Prior Risk Assessment

For Users of Fischer XRF Instruments

For those Models Where Dose Rates 0.1m From Enclosure Exceed 1.0 µSv/h but are less than 7.5 µSv/h.

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Title	Prior Risk Assessment
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1 Introduction

1.1 Regulatory requirement for a Prior Risk Assessment

This Prior Risk Assessment (PRA) has been prepared for users of Fischer XRF analysers.

The PRA is prepared in accordance with Regulation 7 of The Ionising Radiations Regulations 1999 (IRR 99) [1] and takes account of the associated Approved Code of Practice (ACOP) [2] Paragraphs 44 and 45. Information from the manufacturers and suppliers of the sources and the gauges has been used, together with information from Fischer.

This assessment specifically addresses the radiological risk associated with those Fischer XRF instruments where the dose rate at 0.1m from the surface of the instrument exceeds 1µSv/h but is less than 7.5µv/h. This assessment identifies the requirements of regulations 16, 17 18 and 19 of IRR99 and addresses compliance against these regulations.

It does not take into account any other sources of radiation which may also be present in the workplace which are not related to work with this Fischer instrument.

1.2 Overview of the equipment

Fischer provide a range of X-ray fluorescence instrumentation designed for coating thickness measurement and materials analysis. The instruments which are the subject of this assessment are based on 50W X-ray tubes and operate at a maximum potential accelerating potential of 50 KV and a maximum tube current of 1mA.

Figure 1 Typical Higher Dose Rate units

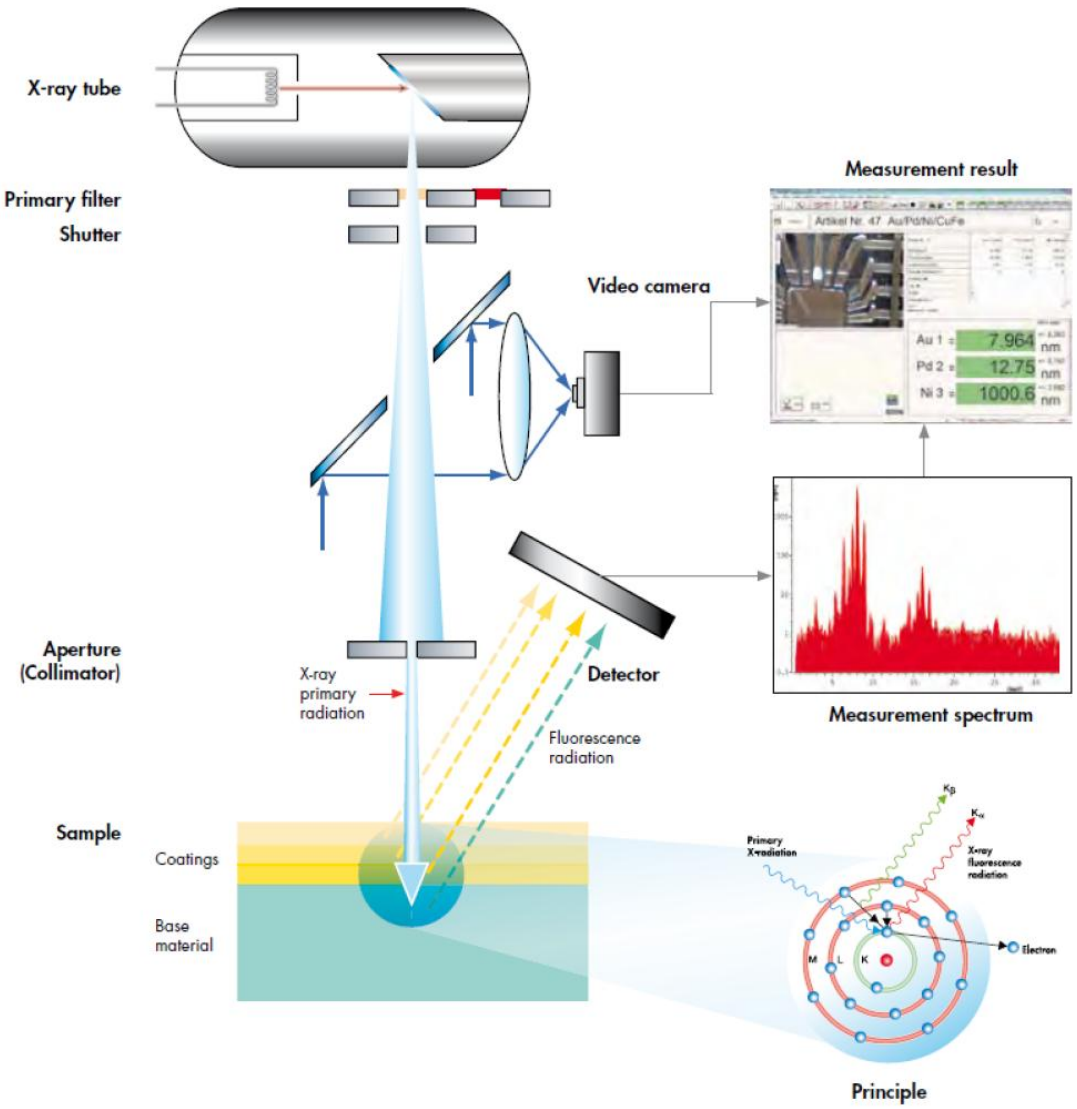

Figure 2. Principle of Operation of Fischer XRF instruments

2 Unmitigated Radiation Hazards

2.1 External Radiation

The dose rate close to the focal spot of the X-ray tube is very high (in the order of a Gy per hour at 1m from the focal spot). Exposures at this dose rate would result in deterministic radiation effects in the form of burns to the hands of the affected individuals in a short period of time.

This risk is highly mitigated by the defence in depth of the designed engineering controls, described fully in Section 3, which virtually eliminates any likelihood of access to the X-ray tube whilst it is generating X-rays.

2.2 Internal Radiation

No internal radiation hazard presented by radiation generated by electrical equipment operating at low accelerating potentials.

3 Dose Restriction Measures

3.1 Engineering Controls, Design Features, Safety and Warning Devices

- Operation of the units is subject to a key switch, which is in accordance to ACOP Para 97.
- Sufficient integral shielding ensures that when the X-ray tube is emitting and the shutter is open, the dose rate at 1m from the external surface of the unit is less than 7.5μSv/h. This is the dose rate when the unit is operating at the maximum voltage and current and is highly pessimistic.
- Generation of the useful beam is terminated by closure of the shutter. Should the shutter fail to lose the control system recognises the “opto-sensor” has not triggered and shuts off the power to the X-ray tube. Requiring a positive trigger from the sensor can be considered as a “fail safe” system.
- Exposure to the operators hands is prevented by the interlock system on the access hood. Opening of the access hood triggers dual micro-switches, both of which must be detected to allow beam generation.
- It should be noted that the action of closing the access door (ie, correcting the fault), does not automatically re-start the beam. The operator must re-start the exposure manually. Collectively, these exposure controls are in-line with the requirements of ACOP paragraph 87.
- The warning signals are clearly visible and are based on highly reliable LED warning lights which indicate the following;
  - POWER ON indicates power to the instrument
  - HV ON indicates that power is supplied to the X-ray tube, such that X-rays are being generated, and
  - SHUTTER OPEN, indicates that X-ray irradiation of the interior of the instrument is taking place.

    If any conflict in the interlock system is detected (for example if only one of the two door micro-switches is activated with the door closed), a CONTROL LED flashes to indicate a fault.

These warning devices are in accordance with ACOP paragraphs 99 and 100.

3.2 Systems of Work

Due to the engineered safety features incorporated into these gauges, the requirements for systems of work are minimal. The following systems of work should be included in the Local Rules:

- All operators who are required to work with these instruments must receive information, instruction and training in relation to the gauges, their safety systems and the Local Rules (including Contingency Plans). This must include:
  - Information on the risks to health created by exposure to ionising radiation
  - The precautions to be taken
  - The importance of complying with the various aspects of the regulations, in particular, their legal duties as an individual, of which those that are relevant to operators are:
    - Not to intentionally or recklessly misuse or without reasonable excuse interfere with any source of ionising radiation.
    - Not to knowingly expose himself or any person to ionising radiation to an extent greater than reasonably necessary for the purposes of the work
    - Exercise reasonable care while carrying out work with ionising radiation
    - To notify the site RPS if there is reasonable cause to believe that he or some other person has received and overexposure, an instrument ahs been damaged.
    - For female operators to notify their employer in writing as soon as they discover they are pregnant.

  Information, instruction and training on other aspects of regulation (ie Notification and appointment of RPA) will also be needed but is not discussed in this PRA.

  For simplicity and effectiveness, the Local Rules may simply refer to this information, instruction and training requirement as attendance on a suitable RPS course.
- Maintenance of the instruments is only to be undertaken with the express permission of an appointed RPS.
- Where the instrument is damaged or it is suspected that any safety features are not functioning correctly the user must:
  - disconnect the instrument from the power supply,
  - inform the RPS
  - ensure a legible notice is attached to the instrument in a prominent position warning that there is a fault with the instrument and it is not be operated.
  -
- Any keys or passwords which prevent unauthorised operation are to be kept securely.

3.3 Personal Protective Equipment

PPE is not appropriate for the radiation protection of operators in respect of these units, as the use of engineering controls and systems of work restrict the exposure to a level that can be regarded as ALARP.

4 Identification of Those At Risk

This instrument is intended for use in the work place by authorised, trained operators. Sufficient shielding has been incorporated into the unit to ensure that no other persons in the area will be affected.

5 Dose in normal routine operations

The instruments assessed here are intended to be used in a specific workplace by the client's operators. There is no attempt to assess other, existing sources of radiation in the area. For the basis of the "likely" dose to operators a maximum dose rate figure of 3µSv/h measured at 0.1m from the surface of the unit has been used. This is the maximum dose rate measured in the field, [3]. This dose rate at a distance of 0.1m is insufficient to give an effective, whole body, dose in excess of 1mSv per annum.

Equivalent dose to the skin or extremities can be calculated on the basis that an operators hand remains close to the unit for 2000 hours a year. On this basis the maximum equivalent dose would be in the order of 6mSv. This can be compared to the equivalent dose limit for skin or extremities of 500mSv per year. This is a conservative estimate based on an unrealistic occupancy factor and real doses are likely to be considerably lower.

6 Accidents, Incidents and other Occurrences

Provided there is no deliberate interference, or attempt to override the interlock system, there is sufficient defence in depth for the "fail safe" interlock systems on both the shutter mechanism and access hatch to prevent any reasonably foreseeable radiation accident.

7 Conclusions and Recommendations

The radiological risk associated with the use of these XRF Units is very low, and is restricted by the engineered design features of the instruments. In normal use it is expected that the exposure of those who undertake work in or around the instruments, will be much less than 1 mSv/a. Such doses are of a magnitude that would not be considered occupationally significant, and may be regarded as ALARP.

In normal operations, the area around the instrument will be designated as a Supervised Area. Although Controlled Area conditions within the X-ray chamber in depth engineered controls ensure that there is no risk of personal exposure. As such it is recommended that Local Rules are prepared for the operation and maintenance of the instrument.

In order to ensure compliance with the Local Rules a Radiation Protection Supervisor, RPS, should be appointed and named in the Local Rules. Prior to appointment as an RPS the individual should receive training in line with the HSE's Core of Competence for RPSs. In addition, a specific module should be provided outlining the specific radiological protection requirements for the safe and complaint use of X-ray based systems.

Considering the potential accident scenarios, their likelihood and severity, it can be concluded that no identified scenarios, which would be likely to give rise to a Radiation Accident, have been identified. Therefore no formal Contingency Plans, in accordance with Regulation 12(1) need to be written.

Based on the findings of this assessment, it can be concluded that:

- There is no need to alter working conditions for any female who declares she is pregnant or breastfeeding.
- Local Rules must be prepared and an RPS trained and appointed to control work described in the Local Rules.
- A suitable Supervised Area Sign should be posted on the instrument to indicate the area designation, see attached example.
- Environmental radiological monitoring must be provided as a requirement to monitor radiation levels within the Supervised Area and demonstrate that the area need not be designated as Controlled. This can be achieved by either the use of a suitable instrument such as a Mini Instruments Mini 900 and 42A scintillation probe, or by the sue of TLD dosimeters posted in an adjacent location to the instrument. For practical purposes the Supervised Area should be considered to extend 0.5m from the instrument in all directions.
- A Dose Investigation Level of 1 mSv is appropriate for this work
- The routine monthly monitoring should be accompanied by a visual inspection of the instrument, its attachments to the reactor vessel and associated warning signs and labels.
- Other planned maintenance of the instrument should be undertaken as specified by the manufacturer or supplier.
- As it is not likely that employees will receive an effective dose of more than 6 mSv in a year, nor is the nature of the sources such that it is reasonably foreseeable that an employee would receive an overexposure in a few minutes, there is no need for any employee working with these sources to be classified.
- As there will be no classified employees, nor will there be any need for non-classified employees to enter Controlled Areas, there is no requirement for personal dose assessment.
- It is appropriate that arrangements for managing radiological safety and regulatory compliance are externally audited by the RPA on a regular basis, and that the findings and recommendations are formally reported.

8 References

1 The Ionising Radiations Regulations 1999, Statutory Instruments 1999 No 3232.
2 Work with ionising radiation: The Ionising Radiations Regulations Approved Code of Practice and Guidance, L121
3 Fischer Field Engineers report, 28/01/1

SUPERVISED AREA

X-RAYS

EXTERNAL RADIATION