

# COMPARATIVE REVIEW OF AWS D1.1 VS CSA W59 & W47.1



## CANADIAN WELDING BUREAU

*A Division of the CWB Group – Industry Services*

7250 West Credit Avenue, Mississauga, Ontario, L5N 5N1.

Tel: (905) 542-1312 Fax: (905) 542-1318

**AWS D1.1:2004**      **Structural Welding Code – Steel**

**CSA Standard W59-03**      **Welded Steel Construction (Metal Arc Welding)**

**CSA Standard W47.1-03**      **Certification of Companies for Fusion Welding of Steel**

July 2004



## **Introduction:**

The purpose of this comparative review is to provide the users of these Standards an overview, which may take hours of thorough study of each individual Standard to find their similarity and differences.

It should be pointed out the AWS D1.1 covers: welding design, welding procedure qualification, fabrication, inspection, stud welding, and strengthening and repairing existing structures. In the CSA Standards, W59 covers similar subjects and W47.1 covers the subjects pertaining to welding procedure qualification, welding personnel qualification and company certification. The latter two subjects constitute the major difference between AWS D1.1 and CSA Standards.

The CSA W47.1 Standard is administered by the Canadian Welding Bureau, which is mandated to certify fabricators and monitor their conformance to Standard's requirements. Whereas the AWS D1.1 is a voluntary conformance Standard and AWS does not monitor or enforce the conformance.

While great effort is made to compare these Standards clause by clause, some clauses of general nature may be omitted. Some clauses are shown for their comparative differences and fundamental importance.



## COMPARATIVE REVIEW OF AWS D1.1, CSA W59 & W47.1

<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
1 General Requirements	1 Scope  2 Definitions and Reference Publications  3 General Requirements	1 Scope  2 Reference Publications  3 Definitions	EQ	
No EQ Clause		4 Administration  Canadian Welding Bureau administers this standard, certifies companies, plants and qualifies welding personnel. Certified companies are monitored by the Bureau to ensure that the requirements of this Standard are being met.		Major difference (also see P.17 and P.18)

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
2 Design of Welded Connections Part A Common Requirements for Design of Welded Connections	4 Design of Welded Connections			
2.1 Scope  2.2 Contract Plans and Specifications	4.1 General Requirements		EQ	
2.3 Effective Areas	4.3 Effective, Weld Area, Length, Throat and Fillet Size		EQ	D1.1 specifies the reduction coefficient for end-loaded long fillet weld.
Part B Specific Requirements for Design of Non-tubular Connections	4.1.1.1 Design Drawings			
2.4 General	Clauses 11 and 12		EQ	

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2.5 Stresses  Table 2.3 Allowable Stresses	Clauses 11 and 12  Tables 11.2(a), 12.2(a) Allowable Stresses  Table 11.2(b), 12.2(b) Limit States Design		EQ	D1.1 – Allowable Stress Design  CSA W59 – Allowable Stress Design and Limit States Design
2.6 Joint Configuration and Details	Clauses 10 11.4 12.4		EQ	
2.6.7 Welds with Rivets or Bolts	Clauses 11.4.3 12.4.3		EQ	
2.7 Joint Configuration and Details Groove Welds	Clauses 10 11 12 Fig. 10.1 to 10.8		EQ	
2.8 Joint Configuration and Details Fillet Welded Joints	4.3.2 4.4 11.4.6 12.4.6		EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
2.9 Joint Configuration and Details Plug and Slot Welds	4.4.2 Plug and Slot Weld Details		EQ	
2.10 Filler Plates	4.6 Fillers		EQ	
2.11 Built-Up Members	11.4.13 12.4.13 Connection of Components of Built-Up Members		EQ	
2.12 to 2.16 Specific Requirements for Design of Non-tubular Connections (Cyclically Loaded)	Clause 12  Table 12.2(a) Allowable Stress Table 12.2(b) Limit States		EQ	D1.1 provides more design formulas.
2.17 Prohibited Joints and Welds	12.4.14 Prohibited Types of Joints and Welds		EQ	
2.18 Inspection	12.5.4 Quality of Welds		EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
Table 2.7 Fatigue Category Limitations (Tubular Connections)	No EQ.			See CSA S473-04 Offshore Design Standard
Table 2.8 Z Loss Dimensions for Tubular Connections	No EQ.			
Table 2.9 Terms for Strength of Connections (Circular Sections)	No EQ.			
3 Prequalification of WPS	10 Details and Welding Procedure Requirements for Prequalified Joints			
3.1 Scope	10.1 General		EQ	
3.2 Welding Processes	3.1.3 10.1.3		EQ	

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3.3 Base Metal / Filler Metal Combinations  Table 3.1 Prequalified Base Metal / Filler Metal Combinations for Matching Strength	Table 11.1		EQ	D1.1 Table 3.1 Lists more Grades of Steel
3.4 Engineer's Approval for Auxiliary Attachments	2.1.1		EQ	
3.5 Min. Preheat and Interpass Temperature Requirements  Table 3.2 Min. Preheat and Interpass Temperature	Clauses 5 and 10  Table 5.3 Min. Preheat and Interpass Temperatures		EQ	
3.6 Limitation of WPS Variables	5.5 Details of Welding	10 Welding Procedure Specifications (WPS)	EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
3.7 General WPS Requirements				
3.8 Common Requirements for Parallel Electrode and Multiple Electrode SAW	5.5.3.3 Procedures for Welding with Parallel Electrodes 5.5.3.4 Procedure for Welding with Multiple Electrodes		EQ	
3.9 Fillet Weld Requirements	4.3.2 Fillet Welds		EQ	
3.10 Plug and Slot Weld Requirements	4.3.3 4.4.2 Appendix B		EQ	
3.11 Common Requirements of PJP and CJP Groove Welds	4.3		EQ	
3.12 PJP Requirements	4.3		EQ	
3.13 CJP Groove Weld Requirements	4.3		EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
3.14 Postweld Heat Treatment	5.12 Stress Relief Heat Treatment		EQ	
Fig. 3.3 Prequalified PJP Groove Welded Joint Details  Fig. 3.4 Prequalified CJP Groove Welded Joint Details	Fig. 10.1 to Fig. 10.8		EQ	
Fig. 3.5 Prequalified Joint Details for PJP T-, Y-, and K- Tubular Connections				See CSA S473-04 Offshore Design Standard.
Fig. 3.6 Prequalified Joint Details for CJP T-, Y-, and K- Tubular Connections	Fig. 10.1 to Fig. 10.8			
Fig. 7 to Fig. 11 Location, Definitions and Details of Tubular CJP Connections	Fig. 10.1 to Fig. 10.8			

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
4 Qualification  Part A General Requirements  4.1 General		1 Scope	EQ.	
4.2 Common Requirements for WPS and Welding Personnel Performance Qualification		8 Welding Personnel	EQ	
Part B Welding Procedure Specification (WPS)		10 Welding Procedure Specifications (WPS)	EQ	
4.4 Type of Qualification Tests		11.4 Types of Test Groupings of Welds	EQ	
4.5 Weld Types for WPS Qualification		10	EQ	

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4.6 Preparation of WPS		11.5 Test Assembly, Position and Specimens	EQ	
4.7 Essential Variables		5.5 Details of Welding Procedures  Table 11 (See Essential Variables for all Welding Processes)	EQ	
4.8 Methods of Testing and Acceptance Criteria for WPS Qualification		11.4 Type of Test Groupings of Weld  11.6 Test Methods and Acceptance Criteria – Soundness Tests  11.7 Test Methods and Acceptance Criteria – Mechanical Tests  11.8 Welding Consumables	EQ  EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
4.9 CJP Welds for Nontubular Connections		Table 13 Procedure Qualification – CJP Groove Welds, Range of Thickness and Diameters Qualifications	EQ	
4.10 PJP Groove Welds for Nontubular Connections		Table 14 (Clause 11.4.5 and Table 11) Procedure Qualification – PJP Groove Welds – Range of Thickness Qualified	EQ	
4.11 Fillet Welds for Tubular and Nontubular Connections		Table 15 (Clause 11.4.5) Procedure Qualification – Fillet Welds Range of Weld Sizes Qualified	EQ	
4.12 CJP Groove Welds for Tubular Connections				See CSA S473-04 Offshore Design Standard
4.13 PJP Tubular Connections				See CSA S473-04 Offshore Design Standard

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4.14 Plug and Slot Welds <i>(Also see 4.29)</i>	4.3.3 Plug and Slot Welds  4.4.2 Plug and Slot Weld Details			CSA W47.1 – Procedure Qualification test is required. D1.1 – Groove Weld Qualification qualifies plug and slot welds.
4.15 Welding Processes Requiring Qualification	5.5 (Describes processes requiring qualification)		EQ	
4.16 WPS Requirement (GTAW)	5.5 (Describes processes requiring qualification)			Both D1.1 and CSA W59 require procedure qualification.
4.17 WPS Requirements (ESW/EGW)	5.5.5 (Procedure qualification required)		EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
Part C Performance Qualification  4.18 General: Welders, Welding Operators and Tack Welder Qualification  4.19 Type of Qualification Tests Required  4.20 to 4.29 Weld Types for Welder and Welding Operator Performance Qualification		8 Welding Personnel  8.2 Qualification Process for Welding Personnel  8.3 Period of Effectiveness  8.4 Renewal of Qualification  8.5 Extent of Qualification  8.6 Record of Qualification  9 Qualification of Welding Personnel  9.6 Welding Personnel Qualification <i>(also see Clause 9.14 requirements)</i>	EQ	CSA W47.1 – Classification of Welding Personnel S, T, FW, WT, ASW See Clause 3 – Definitions  D1.1 – No such classification system
4.30 Methods of Testing and Acceptance Criteria for Welder and Welding Operator Qualification		9.10 Test Methods (including radiographic examination, root-, face-, side-bend tests, macro-etch examinations)	EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
4.31 Methods of Testing and Acceptance Criteria for Tack Welder Qualification		9.14.4 WT Classification		CSA W47.1 WT – Tack Welder
No EQ (See AWS D1.3 Structural Welding Code – Sheet Steel)		9.14.5 ASW Classification		CSA W47.1 ASW – Arc Spot Welder
4.32 Retest		Clauses 9.12, 9.14.4.6, 9.14.5.9	EQ	
Table 4.1 WPS Qualification		Table 16 Procedure Qualification	EQ	
Table 4.2 WPS Qualification – Range of Thick. and Diam. Qualified		Tables 13 and 14 Procedure Qualification – Range of Thick. and Diam. Qualified	EQ	
Table 4.5 PQR Essential Variables		Table 11 Soundness Test Essential Variables	EQ	

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Clause No.	Clause No.	Clause No.		
Table 4.9 Welder Qualification		Table 4 and 19 S and T Classification – Plate Test Assemblies  Tables 5 and 20 T-Classification – Pipe Test Assemblies	Not EQ  Not EQ	<p>Sizes of Test Assemblies and preparation of tests specimens are similar. However, CSA W47.1 requires welders to progress through a hierarchy of welding positions starting with the flat position with no one position qualifying the other (unlike AWS). In addition, CSA W47.1 requires fillet welding tests depending on the complete joint geometry tested (AWS does not require this). Finally, CSA W47.1 requires welders to be check tested every two years to ensure they maintain the required welding skills (AWS D1.1 does not require this). Therefore, CSA W47.1 is tougher in all these areas. <b>In addition, a major difference is:</b>  <b>W47.1:</b>            All qualification tests must be witnessed by the CWB's representative.  <b>D1.1:</b>            The Company records the welding parameters without independent witnessing.</p>
Table 4.10 Welder and Welding Operator Qualification – Number and Type of Specimens and Range of Thickness and Diameter Qualified		Table 4 to 8 Qualification Tests – (Reference made to Figures with test plate thicknesses given)	Not EQ	
Table 4.11 Welding Personnel Performance Essential Variable Changes Requiring Requalification		Table 11	Not EQ	
Table 4.12 Electrode Classification Groups		Table 1 Group Designation of SMAW Electrodes	EQ	

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No EQ		<p>The following comments highlight the major difference between D1.1 and W47.1:</p> <p>(a) Certification of Fabricators (see Note (1))</p>		Major difference. Independent verification
No EQ		<p>(b) Qualify Welding Engineers:</p> <ul style="list-style-type: none"> <li>- Define duties of welding engineers</li> <li>- Outline experience and education requirements</li> </ul> <p>See Clause 6 and Appendices A, B, C.</p>		
No EQ		<p>(c) Qualify welding supervisors</p> <p>See Clause 7.</p> <ul style="list-style-type: none"> <li>- Outline experience and education requirements.</li> </ul>		
EQ (Test Record, No Certificate)		<p>(d) Test Welders and welding operators</p> <ul style="list-style-type: none"> <li>- Issue certificates to qualified welding personnel.</li> </ul>		

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No EQ		(e) Regular visits to certified fabricators - Monitor conformance to Standard by the Bureau's regional representatives from regional offices throughout the country. - Visit to all companies certified to W47.1 by the Bureau.		Major differences.
EQ (By Fabricator)		(f) Qualify and approve welding procedures.		
No EQ		Note (1) See Clause 5.2 The company can be certified in one of the following Divisions: <b>Div. 1:</b> shall employ full-time qualified welding engineer. <b>Div. 2:</b> shall retain the services of qualified welding engineer <b>Div. 3:</b> No engineer is required.  All certified companies are required to employ full-time qualified supervisors.		

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
No EQ		See Clause 5.3 Application for Certification (Information required to satisfy CSA W47.1 for certification)		Major differences.
5 Fabrication	5 Electrodes, Workmanship and Technique			
5.1 Scope	5.1 General		EQ	
5.2 Base Metal	3.2 Base Metal		EQ	D1.1 – Lists more grades of steels
5.3 Welding Consumables and Electrode Requirements	5.2 Electrodes		EQ	
5.4 ESW and EGW Processes	5.2.5 Electrodes, Fluxes and Gases for ESW and EGW		EQ	
5.5 WPS Variables	5.2.1.5 (Covers all Welding Processes)		EQ	

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
5.6 Preheat and Interpass Temperatures	5.7 Preheat, Interpass Temperature, and Heat Input Control		EQ	
5.7 Heat Input Control for Quenched and Tempered Steels	5.5.1.6 Welding Quenched and Tempered Steels		EQ	
5.8 Stress Relief Heat Treatment	5.12 Stress Relief Heat Treatment		EQ	
5.9 Backing, Backing Gas and Inserts	5.5.1.1 Material for Extension Bars, Run-Off Plates and backings		EQ	
5.10 Backing	5.4.9 Backing		EQ	D1.1 shows thickness of backing bars for different welding processes.
5.11 Welding and Cutting Equipment	5.3 Preparation of Material		EQ	

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5.12 Welding Environment	See Notes of Table 5.3		EQ	
5.13 Conformance with Design	4.1 Design of Welded Connections General Requirements		EQ	
5.14 Min. Fillet Weld Sizes	Table 4.4 Min. Fillet Weld Size		EQ	
5.15 Preparation of Base Metal	5.3 Preparation of Material		EQ	
5.16 Re-entrant Corners	5.3.6 Re-entrant Corners		EQ	
5.17 Beam Copes and Weld Access Holes	5.3.7 Beam Copes and Weld Access Holes  5.3.8 Weld Access Hole Dimensions		EQ	D1.1 – Fig. 5.2 and W59 Fig. 5.1 are identical.

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<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
5.17.2 Group 4 and 5 Shapes	5.3.9 Group 4 and 5 Shapes		EQ	These shapes are heavy rolled or built-up shapes.
5.18 Temporary and Tack Welds	5.4.7 Tack Welds 5.4.8 and 12.5.5 Temporary Welds		EQ	
5.19 Camber in Built-Up Members	11.4.13 and 12.4.13 Connection of Components of Built-Up Members		EQ	
5.20 Splices in Cyclically Loaded Structures	12.4.10 Splices in Compression Members  12.4.11 Splices in Tension Members		EQ	
5.21 Control of Distortion and Shrinkage	5.6 Control of Distortion and Shrinkage Stresses		EQ	

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<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
5.22 Tolerance of Joint Dimensions  5.23 Dimensional Tolerance of Welded Structural Members	5.8, 11.5.3, 12.5.3 Dimensional Tolerances		EQ	
5.24 Weld Profiles Fig. 5.4		Fig. 14 Acceptable and Unacceptable Weld Profiles (Clauses 9.10.3.2)	EQ	
5.25 Technique for Plug and Slot Welds	4.4.2 Plug and Slot Weld Details Appendix B Plug and Slot Welds		EQ	
5.26 Repairs	5.10 Corrections		EQ	
5.26.5 Welded Restoration of Base Metal with Mislocated Holes	No EQ		No EQ	

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<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
5.27 Peening	5.11 Peening		EQ	
5.28 Calking	No EQ		No EQ	
5.29 Arc Strike	5.14 Arc Strikes		EQ	
5.30 Weld Cleaning	5.13 Cleaning of Welds		EQ	
5.31 Weld Tabs	11.5 and 12.5 Workmanship		EQ	
6 Inspection  Part A General Requirements  6.1 Scope	7 Welding Inspection    7.1 General		EQ	
6.2 Inspection of Materials	7.2 Inspection of Materials		EQ	

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## COMPARATIVE REVIEW OF AWS D1.1, CSA W59 & W47.1

<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
6.3 Inspection of WPSs and Equipment (See Annex IV and Appendix E)		CWB certified companies adhere to W47.1 certification requirements  10 Welding Procedure Specifications (WPS) (See Appendix D)  11 Welding Procedure Data Sheets (WPDS) (See Appendix C)		CSA W47.1 shows WPS and WPDS in separate formats.  D1.1 – WPS covers WPS and WPDS.
Part B Contractor Responsibilities	3.1.1 Contractor  7.3 Obligation of Contractor		EQ	
Part C Acceptance Criteria  6.9 Visual Inspection	11.5.4.1 12.5.4.1		EQ	
6.10 Liquid Penetrant and MPT PT and MT	7.4.4 7.4.5		EQ	

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## COMPARATIVE REVIEW OF AWS D1.1, CSA W59 & W47.1

<b>AWS D1.1:2004 Structural Welding Code - Steel</b>	<b>CSA W59-03 Welded Steel Construction (Metal Arc Welding)</b>	<b>CSA W47.1-03 Certification of Companies for Fusion Welding of Steel</b>	<b>Identical (ID) or Equivalent (EQ)</b>	<b>Remarks</b>
<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
6.11 Non Destructive Testing	7.4		EQ	
6.12 Radiographic Inspection  Figs. 6.1 to 6.6	8.1 Radiographic Examination of Welds	Tables 14 to 16	EQ	<u>D1.1:</u> Shows more figures Reference Images
6.13 Ultrasonic Inspection	8.2 Ultrasonic Inspection of Groove Welds		EQ	
PART D Non Destructive Testing Procedure				
PART E Radiographic of Testing	8.1		EQ	D1.1 shows more detail figures.
PART F Ultrasonic Testing of Groove Welds	8.2			

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<b>Clause No.</b>	<b>Clause No.</b>	<b>Clause No.</b>		
7 Stud Welding  Annex IX Manufacturers' Stud Base Qualification Requirements	5.5.6 Stud Welding  Appendix H Material Requirements for Stud and Stud Base Qualification Requirements		EQ	
8 Strengthening and Repairing Existing Structures	9 Strengthening and Repair of Existing Structures		EQ	
ANNEXES I to XII Mandatory Information  ANNEXES A to O Non-mandatory Information	APPENDICES A to R Non-mandatory Information except Appendix H which is mandatory	APPENDICES A to E Non-mandatory Information		The AWS D1.1, CSA W59 and CSA W47.1 contain information to assist users to these Standards.

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