

ISO 14644-16:2019 (E)

Cleanrooms and associated controlled environments — Part 16: Energy efficiency in cleanrooms and separative devices

Contents

	Foreword
	Introduction
1	Scope
2	Normative references
3	Terms and definitions
3.1	General terms
3.2	Terms related to installation
3.3	Terms related to energy efficiency
3.5	Abbreviated terms
4	Energy reduction evaluation and implementation process
4.1	General
4.2	New or existing cleanrooms
4.3	Energy performance comparison
4.3.1	General
4.3.2	Compare energy performance
4.3.3	Determine the business case
4.3.4	Monitor and review
4.4	Existing cleanroom retrofit or renovation
4.5	Process for existing cleanrooms
4.5.1	Select project team
4.5.2	Review user requirements and project scope
4.5.3	Collate information on cleanroom performance criteria
4.6	Process for design/construction of new build or updating cleanrooms
4.6.1	Review user requirements and project scope
4.6.2	Undertake energy performance design review
4.7	Comparative review of cleanroom environmental performance
4.8	Identify energy reduction opportunities
4.9	Assess the impact of energy reduction opportunities
4.10	Select energy reduction opportunities for implementation
4.11	Implementation
4.12	Monitor, review and feedback
4.13	Decommissioning
5	Impact of user requirement specification (URS) on energy consumption
5.1	Principle
5.2	Garment levels
6	Airflow volume and compensating factors
6.1	Fresh air supply
6.2	Airflow volume rate
6.3	Source strength and airflow rate calculation for non-unidirectional rooms
6.3.1	Determining air volume flow rate
6.3.2	Ventilation effectiveness index
6.3.3	Compensation factors (Cf)
6.4	Flexible procedure for airflow rate estimation in non-UDAF rooms
6.4.1	General
6.4.2	Design stage
6.4.3	Testing stage

6.4.4	Operational stage
6.5	Air velocity reduction for unidirectional air flow systems.
7	Power management: turn-down, turn-off and recovery.
7.1	Turn-down
7.2	Turn-off
8	Adaptive control
9	Heating and cooling loads
10	Fan and filter selection
10.1	Air movement fans
10.2	Selection of air filters
11	Lighting levels
12	Training
13	Operation
14	Maintenance
15	Decommissioning
Annex A	(informative) Source strength: Air volume and worked example
A.1	Calculating air supply rate in non-unidirectional cleanrooms
A.2	Ventilation effectiveness
A.2.1	Ventilation effectiveness indexes
A.2.2	Air change effectiveness (ACE)
A.2.3	Contaminant removal effectiveness (CRE)
A.3	Emission rate of particles in cleanrooms
A.3.1	General
A.3.2	Emission rate of particles from personnel in a cleanroom
A.3.3	Emission rate of particles generated by equipment
A.4	Example of basic calculation for air supply rate in a non#unidirectional cleanroom
A.5	Calculations of airflow in unidirectional cleanrooms
Annex B	(informative) Energy saving opportunities
Annex C	(informative) Impact assessment
Annex D	(informative) Benchmarking: Energy performance indicators for cleanrooms
D.1	Metrics — General
D.2	Scope of metrics
D.3	Performance indicator metrics and baselines
D.4	Power intensity for contamination removal (PICR)
D.5	Fan energy intensity for contamination removal (EICR)
D.6	Energy intensity (EI)
Annex E	(informative) Useful measures to minimize excess heating and cooling losses or gains
E.1	Heating
E.2	Cooling
Annex F	(informative) Critical area reduction example