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Testing Method of Compatibility Between Working Fluid and Materials for Cold-plate Liquid Cooling

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Foreword

This document is drafted in accordance with GB/T 1.1—2020 "Directives for standardization—Part 1: Rules for the structure and drafting of standardizing documents".

This document is proposed by the GCC Open AI Infra community.

This document is administered by the GCC.

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Testing Method of Compatibility Between Working Fluid and Materials for Cold-plate Liquid Cooling

1 Scope

This document specifies the material compatibility tests and methods for the secondary-side coolant in data center liquid cooling systems, including the technical requirements for glycol-based coolants and deionized water coolants, as well as the compatibility requirements and test methods for the fluid-contacting materials.

This document is applicable to the material compatibility tests for glycol-based coolants and deionized water coolants used in cold plate liquid cooling for data centers, and the selection of fluid-contacting materials.

2 Normative References

The following documents contain provisions which, through normative reference in this text, constitute provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition (including any amendments) applies.

Two product specifications were added:

GCC 2003-2026 Technical Requirements and Testing Methods for Glycol-based Coolant of Cold Plate Liquid Cooling

GCC 2004-2026 Technical Requirements and Testing Methods for Deionized Water Coolant of Cold Plate Liquid Cooling

T/CI 208-2023 Test method for high-temperature stability and substrate compatibility of liquid cooling thermal management materials

3 Terms and Definitions

The following definitions apply to this document:

Fluid-contacting material compatibility: The ability of a data center cold plate coolant and the solid materials (e.g., metals, rubbers, plastics, seals) in contact within the system to avoid significant harmful interactions under specified conditions such as a specified temperature and contact duration, thereby maintaining the stability of the coolant's physicochemical properties and the mechanical and sealing properties of the solid materials.

4 Acronyms and Abbreviations

The following acronyms and abbreviations apply to this document:

EPDM: Ethylene Propylene Diene Monomer

FKM: Fluorokarbon Mubber (Fluororubber)

FVMQ: Fluoro Vinyl Methyl Quarantine (Fluorosilicone Elastomer)

PTFE: Polytetrafluoroethylene

PA66: Polyhexamethylene adipamide (Polyadiohexylenediamine/Nylon-66)

5 Technical Requirements for Data Center Coolant Used in Compatibility Tests

5.1 Data Center Coolant Performance Requirements

Data center coolant shall exhibit good material compatibility with the internal structural materials of components that are directly contacted during liquid circulation, such as the cold plate assembly, pipes, and quick connectors, to ensure long-term operational reliability.

A data center coolant can be formulated on the secondary side using ethylene glycol, 1,2-propanediol (propylene glycol), or deionized water as the base liquid, with the addition of functional agents such as corrosion inhibitors and biocides.

5.2 Technical Specifications for Initial and Long-Term Data Center Coolant Operations

The initial product specifications shall meet the performance requirements and testing methods for ethylene glycol coolant and 1,2-propanediol coolant in Section 5 of GCC 2003-2026 "Technical Requirements and Testing Methods for Glycol-based Coolant of Cold Plate Liquid Cooling" or the performance requirements and testing methods for deionized water-based coolant in Section 5 of GCC 2004-2026 "Technical Requirements and Testing Methods for Deionized Water Coolant for Cold Plate Liquid Cooling".

The long-term operation specifications shall meet the coolant monitoring indicators and requirements in Table 5 of GCC "Technical Requirements and Testing Methods for Glycol-based Coolant of Cold Plate Liquid Cooling" or Table 5 of "Technical Requirements and Testing Methods for Deionized Water Coolant for Cold Plate Liquid Cooling".

6 Fluid-contacting Material Compatibility Requirements and Testing Methods

6.1 Metallic Material Compatibility

The technical specification requirements and testing methods for the compatibility with metallic materials used in the secondary-side system shall meet the requirements in Table 1.

Table 1 Metallic material compatibility

Item		Technical Specification	Testing Method
Static corrosion[a] (88 °C ± 2 °C, 336 h ± 2 h), mass change (mg/cm$^{2)}$	Steel of a certain model	±0.2	Appendix A of GCC 2003-2026
	Copper of a certain model	±0.2	
	Solder of a certain model	±0.2	
	Aluminum of a certain model	±0.4	
Compatibility with rubber materials (100 °C ± 2 °C, 168 h ±	Hardness change (IRHD)	±10	Appendix B of GCC 2003-2026
	Volume change rate/%	-5 to 20	

Item		Technical Specification	Testing Method
2 h)	Tensile strength change rate/%	±50	
	Elongation at break change rate/%	±50	
Compatibility with plastic materials (70±2 °C, 168±2 h)	Mass change rate/%	±5	Appendix C of GCC 2003-2026
	Tensile strength change rate/%	±25	
	Impact strength change rate/%	±25	
Compatibility with inorganic non-metallic materials (80±2 °C, 96±2 h)	Mass change/%	±2.5	T/CI 208
	Volume change/%	±2.5	
a: The standard metals used for testing are 304 stainless steel, T2 copper, TU copper, BCu80PAg brazing filler metal, and 6061 aluminum. **The metal pieces for testing shall be combined with other standard metal pieces to form a test piece group, and the compatibility test shall be conducted according to the test conditions specified in Appendix A.**			

7 Technical Requirements for Fluid-contacting Material Selection

7.1 Technical Requirements for Metallic Materials

Carbon steel, zinc, and pure aluminum shall not be used as fluid-contacting materials. 304 stainless steel (06Cr19Ni10), 316 stainless steel (06Cr17Ni12Mo2), TU1 copper, and TU2 copper are recommended.

7.2 Technical Requirements for Non-metallic Materials

PA66 (Nylon-66) shall not be used as a fluid-contacting material. PTFE (meeting GB/T 39714.2) is recommended. Other non-metallic materials (such as FVMQ, FKM, EPDM rubber, etc.) must undergo compatibility testing. Non-metallic components subject to compatibility testing include but are not limited to butterfly valve sealing rings, exhaust valve seals, drainage valve sealing rings, pipe filter seals, hoses, and pipe flange gaskets.

7.3 Technical Requirements for Contacting Surfaces

Sealing at the contacting surfaces must be achieved using gaskets or seals; the use of threads combined with thread sealant is strictly prohibited.

7.4 Technical Requirements for the Pipe System

The use of thread tape is strictly prohibited on all threaded connections in contact with the secondary-side fluid.