

DIN EN 16602-70-15:2022-02 (E)

Space product assurance - Non-destructive testing; English version EN 16602-70-15:2021

Contents

Page

European Foreword	8
Introduction	9
1 Scope	10
2 Normative references	11
3 Terms, definitions and abbreviated terms	14
3.1 Terms from other standards.....	14
3.2 Terms specific to the present standard	14
3.3 Abbreviated terms and symbols.....	16
3.4 Nomenclature	17
3.4.1 Formal verbs.....	17
3.4.2 Conventions.....	18
4 Principles	19
5 Generic requirements	20
5.1 General.....	20
5.2 Discontinuities and cracks	22
5.3 NDT drawing callouts.....	22
5.4 NDT process and configuration control.....	22
5.5 NDT procedure capability demonstration.....	23
5.6 Organizational guidelines and documentation requirement.....	24
5.7 NDT personnel qualification and certification	24
6 NDT methods	25
6.1 Visual testing	25
6.1.1 Overview.....	25
6.1.1.1 General process for visual testing.....	25
6.1.1.2 Visual testing process variations.....	25
6.1.2 General visual testing requirements.....	25
6.1.3 Visual testing equipment.....	26
6.1.3.1 Overview.....	26
6.1.3.2 Requirements for visual testing equipment.....	26
6.1.4 Visual testing application.....	26

6.1.5	Visual testing documentation	27
6.1.6	Visual testing process control.....	27
6.1.7	Visual testing process limitations and peculiarities	27
6.2	Leak testing	28
6.2.1	Overview.....	28
6.2.1.1	General process for leak testing	28
6.2.1.2	Leak testing process variations.....	28
6.2.2	General leak test requirements	29
6.2.3	Process application	29
6.2.3.1	Leak test procedure.....	29
6.2.3.2	Leak test documentation	30
6.3	Penetrant testing	30
6.3.1	Overview.....	30
6.3.1.1	General process for penetrant testing.....	30
6.3.1.2	Penetrant testing process variations.....	30
6.3.2	General penetrant testing requirements	31
6.3.3	Penetrant testing equipment	32
6.3.3.1	Overview.....	32
6.3.3.2	Requirements for penetrant testing equipment.....	32
6.3.4	Penetrant testing process application.....	32
6.3.5	Penetrant testing documentation.....	34
6.3.6	Penetrant testing process control.....	34
6.3.7	Penetrant testing process limitations and peculiarities	34
6.3.7.1	Overview.....	34
6.3.7.2	Etching requirements	35
6.3.8	Standard penetrant fracture control NDT.....	35
6.3.8.1	Overview.....	35
6.3.8.2	Standard fracture control NDT requirements	36
6.4	Eddy-current testing.....	36
6.4.1	Overview.....	36
6.4.1.1	General process for eddy-current testing.....	36
6.4.1.2	Eddy-current process limitations and peculiarities	37
6.4.2	Eddy-current testing general requirements.....	37
6.4.3	Eddy current testing process variations.....	38
6.4.4	Eddy current equipment	38
6.4.4.1	General.....	38
6.4.4.2	Instruments for the eddy-current testing	38
6.4.4.3	Probes for the eddy-current testing	38
6.4.4.4	Test-setup for the eddy current testing	38
6.4.5	Eddy-current testing process application.....	39
6.4.6	Eddy current testing documentation	39
6.4.7	Eddy current testing process control	39
6.4.7.1	Overview.....	39
6.4.7.2	Reference material blocks for the eddy-current testing	39
6.4.8	Standard eddy-current fracture control NDT	40

6.4.8.1	Overview.....	40
6.4.8.2	Standard eddy current testing requirements.....	40
6.5	Magnetic particle testing.....	41
6.5.1	Overview.....	41
6.5.1.1	General magnetic particle testing process.....	41
6.5.1.2	Magnetic particle testing process variations.....	41
6.5.2	General magnetic particle testing requirements.....	42
6.5.3	Magnetic particle testing equipment.....	42
6.5.3.1	General.....	42
6.5.3.2	Dry particles.....	42
6.5.3.3	Wet particles.....	42
6.5.3.4	Fluorescent particles.....	43
6.5.4	Magnetic particle testing process application.....	43
6.5.5	MT documentation.....	44
6.5.6	MT process control.....	44
6.5.7	MT process limitations and peculiarities.....	44
6.5.8	Standard magnetic particle fracture control NDT.....	44
6.5.8.1	Overview.....	44
6.5.8.2	Standard magnetic particle NDT requirements.....	45
6.6	X-ray radiographic testing.....	45
6.6.1	Overview.....	45
6.6.1.1	General process.....	45
6.6.1.2	X-ray radiographic testing process variations.....	45
6.6.2	General X-ray radiographic testing requirements.....	46
6.6.3	X-ray radiographic equipment.....	46
6.6.4	X-ray radiographic testing process application.....	46
6.6.5	X-ray radiographic testing documentation.....	47
6.6.6	X-ray radiographic testing process control.....	47
6.6.7	Standard X-ray radiographic fracture control NDT.....	47
6.6.7.1	Overview.....	47
6.6.7.2	X-ray radiographic testing requirements.....	47
6.7	Ultrasonic testing.....	48
6.7.1	Overview.....	48
6.7.1.1	General process for ultrasonic testing.....	48
6.7.1.2	Ultrasonic testing process variations.....	48
6.7.2	General.....	52
6.7.3	Ultrasonic testing equipment.....	52
6.7.3.1	General requirements.....	52
6.7.3.2	Couplants.....	52
6.7.3.3	Search units.....	53
6.7.4	Ultrasonic testing process application.....	53
6.7.4.1	General.....	53
6.7.4.2	Scanning.....	53
6.7.4.3	Scanning index.....	53
6.7.4.4	Qualification.....	54
6.7.4.5	Ultrasonic test documentation.....	54

6.7.5	Ultrasonic testing process control.....	54
6.7.5.1	Ultrasonic testing calibration sensitivity and limitations	54
6.7.5.2	Ultrasonic thickness gauge	55
6.7.5.3	Digital ultrasonic thickness gauge.....	55
6.7.5.4	Reference blocks.....	55
6.7.6	Ultrasonic testing process limitations and peculiarities	56
6.7.6.1	Overview.....	56
6.7.7	Standard ultrasonic fracture control NDT	57
6.7.7.1	Overview.....	57
6.7.7.2	Standard ultrasonic testing requirements.....	57
6.8	Proof testing	58
6.8.1	Overview	58
6.8.2	Proof testing requirements	58
7	Non-destructive testing of welds	59
8	Non-destructive testing of products	60
8.1	Overview	60
8.2	General.....	60
8.3	Wrought products	61
8.3.1	Overview	61
8.3.2	Raw material testing.....	61
8.3.3	Common wrought discontinuities.....	62
8.4	Forgings	62
8.4.1	Overview	62
8.4.2	Raw material testing.....	62
8.4.3	Common forging discontinuities	63
8.5	Castings	63
8.5.1	Overview.....	63
8.5.2	Raw material testing.....	63
8.5.2.1	General.....	63
8.5.2.2	Penetrant testing of castings.....	63
8.5.2.3	Ultrasonic testing of castings	64
8.5.2.4	X-ray radiographic testing of castings	64
8.5.2.5	X-Ray computed tomographic (CT) of castings	64
8.5.2.6	Common casting discontinuities.....	64
8.6	Laminated composite materials	65
8.6.1	Overview	65
8.6.2	Raw material testing.....	65
8.6.2.1	Overview.....	65
8.6.2.2	Testing of intermediate products	66
8.6.3	Inspection techniques for composites.....	66
8.6.3.1	General.....	66
8.6.3.2	X-Ray Radiographic testing of composites	66
8.6.3.3	X-ray Computed Tomographic (CT) Inspection of Composites	66
8.6.3.4	Guided In-Plane Wave Inspection of Composites	67

8.6.3.5	Ultrasonic C-Scan and Phased Array (PAUT) of Composites	67
8.6.3.6	Common discontinuities of Composites	67
8.6.4	NDT for joining dissimilar materials	68
8.6.4.1	Overview.....	68
8.6.4.2	Steps for specifying NDT for difficult features	68
8.6.4.3	NDT Coupled with Destructive Testing as Quality Control	69
9	Non-destructive testing of PFCI	70
9.1	General.....	70
9.1.1	Overview	70
9.1.2	General requirements	71
9.1.3	Capability demonstration.....	72
9.1.4	Testing of raw material.....	72
9.1.5	Testing of safe life finished parts	73
9.2	Non-destructive testing of metallic materials	73
9.2.1	General requirements	73
9.2.2	NDT categories versus initial crack size	74
9.2.2.1	Standard fracture control NDT	74
9.2.2.2	Special fracture control NDT	79
9.2.2.3	Crack screening proof test	81
9.2.3	Inspection procedure requirements for Standard fracture control NDT ..	81
9.2.3.1	Overview.....	81
9.2.3.2	Requirements	81
9.3	NDT for composites, bonded and sandwich parts.....	82
9.3.1	Overview	82
9.3.2	Testing requirements	82
9.3.2.1	General requirements.....	82
9.3.2.2	Close visual testing	82
9.3.2.3	NDT methods other than close visual testing.....	82
Annex A	(normative) NDT plan - DRD	84
A.1	DRD identification	84
A.2	Expected response	84
Annex B	(normative) NDT report - DRD	86
B.1	DRD identification	86
B.2	Expected response	86
Annex C	(normative) NDT procedure - DRD.....	91
C.1	DRD identification	91
C.2	Expected response	91
Annex D	(normative) Eddy-current testing instruction - DRD	92
D.1	DRD identification	92
D.2	Expected response	92

Annex E (informative) Catalogue of potential discontinuities.....	93
Annex F (informative) Example for POD evaluation , software and documentation.....	95
F.1 Theory	95
F.2 POD demonstration	96
Annex G (informative) Complementary material information.....	99
G.1 Overview	99
G.2 Forgings and rolled products	99
G.3 Castings	101
G.4 Composite products.....	101
G.5 Ceramics	103
Bibliography.....	104

Figures

Figure 4-1: Flow chart showing steps to be taken for a part and choice of NDT method and technique	19
Figure 6-1: A-Scan, typical display of ultrasonic signals	49
Figure 6-2: B-Scan, typical display of ultrasonic signals	50
Figure 6-3: C-Scan, typical display of ultrasonic signals	50
Figure 6-4: S-Scan, typical display of ultrasonic signals	51
Figure 9-1: Initial crack geometries for parts without holes	77
Figure 9-2: Initial crack geometries for parts with holes	78
Figure 9-3: Initial crack geometries for cylindrical parts	78

Tables

Table 6-1: Examples of acceptance limits leak test rates.....	29
Table 8-1: Thickness differences between sheet and plate	61
Table 9-1: Initial crack size summary, Standard fracture control NDT.....	75