

# DIN EN 13445-6:2021-12 (E)

## Unfired pressure vessels - Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron

<b>Contents</b>		<b>Page</b>
European foreword .....		5
<b>1</b>	<b>Scope .....</b>	<b>6</b>
<b>2</b>	<b>Normative references .....</b>	<b>6</b>
<b>3</b>	<b>Terms, definitions units and symbols .....</b>	<b>7</b>
<b>3.1</b>	<b>Terms and definitions .....</b>	<b>7</b>
<b>3.2</b>	<b>Units .....</b>	<b>9</b>
<b>3.3</b>	<b>Symbols .....</b>	<b>9</b>
<b>3.4</b>	<b>Inter-relation of thicknesses definitions .....</b>	<b>11</b>
<b>4</b>	<b>Service conditions .....</b>	<b>11</b>
<b>4.1</b>	<b>Cyclic loading .....</b>	<b>11</b>
<b>4.2</b>	<b>Limitations on temperature and energy content .....</b>	<b>12</b>
<b>5</b>	<b>Requirements .....</b>	<b>12</b>
<b>5.1</b>	<b>Materials .....</b>	<b>12</b>
<b>5.2</b>	<b>Design .....</b>	<b>14</b>
<b>5.2.1</b>	<b>Technical documentation .....</b>	<b>14</b>
<b>5.2.2</b>	<b>Design methods .....</b>	<b>14</b>
<b>5.3</b>	<b>Founding .....</b>	<b>21</b>
<b>5.3.1</b>	<b>General .....</b>	<b>21</b>
<b>5.3.2</b>	<b>Welding .....</b>	<b>21</b>
<b>6</b>	<b>Material testing .....</b>	<b>21</b>
<b>6.1</b>	<b>General .....</b>	<b>21</b>
<b>6.2</b>	<b>Frequency and number of tests .....</b>	<b>21</b>
<b>6.3</b>	<b>Chemical analysis .....</b>	<b>22</b>
<b>6.4</b>	<b>Graphite structure .....</b>	<b>22</b>
<b>6.5</b>	<b>Inspection documents .....</b>	<b>22</b>
<b>7</b>	<b>Testing and final assessment .....</b>	<b>22</b>
<b>7.1</b>	<b>Testing .....</b>	<b>22</b>
<b>7.1.1</b>	<b>General .....</b>	<b>22</b>
<b>7.1.2</b>	<b>Testing requirements for CQ = 0,8 .....</b>	<b>23</b>
<b>7.1.3</b>	<b>Testing requirements for CQ = 0,9 .....</b>	<b>23</b>
<b>7.1.4</b>	<b>Surface imperfections .....</b>	<b>24</b>
<b>7.1.5</b>	<b>Cracks, laps, cold shut and non-fused chaplets .....</b>	<b>24</b>
<b>7.1.6</b>	<b>Ultrasonic testing and/or sectioning .....</b>	<b>24</b>
<b>7.1.7</b>	<b>Magnetic particle testing (only for ferritic grades) .....</b>	<b>24</b>
<b>7.1.8</b>	<b>Penetrant testing .....</b>	<b>25</b>
<b>7.1.9</b>	<b>Radiographic testing .....</b>	<b>25</b>
<b>7.1.10</b>	<b>Surface roughness .....</b>	<b>25</b>
<b>7.1.11</b>	<b>Minimum wall thickness .....</b>	<b>25</b>
<b>7.1.12</b>	<b>Wall thickness tolerances .....</b>	<b>25</b>
<b>7.1.13</b>	<b>Other dimensions .....</b>	<b>25</b>
<b>7.1.14</b>	<b>Qualification of testing personnel .....</b>	<b>26</b>
<b>7.2</b>	<b>Final assessment .....</b>	<b>26</b>
<b>7.2.1</b>	<b>General .....</b>	<b>26</b>
<b>7.2.2</b>	<b>Hydraulic test pressure .....</b>	<b>26</b>

8	Pressure vessels constructed of a combination of parts in different materials .....	26
9	Marking and documentation .....	26
9.1	Marking of castings .....	26
9.2	Name plate for the complete pressure vessel .....	27
9.3	Documentation .....	27
	(normative) Technical data for the design calculations .....	28
A.1	Purpose .....	28
A.2	Technical data .....	28
A.2.1	Ferritic spheroidal graphite cast iron according to EN 1563:2018 .....	28
A.2.2	Austenitic spheroidal graphite cast iron according to EN 13835:2012 .....	29
	(informative) Ductility .....	30
	(informative) Determination of the minimum local wall thickness and minimum required burst test pressure .....	32
	(normative) Assessment of fatigue life .....	34
D.1	Purpose .....	34
D.2	Specific definitions .....	34
D.3	Specific symbols and abbreviations .....	34
D.4	Limitations .....	35
D.5	General .....	35
D.6	Simplified fatigue assessment .....	35
D.6.1	Pseudo-elastic stress range .....	35
D.6.2	Correction factors .....	36
D.6.3	Fatigue design curves .....	37
D.6.4	Allowable number of cycles .....	43
D.6.5	Allowable stress range .....	43
D.7	Detailed fatigue assessment .....	43
D.7.1	Pseudo-elastic stress ranges .....	43
D.7.2	Corrections to stress range .....	44
D.7.3	Fatigue design curves .....	45
D.7.4	Allowable number of cycles .....	46
D.7.5	Allowable stress range .....	47
D.8	Assessment rule for total fatigue damage .....	47
D.9	Repairs of surface imperfections .....	47
	(normative) Design by analysis for castings .....	48
E.1	Introduction .....	48
E.2	Special requirements to EN 13445-3:2021, Annex B .....	48
E.2.1	Addition to B.8.2.3: Design checks for normal operating load cases .....	48
E.2.2	Addition to B.8.2.4: Design checks for testing load cases .....	48
E.3	Additions to EN 13445-3:2021, Annex C .....	48
E.4	Requirements .....	49
	(informative) Recommendations for in-service validation and inspection .....	50
F.1	Purpose .....	50
F.2	Tests during operation .....	50
F.3	Measures to be taken when the calculated allowable fatigue lifetime has been reached.51	
	F.3.1 General .....	51
F.3.2	Testing of vessels and pressure parts at end of life without indicated damages .....	51
F.3.3	Hydraulic testing of vessels and vessel parts with indicated damages .....	51
	(normative) Specific design requirements .....	52

<b>Issue 1 (2021-05) G.1 Scope .....</b>	<b>52</b>
<b>G.2 Design .....</b>	<b>52</b>
<b>G.2.1 General .....</b>	<b>52</b>
<b>G.2.2 Cover crown thickness, pressure to convex side .....</b>	<b>53</b>
<b>G.2.3 Cover crown thickness, pressure to concave side .....</b>	<b>53</b>
<b>G.2.4 Flange thickness .....</b>	<b>53</b>
<b>(normative) Experimental cyclic pressure testing procedure .....</b>	<b>54</b>
<b>H.1 Purpose .....</b>	<b>54</b>
<b>H.1.1 General .....</b>	<b>54</b>
<b>H.1.2 Experimental methods and other design methods .....</b>	<b>54</b>
<b>H.2 Validity .....</b>	<b>54</b>
<b>H.3 Tests requirements .....</b>	<b>54</b>
<b>H.3.1 General .....</b>	<b>54</b>
<b>H.3.2 Number of parts .....</b>	<b>54</b>
<b>H.3.3 Procedure .....</b>	<b>55</b>
<b>H.3.4 Material tests .....</b>	<b>57</b>
<b>H.4 Allowable number of cycles .....</b>	<b>57</b>
<b>Annex ZA (informative) Relationship between this European Standard and the essential requirements of Directive 2014/68/EU (Pressure equipment Directive) aimed to be covered .....</b>	<b>61</b>
<b>Bibliography .....</b>	<b>63</b>