

A 3D wireframe model of a large industrial facility, possibly a particle accelerator or a large-scale manufacturing plant. The structure is composed of numerous interconnected pipes, beams, and structural elements, forming a complex, elongated shape with several curved sections. The model is rendered in a light gray wireframe style, highlighting the intricate geometry of the design.

“Requirements for Welding Companies”

- for pressurized components 1st section
- for steel structures 2nd section

“Assessment of Weld Seams”

- Requirements for welding tasks internally and externally
- Approvals from a welding company according to DIN EN ISO 3834
- Approvals from a welding company according to PED 2014/68 / EU and AD 2000
- Welding process test
- Welding personnel
- Equipment requirements
- Category requirements
- Requirements for non-destructive weld inspection
- List of valid standards and common abbreviations

Requirements for welding tasks internally and externally



- When are approvals necessary? When the tasks in the area subject to acceptance are covered, during production and assembly!
- Which approvals are required for welding work on pressure vessels and pressurized pipelines?
- Operation: ISO 3834; PED / AD2000;
- Process: ISO 15607, ISO 15614 & 15613
- Personnel: ISO 9606-1, ISO 14732, ISO 14731
Welder, Operator, Welding supervisor
- Equipment: welding consumables & equipment

Approvals from a welding company according to ISO 3834



DIN EN ISO 3834: Quality requirements for fusion welding of metallic materials

Part 1: Criteria for choosing the appropriate level of quality requirements

Part 2: Comprehensive quality requirements

⇒ Part 3: Standard quality requirements

Part 4: Elementary quality requirements

Part 5: Documents whose requirements must be met to demonstrate compliance with the requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4

Part 6: Guideline for the introduction of ISO 3834

Welding companies for pressure equipment must meet at least the standard quality requirements according to DIN EN ISO 3834-3 in accordance with AD HP0, Section 3

Directive 2014/68/EU of the European Parliament and of the Council of May 15, 2014 on the harmonization of the laws of the member states relating to the provision of pressure equipment on the market.

The classification of pressure equipment is based on pressure, volume/nominal size and fluids according to hazard potential in 4 categories

Category I => conformity procedure according to module A

Category II => conformity procedure according to module A2

Category III => conformity procedure according to module H

Category IV => conformity procedure according to module H1/ G

AD 2000, Pressure Vessel Working Group

Companies that manufacture Category II and higher components must meet the approval criteria according to AD HP0 Sections 3.1 to 3.5 and should be listed in VdTüV leaflet 1165.

Companies that manufacture Category I components must meet the quality requirements of DIN EN ISO 3834-3.

Welding Process Test for Pressurized Components



- DIN EN ISO 156xx: Requirement and qualification of welding processes for metallic materials
- ISO 15607: General rules
- ISO 15613: Qualification based on an early work test
- ISO 15614: Part 1, Arc and gas welding of steels and Arc welding of nickel and nickel alloys

- Requirements for the welding process test are specified in AD 2000 HP2/ 1

1. Definition of the welding task
2. pWPS: Preliminary Welding Procedure Specification specifies the provisional criteria and parameters for the welding task
3. The test piece is welded according to the **pWPS**
4. The welded test piece is examined by an independent test institute and if the result is positive, the **WPQR** "Report on the qualification of the welding process" is issued
5. **WPS** is created after the pWPS: valid welding instructions according to which the welding task must be carried out!

Note: A process test is company-related and must be confirmed by a work sample when changing working conditions, equipment or welding aids (welding filler and shielding gas).

- ISO 9606-1: Welder's test* must be checked for validity and cover the scope of the welding task
- ISO 14732: Operator test* must be checked for validity and apply to the automated welding task
- ISO 14731: Welding supervision - tasks and responsibilities
- Welding engineer (IWE / EWE): Use possible without restrictions
- Welding technician (IWT / EWT): Use with restrictions on certain materials
- Welding specialist (IWS / EWS): Use restricted to simple materials

The requirements for personnel are specified in AD 2000 HP3!

(*) The test certificate **must** be issued by a body that deals with the relevant training as scheduled

- Welding consumables: must have a valid welding suitability assessment in accordance with AD 2000 W0 and be listed in VdTÜV leaflet 1000. The associated VdTÜV leaflet and acceptance test certificate for the batch of welding consumable used must be available.
- Welding equipment: must have a current UVV test for portable welding equipment (e.g. orbital systems) in accordance with DIN EN 60974-4 including the test sticker and must be calibrated in accordance with - Part 14: Documents must be available before starting the welding work.

Category Requirements



	Category I	Category II	Category III	Category IV
Operating approval		X	X	X
Procedural check	(X)	X	X	X
Welder / Operator Test	X	X	X	X
Welding supervisor	X	X	X	X
Approved welding consumables	X	X	X	X
Verified welding equipment	X	X	X	X

An admission with a higher category includes the lower categories.
This applies to the manufacture of the individual components (manufacture) and the connection between the individual components (assembly)

Requirements for Non-destructive Weld Inspection



- DIN EN ISO 5817 fusion welded joints on steel, nickel, titanium and their alloys (without beam welding) - assessment groups of irregularities
- 3 evaluation groups D, C, B (low, medium, high), which determine the maximum number and the permissible deviation of dimensions for internal and external errors
- for pressurized pipes, assessment group B applies with 100% visual inspection (VT) and at least 10% X-ray inspection (RT), see AD2000 HP 100 R.
- all other seams on pressure vessels / pressure equipment according to AD HP0 100% visual inspection and 10% penetration test (PT)
- Requirements for the test procedure are specified in AD 2000 HP 5 and the requirements for the test personnel in AD 2000 HP4
- Assessment group B with 100% visual inspection (VT) is defined on vacuum seams (no pressure equipment). Higher requirements can be set for particularly critical welds



“Requirements according to EN 1090 for steel structures in the building inspection area”

Section 2

- Requirements for welding tasks internally and externally
- Brief information on DIN EN 1090
 - Example for defining the execution class
 - Damage classes, stress categories, manufacturing categories, execution class matrix
 - Factory Production Control (FPC)
 - Approval / CE mark / declaration of performance
- Approvals according to ISO 3834 / Quality requirements according to EN 1090
- Quality requirements for SAP
- Welding personnel
- Assignment of welding procedure test
- Equipment requirements
- Requirements for non-destructive weld inspection
- Procedures for weld inspection

Requirements for welding tasks internally and externally



- When are approvals necessary? When the tasks in the area subject to acceptance are covered, during production and assembly
- Which approvals are required for welding work in the building inspection area
- Operation: ISO 3834; EN 1090;
- Process: ISO 15607 and many more
- Personnel: ISO 9606-1, ISO 14732, ISO 14731
Welder, Operator, Welding supervisor
- Equipment: welding consumables & equipment

DIN EN 1090: "Execution of steel structures and aluminum structures" This standard has been valid since 01/01/2010. There are 3 parts:

Part 1: Requirements for conformity assessment of structural components

Part 2: Technical requirements for steel structures *)

Part 3: Technical requirements for aluminium structures

DIN EN 1990 "Euro code: Fundamentals of Structural Design" is divided into 4 execution classes / Execution Classes EXC1 to EXC4 according to an assignment in:

Consequential loss class CC, Stress category SC, Manufacturing category PC

The requirements for the execution class (EXC) are specified in EN 1090-2 Appendix A, **Table A.3**. (e.g. for execution documents and documentation, welding, construction material, corrosion protection, mechanical connections, ...)

The manufacturer of constructions falling within the building inspection area must provide evidence that he meets the requirements of DIN EN 1090. This is done through a corresponding certification by an approved body (NB).

*) * Content of this presentation

Example for determining the execution class: Walk-on platform with railings on one machine



- Access platform with railings on one machine made of S 235 JR profiles.
- It is a welded and screwed version, with continuous support feet and anchoring on the building side.
- The planned building is classified in accordance with the damage class according to 1990 Table 1.
Access platform with railing for one machine CC => 1;
- The stress category is determined for steel in accordance with Table B.1 in accordance with DIN EN 1990. In the case of the access platform for maintenance work on the machine => SC1
- The definition of the manufacturing category for steel in accordance with Table B.2 according to DIN EN 1990 for the welded access platform made of material S235 JR results in the manufacturing category => PC1
- In table B.3 the parameters CC1; SC1 and PC1 read the necessary execution class. In the example => EXC1

Damage classes according to DIN EN 1990

Euro Code: Basics of structural engineering



Consequence class CC1	Consequence class CC2	Consequence class CC3
<p>Building structures, support structures and components with low failure rates.</p> <p>Stairs in residential buildings</p> <p>Railings in residential buildings</p> <p>Agricultural buildings without regular passenger traffic (e.g. barns, greenhouses) Conservatories on residential buildings detached houses with up to 4 floors *)</p> <p>Buildings that are rarely entered by people if the distance to other buildings or areas with frequent use by people is at least 1.5 times the building height *)</p> <p>Other comparable building structures, support structures and components</p>	<p>Building structures, support structures and components that are not listed under CC1 or CC3.</p> <p>e.g. Pedestrian bridges</p> <p>Road bridges</p> <p>Railway bridges</p> <p>Flying buildings</p> <p>Grandstand constructions</p> <p>Towers and masts (e.g. antenna structures)</p> <p>Cylindrical towers (e.g. chimneys)</p> <p>Welded crane runways</p>	<p><u>Building structures, support structures and components with extreme consequences in the event of failure</u></p> <p>Large roof constructions of meeting places / stadiums with more than 5000 spectators *)</p> <p>Buildings with more than 15 floors *)</p> <p>Weir closures with extreme drainage volumes and high hazard potential</p> <p>Safety container in the nuclear power plants</p> <p>Road bridges and railway bridges (see DIN EN 1991-1-7) over densely populated areas or over industrial plants with high hazard potential</p>

*) see also EN 1991-1-7, informative appendix A, table A.1. Note: This assignment only applies to the main load-bearing building structures, support structures and components that are only of secondary importance for the load-bearing behavior can be classified in lower damage consequence classes (CC).

Table B.1 - Proposed criteria for stress categories

Categories	Characteristics
SC1	<ul style="list-style-type: none"> • Support structures and components, dimensioned only for predominantly static loads (example: buildings) • Support structures and components with their connections, dimensioned for earthquake effects in regions with low seismicity and in DCL * • Structures and components, dimensioned for the fatigue effects of cranes (class S0) **
SC2	<ul style="list-style-type: none"> • Support structures and components, dimensioned for fatigue loads according to EN 1993. (Examples: road and railway bridges, cranes (class S1 to S9) **, vibration-sensitive structures when exposed to wind, pedestrians or rotating machines) • Support structures and components with their connections, dimensioned for earthquake effects in regions with medium or strong seismicity and in DCM * and DCH *
<p>* DCL, DCM, DCH: ductility classes according to EN 1998-1</p>	
<p>** For the classification of crane fatigue, see EN 1991-3 and EN 13001-1</p>	

Table B.2 - Proposed criteria for manufacturing categories

Categories	Characteristics
PC1	<ul style="list-style-type: none">• Non-welded components made from steel products of all types of steel• Welded components, made from steel products of the steel grades under S355
PC2	<ul style="list-style-type: none">• Welded components, made from steel products of steel grades S355 and above• Components essential for stability that are welded together on the construction site• Components that are manufactured by hot forming or undergo heat treatment in the course of manufacture• Components made of circular hollow profile truss girders that require specially cut end cross sections

Table B.3 - Recommended matrix for determining the execution class

Consequential damage classes		CC1		CC2		CC3	
Stress categories		SC1	SC2	SC1	SC2	SC1	SC2
Manufacturing categories	PC1	EXC1	EXC2	EXC2	EXC3	EXC3 ^a	EXC3 ^a
	PC2	EXC2	EXC2	EXC2	EXC3	EXC3 ^a	EXC4
<p>a EXC4 should be used on exceptional structures or on structures with high failure rates, in accordance with national regulations.</p>							

Manufacturing requirements for execution classes EXC1 to EXC4 are in accordance with 1090-2 Table A.3

Section 7 welding, point 7.4 defines the qualification of the welding process and the welding personnel!

Means the independent verification of the production by the manufacturer.
The responsibilities and authorities, the requirements and the procedure of the FPC must be set out in writing in a production manual with work instructions and forms and must be certified by an independent test center.

Depending on the company structure, the following manufacturing steps are part of the certification:

- Design, statics
- Welding, cutting, thermal processes for cutting and shaping
- Mechanical connections
- Corrosion protection
- Assembly

Traceability !

Approval CE Mark / Declaration of Performance



The operational and personnel must meet the requirements of DIN EN 1090. The company must be able to present an approval according to DIN EN 1090-1 and -2 for steel/ -3 for aluminum.

On the company certificate:

- certification of factory production control
- the standards (e.g. DIN EN 1090-2, etc.)
- the welding processes used (e.g. 111 MMA, 135 MAG, etc.)
- the materials (max. S355, ...)
- the welding supervisor
- Evidence of the regular check carried out must be listed.

The execution class EXC of the steel structure must result from the manufacturer's CE mark / declaration of performance.

A higher execution class includes a lower execution class for the same area of application.

DIN EN ISO 3834: Quality requirements for fusion welding of metallic materials

Part 1: Criteria for choosing the appropriate level of quality requirements

Part 2: Comprehensive quality requirements

Part 3: Standard quality requirements

Part 4: Elementary quality requirements

Part 5: Documents whose requirements must be met to demonstrate compliance with the requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4

Part 6: Guideline for the introduction of ISO 3834

Which execution class requires which quality requirement is specified in EN 1090-2 Section 7.1 as follows:

- EXC1: Elementary quality requirements; DIN EN ISO 3834-4
- EXC2: Standard quality requirements; DIN EN ISO 3834-3
- EXC3 & 4: Comprehensive quality requirements; DIN EN ISO 3834-2

Quality requirements for Welding Supervisor for the execution classes according to Table 14 EN 1090-2

Tabelle 14 — Technische Kenntnisse des Schweißaufsichtspersonals — Baustähle

EXC	Stähle (Gruppe)	Bezugsnormen	Dicke mm		
			$t \leq 25^a$	$25 < t \leq 50^b$	$t > 50$
EXC2	S235 bis S355 (1.1, 1.2, 1.4)	EN 10025-2, EN 10025-3, EN 10025-4, EN 10025-5, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	B	S	C ^c
	S420 bis S700 (1.3, 2, 3)	EN 10025-3, EN 10025-4, EN 10025-6, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	S	C ^d	C
EXC3	S235 bis S355 (1.1, 1.2, 1.4)	EN 10025-2, EN 10025-3, EN 10025-4, EN 10025-5, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	S	C	C
	S420 bis S700 (1.3, 2, 3)	EN 10025-3, EN 10025-4, EN 10025-6, EN 10149-2, EN 10149-3, EN 10210-1, EN 10219-1	C	C	C
EXC4	Alle	Alle	C	C	C

^a Stützenfußplatten und Stirnbleche ≤ 50 mm
^b Stützenfußplatten und Stirnbleche ≤ 75 mm
^c Für Stähle bis einschließlich S275 ist Kenntnisstufe S ausreichend.
^d Für Stähle N, NL, M und ML ist Kenntnisstufe S ausreichend.

C = extensive knowledge: welding engineer (SFI / IWE / EWE)

S = special knowledge: welding specialist (SFT / IWT / EWT)

B = basic knowledge: Welding specialist (SFM / IWS / EWS)

With EXC1, adequate supervision must be ensured during the execution of the welding work, as specified in EN ISO 3834-4.

- ISO 9606-1: Welder's qualification * must be checked for validity and covered in the scope of the welding task
- ISO 14732: Operator test * must be checked for validity and apply to the automated welding task
- ISO 14731: Welding supervision - tasks and responsibilities

Welding engineer (IWE/ EWE): Use possible without restrictions (C)

Welding technician (IWT/ EWT): Use with restrictions on certain materials (S)

Welding specialist (IWS/ EWS): Use restricted to simple materials (B)

The requirements for the personnel are fixed.

*) Test certificate should be provided by bodies that are scheduled to deal with the relevant training!

- DIN EN ISO 156xx: Requirement and qualification of welding processes for metallic materials
- ISO 15607: General rules
- ISO 15610: Qualification based on the use of tested welding consumables
- ISO 15611: Qualification based on existing welding experience
- ISO 15612: Qualification using a standard welding process
- ISO 15613: Qualification based on an early work test
- ISO 15614-Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
- ISO 15614-Part 2: Arc welding of aluminum and its alloys

Requirements for the welding process test according to table 12 & 13:

Table 13: Methods for qualifying the welding process for the processes 21, 22, 23, 24, 42, 52, 783 and 784 (Spot welding, flash butt welding, friction welding, ...)

Table 12: Allocation of the welding process test/ execution class

Tabelle 12 — Methoden zur Qualifizierung der Schweißverfahren für die Prozesse 111, 114, 12, 13 und 14

Methoden zur Qualifizierung		EXC2	EXC3 EXC4
Schweißverfahrensprüfung	EN ISO 15614-1 ^a EN ISO 17660-1/ EN ISO 17660-2 ^b	X	X
Vorgezogene Arbeitsprüfung	EN ISO 15613 EN ISO 17660-1/ EN ISO 17660-2 ^b	X	X
Standardschweißverfahren	EN ISO 15612	X	X ^c
Vorliegende schweißtechnische Erfahrung	EN ISO 15611	X	—
Einsatz von geprüften Schweißzusätzen	EN ISO 15610		
X zulässig — nicht zulässig			
^a Die Qualifizierung der Schweißverfahren nach EN ISO 15614-1:2017 muss der Stufe 2 entsprechen. ^b Nur bei Verbindungen zwischen Betonstahl und anderen Stahlbauteilen zu verwenden. ^c Sofern nach den Ausführungsunterlagen zulässig.			

EN ISO 17660 "Welding reinforcing steel"

- Welding consumables: must have a valid CE marking with **Declaration of Performance (DoP)**. The associated acceptance test certificate for the batch of filler metal used must be available.
- Welding equipment: must have a current UVV test for portable welding equipment (e.g. orbital systems) in accordance with DIN EN 60974-4 including the test sticker and must be calibrated in accordance with - Part 14: Documents must be available before starting the welding work.

Requirements for Non-destructive Weld Inspection (ZFP)



- DIN EN ISO 5817 fusion welded joints on steel, nickel, titanium and their alloys (without beam welding) - assessment groups of irregularities
- 3 evaluation groups D, C, B (low, medium, high), which determine the maximum number and dimensions of internal and external errors
- Scope of the minimum requirements for non-destructive weld inspection for the corresponding execution class according to EN 1090-2 table 24

Requirements for the weld inspection according to DIN EN 1090-2, table 24

Tabelle 24 — Umfang der routinemäßigen ergänzenden ZfP

Schweißnahtart	Werkstatt- und Baustellennähte		
	EXC1	EXC2	EXC3 ^a
Querverlaufende Stumpfnähte und teilweise durchgeschweißte Nähte in Stumpfstoßen:	0 % ^b	10 %	20 %
Querverlaufende Stumpfnähte und teilweise durchgeschweißte Nähte:			
— in Doppel-T-Stößen	0 % ^b	10 %	20 %
— in T-Stößen	0 %	5 %	10 %
Querverlaufende Kehlnähte ^c :			
mit $a > 12 \text{ mm}$ oder $t > 30 \text{ mm}$	0 %	5 %	10 %
mit $a \leq 12 \text{ mm}$ und $t \leq 30 \text{ mm}$	0 %	0 %	5 %
Vollständig durchgeschweißte Längsnähte ^d zwischen Steg und Obergurt bei Kranbahnträgern	0 %	10 %	20 %
Andere Längsnähte ^d , Nähte angeschweißter Steifen und Nähte, die in den Ausführungsunterlagen als druckbeansprucht spezifiziert sind	0 %	0 %	5 %
^a Bei EXC4 muss der prozentuale Umfang mindestens dem von EXC3 entsprechen. ^b 10 % für Nähte, die in Stahl $\geq S420$ ausgeführt werden. ^c Die Bezeichnungen a bzw. t beziehen sich auf die Kehlnahtdicke und den dicksten verbundenen Grundwerkstoff. ^d Längsnähte verlaufen parallel zur Bauteilachse. Alle anderen Nähte werden als querverlaufende Nähte betrachtet.			

The requirements for the assessment of the weld seams in accordance with section 7.6 "Acceptance criteria" according to EN 1090-2

Procedures for Weld Inspection Destructive (ZP) and Non-destructive (ZfP)



Procedure	DIN EN ISO	Personal
Destructive SNP		
Fracture test	9017 fracture test	
Tensile test	4136 transverse tensile test; 5178 Longitudinal tensile test on the SG	
Weld-on bending test	5173 bending test	
Impact test	9016 impact test; 148-1 Charpy impact test	
Hardness / micro hardness	9015-1 hardness test; -2 micro hardness test	
Micrographs	17639 Macro and microscopic examination of SWN	
Pull test "crusade test"	9018 tensile test on double-T joint / lap joint	
Non-destructive SNP		
Radiography / X-ray	17635 NDT of welded joints, general rules	9712 Qualification and certification of personnel for ZFP
Magnetic powder (St)	17636 radiographic test	
Eddy current test (CrNi)	17638 Magnetic powder test	
Color penetration	17643 Eddy current testing of welded joints by vector evaluation	
Ultrasonic	3452-1 penetrant test	
Visual inspection	17640 ultrasonic testing techniques, test classes and assessment	
PMI test	17637 Visual inspection of fusion welded joints	
	Positive material inspection; Material analysis	

SNP = weld seam test

List of valid Standards and Common Abbreviations



Pressure Equipment Directive, PED	2014/68/EU
http://www.druckgeraete-online.de/seiten/frameset2.htm	
AD 2000 Leaflet A ...	Execution
AD 2000 Leaflet B ...	Calculation
AD 2000 Leaflet W ...	Material
AD 2000 Leaflet HP ...	Manufacturing and Test
Welder exams	ISO 9606
Operator check	ISO 14732
Welding process tests	ISO 15614
Approved welding company	ISO 3834
Weld rating	ISO 5817
Sequence numbers of the welding processes	ISO 4063
General Tolerances in welded structures	ISO 13920
General tolerances for shape and position	ISO 2768
Welding supervisory tasks and responsibility	ISO 14731
Approved personnel for ZfP	ISO 9712

pWPS	pre Welding Procedure Specification
WPS	Welding Procedure Spezifikation
WPQ	Welding Procedure Qualification
WPQR	Welding Procedure Qualification Record
ZfP	Non-destructive material test
RT	X-Ray Testing
PT	Penetration Test
MT	Magnetic Test
US	Ultrasonic Test
VT	Visual Test
PMI	Positiv Material Inspection
ZP	Destructive material test
SAP (L)	Welding Supervisor Supplier
vSAP	Welding Supervisor for the FAIR Project
SFI/EWE/IWE	International Welding Engineer
SWT/EWT/IWT	International Welding Technician
SWM/EWS/IWS	International Welding Specialist
WEZ	Heat-affected zone
SZW	Filler Metal
ITP	Inspection and Testplan
NB	Notify Body

A 3D wireframe model of a large industrial structure, possibly a power plant or refinery. It features a large, circular, multi-layered structure in the foreground, with various pipes, walkways, and smaller buildings in the background.

Thank you for your Attention!

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