Key Data Exhibition Hall 11	
Construction period	Summer 2007 to Summer 2009
Footprint	122.3 m x 215.9 m
Building height	30 m
Exhibition space	23 860 m^2
Façade area	72 933 m^2
Gross space	758 000 m^3

Photo: Svenja Bockhop, Berlin

Practical tests passed

The new Frankfurter Messe Exhibition Hall 11

Christoph Brauneis,
Marcus Lauster,
Gütersloh

The new Hall 11 building and the adjoining Portalhaus has enabled Messe Frankfurt to extend its services to exhibitors and visitors alike - both in technical terms and from an architectural perspective. The hall survived its baptism of fire at the International Auto Show in autumn 2009 with flying colors. This was thanks in no small measure to the refrigeration and air conditioning technology used.

Planning | As part of the urban development of the Frankfurter Messe exhibition site (www.messefrankfurt.de) by architects and urban planners Albert Speer & Partner GmbH (www.as-p.de), several possible sites were considered for the construction of a new Exhibition Hall 11. The final choice fell on the current location on the western side of the exhibition center on the site of the former goods railway which was fortunately available. This meant that the western side of the exhibition site could be developed by constructing Exhibition Hall 11 and the adjoining Portalhaus, while a new prestigious entrance was created with a direct link to the Autobahn. The positioning of the building next to Hall 9 and the decision to make the Portalhaus a central high profile entrance for the site meant that Hall 9 was rescued from its previous relative isolation. The reason for building the new Hall 11 was not so much the need for more space on the exhibition site, but rather the fact that a replacement was needed for older halls. Thus, the original plan was to demolish Hall 6, although this is now to continue in use for another ten years.

In order to produce a finished design as quickly as possible, it was decided from the outset that the plans should be extremely detailed. A test plan for the site was produced at a very early stage in which the architects defined the various functional zones, such as

Key Data Portalhaus

Construction period	Summer 2007 to Summer 2009
Footprint	47 m / 62,7 m x 83,1 m
Building height	30 m
Façade area	13 094 m²
Gross space	117 330 m³

Photo: Messe Frankfurt

The Portalhaus acts as a prestigious entrance to the exhibition site

hall areas, entrance areas and the technical areas. The Building Services Department, headed by Anton Heisler, was responsible for all the technical aspects of the hall's design. The architects had to remember Messe Frankfurt's stipulation that the evaluation of the preliminary plan would be based 40 % on the function of the hall, 30 % on the technology and 30 % on the architecture.

This was the reason why the Building Services Department drew up an evaluation catalog in advance which defined in precise detail how the subsequent evaluation would take place. Aspects such as the economic efficiency of the subsequent use of the building also played a significant role. Although the plans were drawn up before the 2007 EnEV energy saving ordinance came into force, the designers were naturally concerned to ensure that the hall should operate as efficiently as possible. The specifications even went so far as to define the percentage of refrigeration to be provided by absorption refrigerators and compression refrigerators, for example.

The draft designs were then examined and evaluated by the Building Services Team at Messe Frankfurt from a technical perspective and in terms of the quality report. This evaluation then accounted for 30 % of the overall evaluation of the designs. The two successful designs that resulted from this process were then further developed. After this, a decision was made in relation to which design would eventually be built.

Photo: Svenja Bockhop, Berlin

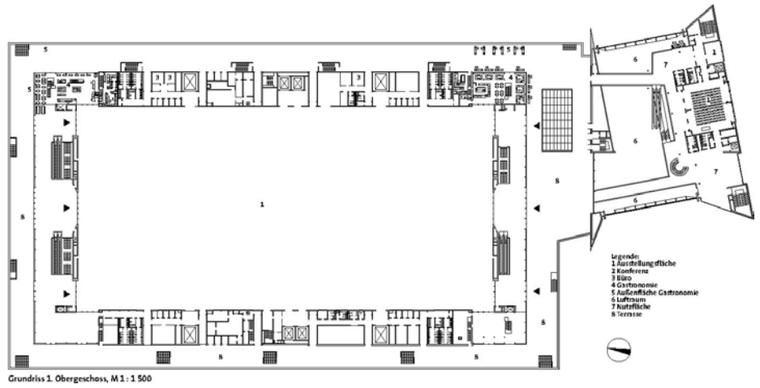
A glimpse inside the Portalhaus

Photo: Christoph Brauneis

Heribert Lausser (Karl Lausser GmbH), Jürgen Alber (LU-VE Contardo), Steffen Zschunke (Johnson Controls), Anton Heisler (Messe Frankfurt) in front of the entrance to the Portalhaus

New paths – new possibilities

Hall 11 and the Portalhaus are among the most important building projects undertaken by Messe Frankfurt in recent years. Its is now possible to do something in the western part of the site, i.e. west of the Torhalle gateway complex on the other side of the railway line, that was previously only possible on the eastern side, namely to take a circular route through the exhibits. The new exhibition hall and the extension of the „Via Mobile" access route, as well as the covered transport system with conveyor belts that run the length and breadth of the site, means that there is now a link from Hall 8, via the Galleria to Hall 9 and via an overhead crossing to the new Hall 11 and via Hall 10 back to the „Via Mobile". This makes the exhibition site even more attractive to exhibitors and visitors alike because they can take a circular route. In addition, it is now possible to cater for two major events – one in the extended western section of the site and one in the eastern part.



Floorplan for Hall 11 and the Portalhaus (1st floor)

When it came to this decision, all the key authorities were consulted at an early stage in order to obtain the greatest possible support for the project. This strategy was something very new for Messe Frankfurt, but the success of the project clearly demonstrates how sensible it is not to integrate technology in an architectural design as an afterthought, but rather to consider building services, usage requirements and architecture from the outset in a common design.

Execution | The new complex, consisting of the hall and the Portalhaus, was designed by architects HascherJehleArchitektur, Berlin (www.hascherjehle.de). When it came to the construction project and practical planning, responsibility from construction lay with Max Bögl (www.max-boegl.de), while Karl Lausser (www.lausser.de) was responsible for the technology. Both businesses were entrusted with the construction of the building as equal partners.

The cornerstone was laid for Hall 11 in October 2007. The construction period was barely two years, so that, despite delays due to weather conditions, the exhibition hall was ready in time for the International Auto Show (IAA) 2009. The investment in Hall 11, the Portalhaus and the entire infrastructure was around Euro 250 million, which Messe Frankfurt raised from its own resources. Quality assurance was provided by Messe Frankfurt itself, which also oversaw the ancillary practical planning. The infrastructure for providing services to the new hall, i.e. gas, water, steam, power, IT, etc., and for disposing of waste water, was implemented before the start of construction. As part of the two-year construction phase, the entire building services installation took only ten months.

Spatial concept | As well as the basement as the machinery area, Hall 11 also has two floors with a combined exhibition space of more than 23 000 m². In addition there are also terraces and open areas that are main used as restaurant spaces, conference and meeting rooms and offices that can be rented by exhibitors. In addition, the necessary social areas are also housed within the building. Taken together, the Portalhaus (13 094 m²) and Hall 11 (105 115 m²) have a total gross floor space of 118 209 m².

The hall is divided into two floors at ground floor and first floor levels, as well as several conference rooms and office zones. In addition, there are social areas, restaurant spaces and machinery zones.

The upper floor has no internal supporting pillars, making the space very flexible. A wide range of media are piped to both floors. The media supply lines are housed in ducts divided in a regular matrix layout, ensuring that the following media are available throughout the hall:

- Electricity
- Data lines
- Fresh water and the associated waste water pipes

In addition, it is possible to provide refrigeration services and compressed air to enable the exhibitors to construct their stands. This decentralized refrigeration system, which can be used to connect external cooling units in the hospitality area of a multi-level exhibition stand for example, is not connected directly to the rest of the cold water network, but is operated by means of plate heat exchangers. When it came to the construction of technical access, care was taken to separate the electrical and water-carrying areas.

Photo: Messe Frankfurt / Ingo Bach

Hall level II.I

Photo: mcl

The machine area under the hall

Photo: Christoph Brauneis

Two rotary screw compressors with a refrigeration capacity of 1.2 MW each

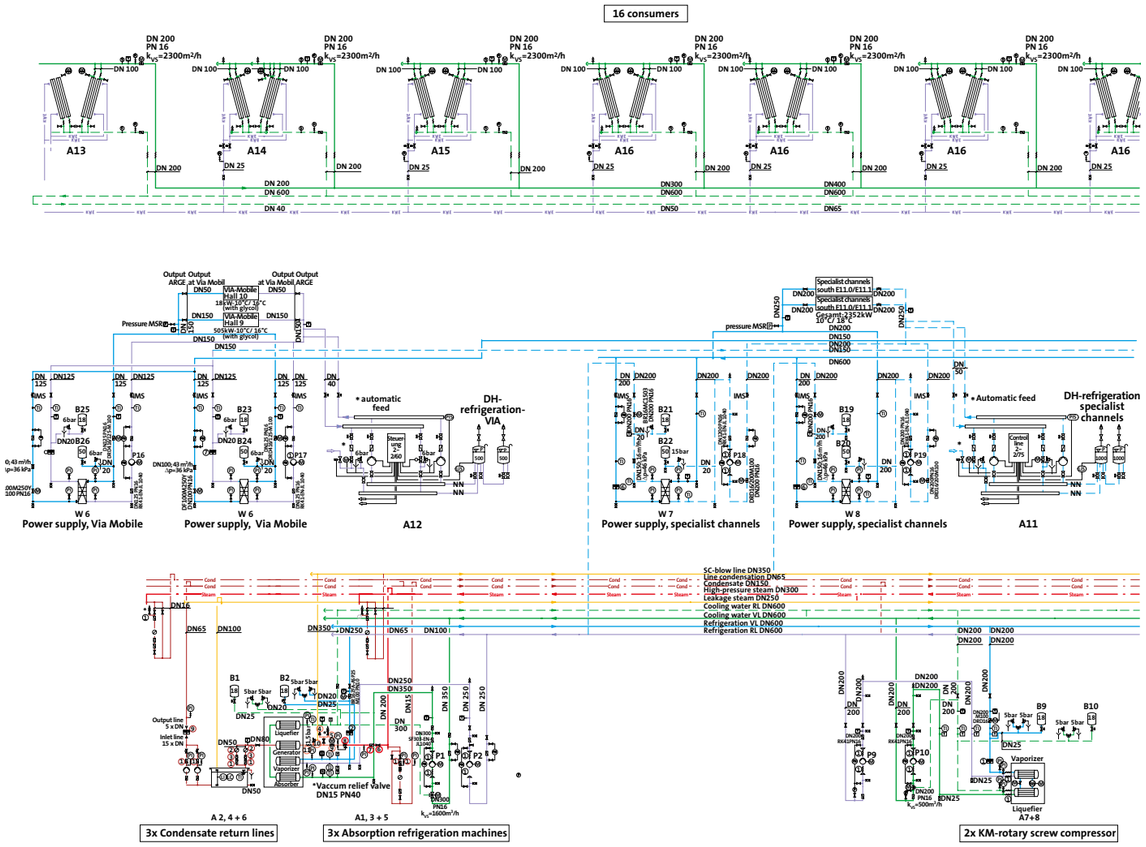
Photo: Christoph Brauneis

Absorption refrigeration machines with a refrigeration capacity of 2.8 MW

The building services concept | The complex system and the various kinds of room and types of usage make enormous demands on the technical equipment used in the building. The complex power supply and simultaneous air-conditioning system are worth mentioning in this context, as heat levels can vary greatly due to the application of energy and the high safety standards because the building is a place of public assembly.
The concept for the hall generally provides for three modes of operation:

a) Idle mode: The hall will be kept at a temperature of 5 °C.
b) Setup and dismantling mode: The rooms are heated or kept at a temperature that enables standards to be set up and dismantled without problems. Fast-opening doors ensure that the hall is only open for short periods, ensuring minimal loss of energy.
c) Exhibition mode: In this case a variety of functionalities and room states are implemented according to requirements and the size of the event.

Refrigeration technology | Refrigeration is provided by three steam-driven York absorber refrigeration machines with 2.8 MW each (re-cooling heat approx. 7 MW with a steam requirement of 6.6 t/h) and three York rotary screw compressors with a refrigeration output of 1.2 MW each (www.johnsoncontrols.de). Together, these offer refrigeration output of around 11 MW. Following the pilot project it was found that demand can be a little higher at peak times. This is covered by incorporating district cooling from Hall 10, where output reserves exist, by means of two additional plate heat exchangers. This high level of refrigeration is required because the thermal load during an exhibition has further increased in recent years, so that Messe Frankfurt now reckons with 300 W/m².
It makes particularly good sense to use absorber technology on the Frankfurt Exhibition Center site because there is a sufficient supply of steam available thanks to the access to the district heating network. In addition, in the experience of Mess Frankfurt, the reliability of absorber systems is several times greater than that of compressor machines, when in operation. This fact and the lower service costs would more than compensate for the additional cost of purchasing the absorbers. 16 recooling units with an output of 1.5 MW and with two frequency converters for regulating speed were installed on the roof of the hall. As with other large projects by Messe Frankfurt (Torhaus, Hall 9 and Hall 4), these were supplied by LU-VE Contardo (www.luve.de) (see for example KKA 6/2007, p. 50 „Perfect landing in Hall 4).
These are „EHDL" recooling units with axial fans and a spray system („Dry & Spray"). These operate as normal dry coolers for most of the year, as long as the ambient temperature is low enough to maintain cooling output under the required conditions (dry mode). When air temperatures rise (in the case of Hall 11 at full load from an exterior temperature of 21.6 °C onwards) the system is automatically activated, spraying the



A1/ A3/ A5	A2/ A4/ A6	A7/ A8	A9	A10	A11	A12	A13 bis A28	B1–B19; B21; B23; B25	B20;B22; B24; B26;
Absorption refrigeration machines	Condensate return lines	KM rotary screw compressor	Pressurizer station	Pressurizer station	Pressurizer station	Pressurizer station	Re-cooler	Expansion vessel	Expansion vessel
Q = 2800 kW 6500 kW 4270 kW		Q = 1200 kW 1370 kW	Refrigeration	Cooling	Refrigeration, Via Mobile	Refrigeration, special channels	Glykol/ Water	Indivdual fise	Indivdual fise
Verd. Abs./Verh. Austr.		Verd. Verfl.	V_{ges} = 2500 ltr.	V_{ges} = 2x1500 ltr.	V_{ges} = 2x500 ltr.	V_{ges} = 2x1000 ltr.	Q N = 1500 kW	V_{ges} = 18 ltr.	V_{ges} = 50 ltr.
ṁ = 301 m³/h 684 m³/h 6577 m³/h	ṁ = 8 m³/h	ṁ = 129 m³/h 150 m³/h	V N = 2x3600 ltr.	V N = 2x1350 ltr.	V N = 2x450 ltr.	V N = 2x900 ltr.	ṁ = 158 m³/h	V N = 14 ltr.	V N = 45 ltr.
t V = 14°C 30°C 1,2 bar(Ü)	Δp = 7 mWS	t V = 14°C 30°C	P O = 4,2 bar(Ü)	P O = 3,6 bar(Ü)	P O = 4,2 bar(Ü)	P O = 3,2 bar(Ü)	t V = 29 °C	P O = 3,6 bar(Ü)	P O = 3,6 bar(Ü)
t R = 6°C 39°C 127°C	n = 2850 min⁻¹	t R = 6°C 39°C	P E = 5,4 bar(Ü)	P E = 4,5 bar(Ü)	P E = 5,4 bar(Ü)	P E = 4,5 bar(Ü)	t R = 38° C	P E = 4,5 bar(Ü)	P E = 4,5 bar(Ü)
Δp = 5 mWS 3,8 mWS 1 mWS	P_{el} = 0,37 kW	Δp = 0,5 mWS 0,5 mWS	P SV = 6 bar	P SV = 5,0 bar	P SV = 6,0 bar	P SV = 5,0 bar	P_{el} = 29,6 W	P SV = 5,0 bar	P SV = 5,0 bar

B27 A/B	P1/ P3/ P5	P2/ P4/ P6	P7/ P9	P8/ P10	P11/ P13	P12/ P14	P15 A/ B/ C/ D	P16/ P17	P18/ P19	P20/ P21
Buffer	Liquifying pumpe	Vapoizer pump Abs.	Vapoizer pump V-KM	Liquifying pump V-KM	WT-free cooling, primary air	WT-free cooling secondary air	Main refrigeration pump	WT-VIA Mobile-secondary	WT-Branches, secondary	WT-District refrigeration, secondary
Cold battery	Normal pump	Standard pumps	Normal pump	Standard pump	Standard pump	Standard pump	Standard pump	Standard pump	Standard pump	Standard pump
V_{ges} = 28.000 ltr.	m = 745 m³/h	m = 301 m³/h	m = 129 m³/h	m = 142 m³/h	m = 79 m³/h	m = 71,8 m³/h	m = 620 m³/h	m = 47,4 m³/h	m = 124 m³/h	m = 358 m³/h
V N = 28.000 ltr.	Δp= 13 mWS	Δp= 11,5 mWS	Δp= 9,5 mWS	Δp= 12 mWS	Δp= 9,3 mWS	Δp= 7,4 mWS	Δp= 20 mWS	Δp= 17,5 mWS	Δp= 20 mWS	Δp= 10 mWS
P O = – bar(Ü)	n = 1480 min⁻¹	n = 1459 min⁻¹	n = 1455 min⁻¹	n = 1445 min⁻¹	n = 1440 min⁻¹	n = 1435 min⁻¹	n = 1485 min⁻¹	n = 1440 min⁻¹	n = 1459 min⁻¹	n = 1459 min⁻¹
P E = – bar(Ü)	P_{el} = 45 W	P_{el} = 15 W	P_{el} = 5,5 W	P_{el} = 7,5 W	P_{el} = 4 W	P_{el} = 3 W	P = 55 W	P_{el} = 4 W	P_{el} = 11 W	P_{el} = 15 W
P SV = 5,0 bar										

Refrigeration Scheme

P22A/ 22B	P23 A/ B/ C/ D	W1/ W2	W3/ W4	W5/ W6	W7/ W8
FK Supply to Hall 9/10	Supply RKW	Plate-HE free Cooling	Plate-HE district refrigeration	Plate-HE, VIA Mobile	Plate-HE, specialist channels
	Standard pumps 4x33%	Q = 500 kW	Q = 300 kW	Q = 300 kW	Q = 1176 kW
ṁ = 358 m³/h	ṁ = 883 m³/h	Prim. Sek.	Prim. Sek.	Prim. Sek.	Prim. Sek.
Δp= 19 mWS	Δp= 220 mWS	ṁ = 83,6 m³/h 71,5 m³/h	ṁ = 418,8 m³/h 357,4 m³/h	ṁ = 43 m³/h 50 m³/h	ṁ = 168 m³/h 126 m³/h
n = 1470 min⁻¹	n = 1485 min⁻¹	t V = 8 °C 16 °C	t V = 6 °C 14 °C	t V = 6 °C 16 °C	t V = 6 °C 18 °C
P_{el} = 30 W	P_{el} = 75 W	t R = 14° C 10 °C	t R = 12° C 8 °C	t R = 12° C 10 °C	t R = 12° C 10 °C
		Δp = 38,2 kPa 30,2 kPa	Δp = 49 kPa 40,5 kPa	Δp = 40,5 kPa 49,2 kPa	Δp = 46 kPa 28,3 kPa

HE=Heat exchanger

Y Funnel siphon
Thermometer
Differential pressure manometer
Manometer with valve
TSL Test pont circuit
STB Safety temperature limiter
SDB Safety pressure limiter
Probe
Temperature probe
Differential sensor/ pressure probe
Frequency converter
Angled overflow valve, featherweight
line regulation valve KSB Bea Control IMS
Through-valve with motor
Non-return valve
Gen. shutoff device
Shutoff valve
Dirt trap
Ball valve
Cap shutoff valve
Valve with solenoid actuator
Three-way valve with motor
TAE Thermal device fuse
Filter
Volumetric flow regulator
Pressure regulator
Pressure monitoring
Vacuum relief valve
Bad point measurement
Thermowell
STW Safety temperature monitor
Fault monitor
Pump
Diaphragm pump
Heat meter
Reducer
Motor shutoff valve
Flowmeter
Contensate drain
Inspection window/ chamber
Inspection window with monitor
Compensator
Pressure reducer
Pressurizer
Expansion vessel
Air heater
Plate heat exchanger
Exhaust silencer

Legend:
Cooling water return
Cooling water forward
Refrigeration return
Refrigeration forward
District refrigeration return
District refrigeration forward
Venting
Leakage steam
High-pressure steam
Low-pressure steam
Steam condensate
Softened water
Gas line
Drinkingwater, hot
Drinkingwater, cold
Control line
Glycol line

① Rubber expansion joint
② Heatmeter DN 250 Q_n=400m³/h; k_{VS}=129 BL=450
③ Heatmeter DN 150 Q_n=150m³/h; k_{VS}=129 BL=300
④ Heatmeter DN 100 Q_n=60m³/h; k_{VS}=71 BL=250 mm
⑤ Heatmeter DN 250 Q_n=400m³/h; k_{VS}=358 BL=450
⑥ Heatmeter DN 150 Q_n=150m³/h; k_{VS}=165 BL=300
⑦ Heatmeter DN 80 Q_n=40m³/h; k_{VS}=43 BL=225 mm
⑧ Heatmeter DN 300 Q_n=600m³/h; k_{VS}=520 BL=500
⑨ Condensate meter DN 25 Q_n=10m³/h

Legend: Steam, condensate line
① Non-return vive DN 50
② Condensate drain DN 50
③ Inspection window DN 50
④ Vent DN 15
⑤ Vacuum relief valve DN 15
⑥ Condensate drain DN 50
⑦ Dirt trap DN 200 PN 25
⑧ Pressure reducer DN 150 PN 16
⑨ Regulating valve DN 200 PN 40
⑩ Safety valve DN 200/300 1,5 bar
⑪ Expansion joint DN 200 PN 16

Photos: Messe Frankfurt

One of the 16 recooling units is lifted onto the roof of Hall 11

necessary quantity of treated water onto the louvers of the blocks (spray mode).
The vaporization of the water sprayed onto the louvers increases the unit's performance and makes it possible to maintain a constant temperature in the cooled liquid under the required conditions. A control system regulates the speed of the fans and the volume of sprayed water as required.

The advantages of the system are:
- Water consumption is limited to a few times in the year.
- Because there is no collecting trough under the heat exchanger, there are no hygiene problems with stagnant water.
- There is no build-up of vapor as with cooling towers.

The recooling unit requires a water spray with a hardness of 1.6 °dH which is treated by means of softening equipment with a dosing unit in the machine level in Hall 11 and pumped to the roof of the exhibition hall by means of a stainless steel pipe network. The

Water treatment for recooler spray mode

Photos (2): Christoph Brauneis

Recooler spray mode is only triggered when external termperatures rise above a set level

volume of spray is 3.3 m³/h with a preliminary pressure of 20 bar.
Weather conditions in the first six months since Hall 11 has gone into service meant that spray mode was not required for any event.
Each recooling unit uses a total of 18 axial fans (800 mm diameter) to move an airflow of 360 000 m³/h. The output air temperature is 37.2 °C, while the output liquid temperature is 30 °C. The acoustic pressure is 63 dB(A) at a distance of 5 m (+ 0.4 dB(A) for the spray system), while the sound power level is 92 dB(A) (+ 0.4 dB(A) for the spray system). There were no particular demands on the devices in terms of sound-proofing, so that no sound-proofing measures were required.
After installation, the recooling units were subjected to a thorough check by Prof. Ulrich Busweiler of the university of Applied Sciences Gießen as part of performance tests. The results not only confirmed the output data specified by the manufacturer, but actually found that recooling performance was better than expected.
The choice of the LU-VE cooler was in line with the general decision by Messe Frankfurt that all open cooling systems on the exhibition site were to be replaced with closed systems. The reasons for using the closed cooling systems were the possible problem of legionaires' disease with open systems, general hygiene aspects, the effort involved in maintenance, the conservation of resources through the significant reduction in water consumption and the avoidance of vapor build-up by the cooling towers.
A refrigeration network exists between Halls 10 and 11, as well as a spur into Hall 9. Two 28 000 liter refrigeration buffer tanks are used to maintain the low temperature.

Absorber

16 1.5 MW Lu-Ve Contardo recooling units adorn the roof of Hall 11

The centrally produced cold water is used to supply several areas, including the cooling in the ventilation systems, the cooling of cooling ceilings in offices and the cooling of underfloor cooling systems in the Portalhaus and foyers.
Decentralized refrigeration is provided by means of direct vaporizers. This includes IT and electrical wiring rooms with internal loads, all cool rooms for restaurant/hospitality applications and around 70 split air-conditioning devices that provide cooling for the walkways around the hall that adjoin the „Via Mobile". 300 kW of cooling capacity is available for this purpose.
Several separate super chillers provide the refrigeration for a redundant data center for the exhibition site.

Clean air technology systems | The engineers were looking for an energy-efficient solution when it cam to supplying the Hall with fresh air. That's why all clean air technology systems in the building, except those on the two floors of the hall have a heat retrieval system. Care was taken to ensure that cost-efficient air-conditioning can be achieved even for smaller events with few visitors or when only part of the hall is used. A system of louvers is used to ensure that only the hygienically essential portion of outside air is added, while around 60 to 70 % of the ambient air can be used in the circulation system.
The primary air is tempered by means of heat exchangers in the ventilation systems. The recycled secondary air receives the applica-

Each of the 16 recooling units has two frequency converters to control speed

Combination system for normal refrigeration and deep freezing for a café

Photos (5): Christoph Brauneis

A total of 288 one- and two-sided induction devices are used to circulate the air around the hall

Clean air technology system

Photos (3): Christoph Brauneis

Indoor roof view

tion of energy through the heat exchangers of the induction devices.

Six clean air technology systems of the same size are installed on each floor of the hall itself, enabling air-conditioning to be provided as and when required. The hall area was divided in such a way that each transverse system (hall width) is responsible for supplying the ambient air as far as the middle of the hall. By dividing the hall in three along the longitudinal axis it is possible to control the right, middle and left areas separately.

A total of 288 one- and two-sided induction devices were installed to distribute the air and these are located in the two-storey hall at a height of 10 meters and have maximum dimensions of 2.50 m x 1.80 m x 0.65 m. The air is fed in from above because Messe Frankfurt wanted to keep the floor and walls free for every conceivable configuration in exhibition construction.

These induction devices have a cooling capacity of 27 kW per device. The simulations carried out in advance have shown that the optimum results can be achieved with special ceiling induction ducts that blow cold air downwards at an angle range from horizontal to vertical - depending on the current load. The air/water systems transport treated primary air into the hall at a rate of 25 m^3/ m h.

The office, hospitality and conference areas are supplied by two filters arranged in series, while the remaining areas are supplied with single-filtered air.

Anton Heisler (Messe Frankfurt), Steffen Zschunke (Johnson Controls), Stephan Hahn (Messe Frankfurt), Jürgen Alber (LU-VE Contardo),

Summary | Exhibition Hall 11 had its mettle tested by the IAA 2009 show. This immediately posed a special challenge right from the start. The car manufacturer that was using the hall to present its vehicles constructed a circuit within the hall on which combustion-engine-driven cars could tour the space. Thanks to the excellent interplay of all the technical aspects and the effective coordination by the hall's operating team, the user was effusive in his praise. There was no problem with irritating exhaust emissions. Following this baptism of fire it seems that the new Hall 11 at the Frankfurt Exhibition Center is well equipped for any challenge that exhibitors may throw its way. This is due in no small measure to the sophisticated clean air technology concept.

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Fire safety technology:	Jörg Parthon
Conveyor technology:	Michael Resch

Construction work:
ARGE H11 Max Bögl/Karl Lausser
Technik GU:
Karl Lausser GmbH, Pilgramsberg

Online-Plus

For lots more photos of Halle 11 and the technology used see the online version of this article at www.kka-online.info. There is also a PDF version of the „Perfect landing in Hall 4" article from KKA 6/2007.