McGill University Health Centre

Glen Site

Radiation Safety Manual for Class II CNSC Consolidated License

License 01185-31-25.n

Vn 9.0, May 2018

This manual available on MUHC Intranet
This manual available on shared drive and medphys/depdocs
CNSC linked at : www.nuclearsafety.gc.ca

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1. Introduction

The Department of Radiation Oncology and the Medical Physics Department of the *McGill University Health Centre* (MUHC) are licensed by the *Canadian Nuclear Safety Commission* (CNSC) to use Class II Prescribed Equipment and radioactive material in its facilities. MUHC is committed to the achievement of compliance in accordance with the relevant CNSC regulations and license conditions. Furthermore, MUHC is committed to ensuring that:

a) radiation doses to all staff and the public during routine use of radioactive materials and Class II Prescribed Equipment and in the event of an emergency remains As Low As Reasonably Achievable (ALARA), and

b) a high standard of radiological safety is maintained at all times in the work environment, and

c) all relevant laws and regulations with respect to the use of licensed materials and activities related to license conditions are respected.

The purpose of this document is to act as both a radiation safety manual and a quality control document.

Quality control and quality assurance are ensured by means of a comprehensive program in both the Department of Radiation Oncology and the Department of Medical Physics. Some of the committee structure in place to ensure the monitoring of these quality control and assurance activities is listed in the committee obligations of the RSO / Class II in chapter 2 of this manual.

This document is updated as necessary.

The first version of this manual (V 1.0) was submitted to CNSC Oct. 29, 2003.
The second version of the manual (V 2.0) was submitted to CNSC April 2004.
The third version of the manual (V 3.0) was submitted to CNSC September 2007.
The fourth version of the manual (V 4.0) was submitted to CNSC September 2010.
The fifth version of the manual (V 5.0) was submitted to CNSC September 2012.
The sixth version of the manual (V 6.0) was submitted to CNSC April 2014.
The seventh version of the manual (V 7.0) was submitted to the CNSC October 2015 following the move to the Glen site in May/June 2015.
The eighth of the manual (V 8.0) was submitted to the CNSC in October 2016.
This version of the manual (V 9.0) was submitted to the CNSC in May 2018.

This document can be found on the MUHC intranet website (Departments/Quality management/Radiation Protection)
This document is on the MUHC internal Depdocs site.
This document is on the public drive on the MUHC Radiation Oncology intranet.

2. Organizational Structure

The ultimate responsibility for radiation safety lies with the Chief Executive Officer of the MUHC. This responsibility is exercised in three ways.

First, the responsibility for safety is delegated to those managers who are responsible for work involving radioactive materials or equipment that generates ionizing radiation. Managers are responsible for ensuring that all work is conducted in accordance with the relevant CNSC license and regulations, and MUHC procedures. Responsibility for safety also rests with each individual working with radioactive materials or radiation generating equipment.

Second, the Class II Radiation Safety Officer for the MUHC Radiation Oncology and Medical Physics departments is delegated by and reports directly to the Chief of Medical Physics to advise on the status of radiation safety issues, including standards of compliance with current regulations and license conditions. The RSO/Class II also maintains a link with the MUHC Director of Quality and Risk Management for administration of matters with regard to radiation safety in the MUHC. The RSO/Class II is a Canadian College of Physicists in Medicine (CCPM) certified physicist who is involved with the clinical, administrative, research and teaching activities of the Departments of Radiation Oncology and Medical Physics. The RSO/Class II must be certified by the CNSC according to REGDOC 2.2.3.

Third, radiation safety is overseen by the MUHC Medical Physics and Radiation Oncology Radiation Safety Committee (RSC). This radiation safety committee is composed of responsible managers and relevant parties and, through a member of MUHC senior management or delegate, reports to the Chief Executive Officer of the MUHC.

2.1

Medical Physics and Radiation Oncology Radiation Safety Committee
Terms of Reference
Approved November 30 2006
Revised April 2014
Revised October 2015
Revised May 2018

Accountability

The Medical Physics and Radiation Oncology Radiation Safety Committee reports jointly to the Radiation Oncology QA Committee, and to the MUHC Chief Executive Officer. A Senior Management Representative of the MUHC belongs to both the Medical Physics and Radiation Oncology Radiation Safety Committee, and the Committee on Medical Imaging and Radiation Protection, thus ensuring communication through to MUHC senior management. An organogram illustrating lines of communication is below.

Purposes

The purposes of the Radiation Safety Committee are as follows:

a) To provide overall co-ordination of the radiation safety program of the Medical Physics and Radiation Oncology departments of the MUHC;
b) To ensure that both the Medical Physics and Radiation Oncology departments consider, and conform to, relevant standards and recommendations where applicable;
c) To review reports from committee members and/or representations from other individuals;
d) To provide a platform for the resolution of conflict on radiation safety issues;
e) To evaluate, and respond to, developments in relevant legislation and technology;
f) To assist in the production of the "*Radiation safety and quality assurance manual for Class II CNSC licenses*";
g) To maintain, review and update the "*Radiation safety and quality assurance manual for Class II CNSC licenses*" on a timely basis;
h) To advise and remain current on the development of standards and recommendations in the broader medical physics and radiation oncology community;
i) To assist in maintaining compliance with all regulations and requirements related to the Canadian Nuclear Safety Commission (CNSC);
j) To maintain written records of all meetings.

Membership

The membership of the Committee is, but not limited to, the following:

- Chief: Medical Physics
- Director: Medical Physics
- Manager Radiation Oncology Department (or delegate)
- Senior Management Representative (or delegate)
- Radiation Safety Officer Class II

- Chief Dosimetrist (or delegate)
- Medical Physicists as invited
- Invitees as requested

Structure

a) Chair
- Chief of Medical Physics.

b) Secretary
- Radiation Safety Officer Class II (MUHC)

c) Members
- Appointed by the committee.

Meetings

Meetings are held up to four times per year. Exceptional meetings may be arranged as required. Quorum, where required for a substantial decision, is 4 members including the Chief of Medical Physics, the manager of Radiation Oncology or delegate, the Radiation Safety Officer, and the representative from senior management. Normal meeting business may be carried out, in good faith, without quorum.

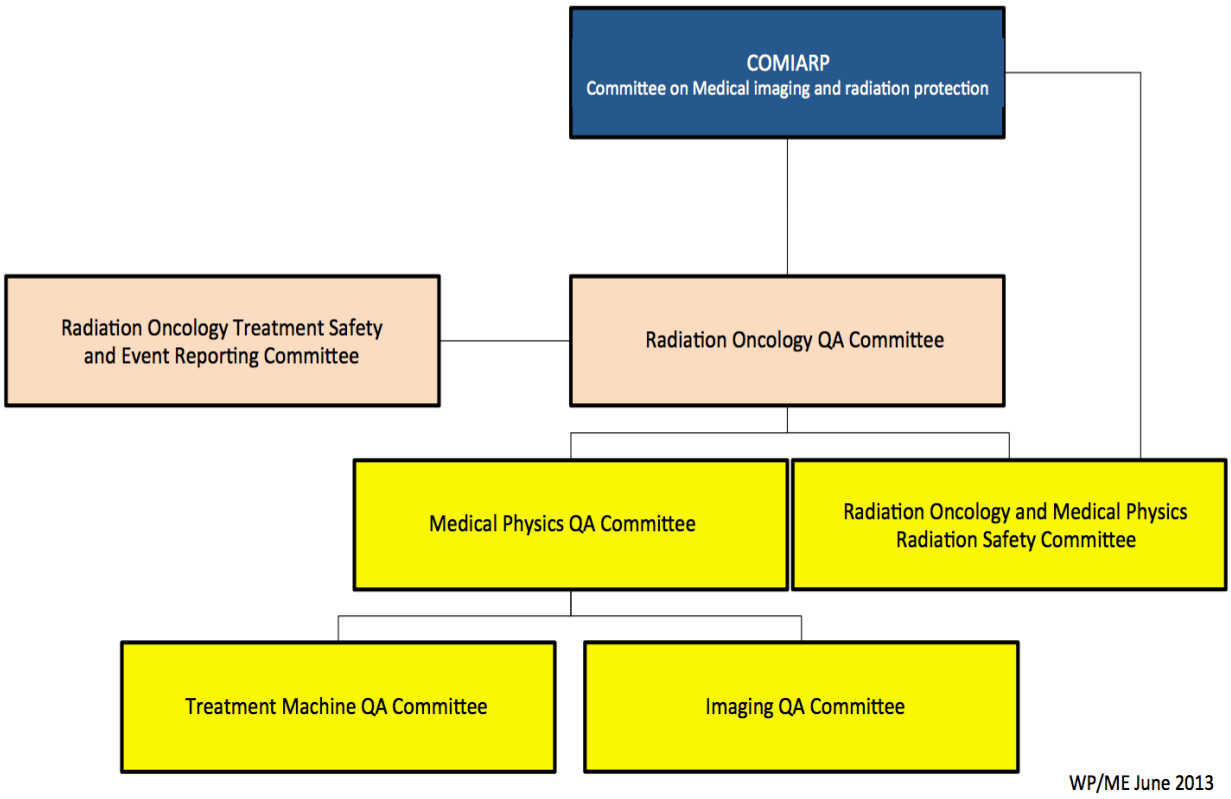
Meeting Outline (typical, not prescribed):

1 Agenda
2 Minutes of Last Meeting, Action Items
3 MUHC related items
4 CNSC related items
5 Radiation Incidents
6 Security
7 Reports and Discussion
8 Training
9 Any other items
10 Date for next meeting

An organigram of the relationship between the RSO/Class II and the administrative structure of the MUHC is shown schematically below.

Centre universitaire de santé McGill — McGill University Health Centre

Radiation Oncology and Medical Physics Committee Structures



Committee obligations and responsibilities of the RSO / Class II are listed below.

a) The RSO/Class II reports to, and is a sitting member of, the Medical Physics and Radiation Oncology Radiation Safety Committee (see above).

b) The RSO/Class II submits reports as requested to the MUHC Radiation Oncology Quality Assurance Committee.

c) The RSO/Class II reports to, and is a sitting member of, the Medical Physics Quality Assurance Committee.

d) The RSO/Class II submits reports as requested to the MUHC COMIARP (Committee on Medical Imaging and Radiation Protection).

e) The RSO/Class II reports to the weekly Medical Physics departmental meeting.

f) The RSO/Class II reports to the weekly Service Engineer's departmental meeting.

Some but not all of the duties exercised by the RSO, related to radiation safety, include the management of the following:

Radiation Safety Committee,
Policies & Procedures (Radiation Safety Manual),
License Management,
CNSC Liason,
RSO designation,
Inventory Control and Reporting of Lost Sources,
Shipping and Receiving,
Education/Training,
Dose Control (OSLD management),
Employee Management,
Worker and activity authorization,
Security Liaison,
Security Systems Testing
QA and QC procedures,
Emergency procedures,
Survey Meters and Leak Tests,
Inspection & audit preparation,
Record Keeping,
Corporate Authority and Liaison.
CNSC Financial Guarantees and AMPs

The RSO/Class II is authorized to be in direct contact with the CNSC regarding licensing matters (see chapter 3) and is designated to have Signing Authority with respect to CNSC licensing matters.

Authority to suspend treatment and / or to close a Class II licensed machine is authorized by any of the following four individuals:

1 The Medical Director of the Department of Radiation Oncology,
2 The Manager of the Department of Radiation Oncology,
3 The Chief of Medical Physics and
4 The RSO / Class II.

Designated Replacement / Back-up RSO and Qualified Person definitions

The CNSC has formalized certification requirements for Class II Radiation Safety Officer (RSO). In October 2009, all Class II licences were amended with a new licence condition **(LC 2995)**: *The licensee shall designate, in writing, as radiation safety officer (RSO) with respect to the licensed activities, the person currently performing the duties of RSO*.

The Chief of Medical Physics will function as the Designated Replacement, and is authorized to act upon all of the duties of the RSO.

In addition, all clinical medical physicists are authorized to act as back-up RSOs in the absence of the RSO or the Chief of Medical Physics. In this capacity it is anticipated that the back-up RSO will handle local situations and incidents pertaining to the immediate safe operations of the Medical Physics and Radiation Oncology department, while leaving other management type activities of the RSO until the return of the RSO or Designated Replacement. As an example the back-up RSO might be expected to deal with the following situations:

- emergency closing of Class II equipment,
  (for example due to operational or security problems)
- other emergency situations
- personnel dosimetry distribution and management
- receipt of sources
- minor contact with the CNSC.

In order to facilitate off-hours operations and emergency treatments a qualified person must be on-site at any time class II equipment is being used. The MUHC thus designates all authorized workers as defined in Chapter 4 of the Radiation Safety Manual to be qualified persons. Thus all radiation therapists, medical physicists, service engineers and qualified graduate students are recognized as qualified persons and are deemed competent to use Class II equipment. These qualified persons are not required to perform the duties of the RSO.

The Class II RSO and backup Class II RSOs are available off hours through the telephone call down list distributed to the MUHC locating department (x 53333 or operator).

3. Licenses

The following table provides describes the CNSC Class II license held by the MUHC.

CNSC License No.	Type of License	Expiry Date
01185-31-25.n	Consolidated (526)	Nov 30, 2025
Item	Manual brachytherapy	
Item	Operate and service medical accelerator and other radiotherapy facilities …	

Licenses are held by the RSO/Class II. A notice of license activity is posted according to General Nuclear Safety and Control Regulations GNSCR 14(1).

The RSO/Class II maintains all appropriate CNSC licenses.
The RSO/Class II maintains all appropriate third party service provider CNSC licenses (Varian, Nucletron-Elekta, Accuray …).
The RSO/Class II co-ordinates license applications, amendments, renewals and revocations.
The RSO/Class II co-ordinates submission of the annual compliance reports on the licensed activity to the CNSC.
The RSO/Class II co-ordinates license renewal applications to the CNSC on a timely basis as required prior to the expiry of the license.
The RSO/Class II coordinates CNSC inspections and audits.
The RSO/Class II maintains the CNSC Sealed Source Tracking System for designated licenses where appropriate.
The RSO/Class II maintains and updates source inventory, and reports discrepancies to the CNSC.
The RSO/Class II co-ordinates wipe testing on a frequency as required by the CNSC license.

The RSO/Class II ensures that a properly calibrated survey meter is available and that calibration is performed on a frequency as required by the CNSC license.
The RSO/Class II co-ordinates and reports to the CNSC any exceeded action levels.

The RSO/Class II maintains a record of, and reports to the CNSC, any reportable incidents as defined in Section 29 & 30 of the General Nuclear Safety and Control Regulations.

The RSO/Class II is authorized to communicate with the CNSC on matters related to relevant MUHC licenses.

The CNSC 24 hour duty officer can be located at (613) 995-0479.

4. Authorization

Authorization to perform activities governed by the Class II, Radiation Oncology and Medical Physics CNSC licenses are assigned by job title. Authorization by job title is implied, whereas authorization to an individual may be explicitly assigned or denied. Authorized use refers to unsupervised operation of equipment and performance of activities under federal and provincial legislation where appropriate.

The Departments of Radiation Oncology and Medical Physics comply with Section 20 of the Class II Nuclear Facilities and Prescribed Equipment Regulations whereby "No licensee shall use Class II prescribed equipment on a person except as directed by a medical practitioner who is qualified to give such direction under the applicable provincial legislation".

Authority to suspend treatment and / or to close a Class II licensed machine is authorized by the following four individuals (see Chapter 2):

1 The Medical Director of the Department of Radiation Oncology,
2 The Manager of the Department of Radiation Oncology,
3 The Chief of Medical Physics and
4 The RSO / Class II.

The job title of *Medical Physicist* includes medical physicists and medical physics residents associated with the hospital or university Medical Physics departments.

For the purposes of authorization, second year Medical Physics Masters (M.Sc.2), Ph. D graduate students, post doctoral fellows are included in this group.

The job title of *Service Engineer* includes electronics engineers and electronics technologists who are members of the Medical Physics Department. As required, manufacturers' service technicians and engineers may also be included at the discretion of the Class II RSO or the Chief of Medical Physics.

The job title of *Radiation Therapists* (sometimes referred to as Radiation Technologists) describes staff deemed competent to treat patients as required by provincial regulations and departmental policies. The manager of the Department of Radiation Oncology assigns staff to this job title.

The job title of *Dosimetrist* includes dosimetrists in the Department of Medical Physics.

The job title of *Radiation Oncologist* includes Radiation Oncology staff physicians.

Authorized users are responsible for ensuring the safe operation of authorized work.

CNSC LICENSE AUTHORIZATION BY JOB TITLE

CNSC License No.	Type of License	Authorized Users
01185-31-25.n	Consolidated (526)	Radiation Oncologist Radiation Therapist Medical Physicist Service Engineer
Item	Manual brachytherapy	Radiation Oncologist Radiation Therapist Medical Physicist
Item	Operate medical accelerator and other radiotherapy facilities …	Radiation Oncologist Radiation Therapist Medical Physicist Service Engineer
Item	Service medical accelerator and other radiotherapy facilities …	Service Engineer Medical Physicist

Security and Access

Security at the Glen site is administered by the GISM (Groupe Infrastructure Santé McGill) under the governance of the MUHC security department.

Access to the department is controlled by pass cards.

Active monitoring of CCTV systems and access to entry points and doors is recorded.

Mandatory Training

Mandatory training is required for all Authorized Users. Mandatory training is given once and comprises the following:

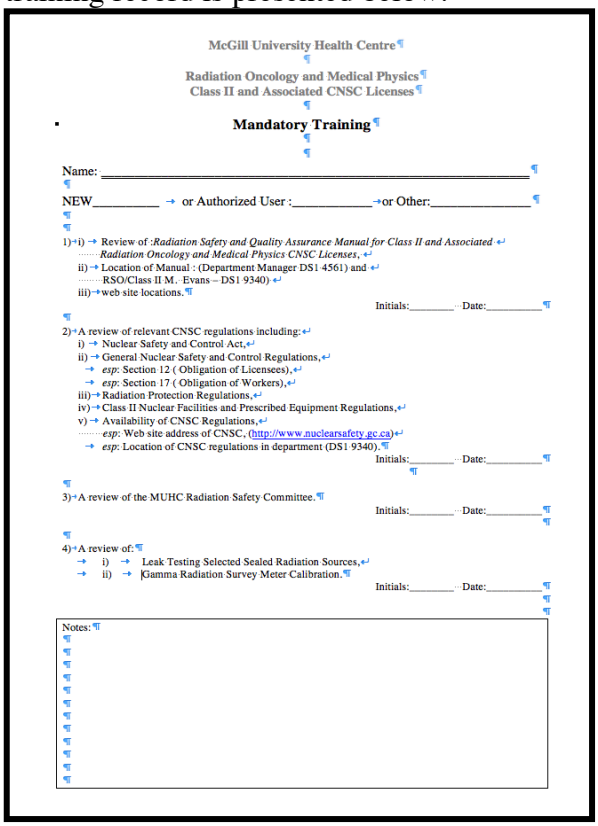
a) i) A review of the *Radiation Safety and Quality Assurance Manual for Class II and Associated Radiation Oncology and Medical Physics CNSC Licenses*,
ii) Location of Manual: Room locations (Radiation Oncology Department Manager and RSO/Class II) and web site locations.

b) A review of relevant CNSC regulations including:
i) Nuclear Safety and Control Act,
ii) General Nuclear Safety and Control Regulations,
esp: Section 12 (Obligation of Licensees),
esp: Section 17 (Obligation of Workers),
iii) Radiation Protection Regulations,
iv) Class II Nuclear Facilities and Prescribed Equipment Regulations,
v) Availability of CNSC Regulations,
esp: Web site address of CNSC, (http://www.nuclearsafety.gc.ca)
esp: Location of CNSC regulations in department (DS1 9340).

c) A review of the MUHC Radiation Safety Committee.

d) Where appropriate a review of:
i) Requirements for Leak Testing Selected Sealed Radiation Sources,
ii) Requirements for Gamma Radiation Survey Meter Calibration.

A sample mandatory training record is presented below:



McGill University Health Centre

Radiation Oncology and Medical Physics
Class II and Associated CNSC Licenses

Mandatory Training

Name: _____

NEW_____ or Authorized User :_____or Other:_____

1) i) Review of :*Radiation Safety and Quality Assurance Manual for Class II and Associated Radiation Oncology and Medical Physics CNSC Licenses*,
ii) Location of Manual : (Department Manager DS1 4561) and
RSO/Class II M. Evans – DS1 9340)
iii) web site locations.
Initials:_____ Date:_____

2) A review of relevant CNSC regulations including:
i) Nuclear Safety and Control Act,
ii) General Nuclear Safety and Control Regulations,
esp: Section 12 (Obligation of Licensees),
esp: Section 17 (Obligation of Workers),
iii) Radiation Protection Regulations,
iv) Class II Nuclear Facilities and Prescribed Equipment Regulations,
v) Availability of CNSC Regulations,
esp: Web site address of CNSC, (http://www.nuclearsafety.gc.ca)
esp: Location of CNSC regulations in department (DS1 9340).
Initials:_____ Date:_____

3) A review of the MUHC Radiation Safety Committee.
Initials:_____ Date:_____

4) A review of:
i) Leak Testing Selected Sealed Radiation Sources,
ii) Gamma Radiation Survey Meter Calibration.
Initials:_____ Date:_____

Notes:

Refresher Training

Refresher training is given on a yearly basis for Nuclear Energy Workers (see chapter 5). Refresher training is given on an *ad hoc* basis for selected employee groups. Medical Physics staff receive updates on radiation safety as recorded in the weekly departmental administrative meeting.

Enhanced training for core staff responsible for responding to HDR brachy emergency situations is given to selected radiation therapists, radiation oncologists, nurses and physicists as described in chapter 7 of this manual. This instruction describes appropriate response to emergencies. HDR training is given on a yearly basis.

Visitors

The Department of Radiation Oncology and the Department of Medical Physics receive many visitors as part of their teaching mandates. Visitors may include students (Physician, Physicists or Technologists), administrators, other health professionals and members of the general public.

Visitors may not act in the capacity of a Nuclear Energy Worker or an Authorized User.

Visitors may be present in areas under the control of an Authorized User, and are under the supervision of an Authorized User.

Visitors are not permitted to be in control of Class II Prescribed Equipment.

Visitors are not required to assist in emergency situations except under the specific conditions of Section 15 (3) of the CNSC Radiation Protection Regulations whereby:
The dose limits prescribed by sections 13 and 14 and subsection (1) may be exceeded by a person who acts voluntarily to save or protect human life.

Visitors are not given Mandatory Training.

Visitors who stay in the department are not issued a personal dosimeter, as per Section 8 of the CNSC Radiation Protection Regulations whereby:
Every licensee shall use a licensed dosimetry service to measure and monitor the doses of radiation received by and committed to nuclear energy workers who have a reasonable probability of receiving an effective dose greater than 5 mSv in a one-year dosimetry period.

Visitors from other institutions (such as CNSC inspectors, Dawson students, third party service providers, etc.) may wear their own dosimeter should they so choose, however the MUHC Class II facility governed by this license bears no responsibility for reviewing, recording, interpreting or analyzing the results of these dosimeters. The RSO may request the visitor to remove his / her dosimeter at any time.

Visitors and staff are not authorized to conduct radiation surveys without the express permission of the RSO. Visitors and staff are not authorized to conduct area radiation monitoring.

Visitors are not issued a dosimeter unless deemed necessary by the RSO / Class II.

Visitor activity and periods of stay are not recorded.

5. Maximum Permissible Doses and Action Levels

In accordance with the CNSC Radiation Protection Regulations, personal external radiation exposure can be measured using a personal dosimeter (OSLD) issued by a Dosimetry Service approved by the CNSC.

OSLD distribution will be limited to Nuclear Energy Workers in the following categories: Radiation Therapists, Medical Physicists, Medical Physics service engineers. Medical staff including nurses, radiation oncologists and medical residents will not normally be required to wear OSLDs. Other staff such as clerical workers, ancillary staff, administration, etc. are also not required to wear OSLDs. Dosimetrists remain classified as Nuclear Energy Workers, however since their work area is remote from the radiation therapy bunkers, they are not required to wear OSLDs.

The following table lists current staff categories, NEW status and OSLD assignment.

Staff title	NEW	OSLD
Therapists	yes	yes
Medical Physicists	yes	yes
Service engineers	yes	yes
Dosimetrists	yes	no
Radiation Oncologists	no	no
Medical Residents	no	no
Nursing staff	no	no
Clerical staff	no	no
Ancillary staff	no	no
Visitors	no	no
Students	no	no

Area OSLDs are located at the linac and HDR brachytherapy console.

For HDR brachytherapy operation, staff that do not normally wear a OSLD may use an area OSLD as they enter the brachy suite to manage an emergency. It is not obligatory to use a OSLD in managing an emergency as there are multiple methods of estimating personal dose received during management of an emergency (ie calculation, measurement, other OSLD users, …).

Medical Physics graduate students (M.Sc., Ph.D., visiting students and post doc fellows) are not NEWs and normally do not require OSLDs. When deemed necessary, these students will be assigned OSLDs, and this distribution is reviewed at the Medical Physics Radiation Safety committee meeting.

Visitors from other institutions (such as CNSC inspectors, Dawson students, third party service providers, etc.) may wear their own dosimeter should they so choose, however the MUHC Class II facility governed by site license 01185 bears no responsibility for reviewing, recording, interpreting or analyzing the results of these OSLDs. The RSO may request the visitor to remove his / her dosimeter at any time. (see chapter 4).

A OSLD may be distributed on an ad hoc basis by the RSO Class II.

NEWs and other staff issued with a OSLD are required to wear their OSLD at all times during which they are working with Class II or other radiation related activities. The RSO/Class II maintains a list of Nuclear Energy Workers and personnel issued with OSLDs.

OSLDs are distributed and returned by designated staff in the Department of Radiation Oncology and the Department of Medical Physics. When OSLDs are not in use (off hours, vacation etc.) they should be left in the department or in the designated area.

OSLDs are reviewed for Action Level excess by the RSO / Class II.

5.1 Nuclear Energy Workers

Nuclear energy workers (NEWs) are defined in accordance with the CNSC Nuclear Safety and Control Act.

In the Department of Radiation Oncology and Medical Physics the following people are designated as NEWs:

Medical Physicists,
Medical Physics Residents,
Service Engineers,
Dosimetrists
Radiation Therapists (sometimes referred to as radiation technologists).

Other staff may be declared as NEWs on an *ad hoc* basis as deemed necessary by the Class II / RSO.

Workers designated as NEW are given an information package and they sign a NEW declaration, a copy of which follows this chapter.

5.2 Dose limits and action levels

Dose limits and action levels are governed in accordance with the CNSC Radiation Protection Regulations (sec. 13 and 14).

When an action level limit has been exceeded, in accordance with license conditions, the RSO/Class II will report in writing to the CNSC.

When a dose limit has been exceeded, in accordance with Radiation Protection Regulations (16), the RSO/Class II will (a) immediately notify the person and the CNSC of the dose, (b) require the person to leave any work that is likely to add to the dose, (c) conduct an investigation to determine the magnitude of the dose and to establish the causes of the exposure, (d) identify and take any action required to prevent the occurrence of a similar incident and (e) within 21 days after becoming aware that the dose limit has been exceeded, report to the CNSC the results of the investigation or on the progress that has been made in conducting the investigation. In accordance with Radiation Protection Regulations (17), the RSO/Class II will apply to the CNSC for an authorization of return to work.

Table 5.1: Effective Dose Limits – current to June 6 2016

PERSON	PERIOD	EFFECTIVE DOSE
Nuclear energy worker, including a pregnant nuclear energy worker	One-year dosimetry period Five-year dosimetry period	50 mSv 100 mSv
Pregnant nuclear energy worker	Balance of the pregnancy	4 mSv
A person who is not a nuclear energy worker	One calendar year	1 mSv

NOTE: The doses specified above do not apply to ionizing radiation received by:

a) A patient in the course of medical diagnosis or treatment by a qualified medical practitioner.

b) A person carrying out emergency procedures as described in CNSC Radiation Protection Regulations (15).

Table 5.2: Equivalent Dose Limits – current to June 6 2016

ORGAN OR TISSUE	PERSON	PERIOD	EQUI DOSE
Lens of an eye	Nuclear energy worker, Any other person	One-year dosimetry period One calendar year	150 mSv 15 mSv
Skin	Nuclear energy worker, Any other person	One-year dosimetry period One calendar year	500 50
Hands and feet	Nuclear energy worker, Any other person	One-year dosimetry period One calendar year	500 50

In order to retain control over the radiation safety program, and in accordance with CNSC Radiation Protection Regulations (sec. 6), action levels are defined. When an action level limit has been exceeded, in accordance with license conditions, the RSO/Class II will report in writing to the CNSC. The following MUHC action levels were approved by the CNSC May 31, 2004.

Table 5.3: Whole Body Action Levels

Worker	PERIOD	EFFECTIVE DOSE
NEW	Quarter-year dosimetry period One-year dosimetry period	5 mSv 5 mSv
A person who is not a nuclear energy worker	Quarter-year dosimetry period One-year dosimetry period	0.5 mSv 0.5 mSv

Memorandum MUHC - CUSM

De/From: Michael Evans. RSO/Class II
Date: 11 September, 2003

À/To: Radiation oncology technologists, Technologues en radio-oncologie
Electronic engineers, Ingénieurs en électronique
Medical physicists, Physiciens médicaux

Objet/Subject: Nuclear Energy Worker designation,
Désignation de travailleur du secteur nucléaire.

Pursuant to the Radiation Protection Regulations of the Nuclear Safety and Control Act, this note is to inform you are designated as a *Nuclear Energy Worker* (NEW), as defined in the Nuclear Safety and Control Act.
This memorandum describes who qualifies as a nuclear energy worker, the requirements of the licensee to a nuclear energy worker, the applicable dose limits and the risks associated with these limits.
Please read the following information, sign and return the attached form to acknowledge your designation as a nuclear energy worker. If you have any questions, please feel free to contact me.

Pour donner suite au Règlement sur la radioprotection de la Loi sur la sûreté et la réglementation nucléaires, la présente est pour vous informer que vous êtes considéré(e) comme «travailleur du secteur nucléaire» tel que défini dans la Loi sur la sûreté et la réglementation nucléaires.
Vous trouverez dans ce mémorandum la description d`un travailleur du secteur nucléaire, les obligations du titulaire du permis envers les travailleurs du secteur nucléaire ainsi que la liste des limites de dose applicables et des risques associés à ces limites.
Veuillez prendre connaissance des documents pré-cités, signer et retourner le formulaire dans lequel vous reconnaissez la désignation de travailleur du secteur nucléaire. Si vous avez des questions, n`hésitez pas à me contacter..

Déclaration
J`ai lu le mémorandum intitulé «Désignation de travailleur du secteur nucléaire» et je reconnais la désignation de travailleur du secteur nucléaire. Je comprends qu`il est possible de recevoir une dose de rayonnement ionisant supérieure à la limite réglementaire fixée pour la population en général et j`accepte les risques associés à ces nivaux d`exposition.

Nom _____

N.A.S _____

Date de Naissance_____

Departement _____

Date _____

Signature_____

Declaration
I have read the memorandum entitled "Nuclear Energy Worker designation" and I acknowledge that I am classified as a nuclear energy worker. I understand there is a possibility I may receive a dose of radiation that is greater than the prescribed limit for the general public and I accept the risks associated with these levels of exposure.

Name _____

S.I.N. _____

Date of Birth_____

Department _____

Date _____

Signature_____

Nuclear Energy Worker

The Nuclear Safety and Control Act defines a nuclear energy worker as follows:

> **"nuclear energy worker"** « ***travailleur du secteur nucléaire*** »
> "nuclear energy worker" means a person who is required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public.

Requirements of the Licensee

As a condition to the Radiation Protection Regulations (Sec. 7) the following provision of information must be given to all nuclear energy workers:

> **Provision of Information**
> **7.** **(1)** Every licensee shall inform each nuclear energy worker, in writing,
> **(*a*)** that he or she is a nuclear energy worker;
> **(*b*)** of the risks associated with radiation to which the worker may be exposed in the course of his or her work, including the risks associated with the exposure of embryos and foetuses to radiation;
> **(*c*)** of the applicable effective dose limits and equivalent dose limits prescribed by sections 13, 14 and 15; and
> **(*d*)** of the worker's radiation dose levels.
>
> **(2)** Every licensee shall inform each female nuclear energy worker, in writing, of the rights and obligations of a pregnant nuclear energy worker under section 11 and of the applicable effective dose limits prescribed by section 13.
>
> **(3)** Every licensee shall obtain from each nuclear energy worker who is informed of the matters referred to in paragraphs (1)(*a*) and (*b*) and subsection (2) a written acknowledgement that the worker has received the information.

Pregnant Nuclear Energy Workers

The obligations of a pregnant nuclear energy worker are (Radiation Protection Regulations Sec.11):

> **Pregnant Nuclear Energy Workers**
> **11.** **(1)** Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee in writing.
>
> **(2)** On being informed by a nuclear energy worker that she is pregnant, the licensee shall, in order to comply with section 13, make any accommodation that will not occasion costs or business inconvenience constituting undue hardship to the licensee.

Dose Limits

The effective and equivalent dose limits from Sec. 13–15 of Radiation Protection Regulations are:

Effective Dose Limits

13. (1) Every licensee shall ensure that the effective dose received by and committed to a person described in column 1 of an item of the table to this subsection, during the period set out in column 2 of that item, does not exceed the effective dose set out in column 3 of that item.

	Column 1	Column 2	Column 3
Item	Person	Period	Effective Dose (mSv)
1.	Nuclear energy worker, including a pregnant nuclear energy worker	(*a*) One-year dosimetry period	50
		(*b*) Five-year dosimetry period	100
2.	Pregnant nuclear energy worker	Balance of the pregnancy	4
3.	A person who is not a nuclear energy worker	One calendar year	1

Equivalent Dose Limits

14. (1) Every licensee shall ensure that the equivalent dose received by and committed to an organ or tissue set out in column 1 of an item of the table to this subsection, of a person described in column 2 of that item, during the period set out in column 3 of that item, does not exceed the equivalent dose set out in column 4 of that item.

	Column 1	Column 2	Column 3	Column 4
Item	Organ or Tissue	Person	Period	Equivalent Dose (mSv)
1.	Lens of eye	(a) Nuclear energy worker	(*a*) One-year dosimetry period	150
		(b) Any other person	(*b*) One calender year	15
2.	Skin	(a) Nuclear energy worker	(*a*) One-year dosimetry period	500
		(b) Any other person	(*b*) One calender year	50
3.	Hands and feet	(a) Nuclear energy worker	(*a*) One-year dosimetry period	500
		(b) Any other person	(*b*) One calender year	50

Dose Limits

Emergencies

15. (1) During the control of an emergency and the consequent immediate and urgent remedial work, the effective dose and the equivalent dose may exceed the applicable dose limits prescribed by sections 13 and 14, but the effective dose shall not exceed 500 mSv and the equivalent dose received by the skin shall not exceed 5 000 mSv.

(2) Subsection (1) does not apply in respect of pregnant nuclear energy workers who have informed the licensee in accordance with subsection 11(1).

(3) The dose limits prescribed by sections 13 and 14 and subsection (1) may be exceeded by a person who acts voluntarily to save or protect human life.

Radiation Risks

The risks associated with exposure to radiation may be classified as either stochastic effects or deterministic effects. The effective dose limits keep an acceptable risk for stochastic effects, while the equivalent dose limits are designed to **prevent** deterministic effects.

Stochastic effects include both cancer induction and genetic effects. They are not thought to have any dose threshold since one photon is sufficient to induce a cellular change resulting in a precancerous cell or a genetic mutation. The *International Commission on Radiological Protection* (ICRP) has studied and published rates in Publication 60 and 103, which we summarize in the following table:

TABLE 1. Nominal Probability Coefficients for Stochastic Detriment (ICRP Publication 60)

	Nuclear Energy Worker	Public
Fatal cancer	0.04/Sv	0.05/Sv
Non-fatal cancer (weighted)	0.008/Sv	0.01/Sv
Severe hereditary effects (all future generations)	0.008/Sv	0.013/Sv
Total	0.056/Sv	0.073/Sv

Members of the public includes children and hence the public has slightly higher risks than nuclear energy workers.

Given these rates, what do they imply about your lifetime risk as a nuclear energy worker?

We can address this question by looking at the maximum risk and the typical risk. The maximum risk occurs when you receive your maximum allowable dose every year of your career. For a 50 year career, this represents a 0.056 chance of an induced cancer or hereditary effect.

Equivalently, about 1 person in 18 exposed at this level would have an induced effect. However, the maximum possible lifetime risk is a gross overestimate because no person would be allowed to chronically receive their maximum allowable dose. In radiotherapy the typical annual dose received in less than one tenth the maximum annual allowable dose. Correspondingly your lifetime risk of an induced effect is reduced to less than 0.0056 or equivalently less than 1 person in 180. To put the size of this risk of an induced cancer or hereditary effect in perspective, your lifetime risk for these effects from exposure to natural background radiation is three times higher and the risk of cancer from any cause is fifty times higher.

For pregnant nuclear energy workers, the risks to the fetus are slightly higher than to the mother because a fetus has developing organs and tissues. The risk of an induced cancer or hereditary effect to the fetus from the maximum-allowable 4 mSv exposure is about 0.0003 or 1 fetus in 3400. Again, the maximums are seldom achieved and a more realistic estimate would be less than 1 fetus in 13000. This comparable to the risk of an induced cancer or hereditary effect associated with the natural background radiation, which affects 1 fetus in 6000.

The risk for deterministic effects, (e.g. congenital malformations) in fetuses are higher than for adults and can occur at lower doses. The effective and equivalent dose limits prevent these effects from occurring but these limits could be exceeded in emergency situations. Consequently pregnant nuclear energy workers are excluded from taking action in emergency situations. Moreover, as a hospital policy, pregnant nuclear energy workers are assigned to duties with lower risk of exposure to keep their occupational exposure low.

Dosimetry Results

All nuclear energy workers (with the exception of Dosimetrists) are issued OSLD badges to monitor their exposure to radiation. At the MUHC, we subscribe to a service provided by the Radiation Protection Bureau branch in Health Canada. The badges are exchanged every three months, analyzed and a report is issued with the results of the readings. The reports are available by request to the respective manager. In each column, there are two doses listed, one above the other. The first line refers to your body dose and the second line refers to your skin dose. Currently, the minimum reportable dose is 0.1 mSv. Dose readings above this value are recorded into your record whereas dose readings below this value are recorded as 0 and indicated by a “-” in the report.

General Nuclear Safety and Control Regulations

OBLIGATIONS

Obligations of Licensees
12. (1) Every licensee shall
(*a*) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;
(*b*) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;
(*c*) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security;
(*d*) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;
(*e*) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence;
(*f*) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity;
(*g*) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;
(*h*) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;
(*i*) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;
(*j*) instruct the workers on the physical security program at the site of the licensed activity and on their obligations under that program; and
(*k*) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.

(2) Every licensee who receives a request from the Commission or a person who is authorized by the Commission for the purpose of this subsection, to conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment, to modify procedures or to install a new system or new equipment shall file, within the time specified in the request, a report with the Commission that contains the following information:
(*a*) confirmation that the request will or will not be carried out or will be carried out in part;
(*b*) any action that the licensee has taken to carry out the request or any part of it;
(*c*) any reasons why the request or any part of it will not be carried out;
(*d*) any proposed alternative means to achieve the objectives of the request; and
(*e*) any proposed alternative period within which the licensee proposes to carry out the request.

Obligations of Workers
17. Every worker shall
(*a*) use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible and reasonable manner and in accordance with the Act, the regulations made under the Act and the licence;
(*b*) comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment;
(*c*) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be

(i) a significant increase in the risk to the environment or the health and safety of persons,
(ii) a threat to the maintenance of security or an incident with respect to security,
(iii) a failure to comply with the Act, the regulations made under the Act or the licence,
(iv) an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information, or
(v) a release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee;
(*d*) observe and obey all notices and warning signs posted by the licensee in accordance with the *Radiation Protection Regulations*; and
(*e*) take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of security.

Travailleur du secteur nucléaire

La Loi sur la sûreté et la réglementation nucléaires définit le travailleur du secteur nucléaire comme suit:

> **« travailleur du secteur nucléaire » "nuclear energy worker"**
> Personne qui, du fait de sa profession ou de son occupation et des conditions dans lesquelles elle exerce ses activités, si celles-ci sont liées à une substance ou une installation nucléaire, risque vraisemblablement de recevoir une dose de rayonnement supérieure à la limite réglementaire fixée pour la population en général.

Obligations du titulaire de permis

D`après le Règlement sur la radioprotection (Sec.7), tout travailleur du secteur nucléaire doit recevoir l`information suivante:

> **Renseignements à fournir**
> **7.** **(1)** Le titulaire de permis avise par écrit chaque travailleur du secteur nucléaire :
> ***a*)** du fait qu'il est un travailleur du secteur nucléaire;
> ***b*)** des risques associés au rayonnement auquel il peut être exposé dans l'exécution de son travail, y compris ceux associés à l'exposition des embryons et des foetus au rayonnement;
> ***c*)** des limites de dose efficace et de dose équivalente applicables qui sont prévues aux articles 13, 14 et 15;
> ***d*)** de ses niveaux de doses de rayonnement
>
> **(2)** Lorsque le travailleur du secteur nucléaire est une femme, le titulaire de permis l'avise par écrit des droits et des obligations de la travailleuse enceinte du secteur nucléaire qui sont prévus à l'article 11 ainsi que des limites de dose efficace applicables qui sont prévues à l'article 13.
>
> **(3)** Le titulaire de permis obtient du travailleur du secteur nucléaire une confirmation écrite que les renseignements mentionnés aux alinéas 7(1)*a*) et *b*) et au paragraphe 7(2) lui ont été communiqués.

Travailleuses enceintes du secteur nucléaire

Les obligations d`une travailleuse enceinte du secteur nucléaire sont (Sec.11 du Règlement sur la radioprotection):

Travailleuses enceintes du secteur nucléaire

11. (1) La travailleuse du secteur nucléaire qui apprend qu'elle est enceinte en avise immédiatement par écrit le titulaire de permis.

(2) Après avoir été avisé de la grossesse, le titulaire de permis prend les dispositions prévues à l'article 13 qui n'entraînent aucune contrainte financière ou commerciale excessive.

Limites de dose de rayonnement

Les limites de dose efficace et équivalente du Règlement sur la radioprotection (Sec. 13–15 du Règlement sur la radioprotection) sont:

Limites de dose efficace

13. (1) Le titulaire de permis veille à ce que la dose efficace qui est reçue par une personne visée à la colonne 1 du tableau du présent paragraphe, et engagée à son égard, au cours de la période prévue à la colonne 2 ne dépasse pas la dose efficace figurant à la colonne 3.

	Colonne 1	Colonne 2	Colonne 3
Article	Personne	Période	Dose efficace (mSv)
1.	Travailleur du secteur nucléaire, y compris une travailleuse enceinte	*a*) Période de dosimét rie d'un an	50
		b) Période de dosimét rie de cinq ans	100
2.	Travailleuse enceinte du secteur nucléaire	Le reste de la grossesse	4
3.	Personne autre qu'un travailleur du secteur nucléaire	Une année civile	1

Limites de dose équivalente

14. (1) Le titulaire de permis veille à ce que la dose équivalente qui est reçue par un organe ou un tissu mentionné à la colonne 1 du tableau du présent paragraphe, et engagée à son égard, d'une personne visée à la colonne 2 durant la période prévue à la colonne 3 ne dépasse pas la dose équivalente figurant à la colonne 4.

	Colonne 1	Colonne 2	Colonne 3	Colonne 4
Article	Organe ou tissu	Personne	Période	Dose équivalente (mSv)
1.	Cristallin	*a*) Travailleur du secteur nucléaire	Période de dosimétrie d'un an	150
		b) Toute autre personne	Une année civile	15
2.	Peau	*a*) Travailleur du secteur nucléaire	Période de dosimétrie d'un an	500
		b) Toute autre personne	Une année civile	50
3.	Mains et pieds	*a*) Travailleur du secteur nucléaire	Période de dosimétrie d'un an	500
		b) Toute autre personne	Une année civile	50

Limites de dose de rayonnement

Situations d'urgence

15. (1) Pendant la maîtrise d'une situation d'urgence et pendant les travaux de réparation immédiats et urgents qui s'ensuivent, la dose efficace et la dose équivalente peuvent dépasser les limites de dose applicables qui sont prévues aux articles 13 et 14, mais la dose efficace ne peut être supérieure à 500 mSv et la dose équivalente reçue par la peau, à 5 000 mSv.

(2) Le paragraphe (1) ne s'applique pas à l'égard de la travailleuse enceinte du secteur nucléaire qui a avisé le titulaire de permis conformément au paragraphe 11(1).

(3) Lorsqu'une personne agit de son propre chef pour sauver ou protéger une vie humaine, les limites de dose qui sont prévues au paragraphe (1) et aux articles 13 et 14 peuvent être dépassées.

Risques associés au rayonnement

Les risques associés à une exposition au rayonnement peuvent être classés comme étant à effets stochastiques ou à effets déterministes. Les limites de dose efficace maintiennent un risque acceptable pour les effets stochastiques pendant que les limites de dose équivalente sont établies afin de **prévenir** les effets déterministes.

Les effets stochastiques incluent à la fois l`induction de cancers et les effets génétiques. Ils ne sont pas considérés comme ayant une dose seuil puisqu`un seul photon suffit pour induire un changement cellulaire résultant en une cellule précancéreuse ou une mutation génétique. La

Commission Internationale sur la Radioprotection (CIRP) a publié le résultat de ses études sur ces incidences (Publication 60 et 103) qui sont résumées dans le tableau suivant:

TABLE 1. Coefficients de probabilité nominale pour les effets stochastiques (CIRP Publication 60)

	Travailleur du secteur nucléaire	**Public**
Cancer mortel	0.04/Sv	0.05/Sv
Cancer non-mortel (corrigé)	0.008/Sv	0.01/Sv
Effets héréditaires sévères (toutes générations futures)	0.008/Sv	0.013/Sv
Total	0.056/Sv	0.073/Sv

La population en général inclue les enfants et, conséquemment, ce groupe a des risques légèrement plus élevés que les travailleurs du secteur nucléaire.

En considérant ces taux, quelles sont les implications sur le risque à vie pour un travailleur du secteur nucléaire?

Nous pouvons répondre à cette question en considérant le risque maximal et le risque typique. Le risque maximal se produit lorsque vous recevez votre dose maximale permise chaque année de votre carrière. Pour une carrière qui s`échelonne sur 50 ans, ceci représente un risque de 0.056 de causer une induction de cancer, un effet héréditaire ou l`équivalent, c`est-à-dire que 1 personne sur 18 exposée à cette dose maximale serait affectée. Cependant, le risque maximal qu`il est possible d`observer pendant toute une vie est une estimation grossière parce qu`il n`est permis à personne de recevoir, année après année, la dose annuelle maximale permise. En radiothérapie, la dose annuelle typique reçue est moins que le dixième de la dose maximale permise et le risque à vie est réduit proportionnellement à moins de 0.0056, c`est-à-dire que seulement 1 personne sur 180 exposée à cette dose serait affectée. Pour illustrer ce risque, mentionnons que l`exposition au rayonnement naturel comporte un risque à vie trois fois plus élevé d`induire un cancer ou un effet héréditaire et que le risque de développer un cancer provenant d`autres causes est cinquante fois plus élevé.

Pour les travailleuses enceintes du secteur nucléaire, les risques au foetus sont légèrement supérieurs à ceux encourus par la mère parce que le foetus a des organes et des tissus en développement. Le risque d`une induction de cancer ou d`un effet héréditaire chez le foetus résultant de l`exposition maximale permise de 4 mSv est d`environ 0.0003, c`est-à-dire 1 foetus sur 3 400 serait affecté. Puisque les expositions maximales sont rarement atteintes, un niveau de risque plus réaliste serait plutôt que moins de 1 foetus sur 13 000 serait affecté. Ceci se compare au risque associé avec le rayonnement naturel qui affecte 1 foetus sur 6 000.

Les risques pour les effets déterministes (i.e. malformations congénitales) chez les foetus sont plus élevés que chez les adultes et peuvent se produire à des doses moins élevées. Les limites de dose efficace et équivalente empêchent ces effets de se produire mais ces limites pourraient être dépassées lors de situations d`urgence. Par conséquent, les travailleuses enceintes du secteur nucléaire sont relevées des tâches qui présentent des risques d`exposition en cas d`urgence. De plus, la politique de l`hôpital en ce domaine recommande que les travailleuses enceintes du

secteur nucléaire soient assignées à des tâches comportant un faible risque d`exposition aux radiations.

Affichage du rapport d`exposition aux radiations

Tous les travailleurs du secteur nucléaire (sauf les "dosimetrists") reçoivent un dosimètre thermoluminescent qui enregistre leur niveau d`exposition à la radiation. À CUSM, le service de dosimétrie est assuré par le Bureau de radioprotection, une division de Santé Canada. Les dosimètres sont échangés tous le trois mois, analysés et un rapport des doses reçues est émis. Les rapports sont disponible, sur demande, de votre chef déquipe. Dans chaque colonne, deux doses apparaissent l`une au-dessus de l`autre. La première ligne indique la dose corporelle et la deuxième ligne indique la dose à la peau. Présentement, la dose minimale qui peut être rapportée est de 0.1 mSv. Les doses dépassant ce niveau sont inscrites dans le dossier tandis que les doses inférieures à ce niveau sont indiquées par un «-» dans le rapport

Règlement général sur la sûreté et la réglementation nucléaires

OBLIGATIONS

Obligations du titulaire de permis
12. (1) Le titulaire de permis :
a) veille à ce qu'il y ait suffisamment de travailleurs qualifies pour exercer l'activité autorisée en toute sécurité et conformément à la Loi, à ses règlements et au permis;
b) forme les travailleurs pour qu'ils exercent l'activité autorisée conformément à la Loi, à ses règlements et au permis;
c) prend toutes les précautions raisonnables pour protéger l'environnement, préserver la santé et la sécurité des personnes et maintenir la sécurité;
d) fournit les appareils exigés par la Loi, ses règlements et le permis et les entretient conformément aux spécifications du fabricant;
e) exige de toute personne se trouvant sur les lieux de l'activité autorisée qu'elle utilise l'équipement, les appareils et les vêtements et qu'elle suive les procédures conformément à la Loi, à ses règlements et au permis;
f) prend toutes les précautions raisonnables pour contrôler le rejet de substances nucléaires radioactives ou de substances dangereuses que l'activité autorisée peut entraîner là où elle est exercée et dans l'environnement;
g) met en oeuvre des mesures pour être alerté en cas d'utilisation ou d'enlèvement illégal d'une substance nucléaire, d'équipement réglementé ou de renseignements réglementés, ou d'utilisation illégale d'une installation nucléaire;
h) met en oeuvre des mesures pour être alerté en cas d'acte ou de tentative de sabotage sur les lieux de l'activité autorisée;
i) prend toutes les mesures nécessaires pour aider le Canada à respecter tout accord relatif aux garanties qui s'applique;
j) donne aux travailleurs de la formation sur le programme de sécurité matérielle sur les lieux de l'activité autorisée et sur leurs obligations aux termes du programme;
k) conserve un exemplaire de la Loi et de ses règlements applicables à l'activité autorisée à un endroit où les travailleurs peuvent les consulter facilement.

(2) Le titulaire de permis qui reçoit une demande de la Commission ou d'une personne autorisée par elle à agir en son nom pour l'application du présent paragraphe, le priant d'effectuer une épreuve, une analyse, un inventaire ou une inspection relativement à l'activité autorisée, d'examiner ou de modifier une conception, de modifier de l'équipement, de modifier des procedures ou d'installer un nouveau système ou équipement, dépose auprès de la Commission, dans le délai mentionné dans la demande, un rapport qui comprend les renseignements suivants :
a) la confirmation qu'il donnera suite ou non à la demande en tout ou en partie;
b) les mesures qu'il a prises pour donner suite à la demande en tout ou en partie;
c) tout motif pour lequel il ne donnera pas suite à la demande en tout ou en partie;
d) toute mesure de rechange proposée pour atteindre les objectifs de la demande;
e) tout autre délai proposé pour donner suite à la demande.

Obligations du travailleur
17. Le travailleur :
a) utilise d'une manière responsable, raisonnable et conforme à la Loi, à ses règlements et au permis, l'équipement, les appareils, les installations et les vêtements pour protéger l'environnement, préserver la santé et la sécurité des personnes, ou déterminer les doses de rayonnement, les débits de dose ou les concentrations de substances nucléaires radioactives;
b) se conforme aux mesures prévues par le titulaire de permis pour protéger l'environnement, préserver la santé et la sécurité des personnes, maintenir la sécurité et contrôler les niveaux et les doses de rayonnement, ainsi que le rejet de substances nucléaires radioactives et de substances dangereuses dans l'environnement;
c) signale sans délai à son supérieur ou au titulaire de permis toute situation où, à son avis, il pourrait y avoir :
(i) une augmentation considérable du niveau de risque pour l'environnement ou pour la santé et la sécurité des personnes,
(ii) une menace pour le maintien de la sécurité ou un incident en matière de sécurité,
(iii) un manquement à la Loi, à ses règlements ou au permis,
(iv) un acte de sabotage à l'égard d'une substance nucléaire, d'équipement réglementé ou de renseignements réglementés, ou leur vol, leur perte ou leur utilisation ou possession illégales,
(v) le rejet, non autorisé par le titulaire de permis, d'une quantité d'une substance nucléaire radioactive ou d'une substance dangereuse dans l'environnement;
d) observe et respecte tous les avis et mises en garde affichés par le titulaire de permis conformément au *Règlement sur la radioprotection*;
e) prend toutes les précautions raisonnables pour veiller à sa propre sécurité et à celle des personnes se trouvant sur les lieux de l'activité autorisée, à la protection de l'environnement et du public ainsi qu'au maintien de la sécurité.

5.3 Pregnant Workers

In accordance with CNSC Radiation Protection Regulations (sec. 13) doses during the balance of the pregnancy are kept below 4 mSv. In addition NEWs are required to follow the CNSC Radiation Protection Regulations (sec. 11).

Pregnant Nuclear Energy Workers

11. (1) Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee in writing.

(2) On being informed by a nuclear energy worker that she is pregnant, the licensee shall, in order to comply with section 13, make any accommodation that will not occasion costs or business inconvenience constituting undue hardship to the licensee.

At the MUHC a policy for pregnant technologists has been in effect since 1991, and revised in 2003. It was revised in Sep. 2007. This policy was revised September 2010. Following the move to the Glen site, this policy was revised in Jan 2016.

Pregnant workers are not removed from high energy linacs (bunkers 1 to 7) for radiation safety reasons. Supporting data for this change has been submitted to the CNSC. Pregnant workers are reassigned according to existing MUHC policy (unrelated to radiation safety) regarding the management of pregnant workers.

Once a pregnant Nuclear Energy Worker has informed the licensee that she is pregnant, a single replacement OSLD will be issued. This, and subsequent, replacement OSLDs will record the dose to the worker (if any) over the duration of the pregnancy. Staff will continue to be placed in the appropriate work environment by the Manager of the Department of Radiation Oncology or the Chief of Medical Physics as appropriate and according to MUHC guidelines.

OSLD use for other pregnant workers shall be determined at the discretion of the managers of the Radiation Oncology and Medical Physics Departments and the RSO Class II.

Restrictions for the HDR brachytherapy unit are designed to prevent the pregnant NEW from being placed in an emergency situation whereby the worker might have to remove a patient during a “source-jam”; otherwise there is no increased inherent danger due to radiation from working in the HDR brachytherapy area.

Radiation safety for pregnant technologists

The recommendations regarding work assignment, related to radiation safety regulations (CNSC Radiation Protection Regulations 11(1)(2)) on radiotherapy machines for pregnant NEWs are as follows:

a)	CT-simulators	**NO RESTRICTIONS**
b)	linear accelerators (bunkers 1 to 7)	**NO RESTRICTIONS**
c)	manual brachytherapy treatments with radioactive sources	**RESTRICTED**
d)	HDR remote afterloading brachytherapy units	**RESTRICTED**

Note: A pregnant NEW should not work on machines designated as **RESTRICTED.**

6. Purchase, Inventory, Storage and Signs

6.1 Purchase, Inventory and Storage of Radioisotopes

RSO/Class II approves sealed source purchases and maintains records. Following receipt, the RSO or back-up RSO (see chapter 2), checks the package with respect to the manufacturer‘s inventory. The RSO maintains a valid TDG (Transport of Dangerous Goods) training certificate covering items related to source receipt.

The RSO/Class II maintains an inventory of sealed sources. The inventory provides details on the sources as well as their location.

The RSO/Class II maintains the Sealed Source Tracking System for designated CNSC licenses as required. If necessary, the RSO reports on lost sources to the CNSC

In accordance with the CNSC Radiation Protection Regulations, radioactive source containers are identified with the radiation-warning symbol, name of its isotope, activity and reference date.

In general, there are very few scheduled radioactive source purchases that occur under Class II Radiation Oncology and Medical Physics activities and no radioactive material or radiation device is received without an appropriate CNSC license.

Four times per year (approximately every three months) a replacement source for the HDR afterloading device is received in the Department of Radiation Oncology. The RSO/Class II is aware of the upcoming source arrival and notifies relevant staff.

Source disposal is co-ordinated by the RSO / Class II.

Depleted Ir-192 sources are removed by Nucletron / Elekta using the services of FedEx. On line tracking is used to ensure that the source arrives at the final destination correctly.

Other sources acquired under CNSC licenses are disposed of according to CNSC Nuclear Substances and Radiation Devices Regulations. Typically the CNSC is informed of disposal.

6.2 Labelling and Signs

As per Radiation Regulations (Sec. 21 (a and b)), areas governed by the CNSC licenses are marked with a durable and legible sign that bears the radiation warning symbol and the words "RAYONNEMENT – DANGER – RADIATION" for effective dose rates greater than 25 μSv/hr (2.5 mR/hr). As per Nuclear Substances and Radiation Devices Regulations (Sec. 22 and 23), and where required, signs and labels will also bear the name of a responsible person as well as telephone numbers that can be activated 24 hours a day. A sample sign is included below.

Where deemed necessary, the X-Ray tube warning sign is posted.

Selected telephone numbers are as follows:

43533	Duty clinical physicist
43532	Duty brachytherapy physicist
48052	Medical Physics department
45533	RSO Class II office
42676	Chief Medical Physics office
53333	Locating
55555	Operator

EN CAS D'URGENCE
(RAYONNEMENT)

In case of

EMERGENCY
(RADIATION)

Call physics personnel for assistance as listed below:

Rejoindre un(e) physicien(ne) à un des numéros suivants:

Medical Physics Department
Département de Physique Médicale

514 934-8052

After normal working hours:

Après les heures de travail régulières:

55555 (Operator) ou / or

514 934-1934 x 55555 (Operator)

7. Brachytherapy

General

Brachytherapy activities at the McGill University Health Center (MUHC) are governed by CNSC licenses and applicable provincial legislation. Brachytherapy activities are comprised of High-Dose-Rate (HDR) and Low-Dose-Rate (LDR) treatments. The majority of treatments are delivered with the HDR afterloading device, while a small subset of patients may be treated with contact therapy.

7.1 Radiation safety for HDR brachytherapy

7.1.1 PERFORMANCE CHECK PROCEDURES

Performance checks are to be performed every day, or prior to treatment – whichever results in fewer operations. This includes emergency or unscheduled treatments on weekends and days on which the clinic does not normally run. As of July 2016 these tests are recorded using the ATLAS QA software

CONSOLE and EMERGENCY TOOLS

1. Turn the console computer on and launch the application. The Treatment Control Station (TCS) will go through a self-test. Insert the key into the console.

2. Verify that the emergency suture kit is in the treatment room, and that the sterilization date has not been exceeded.

3. Verify that the forceps and other emergency source handling tools are accessible.

4. Verify that the emergency safe is in an accessible location.

SAFETY CHECKS AND INTERLOCKS

5. Log in and prepare the "patient" used for the morning QA tests on the TCS. This treatment set up is usually performed with the ruler tool and transfer tube inserted into channel # 1. The length is about 1400 mm and the treatment time is about 120 seconds for a source activity of 10.0 Ci. Commence the "treatment" and verify that the irradiation begins as expected.

6. With the source out verify that the radiation monitor in the treatment room is functioning (see # 16 below). Verify that the radiation warning light on the console is functioning properly.

7. With the source out verify that the warning light over the treatment room turns on.

8. With the source out press INTERRUPT on the console and verify that the source retracts successfully.

9. With the source out press the EMERGENCY STOP button on the console and verify that the source retracts successfully. Open the door, engage the LPO and exit the room. Reset the console interlock with the key.

10. With the source out open the treatment room and verify that the source retracts successfully. Verify that the audible alarm can be heard and that it stops once the source is retracted.

11. With the door still open attempt to run the unit. Verify that it is not possible to run the unit.

12. Close door without pressing the LPO and verify that it is not possible to run the unit.

13. Enter the treatment room and press the time-delay interlock button. Wait for 120 seconds. Close the treatment room door and attempt to run the unit. Verify that it is not possible to send the source OUT.

14. Resume irradiation and verify that the treatment terminates correctly as expected.

15 At the afterloader inside the room, press the red EMERGENCY STOP button. With the button still pressed down, leave the room and go to the console. Verify that the "Emergency ACTIVE" message has become active at the bottom of the display. Return inside the room and reset the EMERGENCY STOP button by pressing it again. Return to the console, reset the alert and verify that the message at the bottom of the monitor reads "Emergency INACTIVE".

16. Verify that the survey meter is working by placing it above the source safe of the microSelectron. As you approach this position from outside the room you should see the needle rise from a zero reading to about 0.5 mR/hr (5.0 μ Sv/hr) or so depending upon the current source strength.

Turn on the pocket dosimeter and let it warm up for about 30 seconds. Place it at a distance of about 2 meters from the microSelectron. Run the microSelectron and retrieve the dosimeter and check that the reading is on the order of 5 mR or so. Zero the dosimeter as per the instructions. Note: this test could be conducted at the same time as test # 5 to save time.

Survey meter use instructions: Hold the survey meter level in the palm of your hand. Please do not use it in any other orientation as this can damage the needle mechanism. Verify that it has been calibrated in the last 12 months. As you turn it on, verify the battery and other status indicators if possible. Set the meter to the **X10** scale and on **quiet** mode. Verify that the meter is working by placing it above the source safe of the microSelectron.

17. Verify that the hand held timer is working properly. Verify that the pocket dosimeter is available.

18. In the treatment room observe that the green status light on radiation monitor in the treatment room is on. This test checks that the battery back-up is working.

19. Source position test: This test verifies the positional accuracy and reproducibility of the source drive mechanism. Connect the needle transfer tube to the ruler tool. Drive the source to "1400" using the program. A picture of the test can be recorded at this point. Verify the correct positioning of the source and indicate this in the daily check list. NOTE: this test can be performed while doing any of test # 5, 7, 9, 10 or 14 above.

PATIENT COMMUNICATION SYSTEM

20. Check that the speaker and the TV monitors are working.

CHECKED BY (Initials)

Check the "Pass" box in ATLAS with your initials. Contact physics personnel for assistance with any problems prior to treating patients. Performance checklists are countersigned in ATLAS on normal treatment days by a co-ordinator or other senior member of the radiation oncology department.

SHUTDOWN – DAILY

Turn key in console to OFF. Place key in designated location. Close the application and turn off the console computer.

7.1.2 GENERAL TREATMENT PROCEDURES

1 SET UP

A - To prevent the source accidentally moving to the **SOURCE OUT** position during set up, keep treatment door open,

B – Always wear your OSLD. Do not leave your OSLD in the treatment room (ie on a lab coat) during treatment, or in any other location where it could receive an erroneous reading.

C During patient set-up:
Verify the patient name,
Keep the patient under continuous observation,
Lock stretcher or table top prior to connecting,
Be sure that catheter numbers are identified prior to connecting,

D When connecting catheters to patient make sure that the afterloader and connecting tubes have a straight approach to the patients' tubes. Avoid any kinks that could block the source path,

E Leave the access panel clear so that the retract cranks are accessible. Lock the wheels of the afterloader. The afterloader should be left in a position where it can be accessed as easily as possible on entry to the room without obstacles in the path.

F Ensure that no one other than the intended patient remains in the room during treatment.

2 - TREATMENT TIME SETTING

Reduce the risk of a wrong treatment time setting by:
(1) Observing the console messages prior to treatment and becoming familiar with console messages.
(2) Making sure that the correct patient data has been used (there are often several patients being treated on the same day).

3. LAST PERSON OUT (LPO) Buttons

There are two LPO buttons in the bunker: one completely inside the treatment room, one in the maze. Prior to permitting a possible source-out occurrence there is a 120 second sequence instigated by pressing the most interior LPO button, followed by pressing the maze LPO button followed by closing the door at the maze entrance. This system reduces the risk of inadvertently irradiating staff. Prior to pressing any of the LPO buttons, staff should always ensure that no one other than the intended patient remains in the treatment room.

4 - SOURCE OUT (BEAM ON)

Ensure that the radiation oncologist is in the vicinity.
Ensure that the physicist is in the vicinity.
Have the secondary stop-watch, the hand survey meter and the pocket dosimeter ready.
Monitor the patient during treatment with the cameras and intercom.

5. TREATMENT DELIVERY

The radiation therapist must be present for treatment to begin and during treatment.

The physicist and radiation oncologist should be present in the department during treatment, and both must be accessible within a short period of time (typically less than a few minutes).

Radiation Oncology Residents may supervise brachytherapy treatments only under the supervision of a staff Radiation Oncologist who is physically present in the department. Radiation Oncology Residents may not supervise treatments during evenings, week-ends and other times when a staff Radiation Oncologist is not present for assistance.

Either the Radiation Oncologist, or the Radiation Therapist, or the Medical Physicist may request that treatment be postponed or delayed should they believe that for any reason there exists an unsafe condition relating either to the patient or the brachytherapy device or associated radiation safety equipment.

The treating therapist must be aware of the status of the patient and the progress of the treatment at all times. Special attention should be paid to patients that are uncomfortable and move in a manner that could be problematic to the source delivery or retraction. If the source does not retract correctly, the operator should take immediate action by pressing the EMERGENCY OFF button. If the source fails to return to the BEAM OFF position upon completion of the set time, follow the instructions outlined in the EMERGENCY PROCEDURES.

6. COMPLETION OF TREATMENT

Prior to entering the treatment room the console is to be checked to ensure that no messages indicating an unsafe working environment exist.
The source-out light over the treatment door should be off.
The in-room radiation monitor should not be indicating a reading, and no audible alarm should sound.
The afterloader should be inspected for any obvious signs of trouble.

Following **each and every** patient treatment, the patient shall be surveyed with the hand-held radiation monitor, and the return of the source to its safe position shall be verified. The box labeled “ROOM SURVEY” in the patient’s electronic treatment record (BRACHY WORKSHEET) is marked with initials to indicate that the source has returned to its safe position. Very rarely you might encounter a patient coming from nuclear medicine containing some residual radio-isotope. This situation may give rise to a reading with the hand held survey meter. If there is any doubt concerning a reading with the survey meter, consult a physicist.

7 . GENERAL SURVEY METER USE INSTRUCTIONS

Prior to using a survey meter check that meter has been calibrated within the last 12 months. Do not use a survey meter that has not been calibrated within the last 12 months (check the identification sticker). Check the battery before using the survey meter. The survey meter has a delicate needle: hold the survey meter flat and avoid rough handling. A typical reading right over the safe of the afterloader when the source is safely in place is about 0.5 mR/hr (5.0 μSv/hr) or less.

7.1.3 EMERGENCY PROCEDURES - microSelectron V2 HDR (#31718)

RECOGNISING AN HDR AFTERLODER FAILURE
The failure of the source to return to its completely safe position may be indicated by one or more of the following conditions:

(a) The yellow "**Radiation"** light at the console or on the status plate of the afterloader is **ON** after the beam has been turned **OFF** and/or
(b) The "**Out of Safe**" light at the console or on the status plate of the afterloader is **ON** after the beam has been turned **OFF** and/or
(c) The SOURCE OUT light over the door remains lit and/or
(d) The room radiation monitor indicates a reading or the alarm is sounding when treatment room door is opened and/or
(e) The hand held survey meter indicates a reading significantly higher than the expected value as determined during the morning performance checks and/or
(f) The pocket dosimeter indicates a reading significantly higher than the expected value as determined during the morning performance checks and/or
(g) A message alert from the console indicates the possible presence of a dangerous situation and/or
(h) An inspection of the afterloader indicates a dangerous situation.

EMERGENCY PROCEDURES – SPECIFIC INSTRUCTIONS

Procedure in the Event of a Stuck Source:

1. Identify that the source is out of the safe as explained above
2. Press the "Interrupt" button
3. If the source fails to retract, press the Emergency Stop buttons in the following order:
   - On console

   After entering room (with pocket dosimeter)
   - Near CT console
   - On wall in treatment room
   - On unit
4. If the source fails to retract, **GO FOR THE GOLD** and attempt to crank the source manually with the **GOLD** hand crank
5. If the source fails to retract, remove the catheter(s)
6. Place entire catheter(s) in pig
7. Remove patient
8. Survey patient
9. Survey room to locate source
10. Survey all involved staff
11. Call RSO (Michael Evans) or backup RSO (any medical physicist) in his absence.
12. Call Elekata / Nucletron
13. Mark room to indicate entry prohibited. Record as much data as possible – dates, names, details of event, …

EMERGENCY STOP BUTTONS

Treatment can be stopped by depressing any of the **EMERGENCY STOP** push buttons located:

a) on the console (1)
b) on the wall beside the door (1)
c) on the walls of the treatment room (5)
d) on the afterloader (1)

Treatment can be stopped by opening the treatment room door.

POWER FAILURE

If the hospital power fails, the following procedure is recommended:

1. Ensure that the treatment is interrupted and that the source is safely retracted.
2. Disconnect the patient from the afterloading machine and turn the key switch on the console to the OFF position.
3. Record the treatment time delivered to the patient by using the stopwatch.

FIRE, SMOKE OR GAS FUMES

If fire, smoke or gas fumes are detected, the following procedure is recommended:

1. Press the nearest EMERGENCY OFF button.
2. Remove the patient from the treatment room.
3. Evacuate personnel to a safe area.
4. Notify fire authorities.
5. If a patient was on treatment at the time the EMERGENCY OFF button was pressed, wait until the console area is safe to re-enter, then record the treatment time using the stopwatch.
6. Do not attempt to use the unit. Call service personnel of the Medical Physics Department.

Instructions pour le bouton d'arrêt d'urgence de la console Nucletron

Chaque fois que le bouton d'arrêt d'urgence sur la console Nucletron est enfoncé, les opérateurs doivent ouvrir la porte de la salle de traitement et entrer dans la salle blindée avant de reprendre le traitement.

Ne pas le faire contrevient à l'article 15 (8) de la réglementation de la CCSN de classe II.

Voir photo ci-dessous.

Instructions for Nucletron Console Emergency Stop Button

Each and every time the Emergency Stop on the Nucletron console is pressed, operators must open the treatment room door, and enter the bunker, before resuming treatment.

Failure to do so contravenes section 15(8) of CNSC Class II regulations .
See photo above.

EMERGENCY PROCEDURES – GENERAL COMMENTS

These guidelines are intended as a general summary of actions to be taken in the unlikely event of the failure of the source to return to its safe position in the remote afterloading device located in the brachytherapy suite. Should this occur, the operator will be expected to take quick and appropriate action, and it is unlikely the guidelines written here will cover the exact set of circumstances under which the operator is placed. Therefore, it is imperative that the person operating the afterloading device be sufficiently familiar with its operation so that consulting this document in a time of emergency is unnecessary.

The failure of the source to return to its intended safe position may be instigated either by a malfunction of the machine or by some unintended patient movement (convulsion, epileptic seizure etc.) causing a break in the mechanical integrity of the source transfer apparatus. In either case the responsibility of the operator, in conjunction with the medical staff, is to remove the source from the patient in the most expeditious manner possible while minimizing time in the proximity of the unshielded source.

Prior to entering the treatment room under emergency conditions, one staff member will affix the emergency pocket dosimeter at waist level and turn on the device, so that an immediate estimate of the body dose can be made following the safe removal of the patient from the room.

When instigating an emergency procedure on the afterloading unit, every effort must be taken to ensure that the transfer tubes are not disconnected from the afterloader. This is to prevent the separation of the source from the afterloading unit.

In the event of a source jam with a secured or sutured implant (interstitial type implants such as ENT, GYN, prostate etc.) the medical personnel can make use of the emergency suture kit located in the treatment room. Every attempt should be made to extract the treatment catheter so that the source is contained in the catheter, and does not dislodge in the patient.

Should the treatment catheter need to be cut to facilitate removal, the open end should be sealed by medical personnel with the forceps available in the treatment room. This is to ensure that the source stays in the catheter and does not dislodge in the patient.

A pair of wire cutters is available in the treatment room together with a pair of long handled forceps. It may be necessary under extreme circumstances to cut the drive cable. This is considered to be an **exceptional** measure and should **only** be attempted when all other options have been considered. Great effort must be taken to ensure that the source does not dislodge in the patient during removal of the catheter.

With the patient removed from the treatment room and the treatment door locked, the patient and all staff concerned with the incident should be re-surveyed with the hand held radiation monitor to ensure that no radioactive material has inadvertently left in the brachytherapy suite. At this point physics personnel may be contacted for further assistance.

Specific roles in Emergency Situations

Therapist

The role of the therapist in an emergency situation is to assist in the management of the patient, and to aid physics personnel. The therapists should help determine the nature of the fault, and the location of the source. The source may be in the patient, in the connector tube, within the afterloader, or elsewhere. The therapist should help in locating medical instruments that may be required by the radiation oncologist, nursing staff or the physics personnel. Following the removal of the patient from the brachytherapy vault, the therapist should assist physics personnel in ensuring that the patient is free of any source of radiation, and that the source has remained in the brachytherapy vault.

Nursing staff

The role of the nursing staff in an emergency situation is to assist in the management of the patient.

Physicist

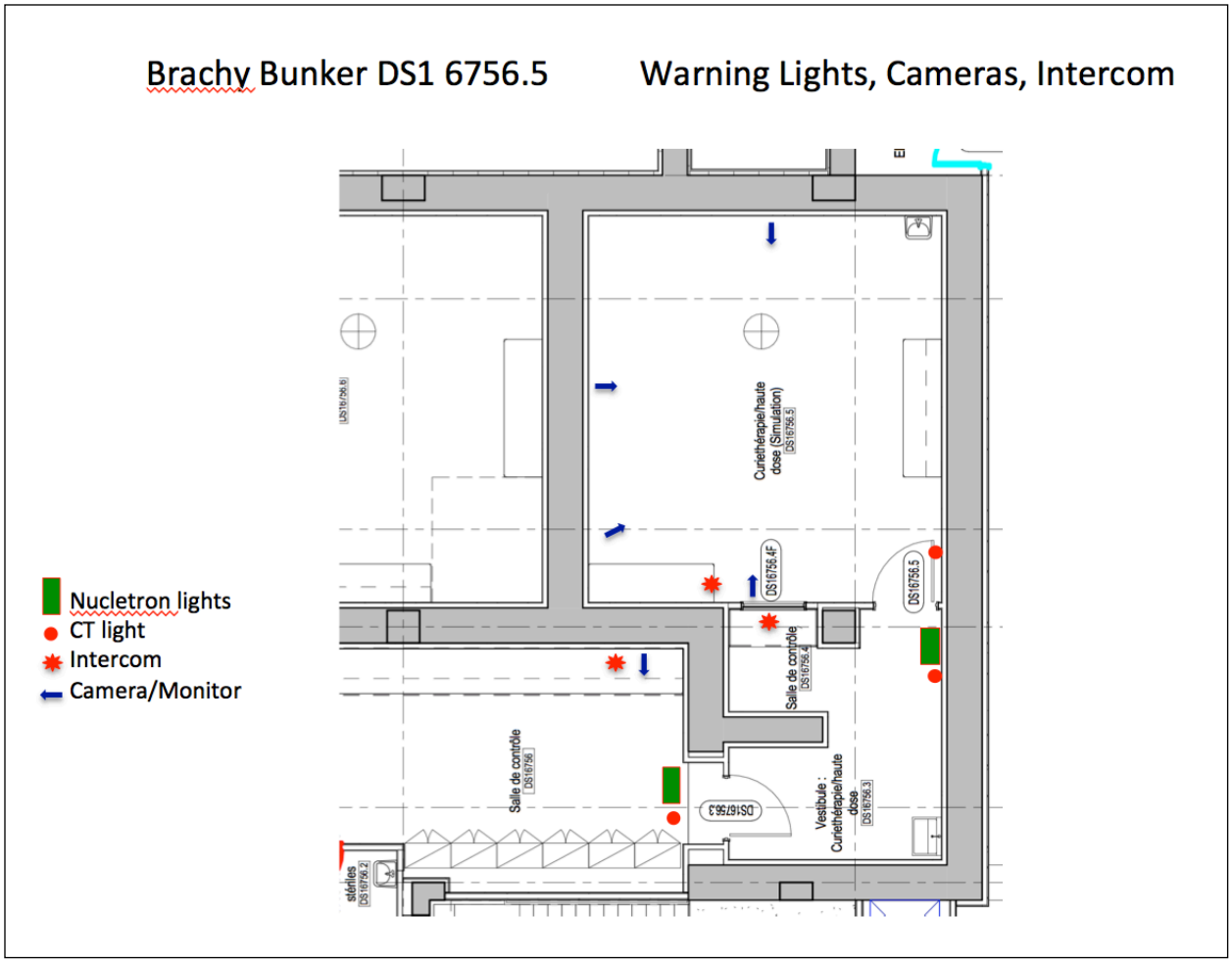
The role of the physicist in an emergency situation is to determine the nature of the radiation emergency, and provide technical assistance in order to safely isolate the source, so that the patient may be managed by the medical team (nursing staff, radiation oncologists and therapists). The physicist is responsible for ensuring that the source remains in the brachytherapy vault following removal of the patient from the vault. The physicist is responsible for securing the brachytherapy vault and for obtaining further technical assistance in order to ensure the security of the source and the immediate environment.

Radiation Oncologist

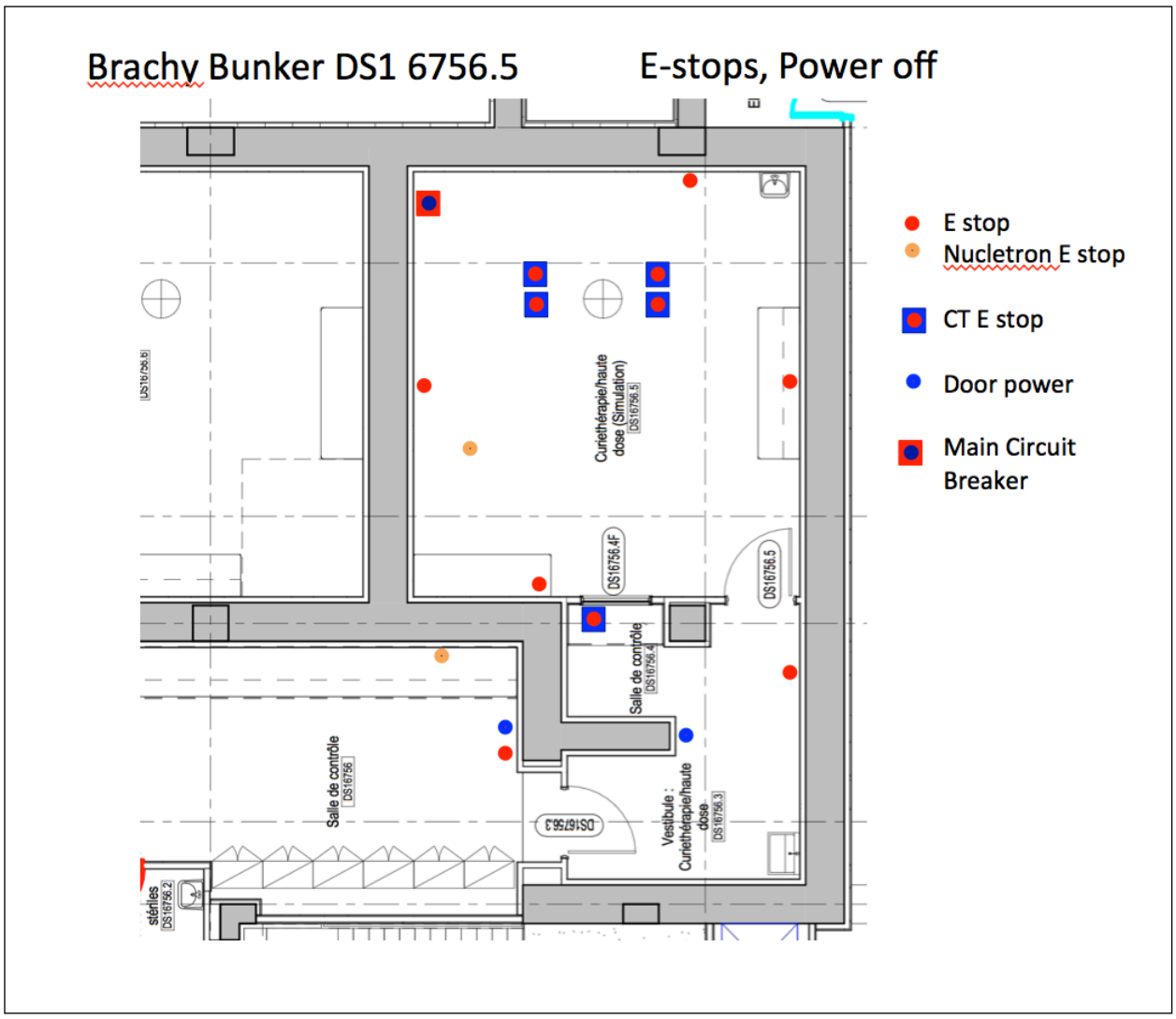
The role of the radiation oncologist in an emergency situation is to lead and assist in the management of the patient, and to aid the therapists, physicists and other personnel in managing the radiation emergency.

Students / Visitors

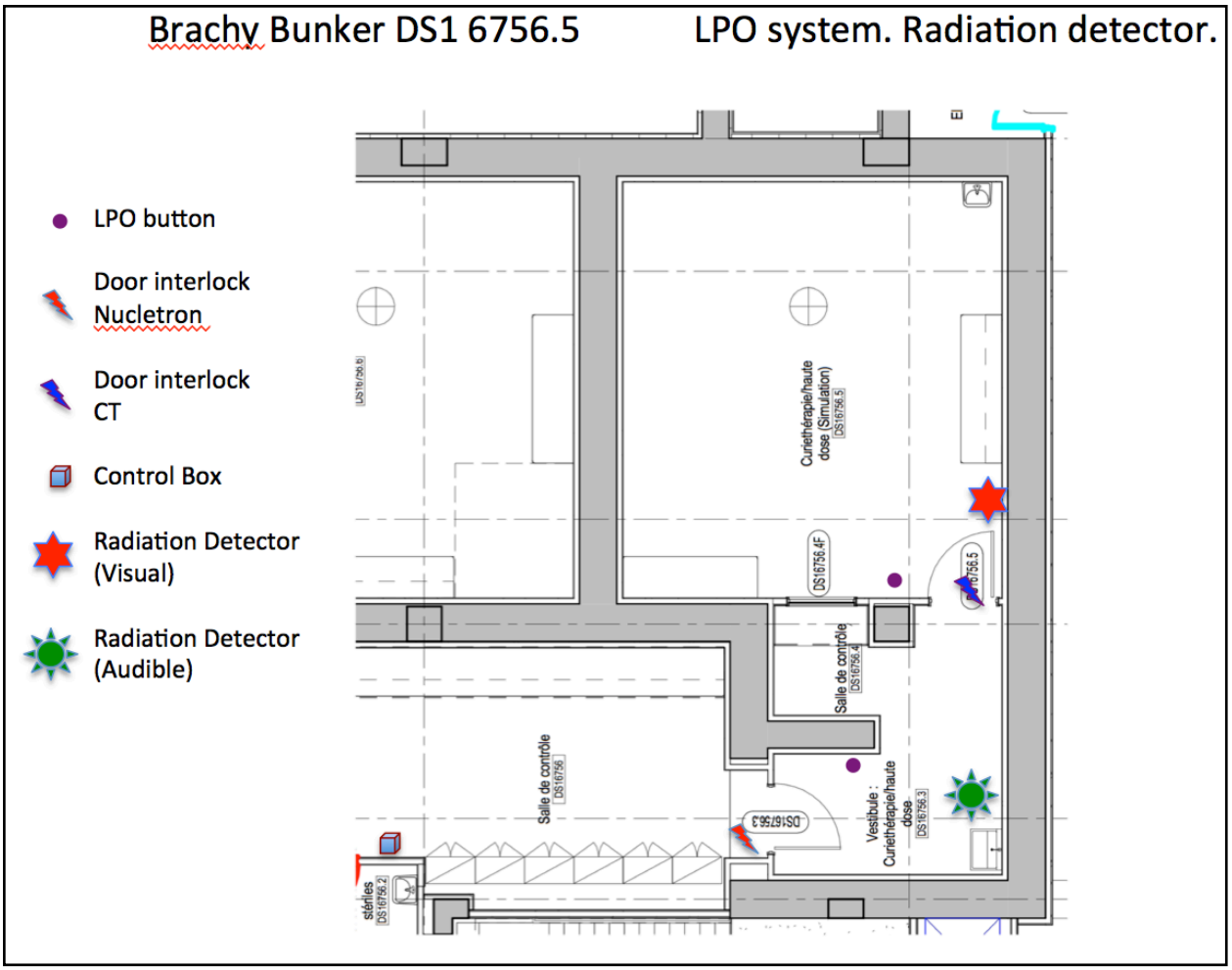
Students and Visitors are not to assist staff in the management of emergency situations. Staff responsible for students and visitors (therapists, nurses, physicists and radiation oncologists) are to ensure that these personnel remain outside the brachytherapy vault during the management of an emergency situation.



Location of warning lights, cameras and intercom in brachy bunker DS1 6756.5



Location of E-stops, door stops and main circuit breaker in brachy bunker DS1 6756.5



Location of Last-Person-Out (LPO) system and radiation detector in brachy bunker DS1 6756.5

STATUS CODES - microSelectron HDR (#31718)

These STATUS CODES represent situation whereby the SOURCE MAY BE OUTSIDE THE SAFE. These status codes should be familiar to all operators of the microSelectron. All EMERGENCY PROCEDURES should be followed. Consult the list of codes at the console for more information.

3, 4, 5, 7
58, 72
110, 111, 112, 113, 116
120, 124, 125, 126, 188, 199
1514, 1538, 2044, 2062:

Source may be stuck outside of safe.

7.2 Radiation safety for manual brachytherapy

7.2.1 PTERYGIUM

A radioactive Sr-90 source is used in the treatment of pterygium. Patients may receive treatments over the course of a number of days.

a) The first treatment is delivered with the radiation oncologist, the radiation therapist and the medical physicist present. Subsequent treatments are delivered by the radiation therapist.

b) Treatment is delivered in the licensed location.

c) OSLDs are worn, or available, during the procedure.

d) The Sr-90 applicator is manipulated using the handle designed for this use. It is never pointed at anyone or handled directly.

e) On completion of treatment, the source is cleaned and placed to its container and returned to the appropriate location.

f) A record of the treatment is made in a log book.

Chapter 7 APPENDIX

HDR Brachytherapy Emergency Training – In Room

Purpose: This document describes the expected content of the MUHC HDR brachytherapy hands on emergency training.

Target Audience:

Radiation Therapists working with HDR brachytherapy
Radiation Oncologists working with HDR brachytherapy
Medical Physicists
Selected staff as required

Course Objectives:

After completing the training, participants should understand the following:

1. Basic operation of the HDR unit
2. Location of all emergency stop buttons, and door power off button.
3. Location of all radiation indicators
4. Location of survey meters
5. Location of emergency equipment
6. Procedure in the event of a stuck source
7. Possible radiation exposure in an emergency

Course Content:

The following information, including a dry run, will be covered in the annual HDR emergency training with participants in the treatment room or console area:

Basic operation of the HDR Unit:

1. Source
    - About the size of a grain of rice
    - Welded to the end of a cable
2. Cables and Cranks
    - Black Crank – check cable with dummy source
    - Gold Crank – Source
3. Motors
    - Regular torque for treatment
    - High torque engaged when E-Stop pushed
4. Positioning the Unit
    - Move unit with head in lowest position
    - Lock wheels for treatment
    - Point handle to door for easy access to E-Stop

Important Locations:

1. Emergency stop and door power-off buttons
    - On treatment console
    - Beside entrance to room
    - On four walls of the treatment room
    - On wall by CT console
    - On the treatment unit
    - Door power-off buttons locations
2. Safety equipment
    - Medical equipment (wire cutters and suture kit)
        - On the wall by the CT window
    - Pig for shielding stray source
        - On floor behind CT gantry
3. Survey meters/Dosimeters
    - Pocket dosimeter and hand held (Ludlum Model 2401-EC) survey meters in cabinet above console
4. Radiation Alerts
    - On treatment console
    - Radiation monitor in room
    - Radiation monitor on afterloader
5. Emergency phone numbers
    - On door of cabinet above console

Identifying presence of radiation:

1. Console Indicates Source is out of safe
    - Light on for "Source Out of Safe"
    - Yellow radiation light on
    - Warning message indicating source is not retracted
2. Room monitor reading
    - Radiation monitors inside treatment room and audible alert
3. Survey
    - Hand held survey meter indicates high exposure

Procedure in the Event of a Stuck Source:

14. Identify the source is out of the safe as explained above
15. Press the "Interrupt" button
16. If fails to retract, press the Emergency Stop buttons in the following order:
    - On console

    After entering room (with pocket dosimeter)
    - Near CT console
    - On wall in treatment room
    - On unit
17. If fails to retract, GO FOR THE GOLD and attempt to crank the source manually with the GOLD hand crank
18. If fails to retract, remove the catheter(s)
19. Place entire catheter(s) in pig
20. Remove patient
21. Survey patient

22. Survey room to locate source
23. Survey all involved staff
24. Call RSO (Michael Evans) or backup RSO (any medical physicist) in his absence.
25. Call Nucletron
26. Mark room to indicate entry prohibited. Record as much data as possible – dates, names, details of event, …

    Note: DO NOT cut the source cable unless it is absolutely a last resort. Cutting the source opens the possibility of losing the source in the room. In addition, accidently cutting the source itself would be problematic.

Possible Exposure:

- As a NEW (nuclear energy worker), to reach the 50 mSv annual limit you can be at 1m from an unshielded new source for approximately 1 hr.
- Staff members who are classified as Public can be at 1m from a patient-shielded new source for approximately 10 minutes before reaching the 1 mSv annual limit.
- The risk to the patient is much higher than the risk to you. Act as quickly as possible to remove the source from the patient.
- Visitors are not permitted to assist in emergency situations except under the specific conditions of Section 15 (3) of the CNSC Radiation Protection Regulations whereby: The dose limits prescribed by sections 13 and 14 and subsection (1) may be exceeded by a person who acts voluntarily to save or protect human life.

8. Linear Accelerators

General

Operation of linear accelerators producing electrons, or photons with energies greater than 1 MV, at the McGill University Health Center (MUHC) is governed by CNSC licenses. All linear accelerator based work is conducted at MUHC – Glen Site, 1001 boul Decarie, Montreal, at the specific locations listed in the license.

Linac models operated by the MUHC are listed below:

Make and Model	Beam Type	Max energy
Varian True Beam	Photons	15 MV
Varian Novalis powered by True Beam STX	Photons	15 MV
Accuray Cyberknife M6 FIM System	Photons	6 MV

In addition a Sr-90 source used for constancy measurement is covered by this license.

Performance Checks

Performance checks are to be carried out every day, or prior to first beam-on: whichever results in fewer operations. This includes emergency or unscheduled treatments and service work on weekends and days on which the clinic does not normally run.

Performance checklists are countersigned on normal working days for patient treatment by a co-ordinator or other senior member of the radiation oncology department.

Varian True Beam and STX Linacs

PERFORMANCE CHECKS AND OPERATING PROCEDURES

1. PERFORMANCE CHECKS

START UP

1. In Machine QA Mode start 12 minute warm-up. Exit to Major Mode.

2. From Major Mode Tools – reboot computer. PassWord “varian”.

INITIAL SAFETY CHECKS

3. Enter bunker and rotate gantry to 0^{o}. The collimator can also be set to 90 degrees. Remove the graticle tray that has been placed there the previous evening. This tray is to prevent accidental puncture of the plastic sheet at the service plate.

4. Press in-room LPO: wait for time-out (40 sec). Observe that red light turns off after 40 seconds.

5. Verify all the collision interlocks located on the gantry are working correctly.

WARM UP LINAC

6. Return to Machine QA Mode and open the file I drive. The file is machine specific and will be labelled as follows:

STX1: I: TDS : H191321 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…
STX2: I: TDS : H191318 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…
TB3 : I: TDS : H191332 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…
TB4 : I: TDS : H191333 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…
TB5 : I: TDS : H191650 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…
TB6 : I: TDS : H191652 : MORNING WARMUP SAFETY : QA_WARMUP_STX1…

7. Perform morning beam checks for electron fields using the BeamChecker. Report any error readings or alerts to physics.

8. Flip the BeamChecker over. Perform morning beam checks for photon fields using the BeamChecker. Report any error readings or alerts to physics.

SAFETY CHECKS LINAC

9. With beam ON verify both status lights over treatment room door. This can be done with any of the warm up fields

10. Begin to deliver the final photon beam in warmup. Press BEAM OFF after a few MU. Ensure that the beam turns off. The BeamChecker will start to beep – ignore it.

11. Restart the beam and force the beam to turn off with the light shower detector at entrance. This can be done by waving your hand through the light shower at the maze entrance.

12. Press LPO button by entrance and verify that LPO light does not turn on.

13 With light shower tripped verify BEAM ON is not possible. This can be done by pressing the beam on button on the console control unit.

14. Unused.

15. Unused.

PATIENT COMMUNICATION SYSTEM

16. SPEAKERS: Check that the intercom and speakers are working.

17. CCTV MONITOR: Check for the clarity of image on the TV monitors.

LASERS, ODI , FIELD LIGHT

19. Verify that the lasers, optical distance indicator (ODI) and field light are functioning properly

CHECKED BY (Initials)

Sign the box with your initials. Contact physics personnel for assistance with any problems prior to treating patients. Performance checklists are countersigned on normal working days by a co-ordinator or other senior member of the radiation oncology department.

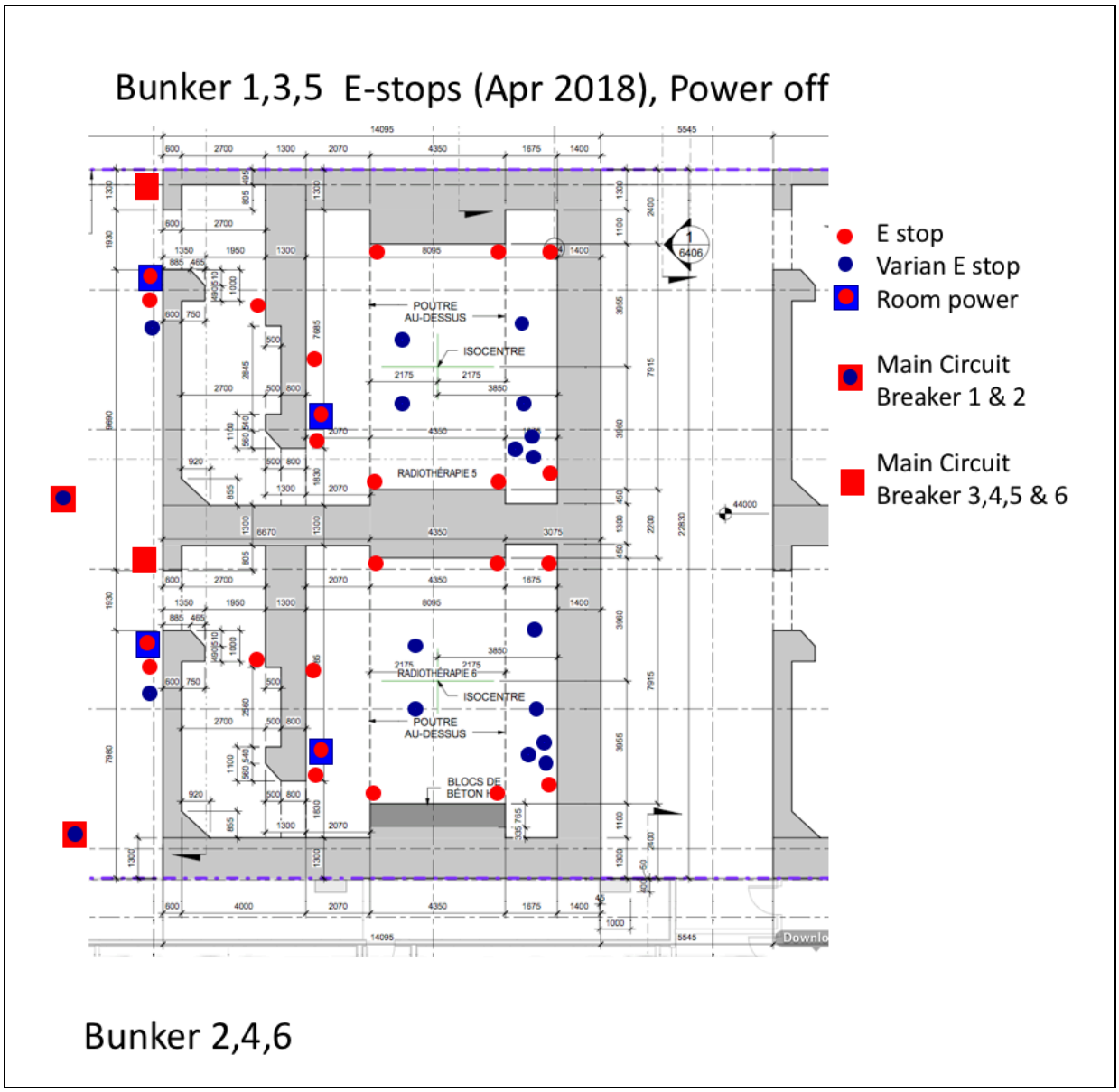
2. SHUTDOWN – DAILY

The linac is often left on for QA, service, teaching or research purposes. If you shut down the linac, follow the posted instructions.

Shutdown procedure: Place the unit in Stand-by. Turn gantry to 120° and collimator to 90°. Insert the graticle tray. Turn off laser from switch outside room. Turn off monitors and close the door to the treatment room area.

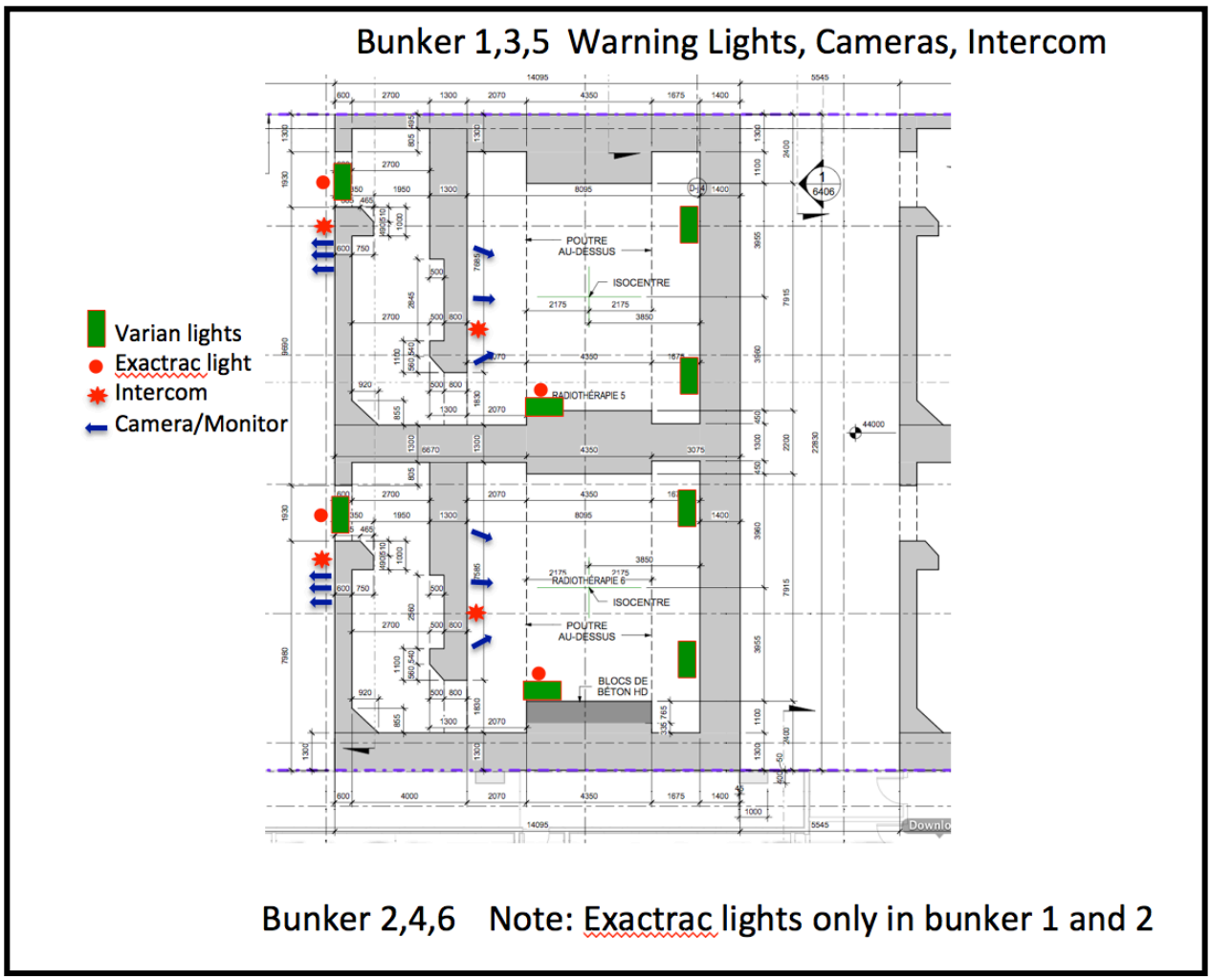
3. EMERGENCY OFF PUSH BUTTONS

The location of various emergency stop buttons and circuit breakers are shown in the diagram below.



4. WARNING LIGHTS

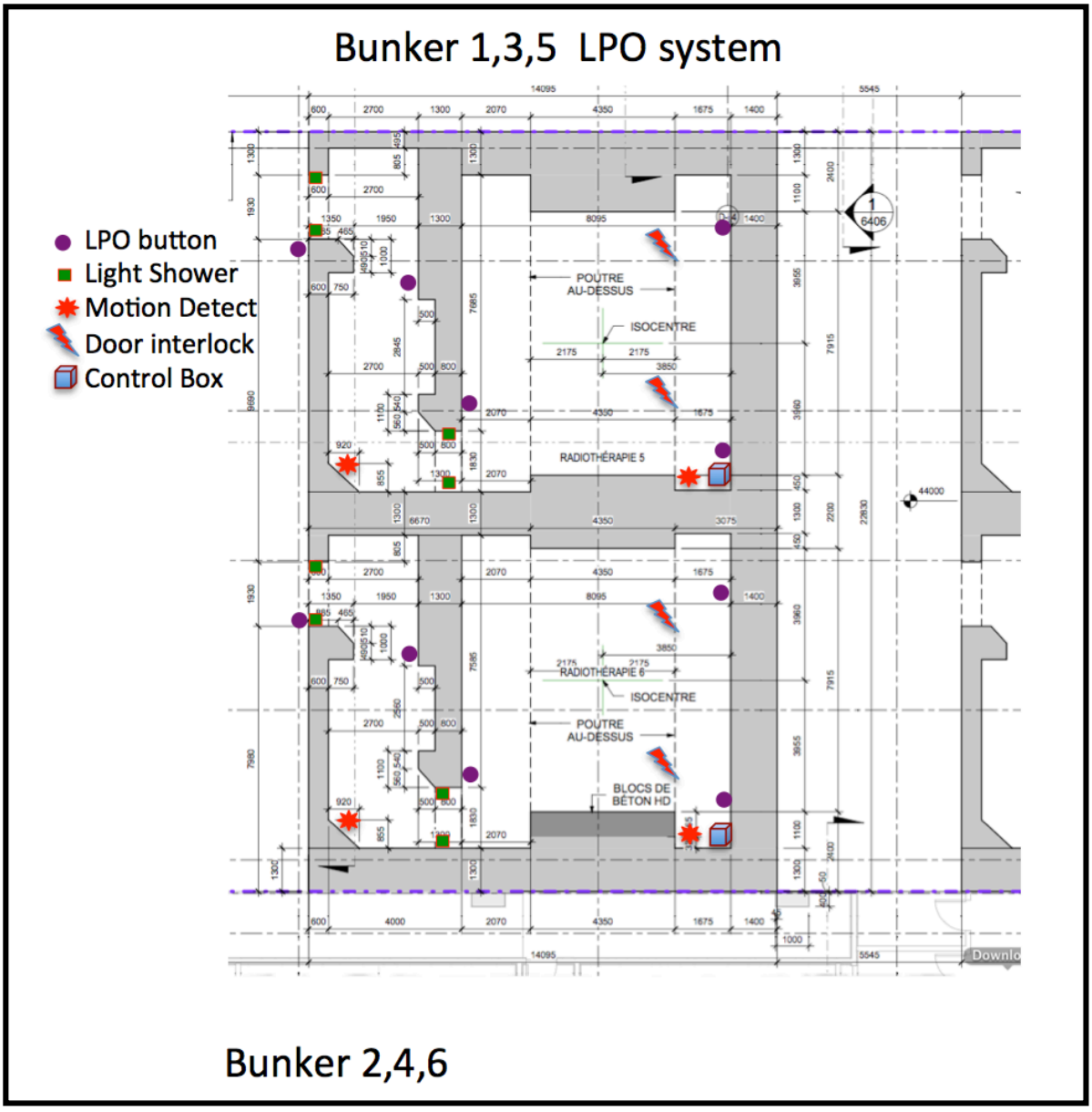
The location of various warning lights, cameras and intercoms are shown in the diagram below.



5. LAST PERSON OUT (LPO) Buttons

There are three LPO buttons in each bunker: one completely inside the treatment room, one in the maze and one just outside the maze entrance. Prior to permitting a possible beam-on occurrence there is a 40 second sequence instigated by pressing the most interior LPO button, followed by pressing the maze LPO button followed by pressing the LPO just outside the maze entrance. This system reduces the risk of inadvertently irradiating staff. Prior to pressing any of the LPO buttons, staff should always ensure that no one other than the intended patient remains in the treatment room.

The location of hardware associated with the last person out (LPO) security system is shown in the diagram below.



6. DAMAGED ACCESSORIES

Report immediately any broken or damaged accessory to medical physics.

7. LASER BEAM

Staff personnel should never look directly into a laser beam.

EMERGENCY PROCEDURES : Varian STX and True Beam

1. TREATMENT BEAM FAILS TO TERMINATE

The linac has failed to properly terminate a treatment if the accumulated MU displayed on the console monitor exceeds the MU1 value preset for the treatment. The following procedure is recommended:

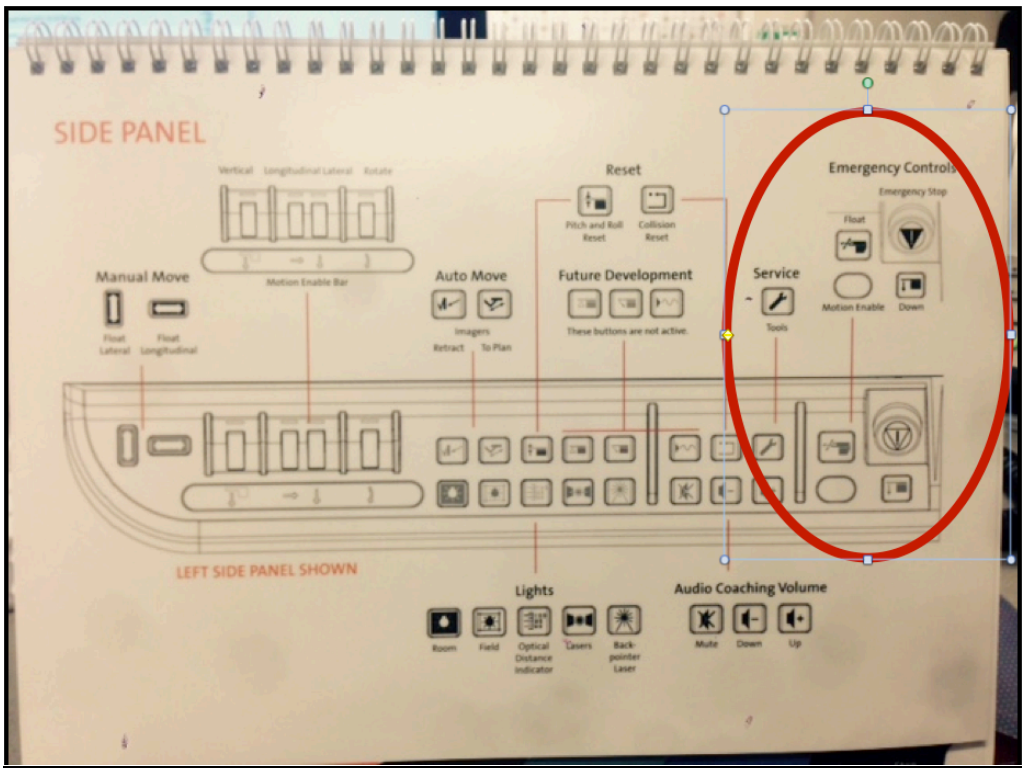
1. Press the BEAM OFF button.
2. If the beam still remains on, press the nearest EMERGENCY OFF button.
3. If the beam still remains on, turn off the main facility circuit breaker. See diagram above.
4. If a patient was receiving therapy, remove the patient by following the procedure outlined in the next section "Power Failure".
5. Record the number of monitor units received by the patient.
6. Do not attempt to use the linac. Call for assistance from the Medical Physics Department.

2. POWER FAILURE

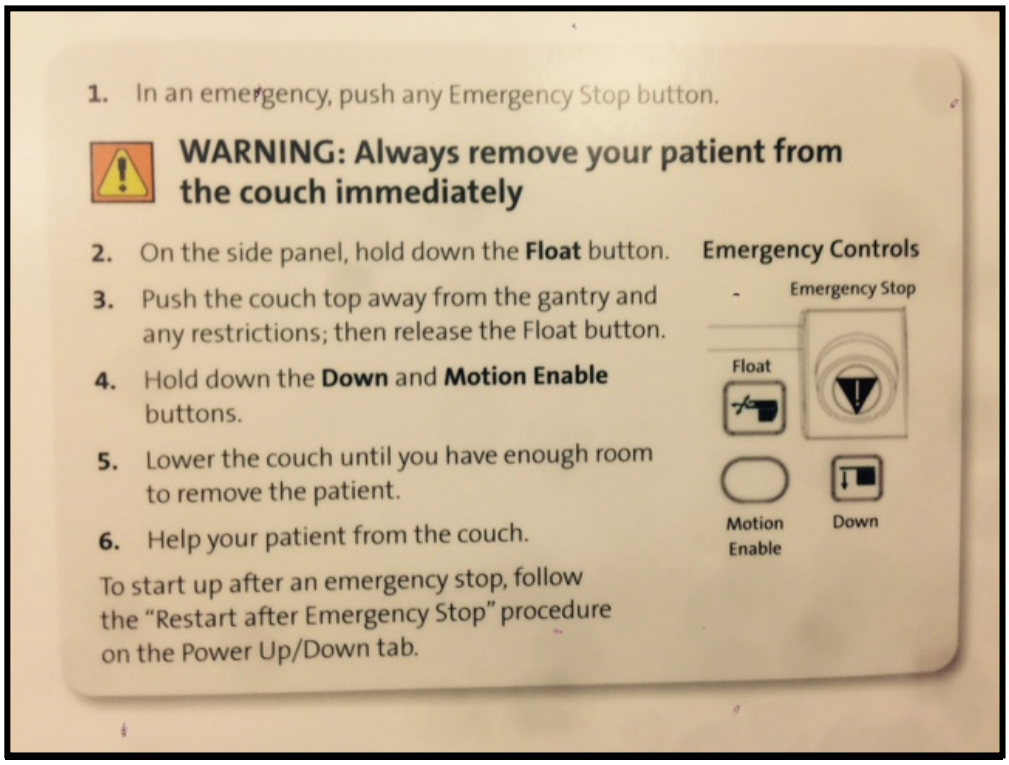
If the hospital power fails, the following procedure is recommended:

1. Emergency lighting should be automatically energized. Locate the flashlight.
2. If a patient is under treatment, remove the patient from the treatment couch.
   Follow the instructions in the True Beam Quick Reference Guide / Emergency Stop section.

The two diagrams below give detail.



Varian instruction info showing location of emergency couch controls on couch side panel.



Varian instructions on use of emergency couch controls.

3. EMERGENCY OFF BUTTONS: MOTION TERMINATION

In addition to terminating the beam, any unwanted motion of the couch or the gantry occurring during either set up or treatment can be stopped by depressing the nearest of the EMERGENCY OFF buttons.

4. FIRE, SMOKE OR GAS FUMES

If fire, smoke or gas fumes are detected, the following procedure is recommended:

1. Press the nearest EMERGENCY OFF button.
2. If the patient is on the treatment couch, remove the patient by following instructions in section 2 of POWER FAILURE.
3. Evacuate personnel to a safe area.
4. Notify fire authorities.
5. Do not attempt to use the linac. Call service personnel of the Medical Physics Department.

Accuray CyberKnife

PERFORMANCE CHECKS AND OPERATING PROCEDURES

1. PERFORMANCE CHECKS

START UP

Follow the manufacturer's recommended start up procedure.

SAFETY CHECKS

1. Press in-room LPO: wait for time-out (40 sec). Observe that the red light turns off after 40 seconds.

2. Arm the LPO system and Press START on console computer to initiate BEAM ON.

3. Observe that the Radiation warning light over entrance is functioning.

4. Press Disable. Observe that beam turns off.

5. Initiate BEAM ON again. Trip beam off with light shower at maze entrance, and verify beam turns off.

6. Press LPO by beam entrance and attempt to turn beam on. Verify that the LPO button does not light up, and that there is no beam on.

PATIENT COMMUNICATION SYSTEM

7. SPEAKERS: Check that the intercom and speakers are working.

8. CCTV MONITOR: Check for the clarity of image on the TV monitors.

CHECKED BY (Initials)

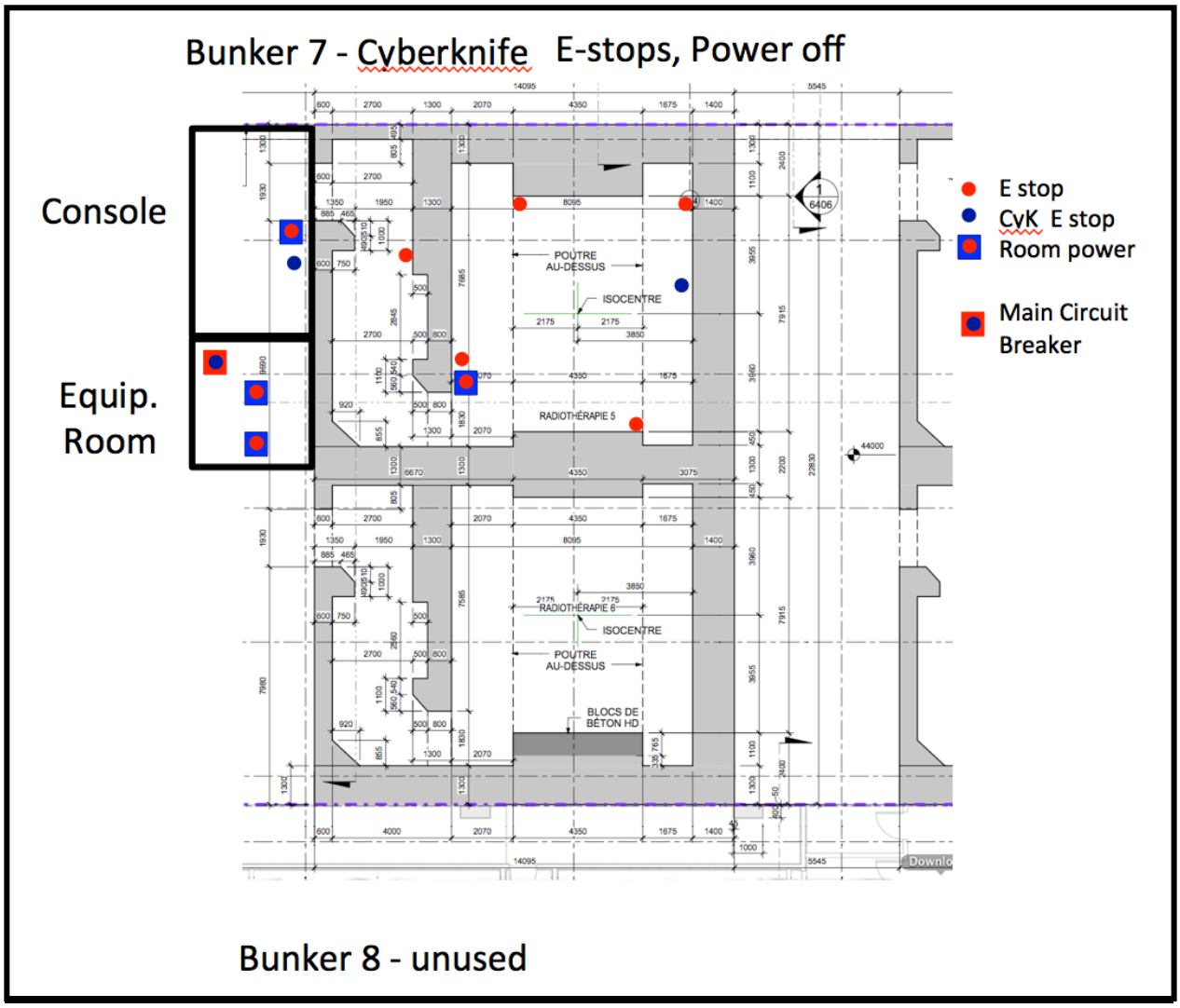
Sign the box with your initials. Contact physics personnel for assistance with any problems prior to treating patients. Performance checklists are countersigned on normal working days by a co-ordinator or other senior member of the radiation oncology department.

2. SHUTDOWN – DAILY

Follow the manufacturer's recommended shut down procedure.

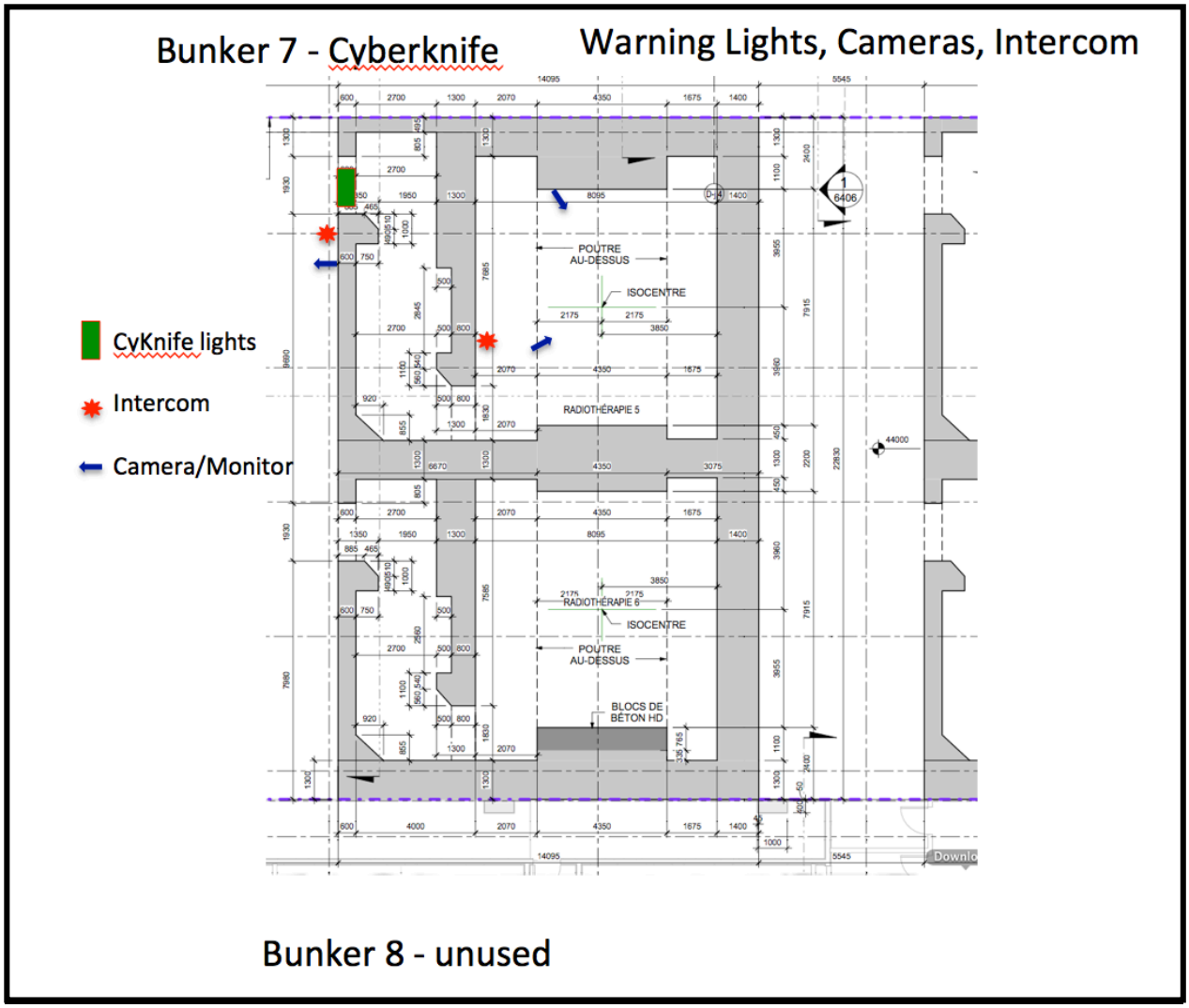
3. EMERGENCY OFF PUSH BUTTONS

The location of various emergency stop buttons and circuit breakers are shown in the diagram below.



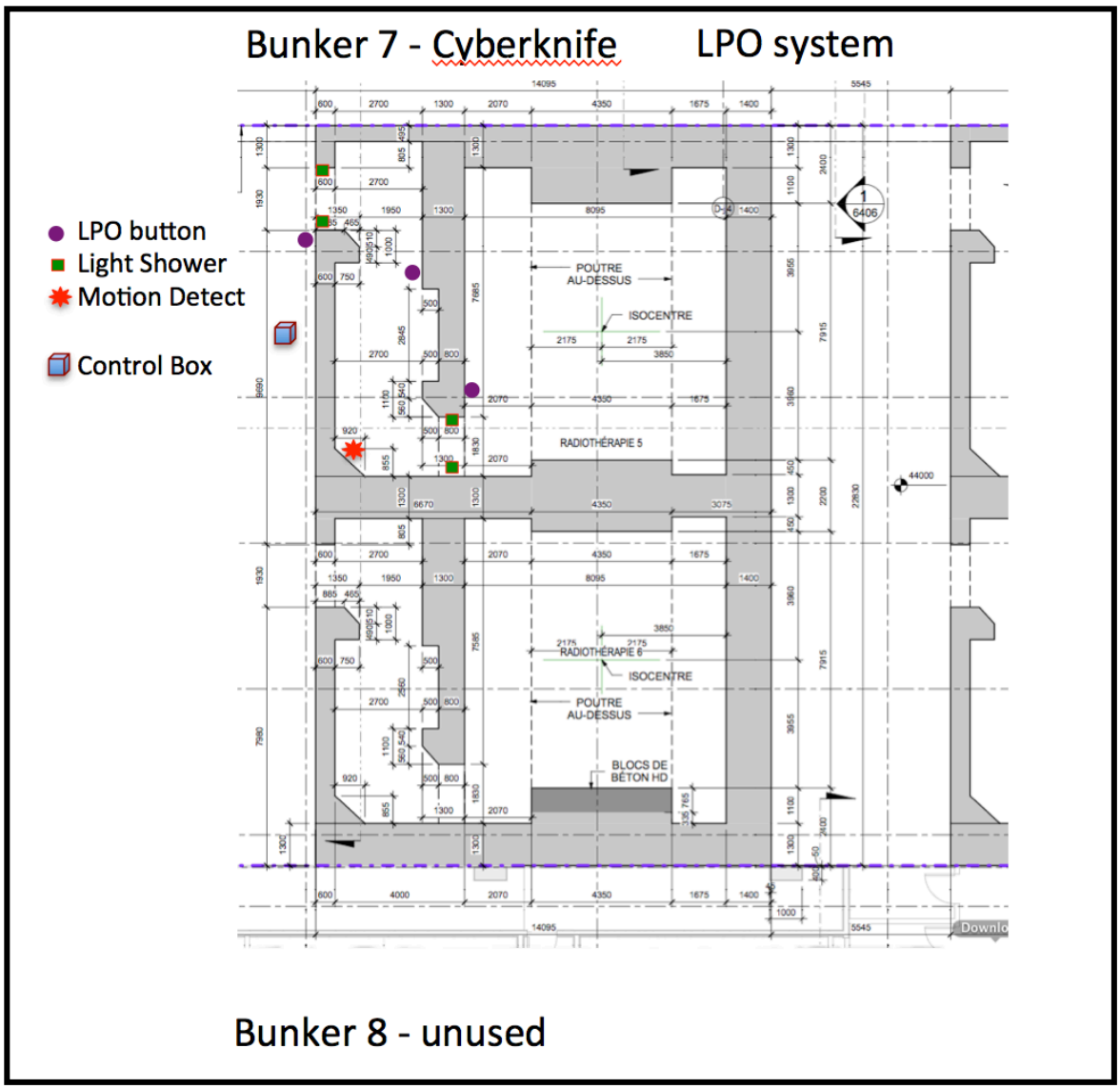
4. WARNING LIGHTS

The location of various warning lights, cameras and intercoms are shown in the diagram below.



5. LAST PERSON OUT (LPO) Buttons

The location of hardware associated with the last person out (LPO) security system is shown in the diagram below.



6. DAMAGED ACCESSORIES

Report immediately any broken or damaged accessory to medical physics.

7. LASER BEAM

Staff personnel should never look directly into a laser beam.

EMERGENCY PROCEDURES: Accuray CyberKnife

1. TREATMENT BEAM FAILS TO TERMINATE

The linac has failed to properly terminate a treatment if the accumulated MU displayed on the console monitor exceeds the MU1 value preset for the treatment. The following procedure is recommended:

1. Press the DISABLE button on the console .
2. If the beam still remains on, press the nearest EMERGENCY OFF button.
3. If the beam still remains on, turn off the main facility circuit breaker. See diagram above.
4. If a patient was receiving therapy, remove the patient by following the procedure outlined in the next section "Power Failure".
5. Record the number of monitor units received by the patient.
6. Do not attempt to use the linac. Call for assistance from the Medical Physics Department.

2. POWER FAILURE

If the hospital power fails, the following procedure is recommended:

1. Emergency lighting should be automatically energized. Locate the flashlight.

3. EMERGENCY OFF BUTTONS : MONTION TERMINATION

In addition to terminating the beam, any unwanted motion of the couch or the gantry occurring during either set up or treatment can be stopped by depressing the nearest of the EMERGENCY OFF buttons.

4. FIRE, SMOKE OR GAS FUMES

If fire, smoke or gas fumes are detected, the following procedure is recommended:

1. Press the nearest EMERGENCY OFF button.
2. Evacuate personnel to a safe area.
3. Notify fire authorities.
4. Do not attempt to use the linac. Call service personnel of the Medical Physics Department.

8.5 Ventilation

Following an analysis by the CNSC in 2011, new guidelines were distributed for ventilation limits around linacs. The CNSC has determined that there is an insignificant risk of either radiation exposure, or ozone exposure, due to low ventilation. Therefore in the event of a loss of ventilation, there is no hazard to staff, patients or public.

The major consequence of a loss of ventilation is the rapid rise of heat caused by linac operation, with the ensuing risk of damage to sensitive operating components in the linac. Normally there are 8 to 12 air changes per hour in the bunkers and this is sufficient to ensure proper heat dissipation.

Thus in the event that ventilation in the radiation oncology department is compromised, it may be possible to continue treatment for a relatively short period of time (perhaps about 15 minutes or so depending upon the seriousness of the ventilation deficit) while steps are taken to restore ventilation. However if a lack of ventilation persists, medical physics staff (engineers or senior physicists) will advise on when to terminate operation of the linacs so as to avoid equipment damage.

8.6 Strontium 90 Check Source

Chamber constancy checks may be performed using the Sr-90 source.

The Sr-90 source is plated on a foil and housed in a shielded container. There is a spring loaded shutter mechanism that is manually retracted to allow the insertion of the ionization chamber. Following the use of the Sr-90 source the container is returned to its designated storage location.

Authorized users exercise caution during the calibration procedure.

The source is labeled with the radiation warning symbol, the source name, the activity on a reference date and contact phone numbers.

Emergency contact numbers are listed in appropriate locations.

9. Service

General

Class II machine servicing at McGill University Health Center (MUHC) is governed by a CNSC license. All work is conducted at MUHC – Glen site, 1001 blvd. Decarie, Montreal. The relevant CNSC license is CNSC License # : 01185-31-n.n.

The current license (CNSC License # : 01185-31-n.n) permits "Extensive Servicing" for the linacs and "Corrective Maintenance" for the HDR afterloader.

For the Elekta-Nucletron V2 HDR, source changes and Preventive Maintenance and Inspection (PMI) procedures are performed by Elekta-Nucletron service engineers on a scheduled basis.

For Varian, service is performed by Varian service engineers as needed.

For Accuray equipment, service and PMI procedures is performed by Accuray service engineers on a scheduled basis.

9. 1 Technical servicing methods and procedures.

Technical servicing, referred to as Preventive Maintenance and Inspection (PMI), and repairs are carried out according to the manufacturer's recommended procedures. Manufacturer's service manuals, as well as updates received during ongoing training of service personnel are used as reference documents.

PMI activities follow a prescribed checklist provided by the manufacturer. Service engineers use this checklist to carry out all PMI activities, and records of this servicing are retained.

Repairs are carried out as needed. Repairs follow the manufacturer's procedures available in manuals, and when necessary, the manufacturer is contacted for outside assistance. Manufacturers providing outside assistance have a valid CNSC servicing license, and a copy of this license is maintained by the RSO Class II.

9. 2 Safe work procedure for servicing Class II equipment

MUHC conducts service activities on Class II equipment as defined under the Class II Nuclear Facilities and Prescribed Equipment Regulations. This equipment includes Linear Accelerators, and the High Dose Rate Remote Afterloading Brachytherapy Unit.

Inspections and maintenance of this equipment are conducted by service engineers on a scheduled basis (typically four times per year at three month intervals) to provide preventative maintenance. Occasionally medical physicists assist serviced engineers. The machine is removed from clinical service for part of a day for this purpose. Servicing operations are also conducted by service engineers when malfunctions are identified.

Exposures to service engineers and medical physicists are kept As Low As Reasonably Achievable (ALARA) by the safe conduct of service operations.

Authorization to Perform Servicing

- Only medical physicists and Medical Physics service engineers whose names are on record with the CNSC are permitted to perform unsupervised servicing of Class II equipment.

- Manufacturer's service representatives who are approved by the CNSC to perform servicing operations are permitted to perform unsupervised servicing of Class II equipment.

- Non authorized service trainees or medical physicists may assist in the servicing of Class II equipment if they are under the direct supervision of an authorized member of staff.

- In some circumstances, it may be necessary for other MUHC employees or outside contractors (e.g., electricians) to aid in the servicing of Class II equipment. An authorized person must be available at all times to ensure the safety of these individuals.

General Service Precautions and Procedures

- Patients must always be removed from the treatment room during servicing operations.

- All personnel must wear their personal dosimeter, if appropriate, while performing servicing operations.

- A properly functioning survey meter, calibrated within the past 12 months, must be available during servicing.

- Staff should pre-plan servicing operations prior to beginning work, if feasible, in order to

minimize the time required to complete the procedure and to keep dose As Low As Reasonably Achievable. Staff should be aware of the location of the "hot spots" near activated components on the linear accelerator and maintain a reasonable distance from them, where this does not interfere with the job. The use of shielding is rarely justified, as it may be of minimal use and will normally increase the time of the exposure.

- Following the completion of any servicing procedure, details of the procedure, including who was involved and, where relevant, an estimate of the time in the accelerator room should be recorded.

- If at any time, a fault is detected on the unit that may have had an impact on radiation safety, the RSO/Class II or other responsible physicist should be notified.

Hazards from Linear Accelerators and Specific Requirements

- When there is no RF in the accelerator (i.e., HV OFF), the only sources of ionizing radiation in the accelerator room are activated components of the room or accelerator. Much of this activation has a short half-life (of the order of 2-3 minutes). Typical dose rates in the accelerator room are 5 μSv/h (0.5 mR/h) or less.

- Some components (particularly in the high energy accelerator beam lines) are activated to higher levels, such that the dose rate at the surface of these components may be significantly higher (i.e., up to 40 μSv/h or 4 mR/h) on contact. Dose rates are reduced rapidly with distance (e.g. 30 cm) from the components. These components comprise the bending magnet assembly, the flattening filter, primary collimator, secondary collimators and target.

    - Service engineers should ensure that whole body dose rates are < 25 μSv/h (2.5 mR/h) when conducting service operations and wherever possible, lower dose rates should be found prior to servicing.

- The dose rate at the surface of the unshielded target may be as high as 60 mR per hour (600 μSv/h), while the target with service shield attached has a dose rate of approximately 1 mR per hour (10 μSv/h). The Chief of Medical Physics or the RSO/Class II will be notified of the need to conduct servicing of the target.

- It would be extremely difficult to conduct a patient treatment while the machine is in service mode and this would be easily noticed by the technologists, as the display would be unfamiliar.

- Following servicing of a linac, the medical physicist and engineer decide whether tests or calibrations are required before clinical use. Manufacturer's recommendations can also be consulted.

Status lights are installed in the modulator area of the Varian linacs. The sliding doors are interlocked with the LPO system.

- Following the repair and calibration of dosimetry sensitive components of the linac, the Service Engineer or Medical Physicist must notify the Chief Technologist or delegate that the linac may be put back into clinical service.

- Components of the accelerator will not be disposed of without ascertaining that there is no radioactivity present.

Hazards from Remote Afterloading Brachytherapy Unit and Specific Requirements

- Servicing operations on the HDR are generally restricted to diagnostic testing of electrical and mechanical components external to the HDR in consultation with a medical physicist. For work outside this scope, Elekta-Nucletron should be called.

- For the remote afterloading equipment, all service and maintenance procedures are performed with the source in the OFF (shielded) position. In this situation, the dose rates at 30 cm from the HDR unit will be < 5 μSv/h (0.5 mR/h) or less. Areas of higher dose rate (up to 10 μSv/h or 1 mR/h) are found close to contact with the unit as shown on the routine survey conducted by Elekta-Nucletron during source change operations and should be consulted for reference.

- Staff must ensure that the HDR is in the OFF position prior to conducting servicing operations.

- Source changes are conducted by Elekta-Nucletron.

- Only in an emergency is anyone to enter the treatment room while the source is stuck in the ON position.

9. 3 RF on in room procedure

Under no circumstances shall anyone remain in the treatment room when the accelerator is operating under conditions which would normally produce radiation.
In rare circumstances during accelerator maintenance, it may be necessary for a service engineer or medical physicist to be present in the treatment room when the accelerator is producing RF in the waveguide. This action should be taken only after alternate approaches have been considered. The time spent in the treatment room should be the minimum required to obtain the necessary service information.

- Two or more staff must be present for the entire procedure.

- The staff should have a properly functioning and calibrated radiation survey meter with audible warning alarms available.

- Radiation may be produced by acceleration of dark current in the waveguide as well as from the operation of high voltage components. Staff should note that actual radiation levels

may vary from the documented levels since dark current magnitudes will vary with accelerator vacuum conditions and RF arcing conditions and will generally be higher if shielding around components is removed.

- Whenever possible the operation of the electron gun should be disabled using an approved procedure specific to the accelerator in question.

- The collimators should be reduced to the smallest field size where possible.

- With one person in the treatment room, the other should be stationed at the control console keeping the former in continuing verbal communication via an intercom and under visual surveillance using closed-circuit TV. The person in the room should ascertain using the survey meter that the radiation levels in the work areas are acceptably low.

9. 4 By-passing of interlocks during servicing

Under no circumstance during maintenance of treatment machines shall the emergency-off circuits be bypassed or disabled. From time-to-time other interlocks may have to be bypassed in the course of maintenance.

For treatment machines that offer operating modes (such as service mode) in which interlocks may be bypassed, the service mode of the machine shall not normally be used for patient treatment.

If a treatment machine is operated in a situation where interlocks are bypassed or have failed (for example, because bending magnets are switched off or have failed), the rules described in this procedure should be followed:

- Service engineers or medical physics staff should review the available data on the patterns of radiation levels expected outside the treatment room.
- A survey meter shall be available at all times
- A sign should be posted at the entrance when interlocks are by-passed.

9. 5 Service License Notes.

A Who may enter the treatment room to perform maintenance.

Departmental medical physicists and engineering staff, as well as the manufacturers' service representatives are permitted to enter the treatment room to perform maintenance.

B Conditions under which activities in (A) may be performed.

Inspections and maintenance will be performed on a routine basis, with the linac removed for from clinical service (typically four times per year at three month intervals) to provide preventive maintenance and inspection (PMI).
When a machine malfunction is identified, the patient is always removed from the treatment room. The service engineer proceeds with identification of the problem and repairs as needed. The physicist and engineer decide whether tests or calibrations are required before resuming clinical use. Following the repair and calibration of the linac the Chief Technologist or delegate is informed that the linac may be put back into clinical service.
The possibility of encountering activated components are well known to physicists, engineers and technologists operating the linac. The only components of concern are the collimator jaws and some other components in the machine head. Distance (more than 30 cm) and time (few minutes after irradiation) decrease the dose equivalent rate to essentially negligible levels. No disposal of activated components is anticipated.
Records on routine machine operation and machine maintenance are maintained.

C The policy for recording intentional bypass of safety interlocks.

Safety interlocks will be bypassed only under extenuating circumstances and this will be done only under supervision of the engineering staff or a medical physicist. Instances requiring a safety interlock bypass will be recorded.

D Safe operating procedures in the vicinity of the linac head

When servicing high energy linacs in the vicinity of the head (MLC, bending magnet, target, etc.) engineers will generally try and work in areas where the exposure rate is on the order of 25 μSv/hour (2.5 mR/hour) or less. Time and distance should be used to minimize exposure. Measurements shall be carried out with a properly calibrated survey meter.

E Personnel Monitoring

All service engineers and physicists are issued a dosimeter (OSLD). Engineering staff and physicists are advised to wear their OSLD at all times in the department and to notify the RSO of any loss or accidental irradiation of their OSLD.

F Service Mode

Linacs are equipped with a service mode. This service mode is available for maintenance and troubleshooting by service engineers, as well as for use by physicists. The service mode interface is completely different from the standard clinical mode interface, and it would be impossible for the therapy technologists to mistake the clinical mode for the service mode.
Should the service mode be left in operation, it would be very difficult for a technologist to inadvertently treat a patient in the service mode. Service mode does not interface with the data management server system. Technologists have no training in service mode, the interface is not intuitive, and they would have difficulty running the linac without prior training.
The design of the service mode makes it extremely unlikely that it would be used clinically by mistake, and service engineers and physicists are instructed not to permit unattended linac use in the service mode.

G Head activation

Measurements to assess head activation were performed on the Varian TrueBeam with a calibrated ion chamber survey meter (Victoreen 451 P) using the following linac setup: the high photon energy mode (15X), gantry angle 0, collimator angle 0, and the MLC fully retracted.

The measurement results for a field size of 10×10 cm^2 and dose rate of 600 MU/min are presented in Table I. Two irradiation conditions were adopted: 500 MU corresponding to a typical patient irradiation condition and 5000 MU corresponding to a servicing irradiation condition where large numbers of monitor units may be given.

Table I. Exposure rate measured at the machine isocenter 30 seconds after irradiation

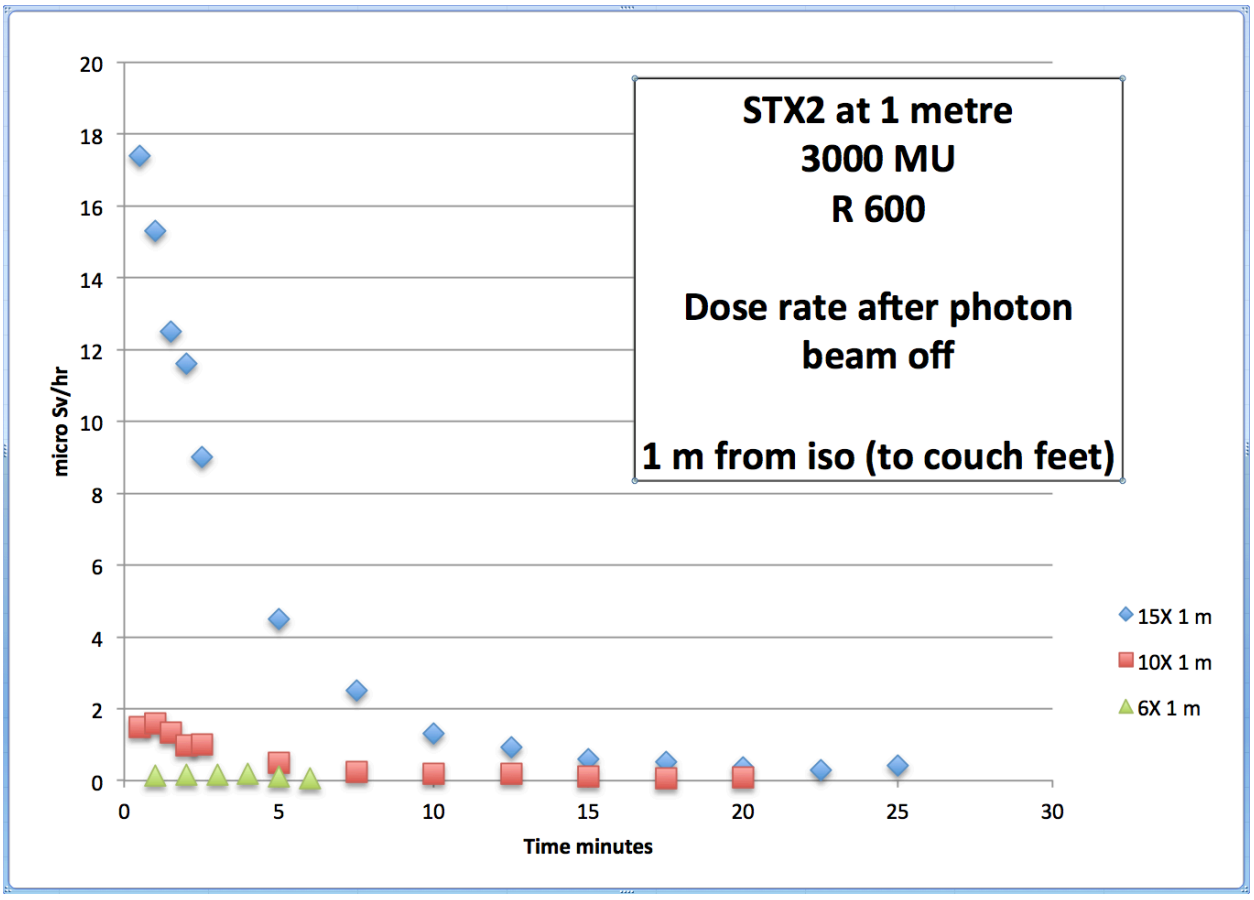
Irradiation (MU)	Field size (cm^2)	Dose rate (MU/min)	Exposure rate mR/h (micro Sv/hr)
500	10×10	600	0.5 (5.0)
5000	10×10	600	2.1 (21.0)

A second set of measurements was taken to demonstrate the typical decay process. Measurements were performed on the Varian TrueBeam with a calibrated ion chamber survey meter (Victoreen 451 P) using the following linac setup: the high photon energy mode (15X), gantry angle 0, collimator angle 0, and the MLC fully retracted.

After a delivery of 5000 MU, the exposure rate was measured at the machine isocenter at various times post irradiation (see Table II). The half-life was determined to be about 3 to 4 minutes for this particular geometry.

Table II. Exposure rate (microSv/h) as a function of time following irradiation with 15X beam and 5000 MU at R600.

Post-irradiation time (min)	micro Sv/h
1	14.5
5	6.2
10	3.4
15	2.1
20	1.6



Graph I. Exposure rate (microSv/h) as a function of time following irradiation with 15X, 10X and 6X beam and 3000 MU at R600.

I Survey Meter Use

Prior to using a survey meter, check that meter has been calibrated within the last 12 months. Do not use a survey meter that has not been calibrated within the last 12 months (check the identification sticker). Also note the serial number of the survey meter you are using. Check the battery before using the survey meter. The survey meter has a delicate needle: hold the survey meter flat and avoid rough handling.
It is always prudent to have a calibrated survey meter available when working in the vicinity of the linacs or HDR afterloader. Be especially careful around the head of the linac or the MLC where activation may occur. If the survey meter reads greater than 25 mR/hr (250 μSv/hr) seek the advice of the RSO / Class II or another medical physicist.

9. 6 Preventive Maintenance and Inspection (PMI).

Preventive maintenance and inspection (PMI) is carried out on Class II Prescribed Equipment. PMI is carried out on the HDR remote afterloader by Elekta-Nucletron service engineers, and on linear accelerators by Varian or Accuray engineers . PMI may also be performed periodically on Varian linacs by Medical Physics service engineers. Activities carried out during this period include, but are not limited to:

- inspection,
- preventive maintenance,
- trouble shooting and
- repairs as needed.

As well. inspection and verification of the following systems and components, where applicable, is performed:

- emergency off buttons,
- warning lights in treatment room and in modulator room
- Last Person Out (LPO) system.

Radiation levels around linacs
Machine: TrueBeam 4
Energy : 15MV X-Rays
Beam Conditions : 1000 MU @ 600 MU/min. FS 20 x 20 cm^2, Gantry at 0°. No phantom.
Measurement : 60 seconds post irradiation with 450P survey meter. July 2015.
Background at console : 0.05 μSv/hr

Position	Measurement μSv/hr
Service plate on central axis	40.0 μSv/hr
Service plate 50 cm from central axis	5.6 μSv/hr
At isocentre	20.0 μSv/hr
Gantry stand by klystron (patient's right)	2.0 μSv/hr
Gantry stand by water system (patient's left)	1.5 μSv/hr
Accelerator waveguide – target end	4.0 μSv/hr
Gantry "throat" - accelerator waveguide – gun end	3.0 μSv/hr
Midway Gantry "throat" - gun on side	3.5 μSv/hr

A half life of about 3 minutes was observed, depending upon the position of measurement and the composition of the activated components.

For additional detailed information see Wang et al, "Characteristics of induced activity from medical linear accelerators", Medical Physics, 32(9), 2899 – 2910, September 2005.

Radiation levels High Dose-Rate Afterloader (Installed March 6, 2006)
Machine: microSelectron V2 SN 31718
Energy : Ir-192
Beam Conditions : ~7.0 Ci. Source fully shielded. Covers on machine.
Measurement : V190I survey meter SN 193. April 2006.
Background at console : 0.01 μSv/hr (0.001 mR/hr)

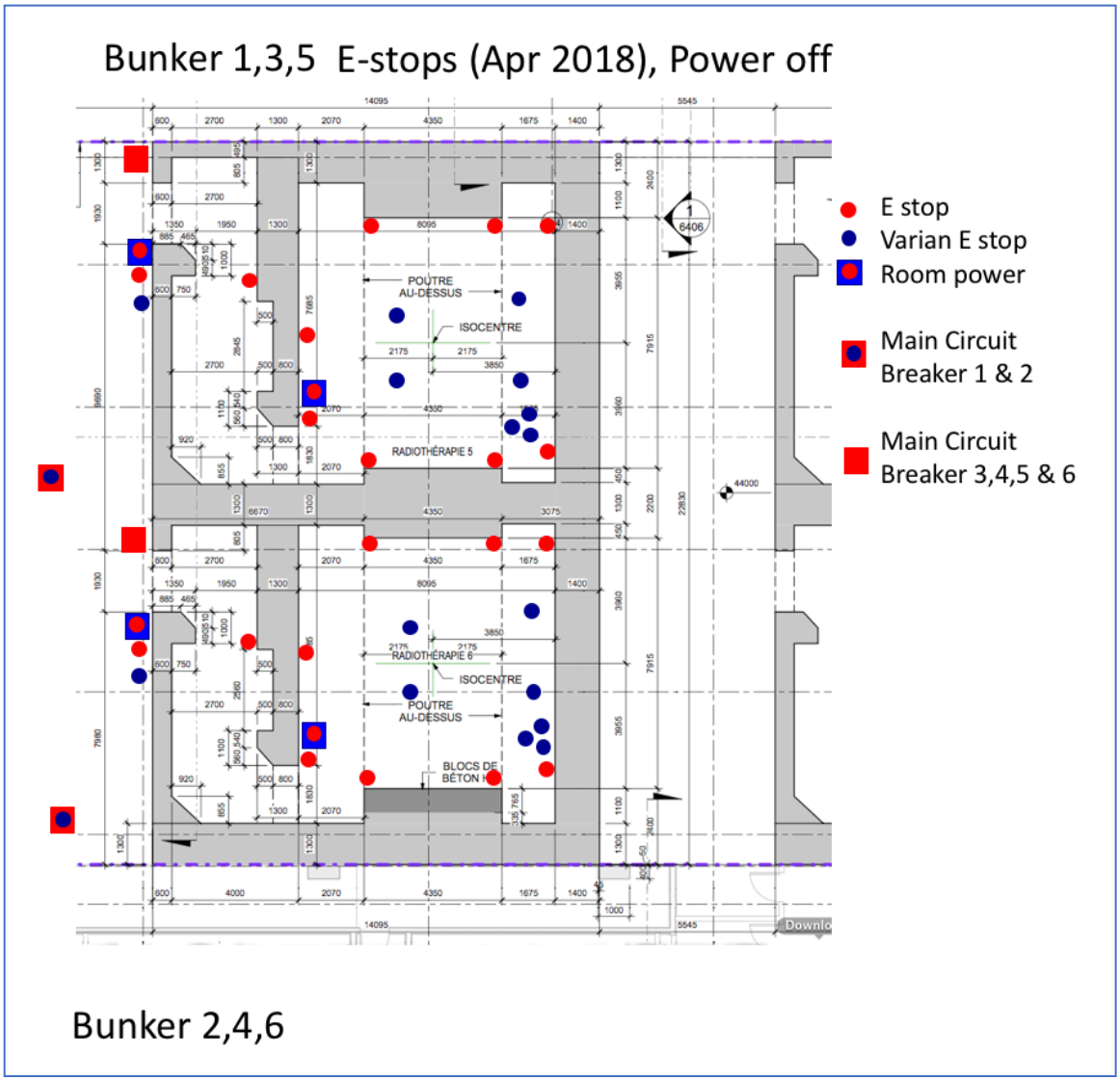
Position	Measurement μSv/hr (mR/hr)
Above safe of unit – surface	1.0 μSv/hr (0.1 mR/hr)
Front end of unit - surface	0.1 μSv/hr (0.01 mR/hr)
Front end of unit – 1 m	0.05 μSv/hr (0.005 mR/hr)
Left side of unit - surface	0.5 μSv/hr (0.05 mR/hr)
Left side of unit – 1 m	0.05 μSv/hr (0.005 mR/hr)
Right side of unit - surface	0.5 μSv/hr (0.05 mR/hr)
Right side of unit – 1 m	0.05 μSv/hr (0.005 mR/hr)
Back end of unit - surface	0.3 μSv/hr (0.03 mR/hr)
Back end of unit – at handles	0.1 μSv/hr (0.01 mR/hr)
Back end of unit – 1 m	.05 μSv/hr (0.005 mR/hr)
Base of unit – surface	.05 μSv/hr (0.005 mR/hr)

9. 7 Quarterly Inspection Tests

9.7. 1 Quarterly Tests for Emergency Stop (E-Stop) buttons.

Done every quarter. Recorded on PMI document.

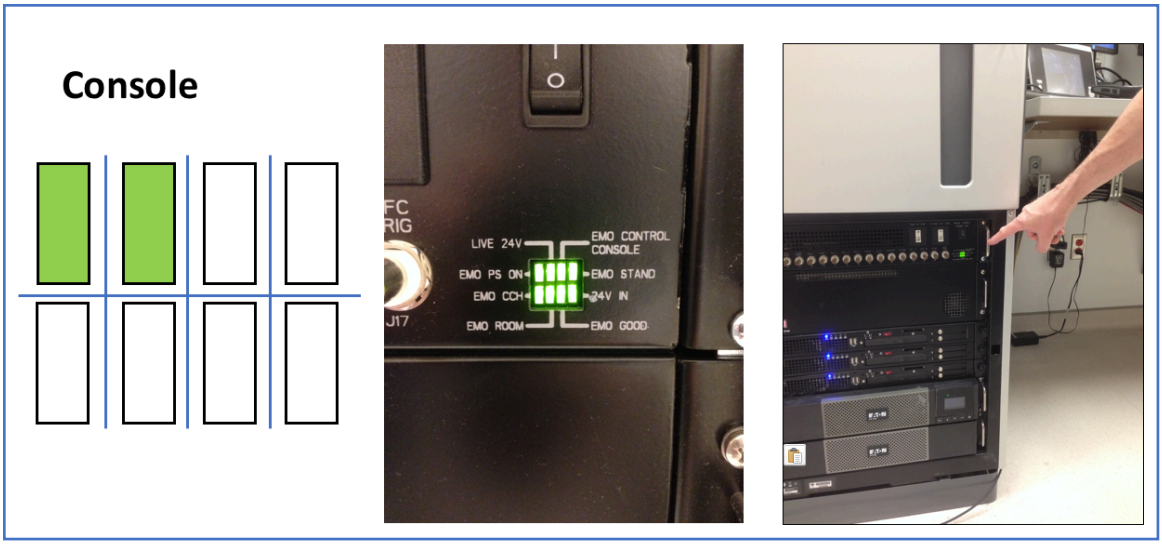
A diagram showing the location of all E-Stops to be tested is below.



Five groups of E-Stops are tested. They are: Console, Customer (also known as “room”) , Couch, Stand and Modulator. The E-Stops can be tested in any order, but the order suggested below is the most efficient. Main circuit breakers , and room power, are not tested.

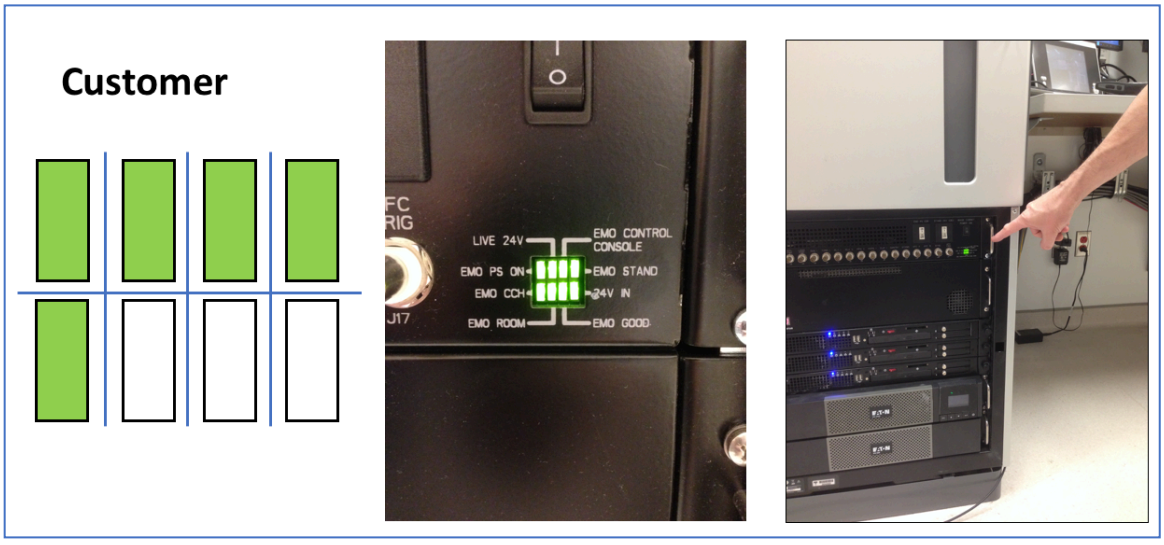
Console

1 Press the Console E-Stop. Verify the correct LED configuration as shown below. Reset the Console E-Stop.



Customer

2 Press the first customer red-mushroom E-Stop beside the maze entrance. Verify the correct LED configuration as shown below. Reset the customer red-mushroom E-Stop. Proceed to test the next 9 customer red-mushroom E-Stop buttons.



Couch

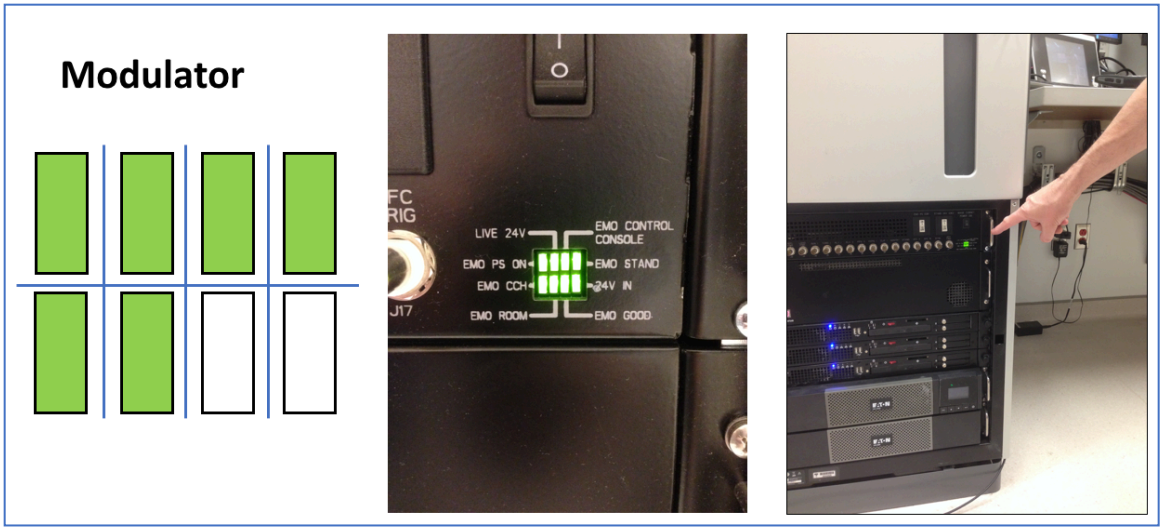
3 Press one of the couch E-Stop buttons. Verify the correct LED configuration as shown below. Reset, and test the other couch E-Stop button.

Stand

4 Press one of the stand red-mushroom E-Stop buttons. Verify the correct LED configuration as shown below. Reset, and test the other stand red-mushroom E-Stop button.

Modulator

5 Press one of the modulator red-mushroom E-Stop buttons. Verify that the machine can not be started when pressing the green Start button in the modulator cabinet. Reset the modulator red-mushroom E-Stop button. Proceed to test the next 2 modulator red-mushroom E-Stop buttons.

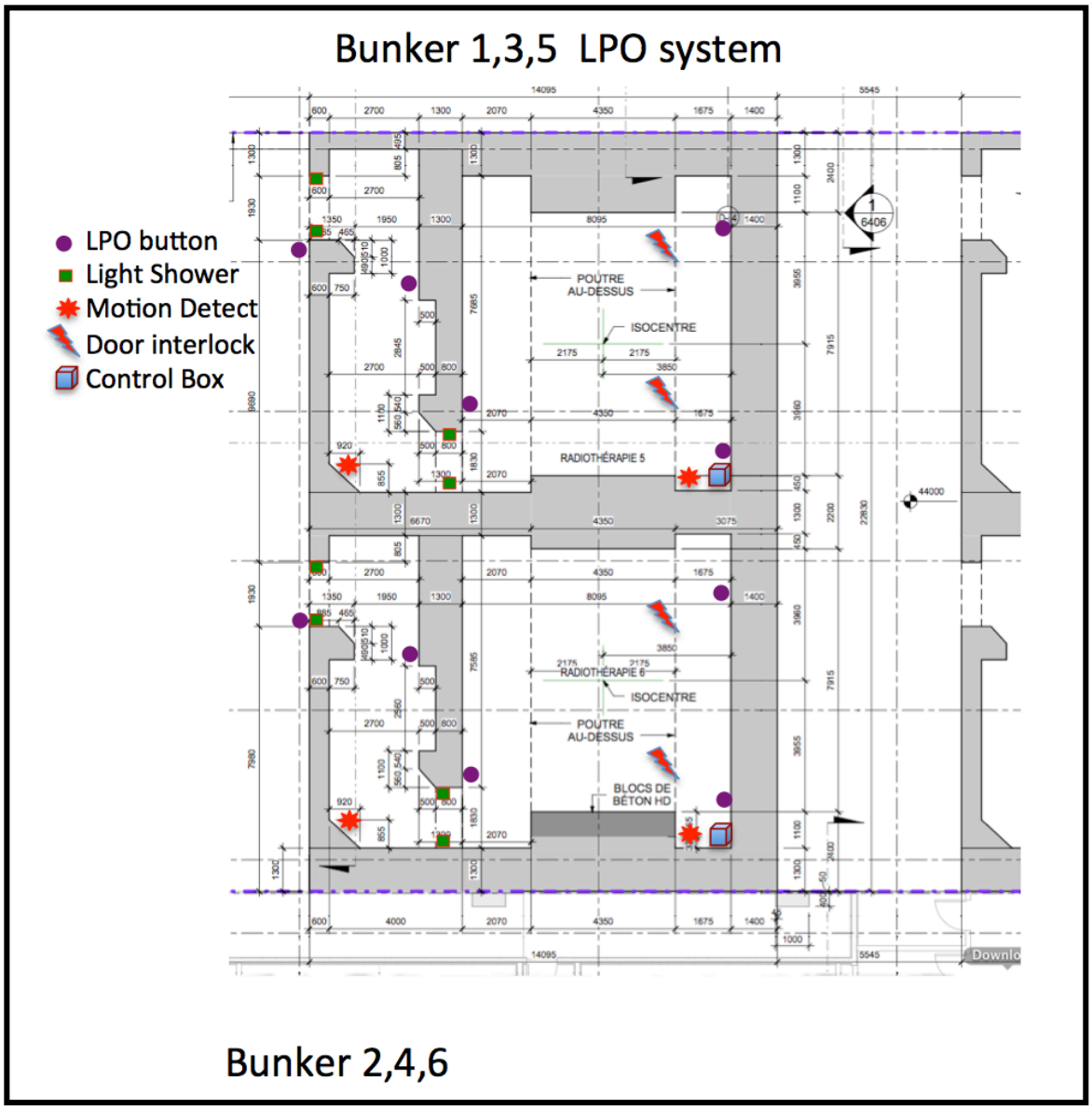


9.7. 2 Quarterly Tests for Last Person Out (LPO) systems.

Done every quarter on all linacs to verify Last Person Out (LPO) and warning light systems not tested on a daily basis, as per license condition.

Linacs 1 to 6 (Varian linacs) have the full set of tests completed. Linac 7 (CyberKnife) has a subset of tests since there are no doors to the modulator enclosures.

A diagram showing the location of various LPO components is below.



1 Press the LPO in the treatment room near the sink, and see that the red light is visible. Open the **Right** modulator door and observe that the LPO light extinguishes.

2 Press the LPO button behind the **Right** modulator door and wait for 15 seconds before closing the sliding panel. Close the sliding door and observe that the LPO light near the sink does not become visible.

3 2 person test. Press the LPO button behind the **Right** modulator door and close the sliding panel. Press the LPO in the treatment room near the sink, and see that the red light is visible. Test that the motion detector behind the sliding doors can trip the LPO system by observing that the LPO light near the sink extinguishes.

4 Press the LPO in the treatment room near the sink, and see that the red light is visible. Open the **Left** modulator door and observe that the LPO light extinguishes.

5 Press the LPO button behind the **Left** modulator door and wait for 15 seconds before closing the sliding panel. Close the sliding door and observe that the LPO light near the sink does not become visible.

6 Press the LPO in the treatment room near the sink, and see that the red light is visible. Wait for about 40 seconds and observe that this LPO light extinguishes.

7 2 person test. Press the in-room LPO, the maze LPO and the LPO in the console so that the system is correctly armed. The person in the room shall trip the in-room light shower and ensure that all LPO lights extinguish.

8 Press the in-room LPO, followed by the maze LPO. Return to the treatment room and trip the in-room light shower. Ensure that the in-room and maze LPO lights extinguish.

9 2 person test. Press the in-room LPO, the maze LPO and the LPO in the console so that the system is correctly armed. One person remains in the maze. The person shall trip the maze motion detector and ensure that all LPO lights extinguish.

10 Press the in-room LPO, the maze LPO and the LPO in the console so that the system is correctly armed. Trip the entrance light shower and ensure that all LPO lights extinguish.

11 Ensure the warning light in the treatment room is functioning correctly by using the in-room camera system.

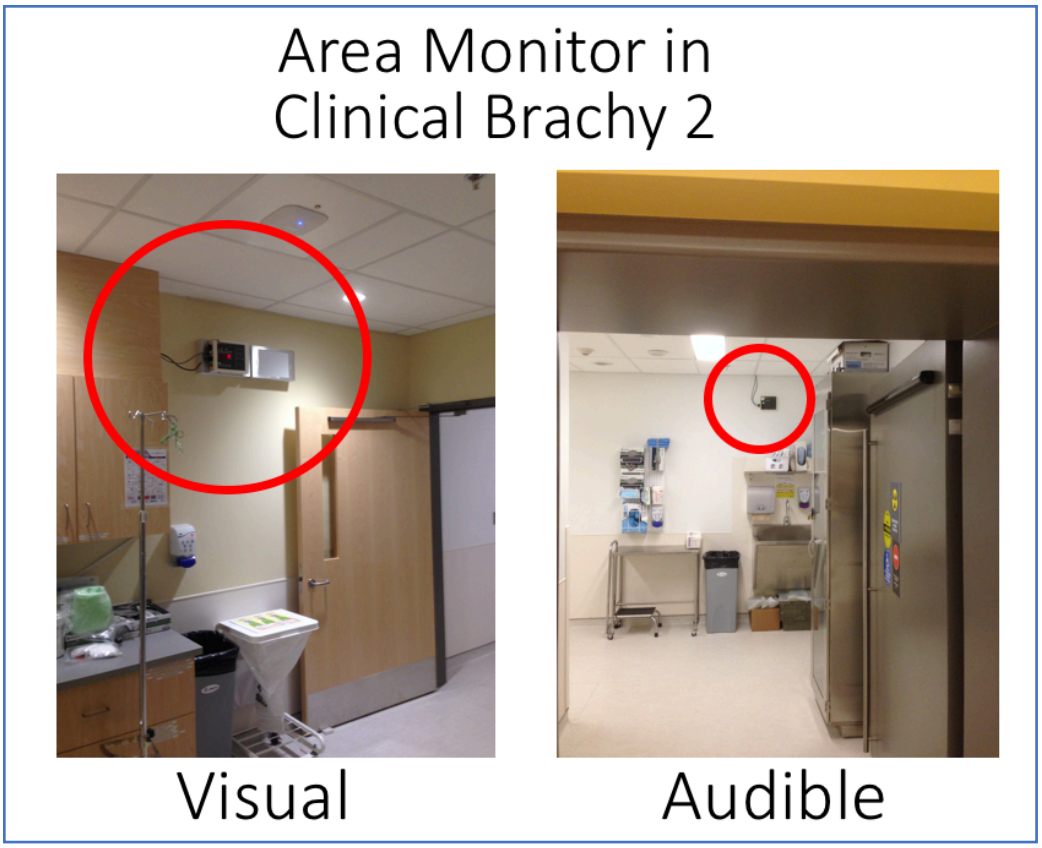
12 Ensure the warning light above the entrance to the treatment room is functioning correctly by observation from the console.

9.7. 3 Quarterly Tests for Brachy Area Radiation Monitors

Done every three months to verify the functioning of the brachy area radiation monitors on battery power alone.

Units tested are listed:
1 Unit in Brachy 1 (Research): DS1 6256. Anticipated for 2018.
2 Unit in Brachy 2 (Clinical): DS1 6256.
3 Spare unit for Brachy 2: Normally found in the storage room DS1 6764.1.

1 Unit in Brachy 1 (Research): DS1 6256. Anticipated for 2018.



2 Unit in Brachy 2 (Clinical): DS1 6256.

3 Spare unit for Brachy 2: Normally found in the storage room DS1 6764.1.

Procedure

1 Obtain a source of radiation for the test. The most convenient is a Cs-137 source. Alternatively, in Brachy 2 the HDR unit or the CT scanner can be used.

2 Note the date and name. Note the source of radiation used.

3 Disconnect the radiation monitor from the hospital power supply.

4 Place the source of radiation near the area monitor (or activate the CT or HDR remotely). Ensure that the unit functions correctly by displaying a visual reading. For the wall unit in Brachy 2 ensure that the audible is also heard.

10. Emergencies

Emergency situations with respect to radiation safety are described in chapters 7, 8, 9.

Emergencies not predicted by standard procedures may require the assistance of personnel from the Medical Physics Department. Daytime telephone numbers are located throughout the Department of Radiation Oncology at locations near to Class II equipment and sealed sources.

Useful daytime numbers for emergency assistance are as follows:

Clinical phone	x 43533
Brachy phone	x 43532
Stereo phone	x 23672
M. Evans office	x 45533
W. Parker office	x 42676
Physics office	x 48052

The MUHC emergency telephone number is 55-555
After hours the MUHC Radiation Safety on call can be reached through locating at X 53333

The MUHC is a corporate entity encompassing a number of hospitals, research institutes and administrative facilities. The MUHC emergency telephone number is a single call point for all emergencies. Assistance can be obtained after-hours by contacting the EMERGENCY telephone number, or through locating. The operator will contact the MUHC Radiation Safety Manger or Chief of Physics, or delegate using the call-down list for emergency assistance for Class II equipment.

CNSC 24 hour duty officer can be reached at (613) 995-0475.
The CNSC license number for the MUHC Class II facility is 01185.
CANUTEC telephone number is (613) 996-6666.

During an emergency, medical physicists may need access to a calibrated radiation survey meter. Security personnel may be asked to assist by permitting access to rooms containing survey meters. Calibrated radiation survey meters are located in the following rooms:

DS1 7122	(Engineers' room)
DS1 6756	(Cupboard above HDR console)
DS1 6764	(Brachy source room)
DS1 9340	(Office of M. Evans : RSO)

During the control of an emergency and the consequent immediate and urgent remedial work, the effective dose and the equivalent dose may exceed the applicable dose limits, but the effective dose shall not exceed 500 mSv and the equivalent dose received by the skin shall not exceed 5 000 mSv.

The above emergency limits do not apply in respect of pregnant nuclear energy workers who have informed the licensee in accordance with subsection CNSC Radiation protection Regulations 11(1).

Dose limits prescribed by CNSC may be exceeded by a person who acts voluntarily to save or protect human life.

CNSC Radiation Protection Regulations 16 states:

When a licensee becomes aware that a dose of radiation received by and committed to a person or an organ or tissue may have exceeded an applicable dose limit prescribed by section 13, 14 or 15, the licensee shall

(a) immediately notify the person and the Commission of the dose;

(b) require the person to leave any work that is likely to add to the dose;

(c) conduct an investigation to determine the magnitude of the dose and to establish the causes of the exposure;

(d) identify and take any action required to prevent the occurrence of a similar incident; and

(e) within 21 days after becoming aware that the dose limit has been exceeded, report to the Commission the results of the investigation or on the progress that has been made in conducting the investigation.

Return to work must be authorized by the CNSC.

Decision data

It may be necessary to decide whether an area is safe to work in following an emergency event. The following data may be useful to a medical physicist or other senior official in making safety decisions.

As a guide, CNSC Radiation Protection Regulations Section 21 (1) states:

1) Every licensee shall post and keep posted, at the boundary of and at every point of access to an area, room, enclosure or vehicle, a durable and legible sign that bears the radiation warning symbol set out in Schedule 3 and the words “RAYONNEMENT—DANGER —RADIATION”, if…

(b) there is a reasonable probability that a person in the area, room, enclosure or vehicle will be exposed to an effective dose rate greater than 25 μSv/h (2.5 mR/hr).

A dose rate of 25 μSv/h would be expected to bring a Nuclear Energy Worker to their yearly limit of 50 mSv (40 hours per week x 50 weeks x 25 μSv/h = 50 mSv) in 2000 hours (a normal working year).

The NEW limit of 50 mSv is reached in a radiation field of 25 μSv/h (2.5 mR/hr) in 2000 hours.
The NEW limit of 50 mSv is reached in a radiation field of 250 μSv/h (25 mR/hr) in 200 hours.
The NEW limit of 50 mSv is reached in a radiation field of 2, 500 μSv/h (250 mR/hr) in 20 hours.
The NEW limit of 50 mSv is reached in a radiation field of 25, 000 μSv/h (2, 500 mR/hr) in 2 hours.

A dose rate of 25 μSv/h would be expected to bring a member of the public (CNSC designation : Any other person) to their yearly limit of 1 mSv in 40 hours.

The public limit of 1 mSv is reached in a radiation field of 25 μSv/h (2.5 mR/hr) in 40 hours.
The public limit of 1 mSv is reached in a radiation field of 250 μSv/h (25 mR/hr) in 4 hours.
The public limit of 1 mSv is reached in a radiation field of 2, 500 μSv/h (250 mR/hr) in 0.4 hours (24 minutes).

During the control of an emergency and the consequent immediate and urgent remedial work, the effective dose and the equivalent dose may exceed the applicable dose limits, but the effective dose shall not exceed 500 mSv.

The emergency limit of 500 mSv is reached in a radiation field of 25 μSv/h (2.5 mR/hr) in 20, 000 hours.

The emergency limit of 500 mSv is reached in a radiation field of 250 μSv/h (25 mR/hr) in 2, 000 hours.

The emergency limit of 500 mSv is reached in a radiation field of 2, 500 μSv/h (250 mR/hr) in 200 hours.

The emergency limit of 500 mSv is reached in a radiation field of 25, 000 μSv/h (2, 500 mR/hr) in 20 hours.

The emergency limit of 500 mSv is reached in a radiation field of 250, 000 μSv/h (25, 000 mR/hr) in 2.0 hours.

For information, the LD50/30 (the instantaneous whole body dose that will be lethal to 50% of individuals in a population, in 30 days) is thought to be on the order of 500 cGy or approximately 5, 000 mSv.

CNSC Radiation Protection Regulations Section 15 (3) states: "*The dose limits…may be exceeded by a person who acts voluntarily to save or protect human life*."

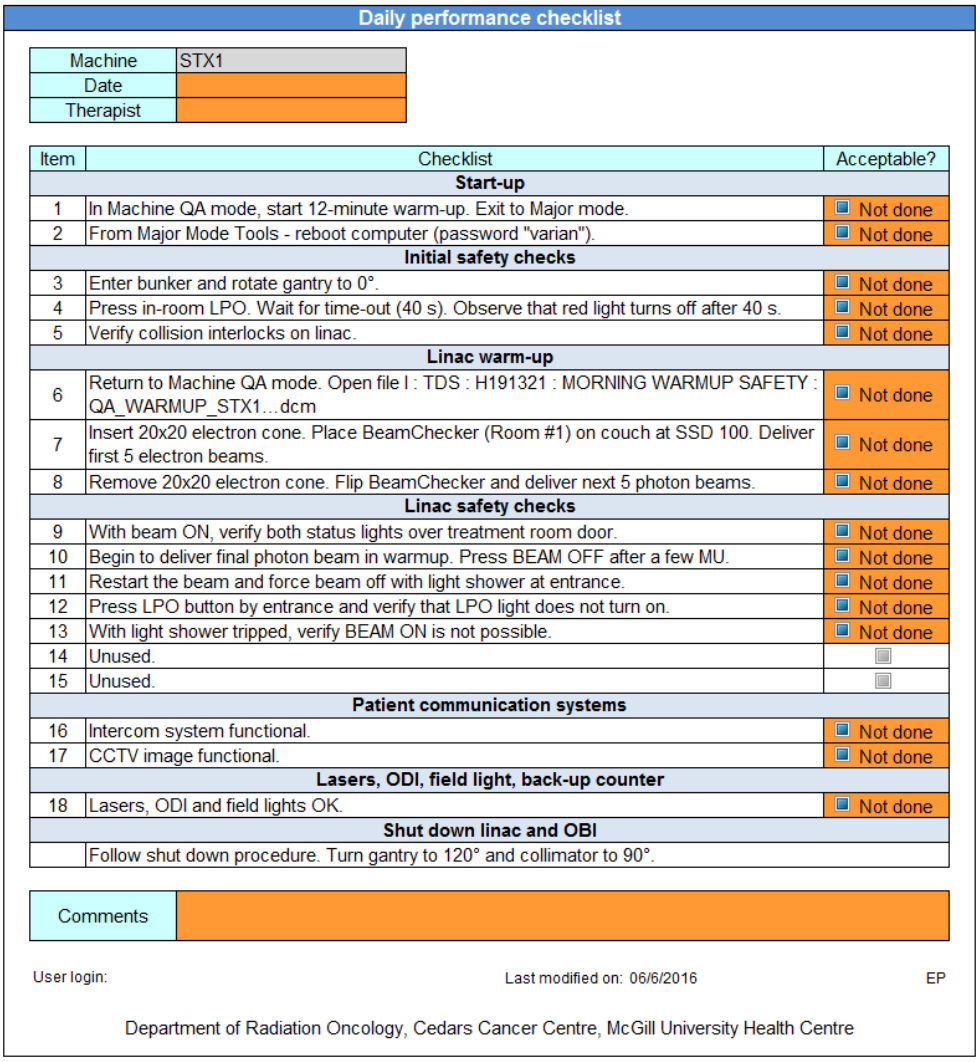
11. Control Documents

Class II and Radiation Oncology activities are governed by CNSC licenses. Control documents are used to regulate and record activities related to radiation safety. The principle control documents are the performance checklists that are used on a daily basis, or prior to the first beam-on of the day. Performance checks are to be performed every day, or prior to first beam-on : whichever results in fewer operations. This includes emergency or unscheduled treatments and service work on weekends and days on which the clinic does not normally run. These checklists provide a demonstrable level of control on the safety mechanisms in the department, and alert service personnel to the presence of faulty equipment.

As of July 2016 all Performance checks (below) have been migrated to an electronic format in the ATLAS software system. The content below is reproduced in ATLAS software.

Performance checklists are not countersigned during commissioning, or non clinical related activities.

Sample ATLAS morning / daily safety checks pages are displayed below.



Daily performance checklist

Machine	STX1
Date	
Therapist	

Item	Checklist	Acceptable?
	Start-up	
1	In Machine QA mode, start 12-minute warm-up. Exit to Major mode.	Not done
2	From Major Mode Tools - reboot computer (password "varian").	Not done
	Initial safety checks	
3	Enter bunker and rotate gantry to 0°.	Not done
4	Press in-room LPO. Wait for time-out (40 s). Observe that red light turns off after 40 s.	Not done
5	Verify collision interlocks on linac.	Not done
	Linac warm-up	
6	Return to Machine QA mode. Open file I : TDS : H191321 : MORNING WARMUP SAFETY : QA_WARMUP_STX1...dcm	Not done
7	Insert 20x20 electron cone. Place BeamChecker (Room #1) on couch at SSD 100. Deliver first 5 electron beams.	Not done
8	Remove 20x20 electron cone. Flip BeamChecker and deliver next 5 photon beams.	Not done
	Linac safety checks	
9	With beam ON, verify both status lights over treatment room door.	Not done
10	Begin to deliver final photon beam in warmup. Press BEAM OFF after a few MU.	Not done
11	Restart the beam and force beam off with light shower at entrance.	Not done
12	Press LPO button by entrance and verify that LPO light does not turn on.	Not done
13	With light shower tripped, verify BEAM ON is not possible.	Not done
14	Unused.	
15	Unused.	
	Patient communication systems	
16	Intercom system functional.	Not done
17	CCTV image functional.	Not done
	Lasers, ODI, field light, back-up counter	
18	Lasers, ODI and field lights OK.	Not done
	Shut down linac and OBI	
	Follow shut down procedure. Turn gantry to 120° and collimator to 90°.	

Comments	

User login: Last modified on: 06/6/2016 EP

Department of Radiation Oncology, Cedars Cancer Centre, McGill University Health Centre

Sample morning safety checks for linacs STX1 and STX2, in ATLAS.

Daily performance checklist

Machine	TB3
Date	
Therapist	

Item	Checklist	Acceptable?
	Start-up	
1	In Machine QA mode, start 12-minute warm-up. Exit to Major mode.	Not done
2	From Major Mode Tools - reboot computer (password "varian").	Not done
	Initial safety checks	
3	Enter bunker and rotate gantry to 0°.	Not done
4	Press in-room LPO. Wait for time-out (40 s). Observe that red light turns off after 40 s.	Not done
5	Verify collision interlocks on linac.	Not done
	Linac warm-up	
6	Return to Machine QA mode. Open file I : TDS : H191332 : MORNING WARMUP SAFETY : QA_WARMUP_TB3...dcm	Not done
7	Insert 20x20 electron cone. Place BeamChecker (Room #1) on couch at SSD 100. Deliver first 5 electron beams.	Not done
8	Remove 20x20 electron cone. Flip BeamChecker and deliver next 5 photon beams.	Not done
	Linac safety checks	
9	With beam ON, verify both status lights over treatment room door.	Not done
10	Begin to deliver final photon beam in warmup. Press BEAM OFF after a few MU.	Not done
11	Restart the beam and force beam off with light shower at entrance.	Not done
12	Press LPO button by entrance and verify that LPO light does not turn on.	Not done
13	With light shower tripped, verify BEAM ON is not possible.	Not done
14	Unused.	
15	Unused.	
	Patient communication systems	
16	Intercom system functional.	Not done
17	CCTV image functional.	Not done
	Lasers, ODI, field light, back-up counter	
18	Lasers, ODI and field lights OK.	Not done
	Shut down linac and OBI	
	Follow shut down procedure. Turn gantry to 120° and collimator to 90°.	

Comments	

User login: Last modified on: 06/6/2016 EP

Department of Radiation Oncology, Cedars Cancer Centre, McGill University Health Centre

Sample morning safety checks for linacs TB3, TB4, TB5 and TB6 in ATLAS.

Daily performance checklist (Cyberknife)

Machine	Cyberknife M6
Date	
Therapist	

Item	Checklist	Acceptable?
Start-up: Follow start up procedure.		
	Safety checks Cyberknife	
1	Press in-room LPO: wait for time-out (40 s). Observe that red light turns off after 40 seconds.	Not done
2	Arm the LPO system and press START on console computer to initiate BEAM ON.	Not done
3	Observe that Radiation warning light over entrance is functioning.	Not done
4	Press Disable. Observe that beam turns off.	Not done
5	Initiate BEAM ON again. Trip beam off with light shower at maze entrance, and verify beam turns off.	Not done
6	Press LPO by beam entrance and attempt to turn beam on. Verify no beam on.	Not done
	Patient communication systems	
7	Intercom system functional.	Not done
8	CCTV image functional.	Not done
	RFU	
9	RFU	
10	RFU	
11	RFU	
Shutdown: Follow shut down procedure.		

Comments	

User login: Last modified on: 06/6/2016 EP

Department of Radiation Oncology, Cedars Cancer Centre, McGill University Health Centre

Sample morning safety checks for Cyberknife in ATLAS.

Daily performance checklist (Brachytherapy)

Machine	microSelectrion V2 HDR
Date	
Therapist	

Item	Checklist	Acceptable?
	Console and emergency tools	
1	Turn TCS on.	Not done
2	Verify emergency suture kit.	Not done
3	Verify emergency handling tools.	Not done
4	Verify emergency safe.	Not done
	Safety checks and interlocks	
5	Log in. Commence irradiation with the morning QA test treatment.	Not done
6	Verify room radiation monitor. Verify the radiation warning light on the console.	Not done
7	Verify status light over door.	Not done
8	Press INTERRUPT on console. Source retracts.	Not done
9	Resume irradiation. Press EMERGENCY STOP on console. Source retracts. Open door and reset LPO - close door.	Not done
10	Resure irradiation. Open door. Source retracts. Alarm sounds.	Not done
11	With door open verify that BEAM ON is not possible.	Not done
12	Close door without pressing LPO and verify that BEAM ON is not possible.	Not done
13	Press time-delay interlock and wait for time-out (120 seconds). Close door and verify that BEAM ON is not possible.	Not done
14	Resume irradiation and verify that treatment terminates as expected.	Not done
15	Verify that EMERGENCY STOP on afterloader is active.	Not done
16	Verify that hand held survey meter and pocket dosimeter functions.	Not done
17	Verify stopwatch function.	Not done
18	Verify green status light on radiation monitor.	Not done
19	Source position test acceptable.	Not done
	Patient communication systems	
20	Intercom/CCTV functional.	Not done
	Shut down procedure	
Turn key in console to OFF. Place key in designated location. Close the application and turn off the console computer.		

Comments	

User login: Last modified on: 08/8/2016 EP

Department of Radiation Oncology, Cedars Cancer Centre, McGill University Health Centre

Sample morning safety checks for V2 microSelectron # 31718 in ATLAS.