

Cooling the Data Center:

Design of a Mechanical Controls Owner Project Requirements (OPR) Template

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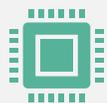
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Background



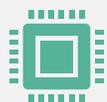
As supercomputers' performance increases, so does the energy loads and associated cost required to operate them



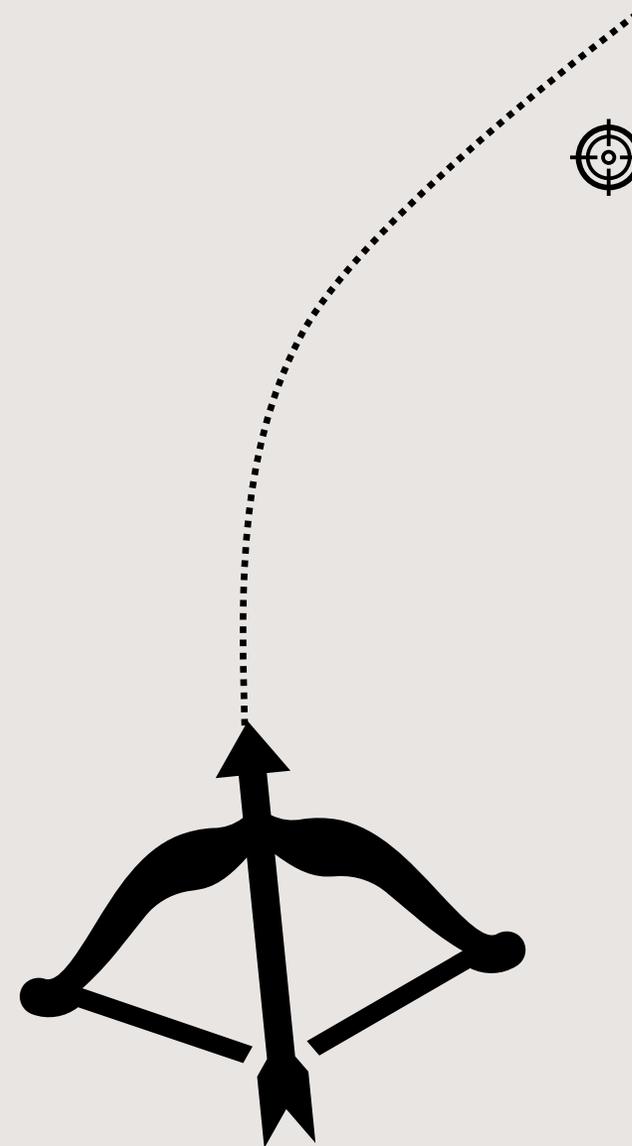
Data center cooling strategies must be designed concurrently with the design of the HPC systems for optimal heat removal



Interdisciplinary collaboration on the co-design of both compute and cooling of data centers resulted in significant improvements in energy efficiency



Appropriate monitoring and control of the cooling systems is key in achieving improved performance & energy efficiency



Case Studies – A gap emerges

With efficiency having to increase, hybrid cooling systems are becoming more prominent, and complexity comes with it

Eni Green Data Centre – Cooling Source selection and transition challenges

NCAR – Balance between automation and human control of cooling source selection and transition

ORNL – Load bank testing during commissioning STILL didn't find everything

Next gen systems for several national laboratories – how to stage equipment and how hard do you run things?

Balance between temperature stability and efficiency



Owner Project Requirements (OPR)

“written document that details the functional requirements of a project and the expectations of how it will be used and operated.”¹

- Essential component in the commissioning of buildings
- Structured approach to ensure what is considered important to the owner is properly addressed throughout all the project.
- Typically developed in the programming/pre-design phase of a project.
- Information is gathered from all stakeholders and users, compiled into the OPR document, and communicated to the designers to provide direction on the development of the project Basis-of-Design (BOD) and subsequent construction documents.
- It also establishes the foundation for objective acceptance criteria.

¹D. McFarlane, “Owner’s project requirements,” ASHRAE Journal, vol. 55, no. 8, pp. 32–38, 2013

Draft Owner’s Project Requirements

ASHRAE HEADQUARTERS
Atlanta, GA

Date: January 3, 2019
Approved By: [Signature]



OPR for Mechanical Controls

Given the complexity and unique requirements of HPC cooling systems, OPRs focused on HPC deployments are needed

Mechanical Controls OPRs

Primary stakeholders –

- Operations and facility managers responsible for mechanical infrastructure and associated cooling control systems

Primary users –

- Architects and engineers (A&E) who provide engineering and design services for HPC site mechanical cooling control systems
- Commissioning Providers for overarching acceptance criteria

Template Design Process

A EE HPC WG Team identified the need for improved specifications of the cooling controls and better integration of their design within the overall cooling design.

The integration is more successful if the specifications are organized as an OPR template and started the work on its design.

The Team held regular weekly meetings throughout the 2020-2021.

Starting with a sample OPR and using ASHRAE commissioning guidelines, the Team built the structure of the template and then proceeded with refining each component.

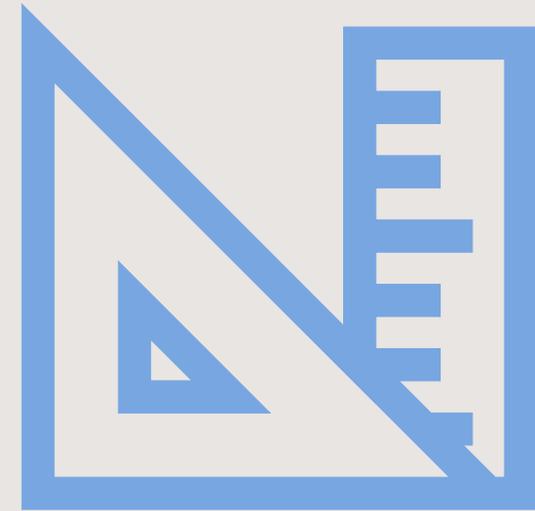
An initial draft was generated in Spring 2021 and shared with the Group. Feedback was collected through meetings as well as through a survey.

Refinements continue to be made.

Proposed OPR Template Structure

Suggested sections

1. Facility purpose and project goals
2. General project description and background
3. Objectives
4. Functional uses
5. Budget considerations and limitations
6. Performance criteria
7. Commissioning scope & participation
8. Long-term operations and maintenance



The OPR Template

The OPR Template is not an OPR

- The template is designed to be applicable to any HPC facility
- The template is intended to be a checklist of suggested topics and categories of content for developing project specific OPRs
- The template includes sample content and examples from past projects

The owner holds the pen for the OPR

- The commissioning provider in collaboration with the architects and engineers should help create and update the project-specific OPR
- The OPR informs the engineering & design team (i.e., A&E) on overall project goals and requirements for development of the Basis-of-Design
- The BOD is owned by the architects and engineers and must comply with the OPR



OPR Template Topics & Sample Content (1)

Sample Objectives

- Seamlessly integrate with existing building controls
 - HPC Systems
 - Existing Building Automation System (BAS)
 - Data Center Infrastructure Management (DCIM)
 - Electrical power monitoring systems (EPMS)
 - Network and sensors
- Execute existing and/or new sequences of operation
- Align with existing standards (e.g., asset naming, electrical and mechanical standards)



OPR Template Topics & Sample Content (2)

Sample Functional Uses

- Define controls systems availability, reliability, and maintainability requirements and how they relate to existing-to-remain control systems
- Enhance existing building controls if they are inadequate
- Establish acceptable new and existing-to-remain control products (hardware & software)
 - Not at their end of life and will not be obsolete in the near term
 - Not in beta testing, have been fully validated
 - Will be supported over the expected lifespan
- Define alarm escalation, nomenclature, and method of communication strategies
- Communications Protocols should be an open protocol such as Redfish and BACNET/SC.



OPR Template Topics & Sample Content (4)

Sample Performance Criteria

- Define the IT requirements for thermal envelope and/or water classification for the data center. This should reference any owner or industry standards, guidelines, or site-specific requirements.
- New systems must adhere to those operational practices already in place with existing infrastructure or be approved as exceptions
- Systems should have the same look and feel (graphical interfaces), and the data should be compatible for all operational data analytic purposes
- Security, including cyber security - The system designed and built shall incorporate best practices and standards for security. This includes the full-service life; from early design through end-of-life.
- Physical control to access to the hardware (e.g.-lockable panels, switches.)



OPR Template Topics & Sample Content (5)

Commissioning

- Commissioning scope needs to be included in the controls sys design
- The Commissioning Provider (CxP) will perform design reviews of the BOD and construction documents
- The CxP will perform routine construction progress inspections to verify construction “means and methods”, and compliance with the CDs
- The CxP will verify 100% point-to-point testing by the controls contractor
- Controls Contractor executes functional testing, load bank testing, and integrated system testing under the direction and oversight of the Commissioning Provider
- The CxP will witness O&M staff training - Training manuals are to be produced and training session(s) provided to all operations staff.
- Documentation- The CxP will ensure all required closeout documentation is specified in the CDs and delivered at project completion.



Example/suggestions for the “operational practices” topic



New systems must adhere to those operational practices already in place with existing infrastructure. Same look and feel (graphical interfaces). Data for all operational data analytic purposes: e.g., GUI, diagnostics. This applies to security and documentation features as well.

[e.g. - For any new system or function that is added to an existing one, a user must not have to re-learn how to interact with the GUI. It should be a seamless transition.]

[e.g. - Scenario. With the implementation of the new control system, the energy data for pumps wasn't carried through to the DCIM system.]

Example/suggestions for the scalability and maintainability topic



Serviceability and Maintainability - All equipment must be maintainable in order to achieve a certain level of availability. Serviceability is the ease with which equipment can be maintained.

- There must be a separation of high and low control voltages. This is done for the safety of troubleshooting. If there is a problem, we can safely access the systems without dressing out in protective equipment (no PPE required)
- Controllers and Sensors must be placed in accessible locations and visible from the floor level

Acknowledgements



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