

# ISO 17546:2024-02 (E)

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

---

<b>Contents</b>		<b>Page</b>
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