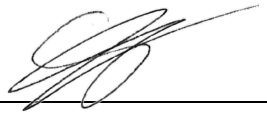
Researching Party	Ingenieursbureau Post en Dekker B.V. Grasweg 41A 1031 HW, Amsterdam
Product Owner	Hörmann Alkmaar B.V. Robbenkoog 20 1822 BB Alkmaar
Project Code	10950
Designation of the product	Dock-leveller technology combined with insulation technology for reduced energy losses both during and outside operation.
Scope of Analysis	Insulation performance analysis of the HTL2-ISO platform, by applying the Thermal Conductivity Model combined with data from a heat loss test. Thereby defining a simplified uniform heat transfer coefficient (U) for each available variant of the HTL2-ISO dock leveller. Only the surface area of the HTL2-ISO is considered within scope, no other heat loss from the environment is taken into account
Method	The Thermal Conductivity Model is applied to compute uniform Heat Transfer Coefficients (U) per length and lip length variation of the HTL2-ISO. Width variations are not shown due to an insignificant impact on the heat transfer coefficient and are included in the tolerance. The convective heat loss caused by leakage through gaps is compensated by a constant energy loss (Q_{Leak}), which is estimated using data from a heat loss test.
Passive State U per Length variation	**Length (mm)** / **U (W/m2K)**: 2000 / 2.8; 2500 / 2.5; 2750 / 2.4; 3000 / 2.3; 3500 / 2.1; 4000 / 2.0; 4500 / 1.9 All U-values are computed in the passive state of the dock leveller with the lip in All U-values are subject to a ± 0.2 tolerance, if tested under similar conditions
Active State U Length vs. Lip-Length	**U (W/m²K)** — Length (mm) / Lip-Length (mm): 2000: 650: 2.6; 950: 2.4; 1150: N/A 2500: 650: 2.4; 950: N/A; 1150: 2.1 2750: 650: 2.3; 950: N/A; 1150: 2.0 3000: 650: 2.2; 950: N/A; 1150: 2.0 3500: 650: 2.1; 950: N/A; 1150: 1.9 4000: 650: 1.9; 950: N/A; 1150: 1.8 4500: 650: 1.9; 950: N/A; 1150: 1.8 All U-values are computed in the active state of the dock leveller with the lip actuated out All U-values are subject to a ± 0.2 tolerance, if tested in similar conditions
Notes on Analysis	All values published are computed based on estimations and a heat loss test, assuming stable conditions and only concerning the dock levellers. Meaning, no fluctuations in atmospheric pressure are taken into account, as well as conduction, ventilation, or leakage through any place else than the dock leveller.

The method of this heat transfer analysis is approved and executed by Post en Dekker B.V.

	
MSc. Eelco Post Director	BSc Daniel Faber Sr. Engineer

Note: For further information concerning the method and calculations, see appendix.

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Appendix A: Detailed method of U-value computation

The heat transfer coefficient *U* is determined through a combination of the Thermal Capacity Model (TCM) and a heat loss test. The theory is used to determine the conductive heat loss through the dock leveller, while the test is used to estimate the convective heat loss through gaps. The convective heat loss is then simplified and taken into account in the conductive heat transfer coefficient *U*.

A.1 The Heat Loss Test

The set-up and conditions of the test:

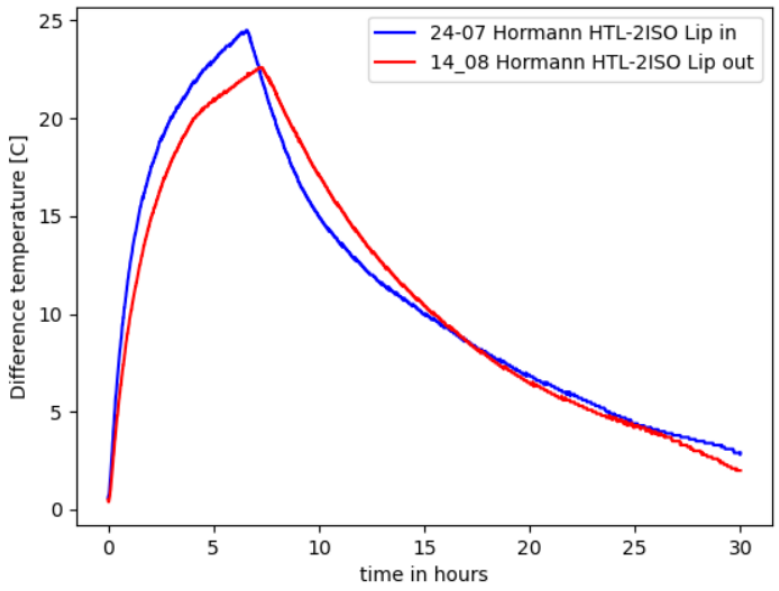
- An HTL2-ISO dock leveller (L2500xW2000) in a room at room temperature
- An insulated box on top of the dock leveller with an open side on the leveller
- Two logging thermostats, 1 inside and 1 outside the box
- A heater inside the box
- Uniform temperature assumption inside the box
- No atmospheric changes in temperature or pressure are taken into account
- All heat loss is assumed to go through the platform

In the heat loss test, an insulated box is placed on the dock leveller, which is then heated until a temperature difference (*ΔT)* of 20°C is reached. The heating is then shut off and the temperature drop is then monitored and logged over time by the thermostats. The box is closed for every direction of heat dissipation except through the dock leveller. It is assumed that all heat loss is either conduction through the dock leveller or convection through gaps. The heat loss through the dock leveller is then measured (see Table 1 and Graph 1).

Table 1 Heat Loss Test Results

Lip in (Passive)	Lip out (Active)
331W	344W

Graph 1 Measured ΔT over time for HTL2-ISO



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A.2 Computing the heat transfer coefficient (U)

By applying the *Thermal Capacity Model (TCM)*, the conductive heat loss is calculated. The difference in calculated heat loss, compared to the test on the L2500xW2000 leveller, is assumed to be caused by convective heat loss through gaps. Since all gaps are constant for each parametric variation of the HTL2-ISO dock levellers, the heat loss is assumed to be constant and therefore compensated by adding a constant number to the total heat loss of 156W, determined by the heat loss test.
For the passive state (lip in) the lip lengths are not taken into account since they are part of the platform in that case. Also, width variations showed only slight variation in the computed heat transfer coefficients, and are therefore included in the tolerance of the heat transfer coefficients based on length variations.
The conductive heat transfer is calculated through the TCM, by applying a temperature difference ΔT of 20°C. First, the materials, their heat conductivity λ, their surface areas A and thicknesses are determined. Heat dissipation into the surrounding concrete and through rubber strips covering gaps is also taken into account. Then, the conductive heat loss Q through the material of the dock leveller is computed (see Figure 1). The convective heat loss, determined by the experiment, is then added to the conductive heat loss to determine the total heat loss through the dock leveller and U is computed by applying: $U = \frac{\mathrm{Q}}{\mathrm{A}\,\Delta T}$

Figure 1 Conductive Heat Loss Calculation (L2500xW2000 leveller)

Concept 3: De HTL2-ISO	Surface	Surface description	Surface area calculation	Surface area (m^2)	Material	Thickness (mm)	Lambda (W/K*m)	Thermal resistance (R-value, m^2K/W)	U-value (W/m^2K)	U-value * Area	Heat loss (Watts)
Closed / Lip in	Sides (2)	Concrete	(L*D*2)+(L*A)	1.33	Concrete	2500	1.7	1.47			
		Steel	(L*D*2)+(L*A)		Steel	4	50	0.00			
							Subtotal	1.47	0.68	0.90	0.10
	Gap (6)	Around the top	(D*C*2)+(A*C)	0.09	Rubber	3	0.2	0.02	66.67	5.83	0.67
	Top (1)	Platform	A*D	5.00	PUR	50	0.02	2.50	0.40	2.00	0.23
	Totals			**6.42**						**1.36**	**174.75**
Open / Lip uit	Sides (2)	Concrete	(L*D*2)+(L*A)	1.33	Concrete	2500	1.7	1.47			
		Steel	(L*D*2)+(L*A)		Steel	4	50	0.00			
							Subtotal	1.47	0.68	0.90	0.10
	Gap (6)	Around the top	(D*C*2)+(A*C)+(J-0,39)*C	0.09	Rubber	3	0.2	0.02	66.67	6.05	0.65
	Top (1)	Top	A*D	5.00	PUR	50	0.02	2.50	0.40	2.00	0.22
	Isolated Lip	Isolated Part of the lip	(J-0,49)*A	0.32	PUR	50	0.02	2.50	0.40	0.13	0.01
	Lip Extention	Lip between Isolation and Truck	P*A	0.20	Steel	23	0.02	1.15	0.87	0.17	0.02
	Totals			**6.94**						**1.33**	**185.13**

Example:
The conductive heat loss is computed to be 175W for the L2500xW2000 leveller in passive state (lip in). The convective heat loss is then added to the conductive heat loss to make up the total heat loss *(Q)* 331W, in this particular case corresponding to the heat loss test in Appendix A.1). The area of the dock leveller *(A)* is determined to be 6.42m^2 (see Figure 1) and the temperature difference *(ΔT)* is 20°C.
Computing to: $U = \frac{\mathrm{Q}}{\mathrm{A}\,\Delta T} = \frac{331}{6.42 * 20} = 2.6\ \frac{W}{m^2 K}$

This value can be found in the datasheet of the L2500 passive state levellers: 2.5 ± 0.2 W/m^{2}K.

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