Radiography Safety Procedure

HEALTH, SAFETY AND ENVIRONMENT PROCEDURE

Radiography Safety Procedure

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Radiography Safety Procedure

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**Document Author**

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<th>HSE-S564392</th>
<th>Approved By</th>
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<td>M.Ansari</td>
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**HSE P.O.G.C Unrestricted Safety Procedure**

**Approved By**

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M.Ansari
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**Document Custodian**

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HSE
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SUGGESTION FORM
1- INTRODUCTION
Pars Oil and Gas Company (POGC), a subsidiary of National Iranian Oil Company (NIOC), was established in 1998. POGC is a developmental and manufacturing organization that specializes in the fields of engineering and management of development projects, production, operation and integrated management of oil and gas reservoirs. POGC’s mission is to ensure sustainable and preservative production and development of Iran’s oil and gas industry in the areas under its responsibility, development of oil and gas value chain as well as optimization of energy supply processes at national, regional and international levels. POGC is also in charge of development of joint and non-joint oil and gas fields of the country including South Pars, North Pars, Golshan and Ferdowsi.

Aimed at creating superior value and boosting the level of satisfaction of the beneficiaries and with an approach focusing on sustainable, integrated and knowledge-oriented production and development, the company feels committed to comply with national and international requirements, regulations and standards in such areas as quality, safety, as well as occupational and environmental health.

2- PURPOSE
This document defines responsibilities and methods to be used to ensure the safety of all personnel and public from exposure to ionizing radiation sources (X-rays, Gamma rays…) used within phases projects premises for inspection purpose.
This procedure provides safety precautions in storage, transport and use of radioactive sources and equipment that are used for radiography activities.

3- SCOPE
This procedure is applicable for each location in all CONTRACTOR south pars gas field development phases projects work locations where there is risk of radiation harm due to the work nature.
This procedure will be applicable for the site radiation protection to all radiographic workers and the other workers against the radiation hazards.
For the requirements not specified in this procedure, Government's regulations, Company's safety regulation and recommended general practice shall be applied.

4- RESPONSIBILITIES
4.1 Site Manager
Ensuring that the term and conditions stated on the radiography procedure are adhered to all time during the work.

4.2 Radiography Personnel
Persons engaged in the actual handling and use of sealed sources and equipment are defined in the regulations as "Radiographer" or "Radiographer's Trainee."
A radiographer is that individual who either performs radiography himself, or who is in attendance at the site of use to personally supervise radiographic operations. The
radiographer is the individual directly responsible to the licensee's management for assuring that radiography is performed at all times in accordance with Department regulations and the conditions of the State license. A radiographer's trainee is any individual who manipulates radiographic exposure devices, sealed sources, related handling tools, or survey instruments while under the personal supervision of the radiographer. It is important that two points be understood: (a) the duties and responsibilities of radiographer may not be delegated to a radiographer's trainee; and (b) any individual who assists a radiographer by manipulating radiographic exposure devices, sealed sources, related handling tools, or survey instruments is acting in the capacity of a radiographer's trainee and must meet the qualifications set by Atomic Energy Organization of Iran (AEOI). Qualifications of the Radiographer and the Radiographer's Trainee are important. Sealed sources used in radiography usually contain multi curie quantities of gamma emitting radioactive material and are hazardous if not used properly. Therefore, each radiographer and radiographer's trainee must meet certain minimum training and experience accordance with accepted radiation safety training courses. A thorough understanding of the hazards and proper procedures for safe handling and use of radiography sources is a fundamental requirement for any individual who is to assume the duties and responsibilities of a radiographer.

Radiation safety education could be consistent with one of the Administered Institute or equivalent. The training and education can be including:
- Acknowledge of ionizing radiation;
- Radiation detection and measurement methods, including survey meters;
- Basic understanding of biological effects of ionizing radiation;
- Personnel monitoring devices;
- Fundamentals of radiation protection: time, distance, shielding;
- Applicable regulations and operational standards.
- Emergency procedures.

The Radiation Safety Officer (RSO) shall ensure that radiographer have the necessary education and training and have demonstrated competence before undertaking the job.

An individual who acts as a radiographer's trainee must be instructed as to the licensee's operating and emergency procedures and must demonstrate competence to use the radiographic exposure devices, sealed sources, related handling tools, and survey instruments, which they will handle, under the personal supervision of the radiographer. Each radiographer's trainee must be supplied with a copy of the operating and emergency procedures.

4.3 HSE Manager
- Ensuring that the term and conditions stated on the radiography procedure are adhered to all time during the work.
- Ensuring that the Radiation Safety Officer (RSO) and Radiation Safety Supervisor (RS) are familiar with this procedure and all persons concerned are trained as well.
- To ensure that the working of this procedure are known and followed by personnel with specified duties for RSO and RS.
- To monitor radiography duties by conducting assessment on the work.
- To ensure that the working of this procedure are known and followed by personnel with specified duties.

4.4 Radiation Safety Officer (RSO)

He must be certified personnel who passed radiation safety advanced course. He is responsible for of site radiation handling, establishing and approving radiation safety technique and procedure, supervising site safety operation, and maintaining calibrated monitoring device. The RSO must control overall radiation safety works at site and permit requirements.

4.5 Radiation Safety Supervisor (RS)

a) He must be certified personnel who trained in radiation basic course.
b) The RS takes responsibility for the performance of general radiation safety work.
c) Each radiographic working team will have a designated RS prior to starting work.
d) At the start of each shift, the RS must ensure that all equipment is in safe working condition. One survey meter must be available for each source in use. Equipment must be transported to the working site with the safety locks in place; under no circumstances equipment to be transported in assemble or open condition.
e) Upon arrival at the work site and prior to operating with any sealed source, the RS must ensure that non-classified person will not be subjected to more than the permitted level of radiation (2.5micro sv/h) at any time.

5- PROCEDURE

5.1 Ionizing Radiations

Ionizing radiations, such as X-Rays generated by different types of equipment and Gamma ray with which are generated by radioactive isotopes Ir-192 are widely used for Non Destructive testing of various welds, pressure vessels, steel structures and etc. the material tested dose not retain any radioactivity when testing is completed.

For all practical purposes, the harmful radiations like X-rays and Gamma ray emitted by radioactive sources have properties, which should be understood. Even tough they have the ability to penetrate the body they cannot be perceived by any of the five senses; they can be absorbed and scattered by matter; they travel in straight lines at the speed of light; they ionize gases; they affect photographic film emulsions and by far the most important they are harmful to living cells. Radiation dosages are cumulative and do not dissipate for a period of time.

The basic principle of radiographic examination of metallic objects is the same as in any other form of radiography such as medical radiography. Holes, voids, and discontinuities decrease the attenuation of the X-ray and produce greater exposure on the film (darker areas on the negative film).

Because RT depends on density differences, cracks with tightly closed surfaces are much more difficult to detect than open voids. Also, defects located in an area of an abrupt
dimensional change are difficult to detect due to the superimposed density difference. RT is effective in showing defect dimensions on a plane normal to the beam direction but determination of the depth dimension and location requires specialized techniques. Since ionizing radiation is involved, field application of RT requires careful implementation to prevent health hazards.

Type of radioactive sources should be requested from certified contractor before starting the contract. For general information about radioactive source should be mentioned that regulators divide radioactive material either sealed or unsealed sources. Sealed sources completely enclose the radioactive material, which is also permanently bonded or fixed to a capsule or matrix designed to prevent its release under the most severe conditions of normal use and handling. Usually, radioisotopes with high radioactivity and radio toxicity are placed in sealed sources to mitigate leakage of the isotope itself. The desired radiation emanates from a sealed source and precautions are necessary to minimize the risk to humans, such as surrounding the sealed source in shielding made of material containing lead. In the case of an unsealed source, the radioactive material remains accessible. It may be contained in a glass vial or other type of container with a removable stopper. Unsealed sources, therefore, could easily present potential radiation hazards if mishandled. Table bellow shows a partial list of radioisotopes usually embodied in sealed sources.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Physical Form</th>
<th>Half-life</th>
<th>Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesium-137 (Cs-137)</td>
<td>Solid (powder)</td>
<td>30.1 years beta</td>
<td>gamma</td>
</tr>
<tr>
<td>Cobalt-60 (Co-60)</td>
<td>Solid (metal)</td>
<td>5.3 years Beta, gamma</td>
<td></td>
</tr>
<tr>
<td>Iridium-192 (Ir-192)</td>
<td>Solid</td>
<td>74 days</td>
<td>Beta, gamma</td>
</tr>
<tr>
<td>Krypton-85 (Kr-85)</td>
<td>Gas</td>
<td>10.8 years</td>
<td>Beta, gamma</td>
</tr>
<tr>
<td>Radium-226 (Ra-226)</td>
<td>Solid</td>
<td>1600 years</td>
<td>Alpha, gamma</td>
</tr>
<tr>
<td>Strontium-90 (Sr-90)</td>
<td>Solid</td>
<td>28.8 years</td>
<td>beta</td>
</tr>
</tbody>
</table>

5.2 Classification of Personnel

5.2.1 Classified persons

Who has been certified fit by a registered medical practitioner and qualified to work with radioactive source. Certified person who is required to manipulate the equipment or who is in any way employed in process involving the use or transportation of isotopes of X-ray machines under the control of the Radiation Protection Supervisor. Radiography operation
shall be done at least by two person, both of them shall be presence at site during radiography operation all the time.

5.2.2 Non-Classified Persons
All other persons who don’t meet the definition above are non-classified person. It must be attended the employment of person under 18 years old is prohibited.

5.3 Permissible Dose for classified Persons

- Classified persons can receive the maximum permissible dose of 7.5 micro Sv/hr or 100 micro Sv/week (40hrs).
- The acceptable yearly exposure is 20 milli Sv (2Rem).
- The 20 msv/year will handle on a 0.1 msv/week basis; but this dose not implies that 0.1 msv/week shall be the upper limit or weekly exposure.
- If necessary, the 1milliSV per quarter may be received as single exposure, but this should be avoided as far as practicable.
- Radiographic contractor usually prepares a monitoring report base on periodic average measurement.
- The maximum permissible accumulate whole-body occupational dose at any age elder than 18 is computed by the following equation :
  \[ MPD = 50 (N-18) \] [MPD= Dose in milli Sv/year, N= Age in year]

5.4 Safety Equipment and Material

5.4.1 Film Badge & Pocket Dosimeter
The radiographer shall wear a film badge and a fully charged pocket dosimeter whenever in or near a radiation area. Pocket dosimeter shall be calibrated at least intervals of twelve months, and film badge shall be interpreted at least one month interval; the radiation dose of each personnel shall be measured and recorded on the personnel dose record as below interval;
  a) Film Badge: Monthly basis 
  b) Pocket Dosimeter: Daily basis or after each working shift

5.4.2 Thermo Luminescent Dosimeters
Thermoluminescent dosimeters (TLD) are often used instead of the film badge. Like a film badge, it is worn for a period of time and then must be processed to determine the dose received.

5.4.3 Survey Meter
The radiographer shall maintain an operable survey meter in the radiation area and use it to verify the area is safe. Survey meter must be calibrated at intervals of not more than twelve months.

5.4.4 Collimator
An appropriate collimator should be used to provide safe working conditions by restricting the radiation beam to minimum size necessary for the work.

5.4.5 Lead Shot
Lead Shot could be used for sealing unexpected radiation leaks around pipes, cracks, crevices and other unforeseen situations. Lead shot is available from stock bags or produced to order in gallon drums. Placed bags of lead shot reduced the rate of radiation.

5.4.6 Radiation Warning sign
Radiation restricted area shall be erected using rope barrier with radiation warning sign to keep non-classified personnel out of the radiation area. Flashing warning lamp must be used at every time and audible alarm shall be used particularly during daytime radiography. The size of this signs could be determined by HSE manager. (See attachment 1).

5.4.7 Audible Alarm Rate Meters and Digital Electronic Dosimeters
Audible alarms are devices that emit a short "beep" or "chirp" when a predetermined exposure has been received. These devices reduce the likelihood of accidental exposures in industrial radiography by alerting the radiographer to dosages of radiation above a preset amount. It is important to note that audible alarms are not intended to be and should not be used as replacements for survey meters.
Most audible alarms use a Geiger-Müller detector. The output of the detector is collected, and when a predetermined exposure has been reached, this collected charge is discharged through a speaker. Hence, an audible "chirp" is emitted. Consequently, the frequency or chirp rate of the alarm is proportional to the radiation intensity.

5.4.8 Lead Box
Use safely store radioactive substances in a lead lined box. This storage system is excellent for storing vials of isotopes, contaminated instruments and tools, radioactive samples, solutions or waste.

5.4.9 Tongs, Clamps, Etc
Use mechanical devices such as tongs, clamps, tweezers, etc., when manipulating radioactive materials to help minimize exposure. Use forceps, tongs, custom-designed holders and spacers to maintain distance between your hand and the source.

5.5 Storage of Gamma-ray Equipment
Gamma-ray exposure or transport camera shall be stored in the approved storage pit. The storage pit must have a lockable gate. An in-out log to record the storage and withdrawal of isotopes shall be maintained and kept at the storage pit area. Similarly, decay charts of all isotopes being stored shall be available at the storage pit area (see attachment 2).

5.6 Protection Factors of Radiation Exposure
This concept is based on the belief that exposure to certain agents could cause undesirable effects. ALARA (As Low As Reasonably Achievable) is the policy of minimizing radiation exposures and health effect resulting from work with radioactive materials. This concept is based on definition, which is maintaining exposures as the regulatory limits as practical with consideration of economics, state of technology, and other considerations. The three principal mechanisms of radiation protection are: time, distance, shielding.
The following controls either as stand alone or combined to minimize an uncontrolled dose to personnel:

5.6.1 Distance
The radiation intensity decreased inversely with the square of the distance from the source. The safe distance for unshielded radiation source based on a maximum permissible dose rate of (7.5 micro Sv/hr).

5.6.2 Time
The radiation exposure rate depends upon exposure time. The less time, lower the exposure rate shall be applied.

5.6.3 Shielding
When adequate distance protection is not practicable, the shielding materials such as lead, steel, or concrete are commonly used to reduce radiation. Half value thickness and tenth value thickness of shielding material are shown in the table 1.
TABLE 1- APPROXIMATE THICKNESS OF SHIELDING MATERIAL

<table>
<thead>
<tr>
<th>Radiation Source</th>
<th>Lead 1/2 Layer</th>
<th>Lead 1/10 Layer</th>
<th>Steel 1/2 Layer</th>
<th>Steel 1/10 Layer</th>
<th>Concrete 1/2 Layer</th>
<th>Concrete 1/10 Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ir-192 (gamma source)</td>
<td>5.5</td>
<td>19</td>
<td>13</td>
<td>43</td>
<td>43</td>
<td>145</td>
</tr>
</tbody>
</table>

5.6.4 General Rules of Good Practice (ALARA)
The basic rules are mentioned by management commitment. The RS is responsible for maintaining oversight of activities under the procedure and RSO reviews measures and examines collective doses and releases to the environment. General rule determines compliance with good practice principles as follow:

- Reduce unavoidable radiation exposure to the shortest time.
- Use any available shielding as additional safeguards.
- Maintain maximum distances while still keeping direct visual contact of radiation areas.
- Consider all hazards involved in the work, such as mechanical, electrical, chemical, biological, and fire.
- Keep radioactive containers covered when not in use.
- After working with radioactive materials, personnel should wash their hands and check hands and shoes for contamination.
- Monitor work surfaces and equipment for contamination.
- Use a collimator whenever possible.
- Use additional shielding such as bags of lead shot if we need any time.
- Use a survey meter, dosimeter, and film badge.
- Ensure that radiation exposure record keeping is available.
- Switch job duties with qualified individuals.
- Eating, drinking, smoking, food storage, in any area posted for the use and/or storage of radioactive materials is prohibited.
- Storage or use of radioactive materials in areas not approved by HSE department is prohibited (Such as non-authorized laboratories, hallways, and stairwells).

5.7 Handling Procedure

5.7.1 In site transport of Radiation Source
The radiation source will only be transported by the Radiation Safety Supervisor (RS) directly from source pit to working area and returned on completion of the works by the RS.
5.7.2 Disposal of Radiation Source
The disposal of wasted source shall be sent to radiographic contractor head office by RSO. The disposal of radioactive material must comply with Atomic Energy Organization of Iran (A.E.O.I.). It should be mentioned that we don't produce radioactive waste. The contracted certified radiographer is responsible for the route radioactive source is disposed. Properly packaged materials and picked up disposal will be provided by certified industrial radiographer in compliance with regulatory agency rules.

5.7.3 Off-site transport
Transporter is responsible for properly securing package in transport vehicle and delivering materials directly to location. The shipment of radioactive material must comply with Atomic Energy Organization of Iran (A.E.O.I.). When transporting the exposure device, it must be stowed securely in the vehicle. Radioactive materials shall not, at any time, be left unattended and No mode of public transportation shall be used to transport radioactive materials (e.g. bus).

5.7.4 Packaging and labeling
The package type and marking is determined by the radionuclide and the activity. There are three categories of package labels that could be mentioned by transporter as shown below;

<table>
<thead>
<tr>
<th>Maximum Surface Radiation Level</th>
<th>Label Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not more than 5 μSv/h</td>
<td>Category I-WHITE</td>
</tr>
<tr>
<td>Between 5 μSv/h and 500 μSv/h</td>
<td>Category II-YELLOW</td>
</tr>
<tr>
<td>Between 500 μSv/h and 2000 μSv/h</td>
<td>Category III-YELLOW</td>
</tr>
</tbody>
</table>

Magenta or black on a yellow background is the internationally recognized colors used to indicate the presence of ionizing radiation. Radiation warning signs indicate the types of exposure levels that may be present in the posted area.
5.8 Site Radiation Safety Procedure

The exposure camera in the lock position shall be monitored to confirm that the radiation dose rate does not exceed 100 micro Sv/hr at 5 centimeters from the surface of camera and 10 micro Sv/hr at 1 meter from the surface of camera. Radiographic subcontractor usually prepares a monitoring report based on periodic average measurement. The RS shall check the conditions of equipment and its accessories prior to operation. The RS and radiographer must wear dosimeter and thermo luminescence dosimeter (TLD), and use survey meter for monitoring source.

Before radiography commences, a controlled supervised radiation area must be established extending to a distance from source at which the dose rate does not exceed 7.5 micro Sv/hr. A radiation rate upper than 20 micro Sv means a forbidden area for any unclassified person. Initial perimeter barriers radiation warning signs shall be installed based on the calculated minimum Safety Boundary Distance (SBD). The distance shall be verified by exposing a bare (un-collimator) source and checking with a calibrated radiation dose rate monitor. This verification activity shall be witnessed by the site RSO. Once the minimum SBD is established, perimeter barriers & radiation warning signs/alarms may be readjusted.

Areas with a dose rate higher than 2 mSv/h is called forbidden area that must be secure, so that nobody can enter unchecked with any part of the body. Access is only permitted under specific conditions and if there is an absolute need for it, the body dose should be calculated and the personal dose measured.

Areas with a dose rate higher than 2.5 μSv/h to 7.5 μSv/h is called supervised area that must be taken to ensure that persons will not be exposed to a higher dose than 5 mSv per annum.

The radiographic set-up shall be completed before the sealed source is exposed. Radiographer must reduce exposure by using collimator, when radiography is performed using a gamma source.
During the radiography, the radiographer must monitor the radiation dose with survey meter in order to prevent a radiation accident and malfunction of equipment. A radiographer shall remain near the remote control device during exposure in order to retract the source in the event of the unauthorized accidental entry in to the radiation area. After using the sealed source, a survey meter shall be used to assure that the source has been returned into the safe position of exposure container. The exposure container shall be locked at all times except when in actual use or under the direct supervision of a radiographer. The exposure container shall be returned to the storage pit after completion of the radiography. During the radiography works, All Non- Authorized Persons will be prevented from entering the area.

Radiographic contractor shall accept approved radiographic work permit from HSE department prior to radiographic work commencement (Doc. Num. MA-64-POGC-001). HSE department will monitor radiographic work ensuring compliance with the condition on the permit.

Radiographic contractor shall perform monitoring radiation and medical surveillance (biological monitoring) for worker base on periodic examination and HSE department will review the record of documentation to ensuring compliance with the condition on the permit.

In addition radiography could be operated in solitude times such as night. Each radiography team shall have at least one survey meter and each member of team shall have a bleeper, one direct reading monitor and dosimeter.

Notice-1: It would better to consider the National Iranian Oil Company (N.I.O.C.) safety regulations are mandatory, PART-14: Occupational health.

Notice-2: It would better to consider the Atomic Energy Organization of Iran (A.E.O.I.) regulations, PART: Safeguarding in front of radius.

5.9 Emergency Procedure

5.9.1 General

Most incidents of emergencies with radioactive sources are due either to a source failing to return to the exposure container during or after use. In case of damage to the conditioning of a radioactive source, the first priority is to move all personnel away from the source. Competent person in charge of handling such materials have measurement and protection equipment. They know the size of the dangerous spherical volume around the source. The radius of this dangerous sphere depends on the strength of the source.

Action by Radiographer and Radiation Supervisor in the event of the above paragraph, the following steps shall be carried out, and the RSO at site should immediately take charge of the situation: The area must be evacuated to a distance measured as safe (radiation dose
rate below 7.5 micro Sv/hr) by means of a survey meter, and erect radiation warning barriers. No person must be allowed to pass the barrier except those engaged in recovery operation.

a) RSO in charge of what happened advising of the need to maintain strict observance of the controlled area by all personnel, until the emergency is resolved.
b) Plan a course of action, thinking it out carefully while outside the barriers. Calculate the ‘stay time’ at the recover working distance that may be allowed for classified personnel.
c) Ensure that a quartz fiber dosimeter is worn throughout operation in addition to the TLD or film badge.
d) Approach the exposed source quickly, and locate the source using survey meter. Place lead sheets over the source to reduce radiation level and attempt to return the source to camera using remote handling techniques.
e) Should this fail, front end terminal with source should be cut by any quick mean from the rest of the equipment, and exposed portion placed in lead box by means of long handling tongs.
f) Replace, if possible, a source which has become separated from its container. Use the long handling tongs and work quickly, keeping all parts of the body at arm’s length from the source. Do not pick it up with bare hands.
g) If the source can not be recovered, replace the shot attenuation, clear and seek professional advice.
h) No attempt will be made by other persons to clear this hazard.
i) The lead box and contents will then be placed in the storage pit.
j) The following action necessary shall be decided and accomplished by RS, i.e. check control unit with camera, urgent film badge or (TLD) examination. Full investigation of the incident circumstance, etc.
k) CONTRACTOR will be advised verbally first, and then in writing regarding any incident and near miss of this nature. The RS site should immediately take charge of the situation.

6- DEFINITION & ABBREVIATION

ALARA : ALARA is an acronym for a principle in radiation protection and stands for "As Low as Reasonably Achievable". The aim is to minimize the risk of radioactive exposure while keeping in mind that some exposure may be acceptable in order to further the task at hand.

Collimator : A radiation shield of lead or other heavy metal which is placed on the end of a guide tube or directly onto a radiographic exposure device to restrict the size and shape of the radiation beam when the sealed source is moved into position to make a radiographic exposure.
**Dose Rate:** Absorbed dose delivered per unit of time

**Film badge:** Personnel dosimeter film badges are commonly used to measure and record radiation exposure due to gamma rays, X-rays and beta particles. The detector is a piece of radiation sensitive film. The film is packaged in a light proof, vapor proof envelope preventing light, moisture or chemical vapors from affecting the film.

**Maximum Permissible Dose (MPD):** The largest amount of ionizing radiation that one may safely receive in a specified period according to recommended limits in radiation protection.

**Radiation:** Radiation is a form of energy. There are two basic types of radiation. One kind is particulate radiation, which involves tiny fast-moving particles that have both energy and mass. Particulate radiation is primarily produced by disintegration of an unstable atom and includes Alpha and Beta particles. The second basic type of radiation is electromagnetic radiation. This kind of radiation is pure energy with no mass and is like vibrating or pulsating waves of electrical and magnetic energy. Light waves, radio waves, microwaves, X-rays and Gamma rays are some examples of electromagnetic radiation.

**Radiographic Testing (RT):** RT is the use of ionizing radiation to produce detailed images of the objects.

**RHM:** Exposure expressed in Roentgen per hour at one meter from a gamma source of strength of one curie

**Roentgen:** It is the unit of exposure and one Roentgen is defined as the amount of radiation which will produce one electrostatic unit of charge in one cc of air at Normal Temperature and Pressure (NTP).

**Sievert (Sv):** The SI unit of absorbed dose equivalent (1 Joule/Kilogram or 100 rems).

**Survey meter:** The survey meter is the most important resource a radiographer has to determine the presence and intensity of radiation.

7- **REFERENCES**

1- Atomic Energy Organization of Iran (IEOI)

2- National Iranian Oil Company (N.I.O.C.) safety regulation, part :14

3- International Commission on Radiological Protection (ICRP)
8- APPENDIX
   APPENDIX 1. Radiation warning signs
   APPENDIX 2. Drawing of Radiation Source Storage Pit
   APPENDIX 3. Area classification for Radiography operating
   APPENDIX 4. Unit Conversion Table
   APPENDIX 5. Type of Radiation
APPENDIX 1. Radiation warning signs.
APPENDIX 2. Drawing of Radiation Source Storage Pit

RI Storage Pit Drawing

Detail "A"

Shield: Steel: 3mm
Sand & Soil: about 3M
Concrete: 200mm
Lead: 11mm (only upper)
Classification Area for Radiography operating

(Distance calculation for Ir192 in meter)

APPENDIX 3. Area classification for Radiography operating

\[ D = \sqrt{\frac{A \cdot t \cdot \gamma}{\text{rem}}} \]

- **D** = Safe Distance = m
- **A** = activity = Ci
- **t** = time = hour
- **g** = Gamma factor = for Ir192 = 0.48 R * m² / Ci * hr
- **rem** = for 7.5 μSv/hr = 0.00075 (Controlled Area)
- **rem** = for 2.5 μSv/hr = 0.00025 (Supervision Area)

For Forbidden Area (2 m Sv / hr) = 1.6 \( \sqrt{\text{Ci}} \) = (approximate distance)
For Controlled Area (7.5 μSv / hr) = 26 \( \sqrt{\text{Ci}} \) = (approximate distance)
For Supervision Area (2.5 μSv / hr) = 44 \( \sqrt{\text{Ci}} \) = (approximate distance)
APPENDIX 4. Unit Conversion Table

Unit Conversion Table: Roentgen & Sievert

<table>
<thead>
<tr>
<th></th>
<th>1.0</th>
<th>10</th>
<th>100</th>
<th>1000</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>microrem/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>millirem/h</td>
<td>0.001</td>
<td>0.01</td>
<td>0.1</td>
<td>1.0</td>
<td>10</td>
<td>100</td>
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<tr>
<td>rem/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td>0.01</td>
</tr>
<tr>
<td>microSv/h</td>
<td>0.01</td>
<td>0.1</td>
<td>1.0</td>
<td>10</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>milliSv/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td>0.01</td>
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<tr>
<td>Sv/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td>0.01</td>
</tr>
</tbody>
</table>

If radiometer calibration by rem we can use the following formula:

\[
2.5 \text{ microSv/h} = 0.25 \text{ millirem/h}
\]

APPENDIX 5. Type of Radiation

Type of Radiation

<table>
<thead>
<tr>
<th>RADIATION</th>
<th>SHIELD</th>
<th>HAZARD</th>
<th>INDUSTRIAL APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha Particles α</td>
<td>Paper</td>
<td>Internal—Inhalation/Ingestion</td>
<td>Smoke Detectors</td>
</tr>
<tr>
<td>Beta Particles β</td>
<td>Up to 1 cm Perspex</td>
<td>Internal—Inhalation/Ingestion External—Superficial Tissues</td>
<td>Emergency Lighting</td>
</tr>
<tr>
<td>Neutron Particles</td>
<td>Paraffin Wax Polythene or Water</td>
<td>Internal/External</td>
<td>Well-Logging</td>
</tr>
<tr>
<td>Gamma Rays γ</td>
<td>Lead or Concrete</td>
<td>Internal/External</td>
<td>Radiography and Well-Logging</td>
</tr>
<tr>
<td>X-Rays</td>
<td>Lead or Concrete</td>
<td>External</td>
<td>Medical</td>
</tr>
</tbody>
</table>
SUGGESTIONS FOR THE POGC
RADIOGRAPHY SAFETY PROCEDURE

MANAGER, HSE Department
Pars Oil & Gas Company
Tehran I.R. Iran

Please consider the following suggestion(s) relative to the POGC Radiography safety procedure:

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______________________________________________________________________________________________
______________________________________________________________________________________________

(Signature)

(Date)

(Address)

Contact Telephone Number

Contact FAX Number