G7.17 Definitions - Calculation of the equivalent dose and the effective dose

Issued January 1, 2005

Section 7.17 of the *OHS Regulation* ("*Regulation*") states:

> In this Division:
>
> "*action level, ionizing radiation*" means an effective dose of 1 milliSievert (mSv) per year;
>
> "*action level, non-ionizing radiation*" means the exposure limits for the general public referred to in section 7.19(4), or if no public limit is referred to, it means the maximum exposure limit for workers in section 7.19(4);
>
> "*effective dose*" means the amount of ionizing radiation, measured in mSv, absorbed by the worker's whole body, adjusted for the energy level and type of radiation and the differing susceptibilities of the organs and tissues irradiated, and if only part of the body is exposed the effective dose is the sum of the weighted equivalent doses in all irradiated tissues and organs;
>
> "*equivalent dose*" means the amount of ionizing radiation, measured in mSv, absorbed by a specific body part and adjusted for the energy level and type of radiation.

The radiation weighting factors (used in determining equivalent dose) and the tissue weighting factors (used in converting equivalent dose to effective dose) are found in ICRP Publication 60, 1990 *Recommendations of the International Commission on Radiological Protection*, and are included here in Tables 1 and 2.

The *equivalent dose* (in mSv) is calculated by multiplying the absorbed dose (in milligrays) by the radiation weighting factor (see Table 1). A typical exposure may include more than one type of radiation, and the total equivalent dose is the sum of the components calculated for each type of radiation.

Table 1: Radiation weighting factors

Type of radiation	Radiation weighting factor (W_R)
Photons (e.g., x-rays or gamma)	1
Alpha	20
Neutrons (various energies)	5, 10, or 20
Protons	5

The *effective dose* (in mSv) is then calculated by multiplying the equivalent dose by the tissue weighting factor (see Table 2) for the part of the body exposed.

Table 2: Tissue weighting factors

Organ or tissue	Tissue weighting factor (W_T)
Gonads (testes or ovaries)	0.2
Red bone marrow; colon; lung; stomach	0.12
Bladder; breast; liver; esophagus; thyroid	0.05
Skin[1]; bone surfaces	0.01
All organs and tissues not mentioned above[2]	0.05
Whole body	1

1. The weighting factor for skin only applies when the whole body is exposed.

2. Hands, feet, or lens of the eye have no tissue weighting factors.

G7.18 Application for ionizing and non-ionizing radiation - Agencies having jurisdiction

Issued August 1999; Revised January 1, 2005

Section 7.18 of the *OHS Regulation* ("*Regulation*") states:

> (1) This Division applies to all sources of ultrasonic energy, non-ionizing and ionizing radiation, including radiation sources governed by the *Nuclear Safety and Control Act* (Canada), except as otherwise determined by the Board.
>
> (2) This Division does not apply to medical or dental radiation received as a patient, or to natural background radiation, except as specified by the Board.

Agencies having jurisdiction over exposure to radiation include WorkSafeBC, the Radiation Protection Services (RPS), and the Canadian Nuclear Safety Commission (CNSC). The mandates of these agencies with respect to radiation are briefly described below.

WorkSafeBC
WorkSafeBC administers the *Regulation*, which includes provisions for protecting workers from exposure to ionizing radiation, electromagnetic fields, lasers, ultraviolet radiation, and ultrasound. The *Regulation* does not differentiate between ionizing radiation in the form of X-rays or from radioactive sources - the requirements apply equally to both. This differs from the CNSC regulations, which only apply to ionizing radiation from radioactive materials or particle accelerators.

A WorkSafeBC inspection is not restricted to issues of radiation, but an officer may also check for compliance with the other applicable sections of the *Regulation*, such as the requirement for an occupational health and safety program.

The WorkSafeBC prevention officer will normally review a radioisotope licence at the work site in order to determine the nature and quantity of any radioactive materials at the workplace.

Radiation Protection Services (RPS)
RPS is a division of the provincial BC Centre for Disease Control. It works closely with interested parties, including employers, citizens groups, associations, and the general public, on matters of all types of radiation, such as radiofrequency, microwave, ultraviolet, laser, ultrasound, and ionizing radiation, as they pertain to public and worker safety. RPS has substantial expertise and the ability to monitor and problem-solve. It also oversees the diagnostic X-ray unit accreditation process for hospitals and other medical facilities and the "partnership programs" developed with the applicable college or association.

The internet site for the RPS is http://www.bccdc.ca/health-info/health-your-environment/ .

Canadian Nuclear Safety Commission (CNSC)
CNSC, previously known as the Atomic Energy Control Board of Canada, is a federal authority that focuses primarily on the control of the health, safety, and environmental consequences of nuclear activities. CNSC does not have a mandate for X-ray machines or for non-ionizing radiation such as radiofrequency, microwave, or ultraviolet radiation.

The CNSC replaced the Atomic Energy Control Board in May 2000 when the *Nuclear Safety and Control Act* and its regulations came into effect. The Internet site for CNSC is http://www.nuclearsafety.gc.ca/.

CNSC inspectors perform routine compliance inspections of organizations (referred to as "licensees") that have received a licence from the CNSC to work with radioactive material. The licence will state what isotopes and devices can be possessed, as well as where and how they are to be handled and maintained. The licence will also list the prescribed (for example, radioactive) substances and devices to which the licence applies and may specify a number of conditions with which the licensee is required to comply. These may include conditions with respect to allowable radiation levels, signage, leak tests, dosimetry, disposal, and reporting of accidents.

The CNSC requires that the licence be available at any location where the prescribed substances are used or stored. A CNSC inspector's primary responsibility is to measure compliance with the conditions on the licence and with the regulations, which apply to the handling of radioactive material. These regulations include CNSC Transport Packaging of Radioactive Materials, and Transportation of Dangerous Goods.

A routine inspection entails checking for and ensuring the accuracy of all records, such as inventory, leak tests, dosimetry, training, and shipping documents. Inspectors would also check that the radioactive material is stored properly and that appropriate signs are posted, such as radiation warning signs and contact details. They also check to see that the appropriate monitoring equipment is available and that it is being properly maintained. Similar to the process followed by WorkSafeBC prevention officers, CNSC inspectors leave a report identifying items of non-compliance and then follow up to ensure compliance is achieved.

CNCS inspectors are also involved in investigating incidents. These investigations can lead to a variety of actions, including the suspension of a licence or prosecution.

G7.19-1 Exposure to ionizing radiation - Exposure limits and exposure period

Issued August 1999; Revised January 1, 2005

Section 7.19(1) and (2) of the *OHS Regulation* ("*Regulation*") states:

> (1) A worker's exposure to ionizing radiation must not exceed any of the following:
>
> (a) an annual effective dose of 20 mSv;
>
> (b) an annual equivalent dose of
>
> (i) 150 mSv to the lens of the eye,
>
> (ii) 500 mSv to the skin, averaged over any 1 cm^2 area at a nominal depth of 7 mg/cm^2, regardless of the area exposed, or
>
> (iii) 500 mSv to the hands and feet.

(2) If a worker declares her pregnancy to the employer, her effective dose of ionizing radiation, for the remainder of the pregnancy, from external and internal sources, must be limited by the employer to the lesser of

(a) 4 mSv, or

(b) the dose limit specified for pregnant workers under the *Nuclear Safety and Control Act* (Canada).

…

Section 7.19(1) provides annual dose limits for all workers exposed to radiation. The time period for measurement is a calendar year, with a start date of January 1, as used by the National Dose Registry (NDR). The NDR administers a centralized radiation dose record system for all radiation workers on a monitoring program in Canada. The NDR is operated by the Radiation Protection Bureau (RPB) of Health Canada. Further information on the National Dose Registry can be found at the Health Canada Internet site at http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/index-eng.php.

Section 7.19(2) provides the dose limits for pregnant workers. The external dose referred to in section 7.19(2) is measured at the abdomen. The time period over which the dose limits apply is the duration of the pregnancy from the date the pregnancy is declared. In order for an employer to ensure that a pregnant worker's dose is limited to the designated exposure limit for the remainder of the pregnancy, the employer needs to know the time period involved, which is from the date the worker declared her pregnancy to the expected date of delivery.

G7.19-2 Notification of worker overexposure to ionizing radiation

Issued August 1999; Revised January 1, 2005; Revised April 30, 2015

Regulatory excerpt
Section 7.19(1) of the *OHS Regulation* ("*Regulation*") states:

A worker's exposure to ionizing radiation must not exceed any of the following:

(a) an annual effective dose of 20 mSv;

(b) an annual equivalent dose of

(i) 150 mSv to the lens of the eye,

(ii) 500 mSv to the skin, averaged over any 1 cm^2 area at a nominal depth of 7 mg/cm^2, regardless of the area exposed, or

(iii) 500 mSv to the hands and feet.

Purpose of guideline
This guideline describes the process for notification to WorkSafeBC of high ionizing radiation exposures, and describes factors to consider when a worker is exposed to levels above the exposure limit.

Notification of high exposures
Reports of worker ionizing radiation overexposure (notifications) to WorkSafeBC may come from an accident investigation report, from the employer, from the National Dose Registry (NDR), or by other means. High Exposure Notifications reported by the NDR are sent by NDR to WorkSafeBC, Prevention and Occupational Disease Initiatives (PODI). In other situations, if a WorkSafeBC prevention officer receives notification of a worker exceeding the annual dose limit, the prevention officer will notify the manager, PODI, without delay. This applies to both the effective dose and to an equivalent dose to the skin, eyes, or limbs.

After a high exposure notification
The manager, PODI, may seek input from occupational health physicians and/or radiological medical advisors and will generally forward a request for an incident investigation to the local WorkSafeBC occupational hygiene officer. This information will be used to help determine the acceptability of the worker's continued employment in the same job category for the remainder of the exposure period (typically the calendar year).

Note that any WorkSafeBC investigation is in addition to an employer's incident investigation required under section 173 of the *Workers Compensation Act* ("*Act*").

A worker whose annual effective dose exceeds 20 mSv, as noted under section 7.19(1)(a) of the *Regulation*, should be protected from further exposure until the following occurs:

- An investigation is completed into the causes of the overexposure
- Required corrective actions are determined and implemented
- A medical opinion is given as to the suitability of further work in the occupation during the control period (normally the calendar year)

In deciding the suitability of a worker continuing in the occupation after a reported overexposure, the employer (in conjunction with WorkSafeBC) should consider factors such as the following:

- **The reliability and accuracy of the reported result**. The thermoluminescent dosimeters (TLDs) used for monitoring the dose of ionizing

radiation have an error factor of about 20%. Also, the incident investigation must determine whether the reading is a real dose to the worker (such as the worker being exposed without protective equipment) or if the dosimeter measured a dose to which the worker was not exposed (such as when the TLD is dropped into the x-ray beam).

- **The magnitude of the dose received**. A worker with an annual effective dose exceeding 50 mSv in a year will normally be restricted from working further in the occupation that led to the high dose for the remainder of the control period (normally the calendar year).
- **The lifetime dose of the worker**. This information can be obtained from the National Dose Registry.
- **The extent of any injury received from the overexposure and the degree of recovery**. It is important to establish any adverse health effects associated with the overexposure (usually not present at less than 500-1000 mSv). Even if there is no indication of acute effects, workers should still be informed of the possibility of long-term adverse health effects resulting from this exposure.
- **Adequacy of control measures implemented by the employer**. These may include protective reassignment, implementation of more protective work procedures, and the increased use of dose monitoring and personal protective equipment.

For some dose levels no other special restrictions should be required if WorkSafeBC is satisfied that the employer is able to adequately control future exposures.

G7.19(4)-1 Exposure to non-ionizing radiation — Radiofrequency

Issued August 1999; Revised January 1, 2005; Revised April 30, 2015

Regulatory excerpt
Section 7.19(4)(a) of the *OHS Regulation* ("*Regulation*") states:

> The employer must ensure that a worker's exposure to non-ionizing radiation does not exceed the exposure limits specified in
>
> (a) for radiofrequency:
>
> (i) *Health Canada Safety Code 25, Short-Wave Diathermy Guidelines for Limiting Radiofrequency Exposure*, 1983, as amended from time to time;
>
> (ii) *Health Canada Safety Code 26, Guidelines on Exposure to Electromagnetic Fields from Magnetic Resonance Clinical Systems*, 1987, as amended from time to time;
>
> (iii) *Health Canada Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz*, 1999, as amended from time to time, and
>
> …
>
> except as otherwise determined by the Board.

Purpose of guideline
This guideline describes occupational exposure limits for radiofrequency radiation.

Radiofrequency (RF) radiation
Radiofrequency is the portion of the electromagnetic spectrum that is between 3 kHz and 300 GHz. This frequency range is below that of visible light and above that of extremely low frequency electromagnetic fields, and includes microwaves, radio, and radar.

In workplaces, RF fields are potentially produced by sources such as television and radio broadcasting facilities, rooftop transmitters, medical equipment, microwave ovens, and RF induction heaters.

Exposure limits
Section 7.19(4)(a) references Health Canada's Safety Codes for exposure limits. The Safety Codes are available on the Health Canada web site: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/index-eng.php

The key exposure limits for RF radiation are the reference levels specified in Health Canada Safety Code 6, published in 2015. They are based on Health Canada's evaluation of the scientific literature related to thermal and non-thermal health effects of RF fields.

The measurement process for exposure to radiofrequency radiation is complex. Health Canada has published the *Technical Guide for Interpretation and Compliance Assessment of Health Canada's Radiofrequency Exposure Guidelines*.

Another guidance document for these measurements is the Industry Canada publication *Guidelines for the Measurement of Radio Frequency Fields at Frequencies From 3 kHz to 300 GHz*.

G7.19(4)-2 Exposure to non-ionizing radiation - Lasers

Issued August 1999; Revised January 1, 2005

Section 7.19(4)(b) of the *OHS Regulation* ("*Regulation*") states:

(4) The employer must ensure that a worker's exposure to non-ionizing radiation does not exceed the exposure limits specified in ...

(b) for lasers:

(i) *ANSI Standard Z136.1-2000, Safe Use of Lasers*, as amended from time to time;

(ii) *ANSI Standard Z136.2-1997, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Source*, as amended from time to time;

(iii) *ANSI Standard Z136.3-1996, Safe Use of Lasers in Health Care Facilities*, as amended from time to time;

(iv) *CSA Standard Z386-01, Laser Safety in Health Care Facilities*, as amended from time to time,

except as otherwise determined by the Board.

Section 7.19(4) refers to applicable ANSI and CSA standards. *CSA Standard Z386-01* is a reproduction of *ANSI Standard Z136.3* but with a few pages of "Canadian Deviations," which make the standard more applicable to the health care environment in Canada.

The determination of worker exposure to non-ionizing radiation from lasers is very complex. Calculation of the exposure limit is dependent on the type of laser being assessed; there is no generic calculation covering all laser sources. Neither a WorkSafeBC prevention officer nor an employer would normally be expected to measure the radiation being emitted by a laser. Rather, compliance with this section will normally be determined by an evaluation of the laser safety program, as required by the applicable standard - such as the program outlined in Table 10 of *ANSI Standard Z136.1-2000*. In this instance, an effective laser safety program is equivalent to an effective exposure control plan, and both are equivalent to actually measuring exposures. In other words, workers cannot be overexposed to laser radiation if there is an effective laser safety program in place.

The employer should establish and maintain an adequate program for the control of laser hazards to the eyes and skin. For class 2 and 3a lasers and laser systems, a laser safety program meeting the requirements of *ANSI Standard Z136.1-2000*, or a program providing an equivalent level of worker protection, constitutes an effective exposure control plan. For class 3b and 4 lasers and laser systems, a laser safety program meeting the requirements of *ANSI Standard Z136.1-2000* constitutes an effective exposure control plan. The requirements of a laser safety program are summarized in Table 10 of *ANSI Standard Z136.1-2000*.

G7.19(5) Exposure to non-ionizing radiation - Ultraviolet radiation

Issued August 1999; Revised January 1, 2005

Section 7.19(5) of the *OHS Regulation* ("*Regulation*") states:

> A worker's exposure to ultraviolet radiation produced by equipment or industrial processes must not exceed the threshold limit values specified in the American Conference of Governmental Industrial Hygienists publication entitled *Threshold Limit Values and Biological Exposure Indices*, dated 2003, as amended from time to time.

Ultraviolet radiation from the sun is not included within the scope of this requirement. Nevertheless, workers and employers should be aware of the hazards associated with solar radiation. Effective means to limit worker exposure include wearing appropriate dress and the use of sun-block creams.

The American Conference of Governmental Industrial Hygienists (ACGIH) requires that the threshold limit values (TLVs) be applied to sources which subtend an angle of less than 80 degrees at the measuring instrument's detector (i.e., the source subtends less than an 80 degree cone with its vertex at the detector). Most industrial sources, such as lamps or welding arcs, subtend a much smaller arc, so the angular restriction does not apply to them. In these cases, the measurements are simply carried out with the detector at the position of the worker's eye or skin, and no further angular considerations are required.

This restriction becomes important when there is exposure to an extended source, such as a tanning bed, or solar exposure at a sandy beach, in snow, or from another large reflective surface. In these situations, ACGIH prescribes that only the contributions within an 80-degree cone be considered. The reason for this is a practical one. Most instruments use interference filters on their detectors and these filters are inaccurate at large angles. The ultraviolet radiation from large angles contributes little to the effect on the eyes or skin because of geometric and physiological considerations.

G7.20(1)-1 Exposure control plan – General requirements

Issued August 1999; Revised January 1, 2005; Revised September 22, 2015

Regulatory excerpt
Section 7.20(1) of the *OHS Regulation* ("*Regulation*") states:

> If a worker exceeds or may exceed an action level, ionizing radiation or action level, non-ionizing radiation, the employer must develop and implement an exposure control plan meeting the requirements of section 5.54(2).

Purpose of guideline
An exposure control plan is required if a worker's radiation exposure exceeds or may exceed the applicable action level. This guideline discusses ways to determine whether a worker's exposure exceeds or may exceed the action level for ionizing or non-ionizing radiation. For further information on exposure control plans, refer to OHS Guideline G5.54-1.

Exposure to ionizing radiation
The action level for ionizing radiation is defined in section 7.17 of the *Regulation* as "an effective dose of 1 milliSievert (mSv) per year." In order to determine whether a worker's annual exposure exceeds or may exceed 1 mSv, an employer may use one or more of the following methods:

- Until it is determined with confidence whether a worker's annual exposure exceeds or could exceed 1 mSv, an employer must ensure that the worker is provided with and properly uses a personal dosimeter acceptable to WorkSafeBC. Refer also to section 7.22 of the *Regulation* and OHS Guideline G7.22 Monitoring exposure. When monitoring has been conducted for at least one year and the incurred doses are properly documented, the employer can use the dose results to determine whether a worker's annual exposure is likely to exceed 1 mSv.

- The Radiation Protection Bureau of Health Canada (RPB) maintains records of occupational exposures to ionizing radiation in Canada based on monitoring information submitted to the RPB by approved dosimetry service providers for Canadian workplaces. Until 2009, RPB regularly published an annual *Report on Occupational Radiation Exposures in Canada* (*Report*) that could be used to check a worker's accumulated dose against the action level. RPB no longer publishes annual dose reports; therefore, the RPB dose archives may only be used if equipment and practices currently in use are the same as those in use when the reports were published (the most recent annual report was published in 2008).

  Using the *Report*, an exposure control plan would not be required if the annual dose incurred by a worker averaged less than 1 mSv over the most recent five years. Note that there is a statistical spread of annual exposures for each job sector and category. Even if the average annual dose for an occupation is less than 1 mSv, a portion of the population may accumulate doses greater than 1 mSv. Therefore, if an employer's work practices or conditions are less protective with respect to radiation standards acceptable to WorkSafeBC (e.g., Health Canada Safety Codes), then the employer must develop and implement an appropriate exposure control plan.

- An evaluation of occupational exposures either by calculation or experimental simulation can be carried out by health physicists or other qualified persons/professionals, based on the characteristics of the radiation source being used, weekly workload, the worksite's exposure control strategy, and other relevant factors. The results of such evaluation can be used to determine whether a worker's annual exposure could exceed 1 mSv. Sample methodologies for conducting such calculations are described in some of the Health Canada Safety Codes e.g., the addendum to *Safety Code 32 Safety Requirements And Guidance For Analytical X-ray Equipment*.

- An employer can rely on a determination made at another workplace setting provided that the workplaces are equivalent in terms of radiation sources used and potential for exposure (e.g., the same number and type of radiation-emitting units, substantially the same equipment parameters being used, work place configuration and shielding plans, safe work procedures, etc.).

For the above methods, the determination of expected exposure levels only remains valid if the radiological conditions remain the same as they relate to radiation sources used, operational settings, workloads, and other relevant factors (e.g., worker practices and experience, worker training, supervision, and instruction). A new assessment of the radiological situation must be performed by a health physicist or other qualified person/professional whenever the working conditions change.

Exposure to non-ionizing radiation
The action level for non-ionizing radiation is defined in section 7.17 of the *Regulation* as "the exposure limits for the general public referred to in section 7.19(4), or if no public limit is referred to, it means the maximum exposure limit for workers referred to in 7.19(4)"

WorkSafeBC accepts that an exposure control plan is not required if any one of the following conditions is met:

- Equipment capable of emitting non-ionizing radiation is being used, maintained, and regularly controlled according to the manufacturer's instructions; and monitoring of field strengths, power densities, irradiance levels, radiant intensities, or ultrasonic sound pressure levels shows that these values cannot exceed the action level in the course of a worker's regular duties.
- Documentation from the equipment manufacturer demonstrates that the radiation exposures incurred by workers cannot exceed the action level.
- For lasers, the class of the laser or laser system is less than class 3, as defined in the latest edition of *ANSI Standard Z136.1, Safe Use of Lasers*.

G7.20(1)-2 Exposure control plan - Control measures

Issued August 1999; Revised January 1, 2005

Section 7.20(1) of the *OHS Regulation* ("*Regulation*") states:

> If a worker exceeds or may exceed an action level, ionizing radiation or action level, non-ionizing radiation, the employer must develop and implement an exposure control plan meeting the requirements of section 5.54(2).

Section 7.20(1) requires an exposure control plan if a worker's level of exposure exceeds or may exceed the applicable action level. For both

ionizing and non-ionizing radiation, adequate engineering and administrative control measures, as specified in the applicable Safety Code or Standard, must be in place in order to control the radiation dose received by any worker to less than the action level. Applying these control measures ensures that the requirements for an exposure control plan are met. Note that under section 5.54(2)(b) of the *Regulation*, control measures are a required element of an exposure control plan.

In assessing the adequacy of control measures for ionizing radiation, the employer is to use all available exposure information (from personal dosimetry and radiation surveys) to compare the effectiveness of the controls with controls in similar industry facilities. If there is an indication of a single high-exposure situation (for one or more workers), a radiation survey under section 7.24(c) of the *Regulation* applies.

When reviewing the results of personal dosimetry, the employer will compare the exposure information with workers in similar groups. If there is a significantly higher dose profile than the industry averages indicate is achievable, the employer is to examine the work practices and other conditions of exposure at the workplace, and alter them to reduce the unusually high doses to the acceptable levels as per section 7.19(3). Data from the National Dose Registry (published annually by Health Canada) is available for the purpose of reviewing worker exposure information.

It should also be noted that section 7.19(3) of the *Regulation* states the "ALARA" principle: "The employer must ensure that the exposure of workers to ionizing radiation is kept as low as reasonably achievable below the exposure limits." For the purposes of section 7.19(3), an employer whose operation demonstrates a significantly higher dose profile than the industry average is expected to reduce worker exposure to the industry average, as that would be considered "reasonably achievable."

G7.20(1)-3 Exposure control plan - Personal protective equipment

Issued August 1999; Revised January 1, 2005; Editorial Revision March 11, 2009; Editorial Revision August 4, 2015

Regulatory excerpt
Section 7.20(1) of the *OHS Regulation* (*"Regulation"*) states:

> If a worker exceeds or may exceed an action level, ionizing radiation or action level, non-ionizing radiation, the employer must develop and implement an exposure control plan meeting the requirements of section 5.54(2).

Purpose of guideline
The purpose of this guideline is to clarify the requirements relating to radiation exposure control measures and to summarize the Health Canada Safety Code references to personal protective equipment.

Exposure control plan
Section 7.20(1) requires an exposure control plan if a worker's level of exposure exceeds or may exceed the applicable action level. Section 5.54(2)(d) addresses the need for written work procedures as part of the exposure control plan. Key to any written work procedure is specific information on any personal protective equipment that may be required to be supplied by the employer for worker protection while undertaking specific hazardous tasks. Section 8.2 of the *Regulation* specifies the responsibility for the employer to provide this type of personal protective equipment.

The preferred control measures for protecting workers from the hazards of radiation involve three key considerations: shielding, distance, and time. Shielding involves placing a mass (a shield) between the radiation source and the worker; the more mass that is placed, the less radiation that the worker receives. Distance also protects workers; the further away a worker is from the source of radiation, the less radiation the worker receives. The less time the worker is exposed to radiation, the smaller the dose of radiation received and the lesser chance for radiation injury. Where these protective measures cannot be used, or are insufficient, personal protective equipment is the minimum requirement.

Personal protective equipment
Section 7.23 of the *Regulation* requires compliance with a number of standards. For ease of reference, the personal shielding protective equipment required by these standards to protect against exposure to radiation is summarized in the table below. Where these standards describe personal protective equipment that is not intended for protection from the hazards of radiation (for example, hearing or respiratory protection), other sections of the *Regulation* apply. Refer to Part 8 of the OHS Guidelines for further information.

Table 1: Personal protective equipment listed in the standards referenced in section 7.23 of the *Regulation*

Standard	Recommended PPE (from Standard)	Relevant sections of the Standard	Additional notes or comments
Ionizing:			
Safety Code 20A (Medical X-ray equipment)[1]	Protective gauntlets, gonad shields, protective gloves, protective clothing, protective aprons, protective glasses	6.3.1; 6.3.2; 6.3.3; 8.1.5; 8.1.6; 8.2.1; 8.3.1; 8.3.2; 8.3.3; 8.4.4; 8.6.1; 8.6.2(2)	
Safety Code 27 (Industrial X-ray equipment)[2]			Discontinued
Safety Code 28	Protective clothing, protective	6.2; 7.1.5; 7.1.7; 7.1.8; 7.1.9;	Protective aprons, gloves, and thyroid shields used

(Veterinary X-ray equipment)	devices, protective aprons, gloves, thyroid shields	7.1.12	for veterinary X-ray examinations must provide attenuation equivalent to at least 0.5 mm of lead at X-ray tube for voltages up to 150 kVp. There are other labelling and design requirements in the Safety Code.
Safety Code 29 (Baggage-check X-ray equipment)	None identified		
Safety Code 30 (Dental X-ray equipment)	Protective devices	8.1.4	
Safety Code 31 (Computed tomography)[1]			Discontinued
Safety Code 32 (Analytical X-ray equipment)	Protective apparel	3.6.4	There is no reference in the Safety Code to a requirement for protective apparel. However, there is a cited requirement that all protective apparel and safeguards must be tested regularly.
Safety Code 33 (Mammography)	Protective clothing	9.1.3; 9.1.6	Discontinued
Safety Code 34 (Industrial x-ray equipment)[2]	None identified	2.2.1(3)	There is no reference in the Safety Code to specific items of personal protective equipment. The RSO "must ensure that all protective and safety equipment… are available."
Safety Code 35 (Large Facilities)[1]	Lead aprons, protective gowns, thyroid shields, protective and leaded glasses, gonad shields, gloves, gauntlets	Section B 4.1	
Safety Code 36 (Mammography)[3]	None identified		There is no reference in the Safety Code to specific items of personal protective equipment. Section 2.1(10) states that "when a protective apron is worn, the dosimeter must be worn underneath the apron." Section 2.1(5) states that "All personnel must use available protective devices."
Radiofrequency:			
Safety Code 26 (Magnetic resonance systems)	None identified		
Safety Code 6 (Radiofrequency fields)		Appendix IV	Electrical safety shoes are referenced, but not required, in Appendix IV.
Safety Code 25 (Short-wave diathermy)	None identified		
Lasers:			
ANSI Standard Z136.1-2014 (Lasers)	Protective equipment, laser eye protection, clothing, gloves, skin protection (such as skin covers or sunscreen creams), respirators, hearing protection	4.4.4; 4.4.4.1; 4.4.4.2; 4.4.4.3; 7.3.4.3; Table 11c; Appendix B8; Appendix D3	Laser eye protection to be used for Class 3B and Class 4 lasers or laser systems. Clothing and gloves that have been specifically selected for suitable protection against laser radiation should be considered for Class 3B and 4 lasers and laser systems. Note that PPE may have serious limitations when used with higher-power Class 4 lasers or laser systems; for example, the protective equipment may not adequately reduce or eliminate the hazard and may be damaged by the incident laser radiation.
ANSI Standard Z136.2	Personal protective equipment to protect against non-laser hazards		Refer to Part 8 of the *Occupational Health and Safety Regulation*.

(Optical fibre systems)	(such as glass fragments, solvents)		
ANSI Standard Z136.3-2011 (Safe Use of Lasers in Health Care) Also CSA Standard Z386-01 (Health Care lasers)	Protective equipment, face shields, laser protective eyewear (e.g., goggles, spectacles, face shields, barriers, windows, and similar protective devices), protective clothing, skin protection (e.g., clothing, gowns, gloves and other devices), shields, helmets, hearing protection	4.6.1; 4.6.2; 4.6.3; 4.6.4; 7.4.2.3 Appendix B: B1.6; B1.6.1; B1.6.2; B1.6.3; B1.6.5 Appendix C: C2.4.1; C6.3.2; C13.4.2	Laser protective eyewear (LPE) shall be accompanied by the following information: (1) Optical density at appropriate wavelengths; (2) Manufacturer's recommendations on shelf life, storage conditions, and appropriate cleaning methods. At present, there is no suitable half-mask respirator used for the specific purposes of excluding all laser generated air contaminants (LGAC). Surgical masks are not designed to provide protection from plume contents. Therefore, the health care facility shall rely on appropriate local exhaust ventilation (LEV) techniques as the first line of protection for occupational exposure to LGAC.
CSA Standard Z386-14 (Laser Safety in Health Care Facilities)	Protective equipment, ocular control measures (e.g., protective eye wear), skin control measures (e.g., applicable and appropriate control measures)	5.3.1.3, 5.3.2.3, 6.3.1.3.(f), 6.3.1.4.1.(c), 6.3.2.3.(b).(iii), 8.2.1.(c) Annex B: B.3 Annex F: F.1; F.2; F.3; F.4; F.5	The laser safety officer to assess potential ocular and skin exposure hazards and implement applicable and appropriate control measures for the application and practice setting. All protective eyewear and filters shall be selected with an optical density (OD) sufficiently high to protect against the wavelengths of the laser in use in the nominal ocular hazard area (NOHA). The protective eyewear shall be: (1) permanently labelled with the applicable OD and wavelengths; (2) worn by all personnel in the NOHA during laser use; (3) maintained according to manufacturer's instructions; (4) have side guards to protect against the beam entering between the eye and the eyewear; and (5) inspected prior to use.
Infrared and Ultraviolet:			
CSA Standard CAN/CSA-C22.2 (Non medical IR and UV lamps)	Protective eyewear	3.3; Appendix C1.1	General requirements: All tanning equipment must be accompanied by sufficient sets of protective eyewear that meet Clause 6.17 of this standard to at least equal the maximum number of persons exposed to UV radiation from the tanning equipment.
Ultrasound:			
Safety Code 23 (Medical ultrasound)	None identified		
Safety Code 24 (Industrial and commercial ultrasound)	None identified		

Notes:

1. Safety Code 35 has replaced Safety Code 20A (only as it relates to large medical radiological facilities) and Safety Code 31 (refer to OHS Guideline G7.23)
2. Safety Code 34 has replaced Safety Code 27 (refer to OHS Guideline G7.23)
3. Safety Code 36 has replaced Safety Code 33 (refer to OHS Guideline G7.23)

G7.20(1)-4 Exposure control plan - Education and training

Issued August 1999; Revised January 1, 2005

Section 7.20(1) of the *OHS Regulation* ("*Regulation*") states:

> If a worker exceeds or may exceed an action level, ionizing radiation or action level, non-ionizing radiation, the employer must develop and implement an exposure control plan meeting the requirements of section 5.54(2).

Section 7.20(1) requires an exposure control plan if a worker's level of exposure exceeds or may exceed the applicable action level. Section 5.54(2)(c) specifies that education and training are a component of an exposure control plan.

An employer or a WorkSafeBC prevention officer may choose to evaluate compliance with this section by asking the worker the following questions:

- What is the hazard?
- What precautions are required to protect against exposure?
- What do you do in the event of an emergency?
- Where do you get further information?

If the worker has received an acceptable level of education and training, the worker will be able to provide information such as following in response to the preceding questions.

The hazard

- Type of radiation, route of exposure, as well as general knowledge of the applicable exposure limits
- Potential health effects from overexposure to radiation, such as the potential for thermal and photochemical effects and skin cancer from ultraviolet radiation
- Any risks or hazards associated with the specific type of radiation to which the worker is exposed - for example, the risks associated with any contamination or leakage of ionizing radiation, the hazard associated with radiofrequency radiation near electro-explosives or flammable substances, and the fire hazard associated with class 4 lasers

How to protect against exposure

- Any shielding requirements
- Minimizing exposure time
- Maximizing distance from the source and staying clear of a collimated or directed beam
- Required safe work procedures
- Required personal protective equipment

What to do in the event of an emergency

For *ionizing* radiation, an emergency might be the uncontrolled release of radioactive material. Actions expected of a worker might include the following:

- Notify the employer.
- Control the spread of contamination.
- Evacuate the area as necessary.
- Notify the appropriate agencies as necessary.

For minor spills or releases, the worker might be expected to follow spill cleanup procedures.

For *non-ionizing* radiation, what constitutes an emergency depends on the type of radiation. For radiofrequency or microwave radiation, an emergency might be an extraordinarily high exposure that might be evident, for example, if a worker gets a severe shock through contact current or if a monitoring procedure shows immediately dangerous field strengths in an area where workers are, or may access. A worker complaining of eye pain should also be considered an emergency. For lasers and for ultraviolet or ultrasound radiation, an acute injury might constitute an emergency situation, such as an eye injury from ultraviolet radiation or a laser source.

In an emergency, actions expected of a worker should include the following:

- Notify the employer.
- Seek first aid and medical attention if necessary.
- Evacuate the area if necessary.
- Implement corrective procedures if necessary (for example, if appropriate, shut off the equipment).
- Notify appropriate agencies as required.

Where to get further information

Sources of information might include:

- Equipment operating instructions
- Written safe work procedures
- CNSC licence and regulations (for work with radioactive sources)
- Relevant standards (such as Health Canada Safety Codes or ANSI standards)
- Radiation Protection Services, WorkSafeBC, CNSC, Health Canada
- Supervisor or employer

G7.20(2) Exposure control plan - Posting of instructions

Issued January 1, 2005

Section 7.20(2) of the *OHS Regulation* ("*Regulation*") states:

> The instructions to workers developed under section (1) must be posted or otherwise available in the work area or near the applicable equipment controls.

If a worker's level of exposure exceeds or may exceed the applicable action level, the employer is to prepare written instructions and make them available in the work area. The written instructions should include written work procedures (such as the safe use of the equipment), emergency procedures, and specifications for personal protective equipment. The boundaries of the (radiation) hazard area are to be indicated through written instructions, signage, or other effective means.

Which was applicable prior to the regulatory amendments effective January 1, 2005.

G7.21 Reproductive hazards

Issued August 1999; Revised January 1, 2005

Section 7.21 of the *OHS Regulation* ("*Regulation*") states:

> (1) The employer must ensure that every worker who exceeds, or may exceed, the action level, ionizing radiation is fully informed of any potential reproductive hazards associated with the worker's exposure to ionizing radiation.
>
> (2) When requested by a pregnant worker or by a worker intending to conceive a child, the employer must make counselling available with respect to the reproductive hazards associated with exposure to ionizing radiation.

The requirements of section 7.21 apply to workers who exceed, or may exceed, an effective dose of 1 mSv per year, the action level for ionizing radiation as defined under section 7.17 of the *Regulation*. See also OHS Guidelines for section 7.20 for additional information.

Counselling should address the specific concerns of the worker with respect to exposure to ionizing radiation and pregnancy outcome. Topics that should be covered during counselling include:

- The specific exposure limits for pregnant workers, as specified by section 7.19(2) of the *Regulation*
- Levels of radiation that may affect fetal development and cancer induction
- Levels of radiation that may cause sterility
- Relative risks of birth defects and childhood cancer associated with radiation exposure
- The importance of the ALARA principle for pregnant workers and for workers intending to conceive a child
- Control measures for preventing inhalation or ingestion of, or contamination by, radioactive materials

Because information about the risks of ionizing radiation is changing rapidly, the material used for counselling workers should be periodically reviewed and updated.

G7.22 Monitoring exposure

Issued August 1999; Revised January 1, 2005; Editorial Revision June 8, 2011; Editorial Revision August 4, 2015

Regulatory excerpt
Section 7.22 of the *OHS Regulation* ("*Regulation*") states:

> Unless exempted by the Board, if a worker exceeds or may exceed the action level, ionizing radiation, the employer must ensure that the worker is provided with and properly uses a personal dosimeter acceptable to the Board.

Purpose of guideline
The purpose of this guideline is to describe a personal dosimeter acceptable to WorkSafeBC.

Acceptable personal dosimeter
The standard method for monitoring *external* alpha, beta, gamma, x-radiation, and neutron radiation dose is to use a personal dosimeter, such as a whole-body or extremity badge worn by a worker. These devices are supplied by a dosimetry service provider who will also perform the post-exposure analysis of the device. Commonly used personal dosimeters for x-ray, beta, and gamma radiation include Thermoluminescent Dosimeters (TLDs) and Optically Stimulated Luminescence (OSL) dosimeters.

Employers participating in a personal monitoring program, using dosimetry, are to ensure that the program is effectively managed. Employees must wear the dosimeters correctly and return them to the employer for submission to the service provider for analysis. It is the responsibility of the service provider to submit the results to the National Dose Registry (Health Canada), as well as to the employer.

A personal dosimeter supplied by a dosimetry service provider who submits the dosimetry data to the National Dose Registry is acceptable to

WorkSafeBC. If an employer wants to use a different personal dosimeter, an application for acceptance must be made to Prevention Practices and Quality. Employers also need to verify that the personal dosimeter is acceptable to any other involved regulatory authority e.g., Canadian Nuclear Safety Commission.

For detailed technical information on acceptable methods of detection and monitoring procedures, the employer should contact the dosimetry service provider, the Canadian Nuclear Safety Commission, or any successor agency, the Health Protection Branch of Health Canada (Radiation Protection Bureau), or the Radiation Protection Services of the BC Centre for Disease Control.

Note: *Internal* radiation dose refers to the dose received by ingestion inhalation, or injection through the skin and would be monitored by such means as urinalysis or by thyroid scan.

G7.23 Acceptable standards

Issued August 1999; Revised January 1, 2005; Editorial Revision March 11, 2009; Editorial Revision March 9, 2012; Editorial Revision September 21, 2012; Editorial Revision March 31, 2015

Regulatory excerpt
Section 7.23 of the *OHS Regulation* (*"Regulation"*) states:

> Equipment producing ionizing or non-ionizing radiation or ultrasonic energy must be installed, operated and maintained in accordance with the following:
>
> (a) for ionizing radiation:
>
> (i) *Health Canada Safety Code 20A, X-Ray Equipment in Medical Diagnosis Part A: Recommended Safety Procedures for Installation and Use*, 1980, as amended from time to time;
>
> (ii) *Health Canada Safety Code 27, Requirements for Industrial X-Ray Equipment Use and Installation*, 1987, as amended from time to time;
>
> (iii) *Health Canada Safety Code 28, Radiation Protection in Veterinary Medicine - Recommended Safety Procedures for Installation and Use of Veterinary X-Ray Equipment*, 1991, as amended from time to time;
>
> (iv) *Health Canada Safety Code 29, Requirements for the Safe Use of Baggage X Ray Inspection Systems*, 1993, as amended from time to time;
>
> (v) *Health Canada Safety Code 30, Radiation Protection in Dentistry - Recommended Safety Procedures for the Use of Dental X-Ray Equipment*, 1999, as amended from time to time;
>
> (vi) *Health Canada Safety Code 31, Radiation Protection in Computed Tomography Installation*, 1994, as amended from time to time;
>
> (vii) *Health Canada Safety Code 32, Safety Requirements and Guidance for Analytical X-Ray Equipment*, 1994, as amended from time to time;
>
> (viii) *Health Canada Safety Code 33, Radiation Protection in Mammography*, 1995, as amended from time to time;
>
> (b) for radiofrequency:
>
> (i) *Health Canada Safety Code 25, Guidelines for Limiting Radiofrequency Exposure - Short-Wave Diathermy*, 1983, as amended from time to time;
>
> (ii) *Health Canada Safety Code 26, Guidelines on Exposure to Electromagnetic Fields from Magnetic Resonance Clinical Systems*, 1987, as amended from time to time;
>
> (iii) *Health Canada Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz*, 1999, as amended from time to time;
>
> (c) for lasers:
>
> (i) *ANSI Standard Z136.1-2000, Safe Use of Lasers*, as amended from time to time;
>
> (ii) *ANSI Standard Z136.2-1997, Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources*, as amended from time to time;
>
> (iii) *ANSI Standard Z136.3-1996, Safe Use of Lasers in Health Care Facilities*, as amended from time to time;
>
> (iv) *CSA Standard Z386-01, Laser Safety in Health Care Facilities*, as amended from time to time;
>
> (d) for infrared and ultraviolet:

(i) *CSA Standard CAN/CSA-C22.2 No. 224-M89 (R1994), Radiant Heaters and Infrared and Ultraviolet Lamp Assemblies for Cosmetic or Hygienic Purposes in Nonmedical Applications*, as amended from time to time;

(e) for ultrasound:

(i) *Health Canada Guidelines for the Safe Use of Diagnostic Ultrasound*, 2001, as amended from time to time;

(ii) *Health Canada Safety Code 24, Guidelines for the Safe Use of Ultrasound: Part II - Industrial and Commercial Applications*, 1991, as amended from time to time,

except as otherwise determined by the Board.

Purpose of guideline
The purpose of this guideline is to provide general information regarding the safety codes and standards that must be complied with under section 7.23 of the *Regulation*.

Safety codes and standards for the use of equipment
Unless otherwise stated in this guideline, the most recent edition of the safety code or standard listed under section 7.23 of the *Regulation* applies.

Health Canada Safety Codes
The Safety Codes are available on the Health Canada web site:
http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/index-eng.php

The Safety Codes can also be ordered from Health Canada (1-866-225-0709).

Safety Codes for ionizing radiation

- Health Canada has published *Safety Code 35, Safety Procedures for the Installation, Use and Control of X-Ray Equipment in Large Medical Radiological Facilities* to replace *Safety Code 20A, X-Ray Equipment in Medical Diagnosis Part A: Recommended Safety Procedures for Installation and Use* (only as it relates to large medical radiological facilities) and *Safety Code 31, Radiation Protection in Computed Tomography Installation*. *Safety Code 20A* continues to apply to small radiological facilities.
- *Safety Code 27, Requirements for Industrial X-Ray Equipment Use and Installation* has been replaced by *Safety Code 34, Radiation Protection and Safety for Industrial X-Ray Equipment*.
- Health Canada has published an addendum to *Safety Code 32*, dated 2014. This addendum is part of *Safety Code 32*.

As a result, equipment producing ionizing radiation must be installed, operated, and maintained in accordance with Safety Codes 20A, 28, 29, 30, 32, 33, 34, and 35, as applicable. The *Regulation* no longer requires compliance with Safety Codes 20A (for large medical radiological facilities), 27, or 31. As stated above, Safety Code 20A continues to apply to small radiological facilities.

Safety Code for radiofrequency
Safety Code 6, published in 1999, was re-written in 2009 and 2015. The 1999 version is no longer available from Health Canada. The 2015 version of Safety Code 6 does not include procedural specifications for installation, operation and maintenance of radiation equipment. WorkSafeBC has determined that the requirements of the 1999 version will continue to apply instead of the 2015 version. To view the 1999 version, contact a local WorkSafeBC regional office or the WorkSafeBC Library (phone toll free 1-888-621-7233 or e-mail library@worksafebc.com).

Additional standards
Safe operating requirements for radioactive materials are specified under the licensing requirements of the Canadian Nuclear Safety Commission.

From time to time, Radiation Protection Services of the BC Centre for Disease Control issues standards and guidelines it has developed. It may also recommend standards and guidelines issued by other agencies related to installation, operation, or maintenance of radiation-producing equipment. WorkSafeBC will normally consider these to be a "standard acceptable to the Board." These additional documents may provide guidance to a prevention officer reviewing a particular facility for compliance. In such a situation, a prevention officer should consult with one of WorkSafeBC's subject matter experts before making a formal decision based on a non-referenced standard.

G7.23(a)(i) and (vi) Radiation protection in radiology - Large facilities

Issued December 21, 2009; Revised June 8, 2011

Regulatory excerpt
Sections 7.23(a)(i) and (vi) of the *OHS Regulation* ("*Regulation*") state:

Equipment producing ionizing or non-ionizing radiation or ultrasonic energy must be installed, operated and maintained in accordance with the following:

(a) for ionizing radiation:

(i) *Health Canada Safety Code 20A, X-Ray Equipment in Medical Diagnosis Part A: Recommended Safety Procedures for*

Installation and Use, 1980, as amended from time to time;

…

(vi) *Health Canada Safety Code 31, Radiation Protection in Computed Tomography Installation*, 1994, as amended from time to time;

…

except as otherwise determined by the Board.

Purpose of guideline

Health Canada has published *Safety Code 35, Safety Procedures for the Installation, Use and Control of X-ray Equipment in Large Medical Radiological Facilities* to replace *Safety Code 20A, X-ray Equipment in Medical Diagnosis Part A: Recommended Safety Procedures for Installation and Use* (as it relates to large medical radiological facilities) and *Safety Code 31, Radiation Protection in Computed Tomography Installation*.

This guideline provides guidance on the application of the occupational health and safety requirements in Health Canada *Safety Code 35* (*SC35*) to large radiological facilities.

Facilities within the scope of *Safety Code 35*

SC35 applies to large medical radiological facilities where diagnostic and interventional radiological procedures are routinely performed using radiographic, radioscopic or computed tomography (CT) equipment. Large facilities are those that operate more than one type of radiological equipment, or have at least three suites of the same type of equipment. Most hospitals and CT facilities fall within this category.

The requirements of *SC35* do not apply to radiation therapy facilities and the equipment used in radiotherapy, including radiation therapy simulators, for localization and treatment planning. *SC35* does not apply to dental (addressed in *SC 30*) or mammography (addressed in *SC 33*) facilities.

SC35 does not apply to small radiological facilities such as most chiropractic, podiatry, physical therapy, and bone densitometry facilities.

> Note: Health Canada is preparing a safety code specific to small facilities. As described in OHS Guideline G7.23, *SC20A* continues to apply to small radiological facilities until the new safety code for small facilities is published.

Health and safety requirements of *SC35*

WorkSafeBC has consulted with the Diagnostic Accreditation Program, College of Physicians and Surgeons of BC, and the Ministry of Health, and has determined that only certain clauses of *SC35* are concerned with occupational health and safety and are requirements under *Regulation* sections 7.23(a)(i) and (vi). These clauses, and any necessary explanatory notes, are listed below in this guideline. The Table may be updated from time to time, based on further consultation with health care sector representatives and possible future amendments to *SC35*.

Table: Health Canada *Safety Code 35* occupational health and safety (OHS) requirements

Description	Clauses with OHS requirements administered by WorkSafeBC
***SC35* Section A - Responsibilities and Protection**	
Responsibility of Personnel	1.0, 1.1, 1.2, 1.2.1 (Refer to Note 1), 1.2.2 (Refer to Note 1), 1.2.4, 1.2.5 (Refer to Note 2), 1.2.6 - 1.2.11, 1.3, 1.3.1 (Refer to Note 3), 1.3.2 (Refer to Note 3), 1.3.3(i), 1.3.3(v), 1.3.4 - 1.3.7, 1.3.11, 1.4, 1.4.1 (Refer to Note 4), 1.4.2 (Refer to Note 4), 1.4.3(i), 1.4.3(ii) (Refer to Note 5), 1.4.3(iii), 1.4.4 - 1.4.15, 1.4.17
Procedures for Minimizing Radiation Exposure to Personnel	2.1.2 - 2.1.8, 2.1.11, 2.1.12, 2.2.2 - 2.2.4, 2.3.3, 2.4(1), 2.4.1, 2.4.1.1 - 2.4.1.4
***SC35* Section B - Facility and Equipment Requirements**	
Facility Requirements	1.1, 1.2.1, 1.2.2 (subclauses 1,2,5,6,7,9 - Refer to Note 6), 1.2.3 (Refer to Note 7), 1.3 (Refer to Note 8)
Medical X-ray Equipment Requirements	2.5.1 (Refer to Note 9), 2.5.2.3, 2.5.3.2, 2.5.3.3, 2.5.3.5, 2.5.3.7, 2.5.4.1
Other Equipment	4.0, 4.1.1, 4.1.5 - 4.1.11
Radiation Protection Surveys	5.0, 5.1 (Refer to Note 10), 5.2 Paragraph 1, 5.2.1 - 5.2.8, 5.2.11, 5.2.12, 5.2.14

Note 1: Clauses A1.2.1 and A1.2.2 set out requirements for qualification and re-qualification of a responsible user (RU). WorkSafeBC will

accept qualifications as outlined in *Safety Code 35*. If the RU is a physician, WorkSafeBC will also accept qualifications that are acceptable to the Diagnostic Accreditation Program. For non-physicians, WorkSafeBC will consider the RU to be qualified if the RU has the authority to fulfill the duties outlined in *SC35* clause A1.2.

The RU is typically a person who is stationed on-site; for smaller facilities, an off-site RU may also be acceptable if the duties are being adequately fulfilled with the assistance of an on-site qualified and competent person. Assessment of compliance will include an assessment of whether the assigned duties are being fulfilled.

Note 2: There is currently no provision in B.C. for licensing or certification of x-ray equipment operators. WorkSafeBC will not require specific licensing or certification for x-ray equipment operators at this time. Adequate supervision, instruction, and training of staff are required under existing sections of the *Workers Compensation Act* (*"Act"*), including sections 115 and 117.

Note 3: Clauses A1.3.1 and A1.3.2 set out requirements for qualification and re-qualification of x-ray equipment operators. WorkSafeBC will accept qualifications as outlined in *Safety Code 35*. If the operator is a physician, WorkSafeBC will also accept qualifications that are acceptable to the Diagnostic Accreditation Program.

Note 4: Clauses A1.4.1 and A1.4.2 set out requirements for qualification and re-qualification of medical physicists and radiation safety officers (RSO). This typically needs to be a person who is stationed on-site; some duties can be contracted as required, and some duties can be done regionally or corporately.

Under these clauses, WorkSafeBC will accept qualifications for a medical physicist that are acceptable to the Diagnostic Accreditation Program.

Until a training course for RSOs in B.C. is readily available, qualifications for an RSO will be assessed as the person's knowledge of the work, the hazards, and the control measures necessary to perform the duties. This knowledge may be obtained by way of education, training, experience, or a combination thereof.

A responsible user can also be the RSO, if qualified as above.

Note 5: Clause A1.4.3(ii) refers to registration of new x-ray equipment. The Diagnostic Accreditation Program's (DAP) Radiation Safety Accreditation Standard specifies that new and replaced medical x-ray equipment be registered with the DAP. Registration forms are available on the DAP website, www.dap.org.

Note 6: Clause B1.2.2 sets out general recommendations that must be considered by the employer when designing the layout of an x-ray facility. The employer may be asked by a WorkSafeBC prevention officer to explain why a recommendation is not implemented. Evidence of consideration of a recommendation would include a written rationale explaining how the recommendation was incorporated or why the recommendation was rejected.

Note 7: Clause B1.2.3 sets out parameters that must be considered during calculation of barrier thicknesses. None of these parameters are mandatory for implementation, since they must only be considered. However, an employer may be asked to provide a rationale as to why a recommendation was not implemented. Evidence of consideration would include a written rationale explaining how the recommendation was incorporated or why the recommendation was rejected.

Note 8: Clause B1.3 sets out requirements for shielding calculations and requires submission of facility and installation plans as well as evidence of factor consideration to the appropriate government agency. WorkSafeBC does not require such submission to WorkSafeBC on a routine basis, but prevention officers may inquire into the determination and effectiveness of shielding in the event of an inquiry by an employer, a high exposure investigation, or a complaint.

Note 9: Clause B2.5.1 sets out construction and performance requirements for x-ray equipment. These requirements are administered by WorkSafeBC to the extent that they address worker health and safety. WorkSafeBC will not address these requirements as part of acceptance testing, which are under the scope of the Diagnostic Accreditation Program, but may assess them as part of the safe operation of the equipment.

Note 10: Clause B5.0 specifies that the survey is conducted by an expert. This is an individual who is qualified by education and experience to perform advanced or complex procedures in radiation protection that generally are beyond the capabilities of most personnel within the facility. These procedures include evaluation of the facility design to ensure adequate shielding is in place, inspection and evaluation of the performance of x-ray equipment and accessories, and evaluation of, and recommendations for, radiation protection programs.

Clause B5.1 requires the owner (or delegate) to contact WorkSafeBC to ascertain inspection (survey) procedures and inspection frequency. Inspection procedures are acceptable if they result in a survey report that covers all required information items described in clause B5.2. The required frequency for x-ray surveys is described in OHS Guideline G7.24(a).

G7.24 Radiation surveys

Issued August 1999; Revised January 1, 2005; Editorial Revision March 11, 2009

Regulatory excerpt
Section 7.24 of the *OHS Regulation* ("*Regulation*") states:

> Except as otherwise determined by the Board, the employer must conduct a radiation survey for ionizing radiation in accordance with

the standard practice specified under the applicable Safety Code listed in section 7.23 (a) or the regulations under the *Nuclear Safety and Control Act* (Canada),

(a) at the times required by the Safety Code or regulations, as the case requires,

(b) if equipment has been damaged or modified, or

(c) if there is an indication of an unusually high exposure of a worker to ionizing radiation.

Purpose of guideline
The purpose of this guideline is to clarify the requirement to conduct radiation surveys.

General survey requirements
For the purposes of section 7.24(b), the term *modified* includes moving the equipment from one permanent location to another. Exempt from this requirement is equipment that is designed to be mobile, such as a portable x-ray unit; a radiation survey is not required every time mobile equipment is moved.

For underground workings, the requirements for a radiation survey are specified in section 22.33 of the *Regulation*.

Specific survey requirements
The specific requirements for a radiation protection survey are listed in each Safety Code (codes are listed in section 7.23 of the *Regulation* and in OHS Guideline G7.23). Only those parts of the radiation protection survey that relate to worker protection are considered mandatory. Not completing the specific items listed for the protection of the patient and for the protection of the public will not be deemed to constitute non-compliance with section 7.24 of the *Regulation*. Table 1 lists the number of requirements in the relevant Safety Code.

Table 1: Requirements for a radiation protection survey

Safety Code	Application	Requirements for radiation survey	Radiation protection survey
20A	Medical[1]	5.1; 5.2	11 specific items
27	Industrial[2]		
28	Veterinary	5.1; 5.2	6 specific items
30	Dentistry[3]	4.3	3 specific items
31	Computed Tomography[1]		
32	Analytical	3.5	15 specific items
33	Mammography[3]	4.3	4 specific items
35	Large Facilities	5.1; 5.2	14 specific items

1. *Safety Code 35* has replaced Safety Code 20A (only as it relates to large medical radiological facilities) and Safety Code 31 (see OHS Guideline G7.23).
2. Safety Code 34 has replaced Safety Code 27 (see OHS Guideline G7.23).
3. While there is no specific section on "radiation protection survey" in Safety Codes 30 and 33, the general requirement for a "radiation protection inspection" is intended to cover the same situation. The expectation of the standard is that the employer will take the appropriate measurements to ensure that workers are not at risk of exposure to ionizing radiation resulting from damage to a piece of equipment.

In all cases, the radiation protection survey or the radiation protection inspection is intended to determine the extent of any damage to the equipment or the facility; thus it is part of an incident investigation. It should be noted that section 173(1)(c) of the *Workers Compensation Act* also applies, when a particular incident had the potential for serious injury (e.g., cancer development) to a worker. Any investigation of such an incident would be expected to include an inspection of the equipment and measurement of any possible leakage of radiation.

The survey should include leak testing, which is an assessment of potential points or areas for escape of ionizing radiation or radioactive material from a piece of equipment. For sealed sources, leakage tests meeting the requirements of the Canadian Nuclear Safety Commission ("CNSC") are acceptable to WorkSafeBC. One common such test is a wipe test, using a filter paper or a cotton-tipped swab to wipe possible areas of leakage, and then measuring the wipe sample for radiation. Situations involving spillage of radioisotopes or other radioactive materials are covered by the provisions of the CNSC licence held by the user. For X-ray equipment (diagnostic, analytical, etc.), a suitable survey meter can be used to identify any leak locations (e.g., an ion chamber monitoring device for accurate results or a Geiger-Mueller counter for estimations).

G7.24(a) Radiation surveys - Clarification of how often to conduct and who can conduct.

Issued February 8, 2007

Regulatory excerpt
Section 7.24(a) of the *OHS Regulation* ("*Regulation*") states:

> Except as otherwise determined by the Board, the employer must conduct a radiation survey for ionizing radiation in accordance with the standard practice specified under the applicable Safety Code listed in section 7.23(a) or the regulations under the Nuclear Safety and Control Act (Canada),
>
> (a) at the times required by the Safety Code or regulations, as the case requires,

Purpose of guideline
The purpose of this guideline is to provide information on how often to perform a radiation survey, and who can conduct a radiation survey.

Maximum intervals for radiation surveys
The Health Canada Safety Codes referenced in section 7.23(a) typically state that a radiation survey (called an inspection in some Safety Codes) is required at regular intervals. Safety Code 29 (*Requirements for the Safe Use of Baggage X-ray Inspection Systems*) is the only Safety Code that specifies a time period (2 - 3 years) between required surveys.

For all other x-ray equipment, the employer must determine the appropriate interval between radiation surveys of the x-ray equipment. In making this determination, the employer should consider the following factors:

- Manufacturer's specifications
- Requirements of the relevant professional association
- Nature of shielding used (e.g. lead or drywall)
- Frequency, nature, and conditions of use of the equipment
- Nature of patient (animal or human)
- Single or multiple users of the x-ray equipment
- Power levels used (kVp and mA settings)
- Results of personal exposure monitoring
- Type of x-ray unit (e.g. fixed or portable, radiographic, or fluoroscopic)
- Age and performance history of the equipment

It is expected that the interval between radiation surveys will not normally be more than three years, except in the case of a dental x-ray unit operating only at or below 70 kVp, where a maximum period of five years between surveys is acceptable because of the low power levels and the nature of usage.

This guideline does not alter the requirements of *Regulation* sections 7.24(b) and (c) which require a survey to also be conducted if the equipment has been damaged or modified, or if there is an indication of an unusually high exposure of a worker to ionizing radiation.

Performance of a survey
Several of the safety codes state that the surveys should be done by the regulatory authority but in BC, the *Regulation* requires the employer to conduct the radiation surveys. The employer may contract with a specialist to perform the survey, but remains responsible for the survey being done with the required frequency and in accordance with accepted standard practice. A specialist acceptable to the BC Centre for Disease Control Radiation Protection Service will normally be acceptable to WorkSafeBC. WorkSafeBC prevention officers may review survey reports to ensure that the terms of the Safety Code and the *Regulation* have been met.

G7.25 Records

Issued August 1999; Revised January 1, 2005

Section 7.25 of the *OHS Regulation* ("*Regulation*") states:

> The employer must
>
> (a) maintain and make available to the Board,
>
> (i) for at least 10 years, records of radiation surveys, and
>
> (ii) for the period that the worker is employed plus 10 years, records of exposure monitoring and personal dosimetry data, and
>
> (b) make the records available to workers.

WorkSafeBC's requirements for record keeping may be different from the time period required by other regulatory agencies. Where this is the case, the longer of the time periods will prevail in order to satisfy the regulatory requirement of that agency. For example, regulations of the Canadian Nuclear Safety Commission (CNSC) currently specify that survey and monitoring records are to be retained indefinitely until written permission is obtained from the CNSC to discard them, whereas section 7.25 of the *Regulation* indicates that they be kept for at least 10 years. In some cases, however, the CNSC may allow records to be discarded after 3 years, and the licence may so stipulate. In this circumstance, section 7.25 of the *Regulation* provides clear indication that WorkSafeBC requires a longer period, that is, 10 years or the period of employment plus 10 years (for personal dosimetry records).

Under protection of privacy legislation personal information cannot be made available to persons other than the monitored worker without express written consent from that worker. This applies to both medical records and the results obtained from dosimetry.

When exposure data is presented in an Inspection Report specific persons will not be identified by name; only their positions will be indicated (except in exceptional circumstances).

Back to Top

G7.27(1) Heat exposure - Application

Issued August 1999; Revised January 1, 2005

Section 7.27(1) of the *OHS Regulation* states:

> (1) Sections 7.28 to 7.32 apply to a workplace if
>
> (a) a worker is or may be exposed to thermal conditions which could cause heat stress,
>
> (b) the thermal conditions could result in a worker's core body temperature exceeding 38°C (100°F), or
>
> (c) the thermal conditions are in excess of the levels listed in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard for unacclimatized workers.

Here are a few examples of workplaces where the sections on heat exposure may apply:

- Pulp mills (around the recovery boilers, paper machines, and lime kilns)
- Sawmills (around the kilns or burners)
- Smelters
- Cement kilns
- Outdoor work sites during hot weather (road construction and asphalt paving, roofing, tree planting)

For outdoor work areas in B.C., heat stress is normally only of concern during periods of hot weather and during activities such as firefighting unless factors such as high humidity, heavy work load, or excessive radiant heat combine to increase the level of risk for a particular work activity.

G7.27(2) Firefighting

Issued January 1, 2005

Section 7.27(2) of the *OHS Regulation* states:

> Subsection (1) does not apply to firefighting if special provisions satisfactory to the Board are in place to ensure that the firefighter's core body temperature is maintained below 38°C (100°F).

Special provisions related to firefighting that fulfill the intent of this section include:

- Instruction and training
- Work procedures that address both the hazards and necessary controls
- Specialized personal protective equipment

G7.28(1) Exposure limits - Using the ACGIH Standard

Issued August 1999; Revised January 1, 2005; Revised February 12, 2008

Regulatory excerpt
Section 7.28(1) of the *OHS Regulation ("Regulation")* states:

> A worker must not be exposed to levels that exceed those listed in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard.

Purpose of guideline
The purpose of this guideline is to explain the use of screening criteria to determine heat stress exposure.

Exposure limits
Table 1 lists values from the 2007 edition of the *American Conference of Governmental Industrial Hygienists* (ACGIH) publication *Threshold Limit Values (TLV®) and Biological Exposure Indices*.

Table 1 : Screening criteria for heat stress exposure (WBGT values in °C)

	TLV®				Action Limit			
Work/Recovery cycle	**Light**	**Moderate**	**Heavy**	**Very heavy**	**Light**	**Moderate**	**Heavy**	**Very heavy**
75 - 100% work	31	28	-	-	28	25	-	-

50 - 75% work	31	29	27.5	-	28.5	26	24	-
25 - 50% work	32	30	29	28	29.5	27	25.5	24.5
0 - 25% work	32.5	31.5	30.5	30	30	29	28	27

WBGT means the wet bulb globe temperature measured with a black globe thermometer (GT), wet bulb thermometer (WB), and a dry bulb (air) thermometer (DB), and measured according to the following equations:

For indoor or outdoor environments without direct exposure to sunlight,

WBGT°C = 0.7WB + 0.3GT

For outdoor environments with direct exposure to sunlight,

WBGT°C = 0.7WB + 0.2GT + 0.1DB

The WBGT is based on environmental conditions (air temperature, radiant heat, and humidity). Table 1 also considers other criteria based on

- Acclimatization - whether or not workers are acclimatized to heat
- Work demands (metabolic rate category for the work) - light, moderate, heavy, or very heavy
- Approximate proportion of work within an hour — 75 -100% work, 50 - 75% work, etc., with the remaining fraction of the hour allocated to recovery or "rest"

This guideline will help clarify the ACGIH table for heat stress exposure by explaining the various screening criteria and providing formulae for calculating the WBGT where the work demands or work environments vary. Further assistance may be obtained by contacting a WorkSafeBC office.

The values in this table were developed for a traditional work uniform of a long-sleeved shirt and pants. If workers are required to wear clothing that would not fit in this category, then adjustments need to be made to the measured WBGT; see OHS Guideline G7.28(2), Clothing Correction Values before comparing to the heat stress exposure screening criteria. For workers wearing clothing that restricts the movement of air or is impermeable to air or water vapour, the above criteria cannot be used and may necessitate physiological monitoring to ensure adequate protection. See OHS Guideline G7.29-3 for further information.

Work demands
To compare a worker's exposure with the screening criteria, an estimate of the worker's work demands (i.e., metabolic rate) needs to be determined as well as a measurement of the WBGT associated with each task performed during a 1-hour time period.

Four different work demand categories are listed in Table 1: light, moderate, heavy, and very heavy. Table 2 gives examples of activities within each category. The representative metabolic rate in watts for light to very heavy work has been added as this is needed to calculate the work demand when a worker carries out different tasks.

Table 2: Metabolic rate categories and the representative metabolic rate with example activities

Category	Metabolic Rate (W)*	Examples
Rest	115	Sitting
Light	180	Sitting with light manual work with hands or hands/arms, and driving. Standing with some light arm work and occasional walking.
Moderate	300	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking.
Heavy	415	Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; walking at a fast pace.
Very Heavy	520	Very intense activity at fast to maximum pace.

** The effect of body weight on the estimated metabolic rate can be accounted for by multiplying the estimated rate by the ratio of actual body weight divided by 70 kg (154 lb).*

Calculations to use if work demands vary
If a worker is assigned different tasks within the hour, it is necessary to determine a time-weighted average (TWA) for the work demands. An acceptable way of doing this is to assign a metabolic rate to each task performed during the averaging period (1 hour), using the values in Table 2, and multiply it by the duration of each task. The product of work demand and duration for each task is then added up, and the sum is divided by the total duration of all tasks performed during the averaging period. The averaging period should be one hour, the same period of time that is used to calculate the time-weighted average WBGT.

The time-weighted average work demand is given by the following formula:

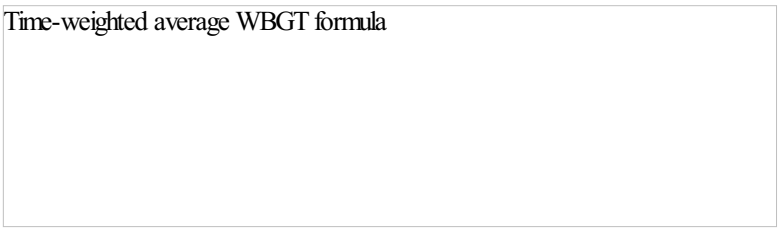
With work demand (TWA) in watts, Table 2 can be used to select the appropriate column (i.e., work demand level: light, moderate, heavy, or very heavy) to use in Table 1. The work demand (TWA) and the WBGT (calculated earlier) are then compared to the heat stress exposure values listed in Table 1.

Proportion of work and recovery
Table 1 gives four work/recovery patterns, and the most appropriate one should be used for comparison with the WBGT calculated earlier. The recovery period percentage does not necessarily mean a complete break from work, but could include "resting" or light tasks such as those listed in Table 2.

Note that the table does not provide exposure values for "heavy" and "very heavy" work demands in a continuous (75 - 100% work) pattern and "very heavy" work demands for a 50 - 75% work pattern. This is because of the high physiological strain associated with "very heavy" work among less fit workers, regardless of WBGT. In such cases, the screening criteria values are not recommended, and a detailed analysis and/or physiological monitoring should be used. (See also OHS Guideline G7.29-3).

Calculations to use if environments vary
If a worker is employed in two or more different work or recovery areas during the hour, a time-weighted average WBGT should be calculated in order to apply the heat stress exposure screening criteria. The time-weighted average is determined by measuring the WBGT for each task performed and multiplying them by the duration of each task. The product of WBGT and duration for each task is then added up, and the sum is divided by the total duration of all tasks performed during the hour.

The time-weighted average WBGT is given by the following formula:



Determining compliance with the exposure levels
Once the time-weighted averages for both workload and WBGT are calculated using the formula above, they are then compared to the levels listed in Table 1. The ACGIH TLV® represents conditions that acclimatized workers who are healthy, unmedicated, and adequately hydrated may be repeatedly exposed to without adverse health effects. The Action Limit applies similarly for the protection of unacclimatized workers. It also represents conditions that require a heat stress control plan.

For instance, if the calculated time-weighted average for work demands is 415 watts, the work demands are considered "heavy." If the worker is acclimatized, conducting 50 - 75% work and if the WBGT time-weighted average is 27 WBGT°C, then the TLV® level of 27.5 WBGT°C will not have been exceeded. The Action Limit of 24°C will have been exceeded and an exposure control plan needs to be developed (see OHS Guideline G7.29-5). If the worker is unacclimatized, the work pattern will need to be readjusted (e.g. by reducing the allocation of work in the work/recovery cycle, by increasing the recovery period, or changing to less strenuous tasks until the worker is acclimatized).

G7.28(2) Clothing correction values

Issued January 1, 2005; Revised February 12, 2008

Regulatory excerpt
Section 7.28(2) of the *OHS Regulation* states:

> Clothing corrections must be applied in accordance with the heat stress and strain section of the ACGIH Standard.

Purpose of guideline
The purpose of this guideline is to specify clothing adjustment factors and values for use when calculating heat stress exposure.

Clothing Correction Factors and Values
The body's main heat-removal mechanism is the evaporation of sweat from the skin, so the clothing worn by workers affects the body's ability to remove heat. The heat stress exposure levels listed in the screening criteria - see OHS Guideline G7.28(1) - are for fully clothed workers wearing summer work garments of lightweight pants and long-sleeved shirt. Workers wearing more clothing may experience lessened evaporative and

convective cooling and therefore the measured wet bulb globe temperature (WBGT) is to be adjusted. Some suggested clothing adjustment factors from the ACGIH Standard are provided in the following table. The figure in the table is to be added to the WBGT measured in the workplace. Factors for other clothing appearing in the literature can be used in a similar fashion following good professional judgment.

Additions to measured WBGT values (°C) for some clothing ensembles

Clothing type	WBGT addition*
Work clothes (long-sleeved shirt and pants)	0
Cloth (woven material) overalls	0
Double-layer woven clothing	3
SMS polypropylene coveralls	0.5
Polyolefin coveralls	1
Limited-use vapour-barrier coveralls	11

* These values must not be used for completely encapsulating suits, often called Level A clothing. Clothing adjustment factors cannot be added together for multiple layers. The values for coveralls assume that only modesty clothing is worn underneath, not a second layer of clothing.

The ACGIH does not recommend using the WBGT heat stress exposure screening criteria for workers wearing clothing that is impermeable to air or water vapour or multiple layers where no data is available for adjustment. See OHS Guideline G7.29-3 for further information.

G7.29-1 Heat stress assessment - acceptable measures and methods

Issued August 1999; Revised January 1, 2005; Editorial Revision June 8, 2011

Regulatory excerpt
Section 7.29(1)(a) of the *OHS Regulation* ("*Regulation*") states:

> (1) If a worker is or may be exposed to the conditions specified in section 7.27, the employer must
>
> (a) conduct a heat stress assessment to determine the potential for hazardous exposure of workers, using measures and methods that are acceptable to the Board, and . . .

Purpose of guideline
The purpose of this guideline is to provide information on the measures and methods that are acceptable to WorkSafeBC regarding heat stress assessments.

Acceptable measures and methods
The first step in a heat stress assessment should be to determine the areas, tasks, or occupations that put workers at risk of heat-related disorders. Factors that should be considered when making this determination include:

- Areas with temperatures above 23°C (summer or winter)
- Areas with high humidity
- Jobs or tasks that require medium to high exertion or strength
- Areas, tasks, or occupations that have been identified as high risk for heat-related disorders through accident investigation reports, first aid treatment record books, and records of injury and disease
- Areas, tasks, or occupations about which employees have expressed concern about heat-related stress

Once it is determined which occupations, tasks, or areas should be monitored, the risk of developing a heat-related disorder should be evaluated.

Several different methods of assessing heat stress are available, including:

- Measurement of environmental parameters, such as air temperature, air velocity, air humidity, and infrared radiation (see OHS Guidelines G7.29-2 and G7.29-4)
- Direct measurement of body temperature (see OHS Guideline G7.29-3)
- Measurement of other physiological responses, such as heart rate (see OHS Guideline G7.29-3)

Environmental parameters are the most practicable for measuring in the field.

If the above measures and methods are used, they will be considered acceptable to WorkSafeBC for the purpose of this section. If alternative measures and methods are proposed, they are to be submitted to the Prevention Practices and Quality Department of WorkSafeBC for consideration. The proposed alternative measures and methods may not be used until written acceptance is given by that department.

G7.29-2 Environmental parameters

Issued August 1999; Revised January 1, 2005

Section 7.29(1)(a) of the *OHS Regulation* states:

> (1) If a worker is or may be exposed to the conditions specified in section 7.27, the employer must
>
> (a) conduct a heat stress assessment to determine the potential for hazardous exposure of workers, using measures and methods that are acceptable to the Board, and . . .

The most common and widely used heat stress index is the wet bulb globe temperature (WBGT). The WBGT combines the effect of humidity and air velocity (natural wet bulb) ambient air temperature, velocity, and radiant energy (globe temperature), and air temperature (dry bulb temperature) into a single value. The values listed in screening criteria for heat stress exposure are WBGT in °C. (See OHS Guideline G7.28(1) for the table of screening criteria.)

To determine the WBGT, a black globe thermometer, a natural (static) wet bulb thermometer, and a dry bulb thermometer are required. For guidelines on measuring the WBGT, refer to "Temperature Extremes" in the *Fundamentals of Industrial Hygiene* published by the National Safety Council. Commercial direct-reading monitors are also available that will measure the environmental parameters and directly calculate the WBGT.

Other heat stress indices are available to measure heat stress, including the wet globe temperature (WGT), or Botsball, and *ISO 7933 Hot Environments - Analytical Determination and Interpretation of Thermal Stress Using Calculation of Required Sweat Rate*. Under certain circumstances, the Botsball may be used instead of the WBGT. For example, a Botsball may be used as a screening tool, or for conditions of moderate radiant heat and humidity such as in general construction work.

Information on the various heat stress indices that are available can be found in such references as:

- NIOSH. 1986. *Criteria for a Recommended Standard: Occupational Exposure to Hot Environments*. Published by the National Institute for Occupational Safety and Health. Available online: http://www.cdc.gov/niosh/docs/86-113/
- Barbara A. Plog and Patricia J. Quinlan. 2002. *Fundamentals of Industrial Hygiene*, 5th edition. Published by the National Safety Council.

For further information regarding measures and methods acceptable to the Board please contact your local WCB office.

G7.29-3 Physiological measures

Issued August 1999; Revised January 1, 2005

Section 7.29(1)(a) of the *OHS Regulation* states:

> (1) If a worker is or may be exposed to the conditions specified in section 7.27, the employer must
>
> (a) conduct a heat stress assessment to determine the potential for hazardous exposure of workers, using measures and methods that are acceptable to the Board…

In some occupations or work environments, workers must wear clothing that is either vapour or air impervious/impermeable. Examples of such clothing are full-body chemical protective equipment (HAZMAT suit) and firefighting turnout gear.

In these particular cases, the use of an environmental measure such as the wet bulb globe temperature (WBGT) will not be indicative of actual exposure conditions experienced by the worker wearing such protective equipment. Instead, the worker should be monitored to ensure that safe body temperatures are not exceeded. The body functions best when the core body temperature is within a range of 36°C to 38°C.

There are two physiological parameters that can be used to monitor a worker's state of heat stress: measurement of the core body temperature and heart rate.

Core body temperature can be measured either directly using rectal temperature or approximated by measuring oral or tympanic (ear-drum/canal) temperatures. Oral temperatures are determined by measuring temperature at the base of the tongue. The worker must not drink or eat anything cold or hot for at least 15 minutes before measurement. The thermometer must be inserted under the tongue, as far as possible, for about 5 minutes, and the mouth must be kept closed as much as possible. Oral temperature is approximately 0.4°C lower than rectal temperature.

The recovery heart rate during rest periods following a work cycle in a hot environment is a measure that can be used to monitor heat stress. There are two models for recovery heart rate.

The first (Brouha) recommends a heart rate criterion level of 110 beats per minute during the first minute of a rest period after work in a hot environment, followed by a reduction in heart rate of 10 beats per minute by the end of the third minute of rest. Levels above these values are indicative of exposure to a heat stress environment.

The second model (Fuller and Smith) recommends that the heart rate in the third minute of a rest period after work in a hot environment should not exceed 90 beats per minute.

Further information on physiological monitoring can be obtained from the 1986 NIOSH document *Criteria for a Recommended Standard: Occupational Exposure to Hot Environments* available on the NIOSH web site: http://www.cdc.gov/niosh/docs/86-113/ or contact an occupational hygiene officer at your local WCB office.

G7.29-4 Heat stress assessment using a dry bulb thermometer or Humidex index

Issued August 1999; Revised January 1, 2005; Revised February 12, 2008

Regulatory excerpt
Section 7.29(1)(a) of the *OHS Regulation ("Regulation")* states:

> (1) If a worker is or may be exposed to the conditions specified in section 7.27, the employer must
>
> (a) conduct a heat stress assessment to determine the potential for hazardous exposure of workers, using measures and methods that are acceptable to the Board, and ...

Purpose of guideline
The purpose of this guideline is to outline the circumstances under which a heat stress assessment may be done using a Humidex-based method or a dry bulb thermometer, and describes procedures for using the Humidex-based method.

Background information
WorkSafeBC recommends taking measurements of the wet bulb globe temperature (WBGT) to measure heat stress, as described in OHS Guideline G7.28(1). This method requires complex instrumentation and training in use of the equipment. The use of other heat stress indices can simplify measurement in certain circumstances. Simplified measurements may be helpful in workplaces where heat stress is a seasonal concern in periods of hot weather conditions. See OHS Guideline G7.29-2 for references on various heat stress indices.

The dry bulb thermometer method and the Occupational Health Clinics for Ontario Workers Inc. (OHCOW) Humidex Based Heat Response Plan (*Humidex method*) are tools that help assess heat stress for the purpose of managing heat stress and strain in the workplace. These methods are not applicable in all circumstances and/or workplaces. Further, these methods do not replace use of the WBGT for assessing compliance with the exposure limits established in section 7.28 of the *Regulation*. (Caution: never ignore symptoms of heat strain even if measurements meet standards.)

Dry bulb thermometer or Humidex-based methods may only be used in situations where workers are not exposed to

- Sources of direct heat (infrared radiation) emanating from industrial equipment such as boilers, furnaces, steam lines, molten metal, or from other hot surfaces. Workplaces with significant radiant-heat load from process-related heat or where workers have experienced heat-related illness should measure the WBGT.
- High humidity levels produced by industrial equipment such as a pulp or paper machine in a pulp & paper mill, or to open sources of high temperature steam.

Humidex-based or dry bulb thermometer methods can be effective for workers wearing clothing that allows effective evaporative heat loss; for workers wearing impervious or semi-impervious clothing, heat stress management should include monitoring of vital signs (see ACGIH TLV® for Heat Stress, section 4).

In essence, these alternate methods are applicable to addressing the issue of heat stress in office buildings, retail facilities, health care facilities, hospitality industry, warehouses, or working outdoors, where a worker is not exposed to process-related heat or to industrially-produced high humidity levels.

Dry bulb method
Air temperature determined using a normal dry bulb thermometer will be considered an acceptable measuring standard under section 7.29 of the *Regulation* if all of the following conditions apply

1. The air temperature measured in the immediate area where the work is taking place does not exceed 35°C (95°F). It is not sufficient to use a temperature level reported from another location, such as over the local radio station, or a reading taken at some distant location on the work site. Reflection off of walls or disruptions in wind flow in the immediate area where the work is being done may cause the temperature to vary significantly from the "general temperature" for the local area.
2. Where sources of radiant heat do not add significantly to the heat load. For example, equipment (an operating boiler or steam lines) and other hot surfaces (a tar and gravel roof or black asphalt pavement being heated by the sun) may be significant sources of radiant heat. A normal dry bulb thermometer does not measure infrared radiation, which is the source of radiant heat.
3. The work being done, if classified as "heavy" as described in Table 2 of OHS Guideline G7.28(1), does not exceed 2 hours in duration
4. Worker(s) are not wearing impervious or semi-impervious protective clothing.
5. If the air temperature measured is 30°C (86°F) or higher, an exposure control plan, as outlined below, is implemented unless the heat exposure is determined through use of the WBGT method to be below the Action Levels listed for unacclimatized workers in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard.

If any of the above conditions are not met, more precise measurements such as WBGT or Botsball temperature plus estimates of workload are required to determine the risk of heat stress in order to achieve compliance with section 7.29 of the *Regulation*.

Exposure control plan (ECP) requirements for dry bulb temperature assessments
If the above limiting conditions are met, and the heat stress assessment is being done using only a normal dry bulb thermometer, and the measured temperature equals or exceeds 30°C (86°F), an ECP for heat stress is to be implemented.

At a minimum, the heat stress ECP is to include

- Worker education and training as noted below
- Continuous availability of cool potable water close to the work area (see section 7.31 of the *Regulation*)
- Personal monitoring of heart rate to confirm the effectiveness of the work/recovery schedule (see details outlined below)
- Continuous supervision by a person knowledgeable in heat stress symptoms and control program requirements

Under this provision, workers in a heat stress environment are to be provided with information about

- Heat-related disorders, associated symptoms and the need to report their symptoms
- Factors increasing susceptibility to heat-related disorders
- Heat stress implications for any existing medical conditions and treatment, such as sleep deprivation, dehydration, diabetes, hyperthyroidism, and some medications
- Safe work procedures for work in heat stress areas, including work/recovery schedules, the importance of fluid loading and replacement, and the immediate reporting of symptoms of heat-related disorders to the supervisor
- Any environmental or personal monitoring programs used on-site
- Safe use of protective clothing and equipment, if required

As part of this provision, workers should check their "resting heart rate" prior to starting work in the area, and again before and after rest periods. At the beginning of the recovery period, the heart rate should not exceed 110 beats per minute. If it does, the work period should be shortened by one-third while maintaining the same rest period. At the end of the rest period, the pulse should be within 10 beats per minute of the resting heart rate before resuming work. Note that heart rate is only one symptom of heat stress. Workers and supervisors need to remain vigilant for other signs of heat-related illness.

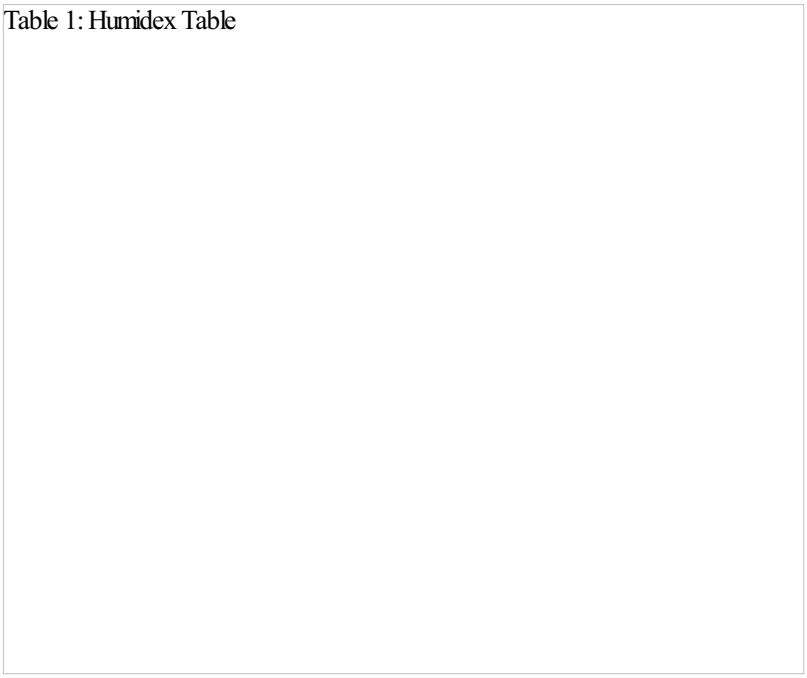
Hot conditions and workload or personal monitoring may indicate that additional rest breaks are needed in the work rest cycle. Rest periods do not always require a change in location from the work environment. Rest periods do require that workers move away from direct sunlight or other sources of radiant heat and that they change to less strenuous tasks to reduce the build-up of body heat.

Humidex Method
The Humidex Based Heat Response Plan is a simplified method of protecting workers from heat stress, (developed by the Occupational Health Clinics for Ontario Workers (OHCOW)). The method is based on the American Conference of Governmental Industrial Hygienists (ACGIH) heat stress/strain TLVs® (Threshold Limit Values) and is a translation of wet bulb globe temperatures (WBGT) into Humidex values. Other factors - air movement, workload, radiant heat sources, and acclimatization - also need to be considered when assessing heat stress.

Humidex values are obtained by measuring temperature (dry bulb) and relative humidity and factoring them into the *Humidex* table below (Table 1). For example the Humidex value for a temperature of 37°C (read across from the left side of the Table) and a relative humidity of 50 percent (read down from the top of the Table) is 49°C. Temperature and relative humidity can be measured by a digital hygrometer (available at most hardware stores) or a sling psychrometer (a wet/dry bulb thermometer for determining relative humidity). It is important that a reading be taken at the actual workplace as Humidex values can vary substantially from location to location.

Table 1: Humidex Table

Table 1: Humidex Table



The following must also be considered (added) when calculating a Humidex value:

- The *Humidex method* assumes that workers are wearing regular summer clothing (light shirt, pants, underwear, socks and shoes). If workers wear coveralls (e.g., cotton coveralls) over summer clothes, then 5°C should be added to the workplace Humidex value. Gloves and/or hard hat would each add 1°C and an apron (or vest) would add 2°C to the Humidex value. For workers who wear encapsulating suits, do not use the *Humidex method*.
- To adjust for radiant heat in direct sunlight (between 10 am and 4 pm), add 2 - 3°C to the Humidex value (pro-rate according to percentage cloud cover).
- For indoor radiant heat exposures, use training, knowledge, and experience to adjust the 2 - 3°C sunlight correction factor by estimating whether the exposure is more or less than the heat exposure to direct sunlight. Workplaces with significant process-related heat load (e.g. from boilers, furnaces, steam lines, etc.) should measure the WBGT.
- Humidex values should be measured at several locations in the work area (safe work procedures should be based on the highest reading).
- Do not base Humidex values on weather station or media reports. Use measurements taken at the worksite.
- Measurement should be recorded hourly if the Humidex is above 30°C.
- Never ignore anyone's symptoms regardless of the measurements.

In order to determine the procedures to be followed to protect workers from heat stress, the calculated Humidex value must then be compared to the Humidex guidelines in the *Humidex Heat Response Plan* table (Table 2). The response (Humidex 1 or Humidex 2) depends on the amount of physical work being done and the level of acclimatization of the workers.

Humidex 1 - corresponds to the ACGIH Action Limit and applies to moderate work loads (e.g., pushing and lifting) for unacclimatized workers, or heavy work loads (e.g., shoveling sand) for workers acclimatized to heat (see also OHS Guideline G7.28(1)).

Humidex 2 - corresponds to the ACGIH TLV® and applies to moderate work for acclimatized workers or light work for unacclimatized workers.

Note: An unacclimatized worker is a worker who is not accustomed to working in a hot environment or who has been out of a hot environment for seven consecutive days. It may take several days for workers to become acclimatized.

Table 2: Humidex Based Heat Response Plan

Humidex 1 Moderate unacclimatized & Heavy acclimatized	**Response**	**Humidex 2** Moderate acclimatized & Light unacclimatized
25 - 29	Supply water to workers on an "as needed" basis	32 - 35
30 - 33	Post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity	36 - 39
34 - 37	Post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms	40 - 42
38 - 39	Work with 15 minutes relief per hour can continue; provide adequate cool (10-15°C) water; at least 1 cup (240 mL) of water every 20 minutes. Worker with symptoms should seek medical attention	43 - 44

40 - 41	Work with 30 minutes relief per hour can continue in addition to the provisions listed previously	45 - 46*
42 - 44	If feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above	47 - 49*
45* or over	Only medically supervised work can continue	50* or over

* at Humidex exposures above 45, heat stress should be managed as per the ACGIH TLV®. The above administrative control measures do not preclude using other means to reduce excessive heat exposures, such as providing additional air conditioners or fans for spot cooling. In fact, engineering controls are the most effective means to control heat stress and should be considered first and in conjunction with the above steps as part of the heat stress ECP. For more examples of control measures, refer to WorkSafeBC publication *Preventing Heat Stress at Work*.

The Humidex Based Heat Response Plan is also available on the OHCOW website. An alternative way to determine the Humidex value is to use the "calculator" on the OHCOW website. Enter the dry bulb temperature and relative humidity level in order to calculate the Humidex value.

Heat Stress ECP
A heat stress assessment and ECP based on the *Humidex method* consists of the following steps:

1. Assign roles and responsibilities in the plan.
2. Train workers in early signs and symptoms of heat stress.
3. Select representative measurement locations in the workplace that will be monitored for temperature and relative humidity.
4. Determine the Humidex value, including the adjustments for clothing and radiant heat.
5. Compare the Humidex value to the appropriate criteria according to work demand and worker condition (Humidex 1 or Humidex 2).
6. Select and apply the control measures listed.
7. Maintain records.
8. Monitor the effectiveness of control measures. Regardless of Humidex values, individual symptoms must never be ignored.

If the above conditions for using the Humidex method are not met, WBGT measurements must be made plus estimates of workload are required to determine the risk of heat stress in order to achieve compliance with section 7.28 of the *Regulation*. Physiological monitoring may also be required.

Humidex Calculation Example # 1
This example concerns a worker performing roadway repairs in the B.C. Interior, in July. The weather is sunny (no cloud cover) and the temperature and relative humidity are 32°C and 30%, respectively.

The Humidex value from Table 1 is 34°C.

As the worker is wearing coveralls and gloves (as well as other safety equipment, e.g., work boots and hard hat), a value of 5°C (for the coveralls) and 1°C (for the gloves and/or hardhat) will have to be added. Another 3°C are added to adjust for radiant heat in direct sunlight (the worker is exposed to direct sun on the roadway). The final calculation for Humidex becomes: 34 + 5 + 1 + 3 = 43 degrees Celsius.

The Humidex value must then be compared to the ranges in Table 2 (Humidex 1 or Humidex 2), depending on whether or not the worker is acclimatized. If we assume the worker is acclimatized and performing heavy work (e.g., shoveling gravel), then Humidex 1 applies.

The recommended response plan would be Humidex 1 (42 to 44°C) and the following control measures would apply:

- Ensure workers are trained to recognize symptoms of heat stress.
- Post "Heat Stress Alert" notices.
- Supply water to the worker as needed - at least 1 cup (240 ml) of 10 to 15°C water every 20 minutes.
- Work with at least 30 minutes relief per hour, however, if feasible work with 45 minutes relief per hour.
- Record temperature and humidity on an hourly basis.

Humidex Calculation Example #2
This example concerns a worker in a commercial office building, in August. The building is not air-conditioned and the interior temperature and relative humidity are 28°C and 30%, respectively.

The Humidex value from Table 1 is 29°C.

The Humidex value must then be compared to the ranges in Table 2 (Humidex 1 or Humidex 2), depending on whether or not the worker is acclimatized. If we assume the worker is performing light work (which is typical in an office environment), then neither Humidex applies (there is no "Light" work category for Humidex 1 and the "Light unacclimatized" ranges for Humidex 2 are all greater than 29°C) and there is no heat stress issue.

In this example, the temperature of the indoor air and the comfort of the occupants are also addressed in *Regulation* section 4.80.

G7.29-5 Exposure control plan

Issued August 1999; Revised January 1, 2005

Section 7.29(1)(b) of the *OHS Regulation* states:

(1) If a worker is or may be exposed to the conditions specified in section 7.27, the employer must . . .

(b) develop and implement a heat stress exposure control plan meeting the requirements of section 5.54(2).

For the general requirements of an exposure control plan, refer to section 5.54(2) and OHS Guideline G5.54-1. Some specific elements of the exposure control plan, as they relate to heat stress, are described below.

General duties and responsibilities
The statement of responsibilities should include roles for both the employer and workers. It should incorporate the following:

- Employer responsibilities:
  - identify and assess areas, tasks, and occupations where there is the potential for heat stress
  - implement and/or provide controls (engineering, administrative, or personal protective equipment) to minimize heat stress
  - provide training and education regarding heat stress, including early signs and symptoms of heat-related disorders
- Worker responsibilities:
  - participate in environmental monitoring program to assess worker exposure to conditions that could cause heat stress,
  - adhere to all control measures or work procedures that have been designed and implemented to reduce exposure to conditions that could cause heat stress
  - leave hot environments if signs or symptoms of a heat-related disorder appear

Risk identification, assessment, and control
This element should state the following:

- How the employer will determine those workers who may be at risk of heat-related disorders
- Who will conduct the heat stress assessments (if specific individuals are not identified, this element should contain easy-to-read instructions outlining how to conduct a heat stress assessment and the methods of control that should be used)
- How the heat stress hazard will be assessed (such as the measurement indices that will be used)
- What controls will be used to eliminate or minimize worker exposure to conditions that could cause heat stress, as well as when and how the controls will be implemented

Refer to OHS Guideline G7.29-1 for guidance on conducting a heat assessment and to OHS Guidelines G7.30-1 through G7.30-3 for information on controlling risk.

Education and training
This element should contain training and education, initial and ongoing, that will be provided to all workers who work in areas, tasks, or occupations where there is a reasonable likelihood of heat stress. The training and education material provided to workers who have not previously worked in a heat stress environment should include the following information:

- Heat-related disorders (heat cramps, heat exhaustion, and heat stroke)
- Relevant signs and symptoms of heat-related disorders
- Predisposing factors for heat-related disorders include the following:
  - lack of acclimatization
  - poor physical fitness
  - obesity
  - increased age
  - dehydration
  - pre-existing medical conditions and treatment (for example, diabetes or hyperthyroidism)
  - short-term disorders and minor illnesses (for example, cold, flu, or diarrhea)
  - chronic skin disorders (for example, rashes or dermatitis)
  - use of medication that may inhibit sweating, reduce blood flow or cause dehydration (for example antihistamines)
  - alcohol abuse and recreational drugs
  - previous heat illness
- Potential health effects of excessive heat stress
- First aid procedures
- Safe work procedures and proper precautions for work in heat stress areas, including the importance of fluid replacement and of immediately reporting the development of signs or symptoms of heat-related disorders to the employer
- Purpose and description of the environmental monitoring program, as well as the benefits to the worker of participating in these programs
- Proper use of protective clothing and equipment, if required

For those workers exposed to environments that could cause heat stress, provide refresher training and education to ensure that workers remain knowledgeable about the above-mentioned items. It is recommended that continuing education be provided at least annually.

For further information, consult WCB booklet *Preventing Heat Stress at Work*, on the WCB web site at www.worksafebc.com.

Written procedures
The employer should prepare written procedures on assessing heat stress, as well as on using control measures to minimize heat stress (for example, positioning and use of supplemental fans for cooling, using and caring for radiant heat reflective clothing, or using vortex or ice-pack

cooling suits).

G7.30-1 Engineering controls

Issued August 1999; Revised January 1, 2005

Section 7.30(1) of the *OHS Regulation* states:

> If a worker is or may be exposed to the conditions specified in section 7.27, the employer must implement engineering controls to reduce the exposure of workers to levels below those listed in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard.

Section 7.30 of the *OHS Regulation* requires an employer to reduce the exposure of workers to heat stress conditions using a hierarchy of control methods: engineering controls, followed by administrative controls and, as a last resort, personal protective equipment.

Engineering controls are the most effective means of reducing excessive exposure conditions that could cause heat stress. Examples of engineered approaches to reduce heat exposure include, but are not limited to, the following:

- **Reducing metabolic heat production**. Automation and mechanization of tasks can minimize the need for heavy physical work and the resulting buildup of body heat.
- **Reducing the radiant heat emission from hot surfaces**. Covering hot surfaces with sheets of low-emissivity material, such as aluminum or other shielding material, reduces the amount of heat radiated into the workplace.
- **Insulating hot surfaces**. Insulation reduces the heat exchange between the source of heat and the work environment.
- **Shielding**. Shields stop radiated heat from reaching workstations. Stainless steel, aluminum, and other bright metal surfaces reflect heat back towards the source. Absorbent shields, such as water-cooled jackets made of black-surfaced aluminum, can effectively carry away heat.
- **Ventilation and air-conditioning**. Ventilation, localized air-conditioning, and cooled observation booths are commonly used to provide cool working conditions.
- **Spot cooling**. Freestanding fans may be used to provide localized air movement at work locations. Typically, an increased rate of air movement over the body will cause increased cooling due to the evaporation of sweat, although this will depend on humidity. (Take care that spot cooling or blowers do not interfere with ventilation systems used to control toxic chemical agents.)
- **Reducing the humidity**. Air-conditioning and dehumidification, as well as elimination of open water baths, drains, and leaky steam valves, all help to reduce humidity.

G7.30-2 Administrative controls

Issued August 1999; Revised January 1, 2005; Editorial Revision August 23, 2011

Regulatory excerpt

Section 7.30(2)(a) of the *OHS Regulation* ("*Regulation*") states:

> (2) If the action described in subsection (1) is not practicable, the employer must reduce the exposure of workers to levels below those listed in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard by providing
>
> (a) administrative controls, including a work-rest cycle, acceptable to the Board or . .

Purpose of guideline
The purpose of this guideline is to establish the administrative controls that are acceptable to WorkSafeBC for the purpose of dealing with heat stress exposure as described in section 7.30(1) of the *Regulation*.

Administrative controls for reducing exposure to heat stress
If engineering controls are not practicable, section 7.30(2)(a) permits the use of administrative controls, such as an acceptable work-rest cycle, to reduce the exposure of workers to below the screening criteria levels.

Several administrative controls that are commonly used to reduce a worker's exposure to heat stress are described below.

- **Fluid replacement and work practices**. Section 7.31 of the *Regulation* requires employers to provide and maintain an adequate supply of cool potable water (10-15°C) close to the work area for the use of a heat exposed worker who is or may be exposed to the conditions specified in section 7.27. Workers should be encouraged to drink small amounts frequently, such as one cup every 20 minutes.
- **Work-rest cycles**. A work-rest cycle refers to the period a worker spends working in a hot or strenuous environment and the time spent in a rest or recovery area.
- **Acclimatization**. The body will adapt to working in hot conditions if it is allowed sufficient time. This physiological process is referred to as acclimatization and can usually be induced in 4 to 7 days of exposure to a hot environment.
- **Scheduling and organization of work**. There are several ways to organize and to schedule tasks so as to minimize the length of time and temperatures to which workers may be exposed. For example:
    - When possible, schedule hot tasks for the cooler part of the day (early morning, late afternoon, or night shift).

    - Schedule routine maintenance and repair work in hot areas for cooler seasons of the year.
    - Adjust schedules where possible so that hot operations are not performed at the same time and place as other operations that require the presence of workers (for example, do not schedule maintenance cleanup while tapping a furnace).
    - Add extra personnel to reduce exposure time for each member of the crew.
    - Where practical, allow workers to set their own pace of work.
    - If weather forecasts predict very hot conditions, postpone tasks that are not urgent until the hot spell is over.
- **Signage**. Heat stress hazard warning signs may be posted in indoor work areas where the heat exposure limits could be exceeded if a worker is continuously exposed to heat.

Administrative controls as outlined above will be considered acceptable to WorkSafeBC for the purposes of this section. If alternative administrative controls are proposed, they are to be submitted to the Prevention Practices and Quality Department of WorkSafeBC for consideration. The proposed alternative administrative controls may not be used until written acceptance is given by that Department.

G7.30-3 Personal protective equipment

Issued August 1999; Revised January 1, 2005

Section 7.30(2)(b) of the *OHS Regulation* states:

> (2) If the action described in subsection (1) is not practicable, the employer must reduce the exposure of workers to levels below those listed in the screening criteria for heat stress exposure in the heat stress and strain section of the ACGIH Standard by providing . . .
>
> (b) personal protective equipment, if the equipment provides equally effective protection as administrative controls.

Where it provides equally effective protection and the use of engineering or administrative controls is not practicable, the use of personal protective equipment is permitted under section 7.30(2)(b).

There are two main types of heat-protective clothing available:

- **Anti-radiant heat or reflective clothing.** This type of clothing may be necessary when there is excessive radiant heat from a hot surface that cannot otherwise be covered or shielded. This clothing is available in different forms, varying from aprons and jackets to suits that will completely enclose the worker from neck to feet. This type of clothing protects only against radiant heat and provides little or no protection from high air temperatures unless auxiliary cooling is used underneath the clothing.
- **Temperature-controlled suits.** This type of clothing provides auxiliary cooling of the body while the worker is in the heat stress environment. There are several different types of temperature-controlled suits commercially available, each using a different method of cooling:
    - ice pack vests
    - wetted overclothing such as terry cloth coveralls or two-piece, whole-body cotton suits
    - water-cooled suits such as hoods, vests, and "long-johns" offering partial or complete body cooling
    - air-cooled suits

G7.33-1 Cold exposure - Application

Issued August 1999; Revised January 1, 2005

Section 7.33 of the *OHS Regulation* states:

> Sections 7.34 to 7.38 apply to a workplace if a worker is or may be exposed to
>
> (a) thermal conditions that could cause cold stress or injury,
>
> (b) thermal conditions that could cause a worker's core body temperature to fall below 36°C (96.8°F), or
>
> (c) thermal conditions that are below the levels classified as "little danger" to workers in the criteria for the cooling power of wind on exposed flesh in the cold stress section of the ACGIH Standard.

The sections on cold exposure apply to work environments where workers may be exposed to either artificial or natural cold. Examples of artificially cold workplaces include cold storage rooms, freezers, and refrigerated transportation units. Examples of industries where workers may be exposed to natural cold include fishing, forestry, construction, and the petroleum industry.

In the context of these sections, exposure is taken to mean exposure to cold air or water either as part of routine work procedures or as a result of accidental or an unplanned event. Examples of accidental or unplanned events include a worker falling into water such as from a boat or breaking through ice (cold water immersion) or a worker becoming stranded outdoors in the cold.

Some examples of cold-related injuries include frostbite, frostnip, trenchfoot, and Raynaud's disorder.

G7.33-2 Cooling power of wind (imperial units)

Issued January 1, 2005

Section 7.33(c) of the *OHS Regulation* states:

> Sections 7.34 to 7.38 apply to a workplace if a worker is or may be exposed to . . .
>
> (c) thermal conditions that are below the levels classified as "little danger" to workers in the criteria for the cooling power of wind on exposed flesh in the cold stress section of the ACGIH Standard.

The ACGIH criteria, in the Fahrenheit scale, are listed in the following table as it appears in "Cold Stress" of *Threshold Limit Values and Biological Exposure Indices* (the ACGIH Standard). See OHS Guideline G7.33-3 for a table in metric units. The table shows the cooling power of wind on exposed flesh. If there is a wind, use the wind speed in the first column and the actual temperature across the top to find what the equivalent temperature would be under calm conditions.

Equivalent chill temperature (imperial units)

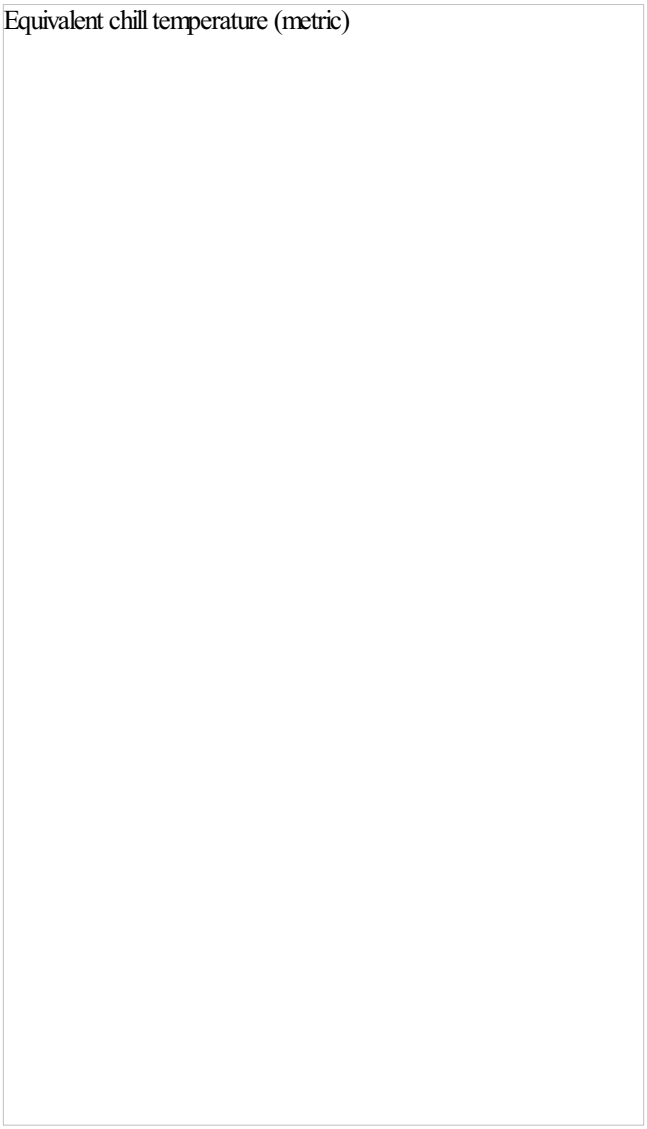
G7.33-3 Cooling power of wind (metric units)

Issued January 1, 2005

Section 7.33(c) of the *OHS Regulation* states:

> Sections 7.34 to 7.38 apply to a workplace if a worker is or may be exposed to . . .
>
> (c) thermal conditions are below the levels classified as "little danger" to workers in the criteria for the cooling power of wind on exposed flesh in the cold stress section of the ACGIH Standard.

The ACGIH Standard provides values for the cooling power of wind on exposed flesh in the Fahrenheit scale. The following table has the same information, expressed in degrees Celsius and in km/h. It is organized for actual temperature to decrease by intervals of 5°C, resulting in an additional column. The table shows the cooling power of wind on exposed flesh. If there is a wind, use the wind speed in the first column and the actual temperature across the top to find what the equivalent temperature would be under calm conditions.



G7.34-1 Cold stress assessment

Issued August 1999; Revised January 1, 2005; Editorial Revision August 23, 2011

Regulatory excerpt
Section 7.34(a) of the *OHS Regulation* ("*Regulation*") states:

> If a worker is or may be exposed to conditions specified in section 7.33, the employer must
>
> (a) conduct a cold stress assessment to determine the potential for hazardous exposure of workers, using measures and methods that are acceptable to the Board, and . . .

Purpose of guideline
The purpose of this guideline is to provide information on the measures and methods that are acceptable to WorkSafeBC regarding cold stress assessments.

Cold stress assessment acceptable to WorkSafeBC
Section 7.34(a) of the *Regulation* requires that a cold stress assessment be conducted if a worker is or may be exposed to conditions which could cause cold stress or injury, or could cause a worker's core body temperature to fall below 36°C (96.8°F), or fall below the "little danger" levels in the ACGIH table (see OHS Guidelines G7.33-2 and G7.33-3). Part of the cold stress assessment for hazardous exposure should include the potential for unplanned exposure.

The first step in a cold stress assessment is to determine the areas, occupations, or tasks that place workers at risk of hypothermia or cold-related injuries. Consider factors such as the following:

- Areas with an equivalent chill temperature below -7°C (see below)
- Fine dexterity tasks that require work with bare hands
- Contact with metal surfaces or use of evaporative liquids (gasoline, alcohol, or cleaning liquids)
- Working on or near bodies of water
- Areas or occupations that have been identified as high risk for cold-related disorders through accident investigation reports, first aid

treatment record books, and records of injury and disease
- Areas or occupations about which employees have expressed concern about cold stress

Once the areas, occupations, or tasks that should be monitored are determined, the risk of developing hypothermia or a cold-related injury should then be evaluated.

A cold stress assessment should include determining the air temperature and wind speed (to determine the "equivalent wind chill temperature"). This information is available by:

- Obtaining weather, temperature, and wind information from the local weather office (such as from Environment Canada) if there is a monitoring station close to the area in which the work is to be conducted.
- Taking a direct measurement of the ambient air temperature using a dry bulb thermometer (or electronic equivalent) and a direct reading of the wind velocity in km/h (or metres/sec) using a velometer, hot-wire thermometer, heated thermocouple, thermistor, or a thermocouple anemometer. Most air velocity instruments also provide a direct readout of air temperature.

Wind chill is a concern when the equivalent chill temperature is less than -7°C. From the metric table in OHS Guideline G7.33-3, the conditions when this occurs are:

- The air is calm and the temperature falls below -7°C
- The wind speed is 8 km/h or greater and the air temperature is -5°C
- The wind speed is 16 km/h or greater and the air temperature is 0°C
- The wind speed is 32 km/h or greater and the air temperature is 5°C

As part of the risk assessment, the potential for a worker's exposure to artificially generated air velocities should also be considered; for example when working in walk-in refrigerators and freezers, when riding all-terrain vehicles or snowmobiles, or when exposed to helicopter rotor downwash.

A general assessment of contact cooling for exposed skin, particularly the hands, should consider the following when workers are in contact with metal:

- Below 15°C - Prolonged contact may impair dexterity
- Below 7°C - Prolonged contact may induce numbness
- Below 0°C - Prolonged contact may induce frostnip or frostbite
- Below -7°C - Brief contact with may induce frostnip or frostbite

For materials other than metal, such as plastics and wood, the temperatures will be lower than those noted above since they are less conductive than metal. Any contact with liquids at subzero temperature is also of concern, particularly with cryogenic "fluids" (super-cooled liquefied gases).

Workers should be provided with gloves or other method of warming the hands when the air temperature is below:

- 16°C for sedentary work
- 4°C for light work
- -7°C for moderate work

If the above measures and methods are used, they will be considered acceptable to WorkSafeBC for the purpose of this section. If other methods are proposed, they are to be submitted to the Prevention Practices and Quality Department of WorkSafeBC for consideration and not to be used until written acceptance is given by that Department.

G7.34-2 Conversion

Issued January 1, 2005

Temperature in degrees Fahrenheit can be converted to degrees Celsius using the following formula.

°Celsius = 5/9 x (°Farenheit - 32)

Wind velocity in miles per hour (mph) can be converted to kilometres per hour (km/h) using the following formula.

km/h = mph x 1.61

G7.34-3 Exposure control plan

Issued January 1, 2005

Section 7.34(b) of the *OHS Regulation* states:

> If a worker is or may be exposed to conditions specified in section 7.33, the employer must . . .
>
> (b) develop and implement a cold exposure control plan meeting the requirements of section 5.54(2).

For the general requirements of an exposure control plan, refer to section 5.54(2) and OHS Guideline G5.54-1. Some specific components of the exposure control plan, as they relate to education and training of workers, are described below.

Education and training
This element should contain initial and ongoing training and education that will be provided to all workers who work in areas where there is a reasonable likelihood of exposure to conditions that could cause cold stress. The training and education material provided to workers who have not previously worked in a cold stress environment should include the following information:

- Recognition of the signs and symptoms of impending hypothermia or excessive cooling of the body even when shivering does not occur
- Recognition of impending frostbite
- Proper re-warming procedures and appropriate first aid treatment
- Proper use of clothing
- Proper eating and drinking practices
- Safe work practices appropriate to the work that is to be performed

For those workers exposed to cold-stress environments, provide refresher training and education to ensure that workers remain knowledgeable about the above-mentioned items. It is recommended that continuing education be provided at least annually.

For further information, consult the WCB publication *Hypothermia*, on the WCB web site at www.worksafebc.com.

G7.35-1 Engineering controls

Issued January 1, 2005

Section 7.35(1) of the *OHS Regulation* states:

> (1) If a worker is or may be exposed to the conditions specified in section 7.33, the employer must implement effective engineering controls to reduce the exposure hazard to levels above those classified as "little danger" to workers in the criteria for the cooling power of wind on exposed flesh in the cold stress section of the ACGIH Standard.

Section 7.35 of the *OHS Regulation* requires an employer to reduce the exposure hazard of workers to thermal conditions that could cause cold stress or injury using a hierarchy of control methods: engineering controls, followed by administrative controls and, as a last resort, personal protective equipment.

Here are some examples of engineering controls to reduce cold exposure:

- Isolate the worker from the environment, where possible.
- Use local heating for the body and especially bare hands (when fine work is required). This may include the use of warm air jets, radiant heaters, or contact warming plates.
- Provide barricades or other structures to block air or reduce air velocities at the work location.
- Provide heated metal tools and equipment handles or cover them with thermal insulating materials.
- Use machine controls and tools designed so that workers do not have to remove mittens or gloves to use them.

G7.35-2 Administrative controls

Issued January 1, 2005

Section 7.35(2) of the *OHS Regulation* states:

> (2) If the action described in subsection (1) is not practicable, the employer must reduce the exposure hazard by providing
>
> (a) effective administrative controls, or . . .

If engineering controls are not practicable, section 7.35(2)(a) permits the use of effective administrative controls to reduce the exposure hazard of workers to thermal conditions that could cause cold stress or injury.

Several administrative controls that are commonly used to reduce worker exposure to cold stress are described below:

- **Work/warm-up schedules**. A work/warm-up schedule refers to the period a worker spends working in a cold environment and the time spent in a warm area. See OHS Guideline G7.35-3 for sample schedules.
- **Scheduling and organization of work**. There are several ways to organize and to schedule tasks so as to minimize the length of time of exposure and to maximize the temperatures to which workers may be exposed. For example:
  - When possible, schedule tasks for the warmest part of the day or when the wind is the most calm.
  - Schedule routine maintenance and repair work for warmer seasons of the year.
  - Postpone non-urgent tasks when equivalent chill temperatures are in the "great danger" portion of the "Cooling Power of Wind" ACGIH table provided in OHS Guideline G7.33-3.
  - Take the equivalent chill temperature into account when planning or scheduling work activities.
- **Fluid replacement and diet**. An ample supply of warm drinks or soup should be available, and workers should be encouraged to drink

them in order to replace fluids lost through breathing and perspiration. Workers should restrict their intake of coffee because of diuretic and circulatory effects. A diet high in fats and carbohydrates may help to maintain body temperature.

G7.35-3 Work/warm-up schedule for a 4-hour shift

Issued January 1, 2005

Section 7.35(2)(a) of the *OHS Regulation* states:

> (2) If the action described in subsection (1) is not practicable, the employer must reduce the exposure hazard by providing
>
> (a) effective administrative controls . . .

A work/warm-up schedule is an example of an administrative control. The ACGIH Standard contains a work/warm-up schedule for a 4-hour shift for workers who are properly clothed. This schedule is acceptable to the Board. Values in the ACGIH table have been converted to metric units in the table below.

Work/warm-up schedule for a 4-hour shift (PDF 33 KB)

G7.35-4 Personal protective equipment

Issued January 1, 2005

Section 7.35(2)(b) of the *OHS Regulation* states:

> (2) If the action described in subsection (1) is not practicable, the employer must reduce the exposure hazard by providing . . .
>
> (b) personal protective equipment, if the equipment provides protection equally effective as administrative controls.

Workers who are at risk of exposure to thermal conditions that could cause cold stress or injury due to unplanned or accidental events should be provided with clothing and equipment sufficient to permit survival from the natural elements until the worker can be removed from the exposure.

As a minimum, a worker should be provided with the following:

- Additional clothing selected in accordance with the anticipated overnight low temperatures for the region in which work or travel is conducted
- A sleeping bag rated for the anticipated overnight low temperatures for the region in which work or travel is conducted
- Survival equipment that will allow a worker to survive the natural elements until rescued

Here are some typical items that should be included in a survival kit:

GENERAL:	**SIGNAL:**
1 - backpack with pockets	1 - mini-flashlight and batteries
1 - 10 ft x 12 ft plastic tarp	1 - compass
1 - 5 ft x 6 ft polar fleece blanket	1 - survival whistle
2 - tarp straps	1 - set of flares
	1 - handheld flare launcher
COOKING:	
2 - large stainless steel cups	**OTHER:**
2 - sets of cutlery	2 - toilet tissue packets
1 - survival stove	1 - 50 foot parachute cord
1 - 500 mL water bottle	1 - sheathed knife
	1 - tube of lip balm and/or sunscreen
FOOD:	1 - container of insect repellent
4 - instant soup mix	1 - small folding saw
10 - tea bags	4 - garbage bags
1 - food ration	
10 - instant hot chocolate	**FIRST AID:**
12 - food bars	1 - basic first aid kit
1 - water treatment kit	

FIRE:	
1 - fire starting kit	

Selection of clothing and wearable personal protective equipment is discussed in OHS Guidelines G7.37-1 and G7.37-2.

G7.36 Heated shelters

Issued January 1, 2005

Section 7.36 of the *OHS Regulation* states:

> If a worker is exposed to a thermal environment with an equivalent chill temperature less than -7°C (19°F), as determined using the criteria for the cooling power of wind on exposed flesh in the cold stress section of the ACGIH Standard, a nearby heated shelter must be available to the worker.

The intent of a heated shelter is to allow workers the opportunity to come out of the cold and warm themselves. The outer layer of clothing should be removed, and remaining clothing should be loosened to permit sweat to evaporate. Workers should be encouraged to use the shelter at regular intervals. Signs and symptoms indicating that the shelter should be used are:

- Onset of heavy shivering
- Minor frostbite (frostnip)
- Feeling of excessive fatigue
- Drowsiness, irritability or euphoria

A heated vehicle may be used as a heated shelter. In cases where workers are in remote or isolated areas without provision of vehicles capable of being heated (such as all-terrain vehicles or snowmobiles) or in cases where workers are on foot, workers should carry adequate equipment and supplies to permit the timely assembly of a heated shelter, if necessary.

G7.37-1 Clothing (whole body)

Issued January 1, 2005

Section 7.37(1) of the *OHS Regulation* states:

> (1) A worker who is or may be exposed to the conditions referred to in section 7.33 must wear adequate insulating clothing and personal protective equipment.

The most widely used approach to dressing for work in cold environments is to use multiple layers of clothing. Generally, three layers of clothing are used:

- An inner layer that absorbs moisture and keeps it away from the skin.
- A second insulating layer that helps keep a layer of air trapped around the body.
- An outer layer that keeps dust, dirt, wind, and moisture away from the previous layer and that can be easily removed to prevent the buildup of body heat. In wet environments, the outer layer should be waterproof.

The insulative value of clothing selected should be based upon the equivalent chill temperature of the work environment and the anticipated metabolic rate of the work activity. Wearing too much clothing can lead to sweating, and wet clothing causes greater heat loss and increases the risk of developing hypothermia.

Many manufacturers of insulated garments provide guidance for recommended temperature and metabolic rate ranges for their clothing. There are also several standards that recommend the insulative value of clothing for use with a given temperature and metabolic rate.

An example of a standard for selecting clothing is the required insulation value or IREQ. For more information on IREQ see the following:

Holmér, Ingvar. "Cold Stress: Part I - Guidelines for the Practitioner." *International Journal of Industrial Ergonomics* 14:139-149 (1994).

The IREQ value, in units of clo, is selected from the following chart based upon metabolic rate and ambient temperature. Once the IREQ is determined, clothing ensembles offering the same value of insulation should be selected. Examples of basic insulation values for different clothing ensembles are listed in the following table.

For further information pertaining to IREQ or other standards that can be used to help select insulated clothing, please contact your local WBC office.

IREQ values needed to maintain low-level physiological strain

IREQ values

Examples of basic insulation values of clothing:

Clothing ensemble	Basic insulation value (clo)
Briefs, short-sleeved shirt, fitted trousers, calf-length socks, shoes	0.5
Briefs, undershirt, underpants, shirt, overalls, calf-length socks, shoes	1.0
Briefs, T-shirt, shirt, fitted trousers, insulated coveralls, calf-length socks, shoes	1.5
Underpants, undershirt, shirt, trousers, jacket, overjacket, overtrousers, socks, shoes, hat, gloves	2.0
Arctic clothing systems	3-4.5
Sleeping bags	3-8

G7.37-2 Clothing (extremities)

Issued January 1, 2005

Section 7.37(1) of the *OHS Regulation* states:

> A worker who is or may be exposed to the conditions referred to in section 7.33 must wear adequate insulating clothing and personal protective equipment.

OHS Guideline G7.34-1 includes general assessment guidelines for protecting the hands. In addition, mittens rather than gloves should be worn when the air temperature is less than -17°C (0°F). Gloves and mittens should have removable liners so they can be effectively dried.

Footwear for use in cold environments should be insulated and should also have removable insoles for effective drying.

Exposed areas of the head and neck should be protected against heat loss and the danger of frostbite by use of adequate head covering and/or facemasks. This is extremely important when equivalent chill temperatures fall within the "increasing danger" portion of the "Cooling Power of Wind" ACGIH table provided in OHS Guideline G7.33-3.

DIVISION 1 - NOISE EXPOSURE

G7.2 Exposure limits
G7.3-1 Noise measurement - when required and performance
G7.3-2 Noise exposure data collected by prevention officers
G7.4 Exemption
G7.5-1 Program - education and training
G7.5-2 Annual program review
G7.6-1 Investigating controls
G7.6-2 Implementing controls
G7.7-1 Selection of hearing protection
G7.7-2 Warning signs and hearing protection
G7.8-1 Annual hearing tests
G7.8-2 Authorized hearing testers
G7.8-3 Hearing test results
G7.8-4 Construction industry
G7.9 Test records

DIVISION 2 - VIBRATION EXPOSURE

DIVISION 3 - RADIATION EXPOSURE

DIVISION 4 - THERMAL EXPOSURE

Heat Exposure

Cold Exposure

G7.11-1 Exposure limits - hand-arm vibration

Issued August 1999; Revised January 1, 2005; Revised October 30, 2018

Regulatory excerpt
Section 7.11(a) of the *OHS Regulation* states:

> The employer must ensure, to the extent practicable, that workers are not exposed to vibration in excess of the limits specified in
>
> (a) for hand-arm vibration, the American Conference of Governmental Industrial Hygienists publication entitled *Threshold Limit Values and Biological Exposure Indices*, dated 2003, as amended from time to time;
> …
>
> except as otherwise determined by the Board

Purpose of guideline
The purpose of this guideline is to outline the exposure limits for hand-arm vibration ("HAV") mentioned in section 7.11(a) as prescribed in the latest edition of the American Conference of Governmental Industrial Hygienists' publication entitled *Threshold Limit Values and Biological Exposure Indices*.

Potential health effects of hand-arm vibration
It is recognized that exposure to vibration may lead to Hand-Arm Vibration Syndrome, a set of upper extremity disorders that include vascular, sensorineural, and musculoskeletal signs and symptoms. Vibration induced health effects could occur both with acute exposures and chronic exposures over time. Some of the signs and symptoms of vibration exposures are tingling, numbness, pain, and reduced sensory perception and dexterity in the hand. Sources of exposure to HAV are commonly associated with rotating or percussive hand-held power tools, vibrating workpieces, and hand-held vibrating controls.

Hand-arm vibration exposure limit
The HAV exposure limit (8-hour energy equivalent total value) of 5 metres/sec^2 is expressed as an equation and in Figure 1 below. The ACGIH states that due to individual susceptibility, the exposure limit should not be regarded as defining a boundary between safe and unsafe exposure levels. The evaluation of vibration, including measurements, must be performed in accordance with the procedures and instructions specified by ISO 5349-1 and ISO 5349-2 as required by section 7.12 of the *Regulation*.

$t_{exp} = 8h(5ms^{-2}/a)^2$, *where a= acceleration*

Using the equation, the table below provides some examples of HAV exposure limits for different exposure durations, as reflected in Figure 1 below.

Exposure Duration (in hours)	HAV Exposure Limits in metres per second squared (m/s^2)
8	5
6	5.8
4	7.1
2	10
1	14.1
0.5	20

Source: ACGIH

For more information about evaluating HAV exposures, refer to the OHS Guideline G7.12, Evaluation.

The *Regulation recognizes*, in the phrase "to the extent practicable" in section 7.11, that there are circumstances with which the exposure limit cannot be fully complied. In such circumstances, section 7.11 requires the employer to reduce the exposure to the lowest extent using all practicable means currently available, even if the exposure limit cannot be achieved. Employers will be considered to have complied with section 7.11(a) if they can demonstrate that they have developed and implemented an exposure control plan in accordance with sections 7.13 and 5.54.

Refer to the OHS Guideline G7.13, Vibration exposure control obligations for more information about developing and implementing an exposure control plan for the exposure to vibration.

G7.11-2 Exposure limits - whole-body vibration

Issued August 1999; Revised January 1, 2005

Section 7.11(b) of the *OHS Regulation* states:

> The employer must ensure, to the extent practicable, that workers are not exposed to vibration in excess of the limits specified in …
>
> (b) whole-body vibration, ANSI Standard S3.18-2002/ISO 2631-1-1997, Mechanical Vibration and Shock - Evaluation of Human Exposure to Whole Body Vibration - Part 1: General Requirements, as amended from time to time;
>
> except as otherwise determined by the Board.

With respect to section 7.11(b), Appendix B of *ANSI S3.18-2002/ISO 2631-1:1997, Mechanical Vibration and Shock - Evaluation of Human Exposure to Whole-Body Vibration - Part 1: General Requirements*, addresses the health effects of vibration on the human body and defines a "health caution guidance zone" for daily exposures of 4 to 8 hours, as follows:

- **Within the zone** - caution is indicated with respect to potential risks for adverse health effects
- **Above the zone** - adverse health risks are likely
- **Below the zone** - adverse health effects have not been clearly documented and/or objectively observed

Whole-body vibration exposure limits in x, y, or z directions

Daily Exposure Duration	Values of the dominant, frequency-weighted (rms), component acceleration, ms^{-2}		
	No clear effects	Caution	Health risks likely
4 hours	Less than 0.6	0.6 to 1.1	Greater than 1.1
8 hours	Less than 0.5	0.5 to 0.9	Greater than 0.9

(rms = root mean square, ms^{-2} = metres per second squared)

The *OHS Regulation* recognizes, in the phrase "to the extent practicable" in section 7.11, that there are circumstances in which the exposure limit cannot be fully complied with. In such circumstances, section 7.11 requires the employer to reduce the exposure using all practicable means currently available (see OHS Guideline G7.13 for further information), even if the exposure limit cannot be achieved.

Employers will be considered to have complied with section 7.11(1)(b) if they can demonstrate that they have carried out an assessment of the risk of whole-body vibration (WBV) by:

1. making a competent estimate of worker exposure in comparison with the exposure limits by using:

- vibration databases on the internet or in the technical/scientific literature, or
- vibration data supplied by the equipment manufacturer, or
- on-site vibration measurements made by a consultant, or knowledgeable person
- relevant data obtained through an industry association, and
- duration of typical, daily contact with the source of vibration.

2. identifying the main contributors to the worker's risk. This involves using the data collected in the estimate to rank-order the sources of WBV to which the worker is exposed.

3. identifying and considering all available WBV risk controls. For example (see also G7.13):

- in selection of new vibration-reduced equipment (eg suspended cabs and suspended seats)
- investigating alternative ways of working which reduce WBV exposure
- ensuring workers always use equipment appropriately
- ensuring surfaces on which vehicles operate are regularly graded and free of irregularities (potholes and bumps etc.)
- ensuring the equipment is maintained in good condition
- minimising the worker's daily exposure time by spreading the job over more days and by job rotation with other workers.

4. monitoring the effects of the implemented risk control measures, and adjusting control measures as necessary.

5. completing a written record of the above steps.

G7.12 Evaluation

Issued August 1999; Revised January 1, 2005; Revised October 30, 2018

Regulatory excerpt
Section 7.12 of the *OHS Regulation* states:

> The evaluation of hand-arm vibration and whole-body vibration must be conducted by the employer in accordance with
>
> (a) for hand-arm vibration, *ISO Standard 5349-1:2001, Mechanical Vibration - Measurement and Evaluation of Human Exposure to Hand-transmitted Vibration - Part 1: General Requirements* and *ISO Standard 5349-2:2001, Mechanical Vibration - Measurement and Evaluation of Human Exposure to Hand-transmitted Vibration - Part 2: Practical Guidance for Measurement at the Workplace*, as amended from time to time;
>
> (b) for whole-body vibration, *ANSI Standard S3.18-2002/ISO 2631-1-1997, Mechanical Vibration and Shock - Evaluation of Human Exposure to the Whole Body Vibration - Part 1: General Requirements*, as amended from time to time;
>
> except as otherwise determined by the Board.

Purpose of guideline
The exposure limits presented in OHS Guidelines G7.11-1 and G7.11-2 for hand-arm vibration (HAV) and whole-body vibration (WBV) acceleration limits are listed according to one or more axes. The reason for this is that the body's response to vibration depends on the direction along which vibration enters the body. For both HAV and WBV, three perpendicular "biodynamic" axes (the x-, y-, and z-axis) are defined. The directions of these axes are described as follows:

Axes of vibration

Axis	Hand-arm vibration (HAV)	Whole-body vibration (WBV)
x-axis	Through the hand, from top towards the palm	Through the body, from the back towards the chest
y-axis	From the right side to the left side, parallel to the knuckles	From the right side to the left side
z-axis	From the wrist through to fingers, parallel to top of the hand	From the feet (or buttocks) to the head

Usually acceleration is dominant along one axis; for whole-body vibration this is often the z-axis.

For the measurement of vibration (HAV and WBV), measured accelerations are frequency-weighted according to the frequency weightings defined in the latest ISO and ANSI standards. The frequency-weighted accelerations can then be compared with criterion values/exposure limits, which are also expressed in terms of frequency-weighted acceleration. (Refer to OHS Guidelines G7.11-1 and G7.11-2 for exposure limits for HAV and WBV, respectively.)

G7.13 Exposure control plan

Issued August 1999; Revised January 1, 2005; Editorial Revision April 27, 2010

Section 7.13 of the *OHS Regulation* states:

> The employer must, if a worker is or may be exposed to vibration in excess of the vibration exposure limits, develop and implement an exposure control plan that meets the requirements of section 5.54(2).

A basic element of an exposure control plan is to determine the severity of the exposure to the agent. Not all equipment presents a hazard from vibration. Examples of equipment that may present a hazard to workers from either hand-arm vibration or whole-body vibration are listed below.

Some equipment that may present a vibration hazard

Hand-arm vibration	Whole-body vibration
Chainsaws, brush cutters, mowers Power saws for cutting metal, wood and stone Percussive tools (such as air-driven drills, wrenches, chisels, hammers, pavement breakers, and riveters or in swaging and flanging) Concrete vibrators Concrete surface preparation equipment Grinders, sanders, polishers, screwdrivers and other rotary tools Sand and aggregate compactors	Log decks Operator cabs for heavy equipment (commonly used in construction and forestry e.g. construction and mine haul & logging trucks, skidders) Forklift trucks, dump trucks Tracked vehicles, excavators, bulldozers, backhoes, scrapers, graders, front end and log loaders Snow removal vehicles Farm tractors Helicopters

When there is a reasonable expectation that vibration presents a significant hazard, the exposure limits in section 7.11 should be considered in the purchase and design of new equipment. In determining whether an exposure control plan is required, the duration of daily exposure and the operating conditions should be taken into consideration, as well as any reports of injury and disease from workers using existing equipment. Equipment that is used less than 0.5 hour per day is not likely to present a significant long-term hazard from vibration, except for the most highly vibrating equipment. It is prudent to regard regular prolonged use of any high-vibration tool or machine as hazardous, especially if it causes tingling or numbness in the user's fingers after about 5 to 10 minutes of continuous operation.

Some useful references in assessing equipment for vibration are the following publications by the Health Safety Executive in the United Kingdom: *Hand-Arm Vibration (HSG88, 1994) and Vibration Solutions - Practical Ways to Reduce the Risk of Hand-Arm Vibration Injury* (HSG170, 1997).

Evaluating equipment for potential for vibration

To evaluate the potential for vibration with respect to the exposure limits referred to in section 7.11, information on the vibration characteristics of the equipment or machinery is to be obtained. For example:

- *Obtaining information from the supplier of the equipment:* The employer should ask the following questions to obtain information from a supplier or designer:
    - Does the equipment meet the exposure limits in the referenced standards?
    - What is the frequency-weighted acceleration of the equipment?
    - Under what operating conditions were the measurements made?
    - Which published standard was used when conducting the evaluation?
- *Researching the relevant literature and available databases:* The Off-Highway Plan and Equipment Research Centre (OPERC) maintains a vibration database, Hand-Arm Vibration Test Centre (HAVTEC), which contains vibration levels for hand-held equipment. It can be viewed on the Internet at: http://www.operc.com/havtec/.
- *Measuring frequency-weighted acceleration values of designed equipment or of equipment before purchase*: These determinations are to be conducted in accordance with a standard acceptable under section 7.12 of the *OHS Regulation*.

Options for control measures

Control measures to protect against hand-arm vibration (HAV) include the following:

- Ensure the tool is properly maintained, serviced and adjusted and anti-vibration mounts and suspended handles are replaced before they deteriorate.
- Keep tools e.g. chisels sharpened.
- Fit grinders with effective, balanced, grinding discs properly centred on the arbour.
- Ensure rotary tools are dynamically balanced.
- Grip the tool handle with the least hand strength practicable
- Cover handles with a resilient wrapping layer. Wrapping handles can offer thermal insulation as well as vibration isolation - especially for steel handles.
- Wear full-fingered, "antivibration" gloves meeting the requirements of *ISO Standard 10819-1996, Mechanical Vibration and Shock - Hand-Arm Vibration - Method for the Measurement and Evaluation of the Vibration Transmissibility of Gloves at the Palm of the Hand.*
- Replace an old tool with a new tool having lower vibration
- Reduce vibration entering the hand by suspending the tool's weight on a balancer
- Substitute a process which eliminates or reduces the need for vibrating tools
- Control the length of a worker's daily exposure by job rotation.

Control measures to protect against whole-body vibration (WBV) include the following:

- Choose a suspended seat containing a vibration-damping mechanism.
- Choose a suspended seat adjustable for the worker's weight.
- Dynamically balance vehicle wheels.
- Fit tires with a low vibration tread pattern.
- Regularly grade the surface over which vehicles operate.
- Reduce speed when moving over bumpy surfaces.
- Avoid sudden load changes (pick up, drop off).
- Avoid bumping into obstacles while driving.
- Fit vibration-damping mechanisms where possible.
- Maintain shock absorbers on vehicles.
- Isolate booths/cabs, etc., by setting them on their own separate foundations.
- Train workers not to jump in order to exit equipment, particularly from an elevation, as the intervertebral discs may have been softened by the vibrating equipment, jumping can more easily cause shock and damage to the body.

G7.14 Information on adverse effects

Issued January 1, 2005

Section 7.14 of the *OHS Regulation* states:

> The employer must, if a worker is exposed to levels of vibration above the vibration exposure limits, inform the worker of the nature of the hazard and possible adverse effects.

Excessive exposure to hand-arm vibration (HAV) can cause vascular, neurological, and musculoskeletal damage to workers' fingers and hands. The symptoms of hand-arm vibration syndrome (HAVS) include circulatory pain (notably triggered by cold), loss of dexterity, and development of bone cysts and joint abnormalities. Workers may complain of episodes of pale, white fingers often triggered by exposure to cold. It is believed that vibration can adversely affect the blood circulation, making fingers sensitive to the vasoconstriction due to cold. Initially, only the tips of one or more fingers are "blanched," but more segments and fingers are affected with further vibration exposure.

Workers also may experience tingling or numbness in the fingers and hands. With continued exposure, the sensations worsen and can interfere with work and result in the loss of the normal sense of touch. Some vibration-exposed workers (rock drillers, forestry workers) may show signs of carpal tunnel syndrome (CTS) suggesting that vibration can combine with repetitive motion, forceful gripping, and awkward postures (all ergonomic stressors) to contribute to hand and wrist disorders.

Higher occurrences of osteoarthritis in the wrist and elbow have been observed in workers using hand-held, pneumatic percussive tools (miners, construction, metal workers). Workers may also complain of muscular weakness, pain in the hands/arms, and reduced grip strength. In some cases, muscle fatigue can cause disability. Other occupational disorders in vibration-exposed workers include tendonitis and tenosynovitis (inflammation of tendons and their sheaths) in the upper limbs.

Whole-body vibration (WBV) may be associated with an increased risk for low back pain, sciatic pain, and degenerative changes in the spinal column including lumbar intervertebral disc disorders.

For the vibration magnitudes in all but the most severe occupational situations, the adverse health conditions of WBV and HAV may not develop until there has been a prolonged period of time (measured in years) of regular daily exposure.

G7.15 Labels

Issued August 1999; Revised January 1, 2005

Section 7.15 of the *OHS Regulation* states:

> If the manufacturer of equipment that produces levels of vibration in excess of the vibration exposure limit does not label the equipment to identify the hazard, the employer is responsible for doing so.

This section requires that equipment producing levels of vibration in excess of recommended limits be labelled to identify the hazard. Ideally, this label will be permanently affixed by the equipment manufacturer during assembly. In many cases, however, the manufacturer will not have permanently affixed a label identifying the hazard. In these cases, the employer is required to affix the label.

The intent of section 7.15 of the *OHS Regulation* is to have the employer contact the manufacturer or supplier to obtain a label if one has not already been provided. The intent of section 7.15 is not to require the employer to measure the vibration level of the equipment.

There is no required format for the label. Any means that effectively communicates the vibration hazard is acceptable. For example, the employer could use a symbol instead of words as long as workers are trained to know what the symbol means.

It will be difficult for an employer to securely apply a label to some small pieces of equipment. For example, an adhesive label applied to a chainsaw used in the woods will likely be damaged beyond legibility before long. In such cases, where a label will likely not stay intact on a piece of equipment, it is acceptable for an employer to keep the label in a location where it will not easily be damaged or destroyed. The label is to be kept near the equipment and be readily available to the worker. Acceptable locations include the equipment's storage case or an accompanying operations manual.

Where the label cannot be applied directly to the equipment, workers should receive instruction in the location of the label.

G7.16 Exposure to cold

Issued January 1, 2005

Section 7.16 of the *OHS Regulation* states:

> When a worker is exposed to hand-arm vibration, the employer, to the extent practicable, must ensure that the worker's hands or arms are not exposed to cold, either
>
> (a) from the environment in which the worker is working or as a result of using equipment, or

(b) from coming into contact with cold objects.

Hand-arm vibration can inflict vascular damage to workers' fingers - a condition known as hand-arm vibration syndrome (HAVS). See OHS Guideline G7.14 for further information. To reduce the incidence of HAVS (and the onset of pain for workers who already have HAVS), workers using vibrating tools should keep their hands warm to improve circulation.

Here are some examples of ways for workers to keep their hands warm:

- Redirect exhaust air from pneumatic tools away from the hands. Compressed air released from pneumatic tools' exhaust ports has a strong cooling effect as it expands to atmospheric pressure.
- Provide dry towels and a change of dry gloves for workers using vibratory tools when their hands may become wet from rain or perspiration.
- Insulate handles of vibratory tools in cold environments.

G7.2 Exposure limits

Issued August 1999; Revised January 1, 2005

Section 7.2 of the *OHS Regulation* states:

> An employer must ensure that a worker is not exposed to noise levels above either of the exposure limits:
>
> (a) 85 dBA Lex daily noise exposure level, or
>
> (b) 140 dBC peak sound level.

The daily noise exposure of a worker, Lex, is derived from the Leq measured with a noise dosimeter or integrating sound level meter (SLM) over a sample time. If a sample time, such as 30 minutes, is representative of the entire shift's noise then:

- The measured sample Leq is equal to the Leq for the shift.
- Lex can be regarded as a Leq corrected for those workers not working shifts of 8 hour duration.
- Lex can be obtained from the measured Leq by applying a correction factor. To determine the correction, use the following nomogram:

For example, if the worker is exposed to a measured level of 88 dBA Leq for a period of 10 hours, the Lex equals 89 dBA (88 plus 1 = 89).

In establishing noise exposure, dosimeter measurements cannot be used to determine peak sound levels. Peaks must be measured directly by the surveyor at the time of exposure using a noise meter set to "Peak" response and "C-weighting."

Occasionally, noise survey results may be questionable due to unrepresentative work conditions prevailing when the survey was done. In such cases, the Lex over a term longer than a normal workday shift may be more desirable. The Lex for other work periods may be obtained by direct measurement or by predicting Lex for the different conditions for the remaining days of a typical cyclical work period, such as a week. The final Lex value is obtained from the logarithmic mean of the Lex values for all days of the cycle.

G7.3-1 Noise measurement - When required and performance

Issued August 1999; Revised January 1, 2005; Revised April 4, 2007; Editorial Revision June 6, 2007

Regulatory excerpt
Section 7.3 of the *OHS Regulation* ("*Regulation*") states:

> (1) If a worker is or may be exposed to potentially harmful levels of noise, or if information indicates that a worker may be exposed to a level exceeding 82 dBA Lex, the employer must measure the noise exposure.
>
> (2) The noise exposure measurement must
>
> (a) be performed in accordance with *CSA Standard Z107.56-94, Procedures for the Measurement of Occupational Noise Exposure*, as amended from time to time, except as otherwise determined by the Board, and
>
> (b) be updated if a change in equipment or process affects the noise level or the duration of noise exposure.
>
> (3) Except as otherwise determined by the Board, noise dosimeters and sound level meters used for measuring noise exposure must

meet the requirements of *ANSI Standard S1.25-1991, Specification for Personal Noise Dosimeters*, as amended from time to time.

(4) The employer must inform affected workers of the results of any noise exposure measurement and the significance of the measurement to risk of hearing loss.

Purpose of guideline
The purpose of this guideline is to

- Discuss the use of sound level meters (SLMs) under section 7.3(1)
- Highlight the current applicable standard by which noise exposure measurement must be performed under section 7.3(2)(a)
- Present some specifications for personal noise dosimeters under section 7.3(3)
- Discuss considerations when using older dosimeters that have a criterion level other than 85 dBA.

Use of SLMs under section 7.3(1)
Noise exposure measurements conducted in accordance with section 7.3(1) of the *Regulation* serve as an initial screening survey to determine if further, more detailed surveys are required. Noise surveys may be carried out with non-integrating SLMs. However, the data obtained must represent an 8-hour exposure level (Lex) for comparison with the screening standard of Lex of 82 dBA. The types of noise, patterns of work, times of breaks, production variables, and worker exposure hours combined with carefully selected grab samples from the SLM should be considered when determining the occupational noise exposure.

Current applicable CSA Standard for procedures for the measurement of occupational noise exposure
For the purposes of section 7.3(2)(a), *CSA Standard Z107.56-06, Procedures for the Measurement of Occupational Noise Exposure* is the current applicable CSA standard. *CSA Standard Z107.56-06* contains the minimum acceptable procedures for the measurement of occupational noise exposure. Note that some of the amendments to *CSA Standard Z107.56* between the 1994 and 2006 version include the addition of

- References to newer and additional standards, some of which must be followed where applicable
- A statement regarding how Lex can be determined from Leq (Annex C Division C.4)
- A requirement for the microphone to be located above the outside edge of the wearer's shoulder or as near as is feasible (section 6.4.4.3). The 1994 version of the standard had stated that the microphone shall be located on the top of the wearer's shoulder or as near as is feasible
- A warning about false peaks, especially when fitting or removing microphones and while at breaks (section 6.4.4.3)
- A recommendation that unwitnessed high peaks should be investigated (section 6.4.4.4)

Also, *CSA Z107.56-06* no longer includes references to Pascal squared hour (Pa^2h). Instead it refers to Lex, as does the *Regulation*.

WorkSafeBC has prepared two booklets entitled *Occupational Noise Surveys* and *Basic Noise Calculations* to assist employers in conducting a noise survey.

The booklets offer guidelines to acoustical consultants and others who need to comply with WorkSafeBC'S minimum acceptable requirements for surveys. Inquiries concerning the acceptability of other standards for measuring occupational noise exposure should be directed to the Industry and Labour Services department for evaluation.

Specifications for personal noise dosimeters
For the purposes of section 7.3(3), *ANSI Standard S1.25-1991, Specification for Personal Noise Dosimeters* is the current applicable standard. *CSA Standard Z107.56-06, Procedures for Measurement of Occupational Noise Exposure* specifies Type 2 tolerance for both integrating sound level meters and noise dosimeters. Type 2 relates to the accuracy required to measure occupational noise exposure.

A noise dosimeter is to be set as follows:

- Criterion level = 85 dBA
- Threshold level below or = 80 dBA or at "Off"
- Exchange rate q = 3

Considerations when using dosimeters that are not or cannot be set to a criterion level of 85 dBA
It is important to know the criterion level of a dosimeter and to make appropriate adjustments to the readings if necessary. Older noise dosimeters in use may still be calibrated to read 100% noise dose when exposed to a sound level of 90 dBA averaged over an 8-hour period. To check a dosimeter's criterion level, inject a known noise dose using a calibrator generating a known level for a fixed period of time, and read the percentage noise dose acquired. For example, a Quest brand calibrator generates a noise dose of 110 dBA for 32 seconds. A dosimeter calibrated to a criterion level of 90 dBA would result in a reading of 11.1%; a dosimeter calibrated to a criterion dose of 85 dBA would read 35%. Older dosimeters, regardless of the criterion level they are set to, can still provide an accurate Leq as long as they are used with a threshold level equal to or less than 80 dBA and the appropriate technique for converting Leq from their noise dose reading and the sampling duration is used.

Availability of standards
CSA standards are available by contacting CSA International in their office in Richmond, B.C. or through their website at:
http://www.csagroup.org/

ANSI standards are available through their website at:

G7.3-2 Noise exposure data collected by prevention officers

Issued August 1999; Revised January 1, 2005; Editorial Revision February 6, 2006

Noise exposure measurements made by prevention officers through fieldwork should be copied to the Hearing Loss Prevention Section for inclusion in the noise level database. The following fields should be completed to facilitate record keeping:

- Firm and location number
- Industry Classification Unit (CU)
- Occupation name for workers sampled
- Noise exposure level in dBA Lex
- Date of sampling
- Inspection report (IR) number
- Descriptive comments about the work activity and the equipment used

Officers should use the Noise Survey Template standard form supplied by the Hearing Loss Prevention Section to complete this information.

G7.4 Exemption

Issued August 1999; Revised January 1, 2005; Editorial Revision October 2005; Editorial Revision February 6, 2006

Section 7.4 of the *OHS Regulation* states:

> An employer is not required to measure the noise exposure of a worker if
>
> (a) based on other information, the employer identifies the worker as being exposed to noise in excess of an exposure limit, and
>
> (b) the employer establishes an effective noise control and hearing conservation program for that worker.

Under section 7.4, an employer does not need to undertake a noise exposure measurement program if it can be determined a worker is exposed to noise in excess of the limits established by section 7.2 by some other means, such as the following:

- The peak noise level limit of 140 dBC is routinely exceeded.
- Short-term Leq measurements indicate that 85 dBA Lex is exceeded on a daily basis (for example, Leq measures at 100 dBA over a 15-minute period).
- A database of worker noise exposures indicates members of a trade/occupation class to be overexposed on a daily basis. The Hearing Loss Prevention Section maintains an extensive database of this type. Contact them at HRNGCONS@worksafebc.com for noise exposure information. Refer also to OHS Guideline G7.8-4 for information on construction trades.
- Noise emission labels on tools or equipment indicate there is a strong possibility of overexposure to noise when used or operated.
- Exposure for groups of workers can be extrapolated from a database of job activities and corresponding partial noise exposures (for example, the Lex of firefighters based upon emergencies attended, equipment involved, typical Leq readings for the vehicles and average duration of each exposure).

If the employer uses one of the above means to determine that exposure is above the limits in section 7.2, then section 7.4(b) requires the employer to implement a noise control and hearing conservation program in accordance with section 7.5, except for noise measurement in 7.5(a).

G7.5-1 Program - Education and training

Issued January 1, 2005

Section 7.5(b) of the *OHS Regulation* states:

> If noise in the workplace exceeds either of the noise exposure limits, the employer must develop and implement an effective noise control and hearing conservation program with the following elements: . . .
>
> (b) education and training; . . .

The education and training of workers exposed to noise above the stated exposure limits as defined in section 7.2 should include:

- The results of any noise exposure measurements
- The effects of noise on hearing
- The proper use and maintenance of hearing protection
- The purpose of hearing testing

Two brochures, *Hear for Good* and *Testing Your Hearing, How and Why*, and a video, *The Hearing Video*, are available to assist employers in implementing the education and training components of the program.

You can also order printed brochures and the video from the WorkSafeBC Store.

G7.5-2 Annual program review

Issued August 1999; Revised January 1, 2005; Editorial Revision October 2005; Editorial Revision February 6, 2006

Section 7.5(g) of the *OHS Regulation* states:

> If noise in the workplace exceeds either of the noise exposure limits, the employer must develop and implement an effective noise control and hearing conservation program with the following elements: . . .
>
> (g) annual program review.

The employer needs to review the noise control and hearing conservation program at least annually to ensure its effectiveness. The review should address:

- The need for further noise measurement
- The education and training of workers regarding noise exposure
- The adequacy of noise control measures
- Selection and use of hearing protection
- Hearing testing and information on the rate and extent of occupational hearing loss

The Hearing Loss Prevention Section has produced a Hearing Conservation Program Evaluation Checklist (pdf 11KB) and sample written hearing conservation programs (Sample Written Hearing Conservation Programs -- small employer (pdf 30KB) and Sample Written Hearing Conservation Programs -- large employer (pdf 38KB)) to assist employers in achieving compliance with program requirements.

G7.6-1 Investigating controls

Issued August 1999; Revised January 1, 2005

Section 7.6 of the *OHS Regulation* states:

> If a worker is exposed to noise above a noise exposure limit, the employer must
>
> (a) investigate options for engineered noise control, and
>
> (b) when practicable, implement one or more of those options to reduce noise exposure of workers to or below the exposure limits.

When noise exposure exceeds either exposure limit set out in section 7.2 of the *OHS Regulation*, the employer is required to investigate ways of reducing noise exposure. An employer may achieve this through review of information provided in trade journals specific to their industries, through contacts in the business or trade associations, or by consulting an acoustical engineer or occupational hygienist.

The use of hearing protection devices should be considered a temporary measure only. Implementation of successful noise control will reduce the ongoing costs of a hearing conservation program in the long run.

G7.6-2 Implementing controls

Issued August 1999; Revised January 1, 2005

Section 7.6 of the *OHS Regulation* states:

> If a worker is exposed to noise above a noise exposure limit, the employer must
>
> (a) investigate options for engineered noise control, and
>
> (b) when practicable, implement one or more of those options to reduce noise exposure of workers to or below the exposure limits.

Section 7.6(b) requires the employer, when practicable, to implement one or more options for engineered noise control to reduce worker exposure to or below the exposure limits. "Practicable" as defined in section 1.1 of the *OHS Regulation*, means "that which is reasonably capable of being done." The incentive for controlling noise increases with the degree of overexposure and associated increasing risk of noise-induced hearing loss.

Noise control solutions lie on a continuum, starting with quick fixes, through regular maintenance, extending through low-cost solutions to large capital expense programs (see examples of controls below). One guide in deciding whether noise control is practicable is to determine if the control measure has been adopted by the industry and found acceptable. Although noise control frequently may be technically capable of being done, it may prove to be impracticable. In some instances, noise control solutions are only achieved through long-term research and development programs or complete rebuilds. However, research and development programs may place an unreasonable economic burden on an individual employer and are therefore considered impracticable. Complete rebuilds would likely also be impracticable unless the employer is, for other

business reasons, planning to rebuild a facility.

Some examples of typical means for engineered noise control are set out below.

- *Repairing*: Cover holes in walls/windows/doors of noise enclosures/operator booths, engine mufflers, doors seals, and sills.
- *Fitting*: Install compressed air exhaust mufflers, air jet noise silencer nozzles, etc.
- *Changing*: Change "screaming" saw blades for quieter blades.
- *Applying*: Apply mechanical damping treatment to steel panels in impact situations, shock absorber configurations in material handling, duct silencers for fan noise, etc.
- *Enclosing*: Enclose planers, molders, punch presses, air compressors, and circular saws.
- *Isolating*: Provide noise enclosure booths (complete or partial) for graders, planermen, and the operators of mobile equipment, veneer lathes, headrigs, edgers, and cutoff saws.
- *Installing*: Install absorbent panels on walls/ceiling near noisy tools, absorbent ceiling baffles, etc.
- *Substituting*: Provide quieter machines/tools/processes such as hydraulic rather than pneumatic power or impact force.
- *Developing*: Develop treatment for band mills, hard rock drills, electric arc furnaces, etc.
- *Modifying*: Change the work process or equipment.
- *Designing and acoustically treating*: Modify the work area.

G7.7-1 Selection of hearing protection

Issued August 1999; Revised January 1, 2005

Section 7.7(1)(c) of the *OHS Regulation* states:

> (1) If it is not practicable to reduce noise levels to or below noise exposure limits, the employer must . . .
>
> (c) give to affected workers hearing protection that meets the requirements of *CSA Standard Z94.2-02, Hearing Protection Devices - Performance, Selection, Care, and Use*, as amended from time to time, except as otherwise determined by the Board, and maintain the hearing protection so that it continues to meet those standards, and

Selection criteria

The current applicable standard is the *CSA Standard Z94.2-02 Hearing Protection Devices - Performance, Selection, Care, and Use*. This standard provides a process for selecting adequate hearing protection for noise-exposed individuals, taking into account factors such as:

- Worker noise exposure
- Worker hearing ability
- Use of other personal protective equipment
- Temperature and climate
- Physical constraints of the worker or work activity
- Comfort

Comfort is a selection criterion specified in the standard and is considered as important as attenuation (sound reduction). It is important since workers will be more likely to properly wear their hearing protectors if there is a comfortable fit, thereby increasing self-compliance.

Hearing protection classification/grade

The *CSA Standard Z94.2-02 Hearing Protection Devices - Performance, Selection, Care, and Use* has two tables that are to be used *together* in selecting hearing protection. The first table provides information on the recommended class or grade of protector for the worker's noise exposure. There are two different rating systems, based on two different ways of measuring hearing protector attenuation. The grade rating method is more reflective of the attenuation the protection will likely deliver in the workplace. Just as Class A protection has more attenuation than Class B, Grade 4 protection has more than Grade 3, and so on.

The second table provides guidance on protection outcomes to prevent overprotection -- the wearing of hearing protection with too much attenuation. Overprotection is undesirable as it:

- May prevent workers from hearing audible warning signals
- Reduces the ability of workers to verbally communicate in the noisy environment, resulting in temporary removal of hearing protection
- Results in the need for workers to "yell" at one another, causing voice strain
- Limits a worker's ability to hear changes in machinery or process performance that may indicate developing production problems
- Does not provide any additional protection against noise-induced hearing loss

Application of the selection criteria in the standard typically means more than one style and class or grade of hearing protector should be made available to workers. For example, if a worksite has noise exposures ranging from 85-98 dBA Lex, then Class A and Class B (Grade 3, 2, and 1) protection should be supplied, to accommodate the criterion "daily noise exposure of the worker." Similarly, if there are workers with hearing impairment at the worksite, Class A and B (Grade 3, 2, and 1) protection should be supplied to accommodate the criterion "worker hearing ability." In addition, earplugs and earmuffs will likely have to be supplied to accommodate the criteria "use of other personal protective equipment," "temperature and climate," and "physical constraints of the worker." This last criterion includes such aspects as very small or very large ear canals,

sensitive skin in the ear canal, and unusual head size or shape.

Specialized hearing protection

Beyond these conventional protectors, the following types of workers may need more specialized hearing protection, due to listening demands:

- Workers with significant hearing losses
- Supervisors
- Trades workers
- Vehicle operators
- Instructors
- Musicians (performers as well as technical support personnel)
- Hospitality workers

Where one- or two-way radio communication is required, a commercially manufactured hearing protection device with built-in speakers and/or microphone should be supplied. There is an entire section in the 2002 CSA standard devoted to specialized hearing protection.

The standard also states that hearing protection must be visually inspected during the annual hearing test for condition and fit.

Further information regarding hearing protection is available in the brochure *Hear for Good* and in the standard practice manual *Sound Advice*.

CSA standards are available by contacting CSA International in their office in Richmond, B.C., or through their website at: http://www.csagroup.org/

G7.7-2 Warning signs and hearing protection

Issued August 1999; Revised January 1, 2005

Section 7.7(1)(b) of the *OHS Regulation* states:

> (1) If it is not practicable to reduce noise levels to or below noise exposure limits, the employer must . . .
>
> (b) post warning signs in the noise hazard areas . . .

Section 7.7(2) of the *OHS Regulation* states:

> (2) Workers in a posted noise hazard area must wear hearing protection.

Sometimes workers move in and out of noise hazard areas during their workday. Supervisors or other workers whose duties require them to routinely work in posted noise hazard areas must be provided with, and wear, hearing protection in the posted areas. Workers who briefly and infrequently pass through posted noise hazard areas do not need to wear hearing protection, except in areas where the exposure limit for peak sound level is exceeded.

The employer may establish workplace policies which exceed the requirements of the *OHS Regulation* regarding the use of hearing protection in noise hazard areas. For example, the employer may instruct workers that use of hearing protection is mandatory for all workers in any designated noise hazard area in their facility.

Hearing protection does not need to be worn when the source of noise that makes the area hazardous is shut down.

G7.8-1 Annual hearing tests

Issued August 1999; Revised January 1, 2005; Editorial Revision April 4, 2007

Regulatory excerpt
Section 7.8(1) of the *OHS Regulation* (*"Regulation"*) states:

> The employer must give workers who are exposed to noise that exceeds noise exposure limits
>
> (a) an initial hearing test as soon as practicable after employment starts, but not later than 6 months after the start of employment, and
>
> (b) a test at least once every 12 months after the initial test.

Purpose of guideline
The purpose of this guideline is to discuss the application of section 7.8(1) to industries in which workers may not be employed continuously for more than six months.

Background
There are a number of industries where noise levels are known to exceed the exposure limits in section 7.2 and in which workers may not be employed continuously for more than six months; however, workers are usually employed in these industries for many months each year. Examples

of such industries are fish processing, shipbuilding, logging, and construction.

Level of risk
Some industries, such as agriculture, involve workforces that are a mix of stable and seasonal workers, who may be exposed to a range of noise levels. Typically, fieldworkers will be exposed to low noise levels and would not need to be tested. Persons most at risk would likely include those farmers, ranchers, and workers who operate equipment with high noise levels, and those who work in some indoor operations involving raising of animals or fowl.

Program options for testing workers
Section 7.8(1) establishes an obligation to test any new worker who is exposed above the noise exposure limits, not just those workers who stay for 6 months with the employer. If the employment lasts less than 6 months, the test should be done within that timeframe or period. In this context, the employer should have a reasonably effective program for testing workers. Two common ways of doing this are as follows:

- Arrange for a hearing testing contractor to visit the place of workplace
- Set up an in-house testing program

With regard to the first option, the visits may be at regular intervals selected by the employer, such as every three months. Alternatively, the employer might arrange the visits for a convenient time in a project, such as before workers leave town to go to a remote area. In either case, if the employer sets up a reasonable program, WorkSafeBC will not be concerned if some workers missed the testing because they started work just after, or finished employment just before, a testing contractor arrived.

In some situations, for example in rural agricultural operations, options other than the two listed above may be appropriate. For example, workers may be sent to a testing facility where available in a nearby town, or workers from a number of farms or ranches may be tested at a location common to them, or at another workplace in the area with an in-house testing program.

Out of province employers
A similar issue arises for out-of-province employers who operate in B.C. for short periods of time. If the workers are working in B.C. for a total of 6 months or more in a year, then hearing tests meeting the requirements of section 7.8 are required for those workers.

G7.8-2 Authorized hearing testers

Issued August 1999; Revised January 1, 2005

Section 7.8(2) of the *OHS Regulation* states:

> Hearing tests must be administered by a hearing tester authorized by the Board.

A list of authorized hearing test contractors is available on the WorkSafeBC website.

Details regarding the standards, criteria, and processes for authorizing testers and for removing authorization are contained in the *Administration Procedures - Industrial Audiometry*.

Authorized testers have been trained to:

- Obtain relevant medical history information
- Record the hearing tests in a manner required by the Board
- Advise the worker of the test results
- Counsel the worker on the use and maintenance of hearing protection
- On request, provide a copy of the test results to the worker

The employer must not disclose or publish a worker's medical history information except as permitted by the Board, in accordance with section 156(1)(a) of the *Workers Compensation Act*. Section 156 states that:

> (1) A person must not disclose or publish the following information, except for the purpose of administering this Act and the regulations or as otherwise required by law:
>
> (a) information obtained in a medical examination, test or X-ray of a worker made or taken under this Part, Part 4 or the regulations, unless the worker consents or the information is disclosed in a form calculated to prevent the information from being identified with a particular person or case; . . .

An employer should also not retain a copy of a worker's medical history.

G7.8-3 Hearing test results

Issued August 1999; Revised January 1, 2005; Editorial Revision 2005; Editorial Revision February 6, 2006

Section 7.8(3) of the *OHS Regulation* states:

The employer must ensure that the authorized hearing tester sends the test results to the Board.

The Hearing Loss Prevention Section maintains a database of hearing tests. Annual statistical reports are provided to all employers that submit hearing test data, confirming numbers and categories of tests processed. The report includes a breakdown by type and category of each hearing test. It is expected that the employer will use this report to determine the rate and extent of occupational hearing loss in their workers when reviewing the hearing conservation program on an annual basis. Prevention officers may obtain this type of statistical report for a particular firm and location, at any time, to assist in evaluating compliance.

G7.8-4 Construction industry

Issued August 1999; Revised January 1, 2005

Section 7.8 of the *OHS Regulation* states:

(1) The employer must give workers who are exposed to noise that exceeds noise exposure limits

(a) an initial hearing test as soon as practicable after employment starts, but not later than 6 months after the start of employment, and

(b) a test at least once every 12 months after the initial test.

(2) Hearing tests must be administered by a hearing tester authorized by the Board.

(3) The employer must ensure that the authorized hearing tester sends the test results to the Board.

In October 1987, an agreement was established between the Board and the construction industry (joint worker/employer representation through the B.C. Construction Association) that workers employed in certain occupations in some construction industry classifications are routinely exposed to noise in excess of the exposure limits. The agreement applies to the classification units (CUs) in the following subsectors:

- 7210 General Construction (with the exception of subunits 721016, 721023, 721029, 721030, 721044 which are not considered hazardously noisy)
- 7220 Heavy Construction
- 7230 Road Building

Noise-exposed occupations in the construction industry

In these CUs, a worker employed in one of the following occupations is to be considered as routinely exposed to noise in excess of the exposure limits:

- Bricklayer
- Carpenter
- Concrete worker (around a pump, vibrator, jack hammer, or powered finishing equipment)
- Driller
- Drywaller (shooting track or boarding)
- Electrician
- Form worker
- Foreman
- Framer
- Labourer
- Mobile equipment operator
- Pipefitter
- Plumber
- Roofer (shake, tar/gravel, membrane, shingle)
- Sandblaster
- Steel erector
- Supervisor
- Truck driver
- Welder/fabricator

A worker in one of the above occupations should normally be part of a hearing test program meeting the requirements of section 7.8. If any worker in one of the listed occupations is not part of a hearing test program, orders may be written on the employer without measuring noise exposure of the worker. There is an extensive noise database documenting exposures for these occupations; the database was established in the mid-1980s and updated in the late 1990s. However, the officer will consider any evidence presented by the employer showing that a particular worker need not be on a hearing test program. For example, noise dosimetry carried out in June 1995 indicates that some mobile equipment operators (operators of modern tracked excavators and front-end loaders) have noise exposure levels below 85 dBA Lex. Advancements in the engineering of engine exhaust, hydraulic, and fan components on this equipment have resulted in lower noise exposures for the operators.

Note that the requirement for a hearing test program is not restricted to the listed occupations. There may be other occupations in these CUs in which workers are exposed to noise in excess of the exposure limits.

Payment for a construction worker's hearing tests

To assist construction industry employers in the above CUs to comply with the hearing test program requirements, the Board has established:

- A central registry of hearing test results
- A card validation system so each construction worker can show when his/her hearing was tested
- A program to pay an authorized hearing test agency a fee per hearing test performed

The Board sets the fee paid to the hearing test agency for each test. The funding for this program is collected from the construction industry as a whole by charging an additional assessment to the CUs referred to above. This is pursuant to section 113(5) of the *Workers Compensation Act*, which provides that the Board may charge a class or subclass with the cost of investigations, inspections, and other services provided to the class or subclass for the prevention of injuries and illness.

An employer in one of the above CUs may comply with the requirements of section 7.8 without using the Board-administered program if the employer wishes. However, employers who participate in and comply with the Board's program are exempt from the obligation to conduct noise exposure measurement under section 7.4 of the *OHS Regulation*.

G7.9 Test records

Issued August 1999; Revised January 1, 2005; Editorial Revision October 2005; Editorial Revision February 6, 2006

Section 7.9 of the *OHS Regulation* states:

> The employer must keep records of
>
> (a) the annual hearing test results for each worker, which must
>
> (i) be kept as long as the worker is employed by the employer, and
>
> (ii) be kept confidential and not released to anyone without the written permission of the worker, or as otherwise required by law,
>
> (b) the education and training provided to workers, and
>
> (c) the results of noise exposure measurements taken under section 7.3.

Original copies of WCB Form H45E32 (the blue and white audiogram form) need not be present onsite at the worksite to fulfill the requirements of section 7.9. The employer may choose to have the hearing test contractor who conducted the tests maintain the hearing test records on behalf of the employer, or to have an occupational health services provider employed by the firm retain the records. Such arrangements should be set out in a written agreement.

A prevention officer may ask for other evidence of compliance with section 7.8 (provision of annual hearing tests to noise exposed workers) such as a copy of the Hearing Conservation Annual Report. This report is provided every February to all employers who submitted hearing test results to the Board in the previous year. The report includes a list of all workers tested (Forms Processed List) and a statistical breakdown of tests into various categories. The Hearing Loss Prevention Section can also provide an officer or employer with year-to-date summaries of the number of tests carried out and a list of workers tested for a given firm and year.

On construction sites, noise exposed workers should normally carry a current Record of Hearing Test card validating that they have been tested. The worker may be asked by a prevention officer to show the test record card.

An officer may ask the employer to obtain actual copies of hearing tests from the hearing test contractor if the officer feels this is necessary to verify compliance. The contractor should provide these to the employer on request.