Radiation Act 2005

Annual report for the financial year ending 30 June 2020

VICTORIA State Government | Health and Human Services

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Radiation Act 2005

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Contents

Radiation regulation in Victoria in 2019–20 – a snapshot

The purpose of the *Radiation Act 2005* (the Act), which commenced in September 2007, is to protect the health and safety of Victorians and the environment from the harmful effects of radiation. The Act requires that the Secretary of the Department of Health and Human Services publishes an annual report that describes the activities of the Secretary under the Act and summarises all authorities issued, renewed, suspended, cancelled, varied, transferred or surrendered during that year. The report must also detail all radiation incidents investigated and provide a summary of all prosecutions for offences in that year.

Impacts of the coronavirus (COVID-19) pandemic

The coronavirus (COVID-19) pandemic affected the radiation safety regulatory program in 2019–20 as staff were deployed to assist with the department's response during the second half of the financial year. The pandemic also triggered an increase in licensing applications, particularly from recently retired medical radiation practitioners seeking to become licensed to assist with the potential need for surge staff in hospitals. As a consequence, there were fewer field-based activities over the second half of the financial year.

Licensing

Under the Act, only licence holders can conduct a radiation practice or use a radiation source. At 30 June 2020 there were 15,082 'use licences' and 2,659 'management licences' issued in Victoria, most of which are held in the medical and dental sectors.

A new licensing system began operation in October 2019, which now has approximately 10,000 registered users.

Quality of radiopharmaceuticals

The department has continued to focus on the quality of radiopharmaceuticals and is collaborating with the Therapeutic Goods Administration on several issues connected with the production and sale of radiopharmaceuticals.

Requirements for dual-energy X-ray absorptiometry

The department imposed new requirements as a condition of licence on all management licences related to using dual-energy X-ray absorptiometry (DXA) for assessment of body composition.

CT-based X-ray units used for security or quality-control purposes

Baggage scanners using computed tomography (CT)-based technology are being installed at airports as part of updated airport security requirements. The department has developed a new standard for such CT-based X-ray units used for security or quality-control purposes. The new standard was implemented early in 2020.

Licensing compliance monitoring

The department conducted 138 inspections and 156 targeted desktop audits and radiation practice surveys in the 2019–20 financial year as part of its licensing compliance monitoring program.

Enforcement

Three prosecutions were initiated in relation to alleged breaches of the commercial tanning ban. A radiation source was rendered inoperative and a 'show cause' notice was issued in relation to the proposed cancellation of the management licence for the radiation source.

Radiation incidents in 2019–20

In 2019–20, 183 radiation-related incidents were reported to the department, 179 of which were in the medical sector. Most of the medical incidents involved unplanned or incorrect exposures to patients.

There has been an increase of about 580 per cent in the number of incidents reported to the department over the past 10 years and a similar increase in the number of incidents involving medical use of radiation over this period.

The increased number of medical radiation incidents over the past 10 years is most likely due to two significant factors – increased awareness of the requirement to report medical incidents and a rapid increase in the use of medical radiation procedures.

The number of reported medical incidents in 2019–20 was about 18 per cent lower than the previous year, compared to a 5 per cent reduction in diagnostic imaging using radiation. The reduction in incidents may be linked to lower health service use during the pandemic and thus fewer procedures and/or errors, or a reduction in the reporting of incidents.

Mandatory testing of medical diagnostic X-ray units

A prescribed radiation source may only be used for human diagnostic purposes if there is a current certificate of compliance in place. The department continued to monitor licensees for compliance with the testing requirements in 2019–20 and to monitor approved testers for compliance both with the conditions of their authorisation and with the provisions of the Act. A high level of compliance (over 80 per cent) was observed during the 2019–20 year.

Radiation shielding requirements

The department is finalising a new radiation shielding assessment framework that will include accreditation of shielding assessors, a shielding assessment standard and generic shielding assessments for certain low-risk practices.

Potential build-up of radioactive material in crematoria

The department took radiation measurements at the three main crematoria in Victoria due to the possibility of build-up of radioactive material following cremation of bodies containing medically administered radioactive material. Findings at one crematorium indicated no elevated levels of radioactivity. Following a review of the data from the first survey, it was decided that there was no benefit in undertaking a survey of the other two crematoria.

Lasers and intense pulse light sources

The department carried out preliminary investigations with a view to examining the possibility of regulating lasers and intense pulse light (IPL) sources. This work followed several media reports on skin damage in people treated with IPL sources.

Mineral sand mining and processing

The department continues to resource the regulation of mineral sand mining, in particular the processing, storage, transport and disposal of the associated naturally occurring radioactive material.

There are currently five mineral sands mining projects across the state at various stages of obtaining the necessary development approvals. There are also two companies licensed under the Act to conduct mineral sand mining and processing in Victoria – Iluka Resources Limited and Donald Mineral Sands Pty Ltd.

Victorian Parliament's Inquiry into Nuclear Prohibition

The department presented to the Victorian Parliament's Inquiry into Nuclear Prohibition in 2019–20.

National policy development

There was a significant focus on working with other Australian jurisdictions through the Radiation Health Committee and the newly established Radiation Health Expert Reference Panel of enHealth, a standing committee of the Australian Health Protection Principal Committee. The focus of this work is to respond to the International Atomic Energy Agency's *Integrated regulatory review service* 2019 report for Australia and, more broadly, to develop national radiation safety policy on a variety of issues.

The department has participated in:

- developing accreditation standards for personal radiation monitoring service providers
- participating in an advisory body for the Australian National Radiation Dose Register
- developing national radiation safety standards for medical diagnostic X-ray units
- the security of high consequence radioactive material
- nationally agreed expectations of compliance with the 2019 Medical Code.

Other activities

Other activities the department undertook during the year include:

- attending Radiation Health Committee meetings
- assessing proposed national standards and codes of practice
- attending meetings of the Radiation Health Expert Reference Panel
  - continuing to deliver a 24/7 emergency response service
  - carrying out six education sessions and one conference presentation.

Introduction

Diagnostic, therapeutic, industrial and other uses of radiation have contributed to the safety and quality of life for all Victorians. However, radiation does involve hazards if it is used inappropriately or unnecessarily. For this reason, the department regulates the use of radiation to protect people and the environment from its harmful effects by licensing users of radiation sources and managers of radiation practices under the *Radiation Act 2005*.

Section 134 of the Act requires that the Secretary of the Department of Health and Human Services, in respect of each financial year, publishes a report that:

a) describes the activities of the Secretary under the Act;
b) includes a summary of all authorities issued, renewed, suspended, cancelled, varied, transferred or surrendered during that year;
c) includes all radiation incidents investigated in that year;
d) includes a summary of all prosecutions for offences against the Act or the Regulations commenced in that year; and
e) includes any other prescribed matter.

This 2019–20 annual report describes the activities of the Secretary for the financial year from 1 July 2019 to 30 June 2020.

Impacts of the coronavirus (COVID-19) pandemic

The coronavirus (COVID-19) pandemic resulted in some impacts on the radiation safety regulatory program as staff were deployed to help respond to the pandemic during the second half of 2019–20. The pandemic also triggered an increase in licensing applications, particularly from recently retired medical radiation practitioners seeking to become licensed to assist with the potential need for surge staff in hospitals. As a consequence, there was a reduction in field-based activities and to policy development over the second half of the financial year.

Much of the activities undertaken in relation to the Act are undertaken by a specialist radiation regulatory team. During this financial year, the team consisted of approximately 10.5 full-time equivalent staff, supported by an investigations officer and a shared resource1 of a three-person registration and licensing team and an information systems officer.

1 These teams provide a shared service in regulating radiation safety, as well as two other regulatory areas: regulating cooling towers to manage the risks of *Legionella* and legionnaires' disease and the regulation of pest control operators.

Legislation

Radiation Act

The 2005 Radiation Act commenced on 1 September 2007. The Act gives effect to Victoria's commitment to the *National directory for radiation protection*, published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). The directory outlines a common approach for Commonwealth, state and territory governments in regulating radiation practices.

The purpose of the Act is 'to protect the health and safety of all persons and the environment from the harmful effects of radiation' and incorporates:

- the radiation protection principle
- a requirement for the Secretary of the department to have regard to both the radiation protection principle and the *National directory for radiation protection*
- the concept of licensed activities; in particular, the licensing framework created by the Act features:
  - management licences to authorise the conduct of radiation practices (such as possessing a radiation source)
  - use licences to authorise a natural person to use a radiation source
  - radiation facility construction licences
- the concept of approved testers and the testing of prescribed radiation sources against declared radiation safety standards
- the concept of approved assessors of security and transport security plans.
- The Act creates a number of significant offences including:
- conducting a radiation practice without a management licence (the maximum penalty in the 2019–20 period for a body corporate for this offence was $1,486,980)
- using a radiation source without a use licence (the maximum penalty in the 2019–20 period for an individual for this offence was $198,264)
- noncompliance with the conditions of a licence (the maximum penalty in the 2019–20 period for a body corporate for this offence was $991,320).

Radiation Regulations

The Radiation Regulations 2017 prescribe:

- licensing fees, including changes to place-enclosed X-ray analysis units and dental 3D volumetric X-ray units into a different fee category and eliminating the fee associated with applying for a variation to an existing licence and transferring an existing management licence
- definitions of radioactive material
- radiation dose limits
- those radiation sources that must be tested and issued with a certificate of compliance before use.

The Regulations also:

- strengthen the security of high-consequence radioactive material
- implement changes to the occupational dose limit to the lens of the eye to reflect recent international and national developments.

Stakeholder engagement and communication

Informed stakeholders are more likely to work in partnership with the department and are more aware not only of the laws that govern them but also of the potential risks associated with their practices and of ways to mitigate those risks. Informing and engaging with stakeholders is critical to the overall regulatory objective and allows for collaboration and education to achieve regulatory objectives.

The department has been making a significant effort to increase email communication with our regulated entities as a means to distribute information. As a result of the need for our staff, like other Victorians, to work from home where possible from the last quarter of the financial year, the department accelerated this effort and is now distributing all written communications by email. Implementing the new licensing system (discussed in the 'New licensing system' section) has greatly assisted in this effort, as has the redeveloped radiation website <https://www2.health.vic.gov.au/public-health/radiation>.

New licensing system

The department's new radiation licensing database was launched in October 2019. It will eventually replace a legacy database that has been in use for almost 15 years. The legacy system requires departmental staff to enter the details contained in each application into the database including the frequent changes in contact details that are associated with more than 20,000 stakeholders. The system also requires a two-stage process where the application is first assessed by the department and then an invoice is sent to the person concerned, which must be paid before the Secretary's delegate can approve the application.

The first stage of implementing the new licensing database focused on the approximately 15,000 licences and approvals issued to individuals – for example, use licences and approvals for testers and assessors. The final stage will focus on the more complex management licences usually held by companies and other organisations. These are the licences that typically authorise possession of radiation sources as well as many other practices.

The new system features a much more contemporary model where users first register their contact details on a web portal. In the case of new applicants, they are then able to apply for licences or approvals. Based on the type of licence that the person wishes to apply for, the system advises the applicant of the documents that they must supply with their application. The new system eliminates the need for data entry by the department, which allows the application to be assessed more quickly than in the past. Similarly, where a fee must be paid, this is done when the application is lodged, which eliminates one of the reasons for the processing delays in our current system.

When an existing individual licence holder registers for the first time, the system verifies their details. They are then be able to:

- download a copy of their licence
- apply for variations to an existing licence or approval
- renew their licence at the appropriate time
- make credit card payments
- update their contact details.

The early implementation of the system did experience some technical issues in the user registration process, but those have now been addressed. At the time of drafting of this report, there are now almost 10,000 registered users of the new system. Existing licence holders are invited to register in a staged approach before their licence expires. We anticipate that almost all individual licence holders should be registered users of the system by the end of the 2020–21 financial year.

Another feature of the new system is that it accommodates those workers who wish to apply for a licence under the mutual recognition laws that operate across Australia. The system allows the person to easily apply under those arrangements.

The system also features an improved public register of licence holders <https://licensing.dhhs.vic.gov.au/public/use-licence>.

Development of a module for management licences has been delayed because of the coronavirus (COVID-19) pandemic but is expected to be implemented during the 2020–21 financial year.

Integrated Regulatory Review Service

The International Atomic Energy Agency's (IAEA) Integrated Regulatory Review Service (IRRS) mission visited Australia from 5 to 16 November 2018. IRRS reviewed the legal and governmental framework of Australian states and territories and the Commonwealth for nuclear and radiation safety against the IAEA's Safety Standards. A follow-up mission will be conducted in 2021–22.

The IRRS report on the mission has been published on ARPANSA's website

<https://www.arpansa.gov.au/sites/default/files/irrs_australia_report_2018.pdf>.

The IRRS report stresses the importance of national uniformity of radiation regulation. Implementation of edition 2 of the *National directory for radiation protection* would be instrumental in addressing some of the recommendations in the IRRS report.

Australia's Environmental Health Standing Committee (enHealth), a standing committee of the Australian Health Protection Principal Committee, has been charged with developing the overall response to the IRRS recommendations. A Radiation Health Expert Reference Panel has been established to, among other things, advise enHealth on developing specific responses to the recommendations. The department has a representative on that panel and continues to work with the panel on developing specific initiatives related to this matter.

Summary of authorities issued by the department

Section 12 of the Act creates an offence for a person to conduct a radiation practice unless the person holds a management licence or is exempted under s. 16 of the Act.

The most common radiation practice requiring a management licence is possessing a radiation source. Other radiation practices include:

- transporting radioactive material
- selling radiation sources
- procuring or arranging research that involves exposing people to radiation
- mining or processing radioactive material.

Section 13 of the Act creates an offence for a person to use a radiation source unless the person holds a use licence or is exempted under s. 16 of the Act.

The number of authorities issued, renewed, suspended, cancelled, varied, transferred and surrendered under the Act during 2019–20 are listed in Table 1.

Table 1: Number of authorities issued, renewed, suspended, cancelled, varied, transferred and surrendered under the Radiation Act, 1 July 2019 to 30 June 2020

Authority	Management licence	Use licence	Tester	Assessor
Issued	112	1,730	3	9
Renewed	1,711	6,171	20	8
Suspended	0	0	0	0
Cancelled	0	0	0	0
Varied	572	261	0	0
Transferred	57	n/a	n/a	n/a
Surrendered	21	77	0	0

The number of current authorities under the Act as of 30 June 2020 is listed in Table 2.

Table 2: Number of authorities issued as of 30 June 2020

Authority	Number
Use licences	15,082
Management licences	2,659
Approved testers	44
Approved assessors	9

The estimate of the sectors in which these licences are held is listed in Table 3.

Table 3: Estimate of the sectors in which licences are held under the Radiation Act, 1 July 2019 to 30 June 2020

Sector	Management licence	Use licence
Dental	1,377 (47.50%)	5,594 (35.67%)
Veterinary	376 (12.97%)	2.398 (15.29%)
Medical	209 (7.21%)	5,565 (35.48%)
Industrial	240 (8.28%)	1,829 (11.66%)
Sales	163 (5.62%)	n/a
Chiropractic	60 (2.07%)	120 (0.77%)
Transport	47 (1.62%)	n/a
Education	33 (1.14%)	93 (0.59%)
Mining	3 (0.10%)	n/a
Other	391 (13.49%)	84 (0.54%)

Enforcement action

Providing advice and education to duty holders will always be the first step in seeking compliance with the Act and the Regulations. However, there may be some instances in which enforcement action is required.

The Act provides the department with several enforcement tools in addition to the power to initiate prosecution.

Available enforcement actions

Improvement notices

The Secretary, or a delegate of the Secretary, may issue this type of notice if they believe that a person has contravened a provision of the Act or the Regulations in circumstances that make it likely that the contravention is continuing or will reoccur, or is likely to contravene a provision of the Act or the Regulations. If issued, the notice will require the person to remedy the contravention or likely contravention or the matters or activities causing the contravention or likely contravention.

Prohibition notices

Like improvement notices, these notices may be issued by the Secretary (or a delegate) under the same circumstances. The notice prohibits the person from carrying on the activity, or the carrying on of the activity in a specified way, until the Secretary or the delegate has certified in writing that the contravention has ceased or that the likelihood of the contravention occurring has passed.

Show cause notice

The Secretary or a delegate may issue a show cause notice notifying a licence holder of an action the Secretary or a delegate proposes taking in relation to a contravention of a requirement of the Act, with an invitation to the holder to show cause why the proposed action should not be taken.

Execution of a search warrant

While the Act provides power for authorised officers to enter certain places to monitor compliance with the Act or the Regulations, under some circumstances it is necessary first to obtain a search warrant to authorise that access. An authorised officer of the department may apply to a magistrate to issue a search warrant if the authorised officer believes on reasonable grounds that there is, or may be within the next 72 hours, a particular thing (including a document) at the place that may afford evidence of an offence against the Act or the Regulations.

Seizure of articles

The Act provides certain powers to authorised officers, including the power to seize anything (including a radiation source or a document) if the authorised officer reasonably believes:

- the seized thing is connected with an alleged contravention of the Act or the Regulations, or
- there is a serious risk to the health or safety of any person or the safety of the environment if the thing is not seized.

Making a radiation source inoperative

The Act provides a power for an authorised officer to make a radiation source inoperative. As an example of an action that could be taken in certain circumstances, authorised officers during this year rendered inoperative an X-ray unit used to treat skin cancers to prevent its use.

Sealing a radiation source

The Act provides the power for an authorised officer to seal a radiation source. In practice, it may be required where it is impractical to seize a unit but it is necessary to prevent its further use.

Suspension or cancellation of an authority

The Act provides that the Secretary, or a delegate, may suspend or cancel an authority.

Prosecution

There are several significant offences contained within the Act and, under certain circumstances, the department may feel it is necessary to initiate prosecutions for these offences.

Enforcement actions taken in 2019–20

Table 4 summarises the formal enforcement actions the department took during the year. These enforcement actions are discussed in more detail later in this report.

Table 4: Enforcement action

Enforcement action	Number
Improvement notice	0
Prohibition notices	0
Show cause notice	1
Execution of a search warrant	0
Sealing a radiation source	1
Execution of a notice to produce*	0
Seizure of commercial tanning units	0
Prosecutions initiated	3

* A notice to produce is a written notice requiring a person to produce documents or evidence that can be used as part of an investigation.

Prosecutions

During the 2019–20 financial year, the department initiated prosecutions against three operators in relation to either offering or providing commercial tanning services.

Section 23D of the Act requires that a person must not:

- provide, or offer to provide, for fee or reward the use of a tanning unit, or
- operate or offer to operate for fee or reward a tanning unit.

The maximum penalty for an offence by a person during the period covered by this report is $9,913.20, while the maximum penalty for an offence by a body corporate is $49,566.00.

Alleged contraventions of the Act by a radiation oncologist

The department investigated alleged contraventions of the Act by a radiation oncologist. The alleged contraventions included using a superficial therapy X-ray unit without a use licence, conducting medical radiation procedures without appropriate justification and failing to optimise medical radiation procedures. The superficial therapy X-ray unit was made inoperative and sealed using the powers of an authorised officer under the Act. The management licence that authorised the radiation practice was suspended pending the outcome of a show cause process in relation to proposed cancellation of the management licence.

Focused activities

Compliance monitoring program and regulatory focus

Monitoring the compliance of radiation practices with the requirements of the Act is primarily carried out through inspecting the practices. Where possible, the department works to promote compliance by providing advice and constructive guidance and by using technology and systems to help licence holders to interpret and comply with the laws and standards applicable to them.

The department conducted 138 inspections in 2019–20 as part of its licensing compliance monitoring program. This number is below the target number of 480 inspections due to:

- the diversion of departmental staff to coronavirus (COVID-19) duties during the last quarter of the financial year and the reduction in field work to coronavirus (COVID19) in the fourth quarter of the financial year
- the increasing workload and complexity of assessing licensing applications, which affects the time available for field work.

To compensate for these factors, 156 targeted desktop audits and practice surveys were conducted in the last quarter of the financial year.

The compliance monitoring program included inspections of:

- linear accelerators used in radiation oncology
- medical imaging practices
- medical practices involving nuclear medicine
- medical practices involving interventional fluoroscopic apparatus
- operations involving mineral sand mining and processing
- practices using industrial radiography equipment
- practices using industrial gauges
- practices using dual-energy X-ray absorptiometry (DXA) units
- practices using high-consequence radioactive material
- licence holders who had not renewed management licences by the due date.

Radiation safety requirements for CT-based baggage scanners

Computed tomography (CT)-based X-ray units have been introduced into airports in the past few years and provide enhanced imaging of luggage for security purposes. They can also be used for such purposes as detecting contaminants in canned or bottled food products.

X-ray equipment used for security or quality-control purposes must comply with the *Statement on cabinet X-ray equipment for examination of letters, packages, baggage, freight and other articles for security, quality control and other purposes (1987)*, published by ARPANSA. CT-based X-ray units, however, cannot meet the requirement that an object not receive a dose in excess of 10 microgray in a single pass through the beam when the conveyor is moving at the slowest rate at which it can be operated in normal conditions.

The department developed a standard, *Requirements for CT-based units for security or quality control purposes*, to apply to such CT-based X-ray units. The standard has been placed on the department's website and is imposed as a condition of licence on


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management licences authorising the possession of CT-based units. Management licences for possessing these devices were issued subject to complying with a licence condition that requires compliance with that standard. The standard does not include a single pass limit. Remote operation of scanners is not permitted under the staffing requirements of the new standard, and there are requirements in the standard for increased supervision and for emergency stop buttons. These requirements compensate for removing the single pass limit.

Smoke detectors and e-waste

Ionisation chamber smoke detectors, which contain a small amount (40 kBq) of Americium-241 (Am-241), are declared by a *Government Gazette* not to be a sealed source apparatus for the purposes of the Radiation Act. The position of the department is that the best disposal option is disposal in domestic trash.

An *Order in Council* published in the *Government Gazette* declared a waste management policy for e-waste, including smoke detectors, under the *Environment Protection Act 1970*. The enforcement of the policy commenced on 1 July 2019. The policy created a prohibition on allowing e-waste in the general (landfill) waste stream. The Environment Protection Authority Victoria (EPA), Department of Environment, Land, Water and Planning (DELWP), Sustainability Victoria and Melbourne Metropolitan Fire Brigade websites all reflected the new arrangements and directed that smoke detectors be disposed of at e-waste collection points. Disposing of smoke detectors as e-waste would have meant that the detectors could have been shredded with the possible dispersion of the Am-241.

The department worked with the EPA to arrive at a solution that ensured that smoke detectors containing Am-241 would continue to be disposed of in domestic waste.

Quality control of radiopharmaceuticals

In 2018–19 the department imposed new quality-control requirements in respect of the production and sale of radiopharmaceuticals in response to concerns about the quality of radiopharmaceuticals.

The department has continued to focus on the complex area of the quality of radiopharmaceuticals and is collaborating with the Therapeutic Goods Administration on a number of issues connected with the production and sale of radiopharmaceuticals.

New requirements imposed on DXA units

DXA is low radiation dose technology that is widely used for measuring bone mineral density. The technology is particularly valuable in detecting and managing osteoporosis. In recent years, DXA has also been used for assessing body composition (fat mass and lean tissue mass) and this information can be used in research into diseases that affect body composition such as obesity, eating disorders and HIV.

In previous years the department identified increasing use of DXA for assessing body composition without reference to clinical indications, resulting in unnecessary exposure to radiation. The department developed a new set of requirements pertaining to DXA for assessing body composition to ensure that unnecessary use is minimised.

The department conducted extensive stakeholder consultation about the proposed requirements.

In the current financial year, the department imposed the new requirements as a condition of licence on all relevant management licences.

Radiation shielding requirements

Almost all applications for new radiation management licences or for variations to existing radiation management licences need to include documentation outlining the shielding that the applicant proposes to put in place to ensure that any person in the vicinity of the proposed radiation source is not exposed to a dose in excess of the prescribed dose limits in the Regulations.

Radiation consultants often calculate shielding requirements for licence applicants and, to date, there have been no regulatory requirements to ensure the quality and consistency of the shielding assessment reports produced by these consultants. In some cases, the shielding assessment reports are of poor quality and have to be returned to the licence applicant.

The department is finalising a new shielding assessment framework to improve the quality of the shielding design and to provide a standardised and consistent framework for assessing the adequacy of the design. The framework will include the accreditation of shielding assessors, a shielding assessment standard and generic shielding assessments for certain low-risk practices. Stakeholders will be invited to contribute and provide feedback during the phased implementation, which is planned to begin with the release of self-assessment protocols for low-risk practices.

Concerns about potential build-up of radioactive material in crematoria

Some Victorian crematorium managers expressed concern to the department about the possibility of build-up of radioactive material following the cremation of bodies containing radioactive material that had previously been administered for therapeutic or diagnostic purposes. As a result of this concern, the department initiated work to take radiation measurements at Victoria's three main crematoria. Findings at one crematorium indicated that there were no elevated levels of radioactivity, and so it was decided that there was no benefit in undertaking a survey of the other two crematoria.

Waste identified as radioactive in a chemical waste stockpile

WorkSafe identified waste with radioactive warning symbols during investigations of a chemical waste stockpile. The department attended the site to investigate. Information associated with the waste indicated that it was likely to be below the values in schedule 1 of the Regulations and would not be considered radioactive material in Victoria. The department has been liaising with the institution from which the waste originated and is arranging for the waste to be characterised before being disposed of appropriately.

Lasers and intense pulse light sources

The department conducted preliminary scoping work to explore the regulation of lasers and intense pulse light (IPL) sources. There is no nationally agreed policy on the regulation of these devices or of the competency standards of those who use them.

The department examined the numbers and types of incidents that have occurred in Victoria and in other jurisdictions.

The department initiated this project following media reports on skin damage in people treated with IPL sources. Regulation of lasers and IPL sources under the Act would potentially be a complex matter that would involve developing a regulatory impact statement. The statement would need to detail options and examine the costs and benefits of each option including any proposed regulation.

The scoping project has been completed but no decision has been made about the possibility for future regulation in this area.

Commercial tanning practices

The *Radiation Amendment Act 2013* commenced on 1 June 2014. This Act amended the 2005 Radiation Act to give effect to the Victorian Government's decision to prohibit commercial tanning services from the end of 2014, among other things.

The department has taken a strong approach to enforcing the legislative prohibition of commercial tanning practices through such measures as recruiting an experienced investigator to lead investigations of all allegations of illegal practices.

The department has investigated all allegations of illegal commercial tanning practices. The department's policy is that, where there is sufficient evidence to support the allegation that commercial tanning practices have been or are being conducted, authorised officers will seize any tanning units on the premises associated with the allegations. During the financial year the department initiated prosecutions against three operators.

Mineral sands mining and processing

The department regulates the processing, storage, transport and disposal of the naturally occurring radioactive material associated with mineral sand mining and processing.

The mining of mineral-rich sands within Victoria generally triggers the need to regulate the radiation safety aspects of the operations due to the presence of naturally occurring radioactive material in low concentrations.

Mineral sands within Victoria are usually mined from ancient beaches, like those that existed in the Murray Basin. Mineral sands were deposited on shores where the large density of the mineral sand grains allowed them to settle close to the then existing shore and be concentrated there while lighter sands tended to be washed out to sea.

There are currently two companies licensed under the Act to conduct mineral sand mining and processing in Victoria – Iluka Resources Limited and Donald Mineral Sands Pty Ltd.

Other projects have been proposed and are currently at varying stages of the required development assessment process, which typically includes a formal environmental effects assessment.

The first five mineral sands projects discussed below are in the Murray Basin; the sixth is in eastern Gippsland.

Iluka Resources Limited – existing operations

Iluka Resources Limited has been mining mineral sands in the west of Victoria since 2005. Part of its operation includes disposing of waste by-products that were generated by processing heavy mineral concentrate (HMC) at its mineral separation plant in Hamilton into the disposal pit at its Douglas mine site in western Victoria, known as Pit 23. The mineral separation plant in Hamilton is currently not operating.

Disposal of the by-products from the processing of HMC into Pit 23 began in 2011. The HMC was produced by mining activities at various Iluka mines, including those at Ouyen and in South Australia. The continued disposal of these byproducts involved Iluka obtaining a planning permit from Horsham Rural City Council.

The department sits on the technical reference group that advises Horsham Rural City Council in relation to Iluka's planning permit for disposing of waste by-products into Pit 23. The reference group meets quarterly at the council offices in Horsham.

The department's regulation of Iluka's operations involving the possession of radioactive material will continue until the rehabilitation of the mine sites has been completed.

Iluka Resources Limited – Wimmera Mineral Sands Project

Iluka Resources Limited proposes to develop the Wimmera Mineral Sands project, which has an approximate area of 2,600 hectares and is located approximately 35 kilometres south-west of Horsham.

The WIM100 deposit is reported to contain approximately 200 million tonnes of heavy mineral sands ore, which is proposed to be extracted and refined onsite to produce zircon, titanium oxide and rare earth products.

The proposal includes:

- the development of a mineral sands mine
- processing plants (including a mineral separation, zircon refinery and rare earth refinery)
- ore receival and liquification system
- mine by-products transport and containment infrastructure
- offsite infrastructure such as powerlines, water pipelines, access roads and a temporary construction camp
- additional offsite infrastructure such as administration buildings, water storage dams, fuel storage and lay down areas.

The proposed mining method is likely to be progressive mining using mobile earthmoving equipment. Nine to 10 million tonnes of ore per annum is proposed to be extracted, which will be refined onsite to produce 192,000 tonnes of recoverable mineral product per annum, over the projected 25-year mine life.

DELWP has convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies during the

preparation of the environment effects statement. The department's Radiation Team is represented on this group.

Find out more from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/wimmera-mineral-sands>.

Donald Mineral Sands

The site for this project is located approximately 17 km southeast of Minyip. Donald Mineral Sands is planning to mine the shallow, fine-grained sand deposit containing accumulations of titanium and zirconium minerals. The valuable minerals (ilmenite, rutile, leucoxene and zircon) will be separated into an HMC and then exported. The remaining non-valuable clays and sands will be returned to the soil profile. The final rehabilitation of the mined area is intended to produce a similar landscape to that prior to the mining project, including restoring native vegetation, drainage and agriculturally productive land.

The project underwent an environment effects assessment process in 2008. Donald Mineral Sands Pty Ltd was issued, and still holds, a radiation management licence to undertake mining and processing of mineral sands. The company has not yet begun operations.

The department continued a program of radon monitoring in the area of the proposed mine to establish a baseline level of radon for comparison with levels during any future mining activities.

Find out more about the project from the Astron website <http://www.astronlimited.com.au/projects-operations/DONALD-MINERAL-SANDS.aspx>.

VHM Limited – Goschen Mineral Sands and Rare Earths project

VHM Limited proposes to develop the Goschen Mineral Sands and Rare Earths project, which has an approximate area of 8,300 ha and is located approximately 20 km south of Swan Hill.

The Goschen deposit is reported to contain approximately 300 million tonnes of ore and is proposed to produce a zircon and rutile concentrate, titanium concentrate and a rare earth concentrate.

The proposal includes developing a mineral sands mine, mining unit plant, wet concentrator plant, interim tailings storage facility, solar drying beds for tailings, slurry pipelines to transfer ore from pits to the processing facilities and additional site infrastructure (site office, warehouse and workshop facilities, loading facilities and fuel storage).

Proposed mining methods involve open pit mining to extract approximately 5 million tonnes of ore per annum, increasing to 10 million tonnes of ore per annum over a projected mine life of 30 years. Mine products are proposed to be transported via road or by rail for export overseas.

DELWP has convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies during the

preparation of the environment effects statement. The department's Radiation Team is represented on this group.

Find out more about this project from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/goschen-mineral-sands-and-rare-earths-project>.

WIM Resources – Avonbank Heavy Mineral Sands project

WIM Resources Pty Ltd proposes to develop the Avonbank Heavy Mineral Sands project, which has an approximate area of 2,500 ha and is located approximately 15 km north-east of Horsham.

The Avonbank deposit is reported to contain approximately 300 million tonnes of ore, and the company proposes to produce a heavy mineral concentrate containing zircon, rare earths and titanium minerals.

The proposal includes:

- a mineral sands mine
- a wet concentrator plant
- starter ore and overburden stockpiles
- slurry pipelines
- additional site facilities such as a site office, warehouse, workshop, rail loading facilities and fuel storage.

The proposed mining methods involve open-pit mining to extract 9–15 million tonnes of ore per year over a projected mine life of 30 years to produce 350,000–600,000 tonnes of heavy mineral concentrate per year. Mine products are proposed to be transported via road or rail for export overseas.

Preliminary meetings were held with WIM Resources to discuss Radiation Act requirements and broader environmental assessment processes in Victoria.

DELWP has subsequently convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies during the preparation of the environment effects statement. The department's Radiation Team is represented on this group.

Find out more about this project from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/avonbank-mineral-sands>.

Kalbar Operations – Fingerboards Mineral Sands Project

Kalbar Operations Pty Ltd proposes to develop the Fingerboards Mineral Sands Project, which has an approximate area of 1,675 ha and is located approximately 20 km north-west of Bairnsdale in East Gippsland.

The proposal includes:

- the development of a mineral sands mine
- two mining unit plants
- a wet concentrator plant (comprising mineral separation processing and tailings thickening and a disposal plant)

- water supply infrastructure
- a tailings storage facility
- additional site facilities such as a site office, warehouse, workshop, loading facilities and fuel storage.

The proposed mining methods involve open-pit mining to extract approximately 170 million tonnes of ore over a projected mine life of 20 years to produce approximately 8 Mt of mineral concentrate. Mine products are proposed to be transported via road or by rail for export overseas.

DELWP convened a technical reference group to advise the proponent and the department, as appropriate, on scoping and adequacy of the studies during the preparation of the environment effects statement. The department has been actively involved in the technical reference group meetings for this project to ensure that potential radiation exposures are properly addressed and that the project establishes programs to obtain and collate the information needed by the department to assess the potential radiation impact on human health and the environment.

At the time of writing of this report, the environment effects statement, together with the draft planning scheme amendment and a Works Approval Application to the EPA has been released for public comment.

Find out more from the DELWP website <https://www.planning.vic.gov.au/environment-assessment/browse-projects/projects/fingerboards-mineral-sands>.

Mandatory testing of medical diagnostic X-ray units

The Act requires that a prescribed radiation source only be used for human diagnostic purposes if there is a current certificate of compliance in place. In recognition that the ability for management licence holders to comply with compliance testing requirements may be limited during the coronavirus (COVID-19) pandemic, the department advised relevant licence holders that enforcement action would not be undertaken if a prescribed radiation source is used between 30 March 2020 and 30 September 2020 for human diagnostic purposes without a current certificate of compliance. However, licence holders were advised that, when possible, compliance testing should be undertaken to ensure that prescribed radiation sources have a current compliance certificate when these radiation sources are used for human diagnostic purposes.

Despite difficulties associated with coronavirus (COVID-19), the level of compliance during the 2019–20 financial year was over 80 per cent.

Emergency response function

Under Victoria's emergency management arrangements, the department is the control agency for radiological emergencies where radiation is the principal hazard. As part of this responsibility, the department maintains a 24/7 response capability involving specialist radiation safety staff. Staff have access to vehicles containing specialist radiation safety detection equipment and ancillary equipment.

The radiation monitoring equipment the department possesses includes:

- radiation survey meters
- a telescopic radiation monitor survey meter (approximately 3 m extension)
- handheld radionuclide identification instruments
- contamination monitors
- wipe sample counting systems that can be deployed in the field
- an air-sampling instrument that can be deployed in the field
- personal electronic radiation dosimeters for all radiation regulatory staff
- a radiation portal monitor for high-volume screening of people for radioactive material contamination.

One of the challenges for the department is how best to maintain a response capability for what are clearly extremely low-likelihood but high-consequence events.

Representation on national committees

During 2019–20 the department was represented on ARPANSA's national Radiation Health Committee by Noel Cleaves, Manager Environmental Health Regulation and Compliance. The role of the Radiation Health Committee is to advise ARPANSA's chief executive officer on matters relating to radiation protection, including formulating draft national policies, codes and standards for consideration by the Commonwealth, states and territories.

Mr Cleaves attended three meetings of this committee during the financial year.

ARPANSA publishes the agendas and minutes of these committee meetings <https://www.arpansa.gov.au/about-us/advisory-council-and-committees/radiation-health-committee/agendas-and-minutes>.

Development of national standards

Code for Radiation Protection in Medical Exposure (2019)

ARPANSA published the *Code for Radiation Protection in Medical Exposure, Radiation Protection Series C-5* (the Medical Code) in July 2019. This code, used in conjunction with the *Code on Radiation Protection in Planned Exposure Situations*, replaces ARPANSA's *Code of Practice for Radiation Protection in the Medical Applications of Ionizing Radiation* (2008). The Medical Code sets out the requirements in Australia for the radiation protection of patients, their carers/comforters and volunteers in biomedical research projects. The Medical Code was developed having regard to the requirements relating to medical exposure described in the IAEA *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements* (GSR) Part 3 (IAEA 2014).

Compliance with the Medical Code will eventually become mandatory through variations to existing management and use licences authorising medical diagnostic and therapeutic practices. A related project is currently underway nationally to develop a set of nationally agreed and consistent expectations of licence holders to demonstrate compliance with the Medical Code. It is expected that the necessary variations to

existing licences will be made once these expectations have been published. The impact of the coronavirus (COVID-19) pandemic will also be an important consideration for the timing of these licence variations.

The Medical Code is available from ARPANSA's website <https://www.arpansa.gov.au/sites/default/files/medical-exposure-code-rps-c-5.pdf>.

New draft safety standard for radiofrequency electromagnetic energy exposure

ARPANSA has been reviewing the *Code for Maximum Exposure to Radiofrequency Fields – 100kHz to 300GHz* (RPS3), published in 2002.

At the time of writing, ARPANSA has released a consultation draft titled *Standard for Limiting Exposure to Radiofrequency Fields – 100 KHz to 300 GHz (RPS S-1)*.

National policy development

In 2019–20, there was a significant focus on working with other Australian jurisdictions through the Radiation Health Committee and the newly established Radiation Health Expert Reference Panel of enHealth to firstly respond to the IRRS report referred to earlier and to also consider other mechanisms to advance radiation safety in Australia. This has required the department to lead or contribute to several related projects throughout the year.

Development of accreditation standards for radiation dosimetry service providers

The conditions placed on management licences usually include requirements for monitoring radiation doses to individuals using personal radiation monitoring devices. Radiation dose monitoring remains a cornerstone of radiation safety. However, there are no nationally agreed guidelines that personal radiation monitoring service providers need to follow to guide aspects such as quality assurance. Regulation of these service providers is inconsistent across Australia. There is currently no direct regulation in Victoria of the providers of these personal radiation monitoring services.

The current service providers include both internationally and locally based companies and organisations.

The department is leading a national project to develop nationally agreed accreditation requirements to assess and approve these service providers and the associated personal dosimeters that they issue to their customers. The proposed requirements include:

- traceability of radiation doses to Australian national standards
- the requirement that personal dosimetry laboratories have a system in place to notify the service user of abnormal doses
- the requirement for a quality management system to be implemented for dose reports, including requirements to ensure consistent data reporting
- requirements both for the laboratory-based activities and for the services that support them

- a requirement for the service providers to provide radiation dose monitoring records to the Australian National Radiation Dose Register hosted by ARPANSA.

The department led a well-received workshop for service providers on this project in Adelaide prior to the International Commission on Radiological Protection conference in November 2019.

If a national agreement on the scheme can be reached, then Victoria will need to make minor amendments to the Radiation Act to incorporate a new regulatory scheme to regulate in this area and to support these accreditation standards.

National radiation safety standards for medical diagnostic X-ray units

The department has been working with other jurisdictions on developing nationally consistent radiation safety standards for certain types of medical diagnostic X-ray units. If adopted these would replace the current Victorian radiation safety standards for these types of units.

Security of high consequence radioactive material

The department has been working with other jurisdictions on the review of the current *Code of Practice for the Security of Radioactive Material* (2007) published by ARPANSA. While Victoria and other jurisdictions have implemented the code of practice, there are aspects that have proven extremely difficult to implement. This, coupled with emerging international guidance and a specific recommendation of the IRRS report described earlier, has triggered a review of the current arrangements including the potential to establish a national register of sealed radioactive sources.

Australian National Radiation Dose Register

The Australian National Radiation Dose Register (ANRDR) is a database designed to store and maintain radiation dose records for occupationally exposed workers. The ANRDR was launched in 2011 for the Australian uranium mining and milling industry. The register now accepts dose records from all industries working with radiation, including the mining, medical, veterinary, industrial, aviation, research and university sectors. Much of the records are drawn from the records of the personal radiation monitoring service providers discussed earlier.

ARPANSA established the ANRDR to make sure workers' radiation dose records are maintained in a centralised register, regardless of where or for whom a person is working.

The ANRDR is the nationally approved central record keeping agency for the dose records of all Australian workers who are occupationally exposed to ionising radiation.

The department has been advocating for improvements and a strengthening of the role of the ANRDR as a central part of Australia's radiation safety system. This advocating has led in part to focusing the project on developing nationally agreed accreditation standards for personal radiation dose monitoring service providers discussed earlier in this report. The department also advocated for a stronger governance system to guide development of the ANRDR and was pleased to see this progress during this financial year. The department now has a representative on an advisory body for the ANRDR

and will continue to advocate for initiatives that result in strengthening the ANRDR as a cornerstone of Australia's radiation safety system.

Find out more about the ANRDR <https://www.arpansa.gov.au/our-services/monitoring/australian-national-radiation-dose-register>.

The department sees a strong relationship between developing the accreditation scheme for personal radiation dose monitoring service providers and the success of the ANRDR.

Nationally agreed expectations of compliance with the 2019 Medical Code

As noted earlier, ARPANSA published the *Code for Radiation Protection in Medical Exposure, Radiation Protection Series C-5* (better known as the 'Medical Code') in July 2019.

Given that compliance with the Medical Code will eventually become mandatory through variations to existing management and use licences authorising medical diagnostic and therapeutic practices, it is critical that the health sector understands what Australian radiation safety regulators expect from their licence holders to be able to demonstrate once the Medical Code becomes mandatory.

Education sessions and conference presentations

The department carried out several education sessions and presentations during the year. These were:

- two lectures on responding to radiation emergencies to CFA personnel (a third scheduled lecture was cancelled due to the coronavirus (COVID-19) pandemic)
- two presentations on radiation safety and the Act and the Regulations to dentists and dental therapists – one at La Trobe University in Bendigo and one at the Melbourne Dental School (another lecture was scheduled at each of the sites but these two were cancelled due to the pandemic)
- a presentation to nuclear medicine interns on regulatory requirements
- a presentation to nuclear medicine technologists, medical physicists and radiopharmacy personnel on quality assurance in nuclear medicine in relation to radionuclide generators
- a presentation on the development of a new radiation safety standard for CT-based units for security or quality-control purposes, given at the International Commission on Radiological Protection conference in Adelaide in November.

Attendance and presentation at the Victorian Parliament's Inquiry into Nuclear Prohibition

On 14 August 2019, the Legislative Council of the Victorian Parliament agreed to the following motion:

'That this House requires the Environment and Planning Committee to inquire into, consider and report, within 12 months, on potential benefits to Victoria in removing prohibitions enacted by the *Nuclear Activities (Prohibitions) Act 1983*, and in particular, the Committee should —

1) investigate the potential for Victoria to contribute to global low carbon dioxide energy production through enabling exploration and production of uranium and thorium;
2) identify economic, environmental and social benefits for Victoria, including those related to medicine, scientific research, exploration and mining;
3) identify opportunities for Victoria to participate in the nuclear fuel cycle; and
4) identify any barriers to participation, including limitations caused by federal or local laws and regulations.'

The department was asked to make a submission and attended the inquiry on 12 March. The department was represented by Melissa Skilbeck, Deputy Secretary, Regulation Health Protection and Emergency Management and by Dr Angie Bone Deputy Chief Health Officer, Environment and Noel Cleaves, Manager Environmental Health Regulation and Compliance.

Read the transcript of the evidence given at that inquiry <https://www.parliament.vic.gov.au/images/stories/committees/SCEP/Inquiry_into_Nuclear_Prohibition_Inquiry_/Transcripts/FINAL_-DHHS-12_March_2020.pdf>.

The reporting date for this inquiry has been extended from 14 August 2020 to 30 November 2020. Once the report is tabled in parliament, an electronic copy will be available for download <https://www.parliament.vic.gov.au/epc-lc/article/4350>.

Secretariat support for the Radiation Advisory Committee

During the year, the department continued to provide secretariat services to the Radiation Advisory Committee, established under Part 10 of the Act. Read about the committee <https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/radiation-advisory-committee>.

A report of this committee's work is tabled in the Victorian Parliament each year and is available on the department's website. Read the 2019–20 report <https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory-framework/radiation-advisory-committee>.

Radiation incidents

Management licence holders must, by a condition of their licence, report incidents that are described in the department's document *Mandatory reporting of radiation incidents* <https://www2.health.vic.gov.au/public-health/radiation/licensing/management-licenses-businesses/general-conditions/incident-reporting>.

The document describes the following as triggers for reporting an incident to the department:

- becoming aware of the loss or theft of a radiation source
- any breach of security relating to the possession or transport of a high-consequence sealed source
- a worker, patient or a member of the public has or may have received an unplanned or abnormal exposure to ionising radiation, other than a justified medical exposure, exceeding 1 mSv total effective dose

- the activity of the material administered to a patient during the administration of radioactive material for human diagnostic purposes exceeds the activity prescribed in the hospital/practice standard protocol for that test by 50 per cent or more
- the activity administered to a patient during the administration of a radioactive material for human therapeutic purposes differs from that prescribed by 15 per cent or more
- the dose delivered during administration of a human therapeutic dose of radiation to a patient from a radiation apparatus or a sealed radioactive source:
  - differs from the total prescribed treatment dose by more than 10 per cent
  - the difference between the total prescribed dose and the delivered dose was not anticipated or accepted as part of the treatment plan
- any human therapeutic treatment delivered to either the wrong patient or the wrong tissue, or using the wrong radiopharmaceutical
- any human diagnostic procedure other than as prescribed that could lead to an effective dose exceeding 1 mSv (including the wrong patient or the wrong body part examined)
- any human diagnostic procedure resulting in an observable acute radiation effect
- any unplanned exposure to a child (under 18 years old)
- any unplanned exposure to a pregnant female
- a human diagnostic procedure that results in a skin dose that exceeds 6 Gy
- any observable radiation injury (note that effects such as erythema, which are expected to occur following therapeutic procedures, do not need to be reported)
- where a radiation source is or has been out of control (this includes situations where, for example, the source is not safely secured or shielded, or contamination is not confined)
- where an ionising radiation apparatus, sealed source or sealed source apparatus is or has been damaged or has malfunctioned in a manner that could result in a person receiving a higher radiation dose than would be received under normal circumstances
- where a surface, substance or material is or has been contaminated by radioactive material in excess of:
  - 1 kBq within any square metre in the case of alpha-emitting radioactive material, or
  - 1 MBq within any square metre in the case of beta-emitting or gamma-emitting radioactive material
- any observable radiation injury
- a worker or a member of the public has or may have received an unplanned or abnormal exposure to ionising radiation (other than a justified medical exposure) exceeding 1 mSv total effective dose
- a transport accident involving radioactive material where there has been damage or possible damage to containers that contain a sealed source, sealed source apparatus or radioactive material
- a transport accident involving radioactive material where there has been a spill or release of radioactive material into the environment.

During 2019–20, 183 incidents were reported to the department compared with 216 in the previous year. Of the 183 incidents in 2019–20, 173 were in the medical sector (Appendix 1). Most medical incidents involved unplanned or incorrect exposures to patients. None of the incidents involved any compromise in security of high-consequence sealed sources.

There has been a significant increase in the number of incidents reported to the department over the past 10 years, with an increase of about 580 per cent in the total number of incidents reported to the department over this period and, in particular, an increase in the number of incidents involving medical use of radiation over this time (Appendix 2). This reflects the increase over the past 10 years of the number of diagnostic imaging procedures that involve radiation in Victoria (Appendix 3).

The increased number of reported medical radiation incidents over the past 10 years may also be due to an increased awareness among licensees of the requirement to report medical incidents as a direct result of the department's increased focus on regulating the medical use of radiation over this period. For example, the requirement to report incidents is now stressed as a part of compliance inspections of medical radiation practices carried out by the department's authorised officers.

The number of reported medical radiation incidents in 2019–20, however, is about 18 per cent lower than the previous year. This compares with an approximately 5 per cent reduction in the number of diagnostic imaging procedures involving radiation between the two years, which may be related to lower health service use during the early stages of the coronavirus (COVID-19) pandemic. The reason behind the reduction in reported incidents in 2019-20 is not known but could be linked to lower health service use during the pandemic and thus fewer procedures and/or errors, or a reduction in the reporting of incidents.

A significant and complex incident involving exposure to workers is included in the incident report at number 183. This incident is still the subject of a detailed investigation by the department, which is not yet completed due to the impacts of the coronavirus (COVID-19) pandemic and the complexity involved.

Appendix 1: Radiation incident details

As a guide to the radiation doses mentioned in Table 5, the public exposure limit is an effective dose of 1 millisievert (1 mSv) per year; while for occupational exposure the limit is an effective dose of 20 mSv per year.

The **becquerel (Bq)** is the standard unit of radioactivity.

1 kBq = 1,000 Bq

1 MBq = 1,000 kBq

1 GBq = 1,000 MBq

1 TBq = 1,000 GBq

The **sievert (Sv)** is the unit of effective dose of radiation and is used as a measure of risk of developing cancer and other late-onset effects.

1,000 mSv = 1 Sv

The **gray (Gy)** is the unit of absorbed dose of radiation and is used as a measure of the likelihood of developing fetal malformations and of developing acute effects such as skin burns.

1,000 mGy = 1 Gy

Radioactive sources

18F fluorine-18

68Ga gallium-68

201Tl thallium-201

99mTc technetium-99m

Pharmaceuticals

DMSA dimercaptosuccinic acid

DOTATATE an amino acid peptide (tyrosine-3-octreotate)

DTPA diethylene-triamine-pentaacetate

FDG fluorodeoxyglucose

HDP hydroxydiphosphonate

HIDA hepatobiliary iminodiacetic acid

IDA iminodiacetic acid

MIBI methoxy-isobutyl-isonitrile

PSMA prostate-specific membrane antigen

Imaging modality acronyms

CT computed tomography

4DCT CT scanning that records multiple images over time. It allows playback of the scan as a video so that physiological processes can be observed and internal movement can be tracked

SPECT/CT single-photon emission computed tomography / computed tomography

PET positron emission tomography

PET/CT positron emission tomography / computed tomography

Table 5: Radiation Act incident summary, 2019–20

Unnecessarily repeated medical imaging procedures

Incident 1	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A hospital patient underwent a CT thoracic aorta scan where the noncontrast phase of the scan was repeated unnecessarily due to the trainee radiographer selecting an incorrect button on the workstation. The effective dose from the unnecessarily repeated CT thoracic aorta scan was approximately 8.5 mSv. Staff at the hospital in a supervisory role were reminded of the importance of close and consistent monitoring of trainees.
Incident 2	**A patient underwent an unnecessarily repeated L4 lumbar nerve root injection under CT guidance due to clerical error.** A hospital patient had an unnecessarily repeated L4 lumbar nerve root injection under CT guidance. The patient had undergone the same procedure two weeks before. In the case of the repeat procedure, the neurosurgeon requested that the patient undergo an L4 nerve root injection. A radiology registrar unsuccessfully attempted to contact the neurosurgeon to establish the validity of the request. The registrar then asked a radiology consultant if injecting the same lumbar level again were reasonable. The consultant advised the registrar to go ahead with the procedure. Following the procedure, the neurosurgeon advised radiology staff that the request has actually been changed from an L4 nerve root injection to an L2/L3 epidural injection. Upon investigation, it was found that the new request had been scanned in by clerical staff, but the old request wasn't removed from the radiology information system (RIS) and was displayed first and so actioned again. The effective dose from the unnecessarily repeated procedure was approximately 2.3 mSv. Clerical staff were reminded to remove cancelled requests from the RIS.
Incident 3	**A patient underwent an unnecessarily repeated nuclear medicine procedure due to nuclear medicine technologist error.** A nuclear medicine dynamic renal scan was being carried out on a hospital patient. After 30 minutes of image acquisition, the nuclear medicine specialist on site deemed that enough data had been acquired and asked the nuclear medicine technologist (NMT) to stop image acquisition. The computer prompted with the following message: 'Not all frames were received or some frames are incomplete. Do you want to save the acquired data?' The technologist accidentally pressed 'No' and the data for the study was lost, so the patient needed to be rebooked for a repeat scan. The effective dose from the first procedure was approximately 1.5 mSv. The NMT involved was reminded to exercise care when stopping a dynamic study early.
Incident 4	**A patient underwent an unnecessarily repeated CT scan due to insufficient contrast injection.** A multiphase kidney CT scan was performed on a hospital patient that was non-diagnostic due to poor contrast enhancement. A multipatient injection system was used for the injection, which involves a saline test bolus. The saline flush in this instance was contrast, so when bolus tracking was initiated opacification of the aorta was observed. When the scan was triggered, there was poor contrast enhancement due to the low volume of contrast remaining in the patient. A junior radiographer who had not been credentialled in using the contrast injection system had set up the system up and had connected the saline input line to the contrast side of the injector and vice versa. The radiographer who performed the scan didn't notice that the contrast enhancement was poor and subsequently imaged the patient in both portal-venous and delayed phases. The effective dose from the nondiagnostic procedure was approximately 27 mSv. The hospital reverted using single and dual-barrel injectors, as per previous practice.

Incident 5	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A hospital patient underwent a CT scan of the abdomen and pelvis in addition to CT pulmonary angiography (CTPA). The patient was booked for the CTPA on one day and had a CT scan of the abdomen and pelvis booked for two days later. The radiographer noticed that the CT scan of the abdomen and pelvis was booked for the later date and brought the scan forward to be done at the same time as the CTPA for the convenience of the patient. The two procedures were approved and protocolled by a radiologist. After the scan, the radiographer realised that the CT scan of the abdomen and pelvis had been completed the day before. Previous imaging had not been thoroughly checked before scheduling the scan. The effective dose from the repeated CT scan of the abdomen and pelvis was approximately 12 mSv. The radiographer involved was reminded to check for previous imaging before carrying out a scan.
Incident 6	**A patient underwent an unnecessarily repeated CT scan due to medical staff error.** A hospital patient underwent an unnecessary CT scan of the cervical spine. The scan had already been performed at another site. The imaging request generated at the hospital noted the prior CT scan of the brain but not the prior CT scan of the cervical spine. The referring physician rerequested the CT scan of the cervical spine. The effective dose from the second CT scan of the cervical spine was approximately 6 mSv. The importance of carrying out proper time-out procedures and of verification of prior imaging was stressed to all staff involved.
Incident 7	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A patient presented to a medical imaging practice for a CT scan of the pelvis to mid-chest region. The data acquired from the CT scan was unintentionally deleted and so the image couldn't be reconstructed. Only one piece of information was to have been removed. The scan had to be repeated. The effective dose from the first scan was approximately 6.5 mSv. Radiographers were instructed that scan data are not to be changed until all images have been generated and stored in the picture archiving and communication system (PACS).
Incident 8	**A patient underwent an unnecessarily repeated CT scan due to a lack of communication between hospital departments.** A hospital patient was referred for a CT colonography. The radiology registrar contacted the registrar from the surgical treating unit and instructed that the patient needed to have contrast agent administered three hours before the planned scan. The patient was subsequently transferred from the surgical treating unit to another department, but the requirement for contrast administration wasn't handed over to nursing staff there. The instructions for contrast administration were, however, documented on the medication chart. The patient was transferred to the medical imaging department for the CT colonography where the radiographers checked with nursing staff that the contrast had been administered. Nursing staff confirmed it had been administered by staff from the department that the patient had been transferred from. During the scan the radiographer confirmed there was no faecal tagging indicating that the contrast had not been administered. The study was then aborted after discussion with consultant radiologists. This incident occurred due to a lack of communication between hospital departments. The effective radiation dose from the CT colonography was approximately 6 mSv. Hospital departments were reminded to pass on all necessary information when carrying out a handover.
Incident 9	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A patient was referred to a medical imaging practice for a CT brain scan. The scan was carried out successfully. The next day a faxed version of the same request was sent to the practice. Due to a heavy workload at the time, the radiographer didn't check the previous imaging of the patient. The patient therefore underwent an additional unnecessary CT brain scan. The effective dose from this unnecessary CT brain scan was approximately 1.2 mSv. Radiographers at the practice were reminded of the importance of adhering to the practice's policy of checking for previous imaging of patients.

Incident 10	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A hospital patient was referred for a CT scan of the left hip and a CT scan of the chest. The radiographer involved performed the CT scan of the left hip then mistakenly set up a second CT scan of the hip instead of a CT scan of the chest. This error was noticed during the reconstructions of the images. The effective dose from the unnecessarily repeated CT scan of the hip was approximately 10 mSv. The radiographer involved was reminded to be careful when entering parameters into CT scanners before examinations.
Incident 11	**A patient underwent an unnecessarily repeated nuclear medicine scan due to failure of pharmacological stress agent injection.** A patient undergoing a nuclear medicine cardiac stress test presented for an injection of a pharmacological stress agent after a radiopharmaceutical was administered. The injection pump for the cardiac stress agent, however, was incorrectly set up – the syringe wasn't clipped into place properly – and no cardiac stress agent was administered. The effective dose from the unnecessary administration of the radiopharmaceutical was approximately 7.2 mSv. The nurse unit manager sent a reminder to nurses that syringes need to be clipped in place correctly in such cases and double-checked for correct attachment.
Incident 12	**A patient underwent an unnecessarily repeated chest X-ray due to referring medical practitioner error.** A paediatric hospital patient presented from an emergency department (ED) for a chest X-ray with the clinical details 'headache, hypertension'. The chest X-ray was conducted. Sixteen hours later another request for a chest X-ray and an ultrasound scan was received for the same patient with the additional clinical notes: 'Persistent hypertension in the ED'. This second chest X-ray was conducted. The ED consultant subsequently notified the imaging department that the second chest X-ray was unnecessary. The intention of the second request was to add an ultrasound scan and the additional clinical notes were for the ultrasound scan. The effective dose from the unnecessarily repeated chest X-ray was approximately 0.16 mSv. ED medical practitioners were informed that requests for imaging with different modalities must be made separately and that any additional requests should not include imaging that had already been requested previously.
Incident 13	**A patient underwent an unnecessarily repeated CT scan due to contrast injection failure.** A hospital patient underwent an unnecessarily repeated CT pulmonary angiogram because the first phase of the scan was performed without contrast. The patient was experiencing pain at the site of injection that was probably due to extravasation. The contrast administration was aborted but the scan wasn't stopped in time. The effective dose from the CT scan without contrast was approximately 9 mSv. The radiographer involved underwent additional training and supervision in the administration of contrast.
Incident 14	**A patient underwent an unnecessarily repeated CT pulmonary angiogram due to failure to inject contrast.** A hospital patient underwent a repeated CT pulmonary angiogram as the first phase of the scan was performed without contrast. The contrast wasn't administered due to the radiographer initiating an injection of saline instead of the contrast agent during the scan. The effective dose from the CT scan without contrast was approximately 27 mSv. Radiographers at the hospital were reminded to check injector settings and to be attentive to the injector pressure during contrast administration.
Incident 15	**A patient underwent an unnecessarily repeated CT angiography scan due to radiographer error.** A hospital patient with chronic pancreatitis presented to the radiology department for a CT angiography scan of the abdomen to investigate the possibility of haematoma and/or aneurysm. The imaging request was correctly protocolled as a CT angiography of the abdomen and pelvis with contrast. The radiographer incorrectly performed the imaging in the portal venous phase instead of the arterial phase. The effective dose from the portal venous phase scan was approximately 2.3 mSv. The radiographer involved was counselled regarding the incident.

Incident 16	**A patient underwent an unnecessarily repeated nuclear medicine scan due to extravasation of the radiopharmaceutical.** A hospital patient presented to a medical imaging practice for a nuclear medicine scan with ^{99m}Tc-HDP. The radiopharmaceutical extravasated into the left cubital fossa (depression on the anterior surface of the elbow joint) due to lack of patency of ultrasoundguided intravenous (IV) cannulation. The procedure had to be repeated. The effective dose from the failed injection was approximately 3.8 Sv. Procedures to minimise the risk of extravasation were reinforced to relevant staff.
Incident 17	**A patient underwent an unnecessarily repeated injection of a radiopharmaceutical due to referring physician error.** A hospital patient presented for a PET scan and received an injection of ^{68}GaDOTATATE. Following the injection, staff realised that the patient had received this scan five days earlier at another hospital. The second scan was aborted, saving the patient from a further unnecessary exposure from the localisation/attenuation CT scan. This incident was due to the referring physician submitting requests for the same procedure to two different hospitals and the NMT not checking for previous imaging before injecting the patient. The effective dose from the injection of ^{68}GaDOTATATE was approximately 2.3 mSv. The referring physician was reminded to submit only one referral for each imaging request. The NMT was reminded to check for previous imaging before carrying out a medical imaging procedure.
Incident 18	**A patient underwent an unnecessarily repeated injection of a radiopharmaceutical due to nuclear medicine technologist error.** A patient presented as an outpatient to a hospital with a referral for a nuclear medicine bone scan. The patient stated that they had not had previous nuclear medicine scans. Following injection of 793 MBq of ^{99m}Tc HDP and the scan, the NMT checked the electronic medical record (EMR) and discovered that the patient had had a bone scan a week before during an inpatient admission. The first bone scan was conducted by a medical imaging practice attached to the hospital. The hospital conducted the second bone scan. The effective dose from the unnecessary nuclear medicine bone scan was approximately 3.2 mSv. The nuclear medicine staff at the hospital and the imaging practice were reminded to check for previous imaging so that repeat imaging is avoided.
Incident 19	**A patient underwent an unnecessarily repeated CT scan of the chest, abdomen and pelvis due to multiple medical staff errors.** A hospital patient was having three-monthly CT scans for monitoring of metastatic colon cancer. The medical imaging department received faxed request for a CT scan of the chest, abdomen and pelvis. This scan was subsequently booked and performed as requested. The original request was then sent to the medical imaging department approximately two weeks later and this request was used to book another CT scan. The referring unit didn't advise the medical imaging department that the original request had previously been faxed to the department and the radiographer involved didn't check for previous scans. In addition, the radiologist didn't check for previous imaging at the time of protocolling. The effective dose from the repeated CT scan was approximately 6.4 mSv. The radiologist and radiographer involved were reminded to check for previous imaging before performing scans. The reception checklist for CT referrals was modified to include a check for whether the same scan had been carried out in the previous eight weeks. If so, the request would need to be shown to a radiology registrar or consultant for review.
Incident 20	**A patient underwent a CT scan without contrast when contrast was required due to radiographer error.** A hospital patient was to undergo a CT scan of chest, abdomen and pelvis with contrast. The patient was prepared for contrast administration, but a non-contrast scan was conducted. The error was immediately identified and the scan was repeated with contrast. The effective dose from the non-contrast CT scan was approximately 4 mSv. The radiographer involved was reminded to be vigilant when selecting parameters for CT scans before examinations.

Incident 21	**A patient underwent a CT scan without contrast when contrast was required due to radiographer error.** A hospital patient was scheduled to undergo a CT scan of the abdomen and pelvis with contrast. At the time of the scan, the injector was incorrectly loaded with saline because the saline and contrast medium preloaded syringes were mixed up. The effective dose from the CT scan without contrast was approximately 5.4 mSv. A directive was sent to all radiology staff at the hospital stating that preloaded unused syringes from an open packet were to be discarded immediately rather than being placed back in the warmer for future use.
Incident 22	**A patient underwent an unnecessarily repeated injection of a radiopharmaceutical due to extravasation of the radiopharmaceutical.** A patient was booked for a nuclear bone scan. 742 MBq ^{99m}Tc HDP was injected into the left cubital fossa and was largely extravasated due to vein collapse. An additional 500 MBq ^{99m}Tc HDP was injected into the right cubital fossa to perform the scan. The effective dose from the extravasation in the left cubital fossa was less than 1 mSv. No further action was necessary.
Incident 23	**A patient underwent an unnecessarily repeated radiotherapy planning 4DCT scan series of the chest.** A hospital patient underwent an unnecessarily repeated radiotherapy planning four-dimensional CT (4DCT) scan series of the chest. A 4DCT scan series consists of about 10 repeated CT scans taken over the same scanning range to provide a number of views throughout the breathing cycle. The number of reconstructed slices in the scan exceeded the allowed limit of the treatment planning system. The scan was subsequently repeated with a smaller scanning range. The effective dose from the unnecessary scan series was approximately 90 mSv. A step requiring radiographers to confirm the number of images is less than that accepted by the 4DCT reconstruction software has been introduced. Radiology staff at the hospital were made aware of the issue of compatibility of reformatted image datasets with the 4DCT reconstruction software.
Incident 24	**A patient underwent unnecessarily repeated thoracic and lumbar spine X-rays due to referring physician error.** A patient was booked in at a medical imaging practice for thoracic and lumbar spine X-rays. The patient was asked if they had had X-rays recently and they indicated that they had not. The X-rays were performed as requested. It was later determined that the patient had in fact had thoracic and lumbar spine X-rays two weeks previously but had gone back to the doctor in the intervening period and received a second request from the doctor for the same study. Neither the doctor nor the patient remembered that X-rays had already been performed. The effective dose from these unnecessary procedures was approximately 1.2 mSv. No further action was necessary.
Incident 25	**A patient underwent an unnecessarily repeated CT scan due to extravasation of the contrast medium.** A hospital inpatient was scheduled for a CT scan of the abdomen and pelvis. The patient arrived from the ward with an IV line in situ running Hartmann's solution. In preparation for IV administration of contrast, the connection to the Hartmann's solution was closed and the line for contrast was connected to the second bung of the existing tubing. When contrast was injected under pressure, the closure into the Hartmann's solution wasn't adequate and the contrast went up the tubing rather than into the patient. The CT imaging was acquired without IV contrast enhancement, requiring a repeat scan with contrast injection. The effective dose from the first CT scan was approximately 7 mSv. No further action was necessary.
Incident 26	**A patient underwent an unnecessarily repeated CT scan of the abdomen and pelvis due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the abdomen and pelvis using the same referral, with approximately nine hours between scans. The effective dose from the repeated scan was approximately 19 mSv. The incident was discussed with the staff members involved who were reminded of the importance of doublechecking previous imaging.

Incident 27	**A patient underwent an unnecessarily repeated CT scan of the brain due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the brain. Pre-scan checks for prior scan requests weren't carried out. When the scan protocol was altered to include a contrast phase, the electronic RIS alerted the radiographer to a duplicate scan and the radiographer aborted the remainder of the scan. The effective dose from the unnecessarily repeated CT scan was approximately 2 mSv. A reminder was sent to all radiology staff to check patient histories before carrying out medical imaging procedures.
Incident 28	**A patient underwent an unnecessarily repeated CT perfusion scan of the brain due to radiographer error.** A hospital patient required a repeat CT perfusion scan of brain. A CT perfusion brain scan typically takes about 45 seconds to complete. Part way through the perfusion scan the radiographer became distracted by a conversation about the patient under investigation and prematurely stopped the scan after 25 seconds, mistakenly believing that the CT scan currently being performed was a contrast timing scan for the next scheduled scan on this patient (CT scan of the circle of Willis). The effective dose from the uncompleted CT perfusion exam was approximately 4.2 mSv. The radiographer involved was counselled about the incident.
Incident 29	**A patient underwent an unnecessarily repeated CT scan due to failure of delivery of the contrast medium.** A hospital patient underwent a CT enterography scan. A cannula was inserted and was confirmed as being patent. Contrast, however, wasn't seen on the acquired scan. The radiographer examined the cannula site and noted that the contrast tubing had become disconnected from the cannula. The effective dose from the CT scan was approximately 4 mSv. Staff members were reminded to check the connection of tubing to cannulas.
Incident 30	**A patient underwent an unnecessarily repeated CT scan of the brain due to saline and contrast syringes being switched.** A hospital patient was scheduled to undergo a CT scan of the brain (circle of Willis) with IV contrast. At the time of the scan, the radiology nurse incorrectly loaded the injector and the saline and contrast syringes were switched. The subsequent CT scan lacked sufficient contrast enhancement and the procedure had to be repeated. The effective dose from the scan was approximately 3.9 mSv. The nurse involved received counselling from the radiology nurse unit manager.
Incident 31	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A patient at a medical imaging practice was booked for two separate appointments: a CT coronary angiogram (CTCA); and a nuclear medicine bone scan and a CT scan of the chest, abdomen and pelvis (CAP) one week later. When the patient presented for the CTCA the radiographer noticed the referral for the CAP and decided to complete both scans in the one examination, after consultation with the reporting radiologist. When the patient then attended for the bone scan a week later, the NMT noted that the referral indicated that the patient also needed a CT CAP scan. This was brought to the attention of the CT radiographer on the day. The radiographer checked the RIS for previous scans and noted the header 'CT coronary angiogram' and assumed that only a CTCA had been performed. The radiographer went on to complete the CT CAP scan. The effective dose from the second CT CAP scan was approximately 4.7 mSv. The first radiographer was reminded to add clear notations to the RIS to alert others of any changes made to imaging. The second radiographer was reminded to check information on the RIS thoroughly.

Incident 32	**A patient underwent an unnecessarily repeated PET scan due to inadequate connection of the radiopharmaceutical injection line.** A hospital patient presented for a PET/CT scan. An activity of 305 MBq ^{18}FFDG activity was drawn up and injected. After the injection, staff discovered that the administration tubing and saline bag had not been turned on correctly. The NMT didn't follow standard hospital protocol for establishing the patency of the injection line before commencing the injection. The on-duty radiologist/nuclear medicine physician deemed the PET scan as nondiagnostic. It was estimated that approximately only 180 MBq ^{18}FFDG was administered. The effective dose from the PET component was approximately 3.4 mSv. The NMT was counselled by the chief NMT about this incident.
Incident 33	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A hospital patient underwent an unnecessarily repeated CT scan of the thoracic aorta. The patient presented to an ED a week before the scheduled scan and underwent the scan. The patient then received the same scan a week later, as originally booked. The radiographer noted the prior imaging but didn't query whether the repeat scan was necessary. The effective dose from the repeat scan was approximately 6 mSv. Radiology staff were reminded to query the necessity of duplicate examinations where they arise.
Incident 34	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A hospital patient presented to the radiology department for a CT angiography scan of the circle of Willis, arch to vertex. Following the injection of the contrast, the CT scan was initiated late due to the scan button not being fully depressed on the first attempt. Due to the delay in the scan initiation, the contrast in the images was suboptimal. The radiology registrar the radiographers consulted at the time of the incident reviewed the images and instructed the radiographers to repeat the scan. The effective dose from the first scan was approximately 6.2 mSv. The radiographer involved received counselling from senior staff.
Incident 35	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A paediatric patient underwent unnecessary anterior–posterior X-rays of the legs. The patient attended the outpatient clinic after the imaging of the legs. The clinician then requested X-ray imaging of the ankle and foot to be completed the same day. When the patient returned to medical imaging, reception registered the previous examination (imaging of the legs) instead of the requested X-ray of ankle and feet. The radiographer performing the examination completed procedure matching with the request that was registered (imaging of the legs) and checked previous imaging but didn't note that the previous imaging was completed earlier that day. The effective dose from the repeated imaging was approximately 0.01 mSv. Staff members were reminded to complete registration and preimaging checks correctly.
Incident 36	**A patient underwent an unnecessarily repeated CT scan due to an error in placement of fiducial markers.** A hospital patient presented for a CT scan of the brain for a preoperative scan using fiducial markers to facilitate the planned surgery. Following the scan, a second request was submitted to repeat the scan because the fiducial markers weren't placed correctly. The neurosurgery team is responsible for placing fiducial markers. The radiology registrar discussed the request with the neurosurgery registrar, who advised that the neurosurgery resident had applied an incorrect number of fiducials and had not confirmed fiducial placement with the neurosurgery registrar before the scan. The effective dose from the first scan was approximately 2.8 mSv. The neurosurgery resident involved received counselling from the neurosurgery registrar.

Incident 37	**A patient underwent an unnecessarily repeated PET/CT scan due to a syringe disconnecting under pressure in the PET stage of the scan.** A hospital patient was booked for a PET/CT scan. The CT component of the scan was carried out first. The PET radiopharmaceutical was then administered by an automatic injector. While under pressure, however, the syringe line disconnected from the IV line. The dose wasn't administered to the patient but collected in a tray under the syringe. The NMT didn't notice the leakage. During the PET component it was observed that the patient had not been administered with the PET radiopharmaceutical. The original failed administration resulted in an unnecessary CT being performed. The effective dose from the first CT scan was approximately 9 mSv. The NMT involved was reminded to ensure the patency of radiopharmaceutical injection lines.
Incident 38	**A patient underwent an unnecessarily repeated ^{18}F-FDG scan and CT scan due to a syringe disconnecting during the ^{18}F-FDG scan.** A hospital patient presented for a whole-body ^{18}F-FDG scan followed by a CT attenuation correction scan. An NMT connected the patient to the FDG line but didn't check the line was connected correctly. As the injector pushed the FDG into the line, some of the FDG leaked out onto the floor; the NMT didn't notice this leakage. The patient received an exposure from the FDG during uptake and then had the CT attenuation correction scan. The entire procedure had to be repeated. The effective dose from the first FDG administration and CT scan was approximately 1.6 mSv. The chief NMT counselled the NMT involved to ensure the patency of radiopharmaceutical injection lines.
Incident 39	**A patient underwent an unnecessarily repeated CT scan due to premature injection of a PET radiopharmaceutical.** A hospital patient was scheduled for a PET/CT scan. The radiopharmaceutical was injected an hour later than intended because the NMT transcribed the time of injection of the ^{19}FFDG for the PET scan incorrectly. The radiographer then carried out the CT scan, assuming that the ^{19}FFDG was administered at the correct time. The reporting physician reviewed the images and decided it was necessary to repeat the CT scan at least 90 minutes after administering the ^{19}FFDG to allow sufficient uptake. The effective dose from the first CT scan was approximately 6.2 mSv. The NMT involved was reminded to be careful to ensure radiopharmaceuticals are injected at the right time.
Incident 40	**A patient underwent an unnecessarily nuclear medicine bone scan due to nuclear medicine technologist error.** A hospital patient underwent an unnecessarily repeated nuclear medicine bone scan. Both nuclear medicine examinations were performed using the same request card. The maladministration was due to the nuclear medicine department receiving a faxed copy of the referral slip with the first nuclear medicine bone scan then being carried out. Eleven days later, the department received the original referral card and the patient was booked for and underwent the second, unnecessary, nuclear medicine bone scan. The NMT involved didn't review previous scans to determine whether the current scan was necessary. The effective dose from the repeated scan was approximately 3.7 mSv. The NMT involved was reminded to check for previous imaging before performing scans.
Incident 41	**A patient underwent a repeated injection of radiopharmaceutical due to extravasation on the first attempt.** A hospital patient was referred for a stress/rest myocardial scan. The NMT checked the IV cannula, flushed it with 20 mL of saline and deemed it viable. There was no sign of extravasation during injection. The patient was injected with 362 MBq of ^{99m}Tcsestamibi. The NMT noticed extravasation when the patient was placed under the gamma camera for imaging and cardiac activity wasn't visible. The NMT completed a second cannulation, and a dose of 323 MBq of ^{99m}Tcsestamibi was injected. Scanning proceeded and a diagnostic result was achieved. The effective dose from the first administration of the radiopharmaceutical was less than approximately 2 mSv. No further action was necessary.

Incident 42	**A patient underwent an unnecessarily repeated CT scan due to radiographer error.** A patient had a CT scan of the lumbar and sacral vertebrae twice. The patient visited the medical imaging practice with two requests. One request was for a CT scan of the lumbar and sacral vertebrae and a second request was for an ultrasound and multiple X-rays including plain X-rays of the lumbar and sacral vertebrae. The CT scan of the lumbar and sacral vertebrae and the X-rays were completed on the day of presentation and the ultrasound was booked for a future date that suited the patient (in three months' time). The ultrasound scan was completed on the future date, but the patient was also inadvertently booked for a CT scan of the lumbar and sacral vertebrae, due to the referral note being misread. The ultrasonographer took the patient to have the CT scan when the ultrasound scan was completed. The estimated effective dose from the second CT scan of the lumbar and sacral vertebrae was approximately 20 mSv. The radiographer involved was reminded to check referrals thoroughly and to check for prior imaging.
Incident 43	**A patient underwent a repeated injection of radiopharmaceutical due to failure of adenosine injection.** A patient was referred for a nuclear medicine myocardial perfusion stress test. The adenosine injection was loaded into the automatic infusion pump and the attending nuclear medicine physician started the infusion. After four minutes the stress dose of 900 MBq ^{99m}Tcsestamibi was injected. It was then realised that the infusion pump had not delivered any of the adenosine medication. The patient had to be rebooked for a follow-up repeat appointment. The effective dose to the patient from the first radiopharmaceutical administration was approximately 6.2 mSv. Staff members involved were reminded to ensure the patency of adenosine injection pathways before injecting radiopharmaceuticals.
Incident 44	**A patient underwent an unnecessarily repeated acquisition of a quad-phase liver CT scan due to radiographer error.** The scanned volume for one acquisition of a quad-phase liver CT scan on a hospital patient was performed in the wrong direction by a trainee radiographer. The unintended acquisition was taken from just superior of the lungs to the tip of the head. The effective dose from the unintended acquisition was approximately 11 mSv. Additional training regarding the visual review of scan range was provided to the radiographer involved and additional emphasis on the importance of visually confirming scan ranges would be included in future training of radiographers.
Incident 45	**A patient underwent an unnecessarily repeated PET/CT scan due to extravasation of a PET radiopharmaceutical.** A hospital patient was scheduled for a PET/CT scan. A cannula was inserted into the patient and a saline flush and 30 mL of ^{18}FFDG were administered via an automated injector. Although it was clear that not all of the ^{18}FFDG was administered, the NMT assumed that enough ^{18}FFDG had been administered to acquire a diagnostic PET/CT scan. It then became clear that the entire dose had extravasated rendering the scan non-diagnostic. The effective dose from the non-diagnostic scan was approximately 5.1 mSv. NMTs were told to check IV injection sites and dose administrations thoroughly.
Incident 46	**A patient underwent an unnecessarily repeated CT phase of a PET/CT scan due to unsuccessful injection of a PET radiopharmaceutical.** A patient attended a medical imaging practice for a PET/CT scan. After a seemingly normal ^{18}FFDG infusion, a CT scan for attenuation correction was carried out. In the meantime, the NMT determined that no PET data was being acquired. Upon investigation there appeared no evidence of spill or extravasation. The 'hot waste' bin, however, had higher than expected radioactivity in it. It appears that the radiopharmaceutical wasn't administered correctly. From the measured dose rate around the hot waste bin, it seems likely that the whole dose was discarded into the bin. After ensuring correct administration of FDG, the patient required a repeat attenuation correction CT. The effective dose to the patient from the initial CT scan was approximately 7 mSv. NMTs were reminded to check radiopharmaceutical delivery sets for any possible structural faults.

Unnecessary, unrequested or unapproved medical procedures

Incident 47	**A patient underwent an unnecessary CT thoracic spine scan due to radiographer error.** A hospital patient underwent an unnecessary CT scan of the thoracic spine. The written request was for a CT scan of the thoracolumbar spine. The radiologist electronically protocolled a CT scan of the lumbar spine because this scan would have yielded the required information. The radiographer performed a CT scan of the thoracolumbar spine based on the written request details. The effective dose from the unnecessary thoracic spine section of the scan was approximately 6 mSv. The radiographer involved was reminded of the importance of checking electronic records for the correct protocolling.
Incident 48	**A patient underwent two unnecessary X-rays of the chest due to radiographer error.** A paediatric patient underwent two unnecessary anterior–posterior X-rays of the chest. The patient, who had respiratory issues, was brought to the medical imaging department with their mother from the ED by a patient services assistant. The patient services assistant nor the radiographer carried out the patient identification process. The request was for a 12-year-old patient who also had respiratory issues. The error was discovered when the patient's doctor rang the radiographer to query why the patient had been imaged. The effective dose from the unnecessary chest X-rays was less than 0.02 mSv. The radiographer involved was reminded of the importance of completing patient identification and procedure matching correctly. All medical imaging technologists were reminded to complete patient identification and procedure matching correctly at the next imaging staff meeting.
Incident 49	**A patient underwent an unnecessary CT chest scan due to multiple process failures.** A hospital patient had a CT scan of the chest about five months before it was requested to have been performed. This error was due to multiple failures in process, particularly relating to review of the request at several stages. The effective dose from the unnecessary CT scan was approximately 6 mSv. Radiology staff involved in this incident were reminded of the importance of ensuring scans are carried out on the date requested and that requests need to be read carefully.
Incident 50	**A patient underwent an unnecessary CT chest scan due to clerical error.** A hospital patient underwent an unnecessary CT scan of the chest. The scan was originally requested to be performed in mid-2020. The scan was erroneously booked in for late 2019 in the electronic booking system and the scan proceeded when the patient arrived on the day. The effective dose from the unnecessary CT scan of the chest was approximately 6 mSv. Clerical staff were reminded to exercise care when entering patient and procedure details in the electronic booking system.
Incident 51	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A CT scan of the chest was requested for a hospital inpatient. The referral indicated that the scan was to investigate nodules, with a repeat scan in about one and a half months to investigate any changes in the interval. However, the scan was repeated after about two weeks and had to be carried out again after the interval indicated in the referral. The effective dose from the unnecessary scan was approximately 1.7 mSv. The radiographer involved was reminded to read clinical notes on imaging request slips carefully.
Incident 52	**A patient underwent an unnecessary CT scan of the brain due to radiographer and clerical staff error.** A patient presented to a medical imaging practice for a CT scan of the chest, abdomen and pelvis and nuclear medicine bone scan. The patient was also incorrectly booked by clerical staff for a CT scan of the head with contrast. The radiographer then didn't use correct patient and procedure ID processes – the patient and procedure details were obtained from the booking form rather than from the actual referral form. The effective dose from the brain scan was approximately 3.0 mSv. The radiographer involved was reminded of the practice's patient and procedure identification processes. Clerical staff members were reminded to exercise care when entering patient and procedure details on imaging requests.

Incident 53	**A patient underwent an unnecessary radiotherapy planning CT scan of the liver due to radiographer error.** A hospital patient underwent an unnecessary radiotherapy planning CT scan of the liver. The radiographer pressed the wrong button to initiate contrast administration and so the monitoring slices that are acquired to determine contrast timing were missed due to the extra time taken to ensure contrast administration had been initiated. Three post-contrast scans were then undertaken to ensure the required phase was captured because there were clinical reasons not to administer further contrast. The first and second scans displayed sufficient contrast. The estimated effective dose from the third, unnecessary scan was 9 mSv. Use of the 'pause scan' button was explained to radiographers.
Incident 54	**A patient underwent an unnecessary CT scan of the chest with inspiration and expiration imaging due to radiographer error.** A paediatric patient underwent an unnecessary CT scan of the chest with inspiration and expiration imaging. The initial imaging request from the patients' treating physicians was scheduled for a certain date. Before that date the treating team contacted the medical imaging department to ask that the scheduled CT be postponed until after the patient's next admission. The medical imaging staff made a note on the patient's file and assumed that the treating team would notify the patient's family. The patient presented to the medical imaging department on the date on the initial imaging request and the study was registered and performed based on this request. The effective dose from the unnecessary CT scan was approximately 0.4 mSv. The chief medical imaging technologist at the hospital counselled the radiographers involved.
Incident 55	**A patient underwent an unnecessary CT pulmonary angiogram scan due to referring physician error.** A CT pulmonary angiogram was requested for an ED patient to query a pulmonary embolus. Subsequently the referring ED physician reconsidered the case and sent a request for a CT angiogram and cancelled the original request in the ED electronic booking system. The original request had already been actioned, however, with the scan booked into the radiology electronic booking system. The effective dose from the unnecessary scan was 10 mSv. An email was sent to all ED physicians stating that changes to orders for medical imaging had to registered directly with the radiology electronic booking system. The 'delete' functionality was removed from the ED electronic booking system to avoid a repeat of this issue.
Incident 56	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A patient presented to a medical imaging practice for a CT scan of the abdomen and pelvis. The scan was to investigate the possibility of a renal fossa haematoma following a left nephrectomy. In addition to the indicated scan of the abdomen and pelvis, the radiographer scanned the chest region. This was because of human error. The effective dose from the CT scan of the chest was approximately 2.2 mSv. The radiographer involved was reminded to use correct patient and procedure identification procedures.
Incident 57	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A hospital patient was requested to have a follow-up CT scan of the abdomen to assess progress of a medical condition. A CT scan of the chest, abdomen and pelvis was carried out about nine months previously. The radiographer for the follow-up scan carried out a CT scan of the chest, abdomen and pelvis in error. The effective dose from the unnecessary CT scan was approximately 8.5 mSv. The radiographer involved was reminded to pay attention to detail and to read request slips carefully.

Incident 58	**A patient underwent an unnecessary CT scan of the brain and cervical spine due to a failure in communication between electronic records management systems.** A hospital patient was referred for a CT scan of the brain and cervical spine and a plain chest X-ray by the ED consultant physician in charge. After the ED registrar re-assessed the patient, the imaging was considered unnecessary. The registrar cancelled the CT scan of the brain and cervical spine in the electronic medical records system (EMRS) because it had not been marked as scheduled in the RIS. Because the request for the chest X-ray in EMRS was marked as scheduled in the RIS, the registrar called the medical imaging department to cancel the booking. The registrar discovered that the cancellation of the CT scan of the brain and cervical spine on the EMRS system didn't flow through to the RIS and the scan was conducted unnecessarily. The effective dose from the unnecessary CT scan was approximately 4 mSv. ED physicians were reminded that all medical imaging cancellation requests must be made by phone call to the relevant medical imaging technologist.
Incident 59	**A patient underwent an unnecessary CT scan of the chest due to radiographer error.** A hospital patient underwent a CT scan of the abdomen and pelvis. The patient also underwent an unnecessary CT scan of the chest. The patient had received a CT chest scan previously. The request was for a CT scan of the abdomen and pelvis and a reformat of the previous chest scan. The radiographer interpreted the request for reformat of prior chest imaging as a request for a scan. The effective dose from the CT scan of the chest was approximately 6 mSv. Radiographers at the hospital were reminded to check prior imaging and the RIS to confirm the correct anatomical site(s) before scanning patients.
Incident 60	**A patient underwent an unnecessary radiation therapy planning CT due to the scan not being cancelled as required.** A hospital patient had an appointment for a radiation therapy planning CT scan before radiotherapy. Subsequently, the decision was made that the best option for the patient in the existing circumstances was surgery. The radiation oncologist didn't cancel the radiation therapy planning CT, and the patient proceeded to have the scan despite it no longer being required. The effective dose to the patient from the CT scan was approximately 4 mSv. The radiation oncologist was reminded of the importance of cancelling bookings for scans no longer required.
Incident 61	**A patient underwent an unnecessary radiation therapy planning CT scan of the head due to the treatment planning system being prescribed incorrectly on the booking form.** A hospital patient underwent an unnecessary CT scan of the head. The patient presented for a radiotherapy treatment planning CT scan of the head using an incorrect treatment planning system. After this scan, staff noticed that the treatment planning system had been prescribed incorrectly on the booking form. The patient was subsequently rescanned using the correct treatment planning system. The effective dose from the repeated components of the scan was approximately 1 mSv. The oncologist was reminded to ensure the correct information was indicated on the booking form.

Wrong patient underwent a medical procedure

Incident 62	**The wrong patient underwent a nuclear medicine bone scan due to referring physician error.** A hospital patient underwent a nuclear medicine bone scan with 700 MBq ^{99m}Tc-HDP being injected. The patient's identification was matched to the request as per protocol and the patient confirmed that they had new back pain as per referral clinical indication. Two minutes into the procedure, the accompanying nurse stated that they were unaware of the clinical question under investigation in this patient (discitis/osteomyelitis), and a closer examination of the referral was made. After calling the referring physician, it was confirmed that the physician had selected the incorrect patient on the ordering system when making the referral. The effective dose from the unnecessary radiopharmaceutical administration was approximately 3.8 mSv. The referring physician involved was reminded to take care when ordering multiple tests for different patients.

Incident 63	**The wrong patient underwent a CT scan due to clerical error.** The wrong patient underwent a CT scan of the chest, abdomen and pelvis because clerical staff entered the incorrect patient details from the referral onto the RIS. The scanned referral was for a patient with the same first name and date of birth as the person incorrectly scanned. The radiographer checked the three patient identifiers against the electronic RIS system, not the scanned paper document. The effective dose from the CT scan was approximately 26 mSv. The radiographer involved was reminded to check all pertinent patient information before carrying out imaging procedures.
Incident 64	**The wrong patient underwent a CTPA scan due to referring physician error.** The wrong hospital patient underwent a CTPA to query a pulmonary embolism because the treating physician placed the wrong patient sticker on the referral. The (incorrect) patient who was scanned had clinical symptoms consistent with a pulmonary embolism. The radiographer correctly carried out patient identification. The effective dose to the patient from the CTPA scan was approximately 13 mSv. The referring practitioner involved was reminded to be careful when placing patients' names on referrals.
Incident 65	**The wrong patient underwent a CT scan of the abdomen and pelvis due to referring physician error.** A patient was admitted to an ED with chest pain. The patient was referred for a CT scan of the abdomen and pelvis. The referring physician placed the wrong patient details on the request slip. The effective dose from the CT scan was approximately 5.8 mSv. The referring practitioner involved was reminded to be careful when placing patients' names on referrals.
Incident 66	**The wrong patient underwent a CT coronary angiogram due to an error in filing of imaging reports by medical staff.** An incorrect hospital patient underwent a follow-up CT coronary angiogram imaging of lung nodules as requested by the lung nodule clinic of the hospital. On reviewing the angiogram, the reporting radiologist indicated that no nodules were evident. The request for the follow-up imaging was generated based on the CT coronary angiogram that another patient had previously undergone. This incident was due to the report for the first angiogram being filed under the records of the first (incorrect) patient when the record was being transferred manually from one radiological information system to another. The dose from the unnecessary CT coronary angiogram was approximately 9.2 mSv. A meeting of a range of senior clinical staff at the hospital recommended the implementation of system changes to minimise the possibility of such incidents in the future. The changes were subsequently implemented.
Incident 67	**The wrong patient underwent a CT scan of the abdomen and pelvis due to referring physician error.** A patient at a medical imaging practice received an unnecessary CT scan of the abdomen and pelvis. This was due to the patient's details being attached to the wrong referral in the ED of the hospital to which the imaging practice was attached. The effective dose from this unnecessary CT scan was approximately 6.5 mSv. All ED physicians at the practice were reminded to be careful when placing patients' names on referrals.
Incident 68	**The wrong patient underwent a CT angiogram due to radiographer error.** A hospital patient underwent an unnecessary CT angiogram because patient identification wasn't properly completed by the radiographer, who thought that this identification had been carried out by other staff members. The effective dose from this unnecessary CT angiogram was approximately 6 mSv. Using correct patient and procedure identification protocols was stressed to radiographers at the hospital.

Incident 69	**The wrong patient underwent a nuclear medicine bone scan due to referring physician error.** A nuclear medicine bone scan with 790 MBq of ^{99m}TcHDP was requested for a hospital inpatient. The imaging request was assigned to the wrong patient, who was in the bed adjacent to the intended patient. The clinical details were accurately and thoroughly filled out for the intended patient but had the wrong patient label attached to it. The fact that it was the incorrect patient was discovered after the ^{99m}TcHDP was injected when the NMT was reading the clinical notes and conferring with the patient before returning the patient to the ward. It became apparent that the clinical details on the request form didn't exactly correspond with the patient's symptoms and medical history. The effective dose to the patient from the scan was approximately 3.9 mSv. The referring physician involved was reminded to be careful when placing patients' names on referrals. The NMT was reminded to check all pertinent patient information and to read clinical notes on imaging request slips carefully before carrying out imaging procedures.
Incident 70	**The wrong patient underwent a CT scan of the abdomen and pelvis due to radiographer error.** A hospital patient underwent a CT scan of the abdomen and pelvis with contrast that was intended for another patient. The radiographer involved used closed questions in identifying the patient. The effective dose from the CT scan was approximately 6.5 mSv. The radiographer involved was reminded to use open questions when identifying patients.
Incident 71	**The wrong patient underwent a CT scan of the brain due to referring physician error.** A hospital patient underwent an unnecessary CT scan of the brain. The ED physician had requested a CT angiogram of the brain, cervical spine and carotid for the incorrect patient. The radiographer didn't picked this up during normal time-out procedures due to the patient having an altered conscious state. An ED physician interrupted the scan after only the brain scan had been performed to inform the radiographer that the request was for the incorrect patient. The effective dose from the brain scan was approximately 2 mSv. The referring physician involved was reminded to be careful when placing patients' names on referrals.
Incident 72	**The wrong patient underwent a CT scan of the cervical and thoracic spine due to radiographer error.** A hospital patient underwent a CT scan of the cervical and thoracic spine with contrast that was intended for another patient. The first patient required a CT scan of the neck, chest, abdomen and pelvis with contrast. The patient had a referral with the correct patient label affixed. Patients for CT also fill out a pre-examination questionnaire if they are to have IV contrast administration. Two patients with the same first name had their referrals and questionnaires incorrectly paired. A time-out procedure was performed using the questionnaire so the patient underwent the wrong scan. The effective dose from the wrong scan was approximately 21 mSv. The radiographer involved was reminded that time-out procedures are to only be performed using referrals.
Incident 73	**The wrong patient underwent a CT scan of the cervical spine and left shoulder due to referring physician error.** A patient underwent a CT scan of the cervical spine and left shoulder intended for another patient. Patient identification was checked by the radiographer and the clinical notes on the referral aligned with the patient's history of a recent fall. On the return of the patient to the ward, the nurse caring for the patient realised that the incorrect patient had been scanned and it was determined that the incorrect patient label was placed on the referral by the referring physician. The effective dose from the CT scan was approximately 8.4 mSv. The referring physician involved was reminded to be careful when placing patients' names on referrals.

Patient underwent incorrect medical procedure

Incident 74	**A patient underwent a CT scan using the wrong protocol due to radiographer error.** A patient at a medical imaging practice was booked for a preoperative protocol CT scan of the shoulder with certain specifications. The radiographer didn't read the request slip thoroughly and carried out a CT scan of the shoulder using the standard protocol. The effective dose from the incorrect scan was approximately 1.8 mSv. The radiographer was counselled to read request slips carefully in future.
Incident 75	**A patient underwent a CT scan using the wrong protocol due to radiology registrar error.** A referring physician and radiology registrar were discussing two referral options for a hospital patient – aortic CT angiography and CTPA. They decided that a CTPA scan was required. When protocolling the case, however, the radiology registrar mistakenly protocolled the aortic CT angiography instead of the CTPA scan. The referring physician identified the error on receiving the images. The effective dose from the unnecessary aortic CT angiography was approximately 13 mSv. The radiology registrar involved was reminded to exercise care when protocolling studies.
Incident 76	**A patient underwent a CT scan using the wrong protocol due to radiologist and radiographer error.** A hospital patient presented to the radiology department of a hospital for a fluoroscopy-guided defaecating proctogram. The radiology registrars and radiographers involved incorrectly performed the imaging using acquisition mode instead of fluoroscopy mode. The use of acquisition mode greatly increased the radiation exposure to the patients. The additional effective dose from using acquisition mode was approximately 27 mSv. The radiology registrars involved received counselling from the deputy director of imaging. The radiographers involved received counselling from the chief radiographer. An email was sent to all radiologists, radiology registrars and radiographers to advise them of the incident and to remind them that defaecating proctogram procedures should routinely be performed using fluoroscopy mode and not acquisition mode.
Incident 77	**A patient underwent a CT scan using the wrong protocol due to radiologist and radiographer error.** A hospital patient presented to the radiology department of a hospital for a fluoroscopy-guided defaecating proctogram. The radiology registrars and radiographers involved incorrectly performed the imaging using acquisition mode instead of fluoroscopy mode. The use of acquisition mode greatly increased the radiation exposure to the patients. The additional effective dose from using acquisition mode was approximately 25 mSv. The radiology registrars involved received counselling from the deputy director of imaging. The radiographers involved received counselling from the chief radiographer. An email was sent to all radiologists, radiology registrars and radiographers to advise them of the incident and to remind them that defaecating proctogram procedures should routinely be performed using fluoroscopy mode and not acquisition mode.
Incident 78	**A paediatric patient underwent unnecessary imaging of the spine due to referring physician error.** A paediatric hospital patient underwent unnecessary anterior–posterior and lateral imaging of the full spine. The patient presented to the medical imaging department with a request for imaging of the full spine. The imaging was completed and the patient returned to the clinic. The clinician advised the patient that the imaging was incorrect and sent the patient back with a new referral that requested imaging of the full spine in brace. The referring physician had requested the initial study incorrectly. The effective dose from the unnecessary imaging was approximately 0.03 mSv. The referring physician was reminded of the importance of completing medical imaging requests correctly.

Incident 79	**A patient underwent a CT scan using the wrong protocol due to radiographer error.** A CT chest angiogram was requested for a patient in an ED. The radiographer made an error by scanning the wrong region. Another staff member had circled '?leak' in the request as the reason for the exam and this circle partly overlaid 'AVR', the requested scan. This caused the radiographer, who was distracted by other matters at the time, to mistake the request as one for EVAR – endovascular aneurism repair, requiring a CT abdominal angiogram protocol. The effective dose from the incorrect procedure was approximately 19 mSv. The radiographer performing the examination was reminded to pay attention to detail when carrying out medical imaging procedures.
Incident 80	**A patient underwent a CTPA scan using the wrong protocol due to referring physician error.** A CTPA was requested for an ED patient to query a pulmonary embolus. Subsequently the referring ED physician reconsidered the case and sent a request for a CT angiogram and cancelled the original request in the ED electronic booking system. The original request had already been actioned, with the scan booked into the radiology electronic booking system. The effective dose from the unnecessary CTPA was 10 mSv. The ED director sent an email to all ED physicians stating that the medical imaging department had to be contacted directly to cancel a request. After this email was sent, the 'delete' functionality was removed from the ED electronic booking system to avoid a repeat of this issue.
Incident 81	**A patient underwent a CT scan using the wrong protocol due to radiographer error.** A hospital patient underwent a noncontrast CT scan of the kidneys, ureters and bladder when the scan protocolled by the radiologist was a portal venous phase CT scan of the upper abdomen including the kidneys. The radiologist reviewed the noncontrast CT scan requested by the referring physician and deemed that there was no need to scan the pelvis. The radiographer involved only referred to the initial request by the referring physician before performing the scan. The effective dose from this unintended exposure was approximately 11 mSv. The radiography supervisor discussed this incident with the radiographer involved, who was reminded to confirm the correct protocol before scanning a patient.
Incident 82	**A patient underwent a CT chest scan using the wrong protocol due to radiology registrar error.** An ED patient underwent a CT examination of the chest that used a CT imaging protocol that wasn't the most optimised protocol based on the clinical condition under investigation. A routine chest imaging protocol was used instead of a CT gated chest protocol. The unnecessary ungated exposure was first identified by a senior radiologist at the time of reporting. The patient subsequently retuned to the ED and received a gated chest CT scan. The unnecessary exposure was due to an incorrect protocol being assigned by the radiology registrar. The scan was initially protocolled as a gated CT chest scan but changed by the registrar to be a CT scan of the chest, abdomen and pelvis, with the registrar failing to specify that the CT chest imaging was still to be in the gated mode. The effective dose from the first (ungated) CT scan was approximately 4.3 mSv. The radiation safety officer counselled the radiology registrar involved about the importance of assigning the correct protocol.

Patient underwent a medical procedure on the wrong anatomical region

Incident 83	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A patient at a medical imaging practice underwent a CT scan of the abdomen in error where a CT scan of the chest was requested. The radiographer involved was distracted by the presence and questions of a student radiographer at the time of positioning. The effective dose from the unnecessary scan was approximately 8.9 mSv. The radiographer involved was reminded to follow the practice's patient and procedure ID processes before starting examinations.

Incident 84	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient underwent a CT scan of the incorrect elbow. The clinical details weren't clear and the patient presentation made it difficult to realise the error. Pain was experienced in the right elbow and this elbow couldn't be extended but it was in fact the left elbow that needed to be imaged. The effective dose from the CT scan of the wrong elbow was approximately 30 mSv. Note that the elbow was placed on the chest for the scan due to the inability to extend above the head. Medical staff members at the hospital were educated about the quality of request information, in particular that imaging requests should contain accurate clinical information to reduce confusion and potential for imaging errors. Radiographers at the hospital were reminded of the importance of performing the time-out procedure to ensure that the correct procedure is performed.
Incident 85	**A patient underwent plain X-rays of the wrong leg due to radiographer error.** A paediatric hospital patient underwent plain X-rays of the right tibia/fibula when X-rays of the left leg were required. The patient presented to medical imaging for follow-up imaging three months after a fracture of the left leg. The radiographer completed patient identification correctly and asked the father and patient which leg required imaging. The father didn't know which leg had been fractured and the patient identified the right leg as being the leg that had the previous fracture. Although the radiographer had looked at the request before calling the patient, they didn't recheck to confirm before imaging and X-rayed the right leg. The effective dose from the X-rays of the wrong leg was less than 0.001 mSv. The radiographer involved was reminded to complete procedure matching correctly. A reminder to all medical imaging technologists to complete procedure matching correctly was given at the next staff meeting.
Incident 86	**A patient underwent a CT scan of the wrong anatomical region due to referring physician error.** A hospital patient required a second CT of the spine (thoracic/lumbar region) before a surgical intervention. The initial CT of the spine was performed only of the lumbar region (L1 level). The unnecessary L1 CT scan was due to the initial CT request from the neurosurgery department indicating the incorrect spinal region. The radiographer followed hospital procedures by correctly identifying the patient and procedure and conducting the CT scan according the CT request card. Following this scan, the neurosurgery registrar contacted the radiology department to request a repeat spinal CT exam be performed of the thoracic/lumbar region due to the incorrect region being initially requested. The effective dose from the L1 CT scan was approximately 20 mSv. The referring physician involved was reminded to request the correct region for procedures.
Incident 87	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient underwent a CT scan of the upper thoracic region when a CT scan of the lumbar region was required. In setting up scan details, the radiographer didn't modify the scan parameters and only modified the reconstruction parameters. The effective dose from the inappropriate scan region was approximately 6 mSv. The radiographer involved was reminded to be careful when entering parameters into CT scanners before examinations.
Incident 88	**A patient underwent a CT scan of the wrong anatomical region due to referring physician error.** An intubated hospital patient presented to the radiology department for a CT angiography scan of the right upper arm to assess for graft suitability over the right elbow site following a multi-trauma accident. The imaging request was made by the trauma and transplant unit in the intensive care unit after discussion with the plastic surgery unit, which requested the right upper arm to be imaged. The plastic surgery unit reviewed the images and found that the right upper arm wasn't within the field of view. The requesting physician entered the incorrect side on the imaging request form. The effective dose from the CT scan of the wrong arm was approximately 13 mSv. The referring physician involved was reminded to request the correct region for imaging procedures.

Incident 89	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient underwent an unnecessary second CT scan of the chest. The patient was booked for a CTPA followed by a CT scan of the abdomen and pelvis. The scan range for the abdomen and pelvis scan was incorrectly set to scan the patient's chest, resulting in the chest being scanned twice. The effective dose from the chest portion of the second CT scan was approximately 8 mSv. The radiographer involved was reminded that every scan range must be planned and checked.
Incident 90	**A patient underwent a CTPA scan of the wrong anatomical region due to radiographer error.** A patient at a medical imaging practice underwent a CTPA scan in which the wrong anatomical region was scanned. The estimated effective dose from the unnecessary scan was 11 mSv. The radiographer involved was reminded to be careful when entering parameters into CT scanners before examinations.
Incident 91	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient was required to undergo a CT scan of the abdomen and pelvis as part of an oncology staging scan but incorrectly underwent a CT scan of the chest due to radiographer error. The effective dose from the incorrect procedure was approximately 9 mSv. The radiographer involved was reminded to be vigilant when carrying out patient and procedure identification processes.
Incident 92	**A paediatric patient underwent a plain X-ray of the wrong anatomical region due to radiographer error.** A paediatric hospital patient underwent an unnecessary lateral X-ray of the right humerus. The patient underwent an anterior–posterior X-ray of the left humerus as requested by the orthopaedic clinician. In preparing for the lateral X-ray of the left humerus, the radiographer rotated the patient the wrong way and a lateral X-ray of the right humerus was performed instead. The orthopaedic clinician for the patient was contacted and advised the medical imaging department that the anterior–posterior image of the left humerus provided sufficient information and that the lateral X-ray wasn't required. The effective dose from the unnecessary lateral X-ray of the right humerus was less than 0.01 mSv. The radiographer was reminded to exercise care when carrying out medical imaging procedures and to be vigilant when carrying out patient and procedure identification procedures. Medical imaging technologists were reminded to ensure the correct anatomical area was imaged.
Incident 93	**A paediatric patient underwent a plain X-ray of the wrong anatomical region due to radiographer error.** A paediatric hospital patient presented to the medical imaging department for a left foot weight-bearing X-ray series. The weight-bearing X-ray series was incorrectly performed on the right foot. The radiographer involved didn't follow the correct time-out procedure to confirm correct patient, correct examination and correct anatomical site. The weight-bearing X-ray series was subsequently performed on the correct foot. The effective dose from the X-ray series on the wrong foot was approximately 0.001 mSv. The radiographer involved was reminded to use correct patient and procedure identification procedures at all times.
Incident 94	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient underwent a CT scan of the right elbow when a scan instead of the left elbow was requested. The radiographer scanned the patient's right elbow based on only verbal advice from the patient. Confirmation of the correct scan location on the RIS would have alerted the radiographer to the side for which the scan was requested. The effective dose from the CT scan of the wrong elbow was approximately 25 mSv. Radiographers at the hospital were reminded to check the RIS to confirm the correct anatomical site before scanning a patient.

Incident 95	**A patient underwent a CT scan of the wrong anatomical region due to radiographer error.** A hospital patient was incorrectly booked for a spinal CT scan when the patient was referred for a CT scan of their foot. The referral was ambiguous and poorly written, leading to confusion about the body part to be examined. The effective dose from the wrong CT scan was approximately 12.5 mSv. Radiographers were told to return inadequate requests to the referring physician. The correct process wasn't followed on this occasion regarding protocolling of CT examinations. Radiographers were told to ensure all CT scans are protocolled by a radiologist before being performed.
Incident 96	**A patient underwent a CT scan of a greater anatomical region than required due to radiographer error.** A hospital patient inadvertently underwent an aortofemoral runoff CT scan that extended beyond the protocolled region requested by the radiology registrar and as specified in the hospital's CT protocol manual. The standard protocol is to scan from coeliac axis to below the feet, whereas the patient was scanned from the lung apices to below the feet. The radiographers performing the scan didn't verify thoroughly the CT scan that had been protocolled by the radiology registrar. The radiology registrar noticed the error while reporting on the images. The effective dose from the unnecessarily scanned anatomy was approximately 1.5 mSv. The radiographers involved were counselled about the incident by the hospital's radiation safety officer.
Incident 97	**A paediatric patient underwent a plain X-ray of the wrong anatomical region due to radiographer error.** A paediatric hospital patient required an anterior–posterior X-ray of the hip and anterior–posterior and lateral X-ray of the right knee. The radiographer involved completed patient and procedure matching appropriately. The radiographer completed the anterior–posterior hip X-ray and then inadvertently completed the anterior–posterior and lateral imaging of the left knee. The radiographer identified the error before finalising the examination and completed the correct imaging on the right knee. The effective dose from the unnecessary X-ray was approximately 0.001 mSv. All radiographers at the hospital were reminded to ensure that they image the correct side during scans.
Incident 98	**A paediatric patient underwent a plain X-ray of the wrong anatomical region due to requesting physician error.** A paediatric patient underwent an unnecessary anterior–posterior and lateral X-ray examination. The patient presented with a request for an anterior–posterior and lateral examination of the C5–T2 vertebrae. The radiographer confirmed the scan range with the requesting rehabilitation physician. The patient's mother also thought this was the correct scan range. The orthopaedic physician contacted the medical imaging department the next day to notify that the whole spine should have been imaged and that the rehabilitation physician had requested the incorrect scan range. A new imaging request was submitted and the correct imaging was performed. The effective dose from the unnecessary X-ray examination was less than 0.1 mSv. The requesting rehabilitation physician was reminded to ensure that correct procedures are requested when ordering scans.

Patient underwent a medical procedure using the wrong modality

Incident 99	**A patient underwent a nuclear medicine hepatobiliary scan instead of an ultrasound hepatobiliary scan due to clerical and nuclear medicine technologist error.** A patient at a medical imaging practice was referred for a hepatobiliary ultrasound scan. The referral was read incorrectly and a hepatobiliary nuclear medicine scan using 204 MBq ^{99m}TcHIDA performed instead. The nuclear medicine scan was consistent with the clinical indications. The referring clinician notified the practice the following day on receiving the report. The ultrasound examination was performed the next day. The effective dose from the nuclear medicine scan was approximately 3.5 mSv. All staff members involved were made aware of the incident and were reminded to ensure that practice's guidelines for rigorous scrutiny of all referrals are observed.

Incident 100	**A patient underwent a stress and rest myocardial perfusion procedure using ^{99m}Tc-sestamibi instead of SPECT/CT due to clerical and nuclear medicine technologist error.** A patient presented to the nuclear medicine department of a hospital for a stress and rest myocardial perfusion procedure using SPECT/CT. The patient was referred by the vascular surgery department for an appointment with the cardiology department. The patient instead brought the referral to the nuclear medicine department, where an appointment was made for a ^{99m}Tcsestamibi stress and rest myocardial perfusion procedure. The bookings staff didn't follow the standard practice of having referrals for stress and rest myocardial perfusion procedures triaged by a senior medical staff member. The incorrect referral and the booking error weren't identified by the nuclear medicine staff members and the procedure was carried out. The nuclear medicine physician later confirmed the booking error and spoke with the patient and the cardiology department. The effective dose from the unnecessary injection of the radiopharmaceutical was approximately 1.7 mSv. The staff members involved received counselling from the chief NMT.

High patient dose during an interventional or fluoroscopic procedure

Incident 101	**A patient underwent an interventional cerebral procedure that resulted in a high radiation dose to the skin.** A patient underwent an interventional cerebral procedure. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 102	**A patient underwent two interventional cardiac catheter procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent two interventional cardiac catheter procedures on the same day. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the two procedures was approximately 10 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 103	**A patient underwent an embolisation of the inferior mesenteric/lumbar arteries that resulted in a high radiation dose to the skin.** An embolisation of the inferior mesenteric/lumbar arteries was performed on a hospital patient. During the procedure the surgeons had to access a number of blood vessels and encountered difficulty with some of them, which led to prolonged radiation exposure. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 11 Gy. The patient developed mild erythema. No further action was necessary.
Incident 104	**A patient underwent an endovascular aneurysm repair that resulted in a high radiation dose to the skin.** A hospital patient underwent an endovascular aneurysm repair under fluoroscopic guidance. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8.5 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 105	**A patient underwent a splenic artery aneurysm embolisation that resulted in a high radiation dose to the skin.** A hospital patient underwent a splenic artery aneurysm embolisation under fluoroscopic guidance. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.

Incident 106	**A patient underwent a coronary interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a coronary angiogram under fluoroscopic guidance and subsequent coronary angioplasty. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 107	**A patient underwent an interventional cardiac procedure that resulted in a high radiation dose to the skin.** A patient underwent an interventional cardiac procedure. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 108	**A patient underwent a fluoroscopic interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional procedure involving the introduction of bilateral internal jugular vein stents under fluoroscopic guidance. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7.6 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 109	**A patient underwent an interventional cardiac procedure that resulted in a high radiation dose to the skin.** A patient underwent an interventional cardiac procedure. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 9.4 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 110	**A patient underwent cerebral interventional procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent two cerebral interventional procedures. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 111	**A patient underwent a fenestrated endovascular aneurysm repair that resulted in a high radiation dose to the skin.** A hospital patient required a fenestrated endovascular aneurysm repair under fluoroscopic guidance. The procedure was extended due to difficult cannulation and complex anatomy. Throughout the procedure steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 112	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an interventional procedure. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 6 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.

Incident 113	**A patient underwent a hepatic angioplasty procedure that resulted in a high radiation dose to the skin.** A hospital patient required a complex bilateral iliac branch device insertion under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 114	**A patient underwent a supra renal stent graft repair that resulted in a high radiation dose to the skin.** A hospital patient required a supra renal stent graft repair under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8.4 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 115	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 10 Gy. The patient developed mild erythema. No further action was necessary.
Incident 116	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 117	**A patient underwent an endovascular aneurysm repair procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an endovascular aneurysm repair procedure under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 6.1 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 118	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 119	**A patient underwent an abdominal interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an abdominal interventional procedure under fluoroscopic guidance. Throughout the procedure, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 8 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.

Incident 120	**A patient underwent two cerebral interventional procedures that resulted in a high radiation dose to the skin.** A hospital patient underwent two cerebral interventional procedures under fluoroscopic guidance. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 9 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 121	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral interventional procedure under fluoroscopic guidance. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 122	**A patient underwent an aneurysm treatment interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an endovascular treatment of anterior communicating aneurysm interventional procedure under fluoroscopic guidance. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 7 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 123	**A patient underwent a cerebral interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent a cerebral angiogram and aneurysm embolisation interventional procedure under fluoroscopic guidance. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 9 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.
Incident 124	**A patient underwent a fluoroscopic interventional procedure that resulted in a high radiation dose to the skin.** A hospital patient underwent an endoluminal repair of femoral arteries and the thoracic aorta under fluoroscopic guidance. Throughout the procedures, steps were taken to keep the dose as low as reasonably achievable. The skin entrance dose from the procedure was approximately 9 Gy. The patient didn't develop any noticeable erythema. No further action was necessary.

Unnecessary radiation exposure due to equipment failure

Incident 125	**A patient underwent unnecessary radiation exposure due to the CT scanner malfunctioning.** A paediatric hospital patient underwent unnecessary radiation exposure due to the CT scanner aborting during a scan. Shortly after starting the CT scan of the tibia, the CT scanner aborted the scan due to a malfunction. The effective dose from the unnecessary partial scan was less than approximately 0.1 mSv. An engineer from the supply company replaced the control box for the CT scanner, which caused the malfunction.
Incident 126	**A patient underwent an unnecessarily repeated CT scan of the chest, abdomen and pelvis due to the CT scanner malfunctioning.** A hospital patient presented for a CT scan of the brain, cervical spine, chest, abdomen and pelvis. The system froze and crashed during the reconstruction of the images. The CT scanner was rebooted but reconstruction was only possible for images of the brain and cervical spine. The images for the chest, abdomen and pelvis couldn't be reconstructed. The CT scan of the chest, abdomen and pelvis had to be repeated. The effective dose from the first CT scan of the chest, abdomen and pelvis was approximately 11 mSv. A technician from the supply company repaired the scanner.

Incident 127	**A patient underwent an unnecessarily repeated CT scan of the brain due to reconstruction algorithm failure.** A patient at a medical imaging practice underwent a CT scan of the brain. The reconstructed images were orientated strangely. The problem occurred because of a failure of the reconstruction algorithm. The effective dose from the scan was approximately 1.3 mSv. A technician from the supply company repaired the scanner.
Incident 128	**A patient underwent an unnecessarily repeated injection of a radiopharmaceutical due to the injection pump for the cardiac stress agent being incorrectly set up.** A patient undergoing a nuclear medicine cardiac stress test presented for an injection of a pharmacological stress agent after a radiopharmaceutical had been administered. The injection pump for the cardiac stress agent, however, was incorrectly set up – the syringe wasn't clipped into place properly – and no cardiac stress agent was administered. The effective dose from the unnecessary administration of the radiopharmaceutical was approximately 7.2 mSv. The nurse unit manager sent a reminder to nurses that syringes need to be clipped in place correctly in such cases and double-checked for correct attachment.
Incident 129	**A patient underwent an unnecessarily repeated CT scan of the abdomen due to the CT scanner malfunctioning.** A CT scan of the abdomen was performed on a patient in an ED during which a 'critical error' message was displayed. The scan data and dose report weren't created and couldn't be retrieved. The CT scanner was restarted and the patient was rescanned successfully. The effective dose due the failed scan was approximately 28 mSv. The supplier indicated that the error was likely due to a one-off software failure, specifically a 'host helix failure'.
Incident 130	**A patient underwent an unnecessarily repeated CT scan of the abdomen and pelvis due to the CT scanner malfunctioning.** An ED patient underwent a CT scan of the abdomen and pelvis. The imaging was uncomplicated and preview images were available immediately after final imaging acquisition. The radiographer then attempted image reconstruction, but the system reported an error indicating that not all the imaging for the patient was created and indicated that the 'Recon' option be used to create the missing images. The radiographer used the 'Recon' option but was unable to reconstruct the imaging, with the same error message continuing to reappear at each attempt. Following several attempts to retrieve the missing images, the patient was re-referred for imaging. The effective dose from the failed scan was approximately 4.1 mSv. The supplier investigated and rectified the error.
Incident 131	**A patient underwent unnecessary mammography scans due to a biopsy needle driver fault.** A hospital patient had five digital mammography scans to obtain a core biopsy. No core samples were obtained due to a needle driver fault even after three attempts to rectify the fault. The dose from the mammography scans was approximately 1.3 mSv. The equipment supplier installed a replacement needle driver.
Incident 132	**A paediatric patient underwent an unnecessary repeat plain radiograph of the pelvis due to mispositioning of an imaging plate in a faulty patient trolley.** A paediatric hospital patient underwent an unnecessarily repeated anterior–posterior radiograph of the pelvis. The patient was brought to the ED after being struck by a car. The patient reported right hip and shoulder pain and left knee pain. The treating physician ordered a series of general radiography scans querying fractures of the left tibia, right shoulder and hip and any other injuries. The radiographers imaging the patient encountered problems in correctly positioning the imaging plate for the radiograph of the pelvis in the anterior–posterior orientation due to a patient trolley malfunction. The positioning of the imaging plate resulted in the iliac crests not being imaged, and the radiograph had to be repeated after repositioning the imaging plate. The effective dose from the unnecessary radiograph was approximately 0.1 mSv. The trolley was subsequently serviced.

Incident 133	**A patient underwent two unnecessary CT thoracic angiograms due to tube arcing in a CT scanner.** A hospital patient was undergoing a CT thoracic angiogram when an equipment malfunction (tube arc) resulted in a non-diagnostic scan in one anatomical region. The radiographer repeated the entire scan with the same CT scanner but the equipment malfunction occurred again, resulting in a non-diagnostic scan in a different anatomical region. The patient was then scanned using another scanner and a diagnostic scan was produced. The first and second scans together provided enough information so that the third scan wasn't necessary. The second and third scans should not have been carried out without consulting a radiologist. The effective dose from the first two scans was 20 mSv. An engineer replaced the X-ray tube. The importance of checking with a radiologist before repeating scans was stressed to the radiographer involved.
Incident 134	**Two patients received excessive skin entrance doses from a fluoroscopy unit due to a collimator leaf not working.** Following a cardiac angiographic procedure at a hospital, staff noted that the radiation dose recorded by the X-ray unit's dose tracking system didn't match dose recorded by the in-built dose-area product chamber. An investigation revealed that one of the collimator leaves wasn't working. It was subsequently determined that this problem had occurred with two patients. These two patients were irradiated beyond the selected fields of view. The skin entrance for these two patients was 3 Gy and 4.5 Gy instead of being roughly 1 Gy and 2 Gy. respectively. A new collimator module was ordered and installed.
Incident 135	**A patient underwent unnecessarily repeated CT scan angiograms of the brain and carotid blood vessels due to the CT scanner malfunctioning.** A hospital patient underwent unnecessary CT scan angiograms of the brain and carotid blood vessels due to an equipment malfunction. The scan had completed successfully but the raw image data couldn't be retrieved, necessitating a repeat scan. The effective dose as result of the first scan was approximately 14 mSv. The supplier investigated and rectified the error.
Incident 136	**A paediatric patient underwent an unnecessarily repeated CT scout scan of the brain due to a control keyboard fault.** A paediatric patient presented to a medical imaging practice for a CT scan of the brain. The radiographer planned the scout CT image and found the keyboard of the main console wasn't working. The keyboard and connections were checked but no problem could be found and the scanner needed to be rebooted. The scout image therefore needed to be repeated once the equipment was restarted. The effective dose from this unnecessary repeat of the scout image of the brain due was approximately 0.02 mSv. This fault was a one-off fault and wasn't investigated.
Incident 137	**A patient underwent an unnecessary whole-body CT scan and injection of ^{18}F-FDG due to failure of an auto-injector system.** A hospital patient underwent an unnecessary whole-body attenuation/localisation CT scan and an injection of approximately 20 MBq of ^{18}F-FDG instead of the prescribed activity of 160 MBq. This incident was caused by a failure of the auto-injector for the ^{18}F-FDG. The additional effective dose received by this patient was approximately 6.8 mSv. Staff used an alternative method of patient injection until the autoinjector system was fixed.

Maladministration of radiopharmaceutical

Incident 138	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient presented to a hospital with an order for a cardiac perfusion study using ^{99m}Tc-MIBI (a cardiac tracer). Immediately after the injection, the NMT discovered that ^{99m}Tc-ECD (a brain tracer) had been administered to the patient instead of the ^{99m}TcMIBI. The effective dose from this maladministration was approximately 5.5 mSv. The NMT involved was reminded to check labelling on vials thoroughly. The relevant standard operating procedure was revised to ensure all technologists double-check the radiopharmaceutical before any administration.

Incident 139	**A patient was administered with the wrong activity of a radiopharmaceutical due to nuclear medicine technologist error.** A patient presented to the nuclear medicine department of a hospital for a stress and redistribution myocardial perfusion procedure using thallium-201 (^{201}Tl). After completing the stress component of the procedure, it was decided that the patient would also need to undergo the rest component. The NMT incorrectly drew up an activity of 37 MBq of ^{201}Tl for the rest component as well as the activity required for the stress component, a total of 140 MBq of ^{201}Tl. The protocol for the rest injection of ^{201}Tl is 37 MBq. The effective dose from the second (unnecessary) administered stress component activity of ^{201}Tl was approximately 14 mSv. The chief NMT counselled the NMT involved about the incident.
Incident 140	**A patient was administered with the wrong activity of a radiopharmaceutical due to nuclear medicine technologist error.** During a routine ^{18}FFDG PET/CT scan, a hospital patient was unintentionally administered with approximately 1,600 MBq of ^{18}FFDG instead of the prescribed 260 MBq. The NMT had unintentionally drawn up the larger amount. The effective dose from the excess activity (1,340 MBq) was approximately 23 mSv. The NMT involved in the incident underwent supervised refresher training in procedures for manual preparation, dispensing and calibration of radiopharmaceuticals for patient administration.
Incident 141	**A patient was administered with the wrong radiopharmaceutical due to imaging bookings administrator and nuclear medicine technologist error.** A hospital patient was referred by an oncologist for a PET/CT scan to assess a meningioma. On the imaging request form, the oncologist selected that the scan was to be performed with ^{68}Gaoctreotate (Gatate). The imaging bookings administrator incorrectly booked the patient for a PET/CT scan using ^{18}Fdeoxyglucose (FDG). This booking error wasn't picked up by the nuclear medicine physician who reviewed and approved the use of FDG, rather than Gatate. Before carrying out the scan, the NMT completed a timeout procedure and reviewed the original imaging request form but didn't identify the differences between the imaging request form, which called for Gatate, and the booking schedule, which called for imaging using FDG. The NMT proceeded to administer 378 MBq FDG and conducted the PET scan. During the scan, the NMT became aware of the error. The effective dose from this misadministration was approximately 17 mSv. The NMT involved was reminded to carry out correct patient and procedure identification processes. Clerical staff members were reminded to exercise care when entering patient and procedure details on imaging requests.
Incident 142	**Two patients were administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** Two hospital patients were mistakenly administered with ^{99m}Tcpertechnetate instead of ^{99m}TcMIBI. The NMT drew the radiopharmaceutical in error from the pertechnetate pot (green colour) instead of the MIBI pot (green with red dot). The NMT didn't doublecheck the radiopharmaceutical by looking at the compound label on the pot. The activity concentrations drawn were very similar to what the MIBI concentrations would have been so the doses weren't flagged as unusual when measured using the dose calibrator. The effective doses to the two patients were approximately 3.5 mSv. The NMT involved was educated about setting up the lab efficiently to reduce errors. The NMT was counselled concerning the incident and the NMT has now changed their practice and process to ensure appropriate separation of pots and doublechecking of labels before drawing up radiopharmaceuticals.
Incident 143	**Two patients were administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A hospital patient presented for a ^{68}GaPSMA scan. The NMT collected the vial labelled ^{68}GaDOTATATE instead of that labelled ^{68}GaPSMA. The NMT administered the ^{68}GaDOTATATE to the patient. The reporting nuclear medicine consultant noticed the error when reporting. By this time, however, a second patient had also incorrectly received an administration of ^{68}GaDOTATATE. The effective dose for the first patient was approximately 4.7 mSv. The effective dose for the second patient was approximately 6.0 mSv. The NMT involved was reminded to check labelling on vials thoroughly before administrating radiopharmaceuticals.

Incident 144	**A patient was administered with the wrong activity of a radiopharmaceutical due to nuclear medicine technologist error.** Doses of ^{18}FFDG were drawn up at a hospital for the day's PET imaging schedule and stored in a sequence that corresponded to the schedule. An NMT selected a patient dose and didn't match the identification details on the syringe with the patient details and didn't perform the required patient and procedure identification processes in place at the hospital before administration. As a result, a patient was administered with 339 MBq rather than the 246 MBq ^{18}FFDG that had been prepared for the patient. The NMT realised the error after administration. The PET scan proceeded with this larger dose of radiopharmaceutical. The effective dose from the additional 93 MBq ^{18}FFDG was approximately 1.8 mSv. The NMT involved was reminded to comply with the hospital's patient and procedure identification processes.
Incident 145	**A patient was administered with the wrong radiopharmaceutical due to nuclear medicine technologist error.** A patient was booked for a nuclear medicine renal scan with ^{99m}TcDMSA. The NMT responsible assumed that the diethylenetriaminepentaacetate (DTPA) kit in the hot-lab fridge was DMSA. The NMT prepared the radiopharmaceutical and injected the patient with 180 MBq. The error was realised upon imaging of the patient. The effective dose from the maladministration was approximately 1.2 mSv. Improvements to labelling in hot-lab refrigerator were implemented. The NMT involved was reminded to check labelling on vials thoroughly.

Misalignment of radiotherapy beam field or unintended irradiation of healthy tissue

Incident 146	**A patient received an unintended radiation dose to healthy tissue due to the patient moving during a treatment fraction.** A patient was undergoing external beam radiation therapy to treat oesophageal cancer. The prescribed radiation dose was 50.4 Gy in 28 fractions (1.8 Gy per fraction). During fraction 6, the patient was observed via closed-circuit TV to be partially sitting up during treatment of the upper chest. The radiation beam was immediately terminated. The patient didn't alert radiation therapists to discomfort and pain during treatment. The patient was repositioned and treatment continued. Precise calculation of the radiation dose to tissues not intended to have been exposed is subject to large uncertainties. Tissues not intended to have been exposed would have received a radiation dose in excess of 1 mGy. The patient was counselled on the importance of remaining in position and was offered further pain management, which was declined.
Incident 147	**A patient received an unintended radiation dose to healthy tissue due to the patient not being repositioned between treatment fields.** A hospital patient was undergoing radiation therapy to their chest, shoulder and abdomen. The treatment position for the abdomen required the patient's right arm to be positioned on their chest. During one fraction of treatment the patient's right arm wasn't repositioned between treatment fields and was subsequently directly irradiated by the oblique radiation angles used for the abdomen treatment. The dose to an unplanned area of the arm, which was a length of 6 cm, 3 cm distal from the elbow, was 4 Gy. The radiation therapist involved was reminded to observe the notes in the record and verify system, which in this case instructed the arm to be repositioned between treatment fields.

Medical procedure failed due to patient non-cooperation or other patient problem

Incident 148	**A patient underwent an unnecessary administration of ^{18}F-FDG due to being required to be transported to a hospital by ambulance before the scan could be carried out.** A patient presented to a medical imaging practice for a PET/CT scan. The patient was injected with 197 MBq ^{18}F-FDG. This was to be followed by an uptake resting time of 60 minutes. During this uptake time, the patient complained of being short of breath. The nurse and radiologist were called to assess the patient. Attempts were made to suction the patient's tracheostomy and oxygen was administered, but the patient still had trouble breathing. The radiologist called for an ambulance and the patient was taken to hospital. The PET/CT scan couldn't be performed. The effective dose from the administration of the ^{18}F-FDG was approximately 4 mSv. No further action was necessary.

Incident 149	**A patient underwent an unnecessary administration of ^{99m}Tcneurolite due their refusal to be scanned after the administration.** A patient at a medical imaging practice undergoing a brain perfusion study querying frontotemporal dementia refused images after being injected with ^{99m}Tc-neurolite 824 MBq. The patient was cooperative and lay still for the injection; however, once in the scanning room the patient's behaviour changed and the patient refused the scan. The effective dose from this incident was approximately 6.3 mSv. No further action was necessary.
Incident 150	**A patient underwent unnecessary pre-scans before a CT scan for a C6 (cervical spine) nerve root injection due to the radiographer discovering that the patient was on blood-thinning medication.** A patient presented to a hospital for a CT scan for a C6 nerve root injection and was brought into the CT scan room. A consent form and a time-out form were completed. After the pre-scans were completed the patient stated they hadn't ceased their blood-thinning medication before the scan and the CT scan wasn't completed. The effective dose from the prescans was approximately 1.5 mSv. The radiographer involved was reminded to question patients about blood-thinning medication before such procedures.
Incident 151	**A patient underwent an unnecessary administration of ^{99m}TcHDP due to developing anxiety before the scan.** A hospital inpatient was referred for a nuclear medicine bone scan. The patient was injected with 806 MBq ^{99m}TcHDP but was highly anxious on returning for the scan. Sedation was required and this was organised, administered and the patient was then handed back to the nuclear medicine staff. The patient wasn't prioritised on the scanner and the sedative had worn off by the time the patient had to be scanned. The scan had to be repeated three days later. The effective dose from the unnecessary injection of ^{99m}TcHDP was approximately 3.2 mSv. The NMT involved was counselled regarding patient care and workflow issues.
Incident 152	**A patient underwent an unnecessarily repeated PET/CT scan due to developing claustrophobia during the scan.** A hospital patient presented to the nuclear medicine department for a whole-body PET/CT scan to investigate previously identified lesions and a mass. During image acquisition the patient became agitated and, with approximately seven minutes of the scan remaining, refused to proceed due to claustrophobia. The scan was aborted. The patient agreed to try the scan again after the administration of a sedative. The wholebody scan was repeated (without repeating the ^{18}FFDG injection). The effective dose from the repeated scan was approximately 8 mSv. No further action was necessary.

A pregnant person was exposed to radiation

Incident 153	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a CT scan of the facial bones. The patient advised practice staff that she wasn't pregnant. The patient subsequently found she was about two weeks pregnant at the time of the scan. The dose to the foetus was approximately 0.005 mGy. The correct procedures were followed in this case.
Incident 154	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a CT scan of the pelvis. The patient advised practice staff that she wasn't pregnant. Subsequently she found that she was approximately six weeks pregnant at the time of the scan. The dose to the foetus was approximately 10 mGy. The correct procedures were followed in this case.

Incident 155	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient underwent a CT scan of the lumbar spine at a medical imaging practice. At the time of the CT scan the patient declared she wasn't pregnant. She subsequently returned to the practice for an abdominal ultrasound scan and it was at this time that an early pregnancy was noted. It was estimated that, at the time of the CT scan, the gestational age was approximately three to four weeks. The dose to the foetus was approximately 32 mGy. The correct procedures were followed in this case.
Incident 156	**A pregnant nurse caring for a patient subsequently found that the patient had recently undergone a nuclear medicine procedure.** A pregnant nurse was unintentionally exposed to radiation while providing nursing care to a patient who had recently undergone a nuclear medicine procedure. The nurse wasn't aware that the patient was on radiation precautions at the time. This incident was due to incomplete handover of the patient. The dose to the foetus was approximately 1 µGy. The hospital departments involved were reminded to carry out correct procedures at the time of handover of patients.
Incident 157	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient attended a medical imaging practice for a CT scan of the lumbar spine. During the pre-examination checks, staff asked if she was pregnant and she stated that she wasn't. The patient underwent the CT scan and was subsequently found to be approximately 15 weeks pregnant. The dose to the foetus was approximately 75 mGy. The correct procedures were followed in this case.
Incident 158	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient attended a medical imaging practice for a gastric emptying study. During the pre-examination checks, staff asked the patient if she was pregnant and she stated that she wasn't. The patient underwent the gastric emptying study and was subsequently found to be in the early stages of pregnancy at the time of the study. The dose to the foetus was approximately 0.1 mGy. The correct procedures were followed in this case.
Incident 159	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient underwent a whole-spine X-ray examination series at a medical imaging practice. At the time of the examination the patient declared that she wasn't pregnant. The patient subsequently declared a pregnancy to the practice four weeks later. The patient was in the early stages of pregnancy at the time of the scan. The dose to the foetus was approximately 3.1 mGy. The correct procedures were followed in this case.
Incident 160	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A hospital patient presented for a CT scan of the lumbar spine. At the time of the examination the patient declared that she wasn't pregnant. After the scan reconstructions it became clear the patient was pregnant, possibly in the second trimester. The dose to the foetus was approximately 12 mGy. The correct procedures were followed in this case.
Incident 161	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A medical imaging practice patient underwent a ventilation–perfusion nuclear medicine scan. At the time of the examination she declared that she wasn't pregnant. The patient subsequently declared a pregnancy to the practice. The dose to the foetus was approximately 0.9 mGy. The correct procedures were followed in this case.

Incident 162	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A hospital patient presented for a PET/CT scan. The NMT completed the PET questionnaire and the patient indicated that she wasn't pregnant. The subsequent CT scan showed the patient was in the early stages of pregnancy. The dose to the foetus was approximately 15 mGy. The correct procedures were followed in this case.
Incident 163	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a CT scan of the neck, abdomen and pelvis with contrast and 17 days later underwent a CT scan of the chest with contrast. For both scans, the patient indicated that she wasn't pregnant. The day after the CT scan of the chest, an ultrasound scan revealed that the patient was about 13 weeks pregnant. The dose to the foetus was approximately 18 mGy. The correct procedures were followed in this case.
Incident 164	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to an ED with acute abdominal pain. The patient was referred for an X-ray. The patient indicated to ED staff that she was on her period and confirmed with the radiographer that she wasn't pregnant. An X-ray of the abdomen was then carried out. The image showed the welldeveloped skeleton of a foetus. The patient was sent to birthing that same day and the baby was born later that night. The developmental age of the neonate was estimated to be 37 weeks. The dose to the foetus was approximately 1.5 mGy. The correct procedures were followed in this case.
Incident 165	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to an ED with abdominal pain and nausea with a suspected flare up of the patient's known Crohn's disease. Upon being questioned, the patient indicated that she wasn't pregnant to both the attending ED doctor and the radiographer. A CT of the abdomen and pelvis was performed, indicating a possible pregnancy. A pelvic ultrasound confirmed that the patient was seven weeks pregnant at the time of the CT scan. The dose to the foetus was approximately 10 mGy. The correct procedures were followed in this case.
Incident 166	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient presented to a hospital for a CT scan of the lumbar spine. The patient indicated that she wasn't pregnant. The CT scan indicated a possible pregnancy. A pelvic ultrasound confirmed that the patient was about five days pregnant at the time of the CT scan. The dose to the foetus was approximately 20 mGy. The correct procedures were followed in this case.
Incident 167	**A patient who underwent a medical imaging procedure was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice underwent a CT scan of the neck, chest and abdomen. The patient indicated that she wasn't pregnant. An ultrasound scan subsequently indicated that the patient was about two weeks pregnant at the time of the CT scan. The dose to the foetus was approximately 6 mGy. The correct procedures were followed in this case.
Incident 168	**A patient who underwent a CT scan of the abdomen and pelvis was subsequently found to have been pregnant at the time of the procedure.** A patient at a medical imaging practice had a CT scan of the chest, abdomen and pelvis to examine flank pain. The patient declared that she wasn't pregnant. Two weeks after the procedure she found she was three weeks pregnant at the time of the scan. The dose to the foetus was approximately 6 mGy. The correct procedures were followed in this case.

Contamination of persons or articles with a radiopharmaceutical

Incident 169	**A patient was contaminated with a radiopharmaceutical after a spill.** A hospital patient required an injection of 850 MBq of ^{99m}Tc labelled ethyl cysteine dimer at the time of a seizure in the epilepsy ward of the hospital. At the time of injection, the syringe connection/cannula leaked, which resulted in most of the radiopharmaceutical leaking onto the patient's clothing, linen and mattress. Nuclear medicine staff monitored the patient and room for contamination and removed contaminated clothing from the patient and quarantined the mattress. Approximately 500–700 MBq leaked from the syringe. No further action was necessary.
Incident 170	**A hot-lab microwave and the adjacent hot-lab area were contaminated with a radiopharmaceutical after a spill.** During routine preparation of ^{99m}Tcsestamibi, a vial containing approximately 9.7 GBq of ^{99m}Tc, as well as its plastic holding container, broke in the hot-lab microwave while being heated, causing contamination of the microwave and the adjacent hot-lab area. The estimated effective doses to the four members of staff involved were all less than 100 µ Sv. These doses were based on dose-rate measurements together with estimates of distances and times spent in proximity to the spill. The hospital purchased a new microwave to prepare radiopharmaceuticals that require heating. The hospital was looking at using a heat block for heating in the future.
Incident 171	**A stress test room floor was contaminated with a radiopharmaceutical after a spill.** A nuclear medicine physician spilt 860 MBq of ^{99m}Tc on the floor in a hospital stress test room. The spill was cleaned up by NMTs wearing appropriate personal protective equipment, including gloves and shoe covers. After the clean-up, the measured count rate was still 1,300 counts per second (cps) approximately 2 cm from the floor. The NMTs contained the area for 29 hours, after which the count rate was measured to be 25 cps approximately 2 cm from the floor. No staff member involved received a radiation dose greater than 1 mSv. No further action was necessary.
Incident 172	**An epilepsy room floor and two staff members were contaminated with a radiopharmaceutical after a spill.** A hospital patient in the epilepsy ward required an injection of approximately 640 MBq of ^{99m}Tc labelled ethyl cysteine dimer (ECD) at the time of a seizure. The syringe/cannula connection leaked upon an attempt to inject the radiopharmaceutical, resulting in most of the radiopharmaceutical leaking onto the floor beside the patient's bed, with a small amount also ending up on one staff member's wrist and clothing and on the clothing of another staff member. Monitoring for contamination of the patient, room and hospital staff was performed by NMTs and the radiation safety officer of the hospital. Decontamination removed a significant amount of the ^{99m}Tc from the floor. The area of floor with residual contamination was then covered with lead shielding until such time that the ^{99m}Tc had decayed. The clothing of the two affected staff members was removed and multiple cleansing of the contaminated skin reduced the count rate to two to three times background levels. Based on imaging of the patient and the radiation count rate after the injection, it was estimated that approximately 90 per cent of the ^{99m}Tc ECD leaked from the syringe. No one received an effective dose greater than 1 mSv. Correct procedures were followed in this case.
Incident 173	**A hospital room floor and a physician's shoes were contaminated with a radiopharmaceutical after a spill.** While preparing to carry out a ventriculoperitoneal shunt patency scan, the NMT dropped a syringe containing approximately 80 MBq of ^{99m}TcDTPA while passing it to the physician for injection, contaminating approximately one square metre of the floor and the physician's shoes. The room was subsequently decontaminated and the physician's shoes were quarantined. Effective doses to all staff involved were less than approximately 10 µ Sv. No further action was necessary.

Incident 174	**A hospital toilet floor was contaminated with a radiopharmaceutical when a patient accidentally urinated on the toilet floor.** A hospital patient presented to the nuclear medicine department for a whole-body PET/CT scan. Within an hour of the patient being injected with 368.85 MBq of ^{18}F-FDG, the patient went to the toilet and accidentally urinated on the toilet floor. The patient's nurse returned the patient to the preparation room and cleaned up the urine spill with gloved hands. Affected linen was discarded in the linen bag and the wipes used to clean up the urine spill were discarded in two rubbish bins. The nurse advised the NMT of the incident. The NMT isolated the affected area and relocated the waste and contaminated linen to the patient's uptake room for storage and decay until the following morning. The nurse's hands and feet were monitored for radioactive contamination; no radioactive contamination was found. It was estimated that approximately 25 MBq of ^{18}F may have been in the patient's urine. No person received an effective dose greater than 1 mSv due to the spilled radiopharmaceutical. No further action was necessary.
Incident 175	**Hospital equipment was contaminated with a radiopharmaceutical after a spill.** A hospital patient required an injection of approximately 820 MBq of ^{99m}Tcbicisate at the time of an ictal episode in the epilepsy ward. During the injection an unknown quantity of the radiopharmaceutical leaked onto the nurse's gloves and the patient's bedding. The injecting nurse reported possible contamination of other surfaces. Radioactive contamination was detected on the linen and mattress of the patient's bed, in the general rubbish bin in the patient's room, in the general rubbish bin at the nursing station, on the top surface of the injection trolley and in the mobile sharps bin located near the nursing station. The floor of the patient's room wasn't contaminated. Contaminated linen, the rubbish from bins and the contaminated sharps bin were collected and taken to the nuclear medicine department for storage and decay. The injection trolley was decontaminated and returned to service. The mattress was taken out of use and transferred to the nuclear medicine department for storage and decay. It was estimated that approximately 10 per cent of the injected activity leaked from the syringe. No person received an effective dose greater than 1 mSv due to the spilled radiopharmaceutical. No further action was necessary.
Incident 176	**Hospital equipment and a patient and nurse were contaminated with a radiopharmaceutical after a spill.** A hospital patient required an injection of approximately 650 MBq of ^{99m}Tc labelled ECD at the time of seizing in the epilepsy ward. At the time of the injection, however, a large amount of the radiopharmaceutical leaked onto the patient's chair, blanket, electroencephalogram sling and clothing and a small amount on spilled on the nurse who injected the patient. The patient, room and other staff members were monitored by nuclear medicine staff members and the hospital's radiation safety officer. Removal of clothing, bed linen, blankets and decontamination measures removed a significant amount of the ^{99m}Tc from the patient and immediate vicinity. The patient chair was removed from service and stored until radiation levels were indistinguishable from background. The nurse underwent decontamination of the contaminated skin (hands/wrist), which reduced the count rate to two to three times background levels. It was estimated that approximately 90 per cent of the ^{99m}Tc ECD leaked from the syringe/extension tubing. No further action was necessary.
Incident 177	**Hospital equipment and a patient were contaminated with a radiopharmaceutical after a spill.** A patient presented to the nuclear medicine department of a hospital for a stress and rest myocardial perfusion procedure. During the injection of the stress dose (1,187 MBq of ^{99m}Tcsestamibi), the threeway tap was inadvertently left open, resulting in the spill of the radiopharmaceutical on to the arm and sides of the patient. The nuclear medicine registrar immediately attempted decontamination of the patient and electrocardiogram (ECG). The ECG leads were found to have a residual activity of 2–3 MBq of activity and the hospital's radiation safety officer advised that it was safe to continue using them on this patient. Affected linen was immediately removed from the patient and discarded in the linen bag and wipes used in decontamination were discarded in a hot waste rubbish bin. The linen bag and the hot waste rubbish bin were then relocated to the radiation waste store by an NMT. The nuclear medicine registrar was counselled by the director of nuclear medicine and reminded to ensure the threeway tap is closed for injections.

Incident 178	**A nuclear medicine technologist was contaminated with a radiopharmaceutical during injection of the radiopharmaceutical.** A hospital patient presented to the nuclear medicine department for a lymphoscintigraphy procedure on the breast. During the injection of the 21 MBq of ^{99m}Tcantimony colloid in the periareolar area, the syringe detached from the needle due to the pressure from the injection, resulting in a small amount of the radiopharmaceutical being sprayed on to the NMT performing the injection. Contamination was found on the NMT's scrub top, neck and glasses. The scrub top was removed and stored in the hot lab to decay. The glasses were decontaminated and returned to the NMT. The contaminated skin was cleaned with alcohol swabs but only briefly due to a pre-existing skin condition of the NMT. The skin dose to the NMT was up to approximately 10 mGy at the contaminated location. The effective dose received by the NMT was negligible. No further action was necessary.

Member of the public reporting the finding of suspected radioactive material

Incident 179	**A member of the public reported the finding of suspected radioactive material.** A member of the public reported to the department that he had noticed a high radiation reading on the radiation monitoring application on his phone in a suburban lot. Two officers of the Radiation Team attended the site with the person in question and determined that the phone application was actually a magnetic field measuring application. There were no radiation levels above background at the site.

Lost or stolen radioactive material

Incident 180	**A company reported the loss of a small radioactive source.** A company reported the loss of a 185 kBq ^{137}Cs check source. A stocktake of the radionuclide inventory within the source safe of the company revealed that the check source wasn't in the safe. Subsequent searches of the company's premises as well as equipment kits didn't locate the source. The source does not present a hazard. The company reviewed and updated its radiation management plan to include improved inventory accounting requirements.
Incident 181	**A company reported the loss of a spent industrial radiography source.** A transport company was engaged by a non-destructive testing company to transport an industrial radiography source container with a decayed radioactive source to Sydney for a source change over. About a week after the source left the premises of the nondestructive testing company, this company was contacted by the company supplying the new source and disposing of the old source and was advised that the supply company had not received the source container. The transport company was unable to locate the source container and instigated a search of its Sydney and Melbourne depots. The searches were completed but the source remained unaccounted for. It eventually arrived at the transport company's Sydney depot nine days after it had been shipped. The root cause for the problem is still under investigation but is suggested to be associated with an unrelated cybersecurity incident.

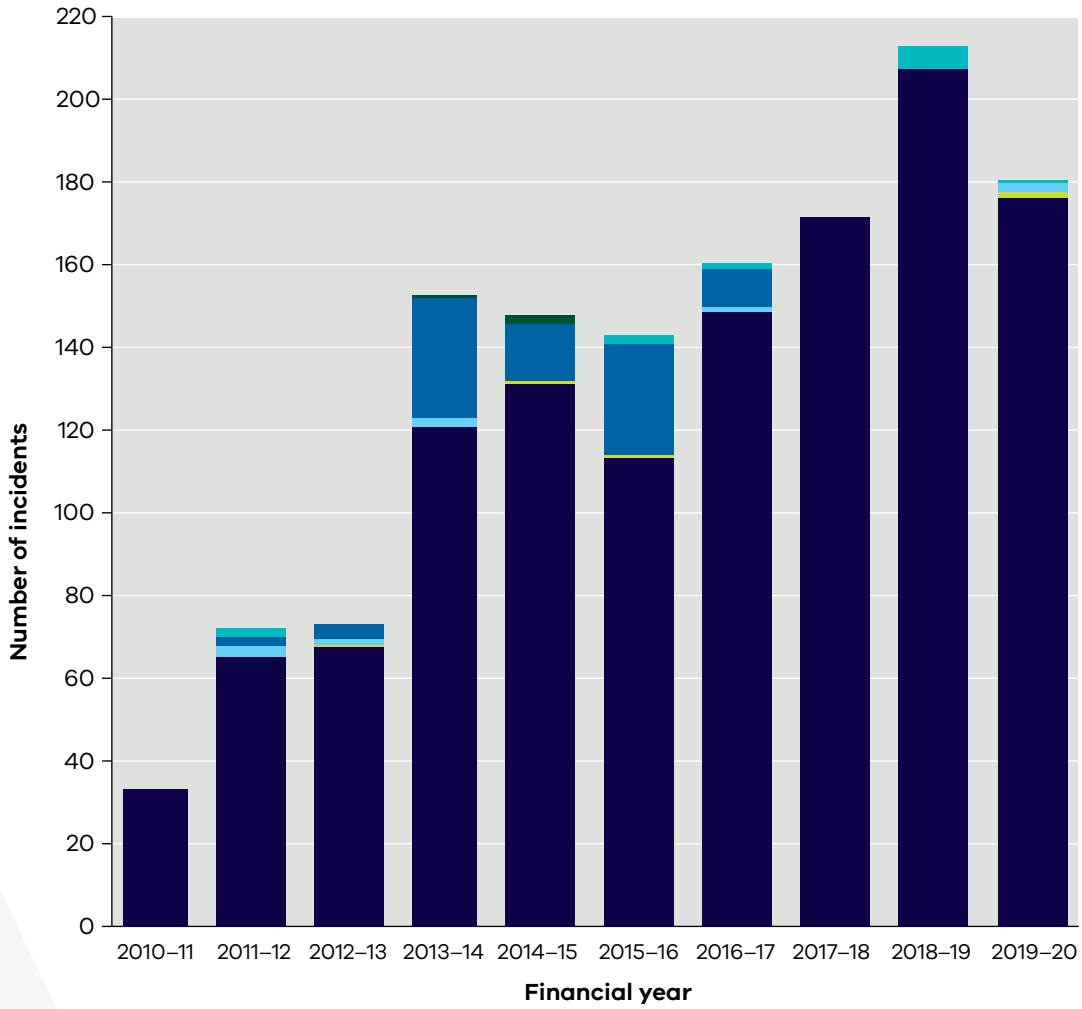
Sealed source apparatus damaged

Incident 182	**A company reported damage to a nuclear density/moisture gauge.** A geotechnical engineering and consulting company advised the department that a nuclear density/moisture gauge was run over by one of its vehicles. The gauge was placed on the ground behind the work vehicle and the field technician moved the vehicle, forgetting the gauge was placed on the ground, and ran over the gauge. The gauge was damaged but the ^{137}Cs source was retracted within the unit so that the effective dose to the technician because of the incident was below 1 mSv. The field technician placed the unit back in its storage container and brought the gauge back to the head office of the company. The field technician was reminded to remain vigilant when using nuclear moisture/density gauges.

Unnecessary radiation exposure during a radiation survey

Incident 183	**Two physicists were unnecessarily exposed to radiation due to misreading radiation survey meters.** A radiation survey was conducted by two medical physicists at a construction site outside of a radiotherapy linear accelerator bunker. The survey was conducted to assess the adequacy of shielding following removal of soil adjacent to the bunker. The soil initially formed part of the primary shielding barrier for the linear accelerator. The survey resulted in unnecessary radiation exposure to the medical physicists and people accompanying the medical physicists. Personal radiation monitoring devices worn by the two physicists recorded doses of 4.8 mSv and 16.5 mSv. No theoretical assessment was performed before the survey to determine what effect the soil removal would have on the dose rate in the area where the survey was conducted. The physicists incorrectly assumed that the monitor was displaying the dose rate in μSv/h when the monitor was displaying mSv/h. The investigation of the incident has been delayed by the coronavirus (COVID-19) pandemic and is still ongoing.

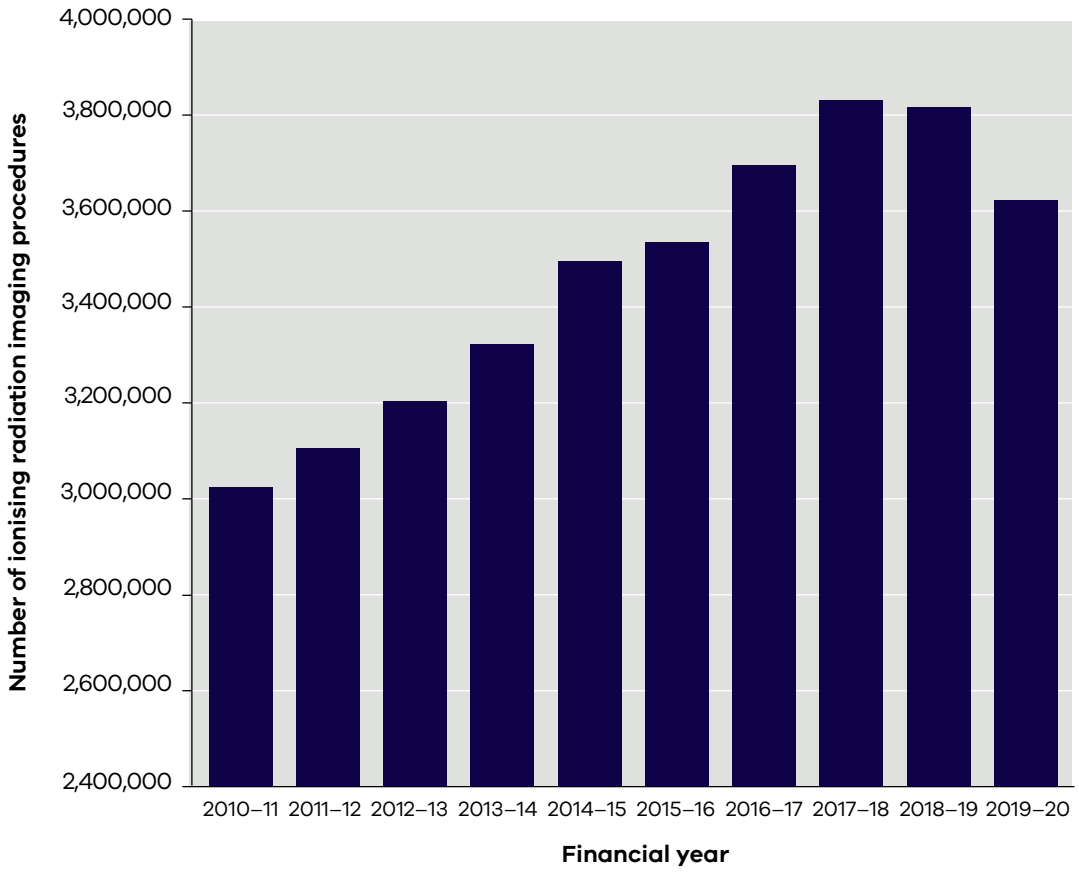
Appendix 2: Overview of reported incidents for the past 10 years, per financial year



- Other
- Industrial
- Inappropriate disposal
- Activation of radiation monitor alarm
- Identifcation of lost, abandoned, stolen or legacy radiation source
- Lost control of radiation source
- Medical

Appendix 3: Diagnostic imaging services over the past 10 years in Victoria

Number of diagnostic imaging services for CT, diagnostic radiology and nuclear medical imaging from Medicare Australia statistics



Glossary

Term	Description
Becquerel (Bq)	The standard unit of radioactivity 1 kBq = 1,000 Bq; 1 MBq = 1,000 kBq; 1 GBq = 1,000 MBq; 1 TBq = 1,000 GBq
CT	Computed tomography – a medical diagnostic X-ray tool
4DCT	CT scanning that records multiple images over time. It allows playback of the scan as a video so that physiological processes can be observed and internal movement can be tracked
CT topogram	A digital overview image in the planning of CT examinations
DEXA or DXA	Dual-energy X-ray absorptiometry – used to measure bone mineral density
DMSA	Dimercaptosuccinic acid – used in assessing renal morphology, structure and function
DOTATATE	An amino acid peptide (tyrosine-3-octreotate)
DTPA	Diethylene-triamine-pentaacetate – used in nuclear medicine lung inhalation studies
Extravasation	The leakage of intravenously infused medications into the extravascular tissue around the site of infusion
Extravenous	Existing or taking place outside of, or administered outside of, a vein or veins
FDG	Fludeoxyglucose – a radiopharmaceutical used in PET
Fiducial markers	Markers that provide a method of ensuring accurate target localisation for tumours or organs for radiotherapy
^{18}F	The symbol for the radionuclide fluorine-18
Gray (Gy)	The unit of absorbed dose of radiation used as a measure of fetal malformations and of developing acute effects such as skin burns 1,000 mGy = 1 Gy
HDP	Hydroxydiphosphonate – used in nuclear medicine bone scans
HIDA	Hepatobiliary iminodiacetic acid
k	Symbol for 'kilo' or 1,000
G	Symbol for 'giga' or 1,000,000,000
^{68}Ga	The symbol for the radionuclide gallium-68
Intravenous (IV)	Existing or taking place within, or administered into, a vein or veins

Term	Description
m	Symbol for 'milli' or 1/1,000
mSv	A unit of effective dose of radiation used as a measure of risk of developing cancer and other late-onset effects 1,000 mSv = 1 Sv
Sestamibi or MIBI	Methoxy-isobutyl-isonitrile – used in nuclear medicine blood perfusion studies
MRI	Magnetic resonance imaging
NMT	Nuclear medicine technologist/technician
PACS	Picture archival and communication system
PET	Positron emission tomography
PSMA	Prostate-specific membrane antigen
Sievert (Sv)	The unit of effective dose of radiation used as a measure of risk of developing cancer and other late-onset effects 1,000 mSv = 1 Sv
SPECT/CT	Single-photon emission computed tomography / computed tomography
^{99m}Tc	The symbol for technetium-99m, which is a radioisotope that can be attached to various pharmaceuticals for use in nuclear medicine scans