1. Module Details	
Module name	**RADIOGRAPHY AND RADIATION SAFETY**
Nominal duration	1 modules It is anticipated that a learner holding the prescribed entry level skills will achieve the module purpose in 35 to 40 hours
Module Codes	EA612
Discipline Code	Non-destructive testing (Code to be allocated)
2. Module Purpose	To provide learners with knowledge of the principles of industrial radiographic testing, and to gain a detailed understanding of the hazards and safety procedures that must be applied when using X-ray and gamma ray equipment.
3. Prerequisites	Nil
4. Relationship to competency standards	This module meets the educational requirements for the issue of a radiation safety licence under the NSW Radiation and Radioactive Materials Act and, in association with the module Industrial Radiography (1144B), these modules meets the training requirements for Level 2 qualification in radiographic testing under AS3998-1992 "Non-destructive Testing - Qualification and Certification of Personnel - General Engineering" and AS-3669-1989 "Non-Destructive Testing - Qualification and Registration of Personnel - Aerospace". Currently no national competency standards have been established at national level. However, the learning outcomes in this course relate to ASF level 5-6.
5. Content	**Production of X-rays and gamma rays** Atomic structure, protons, neutrons, electrons, atomic number, mass number, isotopes. Electromagnetic radiation -wavelength, frequency, energy relationships, intensity. Construction and operation of X-ray tube - anode, cathode, target. Gas and Coolidge tubes. Glass and ceramic tubes. X-ray spectrum - Characteristic and continuous spectra - effect of voltage and current on continuous spectra. Efficiency. Natural and artificial radioisotopes. Production of radioisotopes Decay mechanisms - alpha, beta-, beta+, and gamma. Concept of half life, decay constants. Selection of gamma ray sources. Units - definition of curie, becquerel, conversion of units, multiple units (eg GBq), nuclide chart. **Biological Effects of Radiation** Ionisation, absorption, scatter (Compton, Rayleigh, photo-electric, pair production)

	Attenuation coefficient, absorption edges Units Roentgen, Rad, Coulomb/Kg, Gray. Conversions. Effects of varying doses on living tissue Somatic effects, Genetic effects - cell biology nucleus, cytoplasm, DNA, chromosome, mitosis. Symptoms, effect of time, ICRP recommendations. Dose, dose equivalent, RBE, Rem, Seivert, conversions. Occupancy factor. **Safety Procedures** Types of X-ray equipment Types of isotope cameras Shielding materials Design and requirements for exposure areas Requirements for storage of radioisotopes **Minimising the Dose** Time, distance, shielding. Effect of distance - inverse square law Half and tenth value layers. Emergency procedures, company procedure codes **Radiation Monitoring** General principles - gas ionisation, photographic effect, luminescence. Use of film, film badges, T.L.Ds, ionisation chamber devices, quartz fibre, fluorescent, electronic devices - accuracy, limits (energy/range). **Legal Requirements** Aust./State regulations, Code of Practice (detail). ICRP recommended limits for various persons and various parts of the body for short term, long term and accumulated exposure. Background radiation. Duties of RSO Requirements for transport. IATA regulations. Obligations of the licensee
6. Assessment strategy	Competency based assessment applies. Assessment should be carried out by gathering evidence using a variety of methods or instruments that have validity according to the learning being assessed.
Assessment method	Multiple choice and short answer questions. Written assignments and demonstrated competence through assigned tasks. Final assessment will be by a written examination and practical examination as required by AS3998 for Level 2 Certification.

Conditions of assessment	Assessment will be conducted by suitably qualified assessors, as required by AS3998. The candidate will have access to any equipment, materials and documentation as required for the assessment.
7. **Learning outcome details**	On completion of this module, the learner will be able to
8. **Learning outcome 1**	Describe how X-rays and gamma rays are produced
Assessment criteria	1.1 Sketch and label an X-ray tube, and label a simple atomic model. 1.2 Describe how X-rays and gamma rays are generated. 1.3 Differentiate natural and artificial radioisotopes, and describe the decay processes of radioisotopes. 1.4 Use charts and tables to determine levels of radioactivity.
Learning outcome 2	Describe how ionising radiations absorbed by matter and the biological effects of ionising radiation on living matter.
Assessment criteria	2.1 Explain the processes of absorption and scatter that occur when radiation passes through matter. 2.2 Explain the significance of the various units used to assess ionising radiation. 2.3 Describe how ionising radiation affects living matter and the effect of differing quantities and time on these effects.
Learning outcome 3	Set up and maintain safety controls when working with ionising radiation.
Assessment criteria	3.1 Explain the operation and safety features of various types of radioisotope cameras and X-ray equipment. 3.2 Determine the criteria for the design of exposure areas and storage areas for X-ray and gamma ray equipment.
Learning outcome 4	Describe and implement methods to minimise exposure to radiation workers and to the general public.

Assessment criteria	4.1 Correctly select and use equipment to detect and measure ionising radiation. 4.2 Describe the three factors that can be controlled to minimise radiation exposure to individuals and apply these procedures. 4.3 Calculate shielding thicknesses using first principles as well as tables and charts.
Learning outcome 5	Select and correctly use appropriate radiation monitoring equipment.
Assessment criteria	5.1 Describe the various types of radiation monitoring equipment and their limitations. 5.2 Select equipment and determine radiation fields using safe working techniques.
Learning outcome 6	State and discuss the requirements of the State and Federal Acts and Regulations pertaining to industrial use of X-ray equipment and radioisotopes.
Assessment criteria	6.1 Describe the important aspects of the State regulations as outlined in the Code of Practice for Industrial Radiography. 6.2 Apply the safety requirements of the Act and the Code of Practice in actual situations. 6.3 Prepare radioisotope equipment for safe transport in accordance with regulations.
7. **Delivery of the module**	This module may be taught by active participation, illustration, demonstration and description. This module is practical in nature and theoretically integrated to complement the acquisition of practical skills.
Delivery strategy	This module may be taught and assessed on or off-the-job. The module has a high practical content. Theory and practice will be taught concurrently. There will be a range of learning activities including modified lectures, practical work and project work.

Resource requirements	Human resources • trainer/teacher/mentor • Physical resources • appropriately equipped training room • relevant equipment and information • legislative and regulatory documents
Major texts and references	RECOMMENDED TEXT Radiography & Radiation Safety - P.A. Sheedy (In preparation - Publisher: Technical Secretarial Service) Code of Practice for Industrial Radiography - Environmental Protection Authority of NSW PRACTICAL TEXT Practical Radiography - P.A. Sheedy REFERENCES Non-Destructive Testing Handbook, 2nd Edition, Vol. 3, Radiography Radiation Testing. ASNT, 1985. Industrial Radiography, R. Halmshaw, 1982. Radiographic NDT, G.L. Becker. Du Pont NDT Systems, 1990. Radiation Safety Handbook, Tech Ops. 1986 Working Safely with Gamma Radiography, S. McGuire, 1989. STANDARDS Radioactive Materials and Radiation Emitting Apparatus - NSW Government Act and Regulations
Occupational health and safety requirements	Learners and/or employees undertaking this module should have demonstrated competencies as defined in the Metal & Engineering Industry Standards Unit No 1.2F - Apply principles of OH&S in the work environment. This would apply in the classroom, practical room or workplace.