

Data Center Instrumentation: Operational Analytics, Monitoring & Energy Management

1. Lawrence Berkeley National Laboratory (LBNL)

Operational Data Analytics for Data Center Energy Management

A detailed case study describing how a large high-performance computing (HPC) facility collects, centralizes, and analyzes environmental, power, and equipment telemetry. The resource includes discussions of sensors, monitoring infrastructure, and operational analytics for improving data center performance and energy efficiency.

Resource:

[View Resource](#)

2. ASHRAE Thermal Guidelines for Data Processing Environments

Industry guidance covering facility temperature and humidity measurement, sensor placement strategies, environmental monitoring, and instrumentation practices within data centers.

Resource:

[View PDF](#)

Source:

[Lawrence Berkeley National Laboratory Data Centers Program](#)

3. Center of Expertise for Data Center Energy (DOE / LBNL)

A research and resource center providing tools, methodologies, and studies focused on data center monitoring, energy measurement, power chains, cooling systems, and operational performance analytics.

Resource:

[Visit Website](#)

4. The Green Grid – Library and Metrics Resources

Provides industry-standard measurement frameworks and sustainability metrics, including:

- Power Usage Effectiveness (PUE)
- Water Usage Effectiveness (WUE)
- IT Work Capacity
- Data Center Resource Effectiveness (DCRE)

These resources are particularly valuable when determining what operational parameters should be instrumented, monitored, and reported.

Resources:

- [The Green Grid Resources](#)
 - [Library and Tools](#)
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5. Uptime Institute Global Data Center Survey

Independent research examining data center operational practices, sustainability initiatives, predictive maintenance programs, infrastructure monitoring approaches, rack-density management, and performance measurement trends.

Resources:

- [2025 Annual Survey Report](#)
 - [Uptime Institute Research Center](#)
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Liquid Cooling, Water Systems & Flow Measurement

6. ASHRAE TC 9.9

Water-Cooled Servers: Common Designs, Components, and Processes

A technical white paper discussing:

- Coolant Distribution Units (CDUs)
- Water loop architectures
- Pressure management
- Filtration requirements
- Liquid cooling system design

Flow measurement is presented as a critical operational control parameter.

Resource:

[ASHRAE Water-Cooled Servers White Paper](#)

7. Open Compute Project (OCP)

Data Center Liquid Distribution Guidance & Reference Designs

Industry guidance for liquid-cooled data center environments, covering:

- Cooling-loop architectures
- Liquid distribution systems
- Temperature control methodologies
- Hydraulic balancing
- Facility water infrastructure

Flow metering is identified as a key instrumentation requirement throughout the cooling distribution network.

Resources:

- [OCP Liquid Distribution Guidance](#)
 - [Reference Design PDF](#)
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8. ANSI/ASHRAE Standard 41.8

Standard Methods for Liquid Flow Measurement

Provides standardized methodologies for measuring, validating, and evaluating liquid flow in engineered systems and facilities. This standard serves as a foundational reference for flowmeter selection and measurement accuracy.

Resource:

[ANSI/ASHRAE 41.8 Standard Information](#)

Telecommunications Infrastructure & Cabling Standards

9. BICSI 002

Data Center Design and Implementation Best Practices

One of the industry's leading standards for ICT and data center infrastructure. Topics include:

- Pathways and spaces
- Cable support systems
- Overhead tray design
- Cable routing
- Capacity planning
- Facility operations

Resource:

[BICSI Standards Overview](#)

10. TIA-569

Telecommunications Pathways and Spaces

A foundational telecommunications infrastructure standard addressing:

- Cable trays
- Conduits
- Raceways
- Telecommunications rooms
- Equipment spaces
- Pathway separation requirements
- Cable protection practices

Resources:

- [TIA-569 Primer](#)
 - [Reference Document](#)
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11. TIA-942**Data Center Telecommunications Infrastructure Standard**

The primary telecommunications infrastructure standard for data centers, covering:

- Data center topology
- Telecommunications spaces
- Cable routing strategies
- Structured cabling
- Redundancy planning
- Pathway architecture

Resources:

- [TIA-942 Infrastructure Overview](#)
 - [TIA-942 and BICSI 002 Comparison](#)
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12. USDA Installation of Telecommunications Cables in Federal Buildings

A practical government guidance document that references consensus standards and industry best practices for telecommunications cabling installations within federal facilities, including data centers.

Resource:

[USDA Telecommunications Cabling Guidance](#)