DIN EN 14824:2005-10 (E)

Space engineering - Testing; English version EN 14824:2003

Contents

Page

Foreword 6

1 Scope 7

2 Normative references 7

3 Terms, definitions and abbrevitated terms 8
3.1 Terms and definitions 8
3.2 Abbreviated terms 12

4 General requirements 15
4.1 Testing philosophy 15
4.2 Model philosophy 16
4.3 Development testing 17
4.4 Qualification testing 17
4.5 Acceptance testing 18
4.6 Protoflight testing 18
4.7 Retesting 19
4.8 Test conditions and tolerances 20
4.9 Operations validation testing 25
4.10 Test data 30
4.11 Test documentation 30

5 Qualification testing 32
5.1 Equipment test requirements 32
5.2 Subsystem test requirements 72
5.3 Element test requirements 73
5.4 System qualification test 91

6 Acceptance testing 91
6.1 Equipment test requirements 91
6.2 Subsystem test requirements 102
6.3 Element test requirements 103
6.4 System test requirements 108

7 Protoflight testing 108
7.1 Equipment test requirements 108
7.2 Subsystem test requirements 109
7.3 Element test requirements 109
7.4 System test requirements 110

8 Pre-launch testing 110
8.1 General 110
8.2 Functional tests 111
8.3 Propulsion tests 111
8.4 Integrated launch system test 111
8.5 Manned related tests 111

9 In-orbit testing 112

10 Post-landing testing 113

Annex A (informative) Mechanical and vibration testing for space equipment 114
A.1 Derivation of qualification test levels for units from mechanical test data analysis 114
A.1.1 Introduction 114
A.1.2 Unit level random testing 116
A.1.3 Unit level sinusoidal testing 117
A.1.4 References 117
A.2 Vibration test philosophy 117

A.3 Technical information on mechanical test factors **119**
A.3.1 Introduction **119**
A.3.2 References **119**
A.3.3 Loads **120**
A.3.4 Margin of safety **120**
A.4 Microgravity environment compatibility (MEC) **120**
A.4.1 Introduction **120**
A.4.2 Disturbance source definition **121**
A.4.3 MEC control approach **121**

Annex B (informative) **Temperature limits and test levels for space equipment** **124**
B.1 Introduction **124**
B.2 References **124**
B.3 Influence of equipment temperature limits on thermal design **124**
B.4 Verification by analysis concerning accuracy and level of confidence **125**
B.4.1 General philosophy of uncertainty application **125**
B.4.2 Temperature uncertainty determination **127**
B.4.3 Quantification of uncertainty values **129**
B.4.4 Test correlation criteria **130**
B.5 Standardization of equipment temperature limits **131**
B.5.1 Evaluation and classification of equipment data **131**
B.5.2 Standardization approach **131**
B.6 Standardization of thermal vacuum and cycling test conditions **132**
B.6.1 Evaluation of test requirements **132**
B.6.2 Standardization approach **132**
B.7 Conclusions **136**

Annex C (normative) **Test requirement specification - DRD** **138**
C.1 Introduction **138**
C.2 Scope and applicability **138**
C.2.1 Scope **138**
C.2.2 Applicability **138**
C.3 References **138**
C.3.1 Glossary and dictionary **138**
C.3.2 Source document **138**
C.4 Terms and definitions and abbreviations **138**
C.4.1 Terms and definitions **138**
C.4.2 Abbreviations **138**
C.5 Description and purpose **139**
C.6 Application and interrelationship **139**
C.7 Test requirement specification preliminary elements **139**
C.7.1 Title139
C.7.2 Title page **139**
C.7.3 Contents list **139**
C.7.4 Foreword **139**
C.7.5 Introduction **140**
C.8 Content **140**
C.8.1 Scope and applicability **140**
C.8.2 References **140**
C.8.3 Definitions and abbreviations **141**
C.8.4 General test conditions and requirements **141**
C.8.5 Qualification testing **141**
C.8.6 Acceptance testing **142**
C.8.7 Protoflight testing **142**
C.8.8 Re-testing methodology **142**
C.8.9 GSE testing **142**

Bibliography **143**

Figures

Figure 1 — Equipment qualification test sequence 36

Figure 2 —Shock spectrum equipment qualification 53
Figure 3 — Equipment thermal vacuum test arrangement 55
Figure 4 — Equipment thermal vacuum test sequence 57
Figure 5 — Equipment thermal test arrangement with surface temperature control 60
Figure 6 — Equipment thermal test arrangement with direct temperature control 61
Figure 7 — Equipment thermal test arrangement for forced air cooling (internal or surface cooled unit method) 62
Figure 8 — Accelerated thermal cycling test set-up 64
Figure 9 — Equipment thermal cycling test sequence 65
Figure 10 — Equipment thermal vacuum cycling test sequence 67
Figure 11 — Example of schematic vacuum temperature cycling test sequence 84
Figure 12 — Equipment acceptance test sequence 95
Figure A.1 — Data processing arrangement 115
Figure A.2 — Qualification and acceptance vibration test curves (QAVT/AVT) 118
Figure A.3 — Example of a calculated test level for zone “pallet hardpoints” plus QAVT (Spacelab) 119
Figure B.1 — Temperature limits and margins definitions 125
Figure B.2 — Typical progression of uncertainty in spacecraft programmes 128
Figure B.3 — Example of a typical temperature profile for unit level thermal cycling 135
Figure B.4 — Percent fall-out vs. number of cycles increased for unit level screening 136

Tables

Table 1 — Qualification test levels and durations 21
Table 2 — Acceptance test levels and durations 22
Table 3 — Maximum allowable test tolerances 23
Table 4 — Maximum allowable test tolerances *(continued)* 24
Table 5 — Examples of ground segment validation tests 28
Table 6 — Equipment qualification test baseline 34
Table 7 — Resonance search test levels 45
Table 8 — Sinusoidal qualification test levels for equipment with first frequency > 100 Hz and mass ≤ 50 kg 45
Table 9 — Sinusoidal qualification test levels for equipment with first frequency > 100 Hz and mass > 50 kg 45
Table 10 — Random vibration test levels 47
Table 11 — Random vibration test levels and duration for equipment with mass M ≤ 50kg 48
Table 12 — Random vibration test levels and duration for equipment with mass M >50kg 48

Table 13 — Additional random vibration for AVM 49
Table 14 — Acoustic qualification test level and duration 51
Table 15 — Key and symbols for figures 4,9 and 10.....58
Table 16 — Thermal vacuum test parameters (qualification).....59
Table 17 — Thermal cycling test parameters (qualification) 65
Table 18 — Space vehicle qualification test baseline 75
Table 19 — Tolerances for physical properties 83
Table 20 — Equipment acceptance test baseline 93
Table 21 — AVT spectrum 97
Table 22 — Acoustic acceptance test level and duration.....98
Table 23 — Thermal cycling test parameters (acceptance).....101
Table 24 — Space vehicle acceptance test baseline 103
Table A.1 — QAVT and AVT levels.....118
Table B.1 — Example of typical parameter uncertainties for 1,6 s (90 %) value 130
Table B.2 — Nominal temp. limits for various space vehicle equipment.....133
Table B.3 — Equipment thermal test matrix.....134