heat transfer society

Developments in Pressure Vessel Standards PD 5500, EN 13445 and ASME VIII Div.1

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1

My involvement with standards

1971 – Humphreys & Glasgow, Fabricated Equipment Group – my first introduction to BS 1515, ASME VIII and TEMA.

1976 – BS 5500 first published.

1985 – Finglow – worked on development of computer software for design of pressure vessels to BS 5500.

1986 – Pressure Vessel Design – Concepts and Principles course at the University of Strathclyde – met the people who wrote BS 5500.

1988 – David Nash (from University of Strathclyde) and I started giving courses on pressure vessels design.

1990 – Invited to join BSI sub-committee PVE/1/15 which is responsible for the design methods in BS 5500 (now PD 5500).

2005 – Became Consultant to PVE/1 and sub-committees.

2010 – Started attending CEN TC 54 Working Group 53 (Design Methods)

2

PD 5500 Specification for unfired pressure vessels

BS 5500 Unfired fusion welded pressure vessels was first published in 1976, so next year is its 50th anniversary.

When EN 13445 was published in 2002 BSI was required by the European Committee for Standardization (CEN) rules to withdraw BS 5500 as a conflicting standard. Because EN 13445 was far from complete at that time BSI decided to publish BS 5500 as a Published Document PD 5500. The content was the same but it did not have the status of a standard.

BS EN 13445 is the British Standard for pressure vessels, not PD 5500.

In 2020 the title of PD 5500 was changed to remove the words "fusion welded" as other methods of joining are now included.

3

A new edition of PD 5500 is published every three years, with amendments issued each year.
The latest edition was published in 2024.

Amendment 1 consisted mainly of editorial improvements.

Amendment 2, which has just been published contains:

- additions to the list of BS EN materials that may be used;
- improvements to the calculations for nozzle reinforcement;
- clarification of the definitions of cylinder lengths in Table 3.6-2 and Figure 3.6-1 for calculations for vessels under external pressure;
- two new Enquiry Cases – 5500/145 and 5500/147.

Enquiry cases are published for information and guidance and thus their application is by agreement of the relevant parties. If no adverse comments are received many Enquiry Cases are subsequently incorporated into the main text.

4

Enquiry Case 5500/145 – Use of additive manufacture using wire based direct energy deposition (DED Arc) techniques for the construction of pressure vessel components in accordance with PD 5500

This Enquiry Case gives guidance on the use of PD 5500 for pressure vessels manufactured using wire-based direct energy deposition (DED Arc) techniques, based on mechanical and inspection test data that have been shared by designers and fabricators.

It is intended that this Enquiry Case will subsequently become a new Material Supplement.

It is based on the new Part 14 of EN 13445 that is currently being developed.

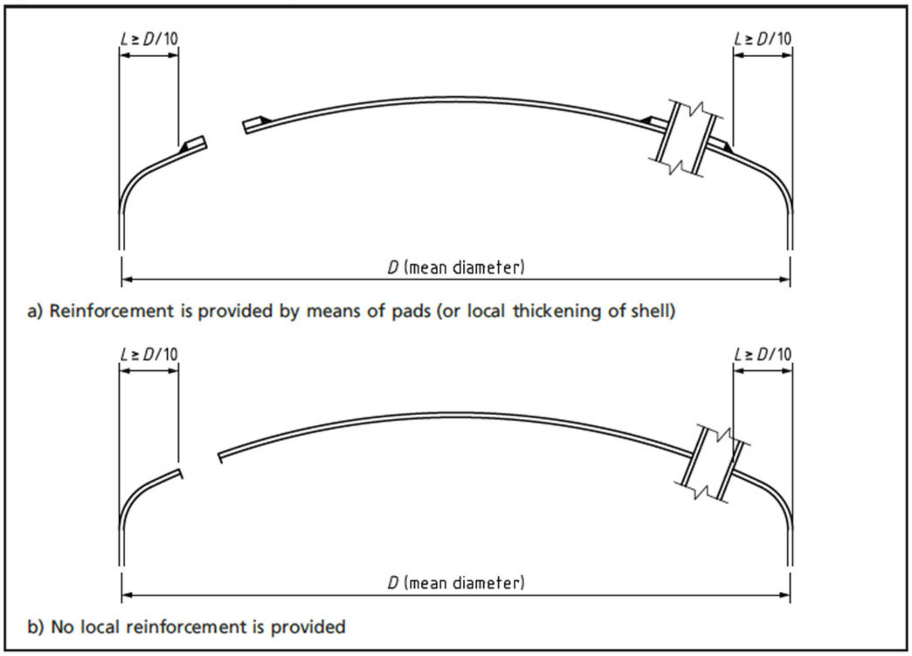
Enquiry Case 5500/145 only covers the DED Arc process at present, whereas EN 13445-14 will also cover powder bed fusion (PBF).

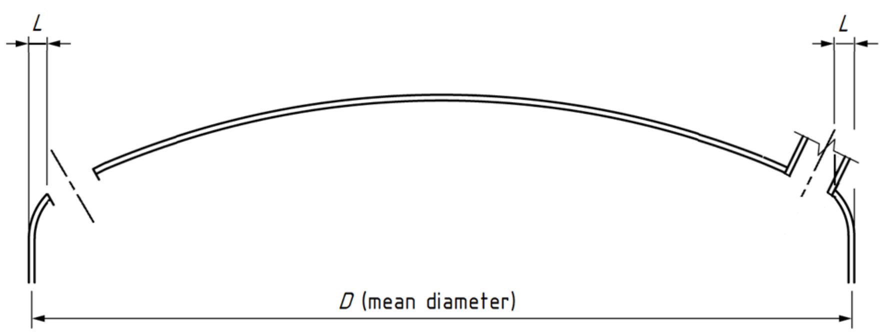
Enquiry Case 5500/147 – Reinforcement of nozzles in the knuckle region of torispherical and semi-ellipsoidal dished ends

This Enquiry Case gives guidance on the design of openings and nozzles that are outside the limits given in Figure 3.5-8.

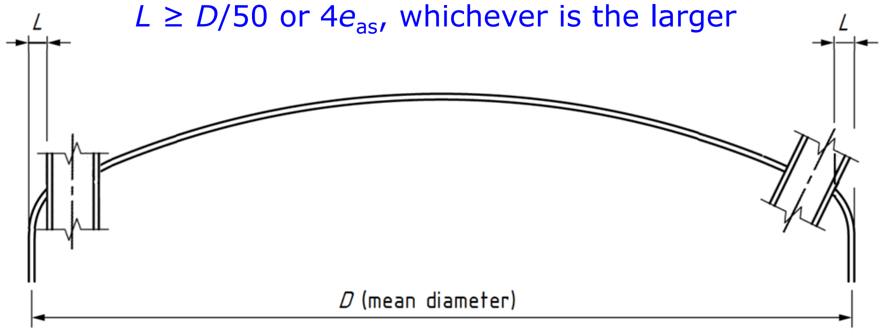
The method is based on Zeneca specification ZEN.VES.0188, Rev B. The use of the area replacement method from BS 5500 Appendix F has been replaced by the pressure area method in 3.5.4.9.

Figure 3.5-8 Positions of openings or nozzles in dished ends (for weld details see Annex E)





$L \geq D/50$ or $4e_{as}$, whichever is the larger



Amendment 3

It is proposed that this amendment, which will be issued as a Draft for Public Comment on 1st January 2026, will contain:

- clarification of the use of analysis thickness and nominal thickness;
- clarification of where the vessel ends and the piping begins;
- replacement of asbestos with mineral fibre in the table of gasket data;
- new Enquiry Case – 5500/148.

Enquiry Case 5500/148 – Additional recommendations for pressure vessels in hydrogen service

The Enquiry Case will give guidance on materials, design, manufacture, inspection and testing for pressure vessels in hydrogen service.

It is based on the new Part 14 of EN 13445 that is currently being developed, and API 660 Shell-and-Tube Heat Exchangers.

It will cover four service conditions, which can exist in combination:

- Hydrogen service at low temperatures;
- Hydrogen Environmental Embrittlement (HEE) or Hydrogen-induced cracking (HIC);
- High Temperature Hydrogen Attack (HTHA);
- Hydrogen service for vessels subject to fatigue.

EN 13445 Unfired pressure vessels

The European Pressure Vessel Code, EN13445 was first introduced in 2002. It aims to follow a five-yearly update cycle, but this has not always been maintained.

A new edition was due to be published in 2019 but this was delayed for two years due to arguments at the European Committee for Standardization (CEN) about the difference between 'greater than', and 'greater than or equal to'.

Amendment 1 to EN 13445-3:2021 was approved at Formal Vote in July 2025 and is due to be published in December 2025. It is the first amendment to EN 13445-3 since 2019. Draft proposals for the subsequent amendment are due to be published for Public Enquiry in 2026. Both these amendments contain some significant improvements to the standard.

EN 13445-3:2021 Amendment 1

Amendment 1 consists of several Work Items which were approved in separate Public Enquiries:

- EN 13445-3:2014 prA14 – Modifications to Clause 9, Openings in shells – July 2019
- EN 13445-3:2014 prA15 – Modifications to Subclauses 9.4.7, 11.4.4 and Annex A – April 2019
- EN 13445-3:2014 prA16 – Modifications to Clause 16 and Annex L – October 2019
- EN 13445-3:2014 prA19 – Modifications to Annex C – November 2019
- EN 13445-3:2014 prA20 – Modifications to Clause 18 and new Annexes NA, NB, NC and ND – May 2019

In 2021 The European Committee for Standardization (CEN) introduced a "New Way of Working" which only permitted a single amendment each year for each part of EN 13445.

As a result the five separate amendments for EN 13445-3 were consolidated into a single amendment for the Formal Vote, EN 13445-3:2021/FprA1:2025. Moreover, amendments are now subject to a quality check by the CEN-CENELEC Management Centre (CCMC) in addition to the review by the Commission's Harmonized Standards (HAS) Consultant for compliance with the Pressure Equipment Directive (PED).

This procedure is significantly more time consuming than in the past, and this, together with the delay in publication of the new edition of EN 13445 in 2021, is the reason why Amendment 1 to EN 13445-3:2021, whose approval was due for 2022, has now been approved at Formal Vote in July 2025 and is expected to be published in December 2025.

The changes and updates contained in Amendment 1 include:

General

Various editorial corrections and improvements have been made.

Clause 9 – Openings in shells

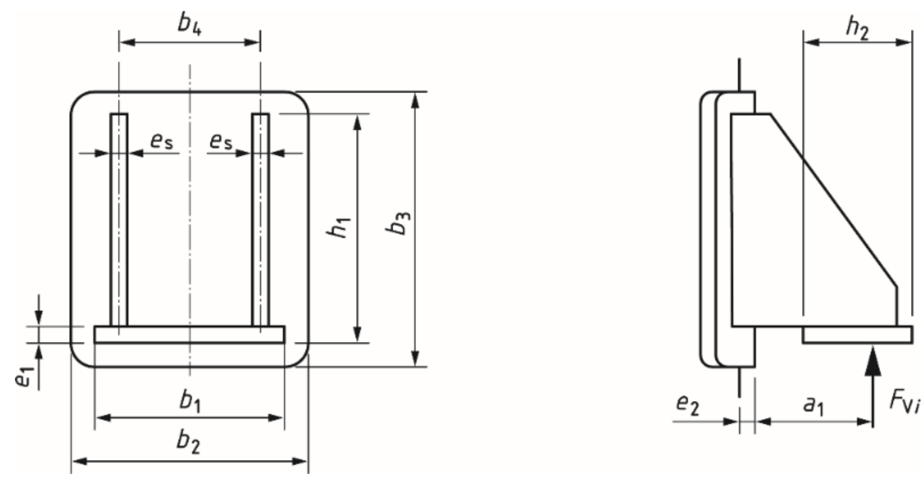
General improvements and clarifications of the design procedures have been made, particularly for oblique nozzles.

The nominal thickness of a reinforcing plate is limited to 1.5 times the nominal thickness of the shell. This limit was previously based on analysis thicknesses.

The cross-sectional area of a reinforcing plate effective as reinforcement is now based on the analysis thickness of the pad and is not limited to the effective shell thickness.

Subclause 16.10 – Vertical vessels on bracket supports

There are extensive changes to subclause 16.10. The four types of bracket considered are the same as those in the 2021 edition of the standard.



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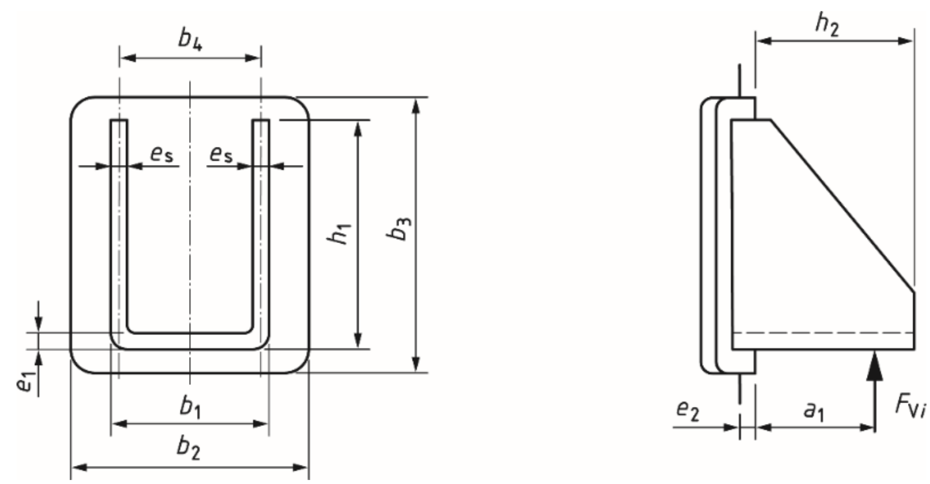

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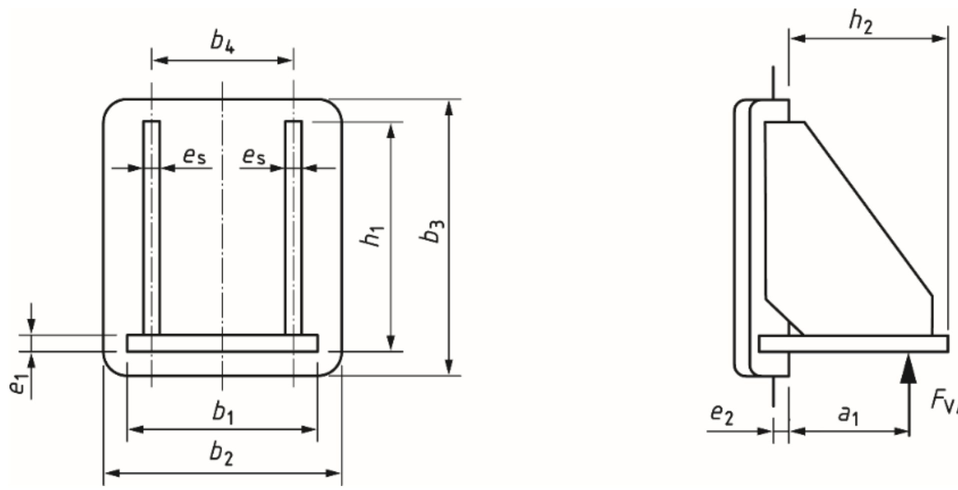

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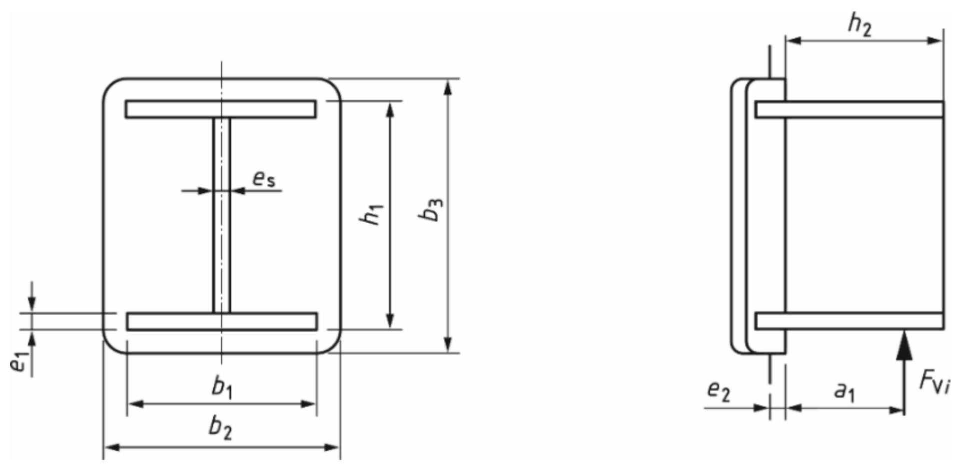

Figure 1 – Support brackets for vertical vessels

18

The analysis has been revised to take account of the effects of horizontal forces as well as vertical forces, and is applicable to brackets fixed to a rigid structure and to brackets attached to support legs. For vessels with support brackets attached to unbraced legs, the second-order effects of the deformed geometry are taken into account by means of an equivalent horizontal force.

New limit load based calculation procedures have been added for the design of the support brackets, including:

- evaluation of the bearing pressure and the anchor bolt loads;
- design of the bearing plate under compressive and tensile loading;
- assessment of the compressive force acting on the gusset plates;
- design of the bracket and reinforcing pad attachment welds.

New subclause 16.15 – Global loads on conical shells and conical transition without knuckles

This new subclause gives limit load based calculation procedures for checking the junctions between cylindrical shells and conical shells, as well as conical transitions between two cylindrical shells with different diameters, for internal pressure in combination with a global axial force and global bending moments. The analysis is not applicable for conical shells and conical transitions with knuckles.

A distinction is made between junctions at the large end of a conical shell, at the small end of a conical shell and junctions for short conical transitions where the ends of the conical part influence each other. Short conical transitions occur mainly in tall vertical vessels (columns) between cylindrical parts with different diameters.

Clause 18 – Detailed assessment of fatigue life

Clause 18 specifies requirements for the detailed fatigue assessment of welded and unwelded components and zones of pressure vessels that are subjected to repeated fluctuations of mechanical and thermal loads. This clause has been extensively revised in Amendment 1.

The determination of structural hot-spot stresses is now covered in Annex NA. Cycle counting and the determination of equivalent stress range have been moved to Annex NB. The fatigue assessment of fillet welds is covered in Annex NC.

There are changes to the classes of some weld details in Table 18-2, but the fatigue design curves are unchanged. Alternative definitions of curves for fatigue Class 90*, 80* and 71* have been added and may be used provided that all the requirements specified in subclause 18.10.6.2 are met.

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Annex A (normative) – Design requirements for pressure bearing welds

Annex A has been completely revised. It no longer specifies design requirements for welds to be used in the construction of pressure vessels. Annex A now specifies that weld details may be used if they are described in EN 1708-1:2010 or if they are required due to design reasons. The selection of weld details shall be made in such a way that the testing required by the applicable testing group can be performed.

The tables in Annex A now specify which types of welds are excluded for design by analysis direct route (DBA-DR), excluded for creep, excluded for fatigue or excluded generally. In addition, the fatigue classes or the references to Table 18-2 are given. Some typical examples are shown on the following slides.

Table A-2 — Pressure bearing welds - Circumferential welds in cylinders and cones, connecting weld between dished end and shell

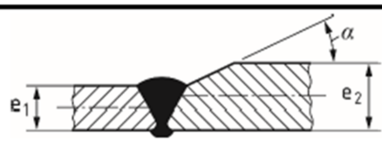
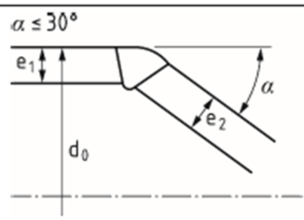
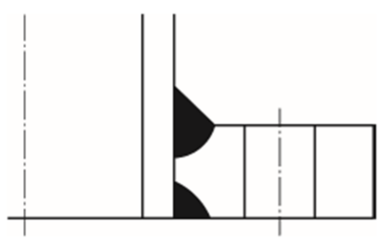
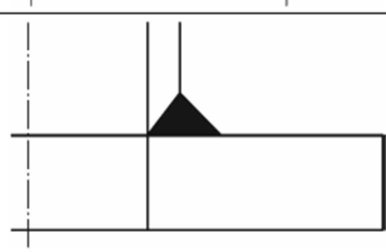
Geometry	Design requirements	Fatigue class	Remarks
	Not allowed for DBA-DR and creep design	see Table 18–2 Detail No. 1.3	$\alpha \leq 30°$
	--	see Table 18–2 Detail No. 1.4	$e_2 - e_1 \leq$ min[$0{,}3e_1$; 4]

Table A-7 — Flanges and collars

	Not allowed for DBA-DR and creep design	see Table 18–2 Detail No. 7.2	Weld dimensions see EN1708-1:2010 No. 5.1.6
	Not allowed for DBA-DR and creep design	63 or 50 if inside not visually inspected	Full penetration

New Annex NA (normative) – Methods of determination of the structural hot-spot stress by finite element analysis using shell or solid elements

This annex gives examples of finite element modelling and analysis in order to obtain structural hot-spot stresses required for the detailed fatigue check according to Clause 18.

Various methods are given for determining structural stresses using shell elements or solid elements, including direct access, linear surface extrapolation, quadratic surface extrapolation and through-wall linearization.

New Annex NB (normative) – Cycle counting and determination of equivalent stress range

This annex describes the determination of cycles of equivalent stress range (Tresca or von Mises) from a design or operational loading history for the purposes of fatigue assessment. The equivalent stress range is determined from the combination of the changes in stress components between the beginning and end of the cycle. The determination of cycles requires a finite element or other stress analysis to be undertaken to determine the components of stress at the loadings or times when a maximum or minimum component stress is likely to arise.

The counting of cycles of equivalent stress due to loads of variable amplitude may be undertaken using one of several recognized methods that are available and commonly used, and recommended procedures are given within this annex, including the reservoir counting method, rainflow counting method and extreme value method.

New Annex NC (normative) – Fatigue assessment of partial penetration welds

This annex is applicable for partial penetration welds modelled by solid elements where the stresses at the weld root are classified with Class 32 and at the weld toe classified with Class 63 according to Table 18-2 in Clause 18.

New Annex ND (normative) – Methods for calculation of stress concentrations σ_{total} and stress concentration factors K_t

This annex gives formulae for calculating stress concentrations σ_{total} and stress concentration factors K_t for various configurations, including a sphere with a circular hole, a sphere with circular added thickness, a cylinder with a circular hole, a small fillet radius, the knuckle in a torispherical head and threads in pressure vessels.

EN 13445-3:2021 AMENDMENT 2

The proposed changes and updates contained in EN 13445-3:2021/prA2:2026 include:

General

The term 'calculation pressure' is defined in Clause 3 as the differential pressure used for the purpose of the design calculations for a component, and 'calculation temperature' is defined as the temperature used for the purpose of the design calculations for a component. In various parts of the standard the incorrect use of the terms 'design pressure' and 'design temperature' instead of 'calculation pressure' and 'calculation temperature' is being corrected.

The terms ‘allowable pressure’ and ‘maximum allowable pressure’ are used incorrectly in a number of places, and these are being corrected to ‘maximum permissible pressure’.

In various places the lists of symbols and abbreviations are being re-arranged in alphabetical order. Various unnumbered formulae are being given numbers and subsequent formulae renumbered.

Improvements are being made to many of the figures.

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Clause 6 – Maximum allowed values of the nominal design stress for pressure parts

Requirements for the evaluation of the nominal design stress for exceptional load cases are being added.

The requirements for nominal design stress f_d for non-alloy and low alloy cast steels are being changed. Instead of having safety factors of 1.9 for proof strength and 3 for tensile strength the safety factors are now the same as those for wrought steels, i.e. safety factors of 1.5 on proof strength ($R_{p0,2/T}$) and 2.4 on tensile strength ($R_{m/20}$), but with an additional casting factor S_c, where S_c = 1.0 for volumetric examination of critical areas or 0.8 for all other cases:

$$f_{\mathrm{d}} = S_{\mathrm{c}} \cdot \min\left(\frac{R_{\mathrm{p0,2}/T}}{1,5} ; \frac{R_{\mathrm{m}/20}}{2,4}\right)$$

30

Requirements for the evaluation of the nominal design stress for austenitic cast steels are being added. These are the same as those for wrought austenitic steels with 30 % ≤ A < 35 %, but with the additional casting factor S_c:

$$f_d = S_c \cdot \left(\frac{R_{p1,0/T}}{1,5} \right)$$

Requirements for the nominal design stress for anchor bolts for the assembly condition are also being added.

31

Clause 8 – Shells under external pressure

The proposed changes included clarifications and minor corrections to:

- Figure 8.5-5 – *Values of P_r/P_y versus P_m/P_y*;
- Table 8.5-1 – *Definition of cylinder length*;
- Figure 8.5-8 – *Dimensional details*;
- Subclause 8.6.4.2 *Varying shell thickness, stiffener size or spacing*.

Clause 10 – Flat ends

For flat ends welded directly to the cylindrical shell the calculation procedure is being revised to give specific requirements for the prevention of gross plastic deformation for all types of load case, and to ensure elastic shakedown for normal operating load cases. As an alternative to the shakedown calculations a fatigue assessment in accordance with Clause 18 may be performed.

The revised method also prevents a problem which could occur when attempting to find the maximum permissible pressure for a flat end of known thickness. 32

In the calculations for pierced flat ends the area of the fillet welds between the nozzle and the flat end is now included in the total area of reinforcement.

The procedure for bolted rectangular, elliptical or obround flat ends is being revised to include calculations for the total hydrostatic end force H, the compression load on the gasket H_G, the minimum required bolt load for the assembly condition W_A and the minimum required bolt load for the operating condition W_{op}.

New figures for bolted rectangular, rectangular with radiused corners, elliptical and obround flat ends are being added.

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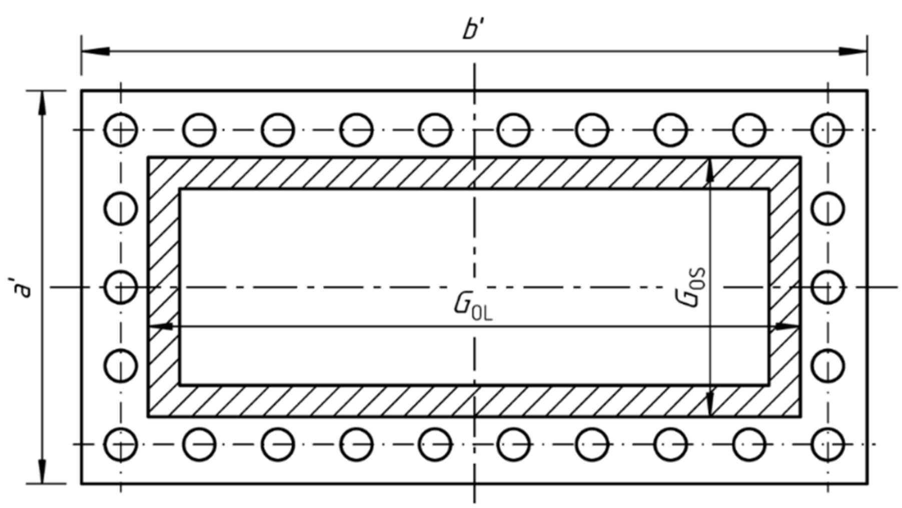

Figure 2 —Bolted rectangular flat end

34

Clause 15 – Pressure vessels of rectangular section

In subclause 15.5.3 Unreinforced vessel, opposite plates of long sides having different thicknesses, the formulae for the bending stresses in the short and long side plates are being corrected.

Clause 16 – Additional non-pressure loads

The term effective pressure P_1 is being introduced consistent with the weighting factors applied to the pressure for different load cases in Table 5.3.2.4–1 – Load combinations. The effective pressure is used instead of calculation pressure in calculations where the stress due to pressure is combined with the stresses due to global loads on the vessel.

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Table 16.2-1 — Effective pressure P_1

Load case [a]	LC0	LC1	LC2	LC3	LC4	LC5	LC6	LC7	LC8	LC9	LC10	LC11
Pressure P_1	P_i	$0{,}9 \cdot P_i$ [b]	$-P_e$ [b]	0	0	0	$0{,}9 \cdot P_i$ [b]	$-P_e$ [b]	0	P_{test} [b]	0	0

[a] The load cases are as defined in Table 5.3.2.4-1.

[b] The internal calculation pressure P_i and external calculation pressure P_e are defined in 5.3.2.4.3, and the test pressure P_{test} is defined in 5.3.2.3. The real operating pressure may be used instead of $0{,}9 \cdot P_i$, if it is limited either naturally (e.g. steam temperature) or by safety related control and instrumentation system.

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Subclause 16.8 – Horizontal vessels on saddle supports

Subclause 16.8 is being revised to include the effects of horizontal axial and transverse loads. The methods are applicable for vessel thickness to diameter ratios from 0.001 to 0.05 and saddle angles from 60° to 180°. There is no limit on vessel diameter.

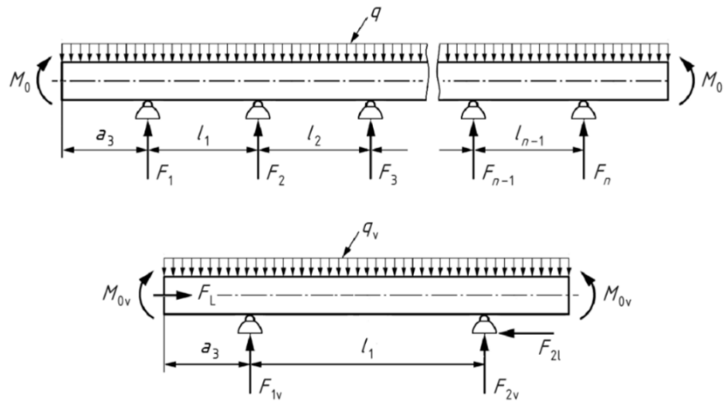

Figure 3 — Calculation model

37

New calculation procedures are being added for the design of the saddles, including the loads on the foundations and the anchor bolts.

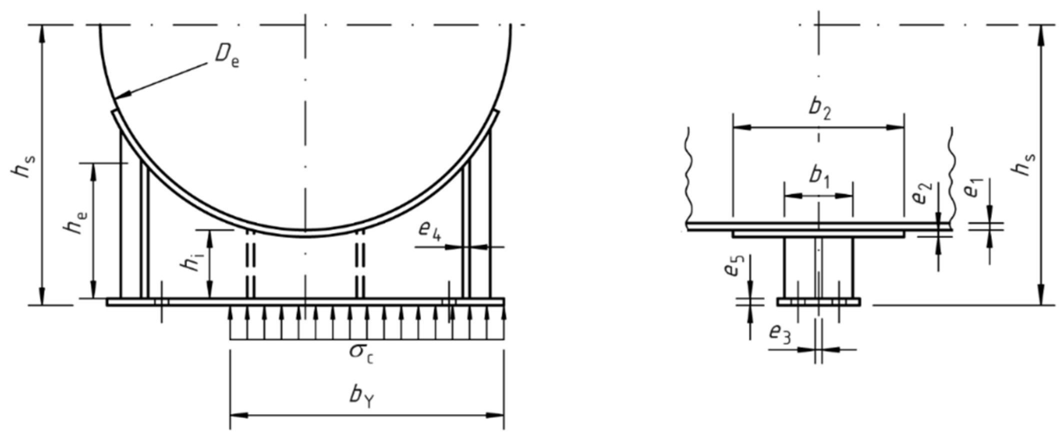

Figure 4 — Saddle parts details

38

Subclause 16.11 – Vertical vessels with support legs

Subclause 16.11 is being extensively revised, including revisions to the calculations for the load limits of the shell to take account of the effects of horizontal forces as well as vertical forces. Calculations are included for the design of the legs, bearing plates and attachment welds, and the evaluation of the anchor bolt loads.

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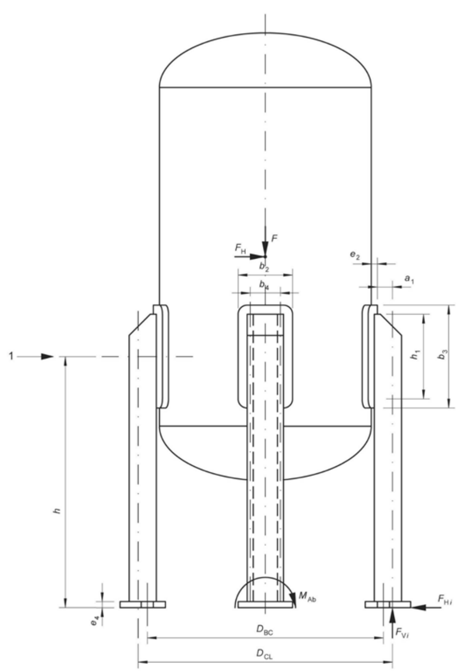
Figure 5 — Support legs on the cylindrical shell



Key

1 location of centre of support leg joint to shell or reinforcing plate

40

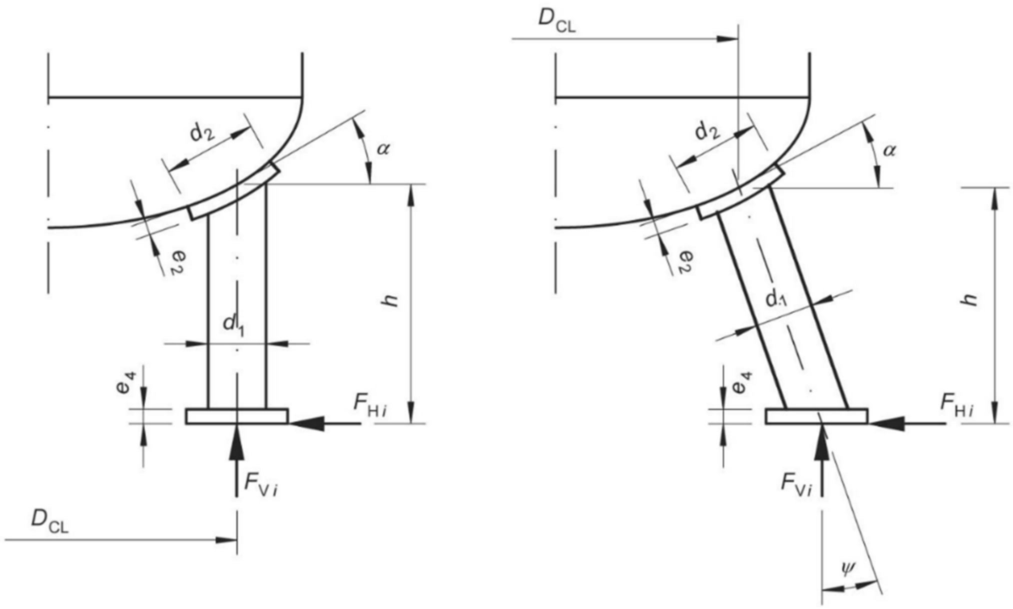
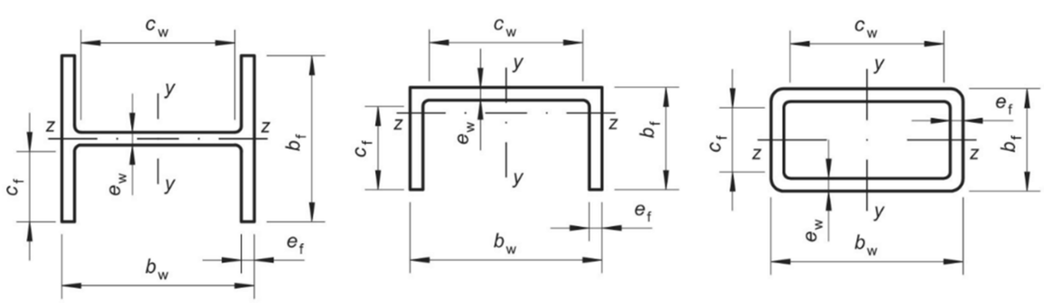


Figure 6 — Support legs on the dished end

41

Various types of legs are covered – I or H sections, channel sections, hollow rectangular sections, equal angle sections and hollow circular sections. The calculation procedure is based on a simplified version of the Eurocode EN 1993-1-1 or EN 1993-1-4, and takes account of the effects of flexural buckling and lateral-torsional buckling.



a) I or H section legs   b) Channel section legs   c) Hollow rectangular section legs

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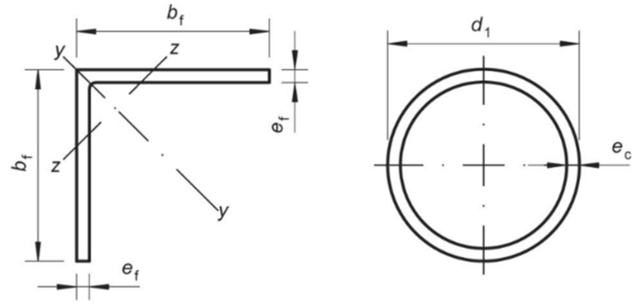

d) Equal angle section legs

e) Hollow circular section legs

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Figure 7 – Typical support leg details

Subclause 16.14 – Global loads on cylindrical shells

This subclause is being revised to be consistent with subclause 5.3.2.4 Load combinations and Clause 22 Static analysis of vessels.

Clause 22 – Static analysis of vessels

Clause 22 is being revised to cover all vessels, not just tall vertical vessels on skirts. The proposed amendments include clarification of the requirements for wind and earthquake loads on horizontal and vertical vessels.

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Annex G – Alternative design rules for flanges and gasketed flange connections

The rules in Annex G were derived from the work of TC74 (Flanges) several years ago, which was published in EN 1591-1:2001.
EN 13445 3:2021 Annex G permits the use of EN 1591-1:2013 for the design of bolted joints considering specified allowable leak rates through the gasket. In Amendment 2 to EN 13445-3:2021 this is being extended to include EN 1591-1:2024.

Some sealing gasket parameters for use when no leakage rate is specified are given in EN 1591-1:2024. When a leakage rate is specified some generic gasket parameters are given in CEN/TR 1591 2:2020, but these are only for use during preliminary calculations. The final calculations must be performed using gasket parameters provided by the selected gasket manufacturer because gasket parameters will vary between different manufacturers.

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The discussion is still open regarding the possibility of providing more general gasket parameters, and about the possibility of providing a calculation method for flanges bolted to heat exchanger tubesheets, which still requires a considerable amount of theoretical work.

In EN 13445-3:2021 Amendment 2 the changes to Annex G are mainly editorial.

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Conclusions

Amendments 1 and 2 to EN 13445-3:2021 represent significant improvements to the standard and include calculation procedures that are not found in most other pressure vessel design codes. These procedures include the design of vertical vessels on bracket or leg supports, and horizontal vessels on saddle or ring supports, all subject to mechanical loads as well as pressure. The procedures include the design of the supports.

It is not possible for the theoretical work still needed for the future development of the standard to be carried out in the context of the actual constraints imposed by the CEN rules. In other words, the preparation of a CEN harmonized standard is only possible when the theory on which the standard is based has been well developed and universally accepted.

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Other changes to EN 13445

A proposed new part EN 13445-12 – Additional requirements for pressure vessels of copper and copper alloys was issued for Public Enquiry in 2020, but there has been no further progress since then.

A new part of EN 13445 was published in 2024:

- EN 13445-11 – Additional requirements for pressure vessels of titanium and titanium alloys

Two new parts of EN 13445 are being developed:

- EN 13445-14 – Additional requirements for pressure equipment and pressure components fabricated with additive manufacturing methods

- EN 13445-15 – Additional requirements for hydrogen applications

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ASME VIII Rules for construction of pressure vessels – Division 1

The first ASME Boiler Code rules were issued under the title 'Rules for the Construction of Stationary Boilers and for Allowable Working Pressures, 1914 Edition.

The American Pressure Vessel Code, ASME VIII used to be published every three years, with amendments issued annually, but the standard is now published every two years with no annual amendments.

A new edition was published in July 2025.

General

The main changes in the 2025 edition of ASME VIII Division 1 are editorial.

A new **Subsection D – Requirements for Specific Types of Pressure Vessels and Components** has been introduced. This consists of various parts which were previously included as appendices or in Subsection C – Requirements Pertaining to Classes of Materials, including:

Part UCC	Design Rules for Clamp Connections (was Appendix 24)
Part UEB	Bellows Expansion Joints (was Appendix 26)
Part UEJ	Flexible Shell Element Expansion Joints (was Appendix 5)
Part UHX	Rules for Shell-and-Tube Heat Exchangers (was in Subsection C)
Part UNC	Vessels of Noncircular Cross Section (was Appendix 13)
Part UPX	Plate Heat Exchangers (was Appendix 45)

Design requirements in ASME VIII Division 2

Another major change is the deletion of design procedures from ASME VIII Division 1 for various components, including those listed below.

Some general requirements are still given in Division 1 but the design requirements in ASME VIII Division 2 are now to be used in lieu of those previously given in ASME VIII Division 1.

Bolted flange connections – Div 2, Part 4.16 (was Div 1, Appendix 2)

Bellows Expansion Joints – Div 2, Part 4.19 (was Div 1, Appendix 26)

Flexible Shell Element Expansion Joints – Div 2, Part 4.20 (was Div 1, Appendix 5)

Shell-and-Tube Heat Exchangers – Div 2, Part 4.18 (was Div 1, Subsection C, Part UHX)

Vessels of Noncircular Cross Section – Div 2, Part 4.12 (was Div 1, Appendix 13)

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Flanges

In ASME VIII Division 1, Appendix 2, Table 2-1.1 gives a cross-reference list for the Division 2 paragraphs containing the requirements previously located in Appendix 2.

Table 2-1.2 gives a cross-reference list for the locations of the Division 2 figures and tables containing the requirements previously located in Appendix 2..

Table 2-1-3 gives a cross-reference list of the design requirements in ASME VIII Division 1 that shall be used in lieu of the corresponding ASME VIII Division 2 requirements referenced in part 4.16.

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Table 2-1-1
Paragraph Cross Reference List

Division 1 Paragraph	Division 2 Paragraph
2-3 Notation – deleted	4.16.13
2-4 Circular Flange Types	4.16.3
2-5 Bolts Loads – deleted	4.16.2 and 4.16.6
2-6 Flange Moment – deleted	4.16.7
2-7 Calculation of Flange Stresses – deleted	4.16.7
2-8 Allowable Flange Design Stress – deleted	4.16.7
2-9 Split Loose Flanges – deleted	4.16.8
2-10 Noncircular Shaped Flanges with Circular Bore – deleted	4.16.9
2-11 Flanges Subject to External Pressure – deleted	4.16.7
2-12 Flanges With Nut Stops – deleted	4.16.10
2-13 Reverse Flanges – deleted	4.16.3.2 and 4.16.7
2-14 Flange Rigidity – deleted	4.16.7

The main differences between the flange design method that was in ASME VIII Division 1, Appendix 2 and the method in ASME VIII Division 2 Part 4.16 are:

- Changes to flange facings and effective gasket width.
- Inclusion of the effects of an applied axial force and an applied external moment.
- Optional type flanges which were previously shown in ASME VIII Division 1, Figure 2-4 sketches (8) to (11) are not included in ASME VIII Division 2, part 4.16.
- There are no charts for factors F, V, F_L, V_L and f. The values are obtained from equations in Table 4.16.5 which are different from the equations which were in ASME VIII Division 1, Table 2-7.1.
- The design of loose-type lap joint flanges is slightly different.

Shell-and-Tube Heat Exchangers

In the 2023 Edition of ASME VIII Division 1 the design requirements for shell-and tube heat exchangers were removed from Part UHX and the design requirements in ASME VIII Division 2, Part 4.18 are now to be used in lieu of those previously given in ASME VIII Division 1.

In the 2023 Edition of ASME VIII Division 1, Part UHX, Table UHX-1.1 gives a cross-reference list for the Division 2 paragraphs containing the requirements previously located in Division 1, Part UHX.

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2023 Edition of ASME VIII Division 1, Table UHX-1.1
Paragraph Cross Reference List

Topic	Division 2 Paragraph
Scope	4.18.1
Terminology	4.18.2
Design	4.18.3
Tubesheet design definitions	4.18.15
Tubesheet effective bolt load, *W**	Table 4.18.6
General conditions of applicability for tubesheets	4.18.4
Tubesheet characteristics	4.18.6
Rules for the design of U-tube tubesheets	4.18.7
Rules for the design of fixed tubesheets	4.18.8
Rules for the design of floating tubesheets	4.18.9
Bellows expansion joints	4.18.11
Flexible shell elements expansion joints	4.18.12

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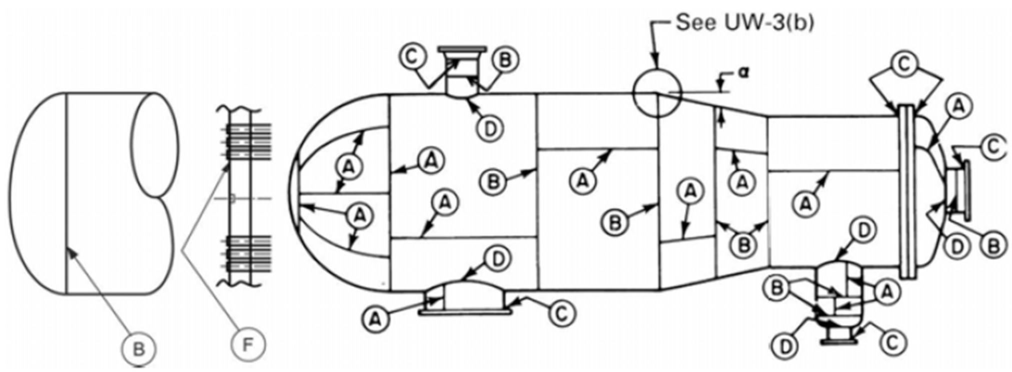
Tube to tubesheet welds

ASME VIII Division 1, UW-3 now includes a new weld joint category:

Category F. Welded joints connecting tubes to tubesheets per UW-20.

Figure UW-3
Illustration of Welded Joint Locations Typical of Categories A, B, C, D, and F



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Thank You

Just a couple more slides that may be of interest

Simon Earland

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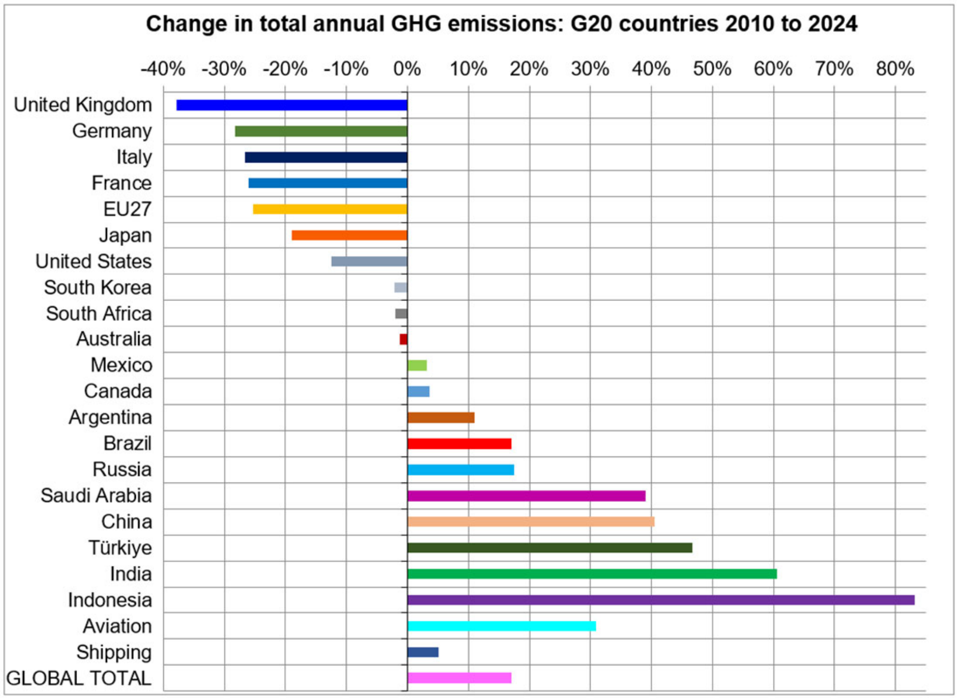
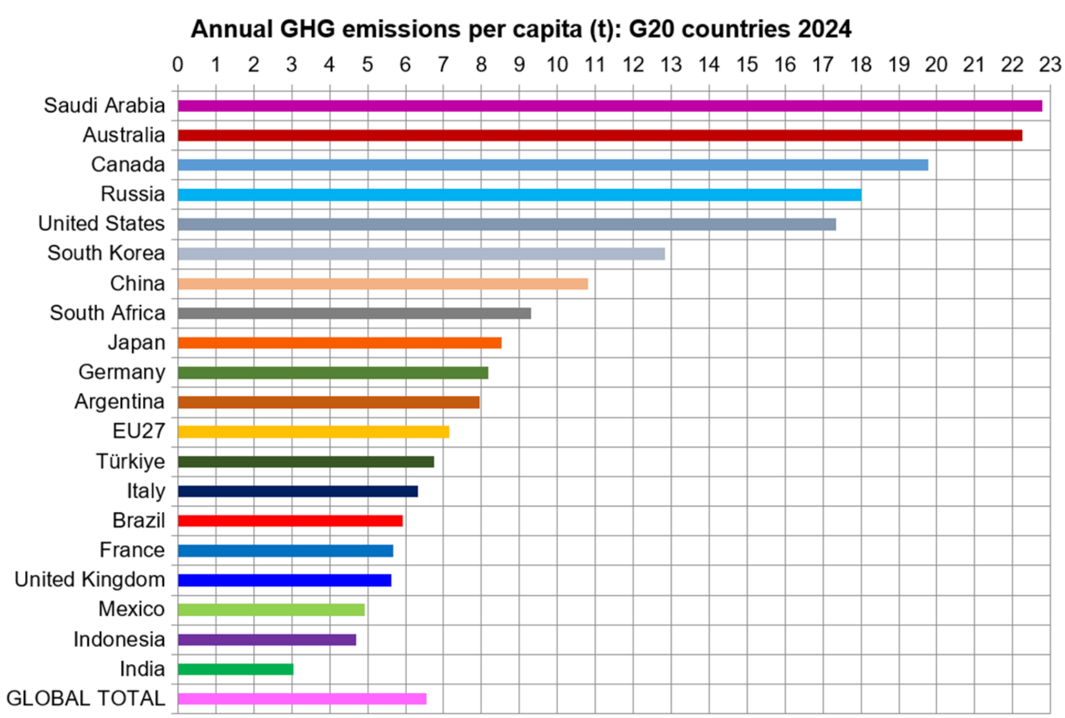
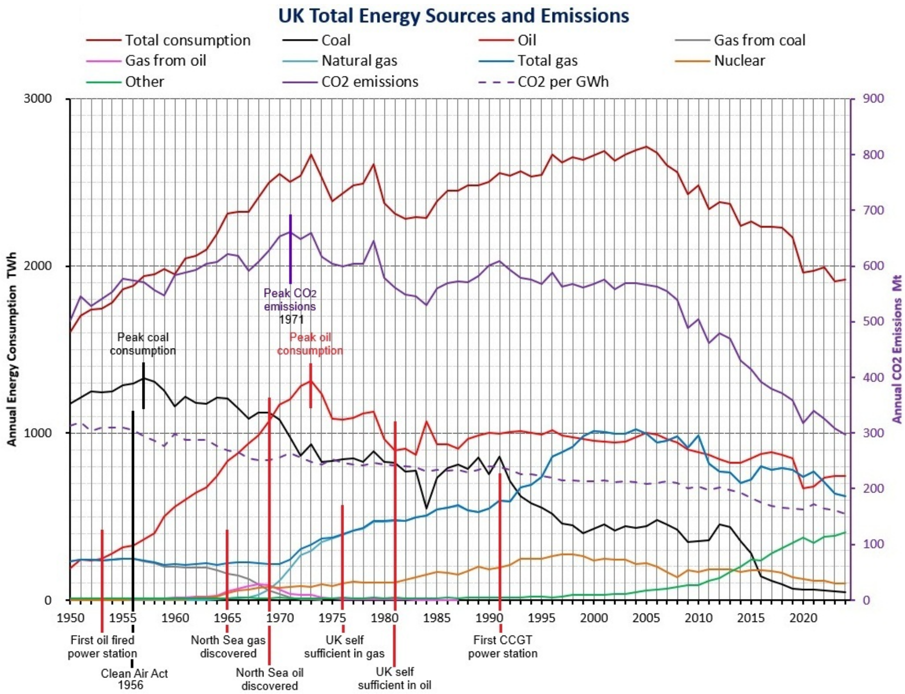

Change in total annual GHG emissions: G20 countries 2010 to 2024
-40%
-30%
-20%
-10%
0%
10%
20%
30%
40%
50%
60%
70%
80%
United Kingdom
Germany
Italy
France
EU27
Japan
United States
South Korea
South Africa
Australia
Mexico
Canada
Argentina
Brazil
Russia
Saudi Arabia
China
Türkiye
India
Indonesia
Aviation
Shipping
GLOBAL TOTAL

59


Annual GHG emissions per capita (t): G20 countries 2024
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Saudi Arabia
Australia
Canada
Russia
United States
South Korea
China
South Africa
Japan
Germany
Argentina
EU27
Türkiye
Italy
Brazil
France
United Kingdom
Mexico
Indonesia
India
GLOBAL TOTAL

60


UK Total Energy Sources and Emissions
Total consumption
Coal
Oil
Gas from coal
Gas from oil
Natural gas
Total gas
Nuclear
Other
CO2 emissions
CO2 per GWh
Annual Energy Consumption TWh
Annual CO2 Emissions Mt
Peak CO2 emissions 1971
Peak coal consumption
Peak oil consumption
First oil fired power station
Clean Air Act 1956
North Sea gas discovered
North Sea oil discovered
UK self sufficient in gas
UK self sufficient in oil
First CCGT power station

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