TECH GUIDE

Fluid-to-Facility™

Data Center Cooling Lifecycle Checklist

A Practical Field Guide for Planning, Designing, Building, Commissioning, Operating, and Optimizing Mission-Critical Water and Fluid Cooling Systems.

APEX

Introduction

Modern AI and high-density data centers demand more than reliable cooling; they require a comprehensive strategy for managing water, glycol, engineered fluids, thermal performance, and operational risk throughout the entire facility lifecycle. Decisions made during planning and design influence commissioning success, long-term equipment reliability, water and energy efficiency, sustainability performance, and ultimately, data center uptime.

The **Fluid-to-Facility™ Data Center Cooling Lifecycle Checklist** provides a structured framework to help owners, operators, EPC firms, general contractors, mechanical contractors, commissioning teams, and facility managers align critical activities across every stage of a cooling system's lifecycle. Rather than viewing water treatment, closed-loop fluid management, commissioning, and operations as independent activities, the checklist promotes an integrated approach that connects source water, cooling towers, closed-loop water and glycol systems, engineered coolants, water reuse, monitoring, and ongoing optimization into one continuous lifecycle strategy.

This checklist is organized into six project phases:

- **Plan** — Establish cooling strategy, water and fluid requirements, lifecycle risks, and commissioning objectives.
- **Design** — Engineer systems for reliability, maintainability, monitoring, and long-term performance.
- **Build** — Protect system cleanliness, coordinate construction activities, and prepare equipment for startup.
- **Startup & Commissioning** — Verify system integrity, establish baseline fluid conditions, and transition systems into reliable operation.
- **Operate** — Maintain water quality, fluid health, thermal performance, and regulatory compliance.
- **Optimize** — Continuously improve efficiency, sustainability, reliability, and lifecycle performance while preparing for future expansion.

Together, these phases support the **Fluid-to-Facility™** philosophy: protecting every stage of the data center cooling lifecycle, from the condition of the water and technical fluids to the performance of the entire facility.

Intended Use

This checklist is intended as a planning, coordination, and best-practice reference to support the lifecycle management of mission-critical cooling systems. It is designed to

facilitate communication among project stakeholders, identify key considerations during each project phase, and promote consistent practices that improve reliability, efficiency, and long-term asset performance.

The checklist should be used in conjunction with project specifications, engineering documents, equipment manufacturer requirements, applicable codes and standards, site-specific operating procedures, and qualified engineering judgment.

Disclaimer

The information contained in this checklist is provided for general guidance and educational purposes only. Every data center project is unique, and cooling system requirements vary based on facility design, equipment, operating conditions, water quality, fluid chemistry, environmental conditions, and applicable regulatory requirements.

This checklist does not replace project-specific engineering, OEM recommendations, commissioning procedures, safety requirements, or applicable codes and standards. Users are responsible for verifying that all activities are appropriate for their specific systems and operating conditions.

Apex assumes no responsibility or liability for the use of this checklist independent of project-specific engineering review, manufacturer guidance, or qualified professional oversight.

Intellectual Property Notice

Fluid-to-Facility™ and the **Fluid-to-Facility™ Data Center Cooling Lifecycle Framework** are developed by Apex to support lifecycle water and fluid management for mission-critical cooling systems. This checklist reflects Apex's integrated methodology for planning, commissioning, operating, and optimizing data center cooling infrastructure.

Phase 1 — Plan

Define the Cooling, Water, and Fluid Strategy
Objective: Establish the cooling architecture, resource strategy, performance requirements, and project responsibilities before detailed design begins.

Cooling Strategy
☐ Define target IT loads, rack densities, and anticipated heat loads
☐ Determine the appropriate air-cooled, liquid-cooled, or hybrid architecture
☐ Evaluate direct-to-chip, immersion, and rear-door heat exchanger technologies
☐ Select the heat-rejection approach, including cooling towers, dry coolers, hybrid systems, or district cooling
☐ Define redundancy, uptime, and resilience requirements
☐ Plan for future capacity, expansion, and retrofit needs

Water Systems
☐ Evaluate source-water quality and seasonal variability
☐ Assess regional water availability and supply risk
☐ Identify water-treatment and pretreatment requirements
☐ Establish Water Usage Effectiveness targets
☐ Evaluate condensate, blowdown, reject-water, rainwater, and wastewater reuse opportunities
☐ Define water-safety and microbiological-control requirements

Glycol and Engineered-Fluid Systems
☐ Identify facility-side and technology-side cooling loops
☐ Determine whether each loop will use treated water, inhibited glycol, deionized water, or another engineered coolant
☐ Confirm fluid compatibility with system metallurgy and OEM requirements
☐ Establish freeze protection, corrosion protection, and fluid-cleanliness requirements
☐ Identify CDU and heat-exchanger interfaces between cooling loops

Risk and Project Readiness
☐ Identify mission-critical equipment and systems
☐ Review owner project requirements and performance objectives
☐ Establish operational KPIs for water, energy, thermal performance, and reliability

☐ Define pressure testing, flushing, cleaning, passivation, filling, and commissioning requirements
☐ Assign responsibilities for testing, documentation, corrective actions, and system turnover
☐ Establish safety, containment, chemical handling, and waste-disposal requirements

Lifecycle Fluid Management Strategy
Establish a Lifecycle Fluid Management Plan that defines commissioning baselines, ongoing monitoring, laboratory testing, maintenance responsibilities, and long-term fluid stewardship to reduce operational risk.

☐ Define the long-term ownership strategy for water and fluid management after commissioning
☐ Establish baseline water and fluid quality requirements that will carry into operations
☐ Define commissioning data that will become the operational performance baseline
☐ Identify lifecycle testing frequencies, monitoring requirements, and laboratory support
☐ Define fluid management responsibilities across commissioning, operations, and maintenance teams
☐ Develop a transition plan from startup and commissioning to ongoing water treatment and fluid management services
☐ Establish documentation, trending, and reporting requirements to support continuous optimization and risk reduction

Phase 2 — Design

Engineer for Reliability, Cleanliness, and Maintainability
Objective: Design systems that are reliable, scalable, accessible, and capable of being properly cleaned, commissioned, monitored, and serviced.

Source Water and Pretreatment
☐ Complete representative source-water analysis
☐ Size filtration, softening, reverse osmosis, ultrafiltration, or other pretreatment equipment
☐ Identify sampling and laboratory-testing locations
☐ Establish chemical-feed and treatment-control locations
☐ Define required water quality for each downstream system
☐ Include adequate makeup-water metering

Cooling Towers and Open Water Systems
☐ Establish target cycles of concentration
☐ Define makeup and blowdown strategies
☐ Specify scale, corrosion, and microbiological-control requirements
☐ Include drift control and basin-management provisions
☐ Evaluate side-stream filtration
☐ Provide adequate access for inspection, cleaning, sampling, and disinfection

Closed-Loop Water, Glycol, and Engineered-Fluid Systems
☐ Define facility-water and technology-cooling loops
☐ Establish the CDU or heat-exchanger interface
☐ Confirm fluid requirements for each loop
☐ Size expansion tanks and pressure-control equipment
☐ Include air separators, high-point vents, and low-point drains
☐ Specify permanent or temporary filtration requirements
☐ Confirm compatible pumps, valves, seals, piping, and heat exchangers
☐ Establish corrosion inhibitor and coolant-quality requirements

Cleaning and Commissioning Provisions
☐ Include fill points suitable for approved water and final coolant

☐ Provide low-point drains for removal of rinse water, cleaners, passivation solutions, and debris
☐ Provide high-point vents for effective air removal
☐ Include connections for temporary circulation pumps and filtration equipment
☐ Ensure adequate flushing flow can reach all branches and major components
☐ Define cleaning, flushing, passivation, drying, and final-fill acceptance criteria

Instrumentation, Sampling, and Monitoring
Online instrumentation and controls
☐ Conductivity
☐ pH
☐ ORP, where applicable
☐ Temperature
☐ Flow
☐ Pressure and differential pressure
☐ Water and fluid volume meters
☐ Turbidity, where continuous monitoring is justified
☐ Leak detection
☐ Remote monitoring and trending
☐ BAS or DCIM integration

Fluid sampling and field-testing provisions
☐ Sampling ports at representative locations
☐ Refractometer testing for glycol concentration
☐ Corrosion-inhibitor testing
☐ Microbiological sampling, where applicable
☐ Turbidity or particulate testing
☐ Laboratory sampling access

Maintainability and Expansion
☐ Isolation valves
☐ Drain and fill connections
☐ Bypass piping
☐ Sampling ports
☐ Filter service access
☐ Equipment removal clearance
☐ Space and connection points for future expansion

Phase 3 — Build

Install, Protect, and Prepare the Systems
Objective: Prevent construction contamination and deliver mechanically complete systems ready for safe startup and commissioning.

Construction Cleanliness
☐ Protect open piping, equipment, tanks, heat exchangers, and fittings from dirt and moisture
☐ Remove welding residue, oils, mill scale, dirt, and foreign material
☐ Verify pipe and equipment cleanliness before system closure
☐ Protect cooling equipment during construction
☐ Install temporary strainers or filtration where required
☐ Prevent cross-contamination between water systems and technical fluid systems

Water Systems
☐ Clean cooling-tower basins
☐ Inspect tower fill, nozzles, strainers, and drift eliminators
☐ Verify pretreatment installation and piping configuration
☐ Confirm makeup, blowdown, drain, and chemical-feed connections
☐ Protect water-treatment equipment prior to startup

Closed-Loop Glycol and Fluid Systems
☐ Verify piping, valves, vents, drains, fittings, and instrumentation are installed as designed
☐ Confirm all high points and low points are accessible
☐ Inspect pressure boundaries and mechanical connections
☐ Verify expansion tanks and pressure-control devices
☐ Confirm temporary circulation and filtration connections
☐ Isolate sensitive equipment that should not be exposed to cleaning chemistry or test pressure

Safety and Containment
☐ Confirm required PPE and site safety procedures
☐ Inspect pumps, hoses, gauges, regulators, filters, and tools before use
☐ Establish spill-containment and leak-response measures

☐ Confirm chemical storage, handling, and disposal procedures
☐ Assign qualified personnel for pressurization, cleaning, passivation, drying, and fluid filling

Documentation
☐ Update as-built drawings
☐ Confirm valve lineups
☐ Record estimated system volumes
☐ Compile equipment manuals and treatment specifications
☐ Approve commissioning and cleaning procedures
☐ Document construction deficiencies and corrective actions

Phase 4 — Startup and Commissioning

Verify Before Placing Systems into Service
Objective: Establish clean, leak-free, air-free, chemically stable systems and document a reliable operating baseline.

4.1 Mechanical Integrity and Pressure Testing
Applicable primarily to closed-loop water, glycol, and engineered-fluid systems
☐ Verify system isolation and valve positions
☐ Use an approved pressure-test method
☐ Increase pressure gradually within approved limits
☐ Inspect piping, valves, fittings, and equipment for leaks
☐ Hold pressure for the required duration
☐ Correct deficiencies before proceeding
☐ Release pressure in a controlled manner
☐ Document test pressure, duration, and results

4.2 Initial Flushing
Water and closed-loop fluid systems
☐ Confirm approved flushing-water quality
☐ Install or verify water metering
☐ Record beginning and ending meter readings
☐ Fill all branches, heat exchangers, and major components
☐ Flush low points, mains, branch lines, fittings, and dead legs
☐ Remove construction debris and visible sediment
☐ Continue until discharge meets project cleanliness criteria
☐ Document water volume, flow conditions, and observations

4.3 Cleaning and Passivation
Primarily closed-loop stainless-steel water and glycol systems
☐ Confirm the approved cleaning and passivation procedures
☐ Verify system volume before chemical addition
☐ Circulate the approved chemistries through all applicable components
☐ Drain and rinse until the specified acceptance criteria are met
☐ Perform stainless-steel passivation where required

☐ Maintain approved concentration and contact time
☐ Drain and rinse the system completely
☐ Verify final pH, conductivity, residual chemistry, iron, or other project criteria
☐ Record chemicals, concentrations, circulation times, and verification results

4.4 Final Blowdown, Drainage, and Drying
Closed-loop water, glycol, and engineered-fluid systems
☐ Blow down all identified low points
☐ Remove sediment and remaining debris
☐ Drain mains, branches, fittings, heat exchangers, and equipment
☐ Verify rinse water has been removed
☐ Use clean, filtered compressed air or another approved drying method where required
☐ Confirm acceptable residual moisture before final filling
☐ Document drainage, drying time, and final condition

4.5 Final Water Fill
Closed-loop water systems
☐ Confirm approved final-fill water quality
☐ Verify compatibility with metallurgy and treatment requirements
☐ Record total fill volume
☐ Add approved corrosion inhibitors or treatment chemistry
☐ Collect a representative baseline sample
☐ Confirm pH, conductivity, inhibitor level, and cleanliness

4.6 Glycol or Engineered-Fluid Fill
Glycol and technical coolant systems
☐ Confirm the approved product and concentration
☐ Verify the fluid is fully premixed where required
☐ Confirm containers, hoses, pumps, and connections are clean and compatible
☐ Record beginning volume or meter reading
☐ Fill slowly while monitoring for leaks
☐ Record total gallons or volume charged
☐ Prevent unapproved dilution or contamination
☐ Collect a representative baseline fluid sample
☐ Verify glycol concentration, pH, inhibitors, and fluid condition

4.7 Air Purging, Circulation, and Filtration
Closed-loop water, glycol, and engineered-fluid systems
☐ Open high-point vents during filling
☐ Remove trapped air from all branches and major components
☐ Circulate fluid through an approved pump and filtration system

☐ Inspect and replace temporary filters as needed
☐ Continue air removal until pressure stabilizes
☐ Confirm expansion tanks, pressure controls, and air separators are operating properly
☐ Verify even fluid distribution across the system

4.8 Cooling-Tower and Pretreatment Startup
Open water systems
☐ Verify source-water and final makeup-water quality
☐ Confirm pretreatment performance
☐ Clean and disinfect systems where required
☐ Calibrate conductivity, pH, ORP, and makeup-water instrumentation
☐ Test chemical-feed, makeup, and blowdown controls
☐ Establish initial cycles of concentration
☐ Confirm scale, corrosion, and biological-control programs
☐ Record baseline tower approach temperature and heat-rejection performance

4.9 Controls and Functional Testing
All cooling systems
☐ Calibrate sensors
☐ Test alarms and interlocks
☐ Verify BAS or DCIM communication
☐ Confirm flow, pressure, and temperature readings
☐ Verify pump, valve, and control sequences
☐ Confirm heat-exchanger and CDU performance
☐ Record pressure drop and thermal data
☐ Inspect for leaks under normal operating conditions

4.10 Baseline Data and Turnover
☐ Collect baseline water and fluid samples
☐ Record water chemistry and coolant condition
☐ Record pressures, temperatures, flows, differential pressures, and fluid volumes
☐ Document thermal performance
☐ Record filter condition and debris findings
☐ Document cleaning, passivation, flushing, drying, and filling activities
☐ Record deficiencies and corrective actions
☐ Train operating personnel
☐ Deliver startup and commissioning reports to project stakeholders

Phase 5 — Operate

Protect Mission-Critical Cooling Infrastructure
Objective: Maintain the clean, stable, and efficient conditions established during commissioning.

Water Systems — Routine
☐ Review source-water and pretreatment performance
☐ Monitor cooling-tower conductivity, pH, and biological control
☐ Inspect tower basins, strainers, fill, and nozzles
☐ Review makeup, blowdown, and reuse volumes
☐ Verify chemical-feed equipment
☐ Monitor scale, corrosion, fouling, and microbiological indicators
☐ Maintain water-safety documentation

Closed-Loop Water Systems — Routine
☐ Review pH, conductivity, corrosion inhibitors, and fluid appearance
☐ Inspect filters, expansion tanks, vents, pumps, and seals
☐ Monitor for air ingress, leakage, and pressure loss
☐ Trend differential pressure across heat exchangers and filters
☐ Control and document makeup-water additions

Glycol and Engineered-Fluid Systems — Routine
☐ Verify glycol or coolant concentration
☐ Confirm freeze protection and inhibitor condition
☐ Monitor pH, fluid cleanliness, and contamination
☐ Test for corrosion metals and degradation products
☐ Inspect for leaks and unplanned fluid additions
☐ Confirm continued compliance with OEM fluid requirements

Suggested Review Frequencies

Monthly
☐ Review water and fluid chemistry
☐ Inspect cooling towers and closed-loop systems

☐ Review sensors, alarms, and monitoring data
☐ Review water and coolant consumption
☐ Check filter differential pressure

Quarterly or Based on System Criticality
☐ Perform laboratory analysis
☐ Review microbiological conditions
☐ Inspect pretreatment equipment
☐ Inspect filters and heat exchangers
☐ Review corrosion and contamination trends

Annually
☐ Clean and inspect cooling towers
☐ Complete comprehensive glycol or coolant analysis
☐ Review water-safety plans
☐ Audit system performance
☐ Review operator training and procedures
☐ Compare current system condition with commissioning baselines

Phase 6 — Optimize

Improve Performance Continuously
Objective: Use operating, water-quality, coolant, and thermal data to reduce risk, improve efficiency, and support future growth.

Water and Energy Efficiency
☐ Review WUE
☐ Evaluate impacts on PUE and energy use
☐ Optimize cooling-tower cycles of concentration
☐ Reduce unnecessary blowdown and water losses
☐ Evaluate condensate, RO reject, blowdown, and wastewater reuse
☐ Review seasonal operating setpoints
☐ Balance water use with energy and heat-rejection performance

Thermal Performance
☐ Trend supply and return temperatures
☐ Review CDU and heat-exchanger approach temperatures
☐ Monitor flow and differential pressure
☐ Identify fouling, air binding, or flow imbalance
☐ Review pumping demand and cooling efficiency

Water-System Health
☐ Review scale and corrosion trends
☐ Evaluate microbiological-control performance
☐ Optimize pretreatment and chemical feed
☐ Review water reuse quality and downstream impacts
☐ Update water-safety procedures as conditions change

Glycol and Engineered-Fluid Health
☐ Compare fluid analysis with commissioning baselines
☐ Evaluate glycol degradation and inhibitor depletion
☐ Review corrosion metals and particulate loading
☐ Assess filtration effectiveness

☐ Determine whether fluid conditioning, partial replacement, or corrective cleaning is required
☐ Investigate repeated makeup additions as a potential leak or contamination indicator

Sustainability
☐ Reduce freshwater consumption
☐ Increase reuse and recycling
☐ Improve water, energy, and emissions reporting
☐ Evaluate dry, hybrid, or alternative heat-rejection technologies
☐ Identify opportunities to protect local water resources

Expansion and Retrofit
☐ Review cooling and hydraulic capacity
☐ Assess liquid-cooling readiness
☐ Evaluate higher-density AI workload requirements
☐ Confirm new equipment and coolant compatibility
☐ Isolate, clean, flush, and passivate new piping before integration
☐ Prevent construction contamination from entering operating systems
☐ Re-establish water, fluid, and thermal baselines after system modifications
☐ Update operating procedures, testing frequencies, and documentation

Critical Startup Gate

Before a water, glycol, or engineered-fluid cooling system enters normal service, confirm:

☐ Mechanical completion and leak testing are documented
☐ Construction contaminants have been removed
☐ Flushing and cleaning requirements are complete
☐ Passivation has been completed where required
☐ Final rinse and cleanliness criteria have been met
☐ Residual water and moisture have been removed as required
☐ The approved water, glycol, or engineered coolant has been charged
☐ Trapped air has been removed
☐ Final chemistry meets project and OEM requirements
☐ Sensors, alarms, interlocks, and controls have been tested
☐ Baseline water, fluid, hydraulic, and thermal data have been documented
☐ Operators have been trained
☐ The final commissioning report has been delivered

How Apex Supports Each Lifecycle Phase

Plan
Consulting, source-water analysis, feasibility studies, water-risk assessment, cooling-fluid strategy, and lifecycle planning.

Design
Pretreatment design support, cooling-tower water strategy, closed-loop fluid requirements, instrumentation planning, maintainability reviews, and commissioning criteria.

Build
Construction support, system-cleanliness planning, flushing, cleaning, passivation, temporary filtration, and equipment protection.

Startup and Commissioning
Pressure-test support, final cleaning, water and glycol filling, air purging, chemistry verification, controls validation, baseline laboratory analysis, and turnover reporting.

Operate
Water treatment, coolant management, laboratory services, remote monitoring, water safety, field service, and preventive maintenance.

Optimize
Performance assessments, water reuse, treatment optimization, energy and WUE improvement, system health trending, expansion planning, and retrofit support.

Partner with Apex

From source water pretreatment to cooling towers, closed-loop water and glycol systems, facility-side water and thermal support for direct-to-chip cooling, high-purity water, wastewater reuse, automation, laboratory services, and ongoing optimization, Apex helps data centers manage the complete water and thermal lifecycle.

Whether you're designing a new AI campus, expanding an existing facility, or optimizing operating performance, Apex's expert team helps reduce project risk, improve cooling reliability, optimize water and energy use, and support long-term sustainability.

Learn More: https://teamapex.com/industries/datacenter/

Fluid-to-Facility™.
Lifecycle Assurance for Data Center Cooling.

DOWFROST™ Service Provider

Apex provides integrated water, fluid, and thermal management solutions across the data center cooling lifecycle. As an authorized distributor and service provider for DOWFROST™ Heat Transfer Fluids, Apex combines proven glycol technology with expertise in direct-to-chip cooling, commissioning, field service, and facility-wide water management.

Through Fluid-to-Facility™, Apex helps data centers improve uptime, efficiency, reliability, and scalability for AI-driven growth.

Learn more

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