
Generic Requirements for Below-Ground Flywheel Energy Storage Systems

Contents

Preface	Preface-1
1. Introduction	1-1
1.1 Purpose and Scope	1-1
1.2 Structure and Use of This Document	1-2
1.3 Requirements Terminology	1-2
1.4 Requirement Labeling Conventions	1-3
1.4.1 Numbering of Requirement and Related Objects	1-3
1.4.2 Requirement, Conditional Requirement, and Objective Object Identification	1-4
1.5 Referenced Requirements	1-4
1.6 FESS Nomenclature	1-4
2. Design Considerations	2-1
2.1 Powering Architectures	2-1
2.2 FESS Power Processing Alternatives	2-3
2.3 Monitoring	2-4
3. General Functional and Performance Requirements	3-1
3.1 General Safety	3-1
3.1.1 Code Compliance	3-1
3.1.2 Grounding	3-1
3.1.3 Frame Current	3-1
3.1.4 Rapid Disconnect	3-2
3.1.5 Protection and Hazards	3-2
3.2 Electrical Hazards	3-2
3.2.1 Electrostatic Discharge (ESD)	3-3
3.2.2 Electromagnetic Interference (EMI)	3-3
3.2.3 Lightning and AC Power Fault	3-3
3.2.4 Miscellaneous	3-3
3.3 Power Backup	3-4
3.3.1 Power Interruption and Restoration	3-4
3.3.2 Transfer Time	3-4
3.3.3 Recoverable Energy	3-4
3.3.4 Recharging	3-6
3.4 Overspeed Prevention	3-6
3.5 Diagnostics and Alarms	3-7
3.5.1 Test Points and Indicators	3-7

3.5.2	Vacuum Monitoring	3-8
3.5.3	Excess Vibration	3-8
3.6	Reliability	3-9
3.6.1	Duty-Cycle	3-10
3.7	Spatial and Weight Requirements	3-11
3.8	Surface and Appearance Criteria	3-12
3.9	Acoustic Noise	3-12
3.10	Toxic Materials	3-13
3.11	Nameplate Ratings	3-13
4.	Electrical	4-1
4.1	Input Requirements	4-1
4.1.1	Off-Line Power Processing (AC Input)	4-1
4.1.1.1	Inrush Current	4-1
4.1.1.2	Power Factor	4-1
4.1.1.3	Input Protection	4-1
4.1.1.4	Input/Output Disconnect	4-1
4.1.1.5	Low Input AC Voltage Protection	4-2
4.1.2	On-Line Power Processing (DC Input)	4-2
4.1.2.1	Inrush Current	4-2
4.1.2.2	Input Protection	4-3
4.1.2.3	Input/Output Disconnect	4-3
4.2	Output Requirements	4-3
4.2.1	-48 VDC Output	4-3
4.2.2	Current Sharing	4-4
4.2.3	Overload	4-4
4.2.4	High Voltage Output Shutdown	4-4
4.2.5	Dynamic Response	4-4
4.3	Isolation	4-4
5.	Environmental and Mechanical	5-1
5.1	Environmental	5-1
5.1.1	Temperature and Humidity Criteria	5-1
5.1.2	Altitude Criteria	5-2
5.1.3	Heat Dissipation	5-3
5.1.4	Fire Resistance	5-3
5.1.5	Weather-Related Exposure	5-4
5.1.6	Miscellaneous Exposure or Hazards	5-4
5.2	Shock and Vibration	5-5
5.2.1	Transportation Vibration	5-5
5.2.2	Equipment Handling	5-5
5.2.3	Low Level Vibration	5-5
5.2.4	Earthquake Performance	5-6
5.3	Critical Vibrations (Resonant Speeds)	5-6
6.	System Failure and Containment/Safety	6-1

6.1	General	6-1
6.2	Fail-Safe Design	6-1
6.3	Alarms	6-2
6.4	Containment Analysis and Evaluation	6-2
6.5	Crash Testing	6-3
7.	Installation	7-1
7.1	General	7-1
7.2	Future Growth	7-2
7.3	Installation Details	7-3
7.3.1	Lifting Details	7-3
7.3.2	Stability	7-3
7.3.3	Intra-system and Inter-system Cabling	7-3
7.4	Maintenance and Replacement	7-4
8.	Documentation and Packaging	8-1
8.1	Documentation	8-1
8.2	Marking, Packaging, and Shipping	8-1
References	References-1

List of Figures

Figure 1-1.	FESS Primary Unit Nomenclature	1-6
Figure 2-1.	Typical DLC, FTTC, or HFC Communications Network Using a Large FESS at Remote Site.....	2-2
Figure 2-2.	Possible FTTC, FTTH, or HFC Communications Network Using a Small FESS at Distributed End-Loop Locations	2-2
Figure 2-3.	Off-line Flywheel Energy Storage System (FESS)	2-3
Figure 2-4.	On-Line Flywheel Energy Storage System (FESS)	2-4
Figure 7-1.	Typical FESS Below-Ground Deployment for Large or Small Remote Applications	7-1