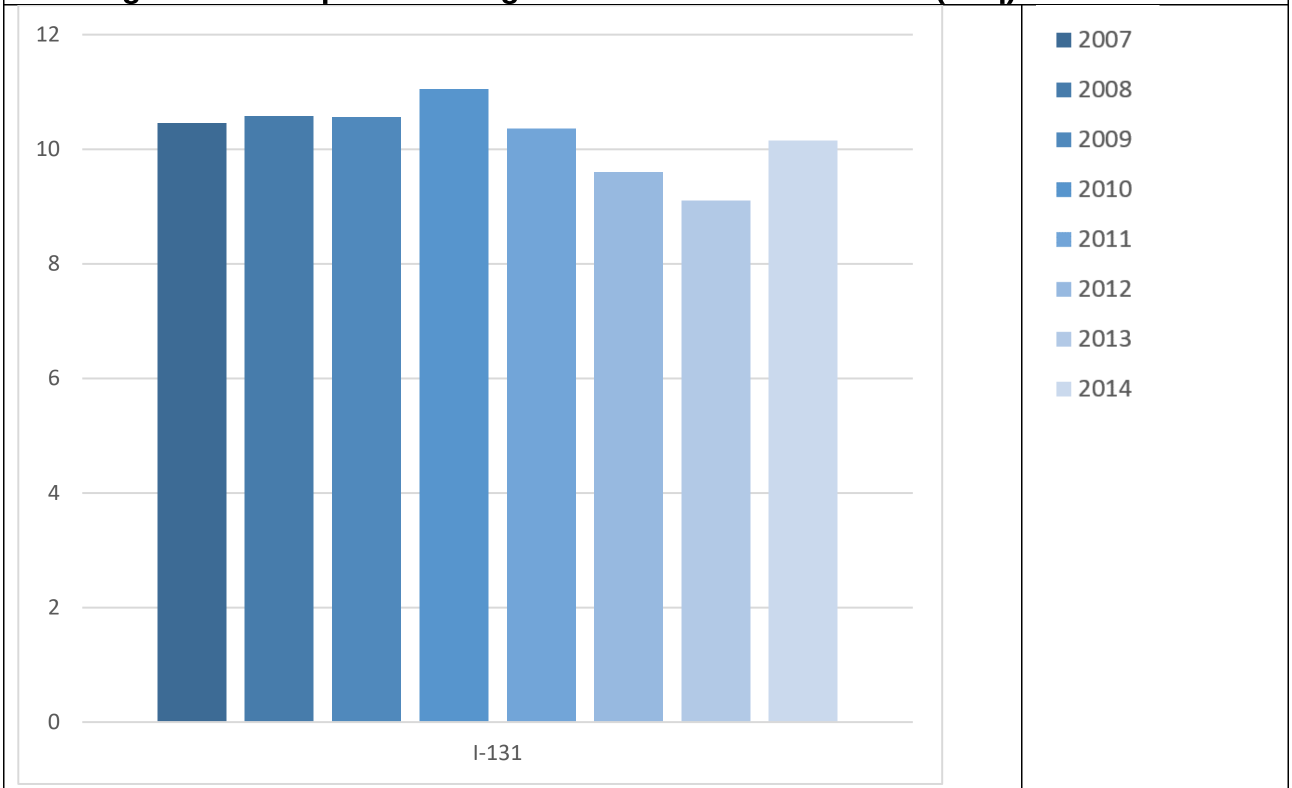
New Figure 12.5: Total beta discharges from isotope production & radio-labelling sector (aerial)



New Figure 12.6: H-3 discharges from isotope production & radio-labelling sector (aerial)

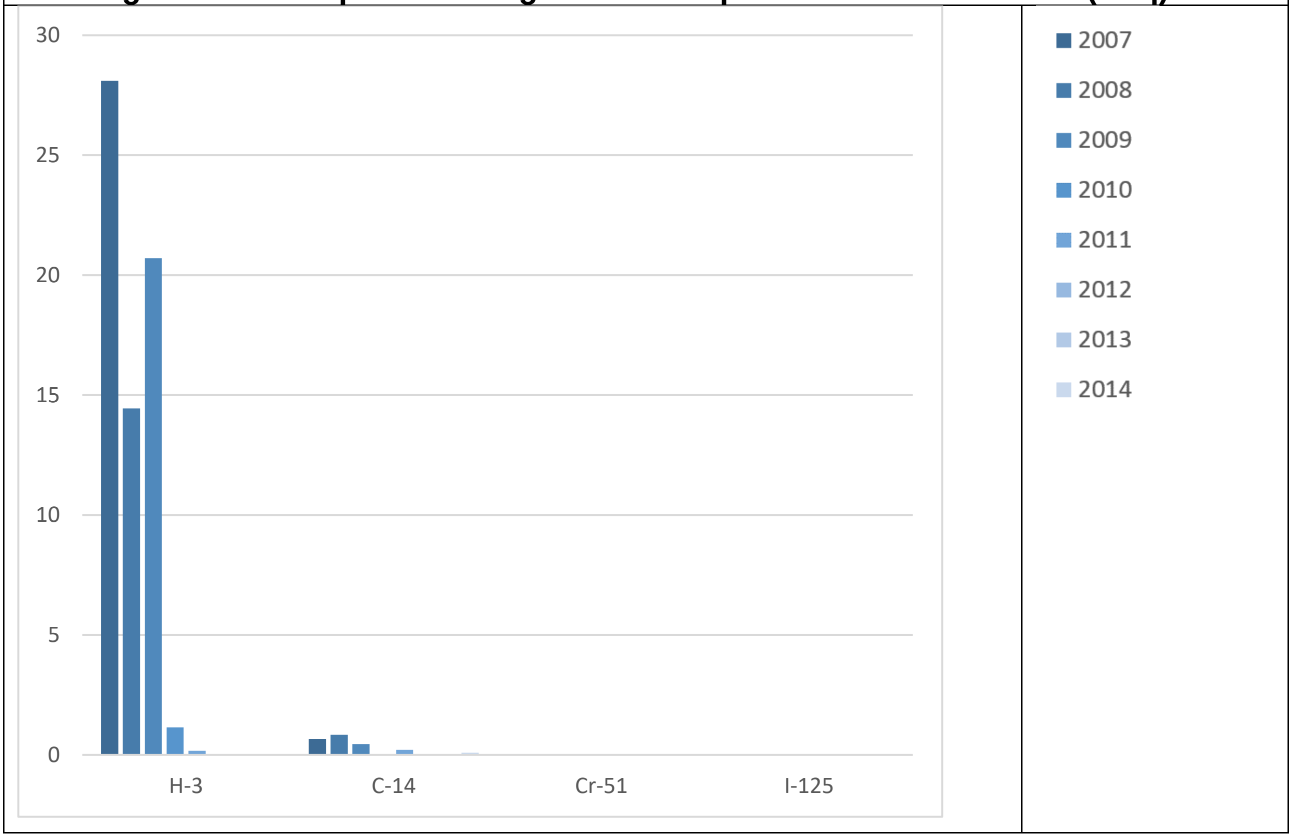


New Figure 12.8: Liquid discharges from the medical sector (TBq)

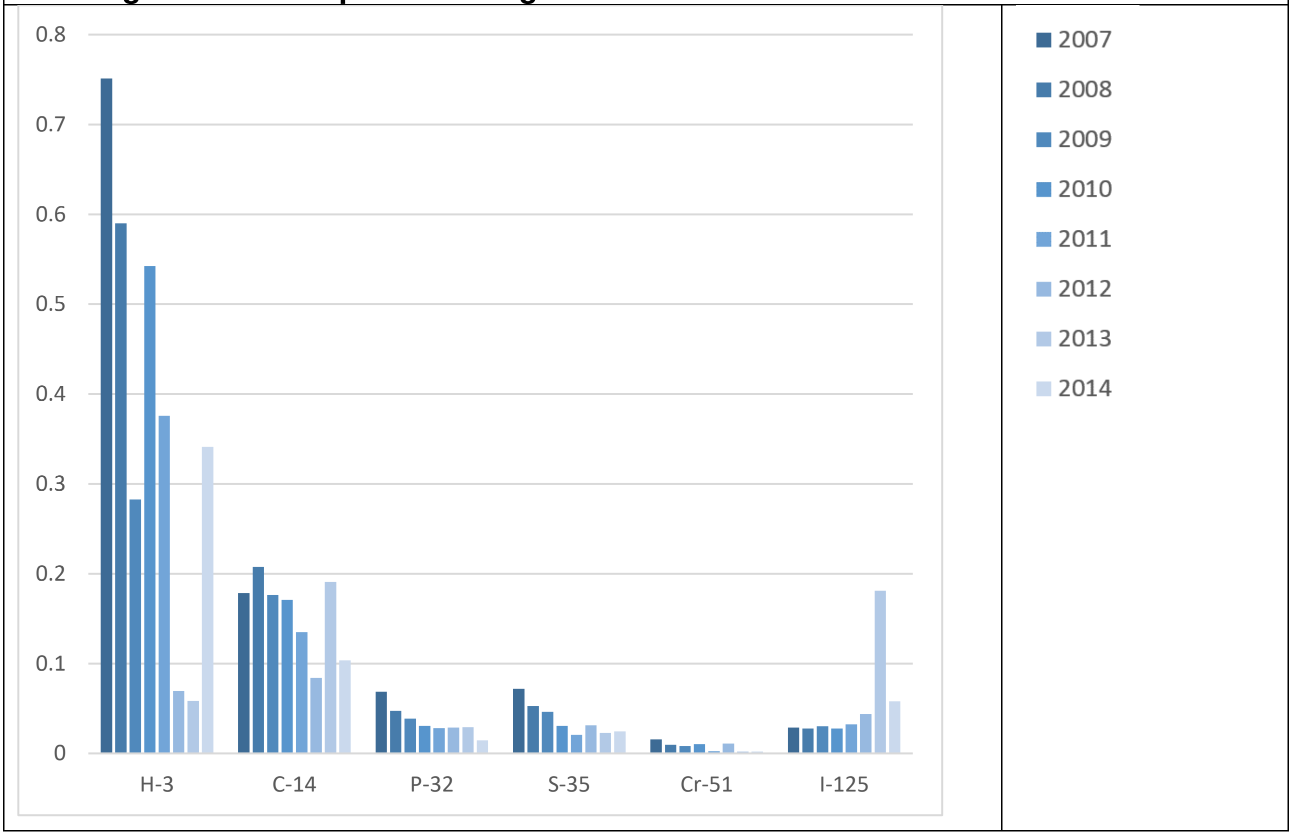


*Tc-99 no longer reported to OSPAR

New Figure 12.10: Liquid discharges from the pharmaceuticals sector (TBq)



New Figure 12.11: Liquid discharges from the academic sector



Discharges from the Non-Nuclear Sector - Naturally Occurring Radioactive Materials (NORM)

160. Forecasts for Naturally Occurring Radioactive Material (NORM) have not been updated since the UKSRDS09. Forecasts and graphs for NORM can be found in the UKSRDS09, chapter 13. Information on assumptions behind the data on NORM, and on the UK Strategy for the management of Naturally Occurring Radioactive Material (NORM) waste in the United Kingdom (2014), can be found in chapter 4, section 2.11.

Discharges from the Waste and Incineration Sector

161. As noted in the UKSRDS09, this sector includes disposals sites such as the LLW Repository (LLWR) in West Cumbria, landfills and commercial incinerators permitted to take radioactive waste, and some dedicated waste treatment facilities.

162. The main changes in the sector since the UKSRDS09:

- In March 2007, the UK Government introduced a more flexible framework for the disposal of certain categories of low level waste (LLW) to landfill. The revised policy led to applications from landfill operators for permits to dispose of LLW at their sites. The landfill sites are:

  - FCC Environment Ltd at the Lillyhall Landfill Site in Cumbria. Their permit, issued in 2011, allows them to dispose of very low level waste (VLLW). To date the site has not accepted any VLLW.

  - Augean plc at the East Northants Resource Management Facility, near Kingscliffe, Northamptonshire. Their permit, issued in 2011, allows them to dispose of low activity low level radioactive waste (LLW) and VLLW.

  - Suez Recycling and Recovery (Lancashire) Limited[9] at Clifton Marsh in Lancashire. They received a permit to dispose of low activity LLW and VLLW in September 2012. This permit replaced previous arrangements authorising disposals at Clifton Marsh by operators at the Springfields and Capenhurst nuclear licensed sites, whose permits used to allow disposal of some solid LLW at Clifton Marsh in their own right. The varied permits now allow those operators to transfer LLW to landfill operators who hold an appropriate EPR16 permit.

- The Metals Recycling Facility (MRF), operated by Cyclife UK[10], first commenced operations in September 2009. The facility is located on the north-eastern edge of the Lillyhall Industrial Estate, about 4 km south-east of Workington. The main function of the MRF is to receive, sort, segregate, monitor and size reduce metallic low level radioactive waste before either treating it on site by surface decontamination, or sending the metal to a sister plant in Sweden for melting. The intent of the process is, as far as possible, to decontaminate the metal, such that it can be returned to the open market as exempt from control as radioactive waste, for recycling. Secondary wastes from the metal treatment containing radioactivity, as either LLW or VLLW, are disposed of to the LLWR or to landfills.

- The UK has four incineration facilities which are permitted to accept some low activity LLW from the nuclear industry. These are Tradebe Inutec at Fawley, Veolia at Ellesmere Port, Grundons at Colnbrook and Augean at Sandwich.

163. Discharges from this sector continue to be very small. As noted in UKSRDS09, owing to the wide variety of activities and the large number of sites within the waste and incineration sector, it has not been possible to produce discharge projections for the sector as a whole.

[9] Previously SITA UK
[10] Previously operated by Studsvik UK Limited

Department for Business, Energy & Industrial Strategy
1 Victoria Street, London SW1H 0ET
www.gov.uk/beis