Electromagnetic radiation exposure to library staff using check-out scanners

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LIST OF ABBREVIATIONS

A/m  amperes per metre
CUPE  Canadian Union of Public Employees
ELF  extremely low frequency
EMF  electromagnetic fields
FDA  Food and Drug Administration
H-field  magnetic field
HF  high frequency
IARC  International Agency for Research on Cancer
ICNIRP  International Commission on Non-Ionizing Radiation Protection
IEEE  Institute for Electrical and Electronics Engineers
MHz  megahertz
mrem  millirems
ORL  Okanagan Regional Library
RF  radiofrequency
RFID  Radio-frequency Identification
SAR  Specific Absorption Rate
UHF  ultra high frequency
V/m  volts per metre
VPL  Vancouver Public Library
W/kg  watts per kilogram
WBDP  whole blood-derived platelets

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EXECUTIVE SUMMARY

The Canadian Union of Public Employees (CUPE) represents the staff of many libraries throughout British Columbia, Canada. The client requested a risk assessment of library checkout scanner exposure upon receiving some concerns from library staff in the Vancouver and Okanagan regions. More specifically, staff questioned whether chronic exposure to low levels of electromagnetic radiation emitted by the checkout scanner could produce adverse health effects among library workers. There was also a level of concern surrounding more vulnerable populations of library staff, primarily health risks to pregnant women and their unborn fetus.

As part of a health sciences course at Simon Fraser University, a group of public health graduate students worked with CUPE to produce this report addressing the following questions: 1) What kind of occupational hazards are library staff exposed to from the use of check-out scanners? 2) What is the dose level of the exposure and is it considered safe for susceptible population subgroups such as pregnant female library staff? and 3) Are there any significant public health concerns?

This report focuses specifically on the type of checkout scanning technology used by the Vancouver Public Library known as radio-frequency identification (RFID) checkout scanners. RFID systems combine radiofrequency (RF) and microchip technology, where microchip tags are read by radio waves. RFID library scanners and other everyday electronics, such as cell phones, Wi-Fi, televisions and computers operate within the radio frequencies portion of the electromagnetic spectrum which ranges from 3 kHz to 300 MHz. Library RFID checkout scanners specifically operate at a frequency of 13.56 MHz. The human exposure science surrounding electromagnetic radiation focuses on a measure known as specific absorption rate (SAR), which is the rate at which electromagnetic energy is absorbed by the body. This measurement uses the units of watts per kilogram (W/kg) and can be measured over the entire body, or for a specific part of the body such as the head or abdomen.

To assess the risk that RFID scanners impose on library employees we began by identifying human health hazards associated with electromagnetic field (EMF) radiation. Human studies examining exposure to EMFs have generally looked at the effects of high-level acute exposure and the resulting impacts on rates of cancer, the cardiovascular and immune systems, and reproductive and developmental diseases. Studies examining low levels of radiofrequency radiation exposure, at the levels one would experience while operating an RFID checkout scanner, have found little or no impact on human health. In fact, in terms of low-level non-ionizing EMFs, there are no published adverse health effects from which to begin modeling a dose-response curve.

The International Commission on Non-Ionizing Radiation Protection has published guidelines for electromagnetic radiation up to 300 GHz, which is relevant to RFID checkout scanners. In Canada, safety limits for human exposure to electromagnetic fields is set out in the Health Canada document Safety Code 6. In uncontrolled environments, the SAR limit set by Health Canada is equal to 1.6 W/kg when exposure is averaged over the whole body mass.

Although no studies have looked specifically at human exposure levels associated to RFID library scanners, data do exist from research on devices which all operate at the same frequency (13.56 MHz), notably an RFID smart card reader used in European transit systems,
and an RFID anti-theft gate. Exposure levels measured in both of these studies were well below the SAR limit of 1.6 W/kg.

The results of our assessment suggest that the risk of exposure to library workers from 13.56 MHz RFID checkout scanners is negligible. Prenatal effects of EMF exposure were also characterized, as the library employees were concerned with adverse health effects on the unborn fetus. Based on our research there also appears to be no substantial health risk to the unborn fetus from RFID exposure. The risk posed by RFID scanners is lower than more common EMF instruments such as mobile phones and wireless internet, and the frequencies emitted by power lines. The risk of developing cancer for the unborn fetus was evaluated and it was determined that there is no significant increase in the overall lifetime risk. Based on these results it appears that the health risks regarding RFID library scanners are more of a perceived risk rather than an actual risk. Education and training are powerful tools that can be used to mitigate such misconception among the general public and among groups with higher exposure to EMFs.

There are a number of limitations in this report. The major challenge in this analysis was the scarcity of research directly measuring exposure levels from RFID checkout scanners. Instead our analysis estimated the effect on library workers from data found in the literature on: 1) SAR and electric and magnetic field strength exposure measurements from devices with a 13.56 MHz operating frequency, 2) human health effects in observational studies of occupational RF exposure, and 3) in vitro studies of RF exposure. There are certainly limitations surrounding the ability to extrapolate these results to the library setting, including differences in spatial exposure to the RFID technology, as well as differences in duration, frequency, operating frequency and time averaging of exposure. Nonetheless, this is the first comprehensive synthesis and assessment of the current literature regarding low-dose EMF exposure and possible adverse health effects for library staff, including prenatal effects on an unborn fetus.

Based on our findings we have developed three major recommendations for CUPE, the Vancouver Public Library, and the Okanagan Regional Libraries and for the Public Health Agency of Canada. Firstly, we recommend that the employers make use of the “Health Perceptions of CUPE Checkout Scanner Employees” survey our team has created with a specific focus on the perceived occupational risks of electromagnetic radiation emitted from RFID scanners. The development of this survey is based on the Health Belief Model, which has been well established in the field of health promotion. Subsequently, we recommend that the communication of the risks associated with RFIDs be improved and provide a potential risk communication tool in the form of a Health and Safety Fact Sheet. This recommendation is relevant for employers of companies that use RFID technologies, for CUPE, and for Canadian health authorities at large. Finally, we recommend that the Public Health Agency of Canada fund an occupational health research study specific to library workers operating RFID checkout scanners. This would allow for the measurement of definitive exposure levels, and would further alleviate concern surrounding the risks associated with checkout scanners.

In conclusion, there are no known adverse health effects from low-dose non-ionizing radiation from 13.56 MHz RF exposure and no public health concern originating from the use of library checkout scanners. However, levels of perceived risk need to be addressed to promote mental well-being of CUPE employees.
INTRODUCTION

The Canadian Union of Public Employees (CUPE) represents the staff of many libraries throughout British Columbia (BC), Canada. The client requested a risk assessment of library checkout scanner exposure upon receiving some concerns from library staff in the Vancouver and Okanagan regions. More specifically, staff questioned whether chronic exposure to low levels of electromagnetic radiation emitted by the checkout scanner could produce adverse health effects among library workers. There was also a level of concern surrounding more vulnerable populations of library staff, primarily health risks to pregnant women and their unborn fetus. The exposure of interest is not isolated to CUPE library staff and the entire population of interest includes 2,247.89 full-time public library employees (professional librarians, library technicians, community librarians, and other staff) (BC Ministry of Education, 2011) and 644.66 full-time Teacher-Librarians (BCTF, 2011) in British Columbia, not including library staff at universities or colleges. Several questions arose from the complaints: 1) What kind of occupational hazards are library staff exposed to from the use of checkout scanners? 2) What is the dose level of the exposure and is it considered safe for susceptible population subgroups, such as pregnant female library staff? and 3) Are there any significant public health concerns?

This report answers the above questions through the risk assessment of library checkout scanner radiation exposure. In the following sections, exposure associated with the use of library checkout scanners will be examined in accordance with the main steps of the risk assessment set out by the Canadian Centre for Occupational Health and Safety (2006). These include: 1) hazard identification, 2) dose-response assessment, 3) exposure assessment, and 4) risk characterization. Further, based on the existing evidence, recommendations of appropriate public health measures will be introduced.

The following report will begin by giving a brief background on electromagnetic radiation, with a focus on RFID technology, and regulatory guidelines for electromagnetic radiation.
exposure. Subsequently, the methodology and results of the risk assessment for library employees will be discussed. Finally, strengths and limitations of the assessment as well as future recommendations will be presented.

BACKGROUND

Before undertaking a risk assessment of the health effects associated with library checkout scanners, it is important to address and clarify a number of concepts and definitions. This background information will help to further define the scope of the risk assessment and inform the report's recommendations.

Types of library scanners: Laser and radiofrequency identification (RFID)

The risk of occupational exposure experienced by library staff depends greatly on the type and model of checkout scanners being used. After making contact with representatives from both the Vancouver Public Library (VPL) and the Okanagan Regional Library (ORL), it was determined that two different types of scanners are used within these systems. The VPL uses library scanners that employ a technology known as radiofrequency identification (RFID). The ORL uses handheld laser scanning devices, in which barcodes are read by red LED lights, and are currently in the process of transitioning to RFID scanners. The risk assessment in this report focuses exclusively on RFID technology.

RFID systems combine radiofrequency (RF) and microchip technology. Library materials affixed with RFID tags (microchips and antennas) have antennas that are powered by passive readers (i.e. have no internal power source) to produce a RF field (Boss, 2004). The information contained in the microchip is then interpreted by the reader and sent to the server, which communicates with the entire library system (Boss, 2004). RFID tags can be read regardless of orientation or alignment (Shahid, 2005) and distance from the item is not a limiting factor, with an approximate read range of 1.5 metres (JISC Technology and Standards Watch, 2006).
This report’s focus on RFID technology rather than handheld laser scanners is based on a number of factors. Firstly, on initial investigation into the laser scanners, it became evident that the only hazard associated with this technology was in the form of retinal damage associated with staring directly into the laser for an extended period of time (OSHA, n.d.). Furthermore, RFID checkout scanners are quickly replacing laser scanners and barcodes, emerging at the forefront of library technology (Ching & Tai, 2009). This trend suggests that our report on RFID scanners is of more relevance both in the specific context of libraries, as well as additional occupational settings.

RFID systems can be found throughout the library at staff and self-checkout stations, conversion stations, exit sensors, book-drop readers, sorter and conveyors, and handheld readers (Boss, 2003). Additionally, RFID technology has been employed in a variety of industries (Roberts, 2006), and standard applications of RFID range from postal tracking, airline baggage management, paper money anti-counterfeiting, toll collection, credit cards, and passports (Roberts, 2006).

**Types of radiation: Ionizing and non-ionizing**

Radiation is energy that is transmitted in the form of waves or streams of particles. It is typically divided into two types: ionizing and non-ionizing radiation. Ionizing radiation is normally associated with sources such as nuclear power and x-ray machines (CNSC, 2010). The health effects of ionizing radiation are well documented, including acute radiation syndrome and many types of cancer (USNRC, 2012). Ionizing radiation can also impact pregnancy, and can increase the risk of fetal death, brain damage, birth defects, and cancer in later life (CDC, 2011). Typically these effects are only seen at extremely high doses of radiation exposure, such as with Japanese atomic bomb survivors and recipients of select medical procedures.

Non-ionizing radiation is a lower energy electromagnetic radiation which can include radio waves, microwaves, and ultraviolet rays (CNSC, 2010). Library scanners and other...
everyday electronics, such as cell phones, Wi-Fi, televisions and computers operate within radio frequencies and emit non-ionizing electromagnetic radiation. Thus, this risk assessment will examine the effects of non-ionizing rather than ionizing radiation.

**The electromagnetic spectrum and radio frequencies**

Radiofrequency fields fall within the electromagnetic spectrum and are generally defined as ranging from 3 kHz to 300 MHz (Appendix A, Figure 1). These are further characterized by band designations, of which RFID library scanners typically fall under the high frequency designation. The health effects associated with RF exposure in humans are an emerging area of study, with a relatively small amount of literature currently published. Given the incredible uptake of cellular phone use worldwide, there has been an increasing concern of the hazards associated with RF field exposure, and most studies currently completed focus primarily on exposure from cell phone use (Ahlbom et al., 2004).

Library scanners utilizing RFID technology typically operate within a frequency of 13.56 MHz, within the high frequency of radio frequencies (J. Narver, personal communication, October 29, 2012). Not all other electronics operate within this designation. For example, cell phones and television use the ultra-high frequency portion of the radio frequency spectrum. Specific RF ranges have been set aside for non-communication purposes, and are referred to as ISM (industrial-scientific-medical) frequencies. 13.56 MHz, the frequency in which RFID scanners operate, is a designated ISM frequency (Hitchcock & Patterson, 1995). Given the lack of specificity in many current studies of radiofrequency, this risk assessment will consider the entire range of the RF spectrum (though the focus will be on 13.56 MHz frequencies when possible). It should be noted, however, that health effects may differ depending on the specific frequency of a technology, and so some findings may not be directly applicable to library scanners and RFID technologies.
Measuring exposure: Specific absorption rate

Dose is the total amount of a chemical or agent that is administered to or absorbed by an organism. For RF dosimetry, the specific absorption rate (SAR) is an important measure of dose (Hitchcock & Patterson, 1995). SAR is a measure of the rate at which electromagnetic energy is absorbed in the body, and uses the unit of watts per kilogram (W/kg). SAR can be measured over the entire body or for a specific part of the body (e.g. head, neck and trunk, or limbs) (Health Canada, 2009). It is important to use SAR to measure exposure, as health effects are determined by the amount of radiation absorbed in the body, not the total amount an individual is exposed to. The SAR measure will be used throughout this report.

Regulatory guidelines for electromagnetic radiation exposure

In Canada, safety limits for human exposure to RF electromagnetic energy in the frequency range from 3 kHz to 300 GHz is set out in the Health Canada document Safety Code 6 (2009). This code applies to all individuals working at, or visiting, federally regulated sites. The document has been adopted by Industry Canada and is the basis for equipment certification specifications outlined in regulatory compliance documents governing the use of wireless devices in Canada. Safety Code 6 (2009) does not apply to deliberate exposure for the treatment of patients by medical practitioners. These guidelines are in place mainly to prevent the occurrence of tissue heating and excitable tissue stimulation which is the result of high level acute exposures (Health Canada, 2009).

The basic SAR exposure limits set out in Safety Code 6 (2009) are shown in Appendix A, Table 2. Controlled environments are those in which exposure is incurred by individuals aware of: 1) the potential for RF exposure, 2) the specific intensity of the field, 3) the potential associated health risks, and 4) possible mitigation strategies. Uncontrolled environments are those that do not meet the criteria for controlled environments, and apply to the general public, including library staff (Health Canada, 2009).
These exposure limits are virtually identical to those specified by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a non-profit, independent body of scientific experts in the field of non-ionizing radiation (ICNIRP, 1998).

Industry Canada publishes various documents based on Safety Code 6 (2009) guidelines for the certification of electromagnetic field emitting devices and products. These documents allow for the evaluation of exposure requirements, mitigation methods (physical barriers, buffers), and labelling requirements. Proper methods for measuring RF are also included. Products and devices must comply with all regulations in order to receive certification for use in Canada (Industry Canada, 2010).

It is important to note that these guidelines are in place to help protect Canadians from the well-known health effects of electromagnetic radiation at high frequencies and high doses. These guidelines may be less useful in the specific context of library scanners, which operate at low frequencies and lead to relatively low levels of exposure.

METHODS

Our group liaised with CUPE representatives Tom McKenna and Vanessa Wolf who provided us with detailed background information on how it came to CUPE’s attention that there was concern surrounding potential radiation exposure from library checkout scanners among VPL and ORL library staff. Based on these concerns, the client requested a risk assessment on low-dose non-ionizing radiation from library checkout scanners.

To determine the source of the exposure of concern, we contacted the VPL and ORL directly to identify the types and models of checkout scanners currently in use at their various branches. We identified that the VPL branches use the 3M™ SelfCheck™ System V-Series and R-Series (Classic Cabinet 8420, Kiosk Model 8420 and Tabletop Model 8422 RFID) scanners (Appendix B, Figures 1 and 2). The ORL branches for the most part use Honeywell 3800LR & 3800G04E handheld laser barcode scanners (Appendix B, Figure 3) and are transitioning to
RFID technology. For reasons described in the Background section, our assessment focuses on RFID technology employed at the VPL.

Further, we contacted the 3M Canada Library Systems Library Productivity Specialist who confirmed the various models of scanners employed at all VPL branches and the RFID scanner operating frequency of 13.56 MHz. We also contacted a professor from the Simon Fraser University Physics Department, who supplemented our information specifically on low-dose radiation from laser scanners.

In addition to the literature review and the actual risk assessment, we have created the “Health Perception of CUPE Checkout Scanner Employees” survey (Appendix C) and Health and Safety Fact Sheet (Appendix D) for use by CUPE, which will be described in detail in the Recommendations section.

The following section will illustrate the results of the risk assessment based on current literature addressing RF exposure and human health.

**RISK ASSESSMENT**

A human health risk assessment involves the estimation of the nature and probability of adverse health effects for those exposed to an environmental stressor, such as low-dose electromagnetic radiation exposure from RFID scanners, at present or in the near future (US EPA, 2012). A risk assessment typically involves the following components: 1) hazard identification, 2) dose-response assessment, 3) exposure assessment, and 4) risk characterization (Figure 1, OSH, 2006; HSE, 2011; US EPA, 2012; WHO, 2012).
Figure 1: Steps of a human health risk assessment specific to low-dose non-ionizing radiation exposure from library checkout scanners. Figure adapted by the authors from US EPA, 2012 and WHO, 2012.

Hazard identification

Hazard identification is the process of determining whether exposure to an environmental stressor results in an increase in specific adverse health events and the likelihood of these events occurring in humans (US EPA, 2012). Based on the current literature, this section will focus primarily on cancer, the most frequently studied health effect of radiation exposure, in addition to the effects on the cardiovascular and immune systems. The potential reproductive, developmental, and prenatal effects of radiation exposure will also be addressed, given the initial concerns raised by CUPE library staff regarding pregnant women. It is important to note that the state of research on radiation exposure and human health has historically focused on high level acute exposures. While these do provide insight into possible
radiation induced health effects, the amount of radiation exposure experienced by a library employee using an RFID scanner is substantially lower.

Biological effect versus adverse health effects

It is helpful to understand the difference between biological and adverse health effects before we continue on with the hazard identification (WHO, 2012). Not all biological effects of exposure are necessarily hazardous, and some may be beneficial. However, there are biological effects of exposure that do lead to pathological effects, i.e. adverse health effects. Non-pathological irritation or discomfort validated as arising from EM exposure can still affect the physical and mental well-being of individuals, which in itself, may be considered an adverse health effect (WHO, 2012).

Health effects of electromagnetic radiation

Research undertaken to determine the health effects of radiofrequency exposure has, in the past, focused on populations with relatively high levels of exposure. This includes occupational studies of radio operators, navy personnel, and cellular company employees, as well as populations living in close proximity to transmission towers for radio, television, microwave and cellular telephones (Albohm et al., 2004). Due to the ubiquity of cellular phones, studies focusing on this specific exposure are increasingly common (Albohm et al., 2004).

Cancer

The most extensive literature examining the relationship between RF exposure and cancer have focused on brain tumours and leukemia (Albohm et al., 2004). Most high quality studies involving occupational exposures have provided little evidence of an association with either outcome (Albohm et al., 2004).

Other types of cancer, such as breast cancer, testicular cancer, ocular melanoma and lung cancer have been studied in relation to occupational RF exposure. While some small
positive associations have been found, for example, a relative risk of 1.5 [95% CI, 1.1 – 2.0] of breast cancer among radio and telegraph operators in the Norwegian merchant ship industry, there is insufficient evidence to reach a clear conclusion on association (Albohm et al., 2004).

Any agents that can damage the DNA of cells are assumed to have carcinogenic potential. In vitro laboratory studies observing the impact of RF exposure on DNA and chromatin structure (Repacholi, 1998) have mainly produced negative findings. Those that did find positive associations with DNA breaks, chromatid exchanges or chromosome aberrations only occurred in the presence of substantial temperature rise (i.e. extremely high dosage) (Repacholi, 1998). Because of this, repeated or prolonged exposure to low-level radiofrequency radiation does not cause direct damage to DNA, as the energy level is not sufficiently high (Habasch, 2002).

The International Agency for Research on Cancer (IARC) has evaluated the scientific data and has classified electromagnetic fields as being “possibly carcinogenic” to humans (IARC, 2011). The IARC based this classification on both human health population studies and a large database of laboratory studies. To put this into context, it is important to understand that the “possibly carcinogenic” classification is also applied to coffee, gasoline engine exhaust, and pickled vegetables, and is often used for agents that require further study. In summary, when the studies are evaluated together, the evidence suggesting that EMFs may contribute to an increased risk of cancer is very weak.

Cardiovascular system

Cardiovascular changes such as blood pressure, heart rate and electrocardiography waveform as a result of RF exposure have been studied, with no acute effects or only subtle effects being detected (such as slight increases in resting blood pressure). These studies have mostly been undertaken using cell phone frequencies, which are significantly higher than RFID frequencies (Habasch, 2002).
**Immune system**

A small number of studies investigating the impact of RF exposure on the human immune systems have been undertaken. Very few biologically significant results have been obtained. Some studies have shown no difference in leucocyte and lymphocyte counts between exposed and unexposed groups, while others have found small alterations in the cytotoxicity of lymphocytes and lymphocyte kinase due to RF exposure (Habasch, 2002; Repacholi, 1998).

**Reproductive effects**

Studies focusing primarily on occupational exposure of physiotherapists to short wave diathermy (typically 27.12 MHz) have found a wide range of potential reproductive effects, ranging from delayed conception, stillbirth, preterm birth after exposure of fathers, and reduced sperm count (Albohm et al., 2004). The strongest evidence of reproductive effects was spontaneous abortion (Albohm et al, 20044). In these cases, exposure parameters varied substantially and the authors point out that any conclusions are tempered by the problem of assessing exposure in these studies.

In general, adverse effects were associated more with high dosage (even for brief periods) than with prolonged low-level exposure, and there is very little evidence that reproduction is affected at low levels of RF exposure (Hitchcock & Patterson, 1995; Repacholi, 1998).

**Prenatal health and developmental effects**

The exposure of a fetus to radiation is referred to as prenatal radiation exposure. This can occur when the mother’s abdomen is exposed to radiation from outside her body, which corresponds to the approximate height of the tabletop RFID library scanners. Since the baby is shielded by the mother’s abdomen, it is partially protected in the womb from radiation sources outside the mother’s body (CDC, 2011). Consequently, the radiation dose to the fetus is lower than the dose to the mother from exposure to radiation from library check-out scanners.
The risk of severe health effects to the fetus is dependent upon its gestational age at the time of radiation exposure and the amount of radiation it is exposed to; however, fetuses are particularly sensitive to radiation between gestational weeks 2 and 18 (CDC, 2011). In the case of ionizing radiation exposure from atomic bombs dropped on Hiroshima and Nagasaki, fetuses exposed during gestational weeks 8 to 18 were found to have a high rate of brain damage, lower IQ, severe mental retardation, stunted growth, and an increased risk of other birth defects (CDC, 2011). Further, animal experiments have demonstrated adverse effects on development and growth in different mammalian species, including decreased birth weights and fetal malformations (Hitchcock & Patterson, 1995). It is important to reiterate that atomic bombs resulted in environmental exposure to an extremely high dose of ionizing radiation, which is at a much higher energy level than non-ionizing RF radiation, while the animal experiments were conducted at very high exposure levels exceeding 9 W/kg (Hitchcock & Patterson, 1995). Therefore, while these studies provide some evidence into the biological effects of radiation, their relevance to the current problem statement regarding RFID library scanners is slim, given the vast discrepancy in radiation level and type.

Radiation-related death is of greatest concern during the first two weeks of pregnancy; however, it should be noted that this would only occur in extreme levels of radiation exposure (CDC, 2011). Additionally, regardless of how much radiation the fetus was exposed to during the first two weeks, few of the babies that survive will have birth defects related to the exposure (CDC, 2011).

The prenatal effects of electromagnetic radiation on lifetime cancer risk have been investigated and, once again, the increased risk depends on the amount, concentration, and time that the baby was exposed (CDC, 2011). As an example, the increase in lifetime cancer risk to the unborn baby would be less than 2% above the normal lifetime cancer risk of 40 to 50% in the case of a radiation dose equivalent to 500 simultaneous chest x-rays (CDC, 2011).
This is far above the amount of radiation a library employee would ever be exposed to occupationally through the use of an RFID scanner.

An epidemiological cohort study examining prenatal effects of EMF exposure (Kallen et al., 1982), evaluated 2,043 offspring of 2,018 female physical therapists who were occupationally exposed to shortwave diathermy, at 27 MHz. This study evaluated the birth outcomes of this cohort and found no significant differences when the occupationally exposed group was compared to a control group from the general population (Kallen et al., 1982).

Dose response assessment

A dose-response relationship describes the quantitative relationship between the amount of exposure to an agent and the resultant likelihood and severity of adverse health effects (US EPA, 2012). Typically, in a monotonic relationship, as the dose increases the measured response also increases. Both the dose at which response begins to appear and the rate at which it increases varies between different individuals and exposure routes.

As with hazard identification, there is frequently a lack of dose-response data available for human subjects and this is particularly true in regards to low dose exposure to electromagnetic fields. While high doses of electromagnetic radiation exposure have been examined more closely, there are limitations in extrapolating low dose responses from these curves. Additionally, even when more extreme, high levels of exposure are used, the adverse health effects of electromagnetic radiation appear to be negligible (Davis et al., 2012).

The Institution of Engineering and Technology (IET) is an independent global body that investigates the potential health effects of lower dose electromagnetic field exposure, ranging from cell phone use to radio transmitters (IET, 2012). In a recent publication they confirmed that there is currently no evidence of adverse health effects from which to begin modelling a dose-response curve specific to low dose EMFs (IET, 2012). Many other international organizations, including the World Health Organization, have also independently reviewed the evidence and
are in agreement with the IET. Given that neither laboratory nor epidemiological studies have been able to report an adverse health effect from low dose EMFs, it is safe to conclude that there is no increased risk of pathology attributable to radiofrequency exposures.

In-vitro effects on AS-1 RBCs and whole blood-derived platelets following prolonged exposure to 13.56 MHz radio energy

Though the dose-response relationship attributed to RFID library scanners has not been studied specifically, there have been a series of in-vitro investigations using the 13.56 MHz frequency employed by RFID library scanners to examine the potential adverse effects on components of human blood (Davis et al., 2012). Using a Food and Drug Administration (FDA)-approved protocol, both red blood cells (RBC) and whole blood derived platelets (WBDP) were subjected to approximately 100 watts of RF energy for an extended duration (23-25 h) to assess worst-case effects.

Three replications of the test were performed and determined that RBC hemolysis and WBDP pH after 23-25 hours of RF were well within the limits of FDA-approved acceptance criteria (Davis et al. 2012). Further, there was no detectable acceleration in cellular degradation of RBC and WBDP products. While there was minimal temperature rise, the relative temperature increase never exceeded the 1.5°C acceptance criterion. This leads to the conclusion that 13.56 MHz-based RFID technology is unlikely to have any significant thermal or biological effects on RBC and WBDP units under the normal operating conditions. This recent laboratory analysis gives further strength to the conclusion that the biological effects of EMF exposure are non-existent, even at an elevated dose.

**Exposure assessment**

The exposure assessment is the process of measuring or estimating the magnitude, frequency, and duration of human exposure to an environmental agent (US EPA, 2012).
Canadian exposure to extremely low frequency electromagnetic fields

On a daily basis, most Canadians are exposed to EMFs in the workplace, and common sources include computer monitors, photocopiers, and fax machines (Health Canada, 2009; IET, 2012). Research has shown that EMFs from electrical devices can cause weak electric currents to flow through the human body. However, these currents are much smaller than those produced naturally by your brain, nerves and heart, and are not associated with any known health risks (Health Canada, 2009). RFID library checkout scanners emit a continuous 13.56 MHz signal available to read tags that come within range, meaning that library staff are constantly exposed to this radiofrequency energy. It is unknown the average amount of time library staff spend scanning items, but it is unlikely to make up an entire work day.

As discussed previously, there has not been an exposure analysis conducted specific to RFID library scanners, however there have been studies published in which similar technologies using 13.56 MHz radio frequencies have been tested. These analyses provide the closest available comparison to RFID library scanners, and currently provide the best evidence for estimating exposure levels. The primary exposure measurement of interest for human health is the SAR, which is the amount of EMF that is actually absorbed by the body, opposed to the amount emitted by the machine. SAR measurements will be supplemented with electric and magnetic field strength exposure measurements and all will be compared to reference values stated in the Health Canada document Safety Code 6 (2009). The results of these investigations are summarized below:

1) **RFID 13.56 MHz smart card readers for electronic ticket systems (Hamnerius, 2009)**

   Exposure measurements have been performed on RFID smart card readers (Time Provider 5000 by the Energy Research Group) in Gothenburg and Stockholm transit systems. Its reader unit emits a continuous signal at 13.56 MHz, the same frequency as RFID library scanners. At a distance of 20 cm or greater, the magnetic field strength is below safety
standards (0.073 A/m) expressed in the ICNIRP guidelines for the general public (Appendix A, Table 4). Closer to the unit (less than 20 cm), exposure limits are above reference values, important when you consider that people place their hands on the reader to scan smart cards (and likewise library items) or, in the worst case scenario, are leaning directly on or over the reader. For near exposures, SAR measurements are used and results from direct human contact with the smart card reader showed a local SAR of 0.1 W/kg, which is well below the reference value (1.6 W/kg) specified in Health Canada’s Safety Code 6 (2009). Put into context, cellular phones, when held against the head, produce a SAR in the range of 1.0-1.5 W/kg when transmitting at full power (Kuster, 2002, IET, 2012).

2) RFID anti-theft gate system (Kong et al., 2008)

This study analysed radiation exposure emitted from a simple matched rectangular loop antenna and a simulated anti-theft gate antenna system (with loop separation of 120 cm), both operating at a frequency of 13.56 MHz. The simple rectangular antenna and gate antenna system emitted an electric field of 265 mV/m and 270 mV/m, respectively, both well below the reference value of 28 V/m (Health Canada, 2009). Unfortunately no SARs were calculated for this exposure, but the low ambient EMF measurements suggest the SARs would be below the safety standard.

3) 13.56 MHz fabricated RFID loop antenna (Senić et al., 2010)

Spatially averaged measured exposure levels for the electric field at the front, centre and rear of a fabricated RFID loop antenna were 1.55 V/m, 0.77 V/m, and 0.47 V/m, respectively. The total spatially averaged exposure level was 0.93 V/m. Once again, all measurements were below the reference value of 28 V/m (Health Canada, 2009).
Risk characterization

Focusing on the general population and specifically on pregnant women and the unborn fetus, the risk of exposure to RF workers from 13.56 MHz library checkout scanners is negligible. When the health effects on the unborn fetus are taken into consideration, there seems to be no substantial health effects from exposure, especially when compared to other EMF instruments working at much higher frequencies. For example, mobile phone use by pregnant women which operate at frequencies of 800 - 900 MHz pose substantially higher EMF exposure level, although it should be noted that the resulting health effects, even at this level of exposure, are inconclusive. To date, the largest epidemiological study conducted on mobile phone use has found no association between increased risk of cancer and cell phone use, although the investigation of long term use continues (IET, 2012).

The dose at which the library workers are exposed to is within the safety standards specified by the Canadian Safety Code 6, EPA as well as the Institute for Electronic and Electronic Engineers (IEEE). The SAR at 0.1 W/kg measured in the study on smart card readers (Hamnerius, 2009), is well within the limit of 1.6 W/kg and in fact occupies the lower end of the limit.

Therefore, the health risk regarding RFID library scanners appears to be more of a perceived risk rather than an actual risk. This should not be taken lightly, as the presence of perceived risk among populations can have negative effects on mental health. Education and training can help commensurate the perceived risks, and dispel common misconceptions. Proper risk communication will provide the basis for mitigating such concerns.

STRENGTHS AND LIMITATIONS

This is the first ever comprehensive synthesis and assessment of existing scientific literature and data undertaken on the issue of low-dose radiation exposure from library check-
out scanners and its health effects on British Columbian library staff. It also addresses in detail the risk exposure on the unborn fetus and for pregnant women, whose actual versus perceived risk may be heightened by their condition. While both laser and RFID scanners are discussed in this report, there is a greater focus on RFID technology that when first implemented in library settings in the late 1990s, quickly outpaced laser scanners and barcodes to be at the forefront of library technology (Ching and Tai, 2009). Therefore, RFID scanning technology is of more relevance both in the specific context of libraries, as well as additional occupational settings.

This report acknowledges that perceived risk may substantially differ from the actual health risk of low-dose radiation exposure from library checkout scanners. In response, our group has designed a “Health Perceptions of Checkout Scanner Employees” survey (Appendix C), which can be used to measure perceived versus actual risk of low-dose radiation exposure from all types of checkout scanners (RFID and lasers) and can be extended to all employees whose daily work involves the use of checkout scanners. The results can help guide resources and programs to alleviate such public health concerns of EMF exposure. An example of such a resource includes a Health and Safety Fact Sheet (Appendix D) designed as a potential risk communication tool for CUPE library staff. Both are described in more detail in the Recommendations section.

While this report was the first to synthesize and assess health effects of low-dose radiation exposure from library checkout scanners, we were unable to find data that directly measured exposure levels from library scanners themselves. Our report extrapolates from data found in published scientific studies on: 1) SAR and electric and magnetic field strength exposure measurements from devices with a 13.56 MHz operating frequency, 2) human health effects in observational studies of occupational RF exposure, and 3) in vitro studies of RF exposure. The results were compared to exposure limits set in the Health Canada Safety Code 6 (2009) document, and were all below reference value, or assessed for adverse effects, of which there were none that met significance. Exposure parameters may have differed amongst
the studies and what may be seen in an everyday library setting, including spatial characteristics and uniformity of the exposure field, duration, frequency, operating frequency, and time-averaging. Therefore, uncertainties exist in our exposure parameters, toxicological information, and risk assessment assumptions.

**RECOMMENDATIONS**

Based on our findings we have developed three major recommendations for future action. Firstly, we recommend that the employers make use of the “Health Perceptions of CUPE Checkout Scanner Employees” survey our team has created, with specific focus on the perceived occupational risks of electromagnetic radiation emitted from RFID scanners. Secondly, we recommend that the communication of the risks associated with RFIDs and EMFs be enhanced using a framework proposed by the World Health Organization. This recommendation is relevant for employers of companies that use RFID technologies, for CUPE, and for any public health agencies who intend to communicate EMF risks. Finally, we recommend that the Public Health Agency of Canada fund an occupational health research study specific to library workers operating RFID checkout scanners. This would allow for the measurement of definitive exposure levels, and would further alleviate concern surrounding the risks associated with RFID checkout scanners.

**Health Perception of CUPE Checkout Scanner Employees Survey**

The “Health Perception of CUPE Checkout Scanner Employees” survey (Appendix C) was developed during our analysis; its objective is to characterize and describe the current employee perceptions regarding the severity of risks and perceived susceptibility associated with checkout scanners. It is based on the Health Belief Model, which is often used as a conceptual framework in health promotion and health behaviour research (Glanz, 2008). The use of this survey will help to determine whether the concerns brought to CUPE regarding
checkout scanner safety were isolated incidents, or whether the perceived risk is widespread among employees. These results could help to guide resources and programs aiming to alleviate public health concerns surrounding this issue of EMF exposure.

We recommend that this tool be piloted in both the VPL and ORL settings. Specific inclusion criteria would need to be established. We recommend that an employee be included in the survey if they operate a checkout scanner occupationally on a regular basis. “Regular checkout scanner use” could be operationally defined as any employee who operates a checkout scanner for a minimum of four hours in a single workday, at least once a week.

While this report focuses on library workers safety, we also recommend that this survey be employed in a much broader setting. Other common work settings in which employees are occupationally exposed to checkout scanners include: grocery stores, department stores and big box stores or supercenters. Using the same operational definition for “regular checkout scanner use”, this survey could be used to characterize the perceived health risks in a much larger population of checkout scanner employees, generating a rich knowledge base from which to guide risk communications associated with EMFs.

Enhancing the risk communication of low-level electromagnetic field exposure

Our second recommendation is that the communication of the risks associated with RFIDs and EMFs be improved. This recommendation is relevant for employers of companies that use RFID technologies, for CUPE, and for public health agencies in general. Typically, when a perceived risk is substantially different than an actual health risk, it can be traced back to improper communication strategies, the way that new technologies are introduced, public mistrust of policy and decision makers, a general lack of dissemination of scientific findings to the general public, and scientific results that are inconclusive or contradictory (WHO, 2002). In the case of EMF risks, the majority of concern has surrounded the now ubiquitous use of mobile phones and the increase in wireless technologies, with RFIDs and library scanners fitting into
the latter category. Our group has created a Health and Safety Fact Sheet (Appendix D), titled “Dispelling the myth of low-dose radiation exposure from library scanners”, as an example of a communication tool that can be used to convey the actual health risk or radiation exposure from library checkout scanners and alleviate the perceived risk of radiation exposure.

In 2002 the World Health Organization published a handbook that speaks in detail about the interplay between perceived risk, scientific evidence, and public policy specifically regarding EMFs (Figure 2, WHO, 2002). This was created in response to the growing public concern surrounding EMFs with the objective of establishing an inclusive and effective dialogue surrounding the associated risks. This incredibly useful resource is available online, and should be consulted by anyone engaging in the risk communication surrounding EMFs.

The US National Research Council defines risk communication as “an interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risks, that express concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management” (WHO, 2002 p. 30-31). This definition allows for the concept of risk communication to include an open dialogue with the public, and especially with individuals expressing higher levels of concern. By addressing the risk communication surrounding EMFs and RFIDs in this way, the discrepancy between perceived risk and actual health risk could be effectively mitigated.

**Figure 2: Evaluating, interpreting, and regulating risks associated with EMF (WHO, 2002)**
Exposure analysis specific to RFID checkout scanners

As our final recommendation, we propose that the Public Health Agency of Canada fund an occupational health research study, specific to library workers operating RFID checkout scanners. This will address some of the limitations of our current analysis, in which exposure for library employees was extrapolated from other settings using 13.56 MHz. This could provide a definitive measurement of exposure levels experienced by library employees, and could even focus on populations with perceived increased susceptibility such as pregnant women.

Using a study protocol that was based on the spatial and temporal exposures associated with checkout scanner employees, the results could be generalized to other relevant populations such as grocery store and department store cashiers. We recommend that the SAR for RFID checkout scanners be measured, in a similar way to the RFID Smart Card reader investigation performed by Hamnerius in 2009. This would provide evidence towards the actual amount of EMF that was being absorbed into the body over a given period of continued scanner use.

Depending on the resources available it may also be advisable to conduct the study using personal EMF meters that the library staff could wear over the course of a day, to gain an even more accurate measurement of an exposure profile. If a number of different library employees were to carry such personal detection devices, an average SAR could be calculated and then again generalized to an ‘average’ library employee exposure. This method would also allow for an aggregate exposure to be calculated, acknowledging that RFID scanners are only one form of EMFs in which an individual may be exposed to.

In summary, conducting an exposure study specific to library employees would further alleviate public concern surrounding EMF exposure from checkout scanners.
CONCLUSIONS

Throughout our report, we conducted a risk assessment of low-dose radiation exposure from library checkout scanner use and its potential adverse health effects. There are currently two main types of checkout scanners in use in the Province of British Columbia, namely handheld laser scanners and RFID scanners. Our report focused on the assessment of RFID scanners for the two reasons: 1) RFID technology is replacing laser technology in library settings and 2) the only known potential adverse health effects from using handheld laser scanners include retinal damage associated with direct staring, rather than radiation exposure. Based on the four step risk assessment process (hazard identification, dose-response assessment, exposure assessment, and risk characterization), we concluded that there are no known adverse health effects that can be expected for BC library staff whose daily work involves the use of checkout scanners. There is no existing evidence on adverse health effects from low-dose non-ionizing radiofrequency radiation exposure at 13.56MHz, where the majority of RFID scanners operate. The existing evidence demonstrates that, even at much higher doses, there are very minimal health effects from this type of radiation exposure. We conclude our report by proposing three recommendations. One is to conduct a survey among BC CUPE employees that utilize RFID scanner on a daily basis. We have designed a pilot survey titled the “Health Perceptions of CUPE Checkout Scanner Employees” to examine employees’ perceived risks of electromagnetic radiation exposure from RFID scanners. Second, is to improve the risk communication of low-level electromagnetic field exposure to address the apparent discrepancy between the perceived risks and the actual health risks indicated by scientific evidence. The third recommendation is to conduct research specific to RFID library checkout scanners with the support of the Public Health Agency of Canada. Implementation of such recommendations are essential to address the current perceived risks among CUPE employees in the aim of
promoting overall health and well-being and to supplement and confirm existing scientific literature regarding RFID library checkout scanner exposure levels and health effects.
REFERENCES


APPENDICES

Appendix A: Tables

Table 1: Nomenclature of band designations (radiofrequencies highlighted)

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Designation</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30 Hz</td>
<td>Sub-extremely low frequency</td>
<td>Sub-ELF</td>
</tr>
<tr>
<td>30-300 Hz</td>
<td>Extremely low frequency</td>
<td>ELF</td>
</tr>
<tr>
<td>300-3000 Hz</td>
<td>Voice frequency</td>
<td>VF</td>
</tr>
<tr>
<td>3-30 kHz</td>
<td>Very low frequency</td>
<td>VLF</td>
</tr>
<tr>
<td>30-300 kHz</td>
<td>Low frequency</td>
<td>LF</td>
</tr>
<tr>
<td>300-3000 kHz</td>
<td>Medium frequency</td>
<td>MF</td>
</tr>
<tr>
<td>3-30 MHz</td>
<td>High frequency</td>
<td>HF</td>
</tr>
<tr>
<td>30-300 MHz</td>
<td>Very high frequency</td>
<td>VHF</td>
</tr>
<tr>
<td>300-3000 MHz</td>
<td>Ultra high frequency</td>
<td>UHF</td>
</tr>
<tr>
<td>3-30 GHz</td>
<td>Super high frequency</td>
<td>SHF</td>
</tr>
<tr>
<td>30-300 GHz</td>
<td>Extremely high frequency</td>
<td>EHF</td>
</tr>
</tbody>
</table>

(Adapted from Hitchcock & Patterson, 1995)

Table 2: SAR exposure limits for controlled and uncontrolled environments

<table>
<thead>
<tr>
<th>Condition</th>
<th>SAR Limit (W/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Controlled</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
</tr>
<tr>
<td>The SAR averaged over the whole body mass</td>
<td>0.4</td>
</tr>
<tr>
<td>The spatial peak SAR for the head, neck and trunk, averaged over any one gram of tissue*</td>
<td>8</td>
</tr>
<tr>
<td>The spatial peak SAR in the limbs as averaged over any 10 grams of tissue*</td>
<td>20</td>
</tr>
</tbody>
</table>

* Defined as tissue volume in the shape of a cube (Adapted from Health Canada, 2009)
Table 3: Exposure limits for persons not classed as RF and microwave exposed workers (including the general public)

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Electric Field Strength; rms (V/m)</th>
<th>Magnetic Field Strength; rms (A/m)</th>
<th>Power Density (W/m²)</th>
<th>Averaging Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.003-1</td>
<td>280</td>
<td>2.19</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>1-10</td>
<td>280/f</td>
<td>2.19/f</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>10-30</td>
<td>28</td>
<td>2.19/f</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>30-300</td>
<td>28</td>
<td>0.073</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>300-1,500</td>
<td>1.585 f^{0.5}</td>
<td>0.0042 f^{0.5}</td>
<td>f/150</td>
<td>6</td>
</tr>
<tr>
<td>1,500-15,000</td>
<td>61.4</td>
<td>0.163</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>15,000-150,000</td>
<td>61.4</td>
<td>0.163</td>
<td>10</td>
<td>616,000/ f^{1.2}</td>
</tr>
<tr>
<td>150,000-300,000</td>
<td>0.158 f^{0.5}</td>
<td>4.21 x 10^{-4} f^{0.5}</td>
<td>6.67 x 10^{-5} f</td>
<td>616,000/ f^{1.2}</td>
</tr>
</tbody>
</table>

* Power density limit is applicable at frequencies greater than 100 MHz (Adapted from Health Canada, 2009)

Notes: 1. Frequency, f, is in MHz
2. A power density of 10 W/m² is equivalent to 1 mW/cm²
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μT) or 12.57 milligauss (mG)

Table 4: Magnetic field strength at 13.56 MHz measured from a smart card reader

<table>
<thead>
<tr>
<th>Distance (cm)</th>
<th>H-field strength (A/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.3</td>
</tr>
<tr>
<td>10</td>
<td>0.4</td>
</tr>
<tr>
<td>20</td>
<td>0.08</td>
</tr>
<tr>
<td>30</td>
<td>0.02</td>
</tr>
</tbody>
</table>

(Adapted from Hamnerius, 2009)
Appendix B: Images

Figure 1. 3M™ SelfCheck™ System V-Series (left) and R-Series Classic Cabinet 8410 (right) used at the Vancouver Public Library branches.

Figure 2. 3M™ SelfCheck™ System R-Series Kiosk Model 8420 (left) and Tabletop Model 8422 (right) used at the Vancouver Public Library branches.
Figure 3. Honeywell 3800LR (left) & 3800G04E (right) handheld laser scanners used at the Okanagan Region Library branches (right).

[Honeywell 3800LR-11E Barcode Scanner (left) and 3800G04E - Honeywell 3800g Scanner (right)]
Appendix C: Survey

Health Perceptions of CUPE Checkout Scanner Employees

Welcome to the "Health Perceptions of CUPE Checkout Scanner Employees" survey. The objective of the survey is to examine the health perceptions of CUPE employees whose daily work involves the use of checkout scanners and its relation to workplace exposures. The aim is to evaluate the current situation of workplace health in BC to better promote the well-being of checkout scanner employees.

We ask you to take 5 minutes to fill in this anonymous survey. There are three sections with a total of ten questions. Please complete the entire survey!

Confidentiality: Your participation in this survey is entirely voluntary and your information will remain confidential. Your name will not be used or linked to any survey results and results will only use aggregated data. If there are any questions you do not wish to answer you may leave them blank. For further information or communication of the results, please contact your CUPE local.

DEMOGRAPHICS

What is your gender?

- Male
- Female

How old are you?

- Under 18
- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 or Above
- Prefer not to answer

WORKPLACE INFORMATION

What is your workplace?

- Grocery Store
- Library
- Department Store
- Other, please specify ...

What is the name and location of your current workplace?

Le ABC Library branch, Alphabet City, British Columbia

How long have you been working at your current job?

- Less than a month
- 1 month-les than a year
- 1-3 years
- Over 3 years
- Other, please specify ...
How many hours on average do you work per week?

- 0-9 hours
- 10-19 hours
- 20-29 hours
- 30-39 hours
- 40 hours
- Over 40 hours

In a typical work day, how many hours do you spend working at a checkout scanner?

- None
- 1-2 hours
- 3-4 hours
- 5-6 hours
- 7-8 hours
- Over 8 hours

What type of checkout scanner do you use at your workplace?

- Handheld scanner
- Table top scanners

- Handheld scanner
- Tabletop scanner
- I don’t know
- Other, please specify... 

What type of technology is used by the checkout scanners at your workplace?

Laser scanners generate a single laser beam, usually through red LED (light emitting diodes) lights, that read barcodes. RFID scanners use radio waves to capture data from RFID microchip tags.

- Laser scanner
- Radiofrequency identification (RFID)
- I don’t know
- Other, please specify... 

PERCEPTIONS OF LOW-DOSE RADIATION EXPOSURE FROM CHECKOUT SCANNERS

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

My chances of low-dose radiation exposure from
checkout scanners are great.

My current health status makes me more susceptible to experiencing adverse effects from low-dose radiation.

There is a good chance I have had low-dose radiation exposure from checkout scanners.

I worry about low-dose radiation exposure from scanners.

It is likely I will have low-dose radiation exposure from scanners in the future.

I am concerned about low-dose radiation exposure from checkout scanners.

The thought of low-dose radiation exposure from checkout scanners scares me.

The thought of low-dose radiation exposure from checkout scanners negatively affects how I perform my duties at work.

The topic of low-dose radiation exposure from checkout scanners has come up frequently in past conversations.

I think low-dose radiation exposure from checkout scanners is a concern for pregnant women.

DEBRIEF

In response to ongoing concerns regarding chronic exposure to low levels of electromagnetic radiation emitted by checkout scanners and its potential adverse health effects, a literature review and risk assessment was conducted. It was concluded that the only hazard associated with laser checkout scanner technology was in the form of retinal damage after prolonged and direct staring into the laser beam. The results also suggest that exposure to radiofrequency energy from RFID checkout scanners (with an operating frequency of 13.56 MHz) is negligible and below reference values expressed in the Health and Canada Safety Code 6 (2009). It was deemed not only safe for healthy workers, but for pregnant workers and the unborn fetus as well.

Thank you for your participation in this survey! Please leave any comments, questions, or suggestions here.

Submit

Online Questionnaire Maker powered by PaidSurvey
Dispelling the myth of low-dose radiation exposure from library checkout scanners

Library staff lean over or near library checkout scanners countless times a day which raises the question, are there any adverse health effects associated with chronic exposure to low levels of electromagnetic radiation emitted by checkout scanners?

What type of checkout scanner?
Laser and radiofrequency identification (RFID) technology are the most frequently employed in library checkout scanners. Laser scanners read barcodes with a beam of red LED light, while RFID scanners read microchips with radio waves at an operating frequency of 13.56 MHz.

What type of radiation?
Radiation can be either ionizing and non-ionizing. Ionizing radiation is typically associated with sources such as nuclear power and x-ray machines, while non-ionizing radiation includes radio waves, microwaves, visible light, and ultraviolet rays. Both laser and RFID scanners emit non-ionizing electromagnetic radiation and RFID library scanners and other everyday electronics, such as cell phones, Wi-Fi, televisions and computers generate radio waves.

What are the health effects of laser checkout scanners?
None. The only hazard associated with laser scanner technology is in the form of retinal damage from staring directly into the laser for an extended period of time.

What are the health effects of RFID checkout scanners?
None. Numerous published scientific studies tell us that exposure measurements performed on RFID devices with the same operating frequency as library scanners (13.56 MHz) are all well below Health Canada reference values and even prolonged exposure is safe. Specific absorption rate (SAR) measurements, the rate at which electromagnetic energy is absorbed into the body, for direct human contact with 13.56 MHz Swedish transit smart card readers indicated a local SAR of 0.1 W/kg, which is below the Health Canada’s reference value (1.6 W/kg). This is in contrast to cellular phones that typically produce maximum SARs of less than 1.5 W/kg within the head. The risk posed by RFID checkout scanners is lower than more common electromagnetic frequency instruments such as mobile phones and wireless internet, and the frequencies emitted by power lines.
Are RFID library checkout scanners safe even for pregnant staff?
Yes. Exposure to radiofrequency energy is safe for both healthy and pregnant staff and for the unborn fetus. The unborn fetus is shielded by the mother’s abdomen and consequently, the radiation exposure to the fetus is even lower than the mother’s exposure to radiation from RFID library checkout scanners.

This fact sheet is part of a more detailed CUPE report on chronic exposure to low levels of electromagnetic radiation emitted by the checkout scanners.

References