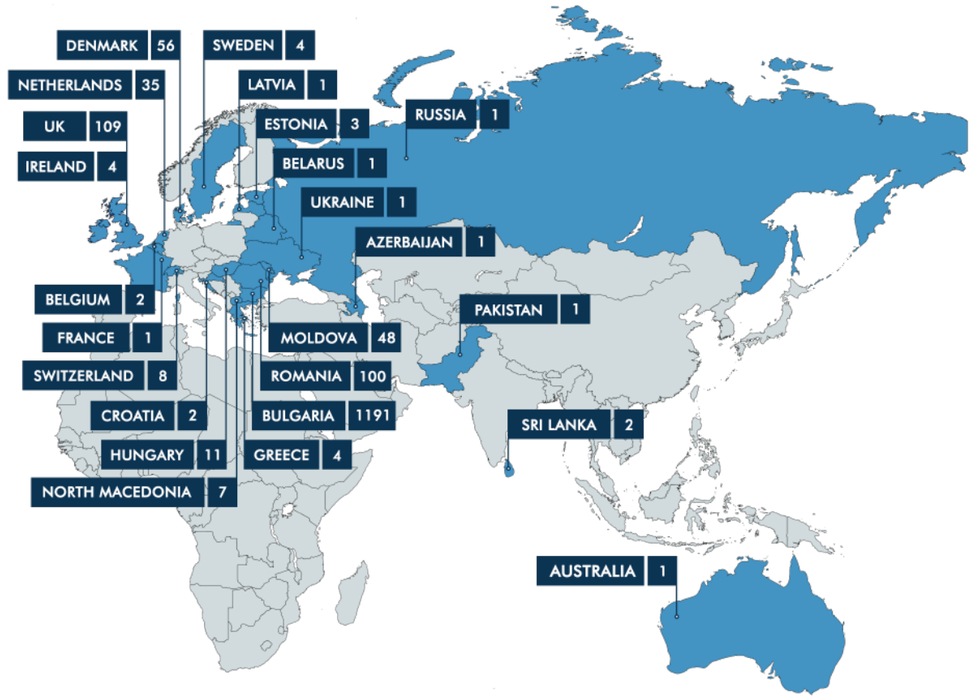
MAX.e³

HYBRID HVAC SOLUTIONS



Damvent
to reach...and exceed

About us



We are Damvent - A Bulgarian Technology company, 100% privately owned, with more than 30 years of experience in the field, specialized in production of the highest/premium class energy – efficient /saving solutions for ventilation and air conditioning.

More than 1600 Hybrids delivered, installed and commissioned in 24 countries across the EU, Asia and Australia.

Concepts

3E - CONCEPT

1e - Every Climate

from -30°C to +55°C

2e - Every Application

suitable for every application where 100% fresh air is needed, by means of covering all possible air treatment processes:

· Filtration
· Recirculation 0÷100%
· Heating
· Cooling + Dehumidification
· Process Ventilation

3e - Every Installation

Every Installation - suitable for all types of mounting, indoor (machinery rooms, technical floors, etc.) and outdoor.

2 STAGE HEAT/COOL/HUMIDITY RECOVERY TECHNOLOGY

Recovering up to 100% of the extract heating/cooling/humidity, achieved - "consecutively" in 2 stages:

1st stage - the sorption rotary heat exchanger, recovers more than 60-80% of the heating/cooling and humidity.

2nd stage - the evaporator/condenser of the air to air heat pump, recovers the rest up to 100%.

ALL IN 1

max.e³ - multifunctional concept solution for fresh air with built-in reversible heat pump and integrated automation system.

100 % FACTORY TESTED

High reliability and reduced installation costs, achieved by 100% factory tests - each unit is tested under factory conditions.
The factory test includes:

· Leakage check
· Vacuuming and loading the system with the exact refrigerant quantity
· Functional testing of all fans and compressors
· Loading the controller's software
· Temperature and pressure checks
· Setting up the required air flow
· Recording all parameters of the unit on a test list.

100% PLUG AND PLAY

Stand alone "one-piece" unit, which only needs a duct system and power supply for start up.

COP/SCOP/SPF

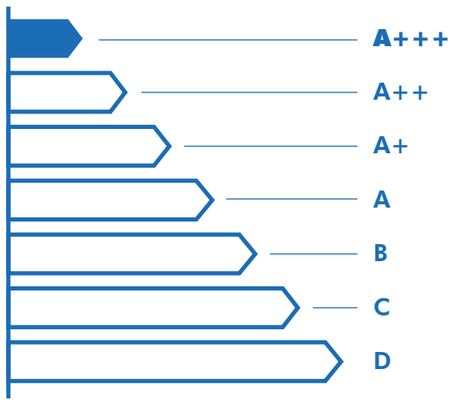
A conventional air cooled heat pump uses the ambient air for the evaporation process and during the winter this air can reach temperatures of -10°C, -15°C or even -20°C. Extracting heat from the ambient air is an inefficient process. In comparison, **max.e³** uses the extract air from the room. Under normal conditions, this air ranges in temperatures from 20÷24°C. Firstly, 65÷80% of the heat and humidity is recovered in the rotary/plate heat exchanger and then at a temperature between 1÷6°C, the air enters the evaporator of the heat pump, thus recovering the other 20÷35%. In this way, we extract up to and more than 100% of the heat from the room air.

According to Euro standard **EN14825**, the highest Energy Efficiency Class for Heat Pumps is **A+++** with SCOP = 3.75 (high temperature) - 4.38 (low temperature).
With **SCOP = 3.8 ÷ 6.5** (on the refrigeration circuit) and **COPnet** of the entire **SCOPnet system = 5 ÷ 15**, the hybrid airhandling units of the **max.e³** series outperform the standards.

Using this method, we achieve a COPsystem of 10 and avoid frost formation on the evaporator (which commonly occurs in all conventional heat pumps).

$$\text{COPnet} = \frac{\text{Q heat recovery + Q heat pump}}{\text{N fans+ N compressor}}$$

Where:
· Q heat recovery - recovered heat in rotary / plate heat exchanger (kW)
· Q heat pump - heat capacity of the heat pump condenser (kW)
· N fans - power consumption from both fans (supply and extract) (kW)
· N compressors - compressor power consumption (kW)



Note:
** **SCOPnet** - seasonal efficiency of the unit in heating mode, with no additional electric heaters, determined by the mandatory conditions laid down in this EU standard and used for marking, comparison and certification purposes.*

Advantages

1

For the Investor
- Significant reduction in initial investment costs
- Significant reduction of installed power
- Low operating (energy) costs
- Saved Space
- Easy maintenance – mono-block unit
- Internet monitoring
- 100% Factory Tested
- Low noise performance

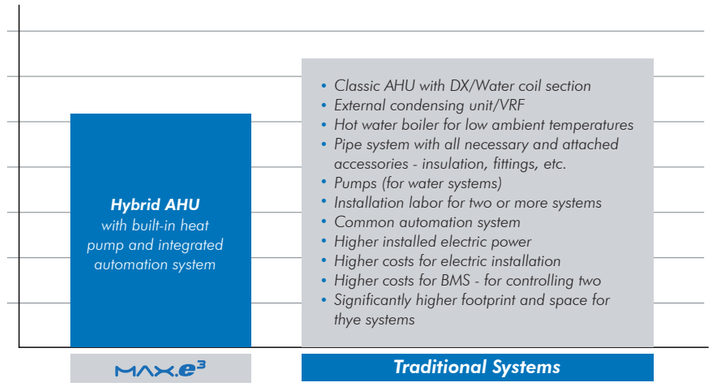
2

For Designers and Consultants
- Significant reduction of initial investment costs
- Low operating (energy) costs and reduction of installed power
- Saves space and design time
- Easy maintenance – mono-block unit
- Internet monitoring
- 100% Factory Tested
- Low noise performance
- Specialized Selection Software available and free to use
- Flexibility for installation on site for the unit
- Fast and easy calculation of energy consumption on an annual basis

3

For Installation companies
- Easy installation on site (needs only connection to the ducts system and power supply)
- Connection to the BMS system through different protocols
- Setting up the unit through Internet
- Lack of working with refrigerants on site

Capital Cost Comparison



Software



Friendly Interface

Light weight, fast and easy to operate with minimal time to enter the input data - from 30 to 90 sec for the calculation

Winter / Summer calculation modes

Ability to export all technical data to .pdf

Visualisation of all air treatment processes within the Mollier diagram

DV_Select

The most important tool for any designer / consultant!
The Specialized hybrid selection software can calculate different modes (winter and summer) and provide extremely accurate calculations.

DV_Select is a technical simulation software for hybrid fresh air units and therefore, in the technical printout, every engineer (designer, consultant) can get acquainted with the air treatment processes, both in the rotary wheel (plate heat exchanger) and within the heat pump unit.

Hardware



Design

The solutions from the **max.e³** series are designed and manufactured in accordance with EN 1886 (Ventilation for buildings-Air handling units Mechanical Performance).

max.e³ is designed as a system with the structure of the unit, manufactured as a mono-block (from size **max.e³-02** to size **max.e³-18**. Bigger sizes like **max.e³-25, 30, 35** are produced on sections) consisting of aluminium profile, supporting elements, connection angles and locking accessories.



Fans

max.e³ use ZAbluefin plug fans with latest EC Blue (Electronically Commutated) from the company Ziehl-Abegg. Fan wheel statically and dynamically balanced on the axis of the direct-driven motor. Fan wheel together with the motor are mounted on a common base frame with vibration dampers.



Automation system

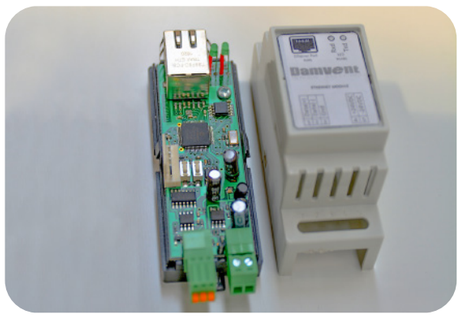
max.e³ is fully equipped with all necessary automation and all executive mechanisms. The electric switchboard is integrated into the unit and located on the operation side. The "Brain" of **max.e³** is specially designed by Damvent controller which controls and manages all processes and protects the unit from eventual cut-offs.



Heat pump

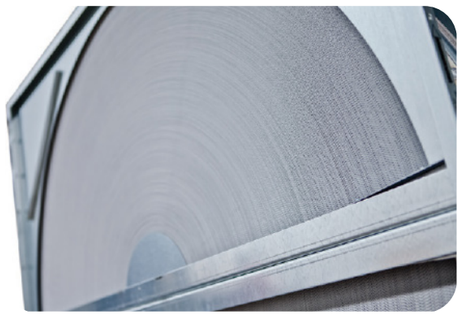
100% DX unit

No additional water, electric or DX heating/cooling coils are needed in the **max.e³**, which makes it independent to other additional heating/cooling sources (boilers, chillers, VRF systems, etc.)



Connectivity and mobility

All hybrid units allow into the corresponding connector of the ICB controller to be mounted specialized Internet circuit board for Internet connection. The built-in circuit board, allows a permanent Internet connection to **max.e³** from any location of the world. This option helps you/us to make adequate reaction to situations requiring fast and accurate solutions to the problem.



Rotary heat exchanger

max.e³ units use an air-to-air rotary heat exchanger - Sorption type, made from aluminum foil and 3Å molecular sieve which gives high sensitivity for absorbing water molecules (HM1 type). Sorption rotors provide an excellent method to pre-cool and dehumidify the fresh air before entering the DX cooling coil.

Temperature efficiency (Sensible) - E ≥ 70%, Humidity - E ≤ 80%.



Filters

Filters are installed at the entrance of the unit to ensure normal operation of the AHU and to prevent contamination of the components.

Microcell filters are used in the units **max.e³**. These filters are made of plated micro glass paper and spaced with hotmelt adhesive beads which are uniformly positioned to deliver optimum airflow.

Factory test

How to overcome the lack of a Dedicated Standard for Hybrids? There is only one way…

With the Ultimate Factory Test (FT).

Every single Hybrid that we produce goes through a full Factory Test in factory conditions and Ready-to-Work.



It includes the following features:

- Vacuuming of the refrigerant circuit and filling up the exact quantity of refrigerant, without extra activity on site
- Functional checks of all executive mechanisms and sensors
- Setting up the exact airflow (CAV), or pressure (VAV) required by the customer
- EEV fine settings
- Measuring and recording all air and refrigerant temperatures (°C) and pressures (bar), voltage (V), currents (A) and power input (kW) of the different components and the unit as a whole
- Simulation of heating/cooling, ventilation or dehumidification modes
- Tsupply control simulation
- Capacity control adjustments (compressors and additional heaters if available)
- LCD display User settings and connectivity
- Fine adjustments of frequency inverters of: fans, compressors, rotary wheel
- Filter settings
- Alarm checks
- Remote control check
- BMS settings
- Labeling of the unit
- Final internal cleaning
- Providing the necessary documentation (manuals, declarations of conformity etc.), plus additional accessories
- Packaging
- …last but not least, comparison between the theoretical performance in the selection software printout and the real measured values during the FT

Mobility



Permanent internet connection

All hybrid units allow an internet circuit board to be connected to the ICB controller for Internet connection. The built-in circuit board allows for a permanent Internet connection to each max.e³ from any location in the world. This option helps you/us react to situations that require fast and accurate solutions to the problem.

Opportunities provided by WEB communicator

Possibility for remote start-up and 72 hours monitoring period

The air-handling unit can be started and adjusted via the Internet, it would be monitored until it reaches and maintains the set parameters.

Software updates

Updates are possible for the controller's software, if the customer requires additional settings or parameter adjustment. These additional settings and updates would be managed/performed over the Internet.

Archive (history) of working and service parameters

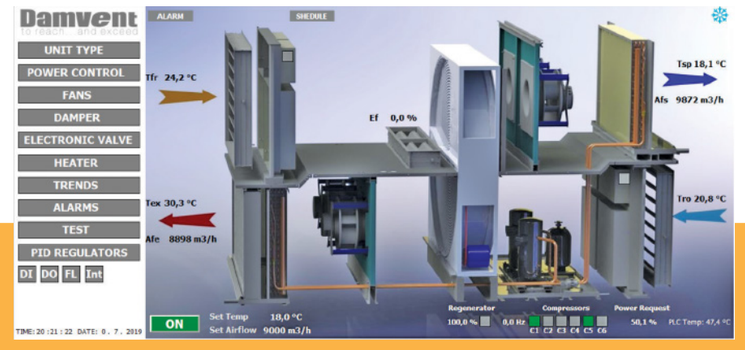
This option would create History logs/archives containing data about the operation of the AHU, using the Supervisory Control and Data Acquisition (SCADA).

Monitoring of the variables, working parameters

Monitoring the status of all variables accessible to the client and the unit's display.

Diagnosis of problems, arising during the operation of the air-handling unit

By analysing the information and data from the history menu, the source of the issue or the reason which triggered it can be found. The problem is solved via the Internet when physical access to the AHU is not required.



Functional diagram

Take a detailed look how the unit is connected with all its components. It is fascinating how such a little technology can have such a big impact on the performance and maintenance of the complete system.

Standards

Dear Customers/Partners,

We, Damvent Ltd. as The Technology Leader in the Hybrid HVAC solutions for fresh air, would like to clarify all standards and SFPint related to our solutions and make a clear statment.

At the moment there is no specific single standard, dedicated for hybrids!
We, Damvent, provide each of our hybrids with 4 separate Declarations of conformity to fully cover the complexity of our solutions:

- *Declaration of conformity in relation to EC Directives :*
- *2014/ 35 /EU - Low Voltage Directive*
- *2006/ 42/ EC – Machinery Direction*
- *2014/ 30 /EU - Electromagnetic Compatibility Directive*
- *2014/ 68 /EU– PED(Category II, Module A1)*
- *EN 1886 : 2007 – Ventilation for buildings-Air handling units-Mechanical Performance*
- *VDI 6022-1: 2011-07- Hygiene requirements for ventilation and air-conditioning systems and units...and others...*

1. Declaration of conformity in relation to EC Directives: EN378-1- Refrigeration system and heat pumps - Safety and environmental requirements Part1: Basic requirements, definitions, classification and selection criteria, with the following clarifications...

2. Declaration of conformity in relation to EC Directives: Directive 2009/125/EC - Ecodesign requirements for air heating, air cooling products, high temperature process chillers and fan coil units, with the following clarifications

3. Declaration of conformity in relation to EC Directives: (EC) 517/2014

**Note: Our hybrid solutions, sizes and models are Not object of regulation in according with Ecodesign requirements for Ventilation units (Commission Regulation(EU) No1253/2014 from 07 July 2014 for applying of EC Directive 2009/125/EC, Art.1, point 2 "g": „This regulation shall not apply to ventilation units which: (a) include a heat exchanger and a heat pump for heat recovery or allowing heat transfer or extraction being additional to that of the heat recovery system, except the heat transfer for protection of frost or defrost".*

All our solutions include an integrated heat pump, which recovers heat and cool, additional to that of the heat recovery system. This means all our solutions include on the extract side after the recovery system an additional coil (evaporator/condenser).
This coil at nominal airflow has an internal pressure drop up to 70Pa, and at max. airflow up to 85Pa, which naturally increases the Total Internal Pressure Drop of the units.
Due to the above facts the SFPint of our Hybrids is naturally expected to be higher than of a classic BVU(with HRS only), and may go above the required SFPint limits, stated in Regulation(EU) No 1253/2014.

SFPint (SFPint is calculated with: Clean M5 filter in exhaust air, Clean F7 filter in supply air, Heat recovery device, Balanced air flow.
For all our max.e^3 hybrids we have calculated the following SFPint @ Nominal airflow in winter mode:

max.e^3 - 02 (Vnom = 1500m^3/h) - SFPint = 664,0 W/m^3/s
max.e^3 - 03 (Vnom = 2500m^3/h) - SFPint = 656,3 W/m^3/s
max.e^3 - 04 (Vnom = 3500m^3/h) - SFPint = 882,6 W/m^3/s
max.e^3 - 06 (Vnom = 6000m^3/h) - SFPint = 758,7 W/m^3/s
max.e^3 - 09 (Vnom = 9000m^3/h) - SFPint = 821,2 W/m^3/s
max.e^3 - 15 (Vnom = 13.000m^3/h) - SFPint = 910,9 W/m^3/s
max.e^3 - 18 (Vnom = 16.000m^3/h) - SFPint = 1049,6 W/m^3/s

We notice that SFPint is very often used for general design and sizing of BVU`s. Please, keep in mind the fact that the source of heating and/or cooling is External for the BVU`s, which are part of the Regulation(EU) No 1253/2014.
For all our Hybrids the source of heating and/or cooling is Internal/Integrated, which is the built-in reversible heat pump.

Based on the above facts we strongly believe and recommend for all Hybrid HVAC solutioins for fresh air, SFPint should not and must not be taken as a major or leading factor when designing or sizing the units.

The major design factors to be taken when designing and sizing Hybrids for fresh air should be:

- Tsupply (winter/summer) = Troom±1-4k (depending on the mode. Tsupply, winter = Troom+1- 2k, and Tsupply, summer = Troom-3-4k). These Tsupply must be achieved without the use of any additional heating/cooling sources (electric heaters, water heaters/coolers, DX coolers)!
- COP of the refrigerant circuit only, where the values at lowest ambient temperatures should be COP≥4.

$$\mathbf{COPnet = \frac{Q\ heat\ recovery + Q\ heat\ pump}{N\ fans + N\ compressor}}$$

Where:
- Q heat recovery - recovered heat in rotary /plate recuperator (kW)
- Q heat pump - heat capacity of the heat pump condenser (kW)
- N fans - power consumption from both fans (discharge and suction) (kW)
- N compressors - compressor power consumption (kW)

- COPnet - that is the most important Energy Indicator for Hybrids! ...

and Damvent was the first company to introduce it in official documentation and selection software.

**TABLE 14 - integral part of "COMMISSION REGULATION (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units".*

Every Hybrid, containing integrated heat pumps must be supplied with this label, providing important key info such as:

1. Seasonal space heating energy efficiency ηs,h this means the ratio between the reference annual heating demand pertaiting to the heating season covered by an air heating product, and the annual energy consumption for heating.
2. "Bivalent temperature" (Tbiv) this means the outdoor temperature (Tj) declared by the manufacturer at which the declared heating capacity equals the part load for heating and below which the declared heating capacity has to be supplemented with an electric back-up heater capacity in order to meet the part for heating, expressed in °C
3. "Operation limit temperature" (Tol) this means the outdoor temperature declared by the manufacturer for heating, below which the heat pump will not be able to deliver any heating capacity and the declared heating capacity is equal to zero, expressed in °C..
4. Indication if the unit is equipped with supplementary heater!!!...and many more

Table 14 (Directive 2009/125/EC)

Information requirements for heat pumps

Information to indentify the model(s) to which the information relates:								max.e^3-09
Outdoor side heat exchanger of heat pump:								AIR
Indoor side heat exchanger of heat pump:								AIR
Indication if the heater is equiped with supplementary heater:								NO
If aplicable: driver of compressor:								electric motor
Parameters shall be declared for the average heating season (for the warmer and colder heating seasons are optional)								
Item	Symbol	Value	Unit		Item	Symbol	Value	Unit
Rated heating capacity (+7°C)	$P_{rated,h}$	24	kW		Seasonal space heating energy efficiency	$\eta_{s,h}$	5.99	%
Declared heating capacity for part load at indoor temperature 20°C and outdoor temperature T_j (@Tsupply = 22°C)					Declared coefficient of performance or gas utilisation efficiency/auxilary energy factor for part load at given outdoor temperatures T_j			
T_j = -15°C	Pdh	29.4	kW		T_j = -15°C	4.82	100	%
T_j = -12°C	Pdh	29.6	kW		T_j = -12°C	4.76	90.3	%
T_j = -7°C	Pdh	31.8	kW		T_j = -7°C	4.88	74.2	%
T_j = + 2°C	Pdh	26.1	kW		T_j = + 2°C	4.8	45.1	%
T_j = +7°C	Pdh	24	kW		T_j = +7°C	6.67	29	%
T_j = + 12°C	Pdh	20	kW		T_j = + 12°C	7.91	12.9	%
T_{biv} = bivalent temperature (-15°C)	Pdh	29.4	kW		T_{biv} = bivalent temperature	4.82	100	%
T_{OL} = operation limit (-20°C)	Pdh	0	kW		T_{OL} = operation limit	-	-	%
Degradation co-efficient heat pumps (**)	C_{dh}		–					
Power consumption in modes other than "active mode"					Supplementary heater			
Off mode	P_{OFF}				Back-up heating capacity (*)	elbu	-	kW
Thermostat - off mode	P_{TO}	0.043	kW		Type of energy input			
Crankcase heater mode	P_{CK}	2 x 0,035	kW		Standby mode	P_{SB}	-	kW
Other Items								
Capacity control	Variable				For air-to-air heat pumps: air flow rate, outdoor measured	–	9000	m^3/h
Sound power level, indoor/outdoor measured	L_{WA}	59	dB		For water/brine-to-air heat pumps: Rated brine or water flow rate, outdoor side heat exchnger	–		m^3/h
Emmissions of nitrogen oxides (if applicabe)	Nox (***)	x	mg/kWh fuel input GCV					
GWP of the refrigerant		1770	kg CO^2_{eq} (100 years)					
(*)								
(**) If Cdh is not determined by measurement then the default degradation coefficient of heat pumps shall be 0,25								
(***) From 26 September 2018 Where information relates to multy-split heat pumps, the test result and performance data may be obtained on the basis of the performance of the outdoor unit with a combination of indoor unit(s) recommended by the manufacturer or importer.								

*Notes

1. Seasonal space heating energy efficiency ηs,h means the ratio between the reference annual heating demand pertaiting to the heating season covered by an air heating product, and the annual energy consumption for heating
2. "Thermostat-off mode" means the condition corresponding to the hours with no cooling or heating load, whereby the cooling or heating function is switched on, but the unit is not operational.
3. "Bivalent temperature" (Tbiv) means the outdoor temperature (Tj) declared by the manufacturer at which the declared heating capacity equals the part load for heating and below which the declared heating capacity has to be supplemented with electric back-up heater capacity in order to meet the part for heating, expressed in °C
4. "Operation limit temperature" (Tol) means the outdoor temperature declared by the manufacturer for heating, below which the heat pump will not be able to deliver any heating capacity and the declared heating capacity is equal to zero, expressed in °C.
5. LWA- measured @1m. from the unit, without ducts at max. airflow 9.000m^3/h
6. ηs,h= 5,55 for colder heating season

Damvent
to reach...and exceed

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