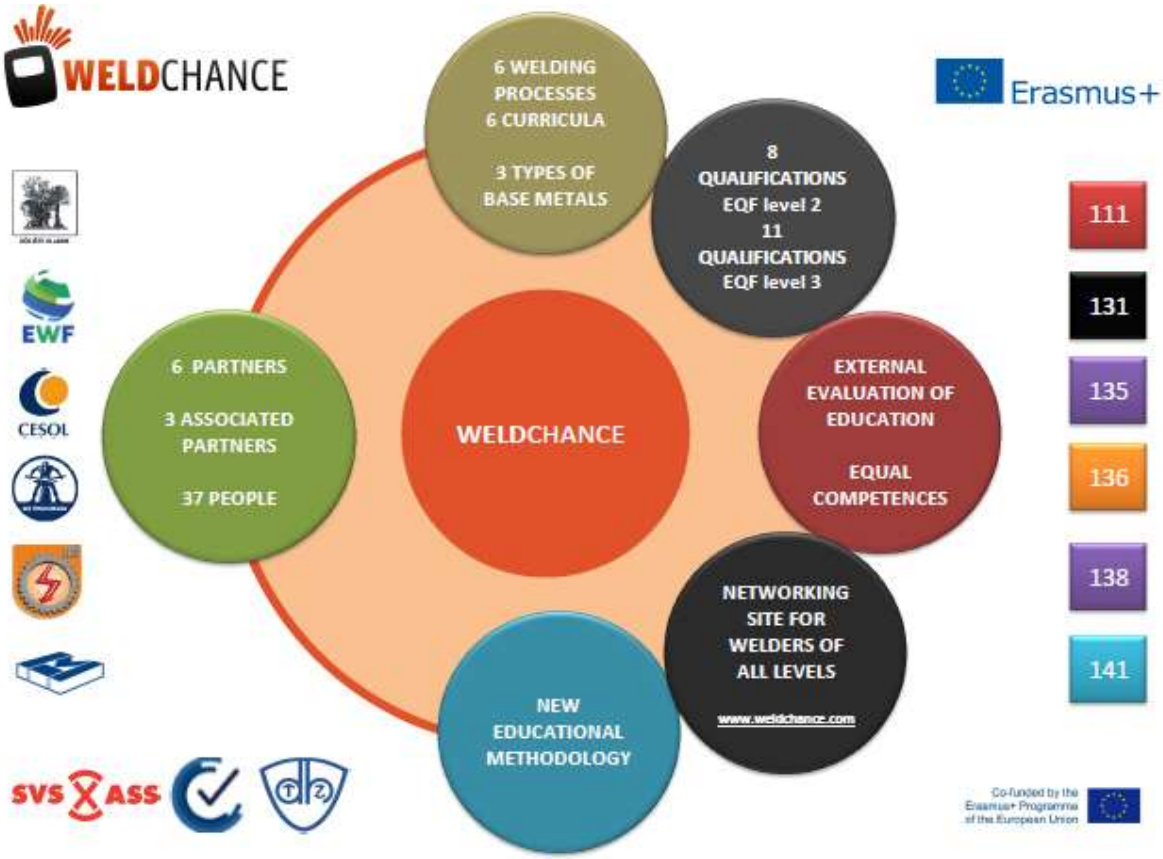
8

METHODOLOGY of VWTS application in welder training

Training Manual



Pula – Brussels / Porto Salvo – Madrid – Basel - Genova – Zagreb – Slavonski Brod

2018.

METHODOLOGY of VWTS application in welder training
Training Manual

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Contens

1. Introduction

Modern vocational education, be it in vocational schools or through adult education, needs to meet certain criteria in order to satisfy the needs of the individual, the economy and society as a whole.

These criteria are expressed through following points:

1. Vocational education and education of adults have to be developed according to the demands of the economy and the labor market,
2. Modern and innovative curricula, teaching methods and techniques have to be implemented into the teaching process,
3. Quality level of practical work needs to be ensured, whether it is in school workshops or in the real sector,
4. Teaching needs to be carried out by competent teachers with experience in practical part,
5. Cooperation with wider community in creation of favorable conditions for vocational education and education of adults.

In welding, as in all segments of society, the digital revolution has raised the bar on necessary knowledge, skills and behavior of workers in order to satisfy the ever growing demands for quality in this very demanding sector.

When satisfying the above-named criteria in welder education, special emphasis needs to be put on:

1. Modern national curricula, where it is extremely important that they be harmonized with international ones, both competence and qualification-wise, in order to ensure the necessary mobility and passageway across the European (international) labor market,
2. Modern teaching methods and techniques in both theoretical and practical part,
3. Ensuring well-equipped workshops (practicum) in vocational schools, adult education institutions or in companies that educate and train welders for their own production,
4. Ensuring a competent and experienced (in practical part) teaching staff

The guiding thought in all of this should be to redirect learning from traditional theories to the digital (Figure 1) and in the cone of learning take methodological direction towards the area of active participation of students/participants and teachers in welder education (Figure 2).

It needs to be emphasized that a system for lifelong education of welders was developed through a European Leonardo da Vinci Partnership project "InteractivWeld“ (www.interactivweld.eu), and that European curricula for 5 welding processes and the appropriate methodology are currently being designed through a european Erasmus+ Strategic Partnership project "WeldChance” (www.weldchance.eu).

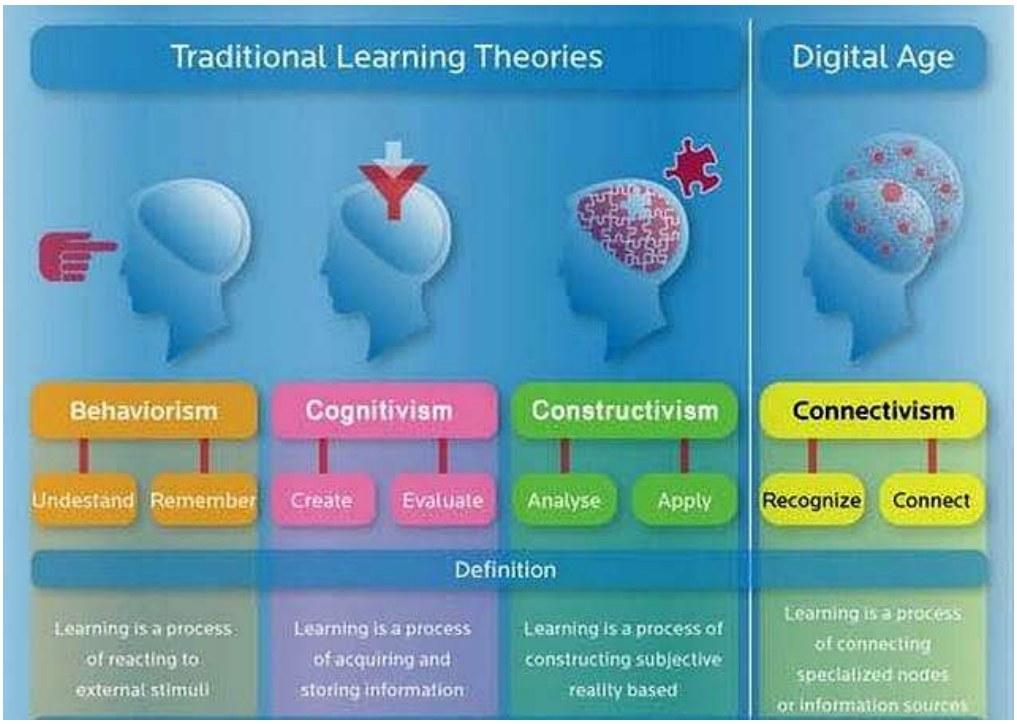


Figure 1. Learning theories

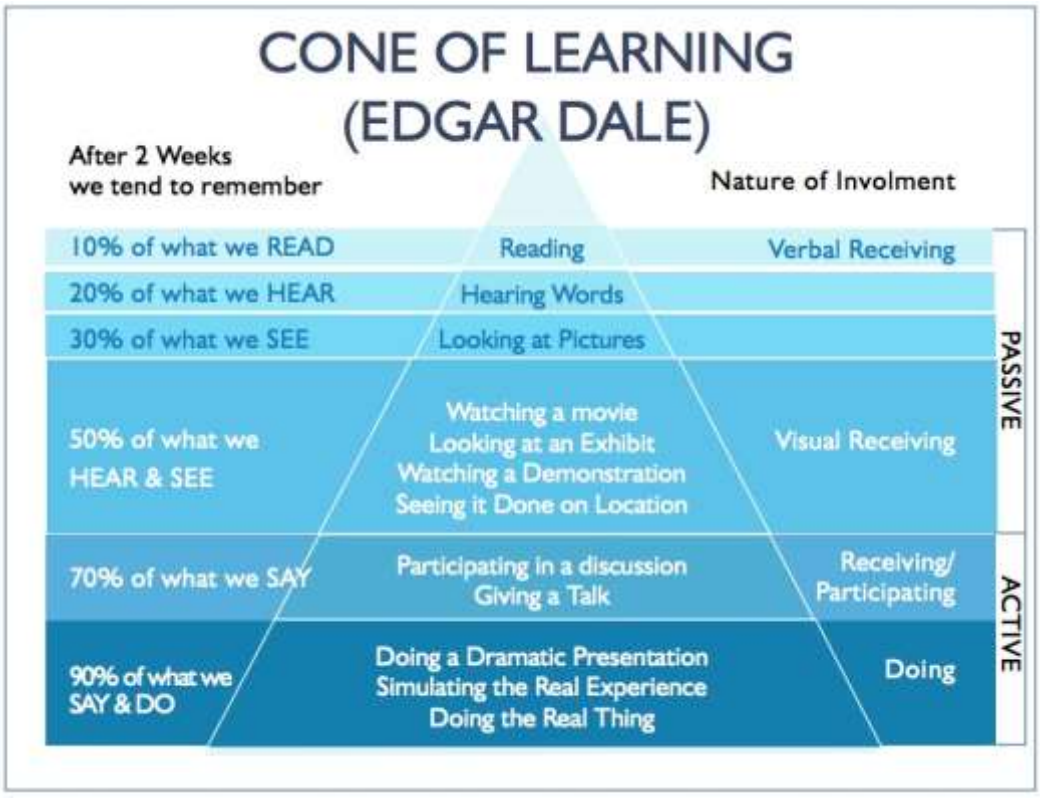


Figure 2. Edgar Dale's cone of learning

2. S – K – S system

The S – K – S system is an integrated interactive system for lifelong education of welders. Integrated because it links three significant elements in welder education: Skills, Knowledge and Stability (Behavior) and interactive because it is a combination of virtual and real, modern and traditional.

Figure 3. S – K – S System

The gist of the S-K-S system depicted in the figure is that after the basic welder education (C) the entire system (S-K-S) is repeated in certain time periods through training in order for the welder to gain insight into what is new in welding, to repeat or correct their welding technique and thus gain confidence (stability), which is beneficial for them as individuals, their company and quality of welding as a whole.

The result of such an approach is a welder who is, during their entire work life, involved in occurrences in the field, always training (repeating the old and acquiring the new skills) and reliable in quality execution of their assignments, which is visible in the following diagram.

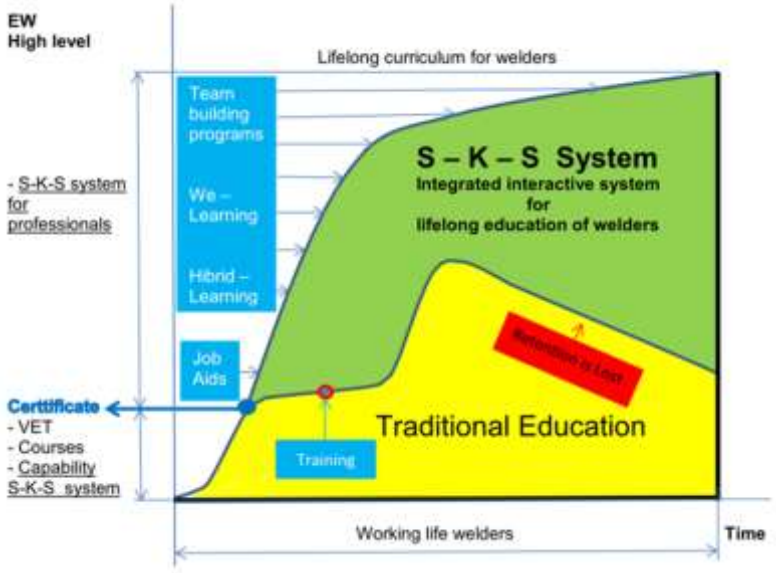


Figure 4. Effects of S-K-S system

The new methodology is going to involve the confirmed results of research that defined the segments of the S-K-S system.

Figure 5. Skills - Learning Archicecture

Figure 6. Knowledge - Learning Archicecture

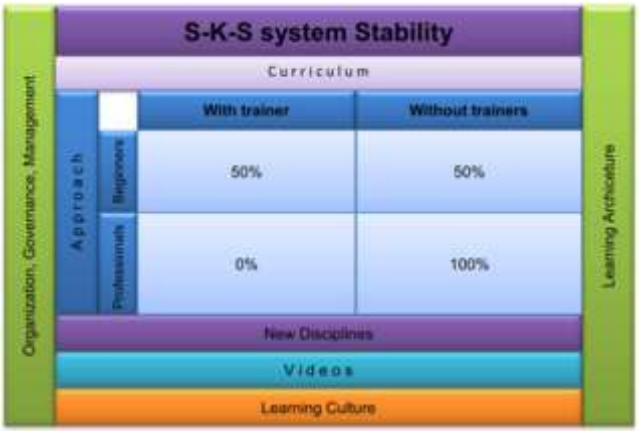


Figure 7. Stability - Learning Archicecture

3. Pedagogical and andragogical approach

The applied methodology is based on recognitions from pedagogy applied in education of students in vocational schools and andragogy applied in education of adults. These recognitions are very important in order to create motivating contents and methods for education of students and adults.

The differences are visible in 5 elements defined by Malcolm Knowles[1] in his paper "The Adult Learning Theory – Andragogy".

Five main differences between pedagogy and andragogy[2][3]

	PEDAGOGY	ANDRAGOGY
Learner	—The learner is dependent on the instructor, the teacher schedules all the activities; determining how, when and where they should take place —Teacher is the one who is responsible for what is taught and how it is taught —Teacher evaluates the learning	—Learner is self-directed and moves towards independence —Learner is responsible for the learning —Self-evaluation is seen
Learner's experience	—There is little experience which could be gained from this kind of learning —Method is didactic	—There is large quantity of experience gained — Method used is problem solving, discussion, service-learning[26]
Readiness to learn	—Standardized curriculum set which will be based on societal needs	—Curriculum is more application based and it revolves around life
Orientation to learning	—Here, it is a process of acquiring subject matter	—Here learning is for performing tasks and solving problems
Motivation	—Motivation is by external pressure, and there is lot of competition for grades	—It is driven by internal motivation. Includes self-actualization, self-confidence etc.

Learning behavior

Adult learners are self directed; they have control over their learning experience and they are 100% responsible for their own learning. They are also deeply involved not only in planning, but also in evaluating their learning, as they know what knowledge they want to acquire. On the contrary, young learners are not self-directed; they still depend on their teachers throughout the learning process. Therefore, their teachers should be responsible not only of what will be taught, but also of how it will be taught and evaluated.

[1] Malcolm Shepherd Knowles (August 24, 1913 – November 27, 1997) was an American Adult Educator
[2] https://en.wikipedia.org/wiki/Andragogy
[3] https://elearningindustry.com/pedagogy-vs-andragogy-in-elearning-can-you-tell-the-difference

The role of learners' experience

Adult learners have clearly more experience than young learners. Their experience becomes the main resource of both their learning and the personal identity they have developed, as the richer and more diverse their experience, the more the diversity they can bring to their own learning. Young learners, on the other hand, present little personal experience by default, and so it is impossible for this experience to serve as a learning resource; it can be only used to build upon.

Orientation to learning

What kind of knowledge adult learners are most interested in? Naturally, adult learners seek information that is useful in their personal lives and work environment. This audience demands that their learning is relevant to their real life issues, problems, and tasks, and that their education will boost their performance levels and help them live their lives in a better, and more satisfying way. Young audience's learning, on the contrary, is subject centered, mearning that the subject determines the sequence according to which the learning content units will be presented and taught.

Readiness to learn

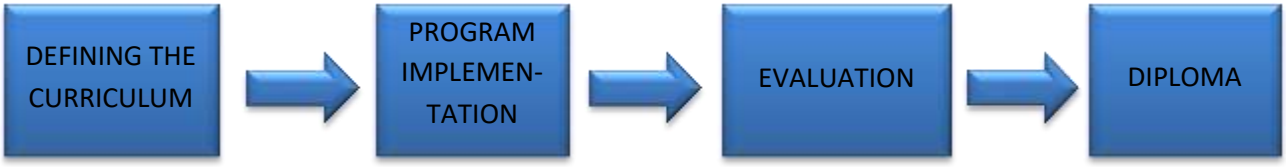
Adult learners' readiness to learn can be triggered by literally anything; a sudden change in their lives, a need for dealing with life tasks and problems more successfully, the desire for self-improvement and self-development, and so on. Adults need to know why to learn something; as soon as they answer this question, they are ready to start. Children, on the other hand, are usually told what to learn; the reason behind their learning is developing their skills to achieve the next level of mastery.

Motivation for learning

What motivates adults to find time for their learning in their busy schedule? Mostly intrinsic motivators; self-esteem, self-confidence, desire for better quality of life, curiosity, self-development, and recognition are only a few factors that motivate adult learners to learn. Needless to say, intrinsic incentives are much more powerful than extrinsic ones, and thus adult learners, more often than not, are more satisfied with the learning process, more focused, more persistent, and more eager to apply their knowledge more frequently and successfully than younger learners. On the other hand, children and teenagers are mostly motivated by extrinsic factors, such as getting good grades or other perks, or avoiding the consequences of failure.

4. Methodologies for lifelong education of welders

The basic methodological concept is shown in the following diagram:



a) Defining the curriculum is important for every start of education or training and is methodologically different depending on who it is done for: students in formal education, adult participants at their own request or companies, i.e. experienced welders.

b) Program implementation is methodologically different for students and experienced welders.

c) Evaluation is a set of achieved results during program implementation in theoretical and practical part based on which the capability of students/participants to approach external evaluation of their education is established.

d) Diploma of completed education is received through external evaluation of each participants' results. External evaluation is carried out by independent authorized institutions in private or public sector.

Methodological approach is divided into two groups:

- Methodology for trainees
- Methodology for experienced welders

4.1. Methodology for trainees

It is differentiated between:

a. methodology for students
b. methodology for adults
c. methodology for companies

Defining the curriculum

There are methodological differences when defining the curriculum according to which the education will be organized.

<u>For students:</u>

In formal education, the curricula are defined according to the demands of the social community. These are national curricula and there cannot be any aberrations. Based on such curricula, modules for theoretical and practical part are chosen, as well as the syllabus and didactical methodology for their implementation. The condition for entering the education for students is medical certificate which proves their physical and psychomotor ability to perform as a welder (according to national regulations).

For adults (individually):

Prior to defining the curriculum, it is necesary to conduct an interview with each participant individually. After interview, the initial testing is carried out, based on which the curriculum is suggested and modules for theoretical and practical part are chosen, as well as the syllabus and didactical methodology for their implementation. Methodology is directed towards dealing with specific issues according to participant's demands. The condition for entering the education for the candidate is medical certificate which proves their physical and psychomotor ability to perform as a welder (according to national regulations).

For companies:

Prior to defining the curriculum, a discussion takes place with people in charge from the company who express and explain their needs for education. What follows next is the initial testing is, based on which the curriculum is suggested and modules for theoretical and practical part are chosen, as well as the syllabus and didactical methodology for their implementation. Methodology is directed towards dealing with specific issues according to company demands. The condition for entering the education for the candidate is medical certificate which proves their physical and psychomotor ability to perform as a welder.

Program implementation:

In program implementation for all three groups of trainees the basic method is interactive and integrational based on the elements of previously presented S-K-S system. The VWTS (Virtual Welding Training System) has to be introduced in theoretical and practical part of education during program implementation, and depending on the type of trainees also the informal learning.

In theoretical part, the anticipated ratio is 50% formal and 50% informal learning (Figure 6).

In practical part for trainees it is foreseen that 40% of work on VWTS precedes the training in real conditions (60%).

Before taking on any new weld type and welding position on VWTS, the participant has to be interactively quizzed on the very same machine, in order to check their theoretical foundations for practical work. After completing the theoretical part, the next step is practical work on the machine - VWTS (up to 40% of time/hours foreseen for training).

The practical part on VWTS consists of training and simulation. The instructor sets the chosen curriculum on the machine and works with the group with up to three participants per machine.

The training phase is comprised of three thresholds which trainees have to pass with the help of the machine (so called "Ghost“). Each of the three thresholds is connected to a parametar that is important for the necessary execution of a weld. In MAG welding these are welding spped (1st threshold), welding speed and stick-out (2nd threshold) and combination of welding speed, stick-out and tilt angle of the welding gun (3rd threshold). Level of success is measured by scoring points (done automatically by the machine), and the instructor sets the percentage of the threshold necessary for successful pass. After the participant has 5 times out of 10 tries successfully passed all three thresholds, they can go over to simulation.

In simulation there is no help of the "Ghost“ and they weld in conditions very similar to real welding conditions. Once the participant has 7 times out of 10 tries successfully passed all three

thresholds, they can go over to real welding, reagardless of whether they have used up all the 40% of the time anticipated for training.

When entering the real welding conditions, the participant is shortly made familiar with the welding machine and the choice of parametres and after that starts welding under supervision of instructor.

Participant success on VWTS is evaluated by the machine, and in real training by te instructor. In adult education, the instructor decides whether the participant has acquired knowledge, skills and stability necessary for approaching the external evaluation of their educational path. In vocational education, at the end of certain time periods, teachers evaluate the work and and ability of students, so that they can approach external evaluation of their education.

Evaluation:

Evaluation process is ever present in welder education. The progress of each student/participant is monitored individually from the very beginning. The VWTS helps significantly with the scoring system.

Final education evaluation is external evaluation that is carried out by institutions authorized by public authorities or IIW/EWF international institutions in the area of welding.

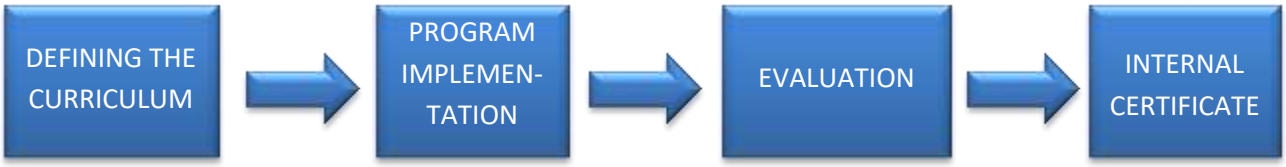
Diploma:

Conditions for acquisition of a corresponding diploma are acquired through external evaluation of welder education.

4.2. Methodology for experienced welders

Experienced welders should go through a comprehensive S-K-S system training in duration of couple of days minimally once in two years.

The basic methodological concept is shown in the following diagram:



The goal of this periodical training is repetition of knowledge, correction of skill (welding technique) and increase in the level of aerobic abilities.

Defining the curriculum

The curriculum is defined after initial testing. The first step is creation of a joint curriculum for the group of welders, and the second is its correction according to individuals in the group.

Program implementation:

According to the S-K-S system.

Theoretical part 20% formally - acquisition of new knowledge and 80% informally - repetition of acquired knowledge.

Practical part 100% on VWTS.

Evaluation:

100% according to scores on VWTS.

Internal certificate:

The company that carried out the training issues a certificate based on the training result.

5. Examples of good practice

5.1. Industrial and Trade School Slavonski Brod – Croatia

Creation of student curricula, trainings and courses connected to the WPSs - MAG – 135

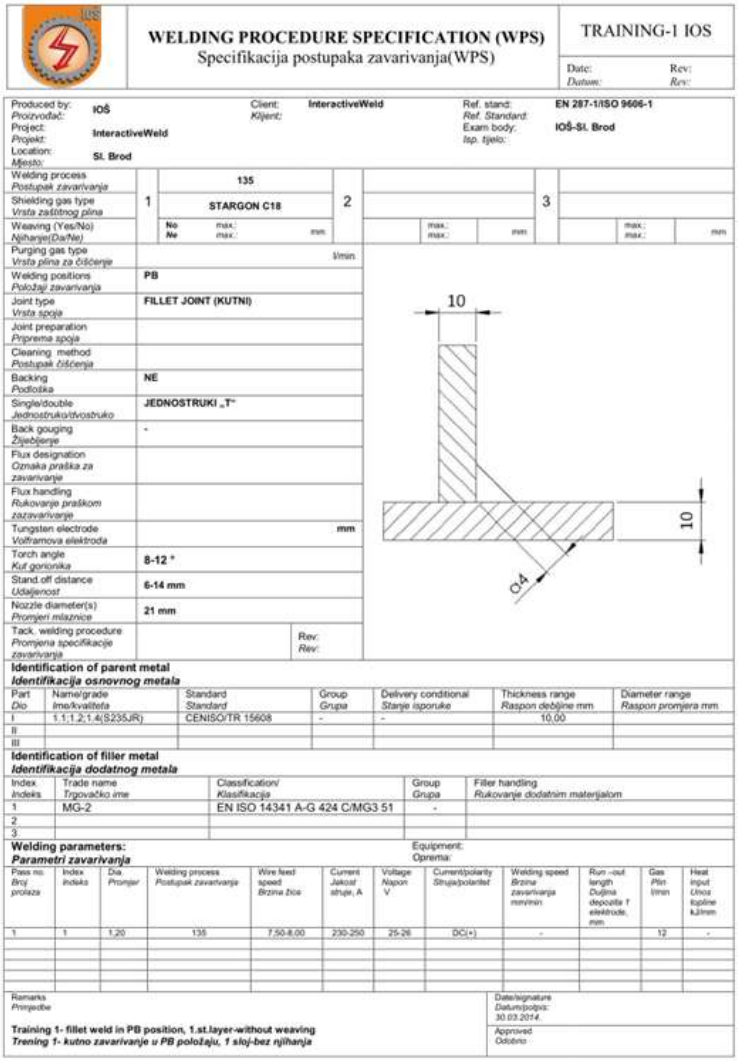
A.Training:

PB fillet joint 1 TRAINING – 1 IOS

Name of Curriculum: InteractivWeld Training - 1

Name of Course: Training - 1 IOS

The above-named training consists of two parts. The first part of the training pertains to the training of the skills on a virtual machine (40%), and the second part pertains to the same training, but on a real welding machine (60%). Both trainings are carried out according to the same WPS.



WELDING PROCEDURE SPECIFICATION (WPS)
Specifikacija postupaka zavarivanja(WPS)

TRAINING-1 IOS

Date: / Datum: | Rev: / Rev:

Produced by: / Proizvođač:	IOŠ	Client: / Klijent:	InteractiveWeld
Project: / Projekt:	InteractiveWeld	Ref. stand: / Ref. Standard:	EN 287-1/ISO 9606-1
Location: / Mjesto:	Sl. Brod	Exam body: / Isp. tijelo:	IOŠ-Sl. Brod

Welding process / Postupak zavarivanja	1	135		2				3			
Shielding gas type / Vrsta zaštitnog plina		STARGON C18									
Weaving (Yes/No) / Njihanje(Da/Ne)		No / Ne	max.: / max.:	mm		max.: / max.:	mm		max.: / max.:	mm	
Purging gas type / Vrsta plina za čišćenje			l/min								

Welding positions / Položaji zavarivanja	PB
Joint type / Vrsta spoja	FILLET JOINT (KUTNI)
Joint preparation / Priprema spoja	
Cleaning method / Postupak čišćenja	
Backing / Podloška	NE
Single/double / Jednostruki/dvostruko	JEDNOSTRUKI „T"
Back gouging / Žljebljenje	-
Flux designation / Oznaka praška za zavarivanje	
Flux handling / Rukovanje praškom zazavarivanje	
Tungsten electrode / Volframova elektroda	mm
Torch angle / Kut gorionika	8-12 °
Stand.off distance / Udaljenost	6-14 mm
Nozzle diameter(s) / Promjeri mlaznice	21 mm
Tack. welding procedure / Promjena specifikacije zavarivanja	Rev: / Rev:

Identification of parent metal
Identifikacija osnovnog metala

Part / Dio	Name/grade / Ime/kvaliteta	Standard / Standard	Group / Grupa	Delivery conditional / Stanje isporuke	Thickness range / Raspon debljine mm	Diameter range / Raspon promjera mm
I	1.1;1.2;1.4(S235JR)	CENISO/TR 15608	-	-	10,00	
II						
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / Indeks	Trade name / Trgovačko ime	Classification / Klasifikacija	Group / Grupa	Filler handling / Rukovanje dodatnim materijalom
1	MG-2	EN ISO 14341 A-G 424 C/MG3 51	-	
2				
3				

Welding parameters:
Parametri zavarivanja

Equipment: / Oprema:

Pass no. / Broj prolaza	Index / Indeks	Dia. / Promjer	Welding process / Postupak zavarivanja	Wire feed speed / Brzina žice	Current / Jakost struje, A	Voltage / Napon V	Current/polarity / Struja/polaritet	Welding speed / Brzina zavarivanja mm/min	Run -out length / Duljina depozita T elektrode, mm	Gas / Plin l/min	Heat input / Unos topline kJ/mm
1	1	1,20	135	7,50-8,00	230-250	25-26	DC(+)	-		12	-

Remarks / Primjedbe

Training 1- fillet weld in PB position, 1.st.layer-without weaving
Trening 1- kutno zavarivanje u PB položaju, 1 sloj-bez njihanja

Date/signature / Datum/potpis: 30.03.2014.

Approved / Odobrio

Figure 7. WPS example

B. Implementation of student curricula, trainings and courses

Training on the virtual machine for MIG/MAG welding process encompasses 4 steps:

1. step: practicing handling the welding gun for the purpose of correct welding speed,

2. step: practicing handling the welding gun for the purpose of correct welding speed, taking into consideration the stick-out,

3. step: practicing handling the welding gun for the purpose of correct welding speed, taking into consideration the stick-out and tilt angle of the welding gun

4. step: practicing welding process through invariable and ideal welding parameters.

Working principle is such that you cannot move to the next step until you have achieved the minimum test score set in the curriculum (60%).

Training on the virtual machine for MMA welding process encompasses 4 steps:

1. step: practicing the manipulation of the rod electrode at the right speed in the right position, threshold: 60%

2. step: practicing the correct welding speed, arc length and correct manipulation of electrode holder at the appropriate angle, threshold: 60%

3. step: practicing with fixed and ideal welding parameters, threshold: 60%

Working principle is such that you cannot move to the next step until you have achieved the minimum test score set in the curriculum.

The above-mentioned trainings follow one another, this means that the student has to achieve satisfactory results in order to be allowed to continue with the next training and successfully finish the entire curriculum.

Once the student has successfully mastered the whole curriculum on the virtual machine, they start welding on real welding machines according to the exact same WPS.

In order to achieve better results with training on the VWTS, the students are divided into small groups (max. 5 students). Welding on real machines is carried out according to the principle - one student, one machine.

C. Evaluation of student curricula, trainings and courses

Monitoring and evaluation of trainees' welding competence - training on VWTS

- monitoring and evaluation of results of the achieved welding speed/igniting, stick-out and tilt angle
- monitoring and evaluation of results achieved after the carrying out of simulation concepts
- monitoring and evaluation of the final result after the carrying out of the training

Monitoring and evaluation of trainees' welding competence - training on real welding machines

Monitoring and evaluation of the student's practical work through 4 elements:
- insufficient penetration
- porosity
- undercuts
- a = measure (FW)

Practical assignments are marked according to the standard EN ISO 5817.

Test criterion ISO 5817:

Group	B	5 Points	Group	C	4 Points
Group	D	3 Points	No		Did not pass

5.2. Končar Steel Structures, Zagreb Croatia

Creation, implementation and evaluation of curricula, trainings and courses for professional welders

A. Training concept on the VWTS

Training concept on the VWTS encompasses:

- initial testing of candidates on the VWTS – simulation concept (3D weld) at the level of 65%

- training of candidates on the VWTS - training concept for welds in different positions at the level of 65%

- final testing of candidates on the VWTS – simulation concept (3D weld) at the level of 65%

Trainings for professional welders are carried out for the purpose of correction of their welding technique.

The trainings are done exclusively on the VWTS (training share 100%).

The training concept on the VWTS is designed according to the company needs - Tailor Made principle (processes, welded joint type, welding positions).

B. Monitoring and evaluation

The monitoring and evaluation of welder's competence achieved through the training on the VWTS will be carried out as follows:

- monitoring and evaluation of results achieved by initial testing
- monitoring and evaluation of results achieved by training
- monitoring and evaluation of results achieved by final testing
- monitoring of the training influence in real working conditions until first weld defects emerge

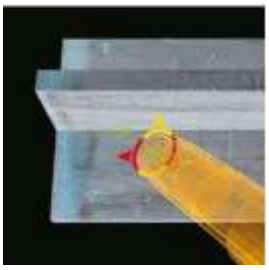
Additional ways of monitoring and marking are arranged according to the needs and demands of individual companies.

6. VWTS – mogućnosti VWTS Fronius and Soldamatic

Possibilities and features of VWTS Fronius and Soldamatic are explained in more detail here because the training of trainers in the scope of WeldChance project was carried out on therse two machines.

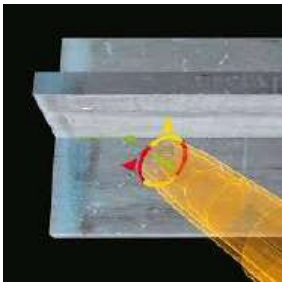
6.1. VWTS Fronius

<table>
<tr><td> 
</td><td>Didactic learning with Virtual Welding
Training sequence:
A virtual teacher(„ghost“) gives the best help possible

Simulation sequence:
Training in a real welding situation (without ghost)</td></tr>
<tr><td colspan="2">TRAINING SEQUENCE</td></tr>
<tr><td> 
  </td><td>Welding processes: MAG, MMA, TIG and Robotic

Who is the trainer?
The virtual teacher – called a „ghost“ ensures optimum help is given

What is taught?
Welding speed
Distance from workpiece
Tilt angle of welding torch / electrode holder</td></tr>
<tr><td colspan="2">WELDING PROCESSES</td></tr>
<tr><td>  </td><td>Manual metal arc welding (MMA)
As an introduction to virtual training
Teaches perfect ignition
Accurate electrode guidance depending on position and welding task</td></tr>
</table>

	**Gas metal arc welding (GMAW)** The most commonly used welding process Teaching of welding speed, distance from workpiece and torch angle
	**TIG welding (WIG)** Teaches perfect welding technique Accurate torch and rod guidance, depending on position and welding task
	**Robotics** Teaches welding speed, distance from workpiece, torch angle and process guidance
 	**"Variable Ghost“ makes virtual welding even more individual** Trainer's know-how and manual skills are stored and provide a training target for the trainees. Torch and electrode guidance in practice correspond to the virtual target on the simulator. No different from real torch guidance.

SIMULATION SEQUENCE	
 	**Welding processes:** MAG, MMA, TIG and Robotic **When?** After training sequence completed Training in a real welding situation – Without „ghost“ **What is taught?** Weld seam formation Parameter settings **Who monitors the trainees?** A video analysis provides feedback
	**Manual metal arc welding (MMA)** Different electrode diameters to choose from Creating awareness of the different settings and their effect on the short arc and spray arc
 	**Gas metal arc welding (GMAW)** Parameters are set by the trainee Creating awareness of the different settings and their effect on the short arc and spray arc
	**TIG welding (WIG)** Different rod diameters to choose from Creating awareness of the different settings and their effect on the arc
	**Robotics** Simulation provides virtual display of the program and welding results. Teaches deposit and welding position

ADDITIONAL FEATURES

Curricula and courses are flexibile
and adapted to the target group
Tak set by trainer on the basis of the
curriculum and course

Glossary function a reference for welding novices
Trainee receives basic information on the selected
topic (e.g. workpiece, welding position, etc.)

CURRICULA AND COURSES

Allow the trainer to..

Manage the course according
to the target group
Define the training content
Set the degree of difficulty (level)
Manage the participants
via log-in function
Save the data

The trainee…

Is given basic information on
welding topics
Can learn about the different
welding positions
Receives information on the current
training content and training task
Can retrieve his training progress
at any time
Can see where there is room for
Improvement thanks to playback
function

RESULTS

- Objective and traceable assessment
  - Comparable training results
  - Objective points system
- Rankings
  - Generated automatically and simplify evaluation
- Playback function
  - Every weld is recorded and can be analysed
- Motivation of participants
  - They compare themselves with one another and spur each other on
  - Improves group dynamics

DATA DOCUMENTATION

- No loss of data
  - Results are saved and archived automatically
- Data can be retrieved at any time and provides information about:
  - Training intensity
  - Individual learning progress
- Data can be used for certificates

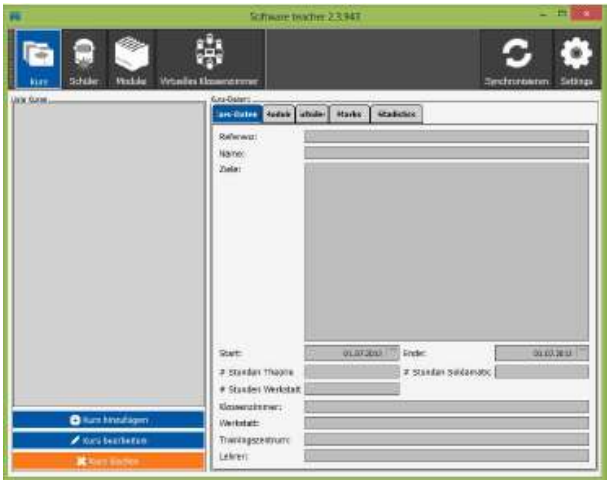
APPLICATIONS / CONFIGURATION	
	➢ Showroom mode,.... For foyers, reception areas, entrance areas, trade fairs, …. ➢ Course mode In course mode the trainee practises welding based on a didactic approach ➢ Open mode Ideal for product presentation and work outside a didactic environment

6.2. VWTS Soldamatic[4]

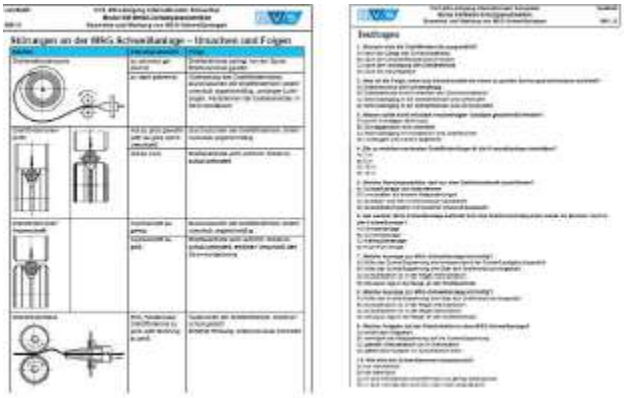
Integrated educational concept

[4] http://www.technifutur.be/downloads/dl_realite_virtuelle_augmentee/6_soldomatic_anke_richter.pdf

TEACHER SOFTWARE



- selfprogramming of individual learning material
- theoretical foundations
- confirmation testing
- individual evaluation of tests (Multiple Choice)
- practical predefined welding tasks (IIW)
- all WPSs can be individually modified (teacher only)
- The ability to check the progress of each individual in realtime
- Crosslinking of the teacher with all students
- Learning level check at any time (theory / test / practice) incl. evaluation



E-LEARNING

- Theory exchange own documents PDF / image / movie or
- Theory-exchange standard reading for example online portal DVS Media
- Small steps and individual exchange theory
- Learning level check at any time (Theory / test) incl. evaluation multiple choice

INDIVIDUAL TRAINING SIMULATOR	
	➢ MIG/MAG ➢ MMA ➢ TIG ➢ Flux cored wire ➢ changeable WPS ➢ all positions (vertical, overhead, downhand etc.) ➢ multilayer ➢ pipe program ➢ changeable amps, volt, gasflow during welding ➢ realistic sound ➢ the realization of realistic positional work due to AR-technology ➢ only the workpiece is animated, realistic background! ➢ realistic graphics with realistic weld pool ➢ realistic workpiece, real torches ➢ helmet without difficult 3D glasses ➢ ability to check the progress of each students activities in realtime: ➢ networking of the teacher with all students ➢ learning statistics check at any time (Theory / test / practice) incl. evaluation training individually, in groups, in the classroom, in workshop ....

INDIVIDUAL COACHING	
	➢ individual training of each motoric: - arc length - travel speed - travel angle - torch angle ➢ distance to workpiece - porosity - spatter - undercuts, etching, root (coming soon) ➢ different training levels (beginner, intermediate, expert) ➢ teachers set in advance individually
INDIVIDUAL ANALYSIS	
	➢ comprehensive analysis of every weld bead ➢ the control of practice time and welding time ➢ Objective evaluation of: - Arc length - Travel speed - Travel angle - Torch angle - Distance to workpiece - Porosity - Spatter ➢ Documentation through graphics, film and printout ➢ e.g. for clients (job centers, companies, company training, staff development, etc.
TRAINING IN THE CABIN	
	➢ Students are trained theory Students passed state tests theory-learning Students have carried out individual practical tests Hand skills have been practiced Transfer of acquired knowledge in the cabin Pre-trained students Reach all goals faster Increase of training quality

7. Annex – exercise examples for instructors

7.1. 8 steps to real welding for trainees

Training:

Step 1: Create WPS for practice according to syllabus created on curriculum basis

Step 2: Enter WPS into Curricula on the machine

Step 3: Training with the help of simulator (VWTS)

a) Possibility of work in the Open Mode (without keeping score)

b) Possibility of work in the Course Mode: Mandatory log-in of each individual in order to keep track of their progress and their status in the group.

Step 4: Training monitoring: self-monitoring by the individual, by the training, corrections.

Step 5: Training results

Five successful passes of all three thresholds out of 10 consecutive tries give the participant the possibility to go over to simulation.

Simulation:

Step 6: Practising where the participant needs to repeat the score from step five. If after three consecutive tries the participant does not pass, they have to go back to step 3.

Step 7: Virtual welding – simulation. The pass constitutes 6 successful results out of 10 consecutive tries. The participant practises until they reach such result.

Step 8: Real welding

7.2. Six steps for experienced welders (correction of welding technique)

Simulation:

Step 1: Initial testing of candidates. 3 passes in the set WPS and curriculum. Training curriculum is created based on individual and group results.

Training:

Step 2: correction of welding technique by practising

Step 3: Training monitoring: self-monitoring by the individual, by the training, corrections.

Step 4: Training results. Seven successful passes of all three thresholds out of 10 consecutive tries are the sign that it is time to go over to simulation.

Simulation:

Step 5: Practising where the participant needs to repeat the score from step 4. If after three consecutive tries the participant does not pass, they have to go back to step 2.

Step 6: Virtual welding – simulation. The pass constitutes 7 successful results out of 10 consecutive tries. The participant practises until they reach such result.

7.3. Seven WPSs for training

WELDCHANCE

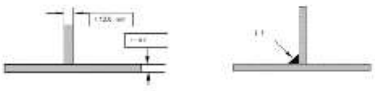
WELDING PROCEDURE SPECIFICATION (WPS)
Specifikacija postupaka zavarivanja(WPS)

TRAINING - IOS

Date: / Datum: | Rev: / Rev:

Produced by: / Proizvođač:	IOŠ	Client: / Klijent:	WELDCHANCE
Project: / Projekt:	WELDCHANCE	Ref. stand: / Ref. Standard:	EN ISO 16814-1
Location: / Mjesto:	SI. Brod	Exam body: / Isp. tijelo:	IOŠ-SI. Brod

	1	2	3
Welding process / Postupak zavarivanja	111		
Shielding gas type / Vrsta zaštitnog plina			
Weaving (Yes/No) / Njihanje(Da/Ne)	max.: max.: mm	max.: max.: mm	max.: max.: mm
Purging gas type / Vrsta plina za čišćenje	l/min		
Welding positions / Položaji zavarivanja	PB		
Joint type / Vrsta spoja	FILLET JOINT (KUTNI)		
Joint preparation / Priprema spoja	OXY FLAME /MACHINING		
Cleaning method / Postupak čišćenja	BRUSHING		
Backing / Podloška	-		
Single/double / Jednostruko/dvostruko	SINGLE "T"		
Back gouging / Žljebljenje			
Flux designation / Oznaka praška za zavarivanje			
Flux handling / Rukovanje praškom zazavarivanje			
Tungsten electrode / Volframova elektroda	mm		
Torch angle / Kut gorionika			
Stand.off distance / Udaljenost	mm		
Nozzle diameter(s) / Promjer mlaznice	mm		
Tack. welding procedure / Promjena specifikacije zavarivanja	Rev: / Rev:		



Identification of parent metal
Identifikacija osnovnog metala

Part / Dio	Name/grade / Ime/kvalitета	Standard / Standard	Group / Grupa	Delivery conditional / Stanje isporuke	Thickness range / Raspon debljine mm	Diameter range / Raspon promjera mm
I			1		10,00	
II			1		10,00	
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / Indeks	Trade name / Trgovačko ime	Classification/ Klasifikacija	Group / Grupa	Filler handling / Rukovanje dodatnim materijalom
1	UTP 614 KB	S Basic E 7018 EN ISO 2560 A E 42 3 B 32 H 10		
2				
3				

Welding parameters: / ***Parametri zavarivanja*** — Equipment: / Oprema:

Pass no. / Broj prolaza	Index / Indeks	Dia. / Promjer	Welding process / Postupak zavarivanja	Wire feed speed / Brzina žice	Current / Jakost struje, A	Voltage / Napon V	Current/polarity / Struja/polaritet	Welding speed / Brzina zavarivanja mm/min	Run –out length / Dužina depozita 1 elektrode, mm	Gas / Plin l/min	Heat input / Unos topline kJ/mm
1		3,2	111		133	MACHINE	DC(+)				

Remarks / Primjedbe

Date/signature / Datum/potpis

Approved / Odobrio

WELDCHANCE	WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: / Datum: Rev: / Rev:

Produced by: / *Proizvođač:*	IOŠ	Client: / *Kljent:* WELDCHANCE	Ref. stand: / *Ref. Standard:* EN ISO 15614-1
Project: / *Projekt:*	WELDCHANCE		Exam body: / *Isp. tijelo:* IOŠ-Sl. Brod
Location: / *Mjesto:*	Sl. Brod		

Welding process / *Postupak zavarivanja*	1	111		2				3			
Shielding gas type / *Vrsta zaštitnog plina*											
Weaving (Yes/No) / *Njihanje(Da/Ne)*		max.: / max.:	mm		max.: / max.:		mm		max.: / max.:		mm
Purging gas type / *Vrsta plina za čišćenje*			l/min								
Welding positions / *Položaji zavarivanja*	PA										
Joint type / *Vrsta spoja*	BUTT JOINT (SUČEONI)										
Joint preparation / *Priprema spoja*	OXY FLAME /MACHINING										
Cleaning method / *Postupak čišćenja*	BRUSHING										
Backing / *Podloška*	-										
Single/double / *Jednostruko/dvostruko*	SINGLE "V"										
Back gouging / *Žljebljenje*											
Flux designation / *Oznaka praška za zavarivanje*											
Flux handling / *Rukovanje praškom zazavarivanje*											
Tungsten electrode / *Volframova elektroda*			mm								
Torch angle / *Kut gorionika*											
Stand.off distance / *Udaljenost*			mm								
Nozzle diameter(s) / *Promjer mlaznice*			mm								
Tack. welding procedure / *Promjena specifikacije zavarivanja*		Rev: / *Rev:*									

Identification of parent metal
Identifikacija osnovnog metala

Part / *Dio*	Name/grade / *Ime/kvalitета*	Standard / *Standard*	Group / *Grupa*	Delivery conditional / *Stanje isporuke*	Thickness range / *Raspon debljine mm*	Diameter range / *Raspon promjera mm*
I			1		10,00	
II			1		10,00	
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / *Indeks*	Trade name / *Trgovačko ime*	Classification/ *Klasifikacija*	Group / *Grupa*	Filler handling / *Rukovanje dodatnim materijalom*
1	UTP 614 KB	S Basic E 7018 EN ISO 2560 A E 42 3 B 32 H 10		
2				
3				

Welding parameters: / ***Parametri zavarivanja*** — Equipment: / Oprema:

Pass no. / *Broj prolaza*	Index / *Indeks*	Dia. / *Promjer*	Welding process / *Postupak zavarivanja*	Wire feed speed / *Brzina žice*	Current / *Jakost struje, A*	Voltage / *Napon V*	Current/polarity / *Struja/polaritet*	Welding speed / *Brzina zavarivanja mm/min*	Run –out length / *Dužina depozita I elektrode, mm*	Gas / *Plin l/min*	Heat input / *Unos topline kJ/mm*
1		3,2	111		81	MACHINE	DC(+)				

Remarks / *Primjedbe*

Date/signature / *Datum/potpis*

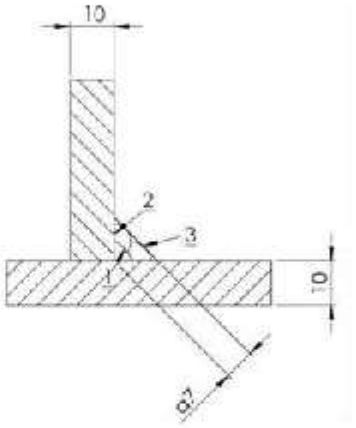
Approved / *Odobrio*

WELDCHANCE	WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: / Datum: Rev: / Rev:

Produced by: / *Proizvođač:*	IOŠ	Client: / *Kljent:* WELDCHANCE	Ref. stand: / *Ref. Standard:* EN ISO 15614-1
Project: / *Projekt:*	WELDCHANCE		Exam body: / *Isp. tijelo:* IOŠ-Sl. Brod
Location: / *Mjesto:*	Sl. Brod		

Welding process / *Postupak zavarivanja*	1	135		2				3			
Shielding gas type / *Vrsta zaštitnog plina*		EN ISO 14175:M21 (Ar 82%, CO_2 18%)									
Weaving (Yes/No) / *Njihanje(Da/Ne)*		No / *NE*	max.: / max.: mm			max.: / max.:	mm			max.: / max.:	mm
Purging gas type / *Vrsta plina za čišćenje*			l/min								

Welding positions / *Položaji zavarivanja*	PB
Joint type / *Vrsta spoja*	FILLET JOINT (KUTNI)
Joint preparation / *Priprema spoja*	OXY FLAME/MACHINIG
Cleaning method / *Postupak čišćenja*	GRINDING, BRUSHING
Backing / *Podloška*	NO/NE
Single/double / *Jednostruko/dvostruko*	SINGLE "T"
Back gouging / *Žljebljenje*	
Flux designation / *Oznaka praška za zavarivanje*	
Flux handling / *Rukovanje praškom zazavarivanje*	
Tungsten electrode / *Volframova elektroda*	mm
Torch angle / *Kut gorionika*	8 – 12°/45°
Stand.off distance / *Udaljenost*	8-15 mm
Nozzle diameter(s) / *Promjer mlaznice*	17-22 mm
Tack. welding procedure / *Promjena specifikacije zavarivanja*	Rev: / *Rev:*



Identification of parent metal
Identifikacija osnovnog metala

Part / *Dio*	Name/grade / *Ime/kvalitета*	Standard / *Standard*	Group / *Grupa*	Delivery conditional / *Stanje isporuke*	Thickness range / *Raspon debljine mm*	Diameter range / *Raspon promjera mm*
I	S355J2+N	EN 100025-2	1,2	-	10,00	
II	S355J2+N	EN 100025-2	1,2			
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / *Indeks*	Trade name / *Trgovačko ime*	Classification/ *Klasifikacija*	Group / *Grupa*	Filler handling / *Rukovanje dodatnim materijalom*
1	MG-2 (Oerlikon)	EN ISO 14341-A:G3Si1	FM1	
2				
3				

Welding parameters: / ***Parametri zavarivanja***
Equipment: / *Oprema:*

Pass no. / *Broj prolaza*	Index / *Indeks*	Dia. / *Promjer*	Welding process / *Postupak zavarivanja*	Wire feed speed / *Brzina žice*	Current / *Jakost struje, A*	Voltage / *Napon V*	Current/polarity / *Struja/polaritet*	Welding speed / *Brzina zavarivanja mm/min*	Run –out length / *Dužina depozita 1 elektrode, mm*	Gas / *Plin l/min*	Heat input / *Unos topline kJ/mm*
1	1	1,20	135 P	8,90 -	215 - 220	27 - 28	DC(+)	300, - 350,		12-18	0,9 - 1,0
2-3	1	1,20	135 P	8,90 -	210 - 225	27 - 28	DC(+)	350, - 400,		12-18	0,8 – 0,9

Remarks / *Primjedbe*

Transfer mode:pulsating current

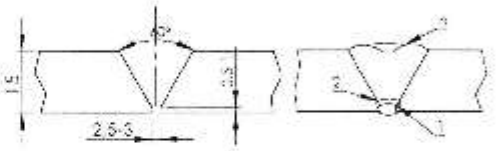
Date/signature / *Datum/potpis*

Approved / *Odobrio*

WELDCHANCE	WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: / Datum: Rev: / Rev:

Produced by: / *Proizvođač:*	IOŠ	Client: / *Kljent:*	WELDCHANCE
Project: / *Projekt:*	WELDCHANCE	Ref. stand: / *Ref. Standard:*	ISO 9606-1
Location: / *Mjesto:*	Sl. Brod	Exam body: / *Isp. tijelo:*	IOŠ-Sl. Brod

	1	2	3
Welding process / *Postupak zavarivanja*	135		
Shielding gas type / *Vrsta zaštitnog plina*	EN ISO 14175:M21 (Ar 82%, CO_2 18%)		
Weaving (Yes/No) / *Njihanje(Da/Ne)*	No / NE; max.: max.: mm	max.: max.: mm	max.: max.: mm
Purging gas type / *Vrsta plina za čišćenje*	l/min		
Welding positions / *Položaji zavarivanja*	PF		
Joint type / *Vrsta spoja*	BUTT JOINT (SUČEONI)		
Joint preparation / *Priprema spoja*	OXY /MACHINIG		
Cleaning method / *Postupak Čišćenja*	GRINDING, BRUSHING		
Backing / *Podloška*	NO/NE		
Single/double / *Jednostruko/dvostruko*	SINGLE "V"		
Back gouging / *Žljebljenje*			
Flux designation / *Oznaka praška za zavarivanje*			
Flux handling / *Rukovanje praškom zazavarivanje*			
Tungsten electrode / *Volframova elektroda*	mm		
Torch angle / *Kut gorionika*	8 – 12°		
Stand.off distance / *Udaljenost*	8-14 mm		
Nozzle diameter(s) / *Promjer mlaznice*	17-21 mm		
Tack. welding procedure / *Promjena specifikacije zavarivanja*	Rev: / *Rev:*		



Identification of parent metal
Identifikacija osnovnog metala

Part / *Dio*	Name/grade / *Ime/kvalitet*	Standard / *Standard*	Group / *Grupa*	Delivery conditional / *Stanje isporuke*	Thickness range / *Raspon debljine mm*	Diameter range / *Raspon promjera mm*
I	S355J2+N	EN 100025-2	1,2	-	15,00	
II	S355J2+N	EN 100025-2	1,2		15,00	
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / *Indeks*	Trade name / *Trgovačko ime*	Classification/ *Klasifikacija*	Group / *Grupa*	Filler handling / *Rukovanje dodatnim materijalom*
1	MG-2 (Oerlikon)	EN ISO 14341-A:G3Si1	FM1	
2				
3				

Welding parameters: / ***Parametri zavarivanja***
Equipment: / Oprema:

Pass no. / *Broj prolaza*	Index / *Indeks*	Dia. / *Promjer*	Welding process / *Postupak zavarivanja*	Wire feed speed / *Brzina žice*	Current / *Jakost struje, A*	Voltage / *Napon V*	Current/polarity / *Struja/polaritet*	Welding speed / *Brzina zavarivanja mm/min*	Run –out length / *Dužina depozita I elektrode, mm*	Gas / *Plin l/min*	Heat input / *Unos topline kJ/mm*
1		1,20	135 D	4,20 – 4,20	135 - 145	18-19	DC(+)	220 -		12-18	0,55 – 0,60
2-n		1,20	135 P	7,00- 7,00	175-190	25 - 26	DC(+)	260-370		12-18	0,58- 0,93

Remarks / *Primjedbe*

Transfer mode:pulsating current

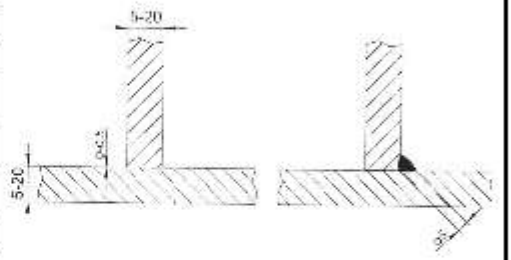
Date/signature / *Datum/potpis*

Approved / *Odobrio*

WELDCHANCE	WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: / Datum: Rev: / Rev:

Produced by: / *Proizvođač:*	IOŠ	Client: / *Kljent:*	WELDCHANCE
Project: / *Projekt:*	WELDCHANCE	Ref. stand: / *Ref. Standard:*	EN ISO 16834-1
Location: / *Mjesto:*	Sl. Brod	Exam body: / *Isp. tijelo:*	IOŠ-Sl. Brod

Welding process / *Postupak zavarivanja*	1	141		2				3			
Shielding gas type / *Vrsta zaštitnog plina*		EN ISO 14175 - I1									
Weaving (Yes/No) / *Njihanje(Da/Ne)*		Yes / *Da*	max.: / max.: 8 mm			max.: / max.:	mm			max.: / max.:	mm
Purging gas type / *Vrsta plina za čišćenje*			l/min								
Welding positions / *Položaji zavarivanja*		PF									
Joint type / *Vrsta spoja*		FILLET JOINT (KUTNI)									
Joint preparation / *Priprema spoja*		OXY FLAME									
Cleaning method / *Postupak čišćenja*		GRINDING, BRUSHING									
Backing / *Podloška*		NONE									
Single/double / *Jednostruko/dvostruko*		SINGLE "T"									
Back gouging / *Žljebljenje*											
Flux designation / *Oznaka praška za zavarivanje*											
Flux handling / *Rukovanje praškom zazavarivanje*											
Tungsten electrode / *Volframova elektroda*		3,2	mm								
Torch angle / *Kut gorionika*		12° - 15°/45°									
Stand.off distance / *Udaljenost*		3-6	mm								
Nozzle diameter(s) / *Promjer mlaznice*		10	mm								
Tack. welding procedure / *Promjena specifikacije zavarivanja*		141 TACK WELDING	Rev: / *Rev:*								



Identification of parent metal
Identifikacija osnovnog metala

Part / *Dio*	Name/grade / *Ime/kvaliteta*	Standard / *Standard*	Group / *Grupa*	Delivery conditional / *Stanje isporuke*	Thickness range / *Raspon debljine mm*	Diameter range / *Raspon promjera mm*
I	S355J2+N	EN 100025-2	1,2	NORMALIZED	5 – 20	
II	S355J2+N	EN 100025-2	1,2	NORMALIZED	5 – 20	
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / *Indeks*	Trade name / *Trgovačko ime*	Classification/ *Klasifikacija*	Group / *Grupa*	Filler handling / *Rukovanje dodatnim materijalom*
1	BOHLER DMO - IG	EN ISO 21952-A: W MoSI	FM3	
2				
3				

Welding parameters: / ***Parametri zavarivanja*** — Equipment: / *Oprema:*

Pass no. / *Broj prolaza*	Index / *Indeks*	Dia. / *Promjer*	Welding process / *Postupak zavarivanja*	Wire feed speed / *Brzina žice*	Current / *Jakost struje, A*	Voltage / *Napon V*	Current/polarity / *Struja/polaritet*	Welding speed / *Brzina zavarivanja mm/min*	Run –out length / *Dužina depozita 1 elektrode, mm*	Gas / *Plin l/min*	Heat input / *Unos topline kJ/mm*
1		3,20	141		220 - 230	11,0-14,0	DC(-)	80,0 – 120,0		6 - 11	0,4 - 1,4
2-n		3,20	141		220 - 230	11,0-14,0	DC(-)	50,0 – 90,0		6 - 11	0,6 – 2,3

Remarks / *Primjedbe*

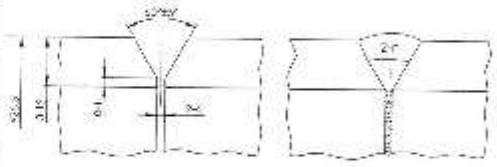
Date/signature / *Datum/potpis*

Approved / *Odobrio*

WELDCHANCE	WELDING PROCEDURE SPECIFICATION (WPS) Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: / Datum: Rev: / Rev:

Produced by: / *Proizvođač:*	IOŠ	Client: / *Kljent:*	WELDCHANCE
Project: / *Projekt:*	WELDCHANCE	Ref. stand: / *Ref. Standard:*	EN ISO 16614-1
Location: / *Mjesto:*	Sl. Brod	Exam body: / *Isp. tijelo:*	IOŠ-Sl. Brod

Welding process / *Postupak zavarivanja*	1	141	2				3				
Shielding gas type / *Vrsta zaštitnog plina*		EN ISO 14175 - I1									
Weaving (Yes/No) / *Njihanje(Da/Ne)*		Yes / *Da* max.: max.: 6 mm			max.: max.:	mm			max.: max.:	mm	
Purging gas type / *Vrsta plina za čišćenje*		l/min									
Welding positions / *Položaji zavarivanja*	PH										
Joint type / *Vrsta spoja*	BUTT JOINT (SUČEONI)										
Joint preparation / *Pripema spoja*	MACHINING										
Cleaning method / *Postupak čišćenja*	GRINDING& BRUSHING										
Backing / *Podloška*	NONE										
Single/double / *Jednostruko/dvostruko*	SINGLE "V"										
Back gouging / *Žljebljenje*											
Flux designation / *Oznaka praška za zavarivanje*											
Flux handling / *Rukovanje praškom zazavarivanje*											
Tungsten electrode / *Volframova elektroda*	3,2 WL15 (Gold) mm										
Torch angle / *Kut gorionika*	80° - 85°										
Stand.off distance / *Udaljenost*	6 - 8 mm										
Nozzle diameter(s) / *Promjer mlaznice*	10 mm										
Tack. welding procedure / *Promjena specifikacije zavarivanja*		Rev: / *Rev:*									



Identification of parent metal
Identifikacija osnovnog metala

Part / *Dio*	Name/grade / *Ime/kvaliteta*	Standard / *Standard*	Group / *Grupa*	Delivery conditional / *Stanje isporuke*	Thickness range / *Raspon debljine mm*	Diameter range / *Raspon promjera mm*
I	S355J2H+N	EN 10210 - 1	1,2	NORMALIZED	3,00- 12,00	25,50 -
II	S355J2H+N	EN 10210 - 1	1,2	NORMALIZED	3,00- 12,00	25,50 -
III						

Identification of filler metal
Identifikacija dodatnog metala

Index / *Indeks*	Trade name / *Trgovačko ime*	Classification/ / *Klasifikacija*	Group / *Grupa*	Filler handling / *Rukovanje dodatnim materijalom*
1	BOHLER DMO - IG	EN ISO 21952-A: W MoSI	FM3	
2				
3				

Welding parameters: / ***Parametri zavarivanja*** — Equipment: / *Oprema:*

Pass no. / *Broj prolaza*	Index / *Indeks*	Dia. / *Promjer*	Welding process / *Postupak zavarivanja*	Wire feed speed / *Brzina žice*	Current / *Jakost struje, A*	Voltage / *Napon V*	Current/polarity / *Struja/polaritet*	Welding speed / *Brzina zavarivanja mm/min*	Run –out length / *Dužina depozita 1 elektrode, mm*	Gas / *Plin l/min*	Heat input / *Unos topline kJ/mm*
1		2,40	141		120 - 130	11,0-12,0	DC(-)	30,0 – 40,0		6 - 12	1,3 - 1,5
2-n		2,40	141		145- 155	12,0-13,0	DC(-)	50,0 – 70,0		6 - 12	0,9 – 2,3

Remarks / *Primjedbe*

Date/signature / *Datum/potpis*

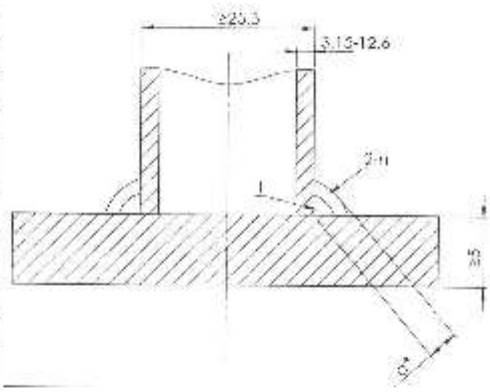
Approved / *Odobrio*

WELDCHANCE	**WELDING PROCEDURE SPECIFICATION (WPS)** Specifikacija postupaka zavarivanja(WPS)	TRAINING - IOS Date: *Datum:* Rev: *Rev:*

Produced by: *Proizvođač:*	IOŠ	Client: *Klijent:*	WELDCHANCE	Ref. stand: *Ref. Standard:*	EN ISO 15614-1
Project: *Projekt:*	WELDCHANCE			Exam body: *Isp. tijelo:*	IOŠ-Sl. Brod
Location: *Mjesto:*	Sl. Brod				

Welding process *Postupak zavarivanja*	1	141	2		3		
Shielding gas type *Vrsta zaštitnog plina*		EN ISO 14175 - I1					
Weaving (Yes/No) *Njihanje(Da/Ne)*		Yes *Da* max.: max.: 6 mm		max.: max.: mm		max.: max.: mm	
Purging gas type *Vrsta plina za čišćenje*		l/min					

Welding positions *Položaj/ zavarivanja*	PB
Joint type *Vrsta spoja*	FILLET JOINT (KUTNI)
Joint preparation *Priprema spoja*	OXY FLAME /MACHINING
Cleaning method *Postupak čišćenja*	GRINDING& BRUSHING
Backing *Podloška*	-
Single/double *Jednostruko/dvostruko*	SINGLE "T"
Back gouging *Žlijebljenje*	
Flux designation *Oznaka praška za zavarivanje*	
Flux handling *Rukovanje praškom zazavarivanje*	
Tungsten electrode *Volframova elektroda*	3,2 WL15 (Gold) mm
Torch angle *Kut gorionika*	75°- 80°/45°
Stand.off distance *Udaljenost*	3 - 6 mm
Nozzle diameter(s) *Promjeri mlaznice*	10 mm
Tack. welding procedure *Promjena specifikacije zavarivanja*	Rev: *Rev:*



Identification of parent metal
Identifikacija osnovnog metala

Part *Dio*	Name/grade *Ime/kvaliteta*	Standard *Standard*	Group *Grupa*	Delivery conditional *Stanje isporuke*	Thickness range *Raspon debljine mm*	Diameter range *Raspon promjera mm*
I	S355J2H+N	EN 10025 - 2	1,2	NORMALIZED	5,00-	
II	S355J2H	EN 10210 - 1	1,2	NORMALIZED	3,15- 12,60	25,50 -
III						

Identification of filler metal
Identifikacija dodatnog metala

Index *Indeks*	Trade name *Trgovačko ime*	Classification/ *Klasifikacija*	Group *Grupa*	Filler handling *Rukovanje dodatnim materijalom*
1	BOHLER DMO - IG	EN ISO 21952-A: W MoSi	FM3	
2				
3				

Welding parameters: Equipment: *Oprema:*
Parametri zavarivanja

Pass no. *Broj prolaza*	Index *Indeks*	Dia. *Promjer*	Welding process *Postupak zavarivanja*	Wire feed speed *Brzina žice*	Current *Jakost struje, A*	Voltage *Napon V*	Current/polarity *Struja/polaritet*	Welding speed *Brzina zavarivanja mm/min*	Run –out length *Duljina depozita 1 elektrode, mm*	Gas *Plin l/min*	Heat input *Unos topline kJ/mm*
1		2,40	141		160 - 180	11,0-14,0	DC(-)	60,0 – 80,0		6 - 11	1,1 - 1,2
2-n		2,40	141		180 - 200	12,0-15,0	DC(-)	65,0 – 80,0		6 - 11	1,2 - 1,3

Remarks *Primjedbe*	Date/signature *Datum/potpis*
	Approved *Odobrio*

8. Document references

8.1. Reference numbers

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8.2. Contact persons:

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9. Bibliography

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