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Learning Resources for the course:

Steel Structure Inspector Course for PED INSPECTOR

This document covers only:

Competence unit no. CU-6 NDT (Non Destructive Testing) INSPECTION, PRESSURE TEST AND DIMENSIONAL CONTROL

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Introduction

The course consists of a number of CU´s. A CU is the smallest element in the education system that specifies Learning Outcomes, Skills and Competence. A CU can be delivered individually or it can be delivered in combinations with other CUs in order to cover a defined range of knowledge and competence.
The course will clarify the inspector's role in manufacturing where it begins well before welding starts, continues during the welding operation, involves action after welding is completed, and is finalized only when the results are properly reported.
The course will be work-based and follows the manufacturing process from the order is received until the welded product is ready for delivery. The inspector is responsible for producing documents that ensure traceability of the components and related manufacturing action throughout this process.

The activities in this course are work-based and follows a product from initial order and as it is being produced in the factory until it is ready for delivery. The manufacturing process has been divided in logical steps whereby the learning activity and learning content and tasks, are distributed according the status of the manufacturing process. In this CU we focus on the NDT methods, Pressure test and Dimensional Control.

In this CU it will be important to get access to examples from companies with practical examples. It is also important to get examples from failures in order to understand what caused the failure and what must be done to correct such failures in the future.

Also note that maintenance and calibration procedures and examples should be available form the students for different type of equipment that will be discussed in this CU.

The students have to submit all tasks, both practical and theoretical, given through the different course CUs. All CUs have practical tasks for the students. The course requires that the student has access to a workshop where products are manufactured. The products in the workshop will be used during the practical training sessions in this course.

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Objective

The objective is that the students get competence in evaluating which NDT method to use and to develop requirements for pressure test and dimensional control.
Additionally it will be important to understand and initiate routines for periodic maintenance and calibration of test equipment.

A. Teacher Guideline.

Content of the Teacher Guideline:
The CU 6 covers the thematic Visual Inspection, NDT, pressure test and dimensional control. The CU contains both a theoretical part as well as a practical part that should be carried out in the workshop.
The theoretical content should follow the EWF Guideline, item 2.3 from module 2, covering Visual Inspection as well as MT and PT.

The documents identified and created in CU 4 can be used in the work that shall be carried out in the workshop.

Important in this CU is the interpretation of the findings in the practical work and how to document this in a correct way.

It should also be highlighted in this CU how to carry out corrective actions and repair for the findings.

The methods have their limitations which should be highlighted. These should be discussed and agreed upon through group discussions.

We assume that the students will have some examples from their own companies.

Try to bring these examples forward and use them as examples for discussions.

Also discuss what may happen if the students do not find or document the errors, and the long term consequences of such examples.

One important topic is the equipment used for the activities. Go through and describe how to use the equipment correct and highlight also the advantages and disadvantages of it. Try to give practical examples as well or ask the students for examples from their companies. Also discuss topics like maintenance and calibration of equipment and routines for doing this at the work shop level.

For dimensional control and pressure test, use practical procedures from the companies, if that are available.

B. Students Guideline

The CU 6 covers the thematic Visual Inspection and NDT, with PT and MT as well as dimensional control and pressure test.
The tasks in this CU cover both the theoretical content and a set of practical tasks to be carried out in your company. Or in the laboratory.

The practical tasks must be documented by submitting short video reports of how you have carried out the control activities.

We assume that you have cases from your company that you can share with the other students and the teacher. Please submit these examples and create a discussion around them.

Examples can be successful examples, but examples of failures are just as important. If you have examples of failures then try to describe how you have corrected these failures.

In the LMS system, under the folder with “Resources and activities”. The material is available as pdf-files, word- and excel files, and video material (online at YouTube and as mp4 files stored in the learning management system). Please notice that the written assignments should be answered by using the word-files that are embedded into the description of the tasks. **You <u>shall not use</u>** the Office package installed on your own device.

C. Learning resources

Support resources from selected from the Internet.

Title	Producer	Reference	Language	No of pages	Copy-right

Learning resources developed in the project.

Title	Producer	Language	No of pages	Copyright
Visual Inspection and NDT testing	Matrai	English	12	No
6520 defects overview	QMS	English	27	No
Dimensional control-size control	Matrai	English	61	No
Non destructive testing	Matrai	English	11	No
EN2-rev1 Dimensional control	Matrai	English	61	No

Video resources created for this CU

Title	Producer	Time	Reference	Language	Format	Copy-right
Visual Inspection of Welds	CSWIP	28.03	ISIM	English	MP4	No
Weld Gauge Measurement		11.00	ISIM	English	MP4	No
Color Vision Test		4.07	ISIM	English	MP4	No
H8301CME	Matrai	0.19	Matrai	Hungarian	mov	No
H8302CME	Matrai	0.53	Matrai	Hungarian	mov	No
H8303CME	Matrai	0.34	Matrai	Hungarian	mov	No
H8304CME	Matrai	0.27	Matrai	Hungarian	mov	No

D. Students tasks

*Carry out visual inspection on an object in production

The object ought to have a number of seems to be inspected.

*Carry out inspection before-during and after welding

*Explain the difference of the expressions—Visual Testing and Visual Inspection

*Select different NDT method for the product and explain why

* Discuss the work instruction for a welding inspector related to NDT

*Report with picture of the tools to be used for visual inspections.

*Give example of documents for visual inspection

* Create 2 -3minutes video from practical work

1. Select the tools and documents to be used for visual inspection
2. Identify where visual inspection shall take place
3. Select tools for visual inspection
4. Carry out visual inspection and report the findings

E. Course evaluation questions

1. Did you find this module relevant ?

* Yes
* No
* I don't know

2. Was it time enough for going through the material ?

* Yes
* No
* I do not know

3. Was the resources relevant for this module ?

* Yes
* No
* I do not know

F. Appendix.

Learning resources developed for this CU.

CU6
VISUAL INSPECTION AND NDT TESTING

Deviations in welding

Numerous factors can cause deviations in the welding process. Deviations could be perfectly avoided by properly setting the welding parameters.

According to the standard EN ISO 6520 these are the main categories of deviations.

100 Cracks

200 Porostiy

300 Solid inclusions

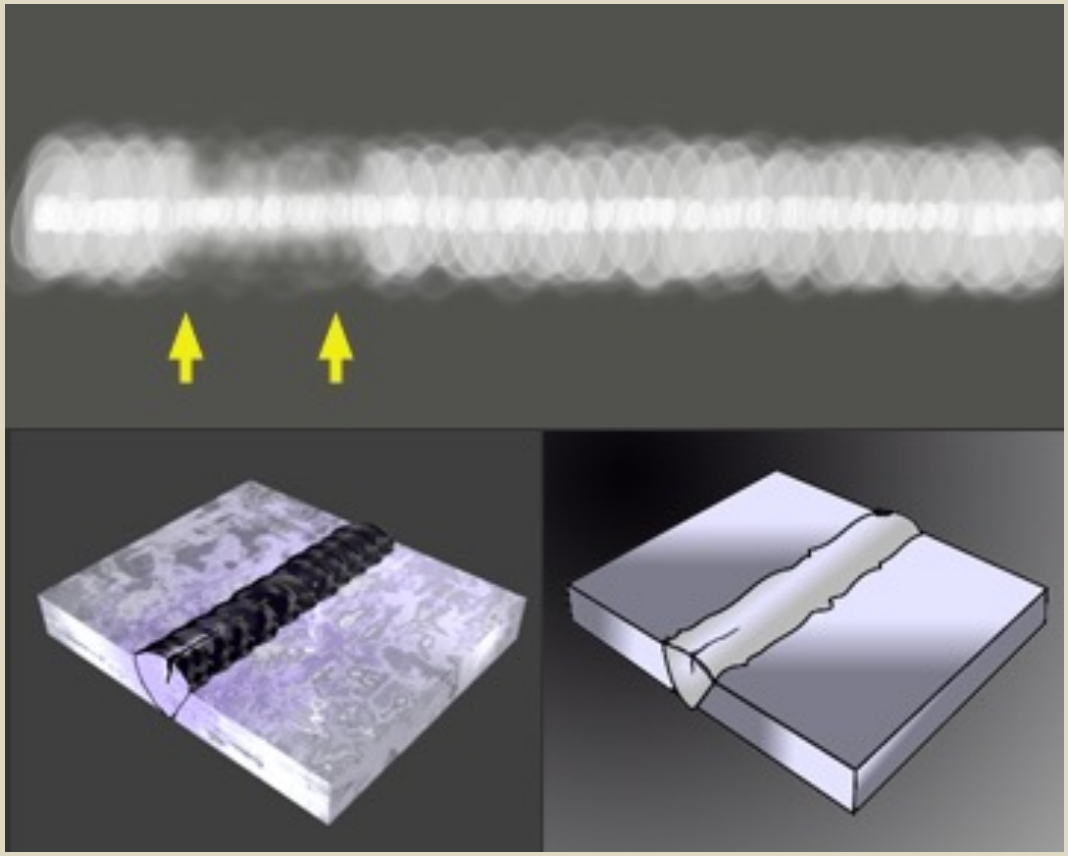
400 Lack of fusion / insufficient penetration

500 Geometric deivations

600 Other deviations

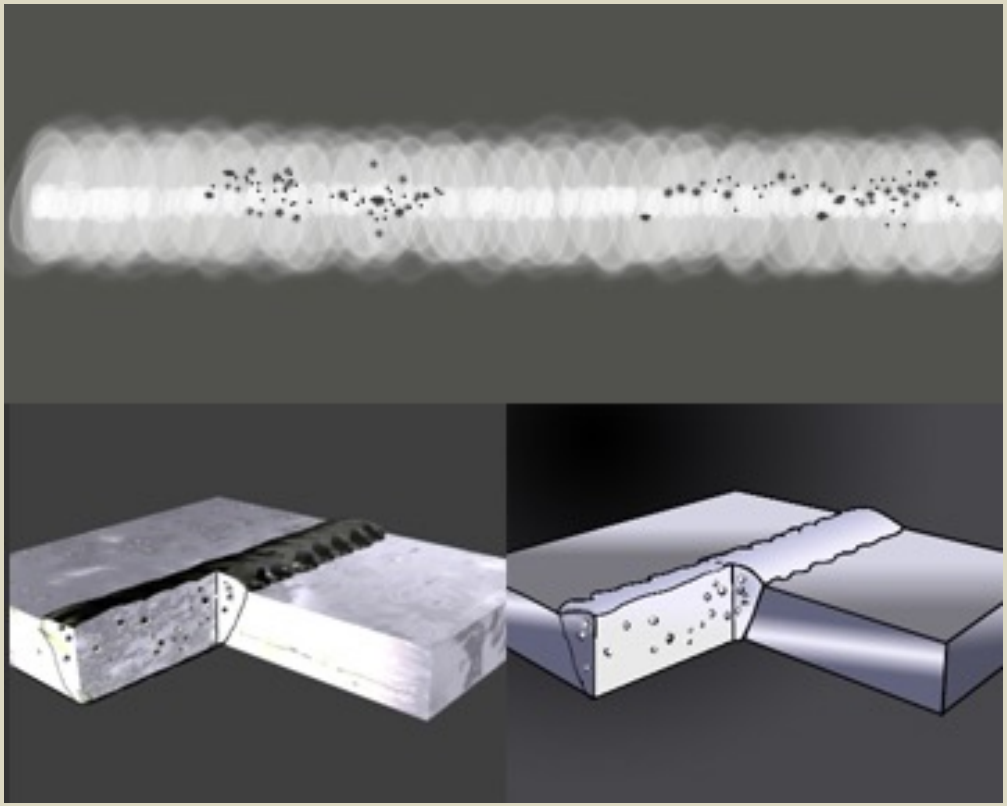
100. Cracks

Crack may occur because of cooling down or tension. They are longitudinal or transverse cracks, inside the heat affected zone or inside the material.



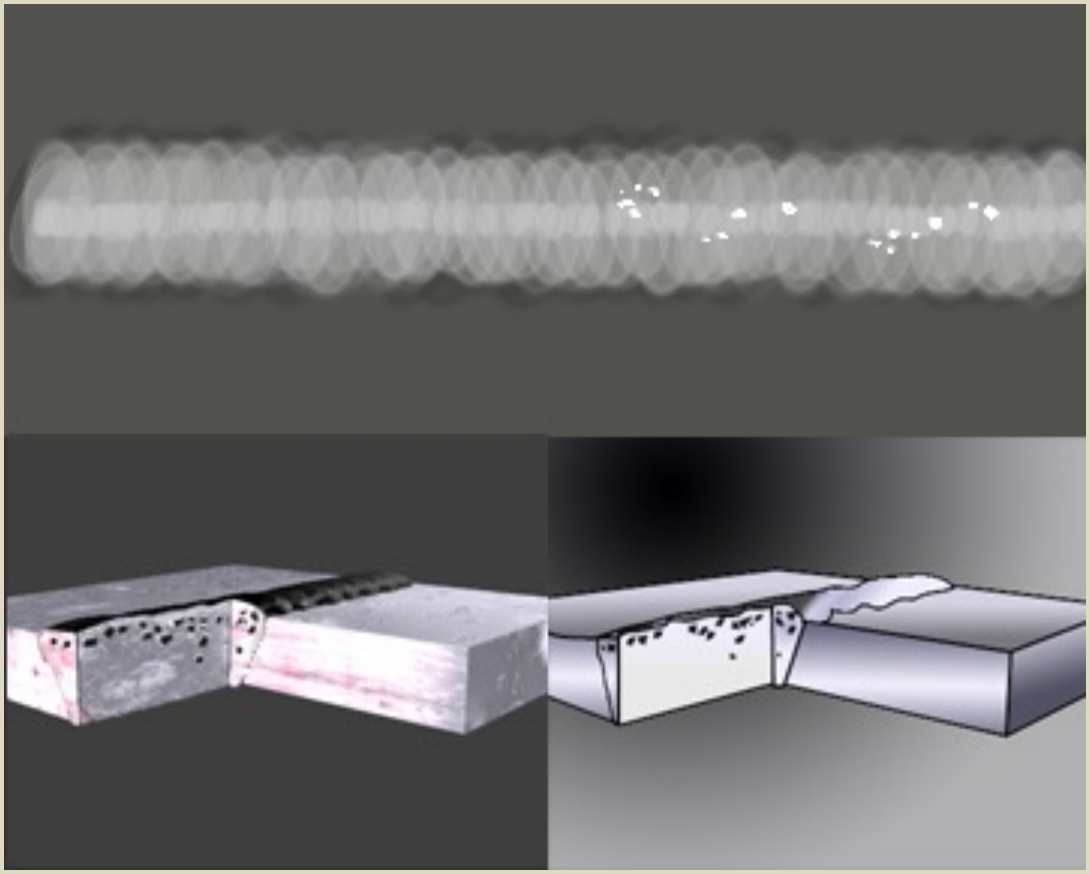
200. Porosity

In a weld, porosity may occur by the lack or interruption of the shielding gas. Sometimes you can see porosity on the surface. Porosity on the X-ray screen is depicted as dark, round spots. They are gassholes or gas-canals.



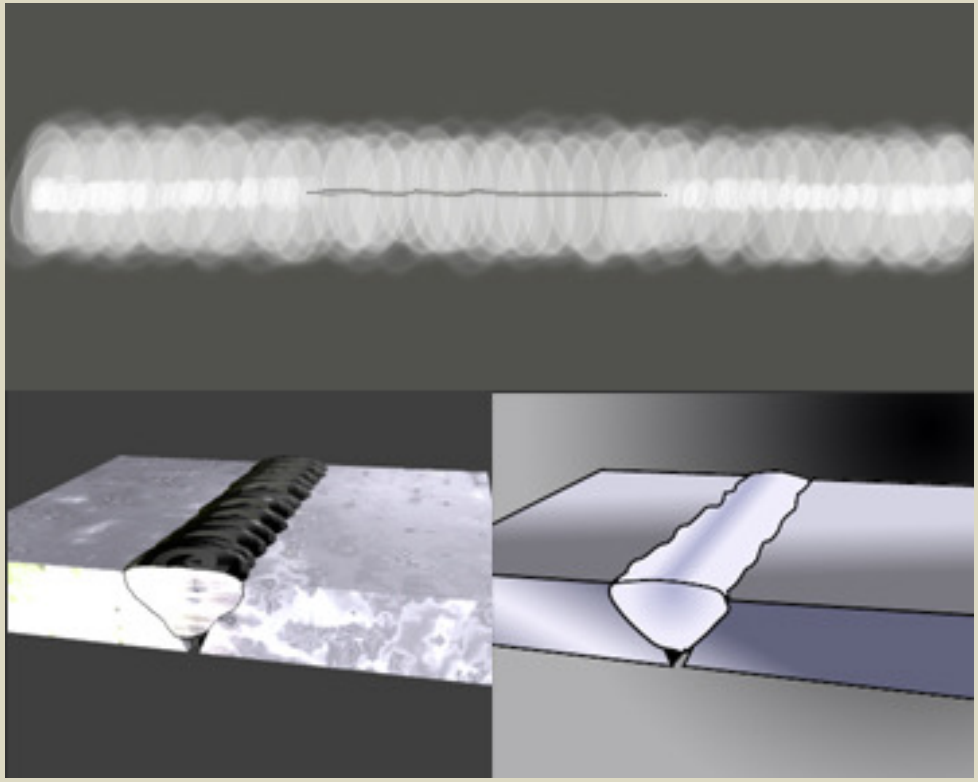
300. Solid inclusions

Solid inclusions occur in many variations. On the X-ray you can see particles of tungsten like white, irregular spots. They arise when the electrode touches the weldpool.



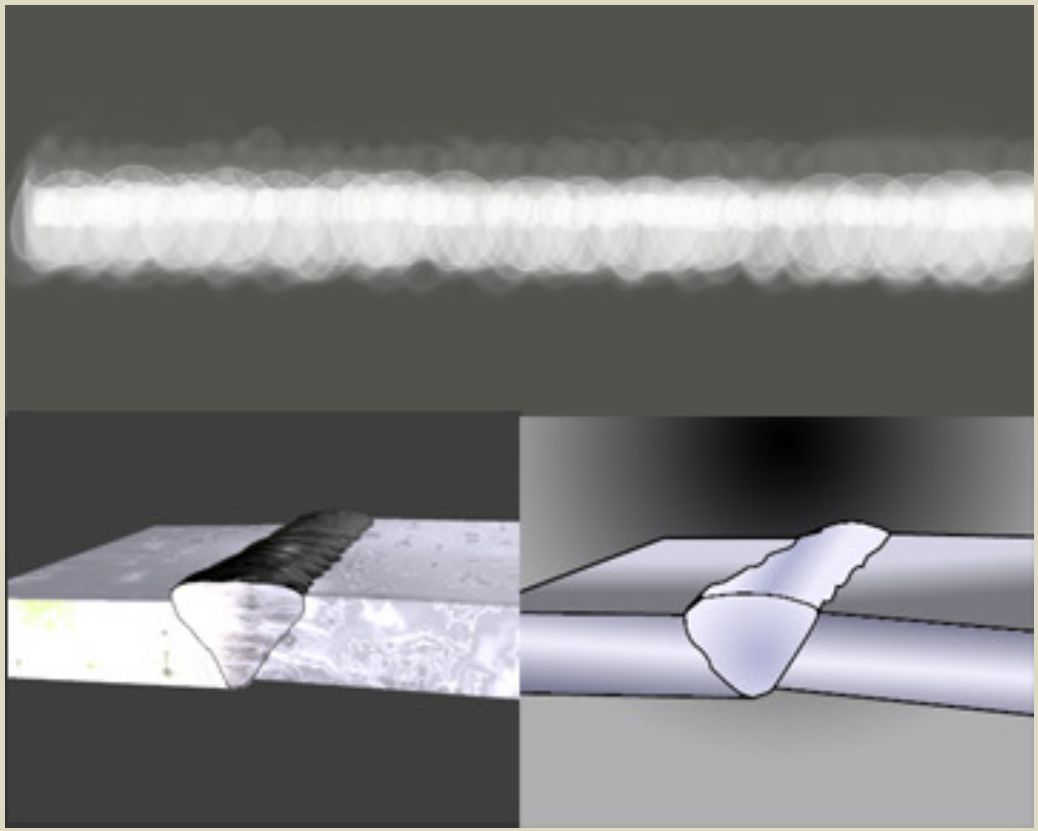
400. Lack of fusion/ insufficient penetration

Lack of fusion/ insufficient penetration is mostly caused by insufficient skills of the welder. See an example of a local insufficient penetration on the X-ray below. The sharp edges of the v-joint are not melted and clearly visible as a grey line.



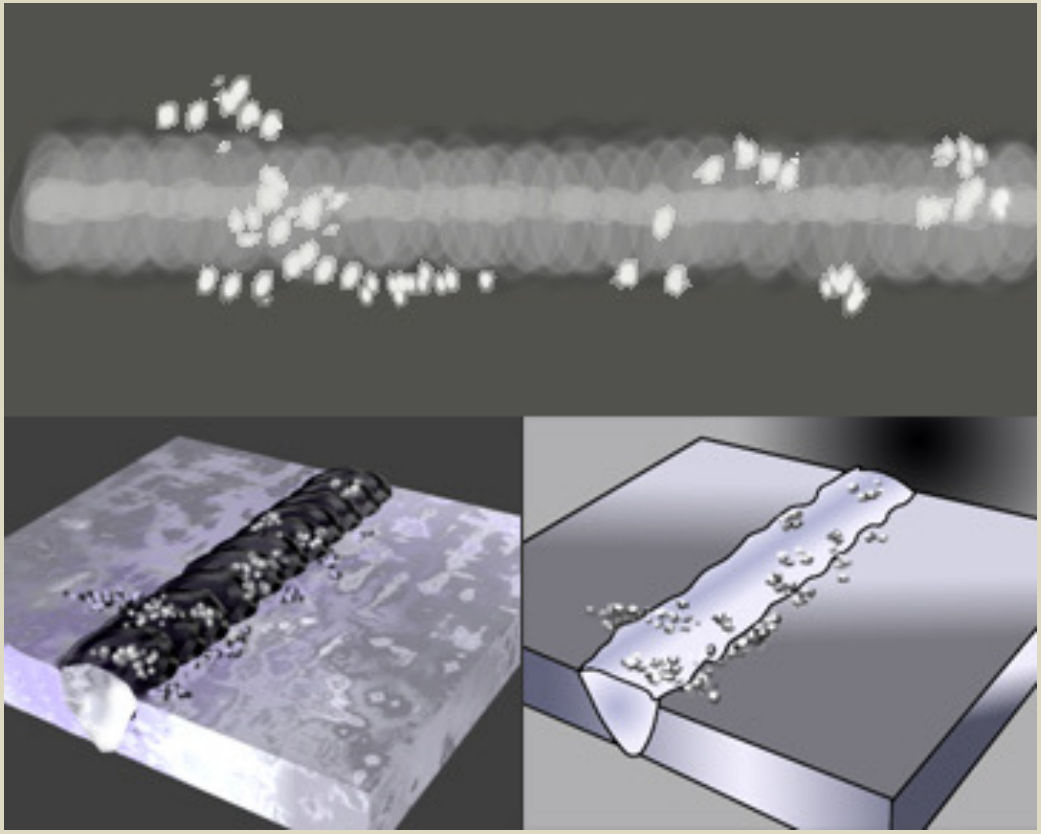
500. Geometric deviations

A frequent geometric deviation is the out-of-line positioning of the pieces. It's commonly called high-low. The deviation is usually caused by the welder. On the X-ray we see black and white differences between one and the other side the weld.



600. Other deviations

The deviations that could not be classified above belong here. In our example we show spatter. Spatter unlikely occurs in TIG welding, since TIG welding is basically a splatterfree process.



1.1 Visual test

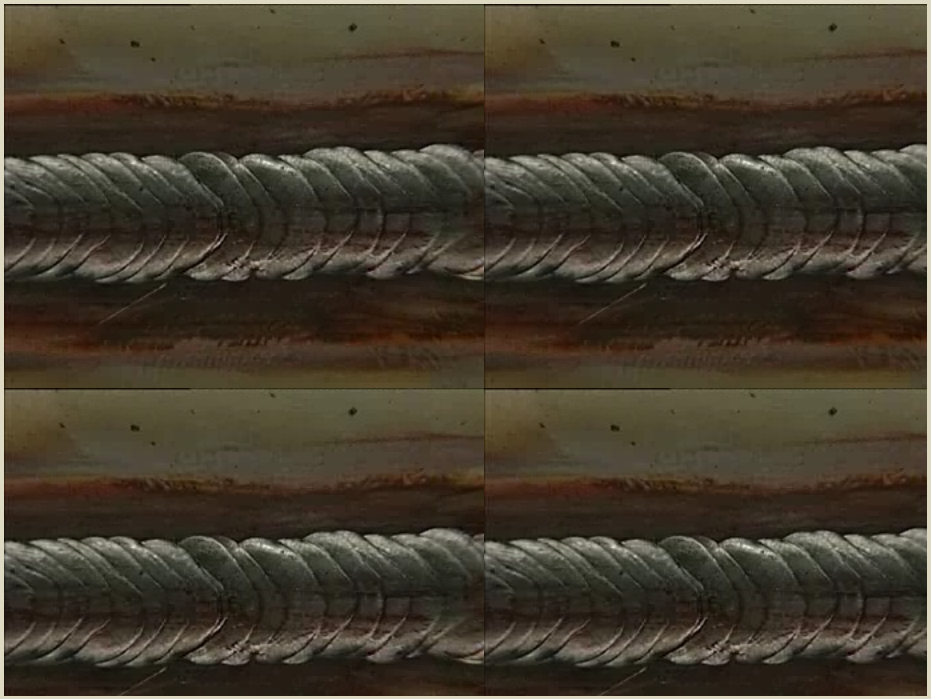
In a visual test, the weld is examined on deviations such as the correct a-value, undercut, convexity, excessive weld metal, etc. The acceptable deviation for steels are given in the standard EN ISO 5817.

1.2 Surface crack test

Two methods are used to find surface cracks: magnetic and dye penetrant examination.

In magnetic examination a liquid containing iron powder is sprayed on the weld. When a strong magnetic field is applied cracks are made visible even under the surface.

In dye test, a red liquid is used to soak the weld. The cracks are visible when a white indicator liquid is added.



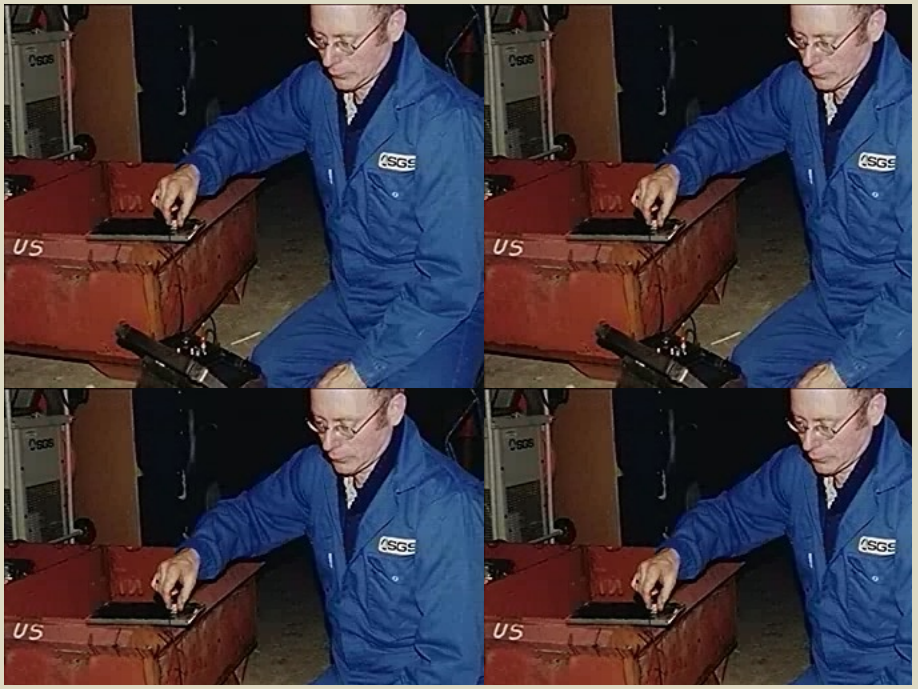
1.3 X-ray test

The base material and the weld are examined with X-rays. The result is recorded on a radiation sensitive screen. – Even with little practice the imperfections are easily recogniseable. X-ray is the most common way of identifying welding deviations in quality assurance.

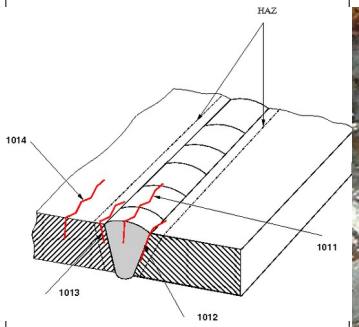
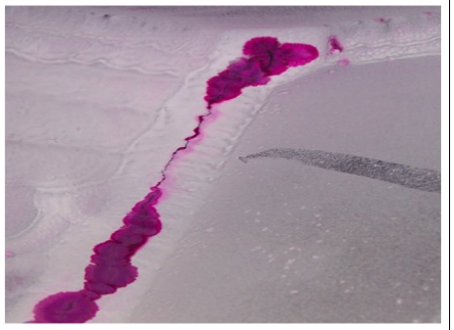
1.4 Ultrasonic test

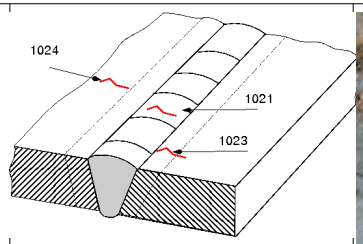
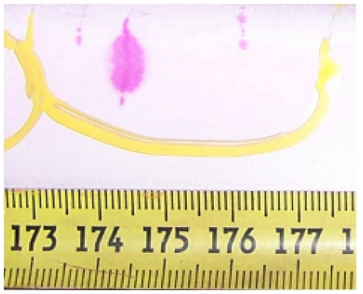
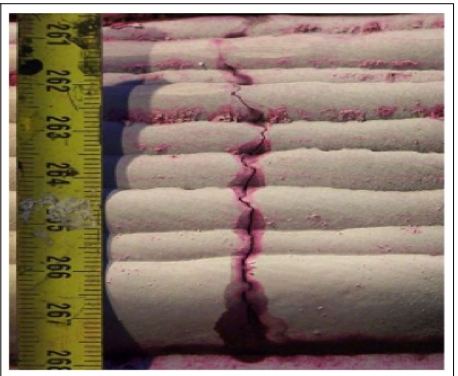
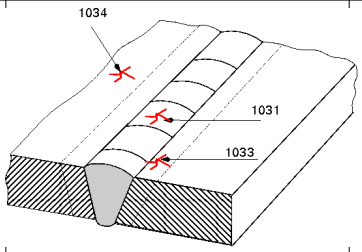
In ultrasonic test the weld is examined by using high-frequency directional sound waves. It works with an emitter-receiver, in which the receiver registers an echo with which you can clearly recognise slag inclusions, lack of fusion and others.

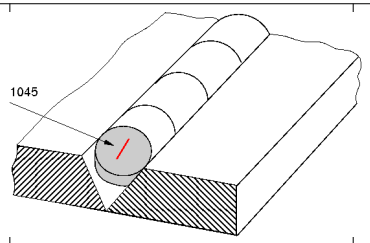
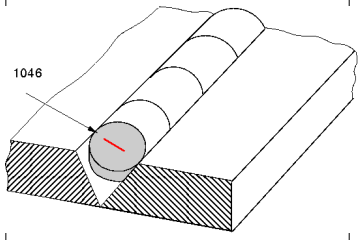
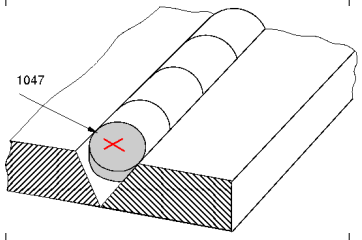
It is a very precise technique to find the location and dimensions of the deviation.

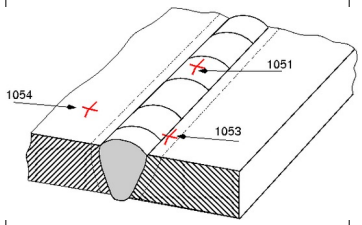
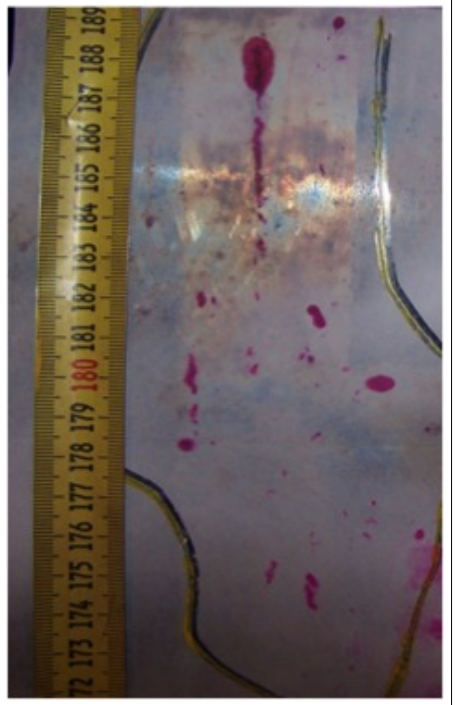


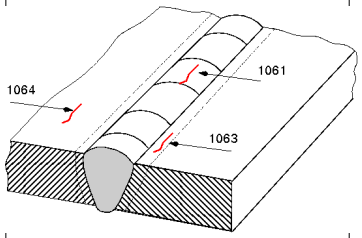
Defects according ISO 6520-1:2007

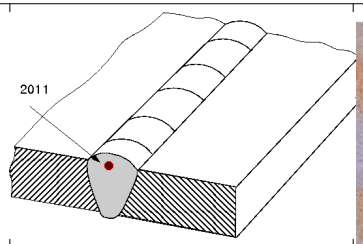
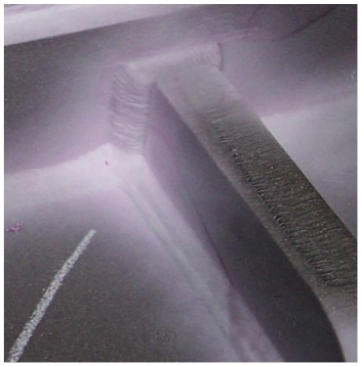
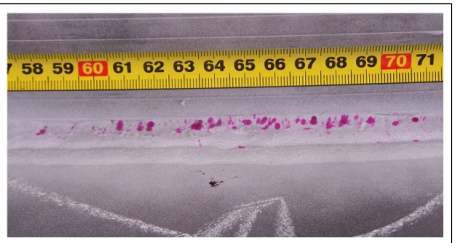
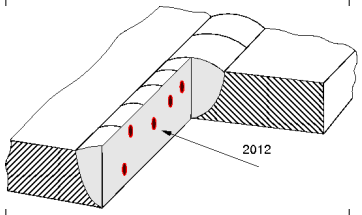
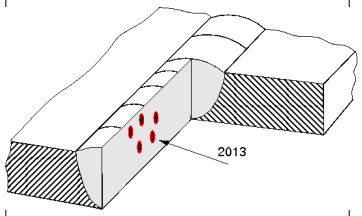
Defect category	Type	Drawing	Examples		
			macromorphology	Macrostructure (crosssection)	Microfracture/microstructure morphology
101	Longitudinal cracks				

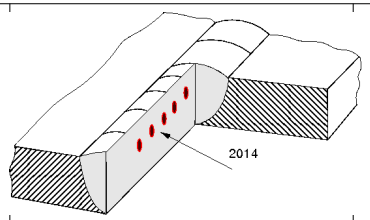
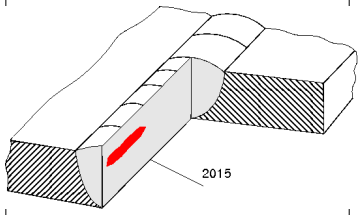
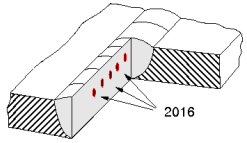
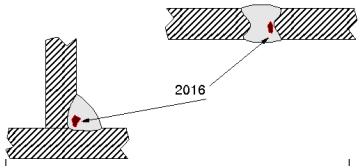
102	Transversal cracks				
103	Radiating Cracks				
104					

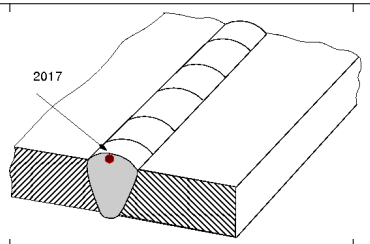
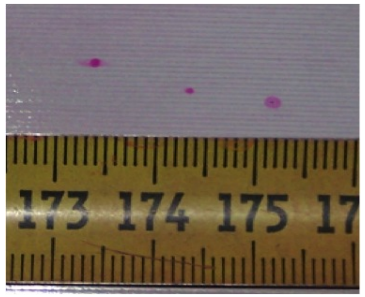
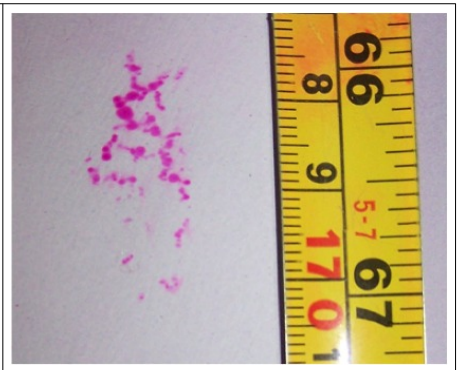
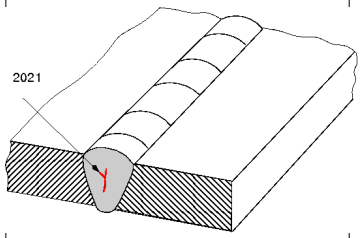
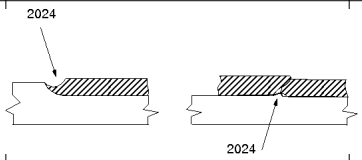
1045	Longitudinal crack				
1046	Transverse crack				
1047	Radiating crack				

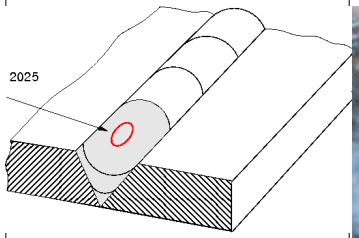
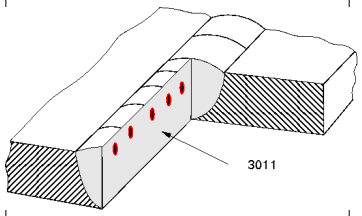
105	Disconected cracks				

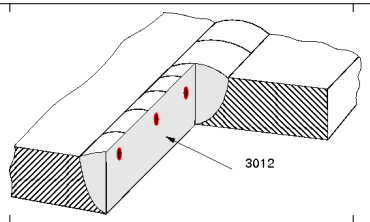
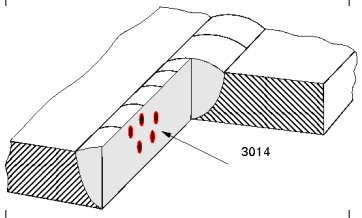
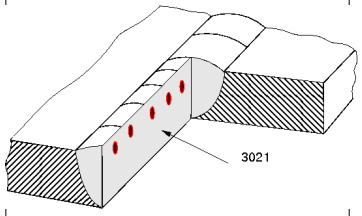
106	Brancing cracks				

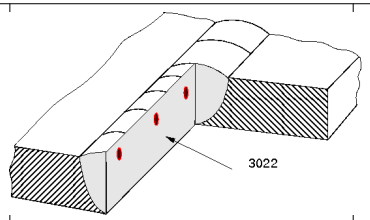
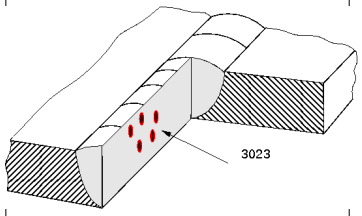
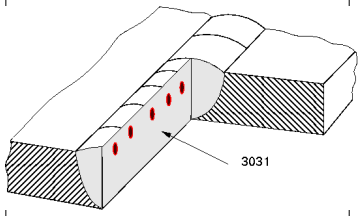
2011	Gas pore				
2012	Uniformly distributed porosity				
2013	Clustered (localized) porosity				

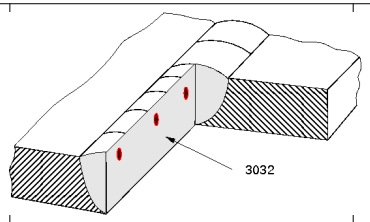
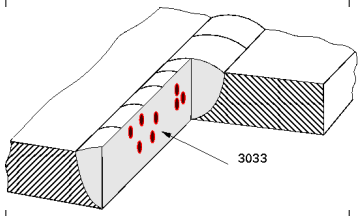
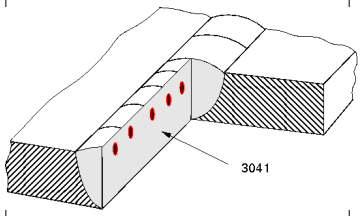
2014	Linear porosity				
2015	Elongated cavity				
2016	Worm-hole	 			

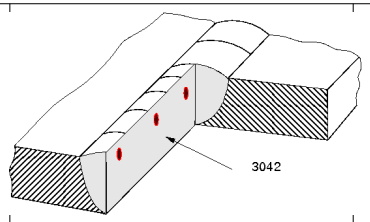
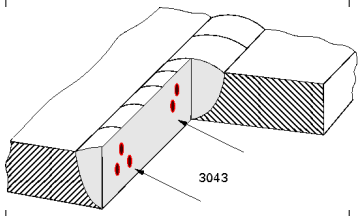
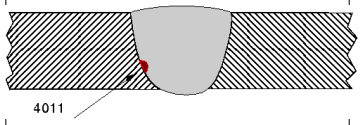
2017	Surface pore				
2021	Interdendritic shrinkage				
2024	Crater pipe				

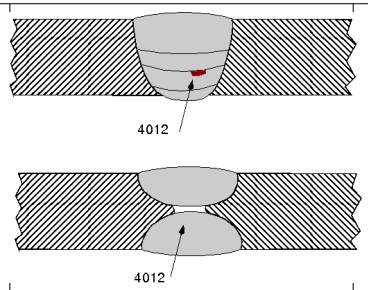
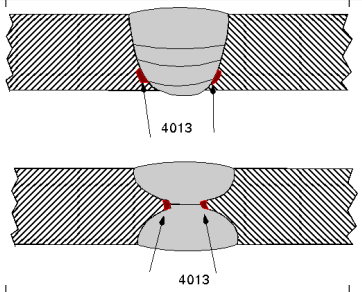
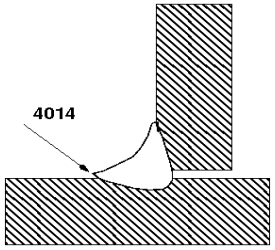
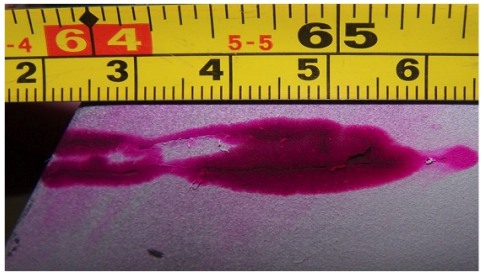
2025	End crater pipe				
301	Slag inclusion				
3011	Linear				

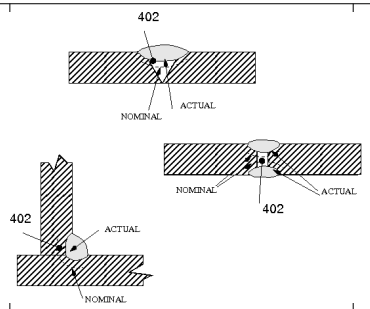
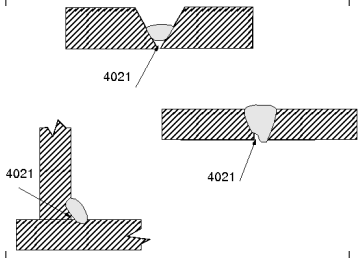
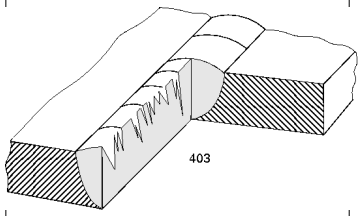
3012	Isolated				
3013	Clustered				
302	Flux inclusion				
3021	Linear				

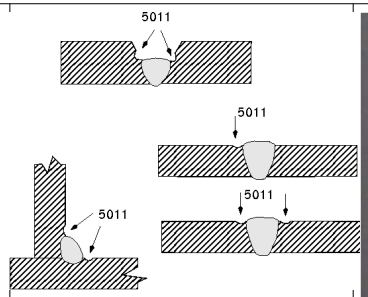
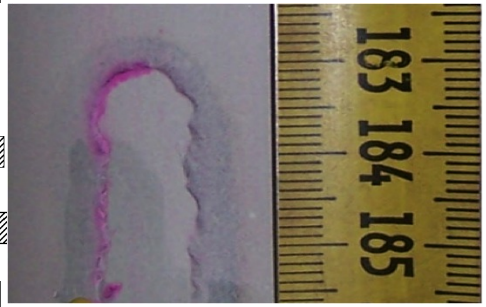
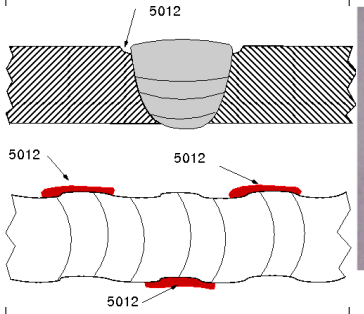
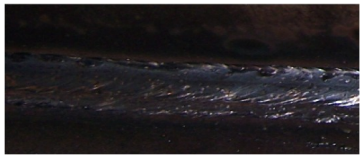
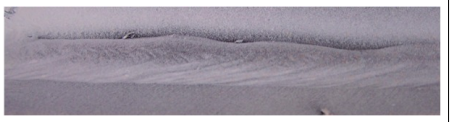
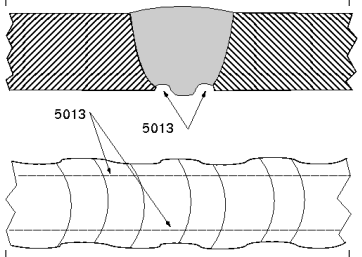
3022	Isolated				
3023	Clustered				
303	Oxide inclusion				
3031	Linear				

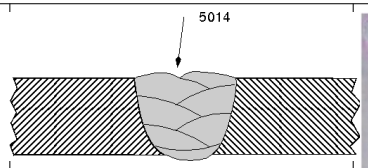
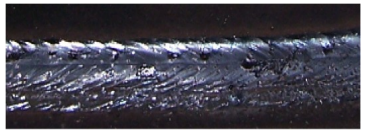
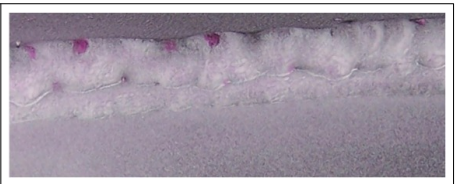
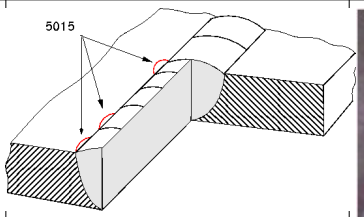
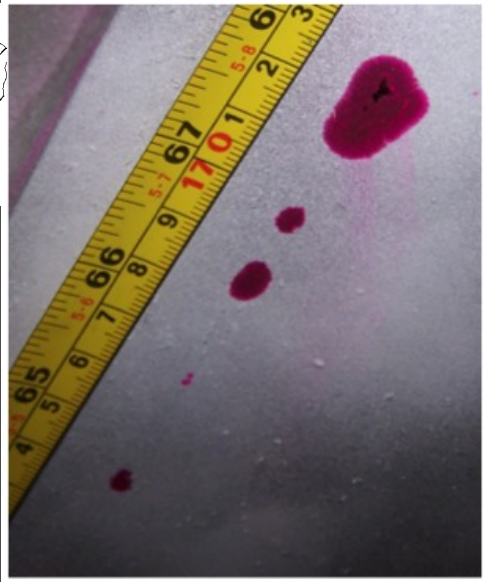
3032	Isolated				
3033	Clustered				
304	Metallic inclusion				
3041	Tungsten				

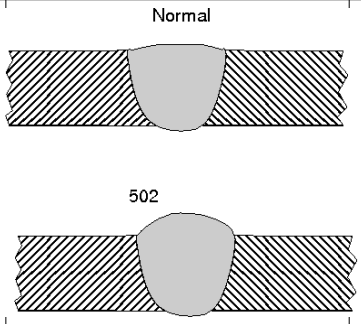
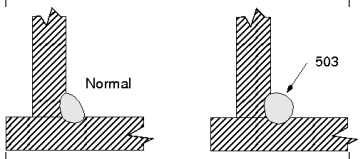
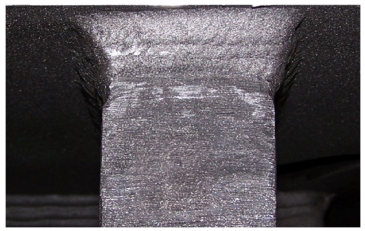
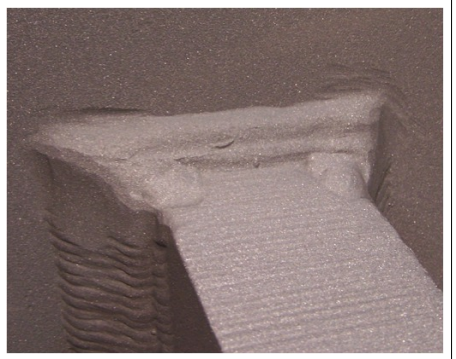
3042	Copper				
3043	Other metal				
401	Lack of fusion				
4011	Lack of side-wall fusion				

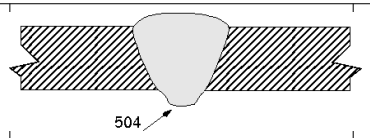
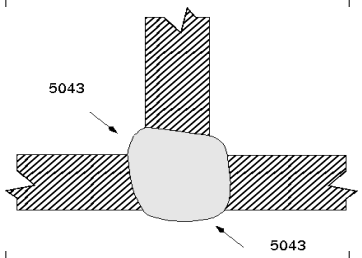
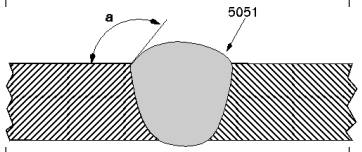
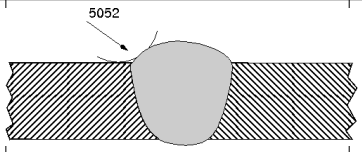
4012	Lack of inter-run fusion				
4013	Lack of root fusion				
4014	Micro crack fusion				

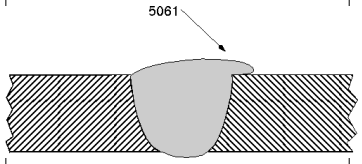
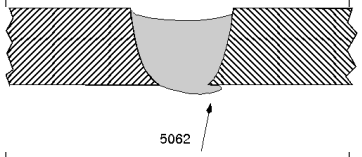
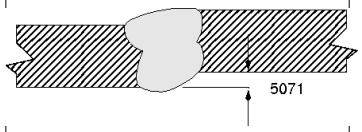
402	Incomplete penetration				
4021	Incomplete root pebnetration				
403	Spiking				
500	Imperfect shape				

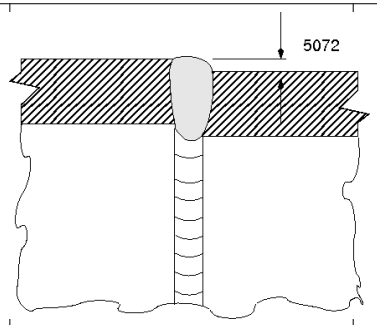
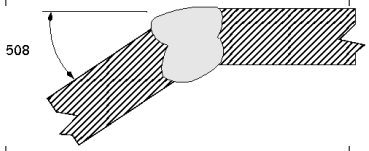
5011	Continious undercut				
5012	Intermittent undercut				
5013	Shrinkage grooves				

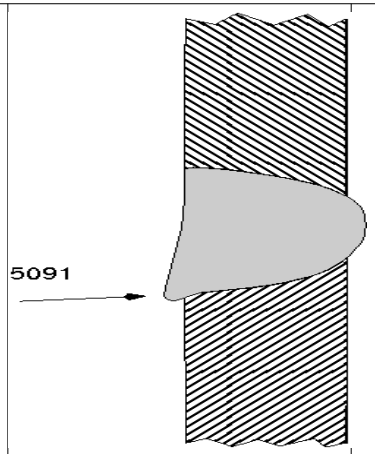
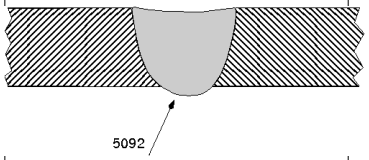
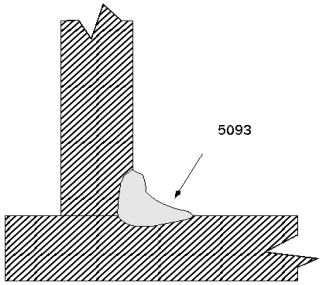
5014	Inter-run undercut				
5015	Local intermittent undercut				

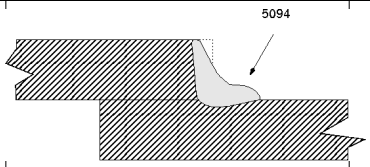
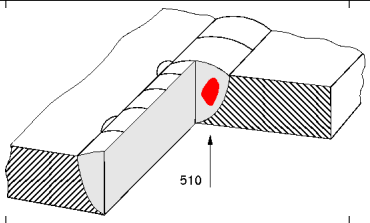
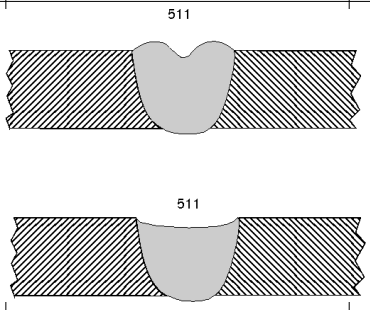
502	Excess weld metal				
503	Excessive convexity				

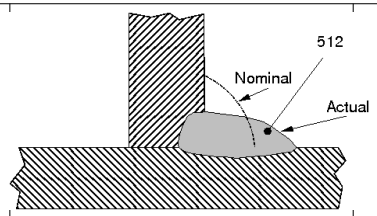
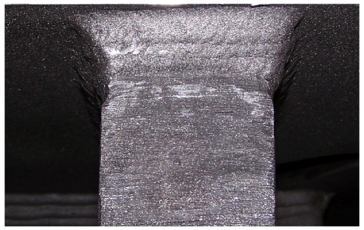
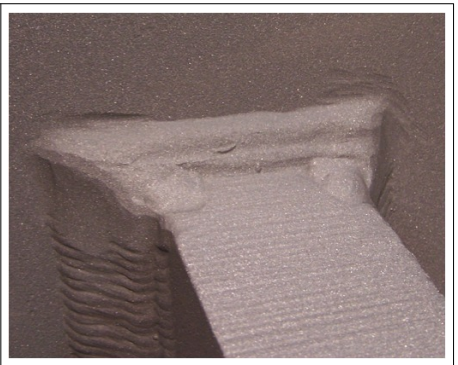
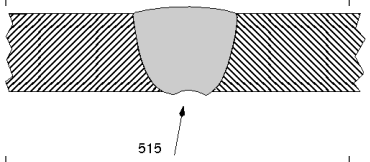
504	Excessive penetration				
5043	Excessive melt through				
505	Incorrect weld toe				
5051	Incorrect weld toe angle				
5052	Incorrect weld toe radius				

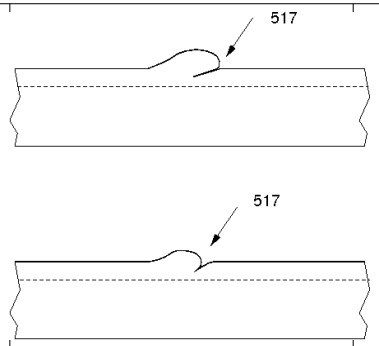
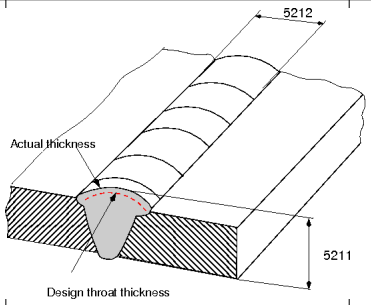
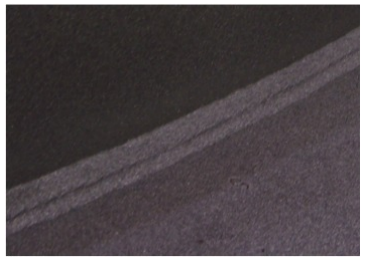
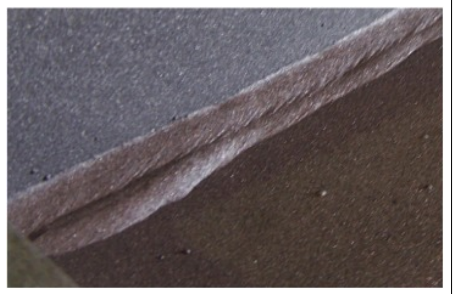
506	Overlap				
5061	Toe overlap				
5062	Root overlap				
507	Misalignment				
5071	Linear misalignment between plates				

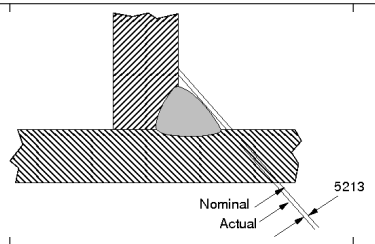
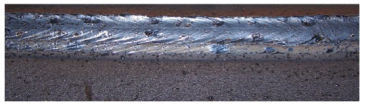
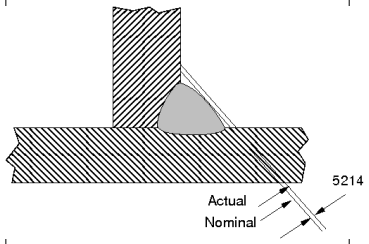
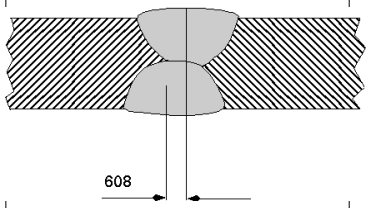
5072	Linear misalignment between tubes				
508	Angular misalignment				
509	Sagging				

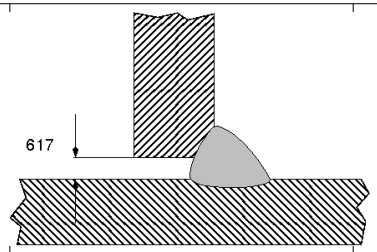
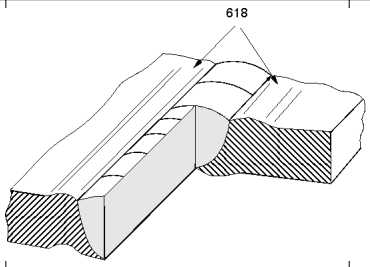
5091	Sagging in horizontal position				
5092	Sagging in the flat or overhead position				
5093	Sagging in a fillet weld				

5094	Sagging at the edge of the weld				
510	Burn-Through				
511	Incompletely filled groove				

512	Excessive asymmetry of fillet weld				
513	Irregular width				
514	Irregular surface				
515	Root concavity				
516	Root porosity				

517	Poor restart				
5171	-in the capping run				
5172	-in the root run				
521	Incorrect weld dimensions				

5213	Insufficient throat thickness			
5214	Excessive throat thickness			
608	Misalignment of opposite run			

617	Incorrect root gap for fillet welds				
618	Swelling				

Not always all fields (macromorphology, crosssection , microfracture/microstructure morphology crosssection) can be filled

CU-6
Product Inspector PILOT Course -2.2-rev01

Dimensional control

Size control

PRESSURE EQUIPMENT

the

MSZ EN 13445, MSZ EN 13480

2014/68/EU – EU guideline –SPVD

according to

44/2016 (XI.28.) NGM Decree to SPVD which transposes the EU Directive

„ which will be discussed”

PRESSURE EQUIPMENT

'Pressure equipment' means vessels, piping, safety fittings and pressure accessories, including, where appropriate, elements connected to pressurized parts, such as flanges, nozzles, connectors, supports, lifting lugs; (2014/68 / EU)

PRESSURE EQUIPMENT

Pressure vessel:

closed or lockable equipment which is not exposed to the direct heating effect of combustion products, chemicals or electricity and has a pressure of more than 0.5 bar; directly connected (inlet and outlet) flanged or welded pipe joints.

Pressure vessel

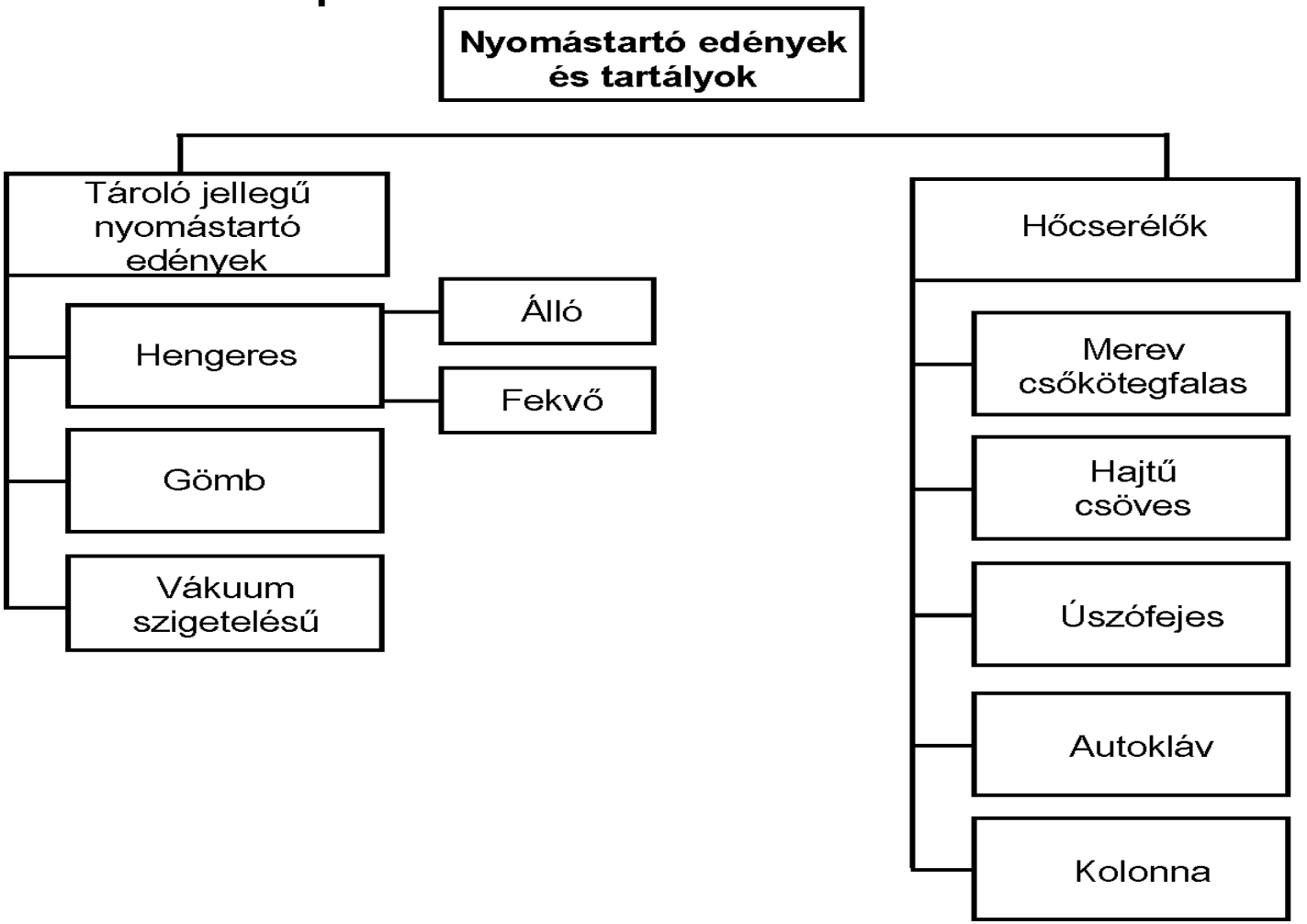
- In the case of pressure vessels, a wide range of complex stresses can be expected, thus
- • extreme operating temperatures up to hundreds of ° C,
- • operating pressure up to hundreds of MPa,
- • May contain extremely toxic, corrosive, scalding, flammable and explosive charges.Their volume can range from a few liters to thousands of m3.

Pressure vessel

- The manufacture, conversion, repair, operation and related safety requirements of pressure vessels, the method of obtaining the necessary permits, and The conditions for granting such tests, the preconditions and methods of inspections, and the content, period and manner of official controls shall be governed by regulations, safety regulations, standards and technical guidelines.,

Pressure vessel

- Variants of pressure vessels:

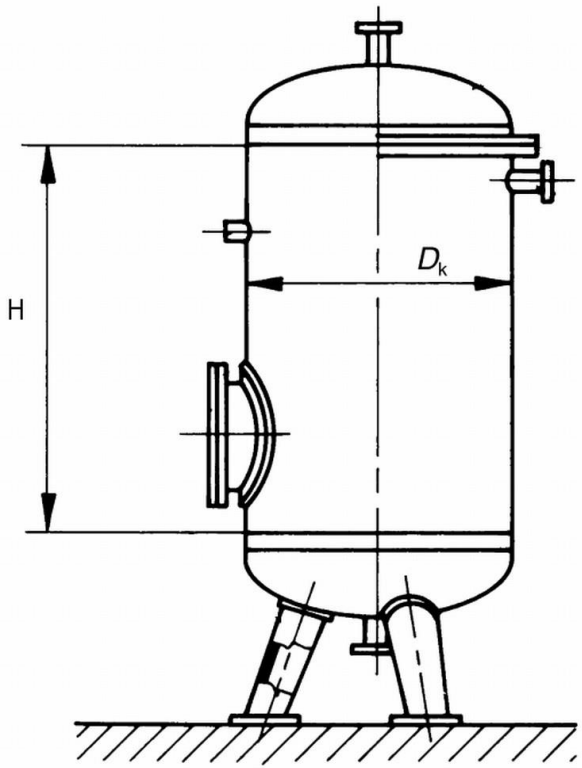


Pressure vessel

Variants of tanks according to their purpose:

- air tanks (for inert gas),
- chemical tanks (for dangerous gases),steam boilers (water with a temperature higher than 100 ° C, steam filling, etc.)According to their design:
- Vertical / vertical longitudinal axis,

- Horizontal / horizontalTheir production: legally regulatedindustrial manufacturing.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Based on EU - compliant concepts 2014/68 / EU required to perform the inspector 's task

- „vessel”:

- a closed system designed and constructed for the reception of pressurized charges and its direct fittings, up to the point of connection with other equipment;

- there may be more than one (connecting) chamber on a vessel;

"EU" concepts for inspector task

- "Pipeline" means a pipeline for the transport of charges and associated components which together form a single pressure system;
- the pipeline is, in particular, a pipe or a system consisting of pipes, pipe systems, fittings, expansion joints and, where necessary, other pressure components;
- a heat exchanger consisting of pipes for cooling or heating the air;

"EU" concepts for inspector task

- 4. "safety fittings" means structures for the protection of pressure equipment against exceeding the permissible limits, including direct pressure relief devices such as safety valves, safety splitting discs, break bars, controlled safety relief systems (CSPRS) and limiting devices that activate or close or correct the means of correction, such as pressure, temperature or charge level switches and safety measuring and control (SRMCR) devices;

"EU" concepts for inspector task

- "Pressure accessories" means devices with an operating function and a pressure housing;
- 'System' means a series of pressure equipment assembled by the manufacturer to form a single functional unit;
- "Pressure" means the pressure in relation to atmospheric pressure, ie overpressure. consequently, the vacuum is negative;

Pressure vessels:

Pressure test :

- Legislative inspection to verify the safety, reliability and leak tightness of a pressurized system - to be carried out by an impartial inspector before any new equipment is put into service.
- The test may be hydrostatic or pneumatic.
- Water is used for hydrostatic testing.
- For pneumatics, air, nitrogen or any other non-combustible and non-toxic gas.

Pressure vessels:

Pressure test:

- The test must be performed under constant supervision during that time, in accordance with the approved and documented test plan - the approved test plan may be used more than once for similar tests after a preliminary inspection, but a separate test report must be drawn up after each test.

"EU" concepts for inspector task

, Maximum allowable pressure (PS)' means the maximum pressure specified by the manufacturer for which the equipment is designed; it is determined at the place specified by the manufacturer and is either the point of attachment of the protective and / or restraining device or the top of the equipment or, if this is not appropriate, any point specified;

"EU" concepts for inspector task

- 'Maximum / minimum temperature (TS)' means the maximum / minimum temperature specified by the manufacturer for which the equipment is designed;
- 'Volume (V)' means the internal volume of a chamber, including the volume of the stubs up to the first point of attachment or to the seam, less the volume of the permanent internal components;

"EU" concepts for inspector task

- 'Nominal size (DN)' means a numerical designation of a size that is generally applicable to all components of a piping system, except those components which are determined by their outside diameter or thread size; this is a rounded number for reference purposes and is only approximately equal to the production dimensions; the nominal size is marked with a “DN” followed by a number;

"EU" concepts for inspector task

- "Charges" means single or multi-component gases, liquids and vapors; the filler may also contain a suspension of solids;
- "Permanent joints" means separable only by a destructive method;
- "Putting into service" means the first use of a pressure equipment or system by a user;

"EU" concepts for inspector task

- "manufacturer":

any natural or legal person who manufactures, designs or manufactures a pressure equipment or system and who markets or uses the pressure equipment or system under his name or trademark;

"EU" concepts for inspector task

- "technical description":

a document describing the technical requirements to be met by the pressure equipment or system;

- "Harmonized standard„

means:Requirement according to Article 2 (1) (c) of Regulation (EU) No 1025/2012: (see slide below)

"EU" concepts for inspector task

Harmonized standard:

a European standard adopted at the request of the EU Commission to facilitate the application of EU harmonization legislation;

National standard:

a standard adopted by a national standards body;

"EU" concepts for inspector task

- European material approval:

a technical document specifying the characteristics of the non-harmonized material for re-use in the manufacture of the pressure equipment; (Decree 44M16 (XI.28) NGM)

"EU" concepts for inspector task

- conformity assessment:

the procedure to demonstrate that the pressure equipment and / or system meets the essential safety requirements set out in the relevant EU Directive on the basis of acceptable results tested and obtained,

"EU" concepts for inspector task

EU-type examination:

the part of the conformity assessment procedure in which a notified body examines the technical design of the vessel and verifies and certifies that the technical design of the vessel complies with the applicable and applicable requirements set out in the relevant legislation.

"EU" concepts for inspector task

- "CE marking" means:
- a mark by which the manufacturer and / or the person who places the product on the market indicates that the pressure equipment or system satisfies all the requirements set out in Union harmonization legislation providing for its affixing;„
- Union harmonization legislation" means:any EU legislation harmonizing the conditions for the marketing of products.

"EU" concepts for inspector task

CE conformity marking and EU declaration of conformity

The manufacturer shall affix the CE conformity marking to each vessel that is in conformity with the type as described in the EU-type examination certificate and satisfies the requirements of the relevant legislative instrument.

The manufacturer shall draw up a written EU declaration of conformity for each vessel model.

The EU declaration of conformity identifies the model of the vessel according to which it was made.

"EU" concepts for inspector task

Reactor:

pressure equipment for the chemical industry, which is used for chemical processes, e.g. used for the transformation and / or production of

General characteristics of pressure vessels

Legend-1:

1 – bottom of vessel,

2 – mantle (cylindrical),

3 _ stub (pipe, prescribed direc

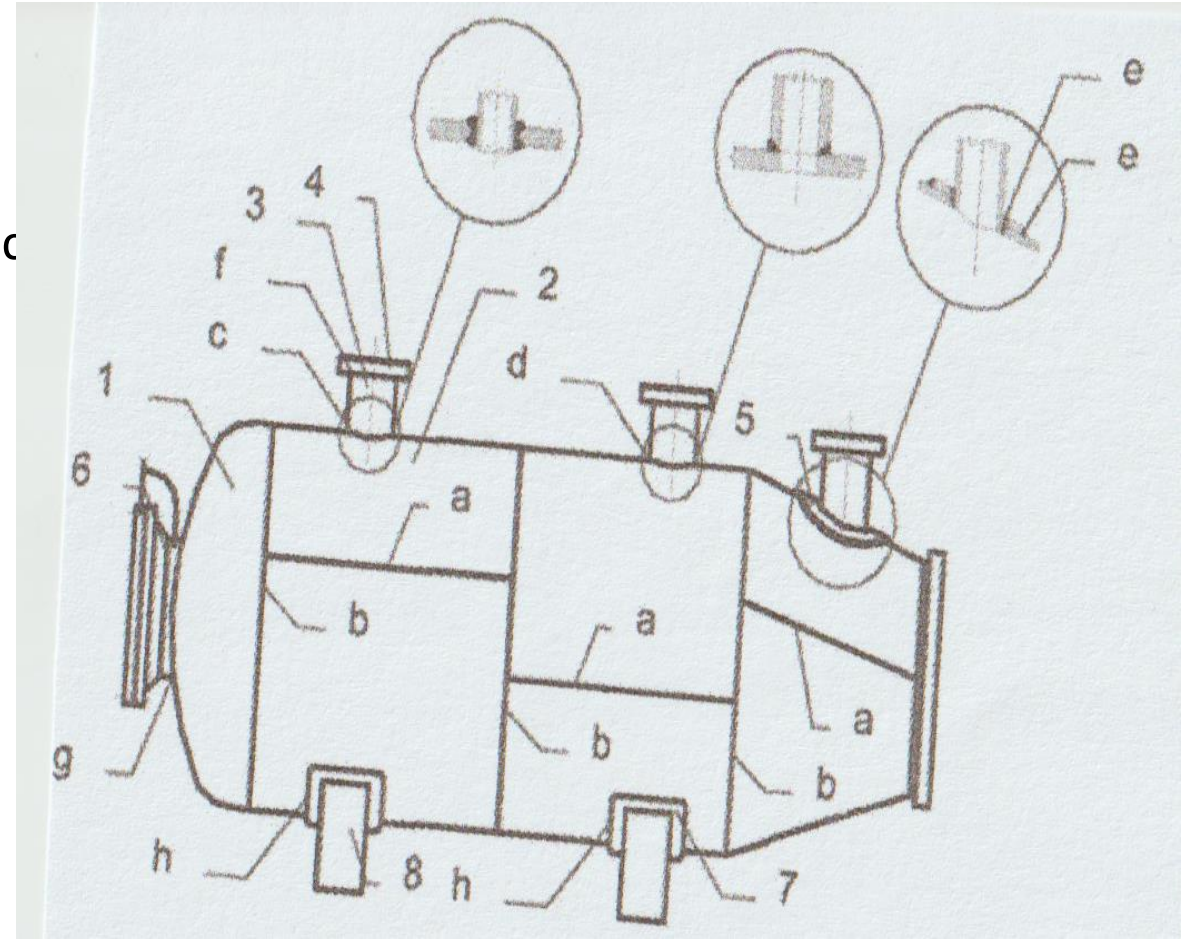
4 – flange,

5 – stiffening collar,

6 – manhole,

7 – pillowcase,

8 – foot (support or (anchorage))



General characteristics of pressure vessels

Legend-2:

- longitudinal seam,
- circular seams,
- through-nozzle welding,
- implanted stump suture,
- stiffening ring seam,
- connecting flange seam,
- manhole seams,
- seam pads,

Pressure Vessels Test Plan

Main elements of the monitoring and inspection plan.

- All plates must be identified using the manufacturer's certificate - this must be done before production can begin,
- Observance of tolerances on plate thickness and size must be monitored,
- Select the location of the point highlight,
- Examination of radiographic recordings,
- Perform dimensional checks and document both internal and external final inspections.

Pressure Vessels Test Plan

- **Main elements of the monitoring and inspection plan.**

- Carry out final external and internal dimensional checks documented in terms of quality and professional suitability,

- Check the validity of all raw material certificates and heat treatment quality certificates,

- It is advisable to participate in any crack test, hardness test and ultrasound test

Pressure Vessels Test Plan

- **Main elements of the monitoring and inspection plan**.
- - Check the prepared preparation of the welded joints and seams,
- - Check the validity and required application of WPS / WPQR,
- Monitor and follow all ultrasound (NDT) tests,
- Ensure that the seller delivers the requirements and documents in the data book without delay,

Pressure Vessels Test Plan

- **Main elements of the monitoring and inspection plan**.

- Inspect the liners of reactors and pressure vessels as instructed,

- Check the suitability of the required production equipment, plant and tools and the validity of the operating licenses,

- Check the required position and interchangeability of the individual structural elements, especially in the case of towers used for chemical reactions,

Pressure vessels Tests

plate material / pipe wall thickness -1:

- the choice of the appropriate raw material for the purpose is a technical and economic task, taking into account the quality level of the raw material manufacturer's production, ie the range of changes in product size and chemical composition, such as minimum thickness, such as plate thickness, pipe wall thickness,
- the aim is to have a minimum material / wall thickness that is safely allowed so that the weight of the product is not unduly high,

Pressure vessels Tests

plate base material / pipe wall thickness -1 :

- whether the plate thickness and plate surface are within tolerance, using the factory quality / conformity certificate,

- verification of compliance with the relevant permitted tolerances and dimensional changes,

- components of the practical calculated thickness :

minimum plate thickness + corrosion allowance + minimum value of the manufacturer's working thickness tolerance,

Pressure vessels Tests

plate base material / pipe wall thickness -2 :

- the choice of the appropriate raw material for the purpose is a technical and economic task, taking into account the quality level of the raw material manufacturer's production, ie the range of changes in product size and chemical composition, such as the smallest thickness, such as plate thickness, pipe wall thickness,
- the aim is to keep the minimum material / wall thickness safely so that the weight of the product is not unreasonably high,

Pressure vessels Tests

plate base material / pipe wall thickness -3 :

- determining the wall thickness is a design task and adapts to the size change range of the raw material manufacturers' products and the possibilities of design solutions,
- certain specifications allow, subject to conditions, a reduction in the nominal thickness and the thickness from the manufacturer,
- the minimum material thickness and corrosion losses for the product must be taken into account,
- material order based on the approved drawing,

Pressure vessels Tests

mantle - shell - ovality :

- maximum tolerance :

$$D_{max} - D_{min}$$

not more than 1% of the nominal diameter of the pressure vessel.

If there is an opening in the jacket, the tolerance value can be increased.

Oval is usually measured from two directions and using a tape measure or laser beam device, one direction being D_{max} a másik: D_{min}

Pressure vessels Tests

orientation of nozzles and accessories :

The designer determines the orientation values.See the pressure manual "manual" for information.(Pressure Vessel Handbook 14th Edition - 2008 - Page 511)

Usually the positioning accuracy : +/- 1^0

Individual values can also be determined by calculation.

The measurement is performed on the tank and a tape measure is usually used.

Pressure vessels Tests

projection of nozzles and accessories :

The length of the nozzle and accessories is the length from the nozzle to the center line of the tank.

The projections and the associated tolerances are usually given in the assembly drawing, for which there is a literature recommendation, e.g. +/- 5 - 6 mm.

A tape measure can be used for practical measurement. The measurement lasts from the outer contour of the shell to the face of the nozzle.

Pressure vessels Tests

leveling nozzles and accessories-1 :

- Information on leveling the nozzle or accessory (Pressure Vessel Handbook, 14th Edition: Edition by Eugene County author)
- A "spirit level" is usually used for leveling, if the bubble is in the middle when measuring, the leveling of the nozzle is correct.

Pressure vessels Tests

leveling nozzles and accessories-2 :

- if the bubble crosses the selected range, check by calculation whether the deflection is within the tolerance value,
- if a bubble is in the middle of the water level scale, measure the distance between the end of the level and the edge of the nozzle.

Pressure vessels Tests

height of nozzles and accessories :

the distance between the center line of the nozzles or accessories and the line touching the bottom or top.

This can also be found in the assembly drawing. The “manual” provides information on tolerance.

Pressure vessels Tests

incorrect fit of welded joint

In the case of first-class welded joints and seams, the joint plays a major role, especially in the case of longitudinal seams..

The operating load of the tank longitudinal seam is approx. 2x - can be affected by the operating load of the circular seam.

Therefore, the activities related to longitudinal seams must be controlled with particular rigor and attention.

Pressure vessels Tests

seam size check

- similar consideration as for joints (see previous slide)
- the value of the tolerance is stricter for the longitudinal seams than for the circular seams - in this case too the longitudinal seams are approx. they carry twice the load as circular seams - so in this case the stress concentration must be reduced.

4.3 Welding operation (EN 13445-5-2014)

- **4.3.a / examination of documents**
- Before commencing any welding operation, the manufacturer must review the relevant documents and documentation to ensure that both the personnel and the welding procedures are validly qualified and competent for the job.

4.3 Welding operation

- **4.3.b / pre-welding preparatory activities:**
- check the seam preparations according to the drawing, the supervisor must certify that the drawing is in accordance with the drawing and that it complies with WPS
- the correct and prescribed choice of material,

4.3.b / pre-welding preparatory activities:

- purity, flawlessness, the failure of which can later result in the defect of the whole bond,
- flawless fitting of the nozzles and branches to the curves and shape of the tank shell and pipelines,

4.3.b / pre-welding preparatory activities:

- corsets, which will eventually be part of the entire joint and therefore free from cracks and other defects,
- adherence to nozzles, various additions, dimensions and tolerances, such as position, fit, direction and anchorage, etc. elements meet, prescribed placement, fastening by welding,

4.3 Welding operation

- **4.3.c/ inspection and testing during welding operation:**
- must be checked during the welding operation in pre-defined steps and in order to ensure that the WPS is complied with.
- These steps can be as follows :
- the correct preheating,
- the appropriate welding procedure,
- the appropriate welding material
- ,the corresponding electrical characteristics,
- the temperature and cleanliness between the respective seams,
- other requirements in the WPS,
- all stitching and temporary fastenings and their compliance with the requirements of the WPS,

4.3.c/ inspection and testing during welding operation:

- the appropriate required welding consumable,
- the corresponding electrical characteristics,
- temperature and cleanliness between the respective seams,
- other requirements in the WPS,
- all stitching and temporary fastenings and their compliance with the requirements of the WPS.

4.3 Welding operation

- **4.3.d/ post-welding inspection and testing:**
- examination and verification of conformity with the drawing,
- Verification that the accurately identified welding has been carried out in accordance with the regulations and that it is possible to trace which of the welders and machine operators made the welded joint and when

4.3 Welding operation

- **4.3.d/ post - welding inspection and testing :**
- verify and certify that the temporary equipment has been technically removed.

Pressure vessels Tests

role of breathing hole

- escape of gases during welding
- welding seam inspection
- close a hole! (corrosion)

Pressure vessels Tests

- variants of welded joints used for pressure vessels:
- - pressure seams, (for example, length and circular seams, stitch seams),
- - seams for pressure components (eg cushion plates),
- - load - bearing seams (eg lifting lugs),
- - non - load bearing seams (eg earthing)

Pressure vessels Tests

- strength factor of welded joints(seam strength factor):
- ✓ 1: certified by a destructive and non-destructive test in its entirety,
- ✓ 0,85: by non-destructive testing, randomly,
- ✓ 0,7: visual inspection.

Pressure vessels Tests

- forged cookware bottoms :

- there is a special requirement for testing forged vessel bottoms,
- the radius of the crown and wrist narrow steel strip or wooden tool for inspection,
- the difference is max. and the min. between the inside diameters must not exceed 1% and a measuring tape or laser measuring device may be used to measure the flange,

They can have several shapes:ellipse,torispheric. Etc.

Pressure vessels Tests

ADDITIONAL INVESTIGATIONS :

- Drop test,
- Leak test,
- Hydrostatic test,
- Vibration test,
- Batch test,
- Pressure test,
- Periodic repeat test,

END

CU-6
Product Inspector PILOT Course -2.2-rev01

Dimensional control

Size control

PRESSURE EQUIPMENT

the

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'Pressure equipment' means vessels, piping, safety fittings and pressure accessories, including, where appropriate, elements connected to pressurized parts, such as flanges, nozzles, connectors, supports, lifting lugs; (2014/68 / EU)

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Pressure vessel:

closed or lockable equipment which is not exposed to the direct heating effect of combustion products, chemicals or electricity and has a pressure of more than 0.5 bar; directly connected (inlet and outlet) flanged or welded pipe joints.

Pressure vessel

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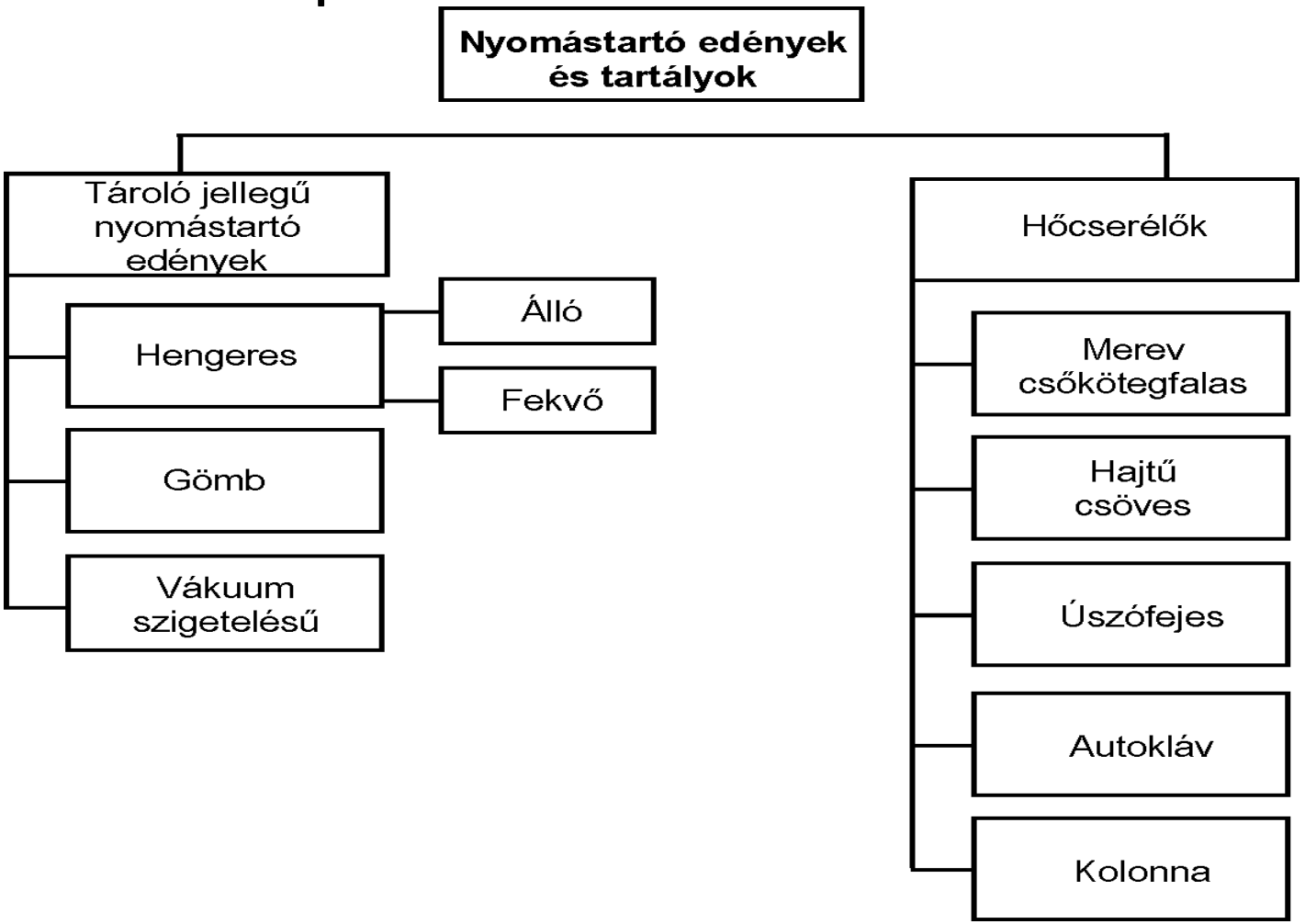
Pressure vessel

- Variants of pressure vessels:



Pressure vessel

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- Vertical / vertical longitudinal axis,

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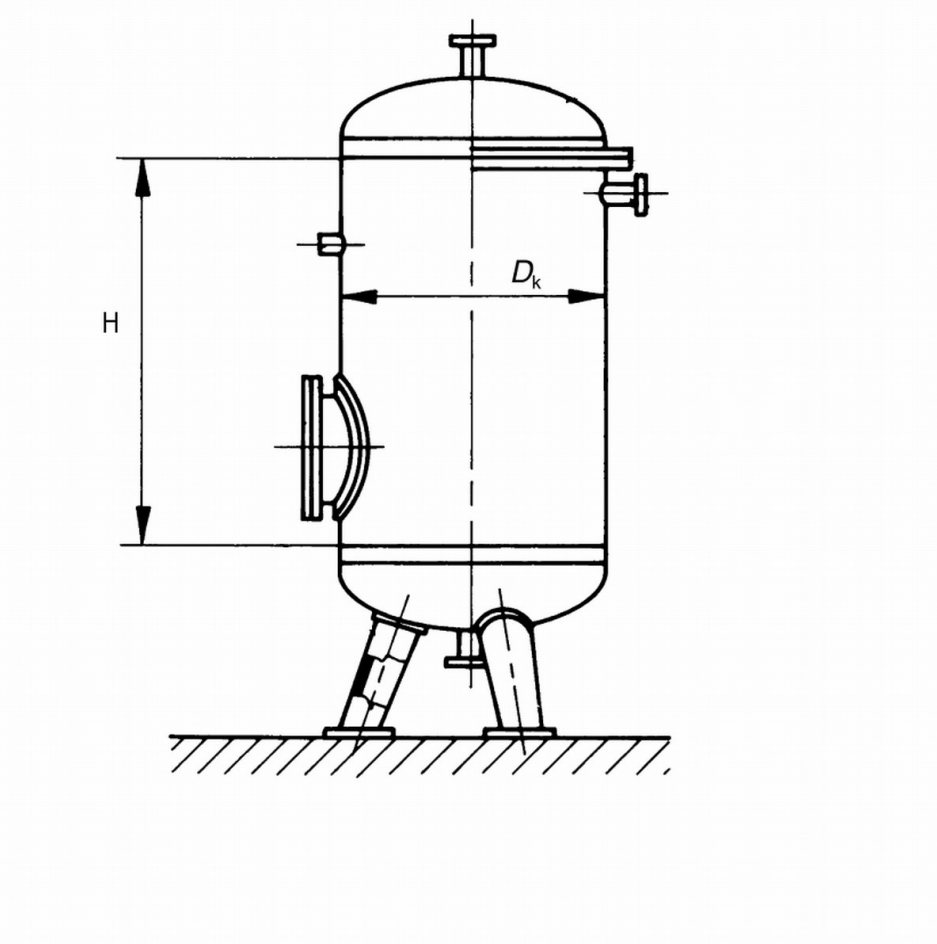
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Based on EU - compliant concepts 2014/68 / EU required to perform the inspector 's task

- „vessel”:

- a closed system designed and constructed for the reception of pressurized charges and its direct fittings, up to the point of connection with other equipment;

- there may be more than one (connecting) chamber on a vessel;

"EU" concepts for inspector task

- "Pipeline" means a pipeline for the transport of charges and associated components which together form a single pressure system;
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Pressure vessels:

Pressure test :

- Legislative inspection to verify the safety, reliability and leak tightness of a pressurized system - to be carried out by an impartial inspector before any new equipment is put into service.
- The test may be hydrostatic or pneumatic.
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Legend-1:

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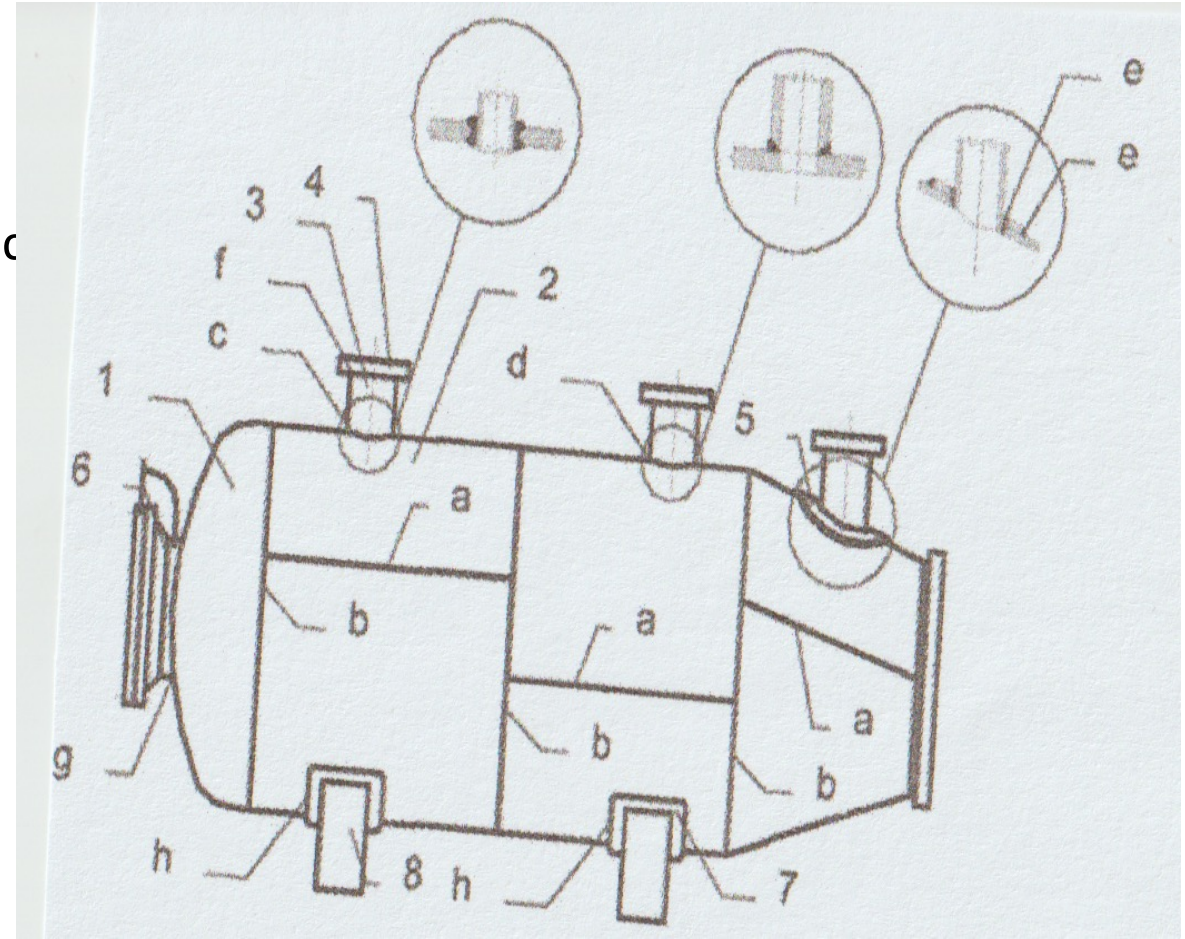

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Main elements of the monitoring and inspection plan.

- All plates must be identified using the manufacturer's certificate - this must be done before production can begin,
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plate material / pipe wall thickness -1:

- the choice of the appropriate raw material for the purpose is a technical and economic task, taking into account the quality level of the raw material manufacturer's production, ie the range of changes in product size and chemical composition, such as minimum thickness, such as plate thickness, pipe wall thickness,
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Pressure vessels Tests

plate base material / pipe wall thickness -1 :

- whether the plate thickness and plate surface are within tolerance, using the factory quality / conformity certificate,

- verification of compliance with the relevant permitted tolerances and dimensional changes,

- components of the practical calculated thickness :

minimum plate thickness + *corrosion allowance* + *minimum value of the manufacturer's working thickness tolerance,*

Pressure vessels Tests

plate base material / pipe wall thickness -2 :

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Oval is usually measured from two directions and using a tape measure or laser beam device, one direction being D_{max} a másik: D_{min}

Pressure vessels Tests

orientation of nozzles and accessories :

The designer determines the orientation values.See the pressure manual "manual" for information.(Pressure Vessel Handbook 14th Edition - 2008 - Page 511)

Usually the positioning accuracy : +/- 1^0

Individual values can also be determined by calculation.

The measurement is performed on the tank and a tape measure is usually used.

Pressure vessels Tests

projection of nozzles and accessories :

The length of the nozzle and accessories is the length from the nozzle to the center line of the tank.

The projections and the associated tolerances are usually given in the assembly drawing, for which there is a literature recommendation, e.g. +/- 5 - 6 mm.

A tape measure can be used for practical measurement. The measurement lasts from the outer contour of the shell to the face of the nozzle.

Pressure vessels Tests

leveling nozzles and accessories-1 :

- Information on leveling the nozzle or accessory (Pressure Vessel Handbook, 14th Edition: Edition by Eugene County author)
- A "spirit level" is usually used for leveling, if the bubble is in the middle when measuring, the leveling of the nozzle is correct.

Pressure vessels Tests

leveling nozzles and accessories-2 :

- if the bubble crosses the selected range, check by calculation whether the deflection is within the tolerance value,
- if a bubble is in the middle of the water level scale, measure the distance between the end of the level and the edge of the nozzle.

Pressure vessels Tests

height of nozzles and accessories :

the distance between the center line of the nozzles or accessories and the line touching the bottom or top.

This can also be found in the assembly drawing. The “manual” provides information on tolerance.

Pressure vessels Tests

incorrect fit of welded joint

In the case of first-class welded joints and seams, the joint plays a major role, especially in the case of longitudinal seams..

The operating load of the tank longitudinal seam is approx. 2x - can be affected by the operating load of the circular seam.

Therefore, the activities related to longitudinal seams must be controlled with particular rigor and attention.

Pressure vessels Tests

seam size check

- similar consideration as for joints (see previous slide)
- the value of the tolerance is stricter for the longitudinal seams than for the circular seams - in this case too the longitudinal seams are approx. they carry twice the load as circular seams - so in this case the stress concentration must be reduced.

4.3 Welding operation (EN 13445-5-2014)

- **4.3.a / examination of documents**
- Before commencing any welding operation, the manufacturer must review the relevant documents and documentation to ensure that both the personnel and the welding procedures are validly qualified and competent for the job.

4.3 Welding operation

- **4.3.b / pre-welding preparatory activities:**
- check the seam preparations according to the drawing, the supervisor must certify that the drawing is in accordance with the drawing and that it complies with WPS
- the correct and prescribed choice of material,

4.3.b / pre-welding preparatory activities:

- purity, flawlessness, the failure of which can later result in the defect of the whole bond,
- flawless fitting of the nozzles and branches to the curves and shape of the tank shell and pipelines,

4.3.b / pre-welding preparatory activities:

- corsets, which will eventually be part of the entire joint and therefore free from cracks and other defects,
- adherence to nozzles, various additions, dimensions and tolerances, such as position, fit, direction and anchorage, etc. elements meet, prescribed placement, fastening by welding,

4.3 Welding operation

- **4.3.c/ inspection and testing during welding operation:**
- must be checked during the welding operation in pre-defined steps and in order to ensure that the WPS is complied with.
- These steps can be as follows :
- the correct preheating,
- the appropriate welding procedure,
- the appropriate welding material
- ,the corresponding electrical characteristics,
- the temperature and cleanliness between the respective seams,
- other requirements in the WPS,
- all stitching and temporary fastenings and their compliance with the requirements of the WPS,

4.3.c/ inspection and testing during welding operation:

- the appropriate required welding consumable,
- the corresponding electrical characteristics,
- temperature and cleanliness between the respective seams,
- other requirements in the WPS,
- all stitching and temporary fastenings and their compliance with the requirements of the WPS.

4.3 Welding operation

- **4.3.d/ post-welding inspection and testing:**
- examination and verification of conformity with the drawing,
- Verification that the accurately identified welding has been carried out in accordance with the regulations and that it is possible to trace which of the welders and machine operators made the welded joint and when

4.3 Welding operation

- **4.3.d/ post - welding inspection and testing :**
- verify and certify that the temporary equipment has been technically removed.

Pressure vessels Tests

role of breathing hole

- escape of gases during welding
- welding seam inspection
- close a hole! (corrosion)

Pressure vessels Tests

- variants of welded joints used for pressure vessels:
- - pressure seams, (for example, length and circular seams, stitch seams),
- - seams for pressure components (eg cushion plates),
- - load - bearing seams (eg lifting lugs),
- - non - load bearing seams (eg earthing)

Pressure vessels Tests

- strength factor of welded joints(seam strength factor):
- ✓ 1: certified by a destructive and non-destructive test in its entirety,
- ✓ 0,85: by non-destructive testing, randomly,
- ✓ 0,7: visual inspection.

Pressure vessels Tests

- forged cookware bottoms :

- there is a special requirement for testing forged vessel bottoms,
- the radius of the crown and wrist narrow steel strip or wooden tool for inspection,
- the difference is max. and the min. between the inside diameters must not exceed 1% and a measuring tape or laser measuring device may be used to measure the flange,

They can have several shapes:ellipse,torispheric. Etc.

Pressure vessels Tests

ADDITIONAL INVESTIGATIONS :

- Drop test,
- Leak test,
- Hydrostatic test,
- Vibration test,
- Batch test,
- Pressure test,
- Periodic repeat test,

END

CU6 Non-destructive testing

1) What non-destructive tests are you aware of?

2) What is the classification of non-destructive tests?

3) Which abnormalities can be examined visually?

4) Which abnormalities can be detected by liquid penetrant testing?

5) What abnormalities can be detected by radiographic examination?

6) What abnormalities can be detected by ultrasound?

7) Which of the following are non-destructive tests?

a) v**isual** inspection, X-ray, ultrasound and crack examination

b) tensile, bending, impact, hardness tests

c) macro inspection

d) answers 'b' and 'c' are correct

8) During the visual inspection of the weld, it should be taken into account that:

a) the welder is using the correct welding parameters

b) the joint design and cleaning are correct

c) the preheating and inter-row temperatures are appropriate

d**) all** answers are correct

CU6 Non-destructive testing

9) The classification of geometrical deviations in metal joints made by bulk welding is classified into which main groups by the standard MSZ EN ISO 6520-1?

a) 6 main groups

b) 5 main groups

c) 3 main groups

d) 4 main groups

10) Which non-destructive test is suitable for the detection of surface cracks?

a) radiographic examination

b) dye diffusion examination

c) magnetic crack detection

d) b) and c)

11) What is the purpose of quality assurance?

a) to speed up production

b) to confirm that the product meets the specified quality

c) to increase turnover

d) to reduce the number of employee**s**

CU6 Non-destructive testing

Which test method is used to detect internal variation?

a) magnetic crack detection
b) X-ray examination
c) ultrasonic examination
d) b) **and c)**

Which of the following are non-destructive tests?

a) V**isual** inspection, X-ray, ultrasound and crack tests
b) Tensile, bending, impact, hardness tests
c) Macroscopic
d) Exhaustive

Excessive suture swelling and edge effacement is affected

a) fatigue properties of the part
b) the hardness of the part to be welded
c) the grain size of the materials to be welded
d) the forming capability

Which quality level of EN ISO 5817 permits surface cracks

a) B
b) D
c) C
d) None

Non-destructive testing

- **purpose:**
  - detection of internal defects or defects not visible to the naked eye in finished or semi-finished products
- **types:**
  - visual inspection
  - dye diffusion
  - magnetic
  - X-ray, isotopic
  - ultrasound

Visual inspection

The physical principle of visual inspection:
Direct or indirect visual inspection of the test piece.
Methods of visual inspection:
Direct: visual inspection with the naked eye or with a magnifying glass and recording of surface deviations.
Indirect: visual inspection is performed in inaccessible or difficult to access areas using an optical instrument (e.g. endoscope).
Applications of visual inspection:
Detection of major continuity defects, material loss,
determination of geometric deviations,
detection of corrosion traces.
Advantages of visual inspection:
simple in principle,
low tool requirements for direct visual inspection,
well documented (by photographic means).
Conditions for inspection:
a suitable environment for observation,
suitable ambient temperature,
surface free from deposits, corrosion.

Dye penetrant test

- liquid penetration method
  - suitable for detecting open surface deviations
- thread:
  - applying the signal fluid to a clean metal surface
  - after the time of penetration, remove the liquid
  - applying developer fluid / aspirating signal fluid from any cracks /
  - evaluation

Magnetic crack test

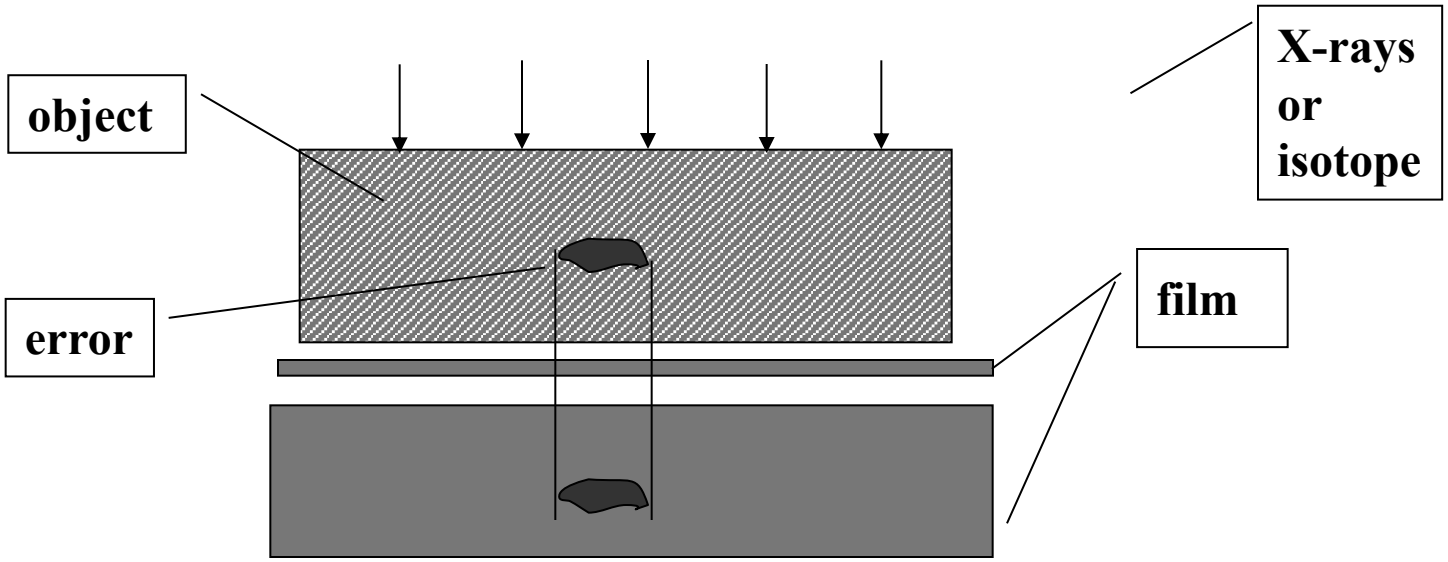
- detect surface or near-surface defects
- principle of testing:
  - in ferromagnetic material, the magnetic force line image is distorted in the vicinity of surface cracks

X-ray testing

- the principle of inquiry:

– short-wave radiation penetrating the material has different effects on the sensitive layer of photographic film depending on the thickness and density of the material

X-ray testing



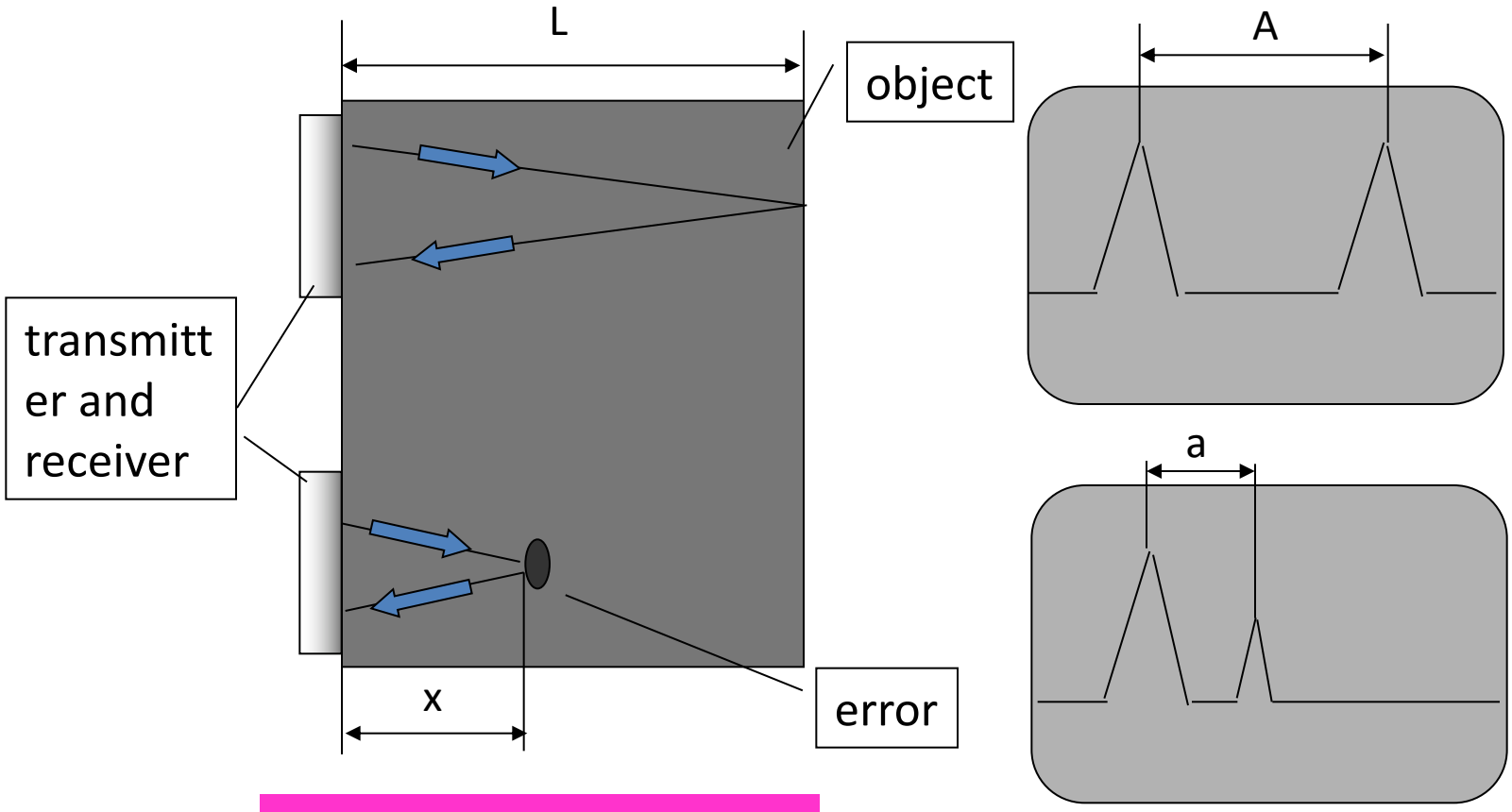
Radiological risk!!!

Ultrasonic testing

- the principle of inquiry:

– in the object, the high period ultrasound propagates in a straight line from a point on the surface where the vibration originates
– if there are no obstacles in its path, it is reflected from the other surface of the object and can be detected
– if the material contains a defect, the ultrasound is reflected from the defect location

Ultrasonic testing



error distance: A : a = L : x