

# X-ray Safety in the Workplace

## for BC Manufacturers & Food Processors



# Partners in Safety: Associate Members

Partners in safety are suppliers or consultants to the BC manufacturing industry who have become Associate Members of the Manufacturing Safety Alliance of BC.



## Acknowledgements

This inspections toolkit was developed as part of a collaborative effort between Radiation Safety Institute of Canada and the Manufacturing Safety Alliance of BC, and with the support of WorkSafeBC, to bring increased attention and awareness of the risks associated with X-ray equipment in the manufacturing sector.

## Disclaimer

This toolkit is intended solely for internal use as an awareness and information guide. It is not intended as a statement of the standards required in any specific situation, nor is it intended that this toolkit should in any way advise anyone concerning legal authority to perform any activities or procedures.

Every effort was made to ensure the accuracy and relevance of this information; however, this material may be subject to change due to various factors. These factors may include regulatory or interpretive changes, and a need to adapt the material to unique situations or procedures.

Nothing in this toolkit will absolve participants from using their sound judgment in the appropriate application of the material learned.

Prepared by the Manufacturing Safety Alliance of BC

## Compliance Inspection Checklist

This document lists requirements at initial machinery installation and/or when relocated. It would be used by the employer and/or XSO to understand what should be included during set up and installation considerations.

| INSPECTION ITEMS  | YES/NO | COMMENTS  |
|---|--------|---|
| Copy of OHS Act and regulations posted Part 2 Division 7.52   |        | Copy of Regulation sec. 7.19 and 7.20 Online accepted and must include guidelines. Everyone must have access & provided with training   |
| Physical condition of workplace inspected by JHSC worker rep OHS Regulation sec. 3.36   |        | Date last inspected. Assistance afforded?   |
| Compliance to Health Canada's Radiation Emitting Devices Act and Regulation Part 14 – Analytical X-ray Equipment  |        | Instructions, labels, controls, meters, lights, indicators labelled as to function, interlocks, on/off switch (control panel and tube), key (or password) actuated, leakage less than 0.5 mR/h at 5 cm from any accessible external surface |
| Compliance to Health Canada's Safety Code 32 – Safety Requirements and Guidance for Analytical X-ray Equipment  |        | Same as RED Reg Part 14 plus room warning sign, preventative maintenance program, training, radiation protection survey   |
| Radiation safety training & educational programs provided OHS Regulation 7.20   |        | Orientation + Continuing Education Training program content based on <a href="http://www.xrayfocus.info">www.xrayfocus.info</a> or <a href="http://www.radiationsafety.ca">www.radiationsafety.ca</a> or equivalent                         |
| Registration of all X-ray sources   |        | Handheld analytical XRF, XRF, XRD, X-ray equipment  |
| X-ray installation conforms to accepted plan layout   |        | Plans accepted and no changes to layout?  |
| Competent person designated for use of X-ray sources  |        | For equipment, documentation of curriculum training received  |
| X-ray worker notification for staff likely to exceed 1 mSv [sec. 7.19]  |        | On file for all X-ray workers   |
| Retention of original purchase information, registration acknowledgement, acceptance of installation letter and any stamped plan drawing, maintenance, survey, calibration, and training records. |        | Everything related to the X-ray source must be documented and retained for a Ministry inspection  |
| Equipment, materials, protective devices in good condition  |        | Checked in-house or by? Frequency?  |
| Shielding, protective devices & X-ray safety features not defeated  |        | Regularly inspected? By JHSC? Incidents?  |

| INSPECTION ITEMS  | YES/NO | COMMENTS  |
|---|--------|---|
| Measures & procedures in place to ensure ALARA [sec. 7.19]  |        | How? (up-to-date policy and procedures, communication to other workers)?  |
| Every reasonable precaution taken to ensure pregnancy dose limit not exceeded [sec. 7.19]   |        | Precautions taken?  |
| X-ray warning signs or devices conspicuously located and posted [sec. 7.20 (2)]   |        | All doors leading into X-ray rooms "Caution X-rays"   |
| Meets definition of equipment [Division 3 Part 7 of OSH Regulations]  |        | Define an analytical X-ray machine by its primary use being the determination of the structure or composition of a sample of material |
| A warning device that indicates when X-rays are produced is mounted on or near the equipment in such a way as to be conspicuous from any position from which the equipment can be opened [sec. 7.20 (2)]  |        | Light visible when X-ray beam is on   |
| Access doors and sample ports shall be interlocked with the X-ray source or with an adequately shielded shutter of failsafe design, and where operation has been interrupted by an interlock, it shall be possible to resume operation only from the control panel after the interlock has been reset [sec. 7.20 (1)] |        | Reset only possible from control panel (X-ray stress measurement control screen)  |
| The equipment shall be so arranged and shielded as to prevent the air kerma rate from exceeding 5 micrograys per hour at any accessible point 5 centimetres from the external surface, under all possible operating conditions  |        | Scatter medium, kVp, mA, meter used, calibration date, survey date, operator to be documented   |
| Questions asked regarding retention of knowledge with respect to the X-ray source and legislation   |        |   |
| How is this equipment designed and built to protect workers from radiation exposure?  |        |   |
| Why are equipment operators not designated as X-ray workers? Do they need to wear dosimetry?  |        |   |
| What are the health effects associated with exposures to X-rays?  |        |   |
| How soon must the Ministry be notified in the event a worker is exposed to radiation levels exceeding legislated limits?  |        |   |
| How are a Gray and Sievert related?   |        |   |

## Daily Safety Inspection Checklist

This document is intended for the operator to use as a start up checklist or for when the machine has been idle and requires warm up again.

| Inspection Items   | Yes/No | Comments |
|--|--------|----------|
| <i>Operator inspection prior to daily start-up</i>   |        |          |
| The manufacturer's recommended warm up procedure must be followed for all components. The warm-up procedure must be repeated if the equipment is left idle for an extended period. |        |          |
| Meters and visual and audible indicators should be checked for proper function.  |        |          |
| Check all shielding, safety interlocks, warning lamps, light curtains and sensors are functioning properly.  |        |          |
| Inspect and verify all mounting hardware are securely tightened, check for proper cable drapes, and secured wire terminations.   |        |          |
| Run an image quality check (using a known reference object).   |        |          |
| X-ray equipment conditions should be visually inspected for loose or broken components and cleanliness.  |        |          |
| The X-ray source assembly should be checked for motion or vibration during operation.  |        |          |

# Monthly Safety Inspection Checklist

This document is intended for the XSO to use as a monthly inspection checklist

| INSPECTION ITEMS   | YES/NO | COMMENTS |
|--|--------|----------|
| <b><i>X-ray Emitting Device (X-RAY SOURCE) Safety Features</i></b>   |        |          |
| Control switches are functional  |        |          |
| Interlocks are functional. A guard or interlock which prevents entry of any part of the body into the primary beam path is used (wherever practical) - Does it work as intended? |        |          |
| Open beam configuration devices equipped with means to prevent access to primary beam  |        |          |
| A permanent shield is used to absorb the primary beam transmitted beyond the detector (radiation levels < 5 $\mu$ Gy/hr @ 5 cm).   |        |          |
| Shielding, diaphragms, cones, and adjustable collimators or any other devices are used to ensure dose limits are not exceeded  |        |          |
| All lights, meters, controls and other indicators must be properly labelled and marked as to function.   |        |          |
| Fail-safe interlocks installed on accessories/components for which their removal leads to direct access to the primary beam or high radiation area of equipment                  |        |          |
| Unused beam ports permanently blocked off with lead  |        |          |
| Inspect all shielding and lead curtains for cracks, damage or wear.  |        |          |
| Authorized operator using the X-ray equipment according to the manufacturer's instructions and recommendation  |        |          |
| Unauthorized persons are kept away from the immediate vicinity of the X-ray equipment.   |        |          |
| Authorized operator performs routine cleaning and maintenance according to the manufacturer's instructions and recommendations and ECP manual                                    |        |          |

| INSPECTION ITEMS  | YES/NO | COMMENTS |
|---|--------|----------|
| <b>Signage/Warning lights</b>   |        |          |
| Every X-ray source capable of producing an air kerma rate greater than 5 micrograys per hour at any accessible point shall be labelled at its operating controls as a source of X-rays.   |        |          |
| Door sign is posted and displays correct contact information (Contains “caution X-ray room” signage and “restricted access”)  |        |          |
| X-ray warning signs are posted conspicuously near X-ray source (map location with exit route, contact names are referenced)   |        |          |
| Separate fail-safe flashing light indicators to indicate when X-ray tube is energized <u>and</u> when X-rays are being produced is mounted on or near the equipment in such a way as to be conspicuous from any position from which the equipment can be opened. (for control panels controlling multiple tubes, <u>each</u> tube must be equipped with <u>both</u> lights) |        |          |
| Control panel has a fail-safe visible indicator, near the X-ray on/off switch that clearly indicates when X-rays are being produced   |        |          |
| Fail-safe warning indicators indicating the open/shut status of shutters are installed: <ul style="list-style-type: none"> <li>• interlocked with X-ray production</li> <li>• normally in ‘closed’ position until opened by positive action</li> <li>• unused shutters secured to prevent opening</li> </ul>  |        |          |
| Control panel labeled with an X-ray warning symbol as described in the Guidebook  |        |          |



| INSPECTION ITEMS  | YES/NO | COMMENTS |
|---|--------|----------|
| <b>Training</b>   |        |          |
| General facility personnel working in the immediate vicinity of the X-ray equipment require awareness training, even though they do not operate the device themselves.  |        |          |
| Authorized X-ray equipment operators have been provided the required training.  |        |          |
| Operators have access to ECP and operator's manuals   |        |          |
| Updated "authorized worker" list is posted in the room containing X-ray source  |        |          |
| All users and workers are informed of the applicable dose limits  |        |          |
| Pregnant users and workers are informed of the dose limits which apply  |        |          |
| Record of the worker's training and test results are up-to-date and kept on file  |        |          |
| <p>XSO or supervisor ensures that the X-ray equipment operator received hands-on training on the safe use of the equipment. The XSO reviewed, with the worker:</p> <ul style="list-style-type: none"> <li>• The safety features of the X-ray equipment,</li> <li>• The procedures for the safe use and maintenance of the X-ray equipment as per the manufacturer's manuals,</li> <li>• How to determine a problem with the X-ray equipment and/or survey meter when conducting leakage measurements, and</li> <li>• All emergency procedures.</li> </ul> |        |          |
| Refresher training provided for operators and XSO every 3 years   |        |          |

## JHSC Workplace Inspection Addendum for X-ray Emitting Devices

This document is intended for the JHSC to use as part of their monthly workplace inspections process. This list provides X-ray equipment specific items to include in that review.

The following items are a few things that should be added to your workplace inspection checklist to ensure that controls for your X-ray emitting devices are effective.

|                                       | INSPECTION ITEMS  | YES/NO | NOTES |
|---------------------------------------|---|--------|-------|
| 1.                                    | Control switches are functional   |        |       |
| 2.                                    | Interlocks are working correctly  |        |       |
| 3.                                    | Guarding in place to prevent contact with the beam  |        |       |
| 4.                                    | All lights, meters, controls, and other indicators are labelled correctly. I.e. no missing labels.  |        |       |
| 5.                                    | Inspect all shielding and lead curtains for cracks, damage, or wear.  |        |       |
| 6.                                    | X-ray equipment is being used as described in the SWP.  |        |       |
| 7.                                    | Is the maintenance schedule followed and documented for the X-ray equipment   |        |       |
| <b><i>Signage/Warning lights</i></b>  |   |        |       |
| 8.                                    | Are safe zones marked with signage, during X-ray operation  |        |       |
| 9.                                    | X-ray warning signs are posted conspicuously at and near X-ray source   |        |       |
| 10.                                   | Separate fail-safe flashing light indicators to indicate when X-ray tube is energized <b>and</b> when X-rays are being produced are working correctly.        |        |       |
| <b><i>Training and Procedures</i></b> |   |        |       |
| 11.                                   | Operators have access to the exposure control program, if applicable, and the operator's manuals  |        |       |
| 12.                                   | Updated "authorized worker" list is posted in the room containing X-ray source  |        |       |
| 13.                                   | Are new workers oriented on X-ray safety (informed of the applicable dose limits and related hazards)   |        |       |
| 14.                                   | If dosimeters are in used, are they being checked and inspected? Do workers know how to use their dosimeters? Are workers wearing their dosimeters correctly? |        |       |

# Annual Safety Inspection Checklist

This document lists standard items to be examined during the annual program review. This work would be conducted by a qualified contractor or the XSO. This list is a reference for the employer and/or XSO for understanding what should be included when reviewing the program annually.

| INSPECTION ITEMS  | YES/NO | COMMENTS |
|---|--------|----------|
| <b><i>Service Technician Annual inspection</i></b>  |        |          |
| System operation verification to establish baseline reference of the system performance level (using a known reference object).   |        |          |
| Alignment of the tube and detector are verified. Adjusted and optimized.  |        |          |
| Conduct testing to ensure all safety interlocks, warning lamps, light curtains and sensors are functioning properly.  |        |          |
| The tube enclosure is wiped cleaned inside and out of debris, and O-rings are replaced. Filament and target are inspected, adjusted if necessary and sometimes replaced. The tube is fully reassembled after cleaning.  |        |          |
| Clean, set compression and re-apply dielectric grease on all high voltage cable connections between the tube and the generator, inspect, clean and adjust generator as needed, test and verify vacuum system and cooler operations, and ensure all fluids are at optimal levels prior to running factory-set warm up and tuning procedures of the entire X-ray equipment. |        |          |
| Update application software and install software patches.   |        |          |
| Send all radiation detection instruments to a competent calibration service provider, for calibration. Ideally, such units will be calibrated for at least two X-ray energies.  |        |          |
| perform leakage testing at a minimum of once per year, in addition to the testing performed upon initial installation, and after maintenance and/or modification, and whenever damage or overexposure incidents have occurred.  |        |          |
| Calibration of all components of the X-ray equipment including gauges, sensors, interlocks, light curtains, and indicators.   |        |          |

## About us

The Manufacturing Safety Alliance of BC is the industry-led, nonprofit health and safety association that helps BC manufacturers and food processors build and certify safety programs that protect workers and cut costs.

The Alliance is also the WorkSafeBC Certifying Partner for the Occupational Safety Standard of Excellence (OSSE), the health and safety Certificate of Recognition for BC manufacturers.

The Alliance offers safety certification, OHS consulting and advisory services, and broad selection of classroom and online training. Our vision is to partner with BC's industry leaders to achieve cultural change that ensures safe workplaces for all employees.

For more information please contact us: