Sesfa	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr		TECHNICAL SPECIFICATION
Doc No: DSF-SPC-PIP-	005	Rev. 1	Page 1 of 11



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Table of Contents

1	INTRODUCTION	.4
2	SCOPE AND OBJECTIVES	.4
3	REFERENCES	.4
4	ACRONYMS	. 5
5	MAXIMUM PERMISSIBLE RADIATION DOSES	. 6
6	CONTRACTOR'S RESPONSIBILITIES	.7

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Doc No: DSF-SPC-PI	P-005	Rev. 1	Page 4 of 11

1 INTRODUCTION

lonizing radiation (electromagnetic or corpuscular) is harmful. NDT Radiographic procedures normally include x or γ -rays radiographic techniques for Inspection and Control of welds in Industrial Systems and Constructions (e.g. pipeline welding), and their users must primarily be concerned and full responsible to protect their personnel (radiographers etc) and the general population by establishing the appropriate safety measures and health regulations for personnel protection against x and γ -rays.

The radiographic equipment used, either x-ray tubes or γ -ray sources (Iridium sources) are hazardous to humans.

The hazardous equipment/material or operations shall not be used if the proper protective measures are not implemented.

Every effort shall be made in order to minimize all hazards and especially of the biological effects of ionizing radiations, as it is clear that tissues and cells experience changes or reactions when are exposed to a certain dose of radiation. These changes or reactions vary and are depended from the absorbed dose of the human organ exposed to each type of radiation and the time. There are non-stochastic and stochastic effects on the human tissues, organs and body in general, that have immediate reactions or changes and may appear later or after many years, without any previous indications. The long term somatic effects can be caused by the cumulative even low dosages of radiation received and occur independently of the actual dose rate. Genetic defects can be caused by extremely low radiation doses and occur at a rate related to the overall population exposure. So the personnel and the general population must be protected against ionizing radiation.

2 SCOPE AND OBJECTIVES

The scope of this document is to provide the basic principles to be followed by the Contractor for radiation protection study and application for the x or γ -rays for radiographic welding inspection of a Pipeline Project. For all practical purposes, the harmful radiation emitted by x-ray equipment or γ -ray radioactive sources are to be considered the same and the Hellenic Legislation requirements of Presidential Decree 101/2018 and Ministerial Decree 45872/2019 apply.

3 REFERENCES

3.1 Reference Documents

- Technical Specification No. DSF-SPC-PIP-001 [WELDING FOR EQUIPMENT AND PIPING]



- Technical Specification No. DSF-SPC-PIP-004 [WELDING INSPECTION]
- Technical Specification No. DSF-SPC-PIP-012 [WELDING]
- Technical Specification No. DSF-SPC-PIP-023 [WELDING INSPECTION OF PIPING FOR M/R STATION]
- Technical Specification No. DSF-SPC-QAC-006 [INSPECTION AND TEST INSTRUCTIONS]

3.2 Reference Codes and Standards

- Presidential Decree 101/2018, (ΦΕΚ 194/Α/20.11.2018) «Προσαρμογή της ελληνικής νομοθεσίας στην Οδηγία 2013/59/ΕURATOM του Συμβουλίου, της 5ης Δεκεμβρίου 2013, για τον καθορισμό βασικών προτύπων ασφάλειας για την προστασία από τους κινδύνους που προκύπτουν από τις ιοντίζουσες ακτινοβολίες και την κατάργηση των Οδηγιών 89/618/EURATOM, 90/641/EURATOM, 96/29/EURATOM, 97/43/EURATOM και 2003/122/EURATOM (ΕΕ L13/17.1.2014) Θέσπιση Κανονισμών Ακτινοπροστασίας»
- Ministerial Decree 45872/2019, (ΦΕΚ 1103/Β/03.04.2019) «Διαδικασίες κανονιστικού ελέγχου πρακτικών ιοντιζουσών ακτινοβολιών αναγνώριση υπηρεσιών και εμπειρογνωμόνων»

4 ACRONYMS

EEAE	Greek Atomic Energy Committee (Ελληνική Επιτροπή Ατομικής Ενέργειας)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units & Measurements
LNG	Liquefied Natural Gas
NG	Natural Gas
HSE	Health, Safety and Environment
PPE	Personal Protective Equipment



5 MAXIMUM PERMISSIBLE RADIATION DOSES

Since ionizing radiations produce undesirable effects on the body tissues, the user must observe the maximum permissible levels of radiation as are imposed and stipulated by the latest National or International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA) and several Decree's, National Governmental Gazettes, i.e. Presidential Decree 101/2018 and Ministerial Decree 45872/2019 etc.

The permissible dose is a dose of ionizing radiation that in the light of present knowledge is not expected to cause appreciable bodily injury to a person at any time during his lifetime.

Although it is difficult to define thresholds or permissible levels for the maximum "dose" of radiation (or more precisely of "Equivalent Dose") absorbed, the values which are applying for external radiation are mentioned below under specific conditions (see also Presidential Decree 101/2018).

The ICRP limits for occupational workers are 20 mSv per year, averaged over defined periods of five years, with the further provision that the dose should not exceed 50 mSv in any single year.

- Effective dose limits for occupational exposure per any single year:

CATEGORY	DOSE LIMIT
Professionally exposed Personnel at work aged 18 or over	20 mSv (2.0 rem)
Professionally exposed trainees aged 16-18	6 mSv (0.6 rem)
Any other person	1 mSv (0.1 rem)

- Equivalent dose limits for the lens of the eye per any single year:

CATEGORY	DOSE LIMIT
Professionally exposed Personnel at work aged 18 or over	20 mSv (2.0 rem)
Professionally exposed trainees aged 16-18	15 mSv (1.5 rem)
Any other person	15 mSv (1.5 rem)

- Equivalent dose limits for the skin (1cm²) and extremities per any single year:

CATEGORY	DOSE LIMIT
Professionally exposed Personnel at work aged 18 or over	500 mSv (50 rem)
Professionally exposed trainees aged 16-18	150 mSv (15 rem)
Any other person	50 mSv (5 rem)

- Equivalent dose limits for women of reproductive capacity:

CATEGORY	DOSE LIMIT
During pregnancy	1 mSv (0.1 rem)

Sesfa	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr		TECHNICAL SPECIFICATION
Doc No : DSF-SPC-P	IP-005	Rev. 1	Page 7 of 11
		1	

0 mSv (0 rem)

Whilst the subject of permissible levels of radiation is a complex one, the dose per hour for the whole body can be derived by interpolation.

The above value is usually used in the calculations of safety barriers for x-ray and gamma-ray installations for the personnel protection.

6 CONTRACTOR'S RESPONSIBILITIES

During breastfeeding

The Contractor shall prepare and submit for reviewing by Owner's Representative following Engineer's recommendation, a complete safety study for the radiation protection taken into consideration x or γ -rays equipment and the provisions of the Greek Atomic Energy Committee (EEAE) as well as Presidential Decree 101/2018 and Ministerial Decree 45872/2019 legislative requirements.

6.1 Safety Study for the Radiation Protection

The safety study shall include as minimum:

- Radiation Calculations, taken into consideration all technical data such as equipment source radio-activity geometry and direction of it, radiation factors, exposure time and total exposure at minimum distance from source, use of direction equipment, safety barriers etc.
- Protection Measures deriving from the above calculations.
- Procedures describing how the above safety protection measures shall be implemented including all the relevant tests and measurements to be performed (according to ICRP and ICRU) in order to prove the adequacy of the applied protection measures. The aforementioned procedure shall include the relevant record forms for the measurements taken.

For safety reasons in residential areas the activity of Ir-192 shall not exceed 2 Ci.

6.2 Reduction of Radiation

Distance, time and shielding are the methods that shall be applied by Contractor for reducing radiation below the maximum permissible levels of doses in accordance with provisions of §5 (above) and other National Legislation requirements as described at Presidential Decree 101/2018 and Ministerial Decree 45872/2019.

6.2.1 DISTANCE

δesfa	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr		TECHNICAL SPECIFICATION
Doc No : DSF-SPC-PIP-	005	Rev. 1	Page 8 of 11

This is an effective method of protection because Gamma and X-radiation emitted by point sources obey the inverse square law, that is the radiation intensity decreases with the square of the distance. Conversely, dose rates at close distances can be extremely high, even for small sources. It is essential, therefore, that sealed sources are never handled directly, but only by remote controls.

6.2.2 TIME

This is also an acceptable method of protection because high dose rates can be accepted over short periods of time, provided that the cumulative dose remains low. The maximum permissible doses as per Presidential Decree 101/2018 and Ministerial Decree 45872/2019 are determined by suitable weighted measurements for the whole body dose for any person from all above methods.

6.2.3 SHIELDING

To lessen harmful radiation, shield materials of high density, such as lead, depleted uranium, or tungsten, shall be used.

A sealed source is constantly emitting radiation and cannot be switched off. To reduce radiation emitted and to facilitate handling of the unit, the sealed source is housed in a shield which is normally made of depleted uranium.

In the use of X-ray equipment, no precautions against emitted radiation are necessary until the electric power is turned on.

6.3 Classification of Personnel

For the classification and protection of personnel, the provisions of Presidential Decree 101/2018 and Ministerial Decree 45872/2019 shall be applied and shall be strictly followed. It must be understood that the classification of personnel does not grant immunity against radiation.

6.3.1 CLASSIFIED PERSONS

Any person who, in the course of his work, is expected to deal with ionizing radiation must be classified. This means that he will have undergone an annual medical examination and that his base line blood count is known. Competent persons and radiographers are Classified Persons.

A Classified Person must wear a film badge which shall be changed at regular intervals and a personal dosimeter at all times when using radioactive material.

6.3.2 COMPETENT PERSONS



Competent Persons are classified personnel who are not normally directly concerned with ionizing radiation but who are capable of dealing with emergency situations and of supervising the use of radioactive equipment.

6.3.3 NON-CLASSIFIED PERSONS

Non-classified Persons are members of the general public who are not exposed to ionizing radiation as part of their jobs.

6.4 Responsibilities for Safe Handling

The Contractor shall appoint Competent Persons to be responsible for the immediate supervision and the enforcement of instructions and standards.

6.4.1 COMPETENT PERSON

The Competent Person will make frequent checks at the beginning of each shift on the zeroing and recharging of dosimeters and on the condition of the equipment.

This person must familiarize himself with all new equipment so that the correct action can be taken in any emergency situation involving the equipment.

6.4.2 RADIOGRAPHER

The Industrial Radiographer should have a firm understanding and should follow strictly the Radiation Protection International requirements as well as Local National Regulations, Presidential Decree 101/2018 and Ministerial Decree 45872/2019, EU Directives, IAEA, ICRP instructions, Codes and Standards etc. imposed in order that may perform his duties without compromising the health and safety of personnel and general public.

At the start of each shift, the Radiographer must ensure that all equipment is in safe working order. All malfunctions must be reported to the Supervisor of Competent Person immediately. The Radiographer must also make sure that he is wearing a valid film badge and a dosimeter which has been charged and zeroed. One radiation monitor must be available for each source in use. Equipment must be transported to the work site with the safety locks in place.

Under no circumstances should equipment be transported in an unsafe condition.

Upon arrival at the job site and prior operating with any sealed source, the Radiographer must ensure than non-classified persons will not be subjected to more than the permitted level of radiation in accordance with the requirements of Presidential Decree 101/2018 and Ministerial Decree 45872/2019.

Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr		TECHNICAL SPECIFICATION	
Doc No: DSF-SPC-PIP-005		Rev. 1	Page 10 of 11

To keep non-classified personnel out of the radiation area, radiation warning and prohibition signs must be clearly displayed and a rope barrier and a flashing light erected.

The limits of the radiation area are determined in accordance with Presidential Decree 101/2018 and Ministerial Decree 45872/2019 by the experienced and qualified radiographer.

A weekly report on the condition of all equipment should be passed to the Supervisor. This report should cover loss, damage, and general wear and tear.

6.5 Storage Areas

Upon completion of work or at the end of each work period, every radioactive source shall be returned to a safe storage area, in accordance with the requirements of Presidential Decree 101/2018 and Ministerial Decree 45872/2019, while the most effective means of storage is within a properly constructed, clearly signed and fenced off compound.

In permanent storage areas a proper fence with a security gate must be installed. For temporary storage areas a rope barrier must be erected around the hazardous area.

In both permanent and temporary storage areas radiation warning and prohibition signs must be fixed to the barriers.

Sources must never be left at any time in the back of a truck whether or not they are under lock and key.

6.6 **Procedure and Forms/Reports**

Contractor shall prepare and submit for reviewing by Owner's Representative following Engineer's recommendation, a complete HSE Procedure for Protection against Radiation, according to this Specification which will be applied to all related works.

The aforementioned HSE procedure shall incorporate:

- Responsibilities of Contractor's involved personnel based on National Legislation requirements.
- Risk Assessment for all related work activities.
- Safe transportation of NDT equipment and material.
- Radiation control, medical requirements and basic dose limits.
- Specific safety measures regarding safe performance of NDT works.
- HSE training and Certifications.
- Personal Protective Equipment (PPE) to be used with relevant CE marking.



- Emergency Radiation Plans and immediate actions to be perceived in case of emergency.
- Sample Reports to be prepared and submitted.

6.7 NDT Contractor Licences, Permits etc.

All Contractors performing NDT radiographic Inspection in Greece must comply to the Greek Presidential Decree 101/2018 and Ministerial Decree 45872/2019 and any other relevant National Law requirements.

All Contractors must be in possession of:

- a current and valid Import Licence for each radiographic source.
- a current and valid Licence for the use of each radiographic source.
- a current and valid licence for the storage and transport of sources.
- a calibrated and certified radiation measurement device.

All personnel must be trained, qualified and equipped with the correct licence, film badge, and registered with the Greek Atomic Energy Committee.

The Contractors must inform, train and warn all involved personnel, the general public and the Authorities for the program of their works (x- or γ -rays) and their consequences.