

Contents	Page
1 Introduction.....	1
2 Scope and purpose	1
3 Definitions.....	2
4 Design philosophy	5
4.1 General criteria	5
4.2 Properties of hydrogen	6
4.3 Metallic materials.....	7
4.4 Compatibility with nonmetallic materials.....	12
4.5 Piping systems	14
4.6 Hazard analysis and risk assessment.....	17
4.7 Site selection	20
5 Piping, valves, and equipment	20
5.1 General criteria	20
5.2 Material selection criteria.....	20
5.3 Electrical hazardous area requirements.....	20
5.4 Piping.....	21
5.5 Valves.....	22
5.6 Other equipment.....	26
6 Cleaning	27
6.1 General requirements.....	27
6.2 Postinstallation cleaning.....	28
7 Construction	31
7.1 General criteria	31
7.2 Specification and manufacture of line pipe material.....	32
7.3 Construction plan.....	32
7.4 Pipe fabrication and welding.....	32
7.5 Assembly and installation.....	33
7.6 Inspection and examination.....	35
7.7 Nondestructive testing.....	36
7.8 Documentation	37
8 Design and construction of stations	37
8.1 Function.....	37
8.2 Design brief	37
8.3 Control station elements.....	38
8.4 Standards and design codes.....	39
8.5 Materials and fabrication	39
8.6 Access limitation.....	39
8.7 Location.....	40
8.8 Grounding.....	40
8.9 Installation	40
8.10 Pressure and leak testing.....	40
8.11 Commissioning.....	40
8.12 Operation.....	42
8.13 Filters/screens	42
9 Operation and monitoring.....	42
9.1 Operation and maintenance manual	42
9.2 Management systems	42
9.3 General safety requirements.....	43
9.4 Personnel for operation and maintenance	43
9.5 Welding and cutting.....	43

9.6	Shutdown, repair, and startup of pipelines	44
9.7	Hot-tapping hydrogen pipelines.....	44
9.8	Venting and pressure relief.....	46
9.9	Commissioning pipelines and stations	46
9.10	Operation and monitoring	47
9.11	Information to third parties, work adjacent to pipelines, and update of documents.....	47
9.12	Specialized surveys.....	48
9.13	Damage to the pipeline system	48
10	General protective measures	49
10.1	Emergency response plan.....	49
10.2	Accident and damage report	50
10.3	Safety management system.....	50

Tables

Table 1—	Minimum acceptable absorption energies for different sizes of Charpy V notch specimens.....	11
Table 2—	Maximum temperatures for various plastic materials in hydrogen service	13
Table 3—	Chemical resistance of elastomers to hydrogen.....	13
Table 4—	Permeation of hydrogen through elastomers	14
Table 5—	Damage criteria for thermal radiation	19
Table 6—	Types of pipeline cleaning pigs	28

Appendices

Appendix A—	Typical arrangements for pipelines systems	53
Appendix B—	Embrittlement and environmental damage mechanisms involving hydrogen and applicable test methods (Informative)	54
Appendix C—	Table of nominal alloy compositions and ranges	58
Appendix D—	Metallurgical factors affecting hydrogen toughness and brittle fracture mechanisms (Informative).....	61
Appendix E—	Table of typical safety distances for hydrogen control and isolating/metering stations (Informative)	65
Appendix F—	Example of preventive maintenance program for hydrogen pipelines (Informative)	66
Appendix G—	Composition criteria for hydrogen and mixtures (Normative)	67
Appendix H—	Requalification of existing pipelines for hydrogen service (Normative).....	68
Appendix I—	Ultra high purity hydrogen pipelines (Informative).....	73
Appendix J—	Examples of risk criteria applicable in The Netherlands and in the United Kingdom (Informative)	74
Appendix K—	References (Informative).....	75

Appendices figures

Figure A1—	Typical transmission and distribution piping systems	53
Figure A2—	Basic components of process control	53
Figure G1—	Classification of gas mixtures containing hydrogen and/or carbon monoxide.....	67
Figure J1—	Examples of risk criteria	74