SLOVENSKI STANDARD
kSIST-TP FprCEN/CLC/TR 17603-31-10:2021

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Vesoljska tehnika - Priročnik za toplotno zasnovo - 10. del: Kondenzatorji s faznimi prehodi

Space engineering - Thermal design handbook - Part 10: Phase - Change Capacitor

Raumfahrttechnik - Handbuch für thermisches Design - Teil 10: Kondensatoren mit Phasenübergängen

Ingénierie spatiale - Manuel de conception thermique - Partie 10: Réservoirs de matériaux à changement de phase

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ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

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Space engineering - Thermal design handbook - Part 10: Phase - Change Capacitor

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Raumfahrttechnik - Handbuch für thermisches Design - Teil 10: Kondensatoren mit Phasenübergängen

This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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European Foreword

This document (FprCEN/CLC/TR 17603-31-10:2021) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

This document is currently submitted to the Vote on TR.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN 16603-31.

This Technical report (FprCEN/CLC/TR 17603-31-10:2021) originates from ECSS-E-HB-31-01 Part 10A.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

This document is currently submitted to the CEN CONSULTATION.

1 Scope

Solid-liquid phase-change materials (PCM) are a favoured approach to spacecraft passive thermal control for incident orbital heat fluxes or when there are wide fluctuations in onboard equipment.

The PCM thermal control system consists of a container which is filled with a substance capable of undergoing a phase-change. When there is an the increase in surface temperature of spacecraft the PCM absorbs the excess heat by melting. If there is a temperature decrease, then the PCM can provide heat by solidifying.

Many types of PCM systems are used in spacecrafts for different types of thermal transfer control.

Characteristics and performance of phase control materials are described in this Part. Existing PCM systems are also described.

The Thermal design handbook is published in 16 Parts.

TR 17603-31-01	Thermal design handbook – Part 1: View factors
TR 17603-31-02	Thermal design handbook – Part 2: Holes, Grooves and Cavities
TR 17603-31-03	Thermal design handbook – Part 3: Spacecraft Surface Temperature
TR 17603-31-04	Thermal design handbook – Part 4: Conductive Heat Transfer
TR 17603-31-05	Thermal design handbook – Part 5: Structural Materials: Metallic and Composite
TR 17603-31-06	Thermal design handbook – Part 6: Thermal Control Surfaces
TR 17603-31-07	Thermal design handbook – Part 7: Insulations
TR 17603-31-08	Thermal design handbook – Part 8: Heat Pipes
TR 17603-31-09	Thermal design handbook – Part 9: Radiators
TR 17603-31-10	Thermal design handbook – Part 10: Phase – Change Capacitors
TR 17603-31-11	Thermal design handbook – Part 11: Electrical Heating
TR 17603-31-12	Thermal design handbook – Part 12: Louvers
TR 17603-31-13	Thermal design handbook – Part 13: Fluid Loops
TR 17603-31-14	Thermal design handbook – Part 14: Cryogenic Cooling
TR 17603-31-15	Thermal design handbook – Part 15: Existing Satellites
TR 17603-31-16	Thermal design handbook – Part 16: Thermal Protection System

2 References

EN Reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS System - Glossary of terms
TR 17603-30-06	ECSS-E-HB-31-01 Part 6	Thermal design handbook – Part 6: Thermal Control Surfaces
TR 17603-30-11	ECSS-E-HB-31-01 Part 11	Thermal design handbook – Part 11: Electrical Heating

All other references made to publications in this Part are listed, alphabetically, in the **Bibliography**.

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions given in ECSS-S-ST-00-01 apply.

3.2 Abbreviated terms

The following abbreviated terms are defined and used within this Standard.

ATC	air traffic control (aerosat)
B & K	Brennan & Kroliczek
GfW	Gesellschaft für Weltraumforschung
HEPP	heat pipe experiment package
HLS	
IHPE	international heat pipe experiment
IKE	institut für kernenenergetik (university of Stuttgart)
LDEF	long duration exposure facility
MEK	methyl-ethyl ketone
MLI	multilayer insulation
PCM	phase-change material
SINDA	systems improved numerical differencing analyzer
SS	stainless steel
SSM	second surface mirror
S day	stoichiometric day, see clause 8.5
TIG	tungsten-inert gas
TIROS	television and infra-red observation satellite

TOC	tag open cup
TCC	tag closed cup
TPHP	transporter heat pipe

Other Symbols, mainly used to define the geometry of the configuration, are introduced when required.

3.3 Symbols

A	cross-sectional area, [m^2]
E	modulus of elasticity, [Pa]
E_{max}	maximum energy stored in the PCM device, [J]
L	thickness of the PCM device, one-dimensional model, [m]
M	mass, [kg]
Q	heat transfer rate, [W]
T	temperature, [K]
T_M	melting (or freezing) temperature, [K]
T_0	temperature of the components being controlled, [K]
T_R	reference temperature, [K]
ΔT	excursion temperature, [K], $\Delta T = T_0 - T_M$
c	specific heat, [J.kg^{-1}.K^{-1}]
h_f	heat of fusion, [J.kg^{-1}]
h_t	heat of transition, [J.kg^{-1}]
k	thermal conductivity, [W.m^{-1}.K^{-1}]
p_v	vapor pressure, [Pa]
q_0	heat flux to the PCM device, one-dimensional model, [W.m^{-2}]
q_R	heat flux from the PCM device to the heat sink, one-dimensional model, [W.m^{-2}]
$s(t)$	interface position, measured from $x = 0$, one-

	dimensional model, [m]
t	time, [d], [h], [min], [s]
t_{max}	time for complete melting, [h]
t_{90}	time for melting 90% of the volume of the PCM, [h]
x	geometrical coordinate, one-dimensional model, [m]
α	thermal diffusivity, [m^2.s^{-1}], $\alpha = k/\rho c$
β	thermal expansion coefficient, volumetric (unless otherwise stated), [K^{-1}]
μ	dynamic viscosity, [Pa.s]
ρ	density, [kg.m^{-3}]
σ	surface tension, [N.m^{-1}]
σ_{ult}	ultimate tensile strength, [pa]
χ	isothermal compressibility, [Pa^{-1}]

Subscripts

C	Container
F	Filler
PCM	Phase-Change Material
T	Total
l	Liquid
s	Solid