



iQVet project D2.2

D2.2 Best practice pedagogical guideline on the welding inspector course

MHtE, *rev2*.

Introduction

This guideline demonstrates best pedagogical practices in the teaching of the welding inspector course. The course is divided into 10 competence units (CU). The CUs are led and taught online or on-site. During the course, the priority is to give hands-on practical examples and tasks to the students and thus implement the work-based learning (WBL) educational methodology. The evaluation of the students performance is also organized online, through a LMS.

The application of the work-based learning methodology

Work-based learning (WBL) is an up-to-date educational strategy, providing real-life work experiences through actual examples from the industry. With WBL the students can improve their technical and problem-solving skills through working on an actual task, which likely to appear during in their future professions.

In the case of the Welding Inspector course, the WBL technique is recommended to be adopted by the following way. The students, who engage in the program, will need to work on a task, bringing their own ideas and their own solution, with the background of the competence unit materials. The teacher is handing out a real technical drawing of a welded product, such as a pressure vessel, storage tank, pipeline, steel structure, etc., coming from an industrial stakeholder. The students are need to go through steps, defined in the competence units, and give their own ideas about the solution individually. The following scenario can be possibly followed:



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1. Revision of the contract elements, data sheets, design of the welded structure
2. Designation of the welded joints to be inspected, according to standards, laws, and risks
3. Design the financial needs to perform these inspections
4. Select the appropriate and obligatory non-destructive and destructive materials testing methods, and select the acceptance criteria
5. Design the necessary post processing methods, such as cleaning, painting
6. Build a table of contents for the material testing documentation, and make a decision about the required correctional actions, maintenance, remaining lifetime
7. Feedback from the teacher, group discussion, personal interviews about the task, the difficulties, etc.

Competence units, and their content

The welding inspector course is based on the following 10 competence units. The competence units are following each other in their content. The acquisition of the competence unit materials is necessary to solve a real-life problem, described in the following section.

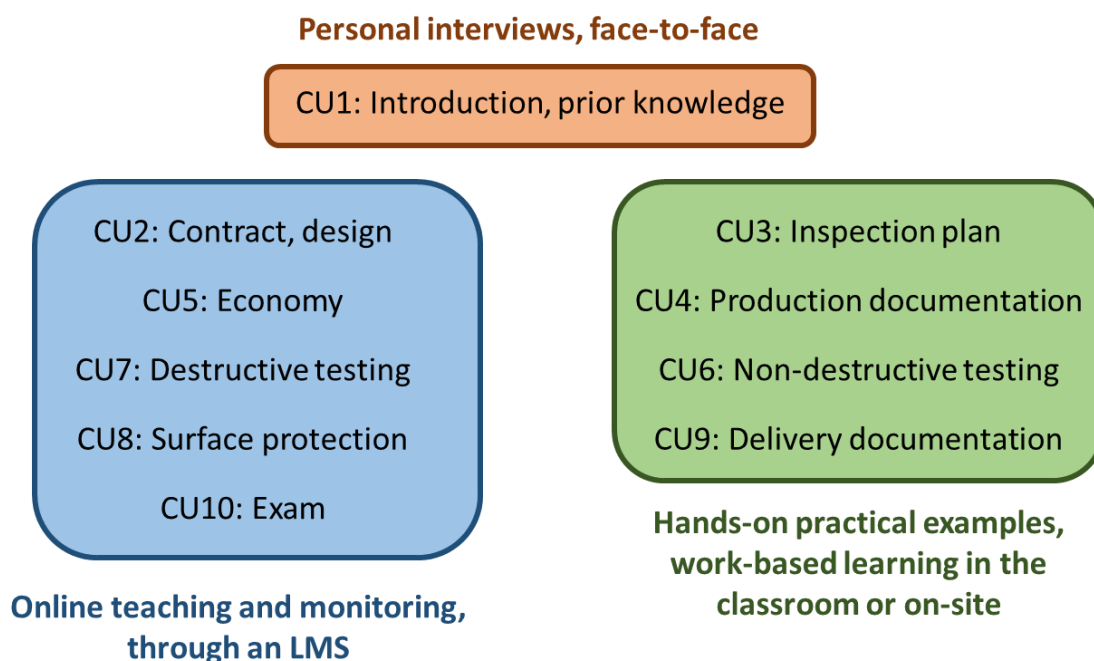


Figure 1. The system of the competence units

CU1 – Introduction, prior knowledge

This competence unit is necessary to assess the prior knowledge of the students, and also the balance the level of knowledge, because students can attend to this program with different backgrounds and diplomas. This competence unit is recommended to be done face-to-face, so the teachers can personally get in touch with them, and also can perform interviews about what the students are expecting to acquire after the completion.

Content

Definitions of welding, materials testing, welding processes, materials science, mechanics, design.

General learning outcomes

Students will know the basic welding procedures, their advantages and disadvantages. The students will get knowledge in the materials testing procedures, related standards, sample sizes. Students will get knowledge in crystal structures, crystal defects and their effects on the mechanical properties.

Specific learning outcomes

Knowledge of gas metal arc welding, gas tungsten arc welding. Knowledge of tensile testing, impact testing, bending testing, hardness testing and metallography. Knowledge of imperfections according to ISO 6520-1 standard. Knowledge of the 7 types of ideal crystal lattices, the point like crystal defects, dislocations, grain boundaries.

Competencies

Knowledge

- Knows the basic principles of welding procedures, materials testing and materials science.
- Knows how to perform a standardized materials testing.
- Can estimate the mechanical properties, based on different imperfections.

Skill

- Evaluate the materials testing results and interpret the standardized mechanical properties.
- Can select the proper welding procedure for the welding of a steel structure.

Attitude

- Strives to put the latest results of the field at the service of their own development.
- Willing to take part in life-long learning in the topic of welding and materials testing.

Independence and responsibility

- Can evaluate the materials testing results independently.
- Can make decisions in the further steps of maintenance, reparation.

CU2 – Contract elements, design review

In this CU the students learn how to interpret the contract elements of a welded structure. Also, the assessment of the design is obligatory. This step is needed to make them able to decide the main risks of the welded joints. This competence unit is advised to be held online, where supportive materials, such as pre-recorded explanatory videos can be shown. The students will pass this course through an LMS, where an essay is need to be uploaded, and also at least 60% score has to be achieved during a multiple-choice questionnaire.

Content

The students will learn the assessment steps according to different national and international standards, in order to be able to classify welded pressure vessel.

General learning outcomes

Knowledge of national and international standards. Knowledge on the necessary data, which should be registered of a welded structure. Knowledge of the basics of design.

Specific learning outcomes

Knowledge of standards related to pressure vessels welded structures (e.g.: EN 1090), what are their content, and how to implement them to a manufacturing company. Knowledge of basic design considerations: statics, mechanics, loads and requirements.

Competencies

Knowledge

- Knows the basic principles mechanics, statics and dynamics.
- Knows the different behaviors of materials to static and dynamic loads.
- Knows how the content and the usability of related international standards.

Skill

- Understands basic design principles.
- Can use related standards and can advise standards to manufacturing companies.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.

Independence and responsibility

- Can read and understand related standards independently.

CU3 – Planning the testing and inspection

In this competence unit, the work-based learning methodology should be implemented. The students get a technical drawing of a welded structure, and they need to plan the materials testing accordingly. The evaluation will be done by a teacher, where all the questions and planning steps can be discussed individually, taking into attention that, the students will have to work independently in the future.

Content

In this competence unit, the students need to designate the material testing locations, processes, extents, internal/external inspections, on-site inspections, inspection during manufacturing, during operation.

General learning outcomes

Knowledge of destructive and non-destructive testing methods and how to apply them to the inspection of welded structures.

Specific learning outcomes

Knowledge of visual inspection, penetrant testing, magnetic particle testing, ultrasonic inspection and radiography. Knowledge of their limitations, and the related standards. Knowledge of how to design a testing plan for each of the listed non-destructive testing methods.

Competencies

Knowledge

- Knows the basic principles of non-destructive testing.
- Knows the basics of physics related to radiography and ultrasonic testing.
- Knows how the content and the usability of related international standards.

Skill

- Can design an inspection plan of a welded structure.
- Can select the suitable materials testing methods to safely inspect a welded structure.

Attitude

- Willing to learn new methods in non-destructive testing.
- Strives to improve international standards in the topic.

Independence and responsibility

- Can design an inspection plan independently.
- Responsible for the safe operation of a welded structure.

CU4 – Production documentation

In this competence unit, the work-based learning methodology should be implemented. The teacher will discuss the prepared documentation of each students during an online discussion, where the proper feedback will also be given.

Content

Highlight the locations based on the risk and testability, material data sheet, welding specifications.

General learning outcomes

Knowledge of how to document the production of a welded structure.

Specific learning outcomes

Detailed knowledge on international standards, which describe the data sheet of welded structures. Knowledge of the basics of manufacturing and production methods, steel making, welding, forming.

Competencies

Knowledge

- Knows the basic production methods.
- Knows the basic principles of steel making, welding and forming.

Skill

- Understands basic production methods.
- Can use related standards and can advise standards to production companies.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.

Independence and responsibility

- Can independently document the production of a welded structure.

CU5 – Economy

In this CU the financial consideration will be look through. The financial considerations need to be taken into attention during the design, inspection, and maintenance stages. The students should be able to select only the necessary materials testing methods, which ensures the safe operation until the next inspection period. Real-life studies can be used in order to show actual financial detail on welded structure inspection. This competence unit will be taught online, where the financial theoretical background can be supported by video materials and frequent consultations. Into the consultation sessions industrial partners can also be involved. The evaluation will be done in an online test, using an LMS.

Content

Basics of finance, financial considerations in the production and inspection of welded structures. Economy of the design of inspection plans.

General learning outcomes

Knowledge of the basics of finance and economy.

Specific learning outcomes

Financial considerations of the production of a welded structure and the design and performing an inspection plan.

Competencies

Knowledge

- Knows the basic principles of finance and economics.
- Knows the financial considerations of the production and the inspection of a welded structure.

Skill

- Can design and perform an inspection of a welded structure with the consideration of financial relations.
- Understands the mechanisms of procurement.

Attitude

- Strive to design economical inspection plans, considering safety and ecological relations.

Independence and responsibility

- Independently designs cost-effective inspection and reparation plans.

CU6 – Non-destructive testing

The unit starts with a theoretical background on the physics of different testing methods. After the theoretical overview, the students get hands-on practical tasks on different NDT techniques, as a work-based learning method. For this purpose, previously prepared welds can be used, which contains certain flaws. The students need to learn how to detect these flaws, also under special circumstances, such as confined spaces, dark areas, etc. The evaluation is done by the teachers and professional, during face-to-face oral interviews.

Content

In this CU the application of different NDT methods, such as, visual testing, penetrant testing, magnetic particle inspection, ultrasonic testing, radiography is presented.

General learning outcomes

Knowledge of the theoretical background on the physics of non-destructive testing.

Specific learning outcomes

Knowledge of visual testing, penetrant testing, magnetic particle testing, ultrasonic testing, radiographic testing. Knowledge of flaws, indications, and their effects on the structural integrity of welded structures.

Competencies

Knowledge

- Knows the basic principles of the physics of different non-destructive methods.
- Knows the application of different non-destructive methods.
- Knows the effects of flaws on the structural integrity of welded structures.

Skill

- Can perform basic non-destructive testing methods.
- Can select the appropriate non-destructive testing method to ensure structural stability of a welded structure.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.
- Willing to improve the knowledge in non-destructive testing methods.

Independence and responsibility

- Independently selects the appropriate testing methods.

CU7 – Destructive testing

In this CU the application of different DT methods, such as, tensile testing, Charpy V-notch, hardness measurement, macro- and micrography is presented. After the theoretical overview, the students get a practical overview on the sample preparation and on performing the tests. This is supported by online video materials, as actual welded structures cannot be tested destructively. The evaluation is done through an online questionnaire in an LMS.

Content

Theoretical background and standards of tensile testing, Charpy V-notch, hardness measurement, macro- and micrography.

General learning outcomes

Knowledge of the theoretical background on the physics of destructive testing.

Specific learning outcomes

Knowledge of tensile testing, impact testing, hardness measurements, macro-and micrography. Knowledge of the related standards and acceptance criteria.

Competencies

Knowledge

- Knows the basic principles of the physics of different destructive methods.
- Knows the application of different destructive methods.
- Knows the effects of mechanical properties on the structural integrity of welded structures.

Skill

- Can perform basic destructive testing methods.
- Can select the appropriate destructive testing method to ensure structural stability of a welded structure.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.
- Willing to improve the knowledge in destructive testing methods.

Independence and responsibility

- Independently selects the appropriate testing methods.

CU8 – Protection of the surface

In this CU the importance of post-processing after the manufacturing and the inspection is presented. The students will be able to know the steps on how to select among these methods according to different considerations. This CU is taught online, where supplementary materials in video form can be handed out. The evaluation will be done through an oral examination in a digital platform, where the students will get a practical example, and they will design the required surface protection methods.

Content

The application and properties of different surface protection methods: painting methods and types, cladding, overlay welding.

General learning outcomes

Knowledge of the theoretical background of corrosion and corrosion protection.

Specific learning outcomes

Knowledge of different types of paints and their resistance to different corrosion degradation.
Knowledge of overlay welding procedure and the selection of proper welding consumables.

Competencies

Knowledge

- Knowledge of the basic principles of corrosion and corrosion protection.
- Knowledge of overlay welding methods and cladding.

Skill

- Can select the proper painting for the corrosion protection of the welded structure.
- Can select proper filler material and welding procedure for overlay welding and cladding.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.
- Willing to improve the knowledge in painting and cladding methods.

Independence and responsibility

- Independently selects the appropriate protective methods.
- Responsible for the corrosion control of welded structures.

CU9 – Delivery documentation

This CU is organized on-site, where the students will get their hand on an operating pressure vessel, as a part of a work-based learning method. The task is to design an inspection plan on-site with the help of the teacher. The teacher only guides the students thinking, as by this CU the students have already gathered the needed theoretical and practical skills. The evaluation will also be done on-site by the teachers.

Content

The students will design inspection plan and document the results.

General learning outcomes

Knowledge of the documentation of an inspection plan.

Specific learning outcomes

Knowledge of the content of the documentation of an inspection plan according to different international and national standards.

Competencies

Knowledge

- Knows the basic principles of how to write documentations of inspection plans.

Skill

- Writes the documentation of an inspection plan, and evaluate it's results.

Attitude

- Strives to put the latest results of the field of related of their own development.
- Willing to take part in the revisions of the related standards.

Independence and responsibility

- Independently writes and evaluates documentations.

CU10 – Repeating and exam with multiple choice questions and practical failure founding method

This CU is done online. For the circumstances of the monitoring the best practice guideline on the different methods to monitor the students skills, knowledge, and attitude can be used. The teachers are encouraged to perform online interviews, because most of the information can be gathered through this way. If one fails, then the test and the oral exam can be retaken in the LMS.

General collaboration among the students in the CUs

Collaboration is expected among the students during the courses. In each of the CUs the students will be encouraged to work in groups, as they engage in collaborative problem-solving. Each student will bring different approaches, experiences and previous knowledge (including silent knowledge) into a problem-solving process. In encouraging collaboration, the time until the solution can be shortened, while each of the members of a collaborative group will have a more detailed and extended view on the task, by sharing their approaches with each other. To increase the effectiveness, the basic structure and management of a collaborative work group will be introduced to the students. The solution process will be supervised by the trainer (on-site or online), letting the students explain their own ideas, bringing in new approaches. This will give extensive experience of a working environment, because students will likely work in project teams during their future duties. Working in collaborative groups will also help to bring the silent knowledges to the surface.

General learning outcomes of the course

After the successful completion of the welding inspector course the students will be able to independently design inspection plans on different welded structures, such as pressure vessels, pipelines, etc. The students will also gather practical experience through the real-life examples. Also, they will be able to learn and perform exams through a learning management system.

Evaluation and grading

After the completion of the online and face-to-face courses, the students should apply to the grading and evaluation session. The evaluation will be organized through an online system, such as Zoom. During the exam, the students will solve a project like example in the topic of welded structure inspection. This real-life example is based on industrial experiences and challenges. The students will need to solve a complex problem going through the steps given during the online lectures. After the completion of the online oral exam, the students also need to prove their understanding in real-life situations. The students will get an on-site example with the leading of the tutor. This real-life example can be a welded pressure vessel or a pipeline at a chemical or energy industrial partner. The students will describe their understanding in how to design an inspection plan, how to document the findings, how to evaluate the imperfections, how to write the report and the certificates.