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Vesoljska tehnika - Priročnik o toplotni zasnovi - 12. del: Žaluzije

Space Engineering - Thermal design handbook - Part 12: Louvers

Raumfahrttechnik - Handbuch für thermisches Design - Teil 12: Luftschlitze

Ingénierie spatiale - Manuel de conception thermique - Partie 12: Persiennes

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Space Engineering - Thermal design handbook - Part 12: Louvers

Ingénierie spatiale - Manuel de conception thermique - Partie 12 : Persiennes

Raumfahrttechnik - Handbuch für thermisches Design - Teil 12: Blenden

This Technical Report was approved by CEN on 28 June 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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European Foreword

This document (CEN/CLC/TR 17603-31-12:2021) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

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 (TR 17603-31-12:2021) originates from ECSS-E-HB-31-01 Part 12A.

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).

1 Scope

Thermal louvers are thermal control surfaces whose radiation characteristics can be varied in order to maintain the correct operating temperature of a component subject to cyclical changes in the amount of heat that it absorbs or generates.

The design and construction of louvers for space systems are described in this Part 12 and a clause is also dedicated to providing details on existing systems.

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

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 Symbols

A	Clause 5: bellows effective area, [m^2]
	Clause 7: contact surface (bourdon sensing element), [m^2]
B	radiosity, [W.m^{-2}]
B*	dimensionless radiosity, $B^* = B/\sigma T^4$
D$_i$	bellows innermost diameter, [m]
D$_o$	bellows outermost diameter, [m]
E	modulus of elasticity, [N.m^{-2}]
F	flexibility, [m.Pa^{-1}]
F$_c$	coil force constant, [N.m^{-2}.Angular degrees^{-1}]
H	energy flux impinging on the unit area, [W.m^{-2}]
J	heat flux to the skin arriving from outside, [W.m^{-2}]
K	bellows spring rate, [N.m^{-1}]
K$_c$	coil deflection constant, [angular degrees, K^{-1}]
L	Clause 5: coil active length, [m]
	Clause 5: length of all convolutions in bellows, [m]
	Clause 6: louver blade spacing, [m]

L_c	length of a single convolution in bellows measured along the surface, [m]
M	torsional moment of a coil, [N.m]
P	fluid pressure, [Pa]
P_t	proportionality limit pressure in a bourdon, [Pa]
Q	heat transfer to the fluid within the bourdon, [J]
Q_0	heat transfer to the fluid within the bourdon after an infinitely large time, [J]
R(θ)	equivalent thermal resistance of the louver system, it is a function of the optical properties of blades, and inner skin surface, but for a given system *R* depends only on the blade angle
R_0	coiling radius of a bourdon, [m]
R_m	mean radius of the bellows, [m]
S	heat flux from the space to the skin, [W.m^{-2}]
S_0	solar constant, S_0 = 1353 W.m^{-2}
T	temperature, [K]
T_C	bourdon filling fluid temperature, [K]
T_0	reference temperature, [K]
ΔT	temperature differential, [K], $\Delta T = T - T_0$
T_{0L}	starting fluid temperature, [K]
T_S	skin temperature, [K]
T*	local dimensionless temperature, $T^* = T^4/T^4_{BP}$
V	inside volume of bellows, [m^3]
X	sensitivity of a bimetal, [angular degrees, K^{-1}]
a	semi-major axis of the bourdon tube cross section, [m]
b	Clause 5: semi-minor axis of the bourdon tube section, [m]
	Clause 6: louver blade width, [m]

c	Clause 5: numerical coefficient given in Table 5-7 under additional data
	Clause 7: fluid specific heat, [J.kg^{-1}.K^{-1}]
f(θ)	defined as $f(\theta) = 1 - [1/R(\theta)]$
$f_{n=1}$	fundamental natural frequency, [s^{-1}]
h	total thermal conductance of a bourdon (sensing element plus fluid, [W.m^{-2}.K^{-1}]
l	length of a given metallic strip when the temperature is T [m]
	live length of the bellows, [m]
l_0	length of a given metallic strip when the temperature is T_0, [m]
m_a	mass of bellows active convolutions, [kg]
m_c	mass of one convolution, [kg]
m_{fa}	mass of fluid trapped in active length at rest, [kg] $m_{fa} = \rho L[0,262(D_o^2+D_oD_i)-0,524D_i^2]$
m_l	mass of liquid within the bellows, [kg]. $m_l = \rho Al$
m_1	mass on bellows free end, [kg]
m_2	bellows mass, [kg]
q	louver heat rejection capability, [W.m^{-2}]
q_{shadow}	heat rejection capability for zero solar input, [W.m^{-2}]
t	thickness of the strip of the coil, [m]
	wall thickness for bellows or bourdon tube, [m]
w	width of the strip of the coil, [m]
x	coordinate along the louver baseplate, [m]
y,z	Coordinates along the outer and inner faces of the blade, [m]
Φ	sun angle, [angular degrees]
α	absorptance

	numerical coefficient which appears in the expression of bourdon flexibility
α_s	solar absorptance
α_λ	spectral absorptance
β	Clause 5: linear thermal expansion coefficient, [K^{-1}]
	Clause 5: numerical coefficient which appears in that expression of bourdon flexibility
	Clause 6: Dimensionless coordinate along the louver baseplate, $\beta = x/L$
β_H	linear thermal expansion coefficient of the high expansibility component of a bimetal, [K^{-1}]
β_L	linear thermal expansion coefficient of the low expansibility component of a bimetal, [K^{-1}]
ε	hemispherical total emittance
ε_I	emittance of the skin inner surface
ε_s	emittance of the skin outer surface
η,ζ	dimensionless coordinates, $\eta = y/L$, $\zeta = z/L$
θ	Clause 5: angular deflection of a coil, [angular degrees]
	Clause 6: louver blade angle, [angular degrees]
ν	poisson's ratio
ρ	Clauses 5 and 7: fluid density, [$kg.m^{-3}$]
	Clause 6: reflectance
ρ_λ	spectral reflectance
ρ^s	specular reflectance
ψ_0	initial coiling angle in a bourdon, also called mechanical preload angle, [angular degrees]
σ	Stefan-Boltzmann constant, $\sigma = 5{,}6697 \times 10^{-8}$ $W.m^{-2}.K^{-4}$
τ	time, [s]