



# Radiographic Inspection Safety

IFU	01	06.04.2023	M. Frenzel, GCQH	V. Metivier, GCQH	D. Martinez, GCE	
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## 1 Scope

This Safe Work Procedure is valid for all activities carried out during construction, pre-/commissioning, and start-Up phases as well as for repair work and small-scale modifications.

This Safe Work Procedure applies to all projects where COMPANY has an overall responsibility for construction and commissioning.

It applies also to all prefabrication and sub-construction areas (e.g., Package Units) in COMPANY area of responsibility.

## 2 Purpose

This Safe Work Procedure defines responsibilities and workflow for the radiographic inspection before and during the execution of construction and commissioning activities on sites under COMPANY responsibility.

The purpose of this Safe Work Procedure is to set out clear procedures and safety requirements for the application of radiography (i.e., X-Ray or Gamma Ray) at site to ensure that such works are carefully planned and safely executed to prevent injurious accidents, occupational illnesses and any further detrimental consequences.

## 3 Definitions

Terms	Definitions
Classified worker	Worker who has the permission to work in the controlled area, because of fulfilling special requirements
Controlled Area	Controlled area is an area where an exposure of more than 3 $\mu\text{Sv/h}$ is possible.
Gamma Ray	<p>Gamma Ray is natural, energy rich electromagnetic radiation with a wavelength in the range of less than 0.01 nanometres, corresponding to frequencies in the range of more than 30.000 PHz. The energy of Gamma Rays is above 100 keV.</p> <p>Gamma Rays are produced from sub-atomic particle interaction (Isotope), such as electron-positron annihilation and radioactive decay; most are generated from nuclear reactions occurring within the interstellar medium of space. Due to their high energy content, they can cause serious damage when absorbed by living cells.</p>
Monitor	'To monitor' radiographic activities for the purpose of this Safe Work Procedure means to give guidance regarding the safe work execution and to spot check the concerned work. It does not require physical presence during the whole working period.
PPE	Personal Protective Equipment
X-Ray	<p>X-Ray (or Roentgen Ray) is artificial generated, energy rich electromagnetic radiation with a wavelength in the range of 10 to 0.01 nanometres, corresponding to frequencies in the range of 30 to 30.000 PHz (1 PHz = <math>10^{15}</math> Hertz).</p> <p>The energy of X-Ray is between 1 keV (Soft X-Rays) and 250 keV</p>

	(Hard X-Rays). X-rays are primarily used for diagnostic radiography and crystallography. X-rays are a form of ionizing radiation and as such can be dangerous.
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For convenience, project documents references provided in this document with originator code "&??", correspond to COMPANY originator code.

## **4 Responsibilities**

### **4.1 COMPANY Project Construction Manager**

COMPANY Project Construction Manager is responsible for the implementation and consideration of this Safe Work Procedure during the planning, tendering and execution of the project. COMPANY Project Construction Manager must evaluate the necessity of the implementation of this Safe Work Procedure.

### **4.2 COMPANY Site Manager**

The Site Manager is responsible for the implementation and inspection of the compliance with this Safe Work Procedure on site. He is responsible for the implementation of the prescribed preventive measures during carried out radiographic work.

### **4.3 Permit to Work Issuer**

The Permit to Work Issuer is responsible for the time schedule of radiographic work, the coordination with parallel work, the review of the defined measures in CONTRACTOR application for a work permit and the review of CONTRACTOR risk assessment and work procedures regarding radiographic activities.

### **4.4 Supervisor**

COMPANY and CONTRACTOR Supervisors are responsible for the inspection of the compliance with this Safe Work Procedure on site in their scope of work.

### **4.5 COMPANY Site HSE Manager**

The Site HSE Manager has the duty to monitor the adherence to the following regulations and to monitor personnel carrying out radiographic work. He must support the Site Manager and all supervisors during the implementation of the following regulations.

### **4.6 COMPANY Site QA/QC Manager**

If more than one Radiographic Supervisor is nominated, COMPANY Site QA/QC-Manager must coordinate the work of all Radiographic Supervisors.

## 4.7 CONTRACTOR

CONTRACTOR carrying out radiographic activities must fulfil the following requirements:

- CONTRACTOR must organise the radiographic activities acc. to this Safe Work Procedure.
- CONTRACTOR must be licensed resp. accredited acc. to local requirements.
- CONTRACTOR must adhere to local radiography requirements about radiation protection.
- CONTRACTOR must submit the following documents to COMPANY before beginning radiography activities and must submit updates without delay.  
These required documents are:
  - CONTRACTOR accreditation / concession
  - Certificates and a list of CONTRACTOR authorised radiation protection representative(s)
  - Certificates and a list of CONTRACTOR Radiographic Supervisor(s) and classified workers (see 4.9 and 4.10)
  - CONTRACTOR risk assessment
  - CONTRACTOR work procedures for radiography activities
  - CONTRACTOR emergency procedure (the procedure must fulfil the requirements of section 5.3)
- CONTRACTOR is responsible to prepare and issue a "Radiographic Work Coordination Plan" (see 5.2.2.1.1).
- CONTRACTOR is responsible that only necessary personnel are present in the controlled area.
- CONTRACTOR is responsible for its SUB-CONTRACTORS and must transfer the requirements of this Safe Work Procedure to its SUB-CONTRACTORS.

## 4.8 CONTRACTOR HSE Manager and Safety Representative

They have the duty to monitor personnel during radiographic work. They must check defined measures and support the supervisors. They must report problems regarding to radiographic work to COMPANY Site HSE Manager immediately.

## 4.9 CONTRACTOR Radiographic Supervisor

Every CONTRACTOR applying radiography on site must nominate a Radiographic Supervisor. He is responsible to monitor all work carried out using radiographic material or radiation.

Requirements of the Education of Radiographic Supervisors

The education must meet local law and regulations.

Beyond these regulations CONTRACTOR must verify the acceptability of his RADIOGRAPHIC SUPERVISOR. In addition to local legal and regulatory requirements, COMPANY has the following minimum requirements on assigned Radiographic Supervisors:

- Experience as a Radiographic Supervisor or one year working as a Trainee Radiographic Supervisor
- appropriate qualifications to monitor radiographic work, e.g.
  - level 2 or 3 acc. to EN 473 or ISO 9712
  - Radiation Safety Officer (RSO) acc. to IRR99 (Ionising Radiation Regulation 1999, UK)

- the Radiographic Supervisor must be able to communicate in the local language.

A deviation from the above stated requirements requires COMPANY approval.

#### **4.10 Classified workers**

All workers working inside the controlled area must be designated as classified workers. Classified workers must fulfil the following requirements:

- appropriate qualification to perform radiographic work, e.g., level 1 acc. to EN 473 or ISO 9712
- Classified workers must be at least 18 years old.
- Female classified workers must not be pregnant or breastfeeding.
- Classified workers must attend trainings and instructions to become aware of radiation protection and what to do in case of an emergency.
- Classified workers must comply with all further requirements in section 5.2.

They must ensure that all boundary marks, signs, audible warnings and warning lights are in place and operating in accordance with the regulations, and that the area is clear before exposing the source. At the beginning of each shift the classified workers must ensure that all equipment is in a safe working condition. All malfunctions must be reported to the Radiographic Supervisor immediately.

#### **4.11 All personnel**

All personnel (COMPANY, CONTRACTOR, SUB-CONTRACTOR) have the responsibility to attend trainings and instructions on site. Radiation Protection must be a topic of the Site induction training.

All personnel must comply with stipulated measures.

### **5 Risk Assessment and Preventive Measures**

#### **5.1 Risk Assessment**

Before start of the construction and commissioning period COMPANY and CONTRACTORs must carry out documented risk assessments considering radiographic work.

Depending on the results, preventive measures must be defined.

The described measures of sections 5.2, 5.3, 5.4 must be checked and implemented.

#### **5.2 Prevention**

##### **5.2.1 General preventive measures**

It must be ensured that the method of operation and radiation energies with the lowest risk reasonably practicable is chosen (e.g., use of x-ray instead of gamma ray).

All preventive measures based on the risk assessment must be checked before starting radiographic activities.

## 5.2.2 Technical and/or organisational measures

In addition to general preventive measures technical and organisational measures must be arranged.

### 5.2.2.1.1 Technical measures

Technical measures are:

- Use of up-to-date radiography systems where isotopes do not leave the container and the radiation beam can be controlled.
- As a rule, a collimator must be used. If the work isn't executable using a collimator, radiographic work could be carried out only if it explicitly mentioned in the work permit.
- Cordoning off of areas and workplaces during radiographic work
- CONTRACTOR conducting radiographic work must cordon off the area, place flashing lights and / or radiation sign boards and check to ensure that all personnel have been vacated from inside the controlled area. CONTRACTOR must ensure that no unauthorised personnel can enter the controlled area during the radiographic work. The distance of the barriers must be sufficient to ensure that no more than 3  $\mu\text{Sv/h}$  exposure occurs at the barrier perimeters (measuring see 5.2.3.5). Independent from this requirement, the bannered area must comprise a minimum radius of 2,5m / 8ft. around the radiation source. Emergency escape routes for personnel working inside the controlled area must be secured in a proper way.
- The radiographic work must be stopped immediately if unauthorised personnel enter the controlled area.
- Before starting radiographic activities an appropriate warning signal (acoustic and visual) must be given, to caution personnel staying in the controlled area by mistake. The chosen alarm signal must not be used for other purposes.
- For emergency cases during radiographic work a manual alarm device is required. The manual alarm device must be arranged for cases of a radiation accident (see 5.4.2). In cases of a radiation accident personnel must stop all work immediately and go to the assembly areas. Radiographic material must be secured as far as possible.
- The controlled area must be tagged as per attachment 1.
- Radiation sources must be tagged as per attachment 2.
- Transportation vehicles for radiation sources must be signed acc. to local requirements.
- Radiographic equipment must be inspected acc. to legal requirements and checked before commencing of work.

### 5.2.2.1.2 Organisational measures

CONTRACTOR is responsible to prepare and issue a "Radiographic Work Coordination Plan" (see section 5.2.2.2.1).

Every radiographic work requires a special work permit (see &??-W-PQ 9601 'HSE Program Site' and &??-W-SC 9601 'Permit to Work System').

In addition, the following organisational measures must ensure the safe execution of radiographic work:

- unauthorised personnel must not enter controlled areas
- a radiographic team must not work inside the controlled area of another radiographic team

- execution of radiographic work must be communicated to all parties concerned
- responsibilities must be well-defined
- radiographic work must be carried out by at least 2 classified workers
- radiographic work must be monitored by the Radiographic Supervisor

#### **5.2.2.1.3 Radiographic Work Coordination Plan**

The plan must be issued once a week, updated daily and include the following:

- A site plan including the location of all controlled areas.
- The plan must document measures and personnel working inside the controlled areas.
- The plan must be displayed at an adequate spot.
- If more than one CONTRACTOR carries out radiographic work the Radiographic Work Coordination Plan must be issued by COMPANY.

#### **5.2.2.1.4 Radiographic Work timeframe**

By the definition of an appropriate timeframe, it must be assured that radiographic work is not carried out during other working activities in the same area.

Radiographic activities must not be carried out during normal working hours as far as possible.

Possible radiographic timeframes could be during the night or days no other work will be carried out (e.g., public holidays, weekend).

Radiographic worktime must be announced by placards, in the coordination meetings or other appropriate meetings.

#### **5.2.2.1.5 Work Permit**

For work permits see &??-W-PQ 9601 "HSE Program Site" and &??-W-SC 9601 "Permit to Work System".

The work permit must include (but not be limited to) the following information:

- description of the permitted radiation material resp. radiographic equipment
- description of the controlled area (dimensions horizontally, vertically) and its barricading
- description of the radiographic work timeframe
- necessary PPE for all personnel working inside the controlled area
- use of valid film badges and/or pocket dosimeters
- description of the barricading measures
- behaviour in cases of emergency if deviations from the basic rules are necessary
- names of the Radiographic Supervisor and other responsible persons
- names of all persons attending inside the controlled area

The work permit must be available next to the location of the controlled area.



### **5.2.3 Personal and individual measures**

#### **5.2.3.1 Medical Examination**

Classified workers must be examined by a doctor (with accreditation in radiation) with regard to medical indications not to work with radioactive material or other forms of radiation.

Classified workers of COMPANY must be examined acc. to the local requirements.

Deviations from these requirements require COMPANY approval.

#### **5.2.3.2 Basic Personal Protection and Hygienic Measures**

Personnel must regard the following measures:

- Not to drink or eat inside the controlled area.
- To clean hands and face as soon as possible after leaving the controlled area.

#### **5.2.3.3 Personal Protective Equipment**

Depending on the results of the risk assessment PPE must be provided and used by personnel. All PPE must be applied acc. to manufacturer's instructions.

All personnel must be trained in the use of PPE. This training must be documented.

#### **5.2.3.4 Dose Rate Alarm Device**

When applying Gamma Ray, at least one classified worker must wear a dose rate alarm device. On a daily basis a function check must be carried out prior start of radiography work.

#### **5.2.3.5 Local Dose Rate Measuring Device**

To check the dose rate at the boundary of the controlled area, a dose rate measuring device must be applied by the classified workers.

#### **5.2.3.6 Personal Monitoring**

##### **1) Use of Film Badges**

- a) All classified workers must wear approved film badges inside the controlled area. Film badges must be issued by the Radiographic Supervisor of CONTRACTOR on a monthly basis. At the end of the monthly period, film badges must be returned to the Radiographic Supervisor together with the personal dosimeter records. The film badge results must be entered on the personal dose record and kept in the personnel files (see below 4)).
- b) Wearing of film badges:  
The film badge is placed in the holder with the serial number clearly visible throughout in front window of the holder. The holder is pinned to the outer clothing at waist level at the front of the body, with the back of the holder nearest to the body. The film badge must be worn at all times during working hours.

##### **2) Use of personal dosimeter.**

Personal dosimeters must be worn at all times during working hours by all workers inside the

controlled area. Personal dosimeters must have a measuring range of 0 to 2 mSv. Personal dosimeters must be zeroed and recharged at the beginning of each working day. With regard to the keeping of records see paragraph 4 'Records'.

### 3) Maximum Permissible Dose

The maximum permissible dose shall not exceed the following maximum effective dose.

For the whole body:

Case	Effective Dose
non classified worker	1mSv per year
classified worker	20 mSv per year
work life dose (classified workers)	400 mSv
emergency cases (during rescue of persons)	100 mSv once per year

### 4) Records

- Daily records: The classified workers must keep a daily record of their personal dosimeters. The Radiographic Supervisor must ensure that these records are maintained and kept up to date. Any daily exposure indicated by the dosimeters to be above the allowable limit (0.4 mSv/day) must be reported immediately to the Radiographic Supervisor.
- Monthly Records: Records of monthly film badge readings must be kept and reviewed by the Radiographic Supervisor.

## 5.2.4 Training and Instruction

### HSE Induction / Orientation training

The HSE Induction / Orientation training provided to all employees must include the topic radiation protection (signs, barriers, emergency case etc.).

#### 5.2.4.1 HSE training for classified workers

This training must be provided by CONTRACTOR at least once a year to all classified workers. It must include (but not limited to) the following topics:

- Correct behaviour during radiographic work
- Correct cordoning off and placement of warning signals
- Storage of radiation material and radiographic equipment
- Personnel Monitoring
- Use of PPE
- Responsibilities and duties
- Behaviour in cases of emergency

Female classified workers must be informed about the special rules and protection requirements:

- Female classified workers must inform their supervisor immediately, if they have recognized they are pregnant.
- Female classified workers must not conduct radiographic work during the pregnancy and till they are not breastfeeding anymore.
- Female classified workers maximum permissible part body dose (uterus) must not exceed 0,5 mSv per year.

## **5.3 Storage of radiographic equipment**

### **5.3.1 Storage requirements**

The storage must meet the following requirements:

- requirements acc. to the local law and regulations
- fire- and flood-proofed storage
- no access for unauthorised personnel (e.g., fencing and locking)
- labelled acc. to attachment 1
- the dose rate at the borderline to the accessible area for unauthorised personnel must not exceed 3  $\mu\text{Sv/h}$  and at least weekly measures of the dose rate must be carried out and documented

### **5.3.2 Access requirements**

The access to radiation sources and x-ray tubes must be controlled and limited to authorised personnel. This includes the storage and the transportation in vehicles.

The issue and receipt of radiation sources must be documented in a logbook.

## **5.4 Instruction for cases of emergencies during radiographic work**

### **5.4.1 Emergencies not caused by radiographic work**

- fire, explosion (not in the area of the radiation source)
- accident
- storm, etc...

The radiographic work must be stopped immediately.

The radiation sources must be secured. Follow the requirements of the emergency procedure issued for the construction site.

### **5.4.2 Emergencies caused by radiographic work**

- Source cannot be returned to the shielded position by normal means
- Source lost or dropped out of camera
- Leaking or damaged source

An alarm must be given using the manual alarm device. If necessary, the area must be immediately cleared of all personnel and be cordoned off at the 3  $\mu\text{Sv/h}$  radiation level. The radiation sources must be secured.

The further instructions of the emergency procedure issued for construction site must be followed.

### 5.4.3 Fires involving radiation sources

Sources and containers of approved designs are not combustible and are manufactured to withstand fire without damage. If a fire occurs, the sources must be removed from the area, if this can be done without a risk. If the above-mentioned course of action is not possible, sources must be abandoned, and the fire service must be informed of their presence.

The further instructions given in section 5.4.2 must be followed (alarm, cordoning off).

### 5.4.4 Personnel involved in an emergency case

Every person involved in an emergency case where a possible contamination cannot be definitively excluded must be examined by a doctor.

### 5.4.5 Reporting and Investigation

Every incident caused by the radiographic work (see section 5.4.2) must be reported immediately by the Radiographic Supervisor or the concerned classified worker to the Site Manager, the Site HSE Manager and the QA/QC Manager of Company.

The emergency must be investigated by CONTRACTOR like any other incident/accident.

## 6 Referenced Documents

Document	Title
&??-W-PQ 9601	HSE Program Site
&??-W-SC 9601	Permit to Work System

## 7 Documentation and Records

This document and relevant records shall be controlled as defined in "Preparation of Internal Documents" (&AZ-Q-PP 1050.060.010 (EN)), "Distribution of Documents" (&AZ-Q-PP 1050.063.010 (EN)) and "Archiving of Documents" (&AZ-Q-PP 1050.066.010 (EN)).

## 8 Revisions

Proposals for revisions of this Safe Work Procedure should be forwarded in writing to the Global Construction department 'Construction and Commissioning HSE'.

## 9 Distribution

This document will be administered and distributed by the Global Construction department 'Construction and Commissioning HSE'.

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## ATTACHMENT 1 "Controlled Area"



If special PPE is required further signs must be supplemented.



This sign can be used additionally

## ATTACHMENT 2 "Radiation Source"



This sign can be used additionally