Lambert Radiation Shielding Ltd.

JULY 2023

RADIATION SHIELDING INSTALLATION FACTS

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INTRODUCTION TO LAMBERT RADIATION SHIELDING LTD

Lambert Radiation Shielding Ltd., a Canadian company, specializes in providing shielding solutions to protect the staff and public from dangers of ionizing radiation - a class 1 carcinogen. This includes designing and installing shielding systems for various applications, such as medical imaging facilities, NDT applications, Cyclotron operations, LINAC bunkers and educational environments.

Lambert offers a range of shielding materials and products, such as unbroken - penetration free radiation shielding barriers, lead lined doors, glazing and leaded interlocking designs for workers and the public who are exposed to ionizing radiation.

We also provide consulting services to assess radiation barrier risks, develop radiation designs for all site-specific applications. Lambert Radiation Shielding was founded in 1948 with a long history of experience and expertise in the field of shielding all aspects of Ionizing, non-Ionizing, Gamma and neutron shielding having established a reputation for providing high-quality and reliable shielding solutions. Over the years, we have evolved and expanded our shielding designs to keep up with technological advancements and changing industry standards. A one-of-a-kind specialized firm that you can rely on.

We have put together what we feel is vital information that the Health Authorities and project team should be aware of and the extent that we must all go to ensure that the best practices are used to keep the staff and public in a safe work environment. By keeping the Health Authority, the Health Professional Unions and WorkSafeBC all on the same page with transparency will allow greater safer, compliant and confident workplace. The staff will know instinctively that this project has the correct construction team assembled keeping all parties in mind. This would be the first of its kind - a pinnacle moment and an achievement never before accomplished on any health care project in North America.

INTRODUCTION TO IONIZING RADIATION

There are four main types of ionizing radiation:

- alpha particles,
- beta particles,
- gamma rays
- neutrons

Each type has different properties and requires different types of shielding.

X-ray radiation is a form of electromagnetic radiation that has the ability to penetrate through various materials including the human body. While x-rays are essential in medical diagnosis and treatment, repeated exposure to x-rays can be harmful to human health. X-ray radiation shielding is an essential safety measure in medical facilities that use x-ray equipment. The purpose of x-ray radiation shielding is to protect patients and medical personnel from the harmful effects of radiation exposure. In this report, we will discuss the importance of x-ray radiation shielding installation and its criticality in medical facilities.

The size of X-ray wavelengths is typically in the order of picometers (10^-12 meters). X-rays are a type of electromagnetic radiation with high energy and short wavelengths, ranging from approximately 0.01 to 10 nanometers (10^-9 meters) in size. This allows X-rays to penetrate matter and create detailed images of internal structures, making them useful for medical imaging, industrial inspection, and scientific research. The size of X-ray wavelengths also makes them potentially harmful to human health if proper safety measures are not taken to limit exposure.

If you took a millimeter and divided it into a million parts, and then took less than a 1/10th of that, you would have the average wavelength of x-ray. This is why x-rays pass through us. It literally fits through the spaces in our atoms. In contrast, a longer wavelength such as visible light is not able to pass through us. We thus create a shadow when we block the light. Wavelengths of visible light are roughly 4000 to 8000 times longer than an average wavelength of x-ray. The size of x-ray wavelengths requires an electron microscope to measure, this is why Health Canada requires an unbroken barrier, to prevent the thousands of penetration hotspots poisoning the staff and public.

X-ray radiation is a form of ionizing radiation that can penetrate materials and tissues and is commonly used in medical imaging. Exposure to ionizing radiation can cause damage to cells and DNA, and the risk of such damage increases with the accumulative dose of radiation received over time, which means that the damage caused by each exposure adds up over time. Therefore, repeated exposure to X-ray radiation can increase the risk of developing radiation-induced health problems, such as cancer and genetic mutations.

To minimize the risk of cumulative radiation exposure, medical professionals use the principle of "as low as reasonably achievable" (ALARA) when performing X-ray procedures. This means that they strive for the lowest possible dose of radiation, however, it's still important to be aware of the potential risks and to follow appropriate safety measures to minimize radiation exposure.

Lambert offers a range of shielding materials and products, such as unbroken **DUAL CAVITY** penetration free radiation shielding barriers, lead lined doors, and leaded glazing for workers who are exposed to ionizing radiation using installation methods perfected over our 75 years of onsite experiences.

WHAT IS X-RAY SHIELDING?

X-ray radiation shielding is a protective barrier that is designed to absorb and reduce the amount of radiation that penetrates through it. X-ray shielding materials can include lead, concrete, steel, or other dense materials. The effectiveness of the shielding material depends on its thickness, density, and composition. The chosen shielding material can be used to line the walls, ceiling, and floor of the x-ray room. The purpose of x-ray radiation shielding barriers is to reduce the exposure of medical personnel and patients to harmful radiation by reducing it down to a predetermined lowest dose rate. By achieving this task to meet the calculated safe dose rates outside the radiation shielding barrier, a barrier must be constructed to meet this Health Canada Safety Code #35 per page 19 item 1.2.2.9 requirement: "Shielding must be constructed to form an unbroken barrier and if lead is used, it should be adequately supported to prevent “creeping”."

WHY IS X-RAY RADIATION SHIELDING CRITICAL?

1. Protection of Medical Personnel:

Medical personnel who work in x-ray facilities are exposed to higher levels of radiation compared to the general public. Prolonged exposure to x-ray radiation can increase the risk of developing radiation-induced health conditions such as cancer, cataracts, spontaneous abortions and genetic mutations. The installation of x-ray radiation shielding barriers provides an effective shield between the x-ray producing equipment and medical personnel, reducing their exposure to harmful radiation.

WorkSafeBC ("WCB") Consultation Guidelines G7.18 - Application for Ionizing and Non-Ionizing Radiation Worker Position – Canadian Union of Public Employees (BC)("CUPE")[1]

- Radiation is an IARC 1 known carcinogen. As per CAREX Canada: "Ionizing radiation has been classified by the International Agency for Research on Cancer (IARC) as Group 1, carcinogenic to humans, in three separate monographs: Vol. 75: X and gamma radiation, Vol. 78: alpha, beta and neutrons, and, most recently, Vol. 100D, part of a volume reviewing all Class 1 carcinogens. Epidemiological evidence has confirmed a strong association between ionizing radiation and leukemia, as well as cancers of the thyroid, breast, salivary gland, esophagus, bone, stomach, colon, skin, brain and central nervous system, kidney, and lung. Many other cancer sites also show links with ionizing radiation exposure. The risk of developing cancer can be influenced by factors such as dose, dose rate, age, sex, genetics, lifestyle, environmental exposures, and time post exposure."

- The approach taken for carcinogens – including radiation **– is that there is no safe level of exposure**. This is supported by the Center for Disease Control and Prevention ("CDC") and by The National Institute for Occupational Safety and Health ("NIOSH").17 They state that: "…**there is no safe level of exposure to a carcinogen**, and therefore that reduction of worker exposure to chemical carcinogens as much as possible through elimination or substitution and *engineering controls is the primary way to prevent occupational cancer."*

IAEA - OCCUPATIONAL RADIATION PROTECTION IN MEDICINE[2]

- "Occupational radiation protection (ORP) in health care is complex. Among the topics discussed include monitoring of staff,

shielding, issues in interventional radiology and occupational radiation protection culture, including ethical issues."

- "In daily practices, radiation protection culture needs to be examined, reflected on and become pervasive. The new Basic Safety Standards would facilitate enhanced radiation protection culture. The three S's (Standards, Shields, and Skills) are the main important factors to improve occupational radiation protection in medicine. Standards are required for equipment; **Shielding should be purpose designed** and skills and knowledge are needed in practice."

- "Radiation protection should be an integral part of the general health and safety protection of workers and of safety regulation and management systems in the workplaces. Workers may face a wide range of occupational hazards and unduly protecting workers against one or a few hazards may be detrimental to occupational safety and health, if such protection undermines protection against other comparable or greater workplace hazards. Radiation hazards are just one type of hazard to which workers are exposed, and these hazards may be more or less significant than other occupational hazards. In some settings, radiation protection may be of secondary or tertiary importance. Therefore, application of radiation protection measures, including application of optimization, must be examined within the context of the totality of workplace hazards, thereby using resources to achieve the greatest gain in worker protection. A more holistic approach is needed that recognizes and appropriately protects against this large range of hazards. In addition, although social and economic factors are taken into consideration in applying the optimization principle, there should be no fundamental difference in standards of protection between developed and developing countries. For the sake of worker protection and credibility, international standards must be applied uniformly and effectively. Operating experience in protecting workers must also be shared and used to make appropriate revisions to the standards and facilitate their effective application."

BONN CALL FOR ACTION[3]

- The aims of the Bonn Call-for-Action are to **strengthen the radiation protection of patients and health workers overall**.

- Further the establishment of sufficient legislative and administrative framework for the protection of patients, workers and the public at national level

Radiation Protection and Safety: Awareness and Implementation of the Bonn Call for Action Priorities in Canada[4]

- Radiology exams, however, expose patients and radiology workers to X-ray and gamma-ray radiation, which can have dose-dependent adverse effects. This kind of radiation is used in several medical imaging procedures including angiography, fluoroscopy, computed tomography (CT), and radiographic and nuclear medicine imaging.3 In alignment with the linear, no-threshold (LNT) dose response model for post-radiation exposure cancer risk — keeping radiation doses as low as reasonably achievable (i.e., the ALARA principle) reduces such risk.

- Invest in the development of innovative projects in radiation protection.

Increased lead concentrations in the hairs of radiographers in general hospitals[5]

- We speculate that the lead shielding materials disintegrate over time and the lead dusts escape the capillary pores of plasterboards.

Regulatory Change A Primer on Protecting Workers from Lead Exposure[6]

- A Primer on Protecting Workers from Lead Exposure: Lead dust, mist or fume enters the body through ingestion and inhalation. Once absorbed, lead binds strongly to red blood cells, and is then deposited primarily in the bones, where it accumulates and can lead to adverse health effects on the formation of blood, the renal system, the nervous system, and even the reproductive system. Continued uncontrolled exposure to lead could cause serious health problems such as kidney damage, nerve and brain damage, and infertility.

Diagnostic X-ray examinations and increased chromosome translocations: evidence from three studies[7]

- While the benefit of radiation use in disease diagnosis and patient treatment remains undisputed, the current pooled study demonstrates that low-dose diagnostic X-rays are associated with measurable cumulative chromosome damage.

Healthcare Workers Occupationally Exposed to Ionizing Radiation Exhibit Altered Levels of Inflammatory Cytokines and Redox Parameters[8]

- Today, surveillance of healthcare workers chronically exposed to ionizing radiation only provides information on accidental overexposure, not on the real chronic risk of exposure to low

dose ionizing radiation. Therefore, there is an urgent need to closely examine potential pathological changes occurring in workers chronically exposed to ionizing radiation. Although occupational exposure to ionizing radiation generally falls well below the currently accepted limits (i.e., less than 50 millisieverts (mSV)) set by the International Commission of Radiation Protection (ICRP)

Variations induced in human erythrocytes by ultra-low X-ray doses[9]

- X-rays even at low levels of exposure may have oxidizing effect on erythrocytes, which must be taken into account for workers operating on X-ray equipment.

Simpkin 147 AAPM[10]

- We are allowing visual inspections during construction and then hope nobody puts a nice big gash into the shielding before the walls are covered up or puts a screw to hold a towel dispenser through your shielding.

Adequate radiation protection could help prevent breast cancer in female healthcare workers[11]

- Ionizing radiation is a known human carcinogen and breast tissue is highly radiation sensitive. As such, there are concerns that regular exposure to ionizing radiation during image-guided procedures may be linked to a higher risk of breast cancer in female healthcare workers.

2. Protection of Patients:

Patients who undergo x-ray procedures are also at risk of radiation exposure. While the amount of radiation exposure during an x-ray procedure is relatively low, repeated exposure over time can increase the risk of developing radiation-induced health conditions. The installation of x-ray radiation shielding ensures that patients are protected from harmful radiation while undergoing x-ray procedures.

3. Regulatory Compliance

Medical facilities that use x-ray equipment are required by law to comply with regulatory guidelines and standards for radiation safety. Failure to comply with these guidelines can result in legal penalties and fines. The installation of x-ray radiation shielding is a critical component of regulatory compliance for medical facilities.

BILL 47: ENSURING SAFETY AND CUTTING RED TAPE ACT, 2020[12]

- Part 7 Compliance and Enforcement Serious injuries, illnesses, incidents and worker exposure to radiation.

Radiation Protection in Radiology—Large Facilities Safety Code 35[13]

- The need for radiation protection exists because exposure to ionizing radiation can result in deleterious effects that manifest themselves not only in the exposed individuals but in their descendants as well. These effects are called somatic and genetic effects, respectively. Somatic effects are characterized by observable changes occurring in the body organs of the exposed individual. These changes may appear within a time frame of a few hours to many years, depending on the amount and duration of exposure to the individual. Genetic effects are an equal cause for concern at the lower doses used in diagnostic radiology. Although the radiation dose may be small and appear to cause no observable damage, the probability of chromosomal damage in the germ cells, with the consequence of mutations giving rise to genetic defects, can make such doses significant for large populations.

- Since it is not possible to measure carcinogenic effects at low doses, estimates of the incidences of radiation effects at low doses are based on linear extrapolation from relatively high doses. Due to the uncertainties with respect to radiological risk, a radiation protection risk model assumes that the health risk from radiation exposure is proportional to dose. This is called the linear no-threshold hypothesis. Since the projected effect of a low dose increases the incidence of a deleterious effect only minimally above the naturally occurring level, it is impossible to prove by observation either the validity or falsity of this hypothesis. However, the linear no-threshold hypothesis has been widely adopted in radiological protection and has led to the formulation of the ALARA (As Low As Reasonably Achievable) principle. The ALARA principle is an approach to radiation protection to manage and control exposures to radiation workers and the general public to as low as is reasonable, taking into account social and economic factors.

- It is necessary that personnel within the facility be protected from excessive exposure to radiation during the course of their work.

British Columbia (Workers' Compensation Appeal Tribunal) v. Fraser Health Authority[14]

- Our interpretation is that if a staff member receives a radiation induced illness and claim it was work related the BC Supreme Courts have set precedent that the Health Authority must prove the illness was not work related. All one has to do to find the Health Authority at fault is to dismantle a shielding partition in the workplace. If the installation has penetrations in the lead shielding, there is no defense as the unknown radiation leakage could cause an accumulative dose rate above the qualified experts shielding designs. By Hiring Lambert this limits the Health Authorities liability as Lambert is known as a qualified expert. LRS is bound by LAW to ensure shielding installation meets codes and regulations.

Fraser Health Authority v. Workers' Compensation Appeal Tribunal[15]

- Liability when using radiation shielding installation methodologies that do not form an unbroken barrier:

  "More precisely, the majority found that the contribution of the employment to their cancers was more than de minimis (or trivial). The majority applied section 250(4) of the Workers Compensation Act, which provides that if the evidence supporting different findings on a compensation issue is evenly weighted WCAT must resolve that issue in a manner that favours the worker"

- Limited liability once a qualified radiation shielding contractor is used with the ARSP radiation shielding barrier without penetrations (radiation hotspots):

  "In the end, WCAT's conclusion was speculative and ignored a policy requirement that there must be positive evidence to support a causal link. The relaxation of the standard of proof in section 250(4) does not assist the workers' when there is no evidence capable of supporting causation."

4. Public Safety:

Medical facilities that use x-ray equipment are located in public areas. The installation of x-ray radiation shielding ensures that the general public is protected from harmful radiation exposure. In addition, the installation of x-ray radiation shielding in medical facilities helps to alleviate public concerns about the safety of x-ray procedures.

X-RAY SHIELDING DESIGN

The design of x-ray radiation shielding barriers is critical to its effectiveness in reducing radiation exposure. The design of x-ray radiation shielding barriers should take into consideration factors such as the type of x-ray equipment, the type of newly introduced procedures performed, and the location of the x-ray room. The design of x-ray radiation shielding should also comply with regulatory guidelines and exceed minimum standards for radiation safety.

If the owner or its agents provide shielding details for the installation of the shielding barriers be aware that the owner is now taking responsiblity for the shielding integrity and any costs attributable by future libel civil claims that will derive from this act, including the costs to repair the radiation shielding barriers in an active hospital. A pandoras box of liability that should be avoided at all costs. Health Authorities should specify that the shielding barriers are constructed as unbroken. The Shielding Contractor will be responsible to meet that requirement.

The thickness and density of the shielding material used in x-ray radiation shielding design, will be as calculated for each site-specific IR shielding barrier by the project's Qualified Radiation Expert, should be sufficient to reduce the amount of radiation that penetrates through it. The type of shielding material used should also be appropriate for the type of radiation being emitted by the x-ray equipment.

The design of x-ray radiation shielding barriers should also take into consideration the placement of the x-ray equipment within the x-ray room. The x-ray equipment should be positioned in a way that minimizes radiation exposure to medical personnel and patients. In addition, the x-ray room should be designed to prevent radiation leakage into adjacent areas.

RADIATION SHIELDING ADVANCEMENTS

1. Advances in materials science and technology have led to the development of new radiation shielding techniques. For example, we (Lambert Radiation Shielding) have introduced the ARSP single wall **dual cavity** penetration free barrier, the only radiation shielding barrier of its kind. This barrier is the only known system to meet the Health Canada Safety Code #35 requirement providing an unbroken barrier. This is also the only system that provides that the X-ray staff are receiving the radiation dose rates calculated by the Medical Physicist period. The ARSP barrier is the first of its kind developed to improve shielding effectiveness and reduced shielding material requirements compared to traditional shielding installation methodologies used here and in underdeveloped countries. There are no excuses to continue to risk costly liability by using antiquated radiation barriers that are known to expose staff and public additional radiation dose due to their poor design.

2. The ARSP system can, if requested, as an option can have an encapsulating coating applied to limit the lead dust in the workplace. This coating is color corresponding to various lead weights to assist the qualified expert during inspections or future room renovations.

3. To help our environment and a major asset to the Health Authority the ARSP barrier has GHG reduction value. Since there are no penetrations to the face of the shielding the radiation shielding barrier plates can be reused for 200 years, the lifespan of the lead. A direct benefit, over todays typical single use radiation barrier, is the potential of saving 150 million pounds of lead from the smelting process every year, globally. In addition, should the workload increase, the GWB can be removed and additional lead plates inserted, to upgrade the attenuation provided, as required.

X-RAY RADIATION SHIELDING INSTALLATIONS

An independent qualified installation specialist must perform the installation of x-ray radiation shielding barriers.

Using a qualified radiation shielding installation contractor has several benefits, including limiting the owner's liability:

1. Expertise and Experience: A qualified radiation shielding installer contractor has the necessary expertise and experience to design, install and test radiation shielding systems. They are familiar with industry standards, codes and regulations, and have the necessary knowledge to ensure that the shielding is designed and installed correctly.

2. Quality Work: A qualified contractor will use high-quality materials and employ proper installation techniques to ensure that the radiation shielding is effective and long-lasting. They will also conduct quality control checks throughout the installation process to ensure that the shielding is installed according to the design specifications.

3. Safety: A qualified radiation shielding installer contractor will prioritize safety during the installation process, ensuring that all workers and occupants are protected from potential radiation hazards. They will also provide proper training for staff on the proper use and maintenance of the shielding systems to ensure continued safety.

4. Compliance: Radiation shielding systems must comply with strict regulations and codes, and a qualified contractor will have a thorough understanding of these requirements. They will ensure that the shielding system is designed and installed to meet all applicable regulations and codes.

5. Cost-Effective: A qualified contractor can provide cost-effective solutions by identifying the most appropriate materials and installation techniques for a particular application. They can also provide ongoing maintenance services to ensure that the shielding system remains effective over time.

Why should you use a qualified radiation shielding installation contractor on your project?

1. It is essential to work with qualified and experienced professionals in this field to ensure that the appropriate measures are taken to protect workers and the general public from the harmful effects of ionizing radiation. Unfortunately, not all contractors who offer radiation shielding services are qualified or experienced enough to provide adequate protection. The use of unqualified contractors can result in substandard shielding, which may fail to protect against radiation exposure.

2. In addition to the dangers of exposure to ionizing radiation, there is also the risk of failed installation methods. Improperly installed radiation shielding can lead to gaps or weaknesses in the shielding material, which can compromise the effectiveness of the shielding. These gaps or weaknesses can result in harmful radiation exposure, leading to serious health consequences for workers and the public.

3. To avoid these risks, it is crucial to work with a reputable and experienced radiation shielding contractor who has the necessary qualifications and expertise to provide high-quality shielding solutions. Lambert Radiation Shielding has a proven track record in this field and has been providing radiation shielding services for 75 years. They use only the latest technology and materials to provide effective and reliable shielding solutions. Furthermore, they have an excellent reputation for delivering projects on time and on budget.

4. We urge you to be diligent when selecting a radiation shielding contractor and to ensure that the contractor you choose has the necessary qualifications and experience to provide effective radiation shielding solutions.

5. We believe that we at Lambert will be a valuable partner in ensuring that your organization is protected from the harmful effects of ionizing radiation and failed installation methods.

Is there a liability when using a low bid, unqualified radiation shielding contractor?

1. Using an unqualified radiation shielding contractor can pose a significant liability risk for your organization. If the contractor does not have the necessary qualifications

and expertise to provide effective radiation shielding solutions, there is a high risk of substandard shielding, which may fail to protect against radiation exposure.

2. If workers or members of the public are exposed to ionizing radiation due to the failure of substandard shielding provided by an unqualified contractor, your organization may be held liable for any resulting harm or damages. This can include legal action, fines, redesign and replacement of radiation shielding barriers and damage to your organization's reputation.

3. Furthermore, if the unqualified contractor fails to install the shielding properly, there is a risk of gaps or weaknesses in the shielding material, which can compromise the effectiveness of the shielding. This can lead to harmful radiation exposure, resulting in serious health consequences for workers and members of the public.

4. To avoid these risks, it is essential to work with a qualified and experienced radiation shielding contractor who has the necessary qualifications, expertise, and experience to provide high-quality shielding solutions. This will help ensure that your organization is protected from the harmful effects of ionizing radiation and that you are not held liable for any resulting harm or damages.

In conclusion, it is vital to take the selection of a radiation shielding contractor seriously and to ensure that you engage the services of a qualified and reputable contractor. Failure to do so can result in significant liability risks for the project and your organization. *It is up to the Owner to ensure the Radiation Shielding Installer is qualified.

Do consultants relieve a Construction Manager or Owner of liability of radiation injuries due to poorly designed radiation shielding barriers?

1. Consultants can provide valuable advice and support to a construction manager or owner in the design and installation of radiation shielding barriers to help protect workers and the public from ionizing radiation. However, they do not necessarily relieve the construction manager or owner of liability for radiation injuries resulting from poorly designed radiation shielding barriers.

2. While consultants can assist with tasks such as designing radiation shielding systems and conducting risk assessments, it is ultimately the responsibility of the

construction manager or owner to ensure that appropriate measures are taken to protect workers and the public from the harmful effects of ionizing radiation. This includes ensuring that radiation shielding barriers are constructed and installed in compliance with all applicable radiation safety regulations and standards by using a Qualified Radiation Shielding Contractor.

3. If radiation injuries occur due to poorly designed radiation shielding barriers on a construction project, and it is determined that the construction manager or owner did not take appropriate measures to prevent these injuries, they may still be held liable for any resulting harm or damages, regardless of whether a consultant was involved in the project.

4. In conclusion, while consultants can provide valuable support and advice in the design and installation of radiation shielding barriers, their opinions do not necessarily relieve a construction manager or owner of liability for radiation injuries resulting from poorly designed radiation shielding barriers. It is essential to ensure that the project is managed carefully and in compliance with all applicable radiation safety regulations and standards to minimize liability risks.

Do consultant's errors and omissions insurance relieve a construction manager or owner of liability of radiation injuries?

5. Consultants' errors and omissions (E&O) insurance can provide a measure of financial protection to both the consultant and the construction manager or owner in the event of a claim arising from the consultant's negligence or professional errors or omissions. However, it does not necessarily relieve the construction manager or owner of liability for radiation injuries.

6. While E&O insurance can provide financial compensation for damages arising from a consultant's professional errors or omissions, it does not necessarily absolve the construction manager or owner of their responsibility to ensure that the project is managed in compliance with all applicable radiation safety regulations and that appropriate measures are taken to protect workers and the public from the harmful effects of ionizing radiation.

7. If radiation injuries occur on a construction project, and it is determined that the construction manager or owner did not take appropriate measures to prevent these

injuries, they may still be held liable for any resulting harm or damages, regardless of whether the consultant has E&O insurance.

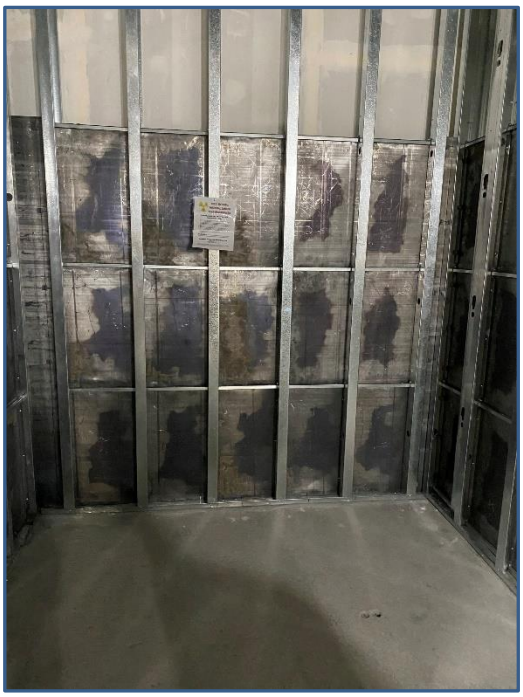
If a Health Authority provides shielding designs and they cause staff a radiation injury will the project construction manager or shielding contractor be held liable

1. If a Health Authority provides shielding designs, in the tender process, and these details are the cause of a staff radiation injury, the liability for the injury would hold the Health Authority accountable. In general, liability for radiation injuries resulting from poorly designed radiation shielding barriers may be shared by multiple parties, including the Health Authority, project construction manager, and shielding contractor.

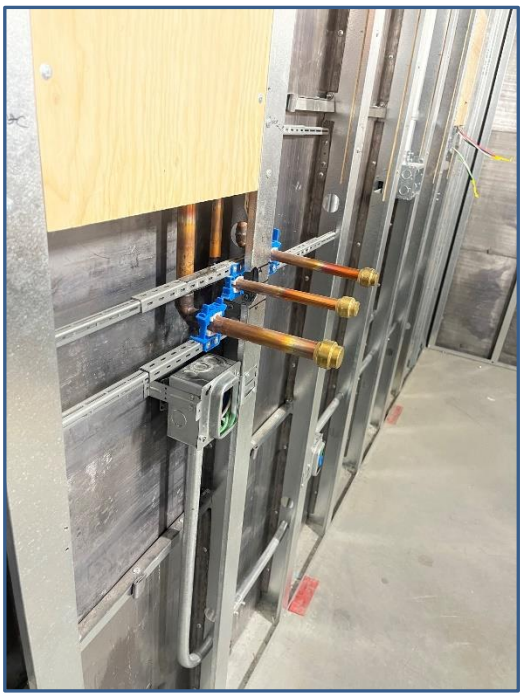
2. The Health Authority may be liable if they provided a shielding design that did not comply with applicable radiation safety regulations and standards or failed to take into account the specific needs and conditions of the construction project. Similarly, the project construction manager and shielding contractor may be liable if they failed to detect and address any deficiencies in the shielding design or failed to ensure that the shielding was installed and used properly.

3. In conclusion, if a Health Authority provides shielding designs that cause staff a radiation injury, the liability for the injury would depend on the specific circumstances of the case. Liability may be shared by multiple parties, including the Health Authority, project construction manager, and shielding contractor, depending on the extent of their involvement and responsibility for the design and installation of the shielding.

ARSP INSTALLATIONS



ARSP INSTALLATIONS



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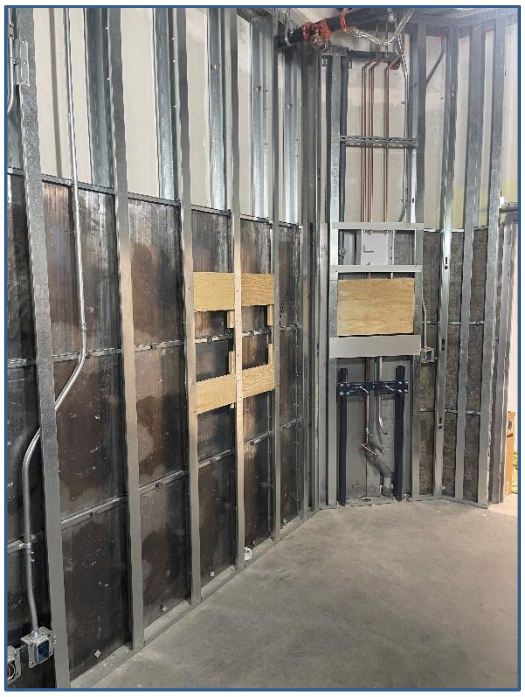
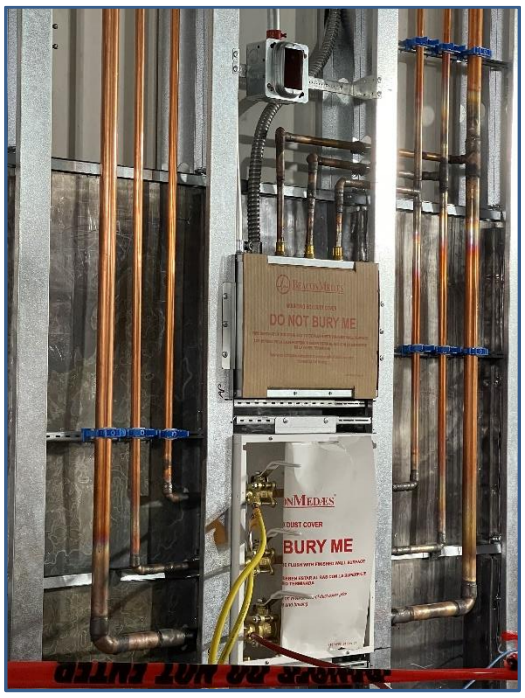
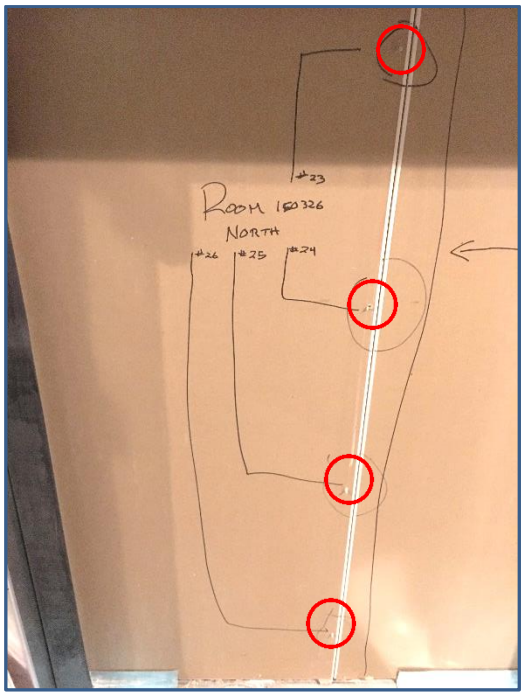
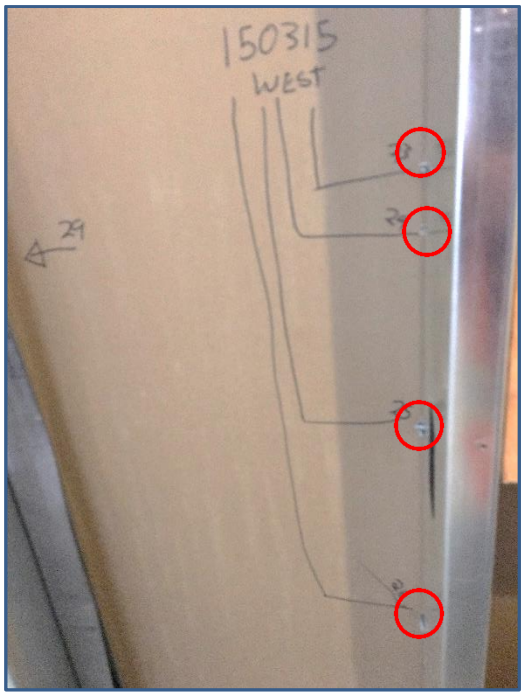


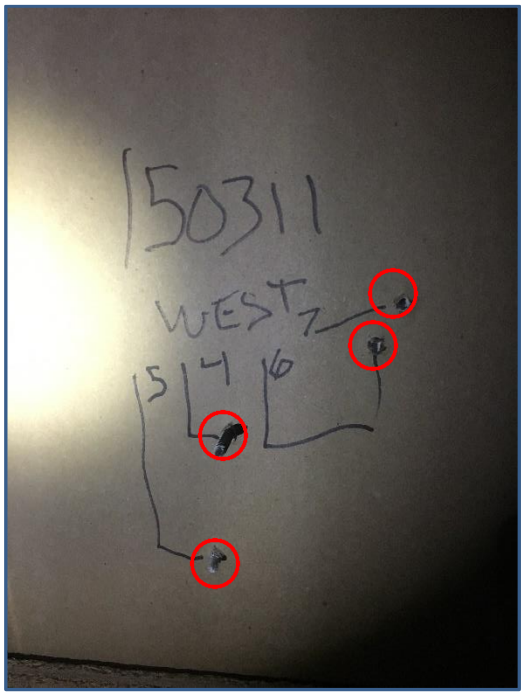


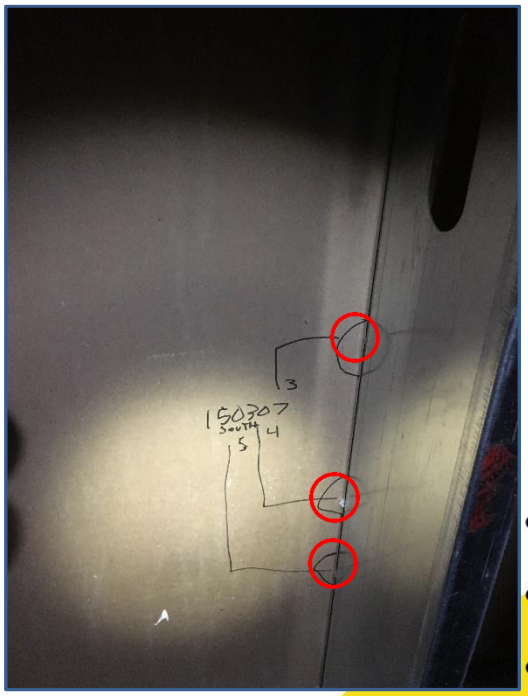
ARSP INSTALLATIONS

TRADITIONAL RADIATION SHIELDING – PENETRATIONS THROUGH THE LEAD SHEETS CAUSING "HOTSPOTS"

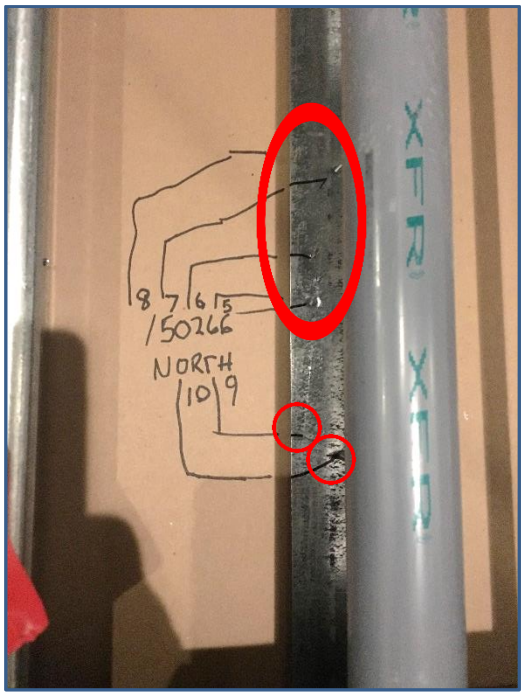


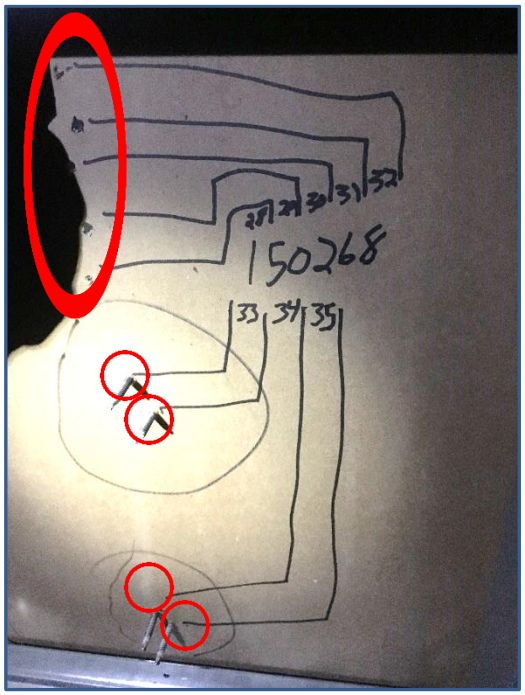


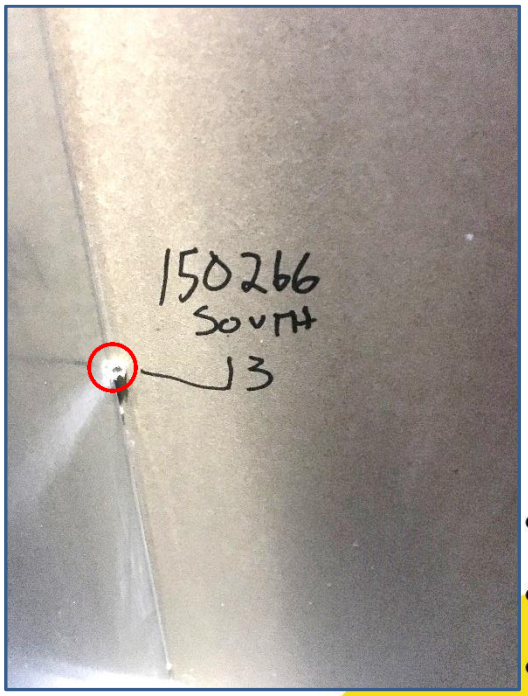




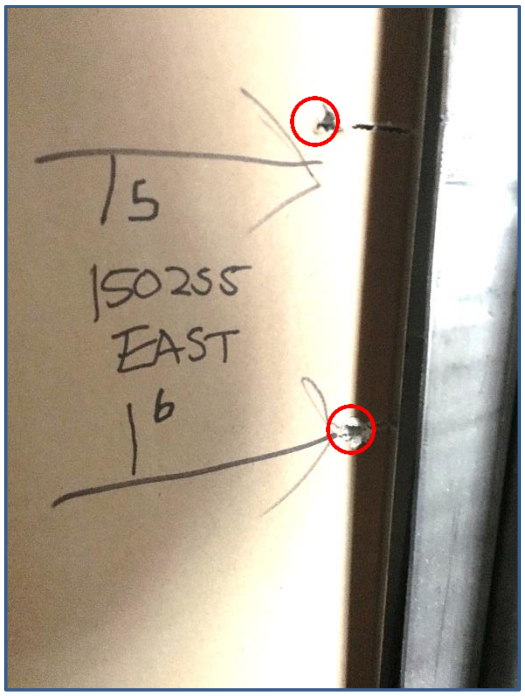
TRADITIONAL RADIATION SHIELDING – PENETRATIONS THROUGH THE LEAD SHEETS CAUSING "HOTSPOTS"

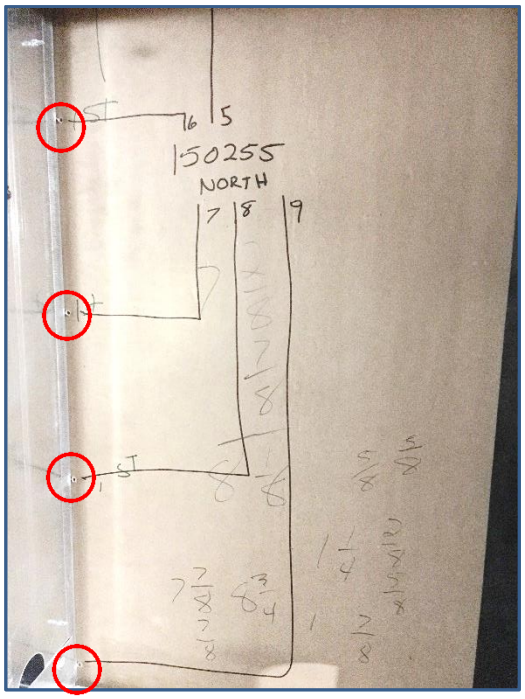


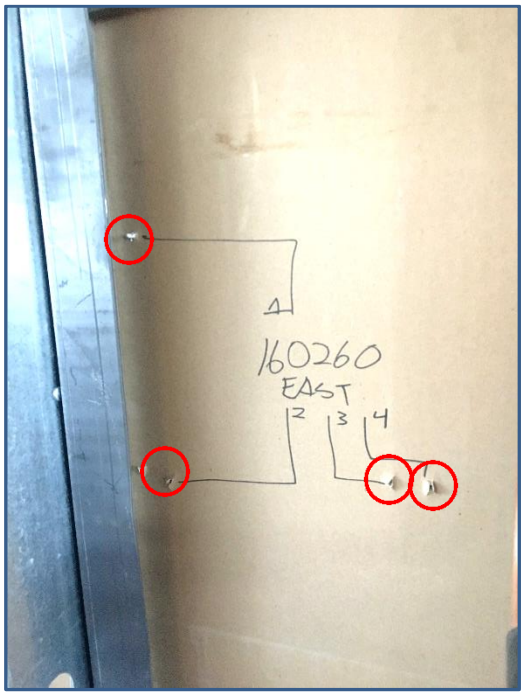


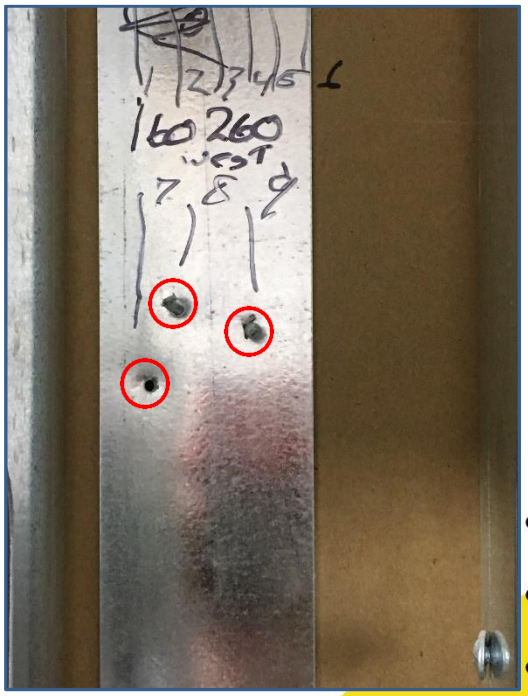


TRADITIONAL RADIATION SHIELDING – PENETRATIONS THROUGH THE LEAD SHEETS CAUSING "HOTSPOTS"









BACKSHIELDING – COSTLY IN BOTH TIME AND MATERIAL BUT NECESSARY TO BAFFLE PENETRATIONS TO THE LEAD

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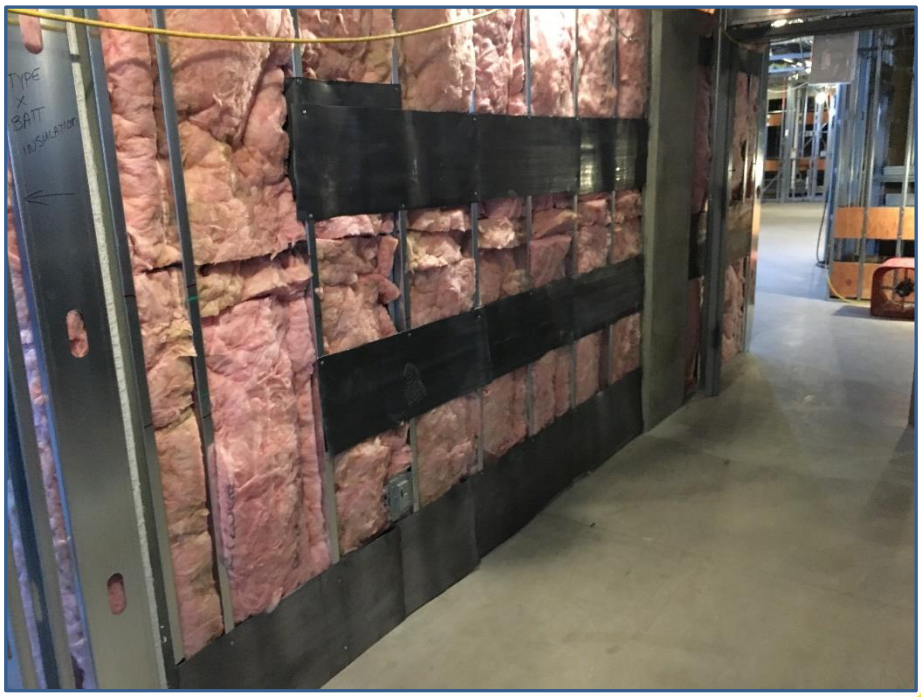
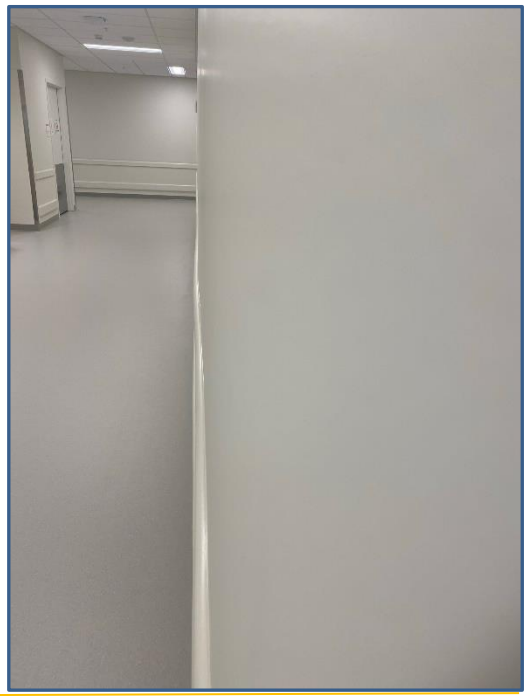
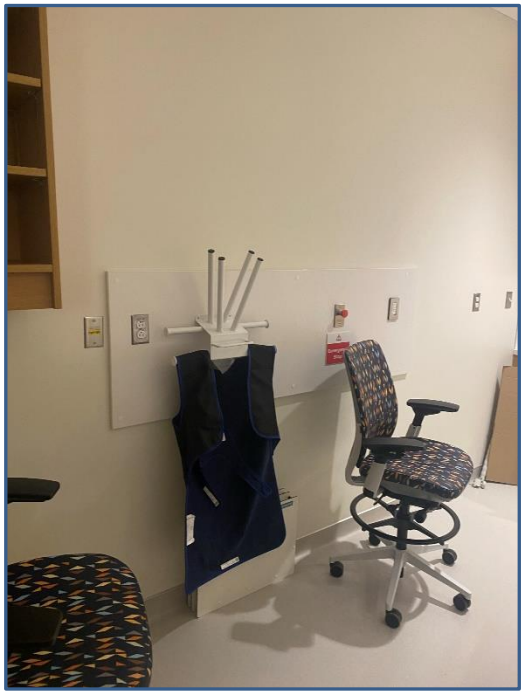


WAVEY WALL – MULTIPLE LAYERS OF LEAD INSTALLED TO BAFFLE PENETRATIONS CAUSES THE DRYWALL TO BULGE CREATING UNSIGHTLY WALLS



EXPOSED LEAD APRON/ELECTRICAL – SINGLE WALL RADIATION BARRIER WITH UGLY EXPOSED ELECTRICAL CONDUIT AND LEAD APRON EXPOSED WOOD BACKING – AN INFECTIOUS DISEASE NIGHTMARE TO HEALTH FACILITIES.



APPENDIX

1. WorkSafeBC ("WCB") Consultation Guidelines G7.18 - Application for Ionizing and Non-Ionizing Radiation Worker Position – Canadian Union of Public Employees (BC)("CUPE")

   https://d3n8a8pro7vhmx.cloudfront.net/cupebcvotes2014/pages/1551/attachments/original/1568060171/Reps_T-McKenna_Submissions_2019_Consultation-Guidelines-G7.18-Ionizing-Radiation_09Sept2019.pdf?1568060171

2. IAEA - OCCUPATIONAL RADIATION PROTECTION IN MEDICINE

   https://www.iaea.org/publications/13660/occupational-radiation-protection

3. BONN CALL FOR ACTION

   https://www.iaea.org/sites/default/files/17/12/bonn-call-for-action.pdf

4. Radiation Protection and Safety: Awareness and Implementation of the Bonn Call for Action Priorities in Canada

   https://www.cadth.ca/radiation-protection-and-safety-awareness-and-implementation-bonn-call-action-priorities-canada

5. Increased lead concentrations in the hairs of radiographers in general hospitals

   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7794336/

6. Regulatory Change A Primer on Protecting Workers from Lead Exposure

   https://www.worksafebc.com/en/resources/law-policy/act-amendments/regulatory-change-primer-protecting-workers-lead-exposure?lang=en

7. Diagnostic X-ray examinations and increased chromosome translocations: evidence from three studies

   https://europepmc.org/article/PMC/PMC3075914

8. Healthcare Workers Occupationally Exposed to Ionizing Radiation Exhibit Altered Levels of Inflammatory Cytokines and Redox Parameters

   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6356728/

9. Variations induced in human erythrocytes by ultra-low X-ray doses.

   https://www.researchgate.net/publication/271199338_Variations_Induced_in_Human_Erythrocytes_by_Ultra-low_X-Ray_Doses_S_Sallam_Journal_of_Biophysical_Chemistry_JBPC_2011

10. Simpkin 147 AAPM

    Copy available upon request.

11. Adequate radiation protection could help prevent breast cancer in female healthcare workers.

    https://www.news-medical.net/news/20230413/Adequate-radiation-protection-could-help-prevent-breast-cancer-in-female-healthcare-workers.aspx

12. BILL 47: ENSURING SAFETY AND CUTTING RED TAPE ACT, 2020

    https://www.canlii.org/en/ab/laws/astat/sa-2020-c-32/latest/sa-2020-c-32.html

13. Radiation Protection in Radiology—Large Facilities Safety Code 35
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/safety-code-35-safety-procedures-installation-use-control-equipment-large-medical-radiological-facilities-safety-code.html
14. British Columbia (Workers' Compensation Appeal Tribunal) v. Fraser Health Authority
https://www.canlii.org/en/ca/scc/doc/2016/2016scc25/2016scc25.html
15. Fraser Health Authority v. Workers' Compensation Appeal Tribunal
https://www.wcat.bc.ca/app/uploads/sites/638/2020/12/FraserHealthAuthority_2016_SCC_25.pdf

And for additional information:

16. ARSP Pamphlet
http://crpa-acrp.org/home/wp-content/uploads/2014/10/Fred-Lambert-ARSP-Pamphlet-Spec-G.pdf
17. HEALTH RISKS FROM EXPOSURE TO LOW LEVELS OF IONIZING RADIATION
https://nap.nationalacademies.org/catalog/11340/health-risks-from-exposure-to-low-levels-of-ionizing-radiation