

WHOP009

RADIATION MANAGEMENT PLAN

Portable XRF Unit

1. INTRODUCTION

This radiation safety manual has been prepared, for the safe use of the Thermo Scientific Niton XL3T Portable XRF (PXRF) units used for geophysical work as carried out by Investigator Resources Limited. This safety manual will help the users of the PXRF to understand the radiation safety principles and issues associated with the operation of the units and thus to minimise the radiation exposure received during the operation of these units.

All operators must have completed the required training and be licenced with the EPA to operate the type of PXRF equipment as indicated. Unlicensed and untrained personnel are not authorised to handle or operate PXRF equipment (even under supervision).

All the licenced operators using the PXRF units, must familiarise themselves with this safety manual. Failure to understand the radiation safety principles and the safe use of the equipment can result in accidental over exposures to the users of the units as well as to others present near to the unit in operation.

2. PORTABLE XRF UNIT

The PXRF contains a X ray tube that emits radiation when it is energised (when the trigger switch is depressed and battery power is present). When the power to the X ray tube is cut off by releasing the trigger switch the production of X rays ceases. The important points to remember are:

- X rays are not generated when the unit is turned on or when the software is loaded
- X rays are generated only when the trigger switch is depressed (this is when power is applied to the X ray tube)
- When the X ray tube is energised the unit emits a directed radiation beam (primary beam). The primary beam when hitting a surface (the item being analysed), emits scattered or secondary beam.

See the figures below.



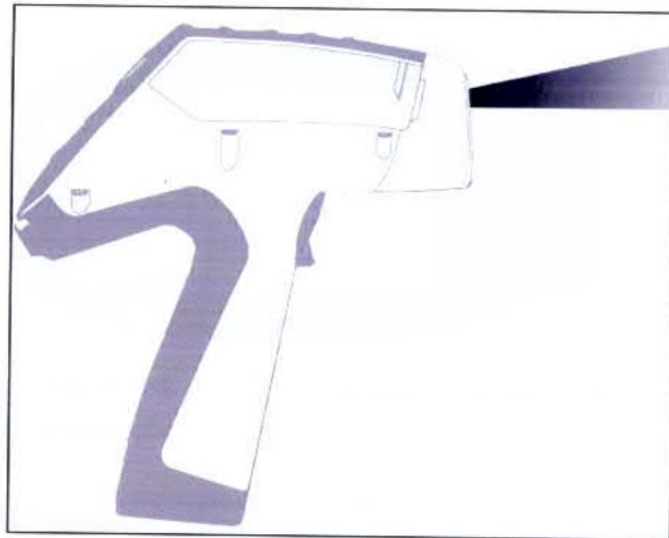


Figure 1-1. Primary Beam

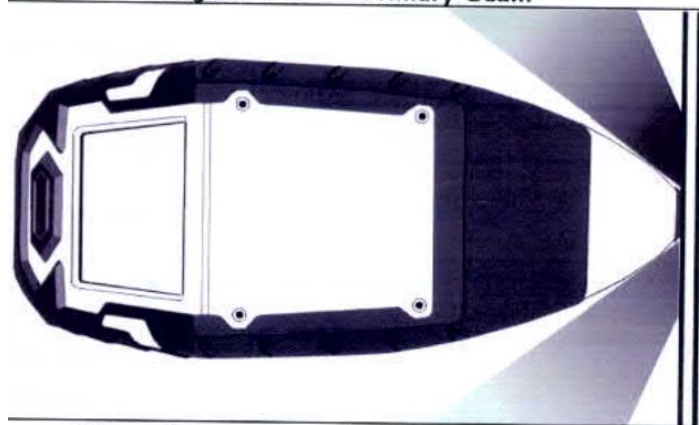


Figure 1-2. Secondary (Scattered) Beam

The primary beam emitted by the unit is very strong at very close distances to the aperture. It can be as high as 500 mSv on contact to the aperture. As the distance from the aperture increases the radiation levels come down to lower levels.

Because of this:

- If the body of the user is very close to the aperture of the unit it can deliver very large amount of radiation dose in a very short time
- A few minutes of exposure in this way can deliver dose above your annual limit of 20 mSv

The user must avoid exposure from the primary beam at all times and should ensure the following is undertaken:

- Items to be analysed should NOT be held by hand or with hands anywhere nearby. (place on a suitable firm substrate)
- The XRF should NEVER be pointed at a person or yourself.
- The aperture should NEVER be looked at (if aperture window requires checking or cleaning the battery should be removed prior)
- Other workers should not be positioned in the vicinity or any potential "line of fire" situations (eg standing opposite the user)
- The XRF should never be stored or left in a position where the trigger may be depressed by accident – always remove battery.

The radiation level expected from the secondary beam is very low and is usually in the range of 0.5 to 1 μSv . Hence, the amount of radiation dose received by a user from this source is very negligible and of generally lower concern.

2.1. ACCIDENTAL EXPOSURES

The scattered or secondary beam from a PXRF unit is very weak and hence will not result in high radiation exposure. On the contrary the primary beam is capable of delivering a very large dose in a short period of time.

As a result, the safe operation of the unit involves avoiding exposure to the primary beam.

2.2. SAFETY FEATURES OF PORTABLE XRF (PXRF)

To prevent accidental exposure to the primary beam the PXRF has a number of built-in safety features:

- The X ray tube is energised only when power is applied to it by depressing the trigger
- The unit is inert when not energised and as such is safe when no battery is installed to power the unit.
- The generation of X rays ceases when the trigger switch is released
- The unit has a proximity “interlock” feature which turns the unit off if lifted off a substrate (if lifted greater than 3cm) being tested as a safety feature to prevent primary beam exposure.
- The four red warning lights flash when the X ray tube is on and X rays are generated. These warning lights go off as soon as the trigger switch is released.
- The maximum time taken to analyse a sample is set 2 minutes after which the unit will turn itself off.

The above safety features will make sure that the operator of the unit will not be exposed to the primary beam. The operation of the above safety features must be checked during the operation of the unit and the operator must not use the equipment if any of the above features are not operating correctly.

Investigator Resources require that the primary safety features including interlock test, backscatter test and warning lights in addition to confirmation of unit stopping when trigger released to be undertaken at a minimum every 3 months in accordance with regulatory requirements, in addition to tests on commencement of any program of work.

2.3. USING THE PXRF WITH SAMPLE HOLDER

The manufacturer of the unit allows its operation either as a table top unit or as a hand held unit.

The PXRF when used inside an office building must always be used along with the sample holder and stand.

The sample holder has a metallic shield inside it, which absorbs most of the X rays and thus minimises its escape to outside the shield. When used with the sample holder the primary beam is safely contained inside it and thus operating the unit will not deliver any dose to the operator from the primary beam. This is the safest way to use the unit inside a building or in areas occupied by people.

When using the unit in this mode:

- Close the sample holder before energising the unit. Never turn the PXRF on (engage trigger) when the sample holder is open
- Never remove the PXRF from the stand before turning the X rays off by releasing the trigger
- After a measurement, before opening the sample holder, make sure that the trigger is released and X ray warning lights are off

2.4. USING PXRF WITHOUT SAMPLE HOLDER

Use the PXRF without the sample holder only when it is absolutely necessary. This mode of operation is allowed only out in the field (drilling and exploration areas) but not allowed inside office buildings or in areas occupied by others.

When the PXRF is used without its sample holder there is no shield to the primary beam other than the test surface/sample itself.

The operator must make sure that no part of his body is in between the aperture and the test surface to avoid exposure to the primary beam.

To test a sample out in the field:

- Select an unoccupied area away from personnel
- Place the sample on the ground or a firm, solid substrate
- Hold the PXRF in such a way that the primary beam is directed away from the operator but directed to the sample
- The aperture of the PXRF must be in contact with the sample while making the measurement
- Never allow any part of the body of the operator to be in the path of the primary beam

3. RESPONSIBLE PERSON

To prevent unauthorised use of the PXRF, and to make sure that the unit is always used in a safe manner by trained and licensed staff, it must be kept under the direct supervision of a person in the geology department who has a valid radiation licence when in field use.

The Exploration Manager, who is listed as the Radiation Safety Officer must, from time to time, nominate a person who will be responsible for the task of supervising the PXRF on projects.

The responsibilities of this person are:

- Being in charge of the PXRF unit owned by Investigator Resources (whether the units are used at a mine site or at exploration areas)
- Maintaining the units in good working condition and undertaking regular safety inspections and reporting these within the Investigator Resources Safety Management System
- In case of reported or suspected fault: Ceasing the use of the unit, Informing the Responsible Officer and arranging for repair and service by an authorised agent.
- Preventing the unauthorised use of the units by ensuring only licenced personnel can operate.
- Ensure the safe storage and appropriate security of the unit (storage in Adelaide office in rear storeroom which is the registered location OR storage in the field in a secure location that prevents unauthorised use or tampering.
- All users are trained, in PXRF operation and radiation safety, by an external trainer (manufacturer, authorised representative or a qualified radiation consultant)

- All users are licensed by the relevant state regulatory unit to operate an ionising radiation apparatus with licence sited and recorded in the IVR Safety Management System
- Maintaining a list of the trained and licensed users
- Maintain a utilisation log of the units
- Making sure that all users of the PXRF read and understand the following documents:
 - “NitonUsersGuide” by ThermoScientific
 - “Niton Resource Guide – Safely and Effectively Using Your Analyser” by Thermo Scientific
 - “Use of the Portable XRF” Safe Work Procedures by Investigator Resources geology department
 - “Radiation Safety Manual – Portable XRF Units” by Investigator Resources Radiation Safety Officer
- The RSO is informed of any changes regarding the use of the units, its location, sale, and acquisition of new units.

4. RESPONSIBILITIES OF RADIATION SAFETY OFFICER (RSO)

The RSO has the following responsibilities:

- Provide access to radiation safety training to the users of PXRF
- Ensure Quarterly inspection of the PXRF units to make sure that they satisfy the requirements of the Ionising Radiation Regulations
- Review and modify the Radiation Safety Manual as and when required

5. RESPONSIBILITIES OF THE PXRF USER

The authorised users are responsible for the safe use of the PXRF units following the correct procedures.

The users must:

- Follow proper operating procedures as described in training and in the instrument operating and safety manuals
- Use dosimetry devices such as TLD badges when required (note that as of 7 July 2016 Government Gazette No.40 Section 44 of the South Australian Radiation Protection and Control Act of 1982 *provided an exemption for specified employers from the requirements of Regulation 17 of the Radiation Protection and Control (Ionising Radiation) Regulations 2015, in so far as the regulation applies to radiation workers who operate an XRF or XRD apparatus subject to the following conditions:*
 - *That the XRF or XRD apparatus is maintained in good working order and condition.*
 - *That the employer issues a monitoring device to a radiation worker if directed in writing to do so by the SA EPA.*
 - *That this exemption does not apply to monitoring of persons operating the apparatus for purposes of installing, maintaining or servicing the apparatus, or any radiation worker who is occupationally exposed to radiation from other sources than XRF or XRD apparatus.*

- Report any unsafe or suspected faults, operating conditions or incidents to their supervisor/RSO
- Immediately cease the operation of the unit and follow the emergency procedure in case of a suspected fault
- Prior to each use, the operator must inspect the unit for damage or malfunction and ensure a safety audit of interlock functions has occurred and is valid for the period.
- On completion of work the operator must ensure the unit is clean and stored in a secure fashion with a check that no damage has occurred to the unit.
- In the case of “loss or theft” of the unit, the following are MUST be notified as soon as practicable
 - Report immediately to the RSO and notify the relevant Radiation Safety Department for the EPA jurisdiction work is being conducted in
 - Report to incident to the Police
- Following the completion of work and the unit is to be stored with the unit’s battery power source removed with the unit secured appropriately in its case and locked away.

6. TRANSPORTATION OF THE PXRF

The PXRF unit should always be transported inside its designated hard case with locks applied.

The PXRF unit should always be transported with batteries removed from the unit such that it is inert.

Transportation of the unit for service and repairs or work in an alternate jurisdiction should be undertaken with the batteries removed and secured and the case securely locked and with registered transportation with tracking records.

The manufacturer of the PXRF device have advised that hazardous goods declarations are not required given the unit is inert without a power source.

7. EMERGENCY PROCEDURE

The PXRF unit is designed in such a way that once the trigger switch is released the power to the X ray tube is cut off which in turn will cease the production of X rays. In the unlikely event of an abnormal operation of the unit it can happen that:

- The X rays are generated even after the trigger is released
- The warning lights remain on even after the trigger is released

If X ray generation is suspected even after releasing the trigger it must be treated as an emergency situation that can deliver large amounts of radiation dose to the operator. In the event of such an emergency situation follow the procedure below:

- Make sure that no one is near the unit other than the operator
- Hold the unit in such a way that the primary beam is directed away from the operator
- Remove the batteries from the unit
- Once the batteries are removed it is completely safe and no X rays can be present
- Inform the radiation safety officer and your supervisor

- Do not use the unit without fixing the fault

8. RECORD KEEPING

The responsible person of the geology department under whom the units are kept is responsible for record keeping. The records must be kept in an identified location and must be made available for review by regulators upon request.

The following records must be kept:

- Personnel training records
- Manufacturer provided instruction manuals, service and maintenance records
- List of authorised users

In addition to the above, the following records will be kept by the RSO:

- Personnel dosimetry records (if required)
- Quarterly inspection of the units to comply with the regulations