

ISO 17546:2024-02 (E)

Space systems - Lithium ion battery for space vehicles - Design and verification requirements

Contents		Page
Foreword		vi
Introduction		vii
1	Scope	1
2	Normative references	1
3	Terms and definitions	1
4	Symbols and abbreviated terms	6
5	Cell	6
5.1	Performance	6
5.1.1	General	6
5.1.2	Test requirements	7
5.1.3	Test data trending [4]	7
5.1.4	Cell qualification test	8
5.1.5	Leakage (hermetic) test	8
5.1.6	Safety tests	8
5.1.7	Thermal/thermal vacuum test [5]	8
5.1.8	Mechanical environmental test	8
5.1.9	Radiation test	9
5.1.10	Life cycle test	9
5.1.11	Models for analysis	10
5.2	Safety	10
5.2.1	General	10
5.2.2	Hazard description	10
5.2.3	Protective devices as a hazard control	10
5.2.4	Safety testing	11
5.2.5	Important test considerations	12
5.2.6	Optional test	13
5.3	Logistics	13
5.3.1	General	13
5.3.2	Cell manufacturing, storage and testing	14
5.3.3	Safety measure for handling	14
5.3.4	Cell transportation	15
5.4	COTS cells for space use	15
5.4.1	General	15
5.4.2	Safety requirements	15
5.4.3	Lot integrity assessment	15
5.4.4	Mission conformance test	15
5.4.5	Charge and discharge test	15
5.4.6	Thermal vacuum test	16
5.4.7	Mechanical environment test	16
5.4.8	Cycle life test	16
5.4.9	Storage life test	16
6	Battery	16
6.1	Performance	16
6.1.1	General	16
6.1.2	C/n charge or discharge current (c-rate)[4][5][6]	16

6.1.3	Cut-off voltage	16
6.1.4	Cycle	17
6.1.5	Depth of discharge (DOD)[4][5][6][13]	17
6.1.6	End of charge voltage	17
6.1.7	Energy	17
6.1.8	Energy density	17
6.1.9	Energy reserve [4][5]	18
6.1.10	Fully charged [9][13]	18
6.1.11	Nameplate capacity	18
6.1.12	Nominal capacity	18
6.1.13	Nameplate energy [5][12]	18
6.1.14	Nominal voltage [9]	18
6.1.15	State of charge	18
6.1.16	Standard method for capacity measurement	19
6.1.17	Battery internal resistance (ohmic)	19
6.1.18	Battery impedance	19
6.1.19	Life test demonstration	19
6.1.20	For GEO simulated	20
6.1.21	For LEO simulated	20
6.1.22	For launch vehicle: simulate ground storage and usage at launch phase	20
6.1.23	Battery general requirements [5][11]	20
6.1.24	Electrical design	21
6.1.25	Thermal design	21
6.1.26	Mechanical design	21
6.1.27	Cell-to-cell balancing mechanisms	21
6.1.28	Marking	21
6.1.29	Cell matching	21
6.1.30	Polarization testing (optional)	21
6.1.31	Self-discharge rate test	22
6.1.32	Tailoring screening tests	22
6.1.33	Cell matching criteria	22
6.1.34	Contamination control	23
6.1.35	Test data trending [4]	23
6.1.36	Flight verification acceptance testing [5]	23
6.1.37	Assurance of the life estimation [8]	23
6.1.38	Parameter measurement tolerances	23
6.1.39	Battery testing [5][15]	24
6.1.40	Development testing [4][15]	24
6.1.41	Charge control testing	24
6.1.42	Thermal control testing	24
6.1.43	Mechanical test	25
6.1.44	Qualification test [4]	25
6.1.45	Qualification test levels and duration	25
6.1.46	In-process inspections and tests	25
6.1.47	Data collection and acquisition rates	25
6.2	Safety	26
6.2.1	General	26
6.2.2	Definitions of dangerous phenomenon	27
6.2.3	Technical requirement	27
6.2.4	Fault tolerance	27
6.2.5	Hazard controls [5]	28
6.2.6	Over-current prevention	28
6.2.7	Over-voltage protection	28
6.2.8	Temperature/current management	28
6.2.9	Insulation and wiring	28
6.2.10	Positive protection against accidental shorting	29
6.2.11	Venting	29
6.2.12	Crew touch temperature requirements	29
6.2.13	Terminal contacts	29
6.2.14	Safety testing	29
6.2.15	Important test considerations	30
6.2.16	Thermal runaway propagation	31

6.2.17	Special provision	31
6.2.18	Description for necessary information for system safety review	31
6.3	Logistics	32
6.3.1	General	32
6.3.2	Manufacture/assembly storage and testing	32
6.3.3	Safety measure for handling	33
6.3.4	Transportation	33
7	Battery onboard space vehicle	33
7.1	Performance	33
7.1.1	General	33
7.1.2	Basic design	34
7.1.3	Electrical ground bonding	34
7.1.4	Temperature reference point of battery module	34
7.1.5	Preparation for handling, transportation	34
7.2	Safety	35
7.2.1	General	35
7.2.2	Definitions of dangerous phenomenon	35
7.2.3	Technical requirement	35
7.3	Logistics	35
7.3.1	General	35
7.3.2	Safety measure for handling	35
7.3.3	Integration to the space vehicle	36
7.3.4	Battery maintenance on the space vehicle	36
7.3.5	Battery transportation equipped in space vehicle	36
8	Launch site	37
8.1	General	37
8.2	Performance	37
8.3	Safety	37
8.4	Logistics	38
8.4.1	General	38
8.4.2	Safety measure for handling	38
8.4.3	Preparation for transportation	38
8.4.4	SOC level for transportation	38
8.4.5	Container for transportation	38
8.4.6	Battery testing (health checking after transportation)	38
8.4.7	Inspection	39
8.4.8	State of health verification	39
8.4.9	Battery storage at launch site	39
8.4.10	Self-discharge rate	39
8.4.11	Protection under integration	40
8.4.12	Handling plate	40
8.4.13	Electrical connection	40
8.4.14	Electrical checkout	40
8.4.15	Battery monitoring	40
8.4.16	Battery monitoring preceding launch	40
9	Mission in orbit and end of life	40
Annex A (informative) Parameter measurement tolerances		42
Annex B (informative) Example of cell qualification test		43
Annex C (informative) Hazard identification method		45
Annex D (normative) Safety measure for handling		47
Annex E (informative) Transportation		49
Annex F (informative) Lot assessment of COTS cells		53
Bibliography		55