Laminar outlet for operating theatres
OP....
Preliminary remarks
Apart from maintaining thermal comfort, the task of air distribution in operating theatres is primarily the reduction of germ and particle concentration. For this purpose conditioned air is purified in HEPA filters before it enters the operating theatre. Of major importance here is the selection of a suitable air distribution system, as this is decisive for the quality of air flow in the operating zone.

The laminar outlet for operating theatres from KRANTZ KOMPONENTEN ensures excellent air flow in the operating zone. It is designed so that the filtered, sterile supply air flows through the operating zone without an admixture of indoor air. The germs and aerosols released by occupants are displaced into the adjacent room zone and removed with the exhaust air.

Construction design
The main components of the laminar outlet are the rectangular air outlet housing 1 with air outlet frame 1a and air discharge element 2 on the underside and two housings 3 on the top side each with a built-in HEPA filter 4.

Depending on the placement of surgical lighting in the operating theatre, the air discharge element is either split with a feedthrough 7 for the lighting (in built-in surgical lighting 7a) or undivided (with external surgical lighting).

The air discharge element can be removed or folded downwards. This makes the housing interior easily accessible for cleaning and disinfection. Equally easy to reach are the HEPA filters, which can be replaced from the room.

The sealing frames 11 (Figure 4) for the filter cells have a test groove 11a (to DIN 1946, Part 4). The leakage test point 12 and the measurement point 13 for filter pressure loss are easily accessible from below with downfoldable air discharge elements.

As a standard fixture, air-tight shutoff dampers 9 with an electric servomotor 9a are built into the connection spigots 5 of the filter housings. On power loss the dampers close automatically. The dampers can be closed for maintenance work.

As an alternative, air-tight shutoff dampers 10 are available for attachment to the connection spigots 5 (dimensions on request). The connected servomotors 10a are external and accessible from below via an inspection opening 17 when the air discharge element is folded down.

The air discharge element 2 is made of fine-mesh laminar fabric (polyester) with a surrounding stainless steel frame. The air outlet housing is made of stainless steel and the filter housing of powder-coated sheet steel 1).

The air outlet housing 1 is usually installed flush with the ceiling. The air discharge element 2 is situated below the ceiling (Figure 5). If required, the air outlet housing is also available for building onto (Figure 6) or into (Figure 7) the ceiling.

1) Stainless steel on request
Laminar outlet for operating theatres

Figure 3: Outlet for operating theatres, dimensions

Figure 4: Detail of filter housing

Technical data

The air outlet is available in four sizes with the following dimensions 1) and data:

<table>
<thead>
<tr>
<th>Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (mm)</td>
<td>2400</td>
<td>2400</td>
<td>2400</td>
<td>2400</td>
</tr>
<tr>
<td>B (mm)</td>
<td>1400</td>
<td>1800</td>
<td>2200</td>
<td>2400</td>
</tr>
<tr>
<td>D (mm)</td>
<td>405</td>
<td>405</td>
<td>425</td>
<td>425</td>
</tr>
<tr>
<td>E (mm)</td>
<td>160</td>
<td>160</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>F (mm)</td>
<td>787</td>
<td>787</td>
<td>940</td>
<td>940</td>
</tr>
<tr>
<td>G (mm)</td>
<td>787</td>
<td>940</td>
<td>940</td>
<td>940</td>
</tr>
</tbody>
</table>

Filter cell 2)

- Width (mm) | 762 | 762 | 915 | 915 |
- Length (mm) | 762 | 915 | 915 | 915 |
- Height (mm) | 110 | 110 | 110 | 110 |

Volume flow rate

<table>
<thead>
<tr>
<th>V (l/s)</th>
<th>650</th>
<th>860</th>
<th>1050</th>
<th>1140</th>
</tr>
</thead>
<tbody>
<tr>
<td>2400</td>
<td>3100</td>
<td>3800</td>
<td>4100</td>
<td></td>
</tr>
</tbody>
</table>

Discharge velocity 3) (m/s) | 0.20 - 0.24 |

Pressure loss of filter cell 4) (Δp, Pa)

<table>
<thead>
<tr>
<th>Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δp (Pa)</td>
<td>127</td>
<td>130</td>
<td>135</td>
<td>145</td>
</tr>
</tbody>
</table>

Key for all pages:
- 1 Air outlet housing
- 1a Air outlet frame
- 1b Perforated metal sheet
- 2 Air discharge element
- 3 Filter housing
- 4 HEPA filter
- 5 Connection spigot
- 6 Ceiling connection profile
- 6a End frame
- 7 Throughe for surgical lighting
- 7a Surgical lighting (at customer’s expense)
- 8 False ceiling
- 9 Built-in shutoff damper
- 9a Servo motor
- 10 External shutoff damper (optional)
- 10a External servomotor
- 11 Sealing frame
- 11a Test groove
- 11b Dry sealing
- 12 Leakage measuring point
- 13 Pressure measuring point
- 14 Contact pressure fixture
- 15 Suspension
- 16 Ceiling connection for surgical lighting (at customer’s expense)
- 17 Inspection opening, if using with built-on dampers 10
- 18 Air guiding curtain 5)

1) Other dimensions on request
2) Per size 2 filter cells Class H14, DIN EN 1822-1
3) Related to A x B
4) Initial pressure loss Δp-initial with uncontainsed filter cell related to V_{max}. Recommendation: filter change at Δp-final = 2 x Δp-initial.
5) Air guiding curtain on request
6) Housing for sizes 3 and 4 is split
Connection to false ceiling

The connection of the false ceiling as in Figures 5 and 6 produces a more advantageous flow pattern.

Mode of operation

The air discharge element generates a laminar displacement flow directed vertically downwards to the operating zone. At a discharge velocity of 0.15 m/s the displacement flow is already stable and remains so in the presence of operating personnel performing their usual activity.

With the operating theatre outlet from KRANTZ KOMPONENTEN any tangential flows caused by centrically placed lighting can be prevented reliably with the help of a diaphragm.

In the marginal zone of the supply air jet admixture with indoor air is generally unavoidable. The jet constricts in this mixing zone. The construction of the air outlet, however, ensures that the operating area is flushed with filtered and sterile supply air only. The mixing zone lies outside this area.

Supply air temperature should be 0.5 to 4 K below room temperature.

Hygiene tests based on DIN 4799 1 confirm extremely low germ concentrations in the operating zone 2, where the number of colony-forming units (CFU) can be reduced to less than 5 per m³ of air. This amounts to a degree of contamination < 0.1 3.

Sound power level and pressure loss

The sound power level depends on the shape and size of the duct connection. It has been ascertained for three typical duct connection types (see sketches below) and is shown in the graph and table. Pressure losses are also indicated.

The air velocity in the ducts and fittings of the connection system should not exceed 3.5 m/s.

1) DIN 4799 Ventilation and air conditioning; air distribution systems for operating theatres; Issue June 1990
2) Test report on a single and divided air distribution system to DIN 4799, Lübeck Medical University, Institute for Hygiene, July 1992
3) The degree of contamination is defined as the ratio of germ concentration in the clean zone (protected zone) to germ concentration in the remainder of the operating theatre
Laminar outlet for operating theatres

<table>
<thead>
<tr>
<th>Air discharge velocity $u$ in m/s</th>
<th>Total pressure loss $\Delta p$ in Pa</th>
<th>Sound power level $L_{WA}$ dB(A)</th>
<th>Octave band centre frequency in Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td><strong>Connection type 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>142</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>0.22</td>
<td>155</td>
<td>37</td>
<td>48</td>
</tr>
<tr>
<td>0.24</td>
<td>169</td>
<td>39</td>
<td>50</td>
</tr>
<tr>
<td><strong>Connection type 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>156</td>
<td>38</td>
<td>49</td>
</tr>
<tr>
<td>0.22</td>
<td>171</td>
<td>40</td>
<td>51</td>
</tr>
<tr>
<td>0.24</td>
<td>186</td>
<td>42</td>
<td>54</td>
</tr>
<tr>
<td><strong>Connection type 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.20</td>
<td>164</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>0.22</td>
<td>180</td>
<td>42</td>
<td>50</td>
</tr>
<tr>
<td>0.24</td>
<td>196</td>
<td>44</td>
<td>52</td>
</tr>
</tbody>
</table>

1) Sound power level and pressure loss contain the values for the operating theatre outlet including the duct connection type
2) Stainless steel on request

**Features**

- Operating zone free of germs and aerosols through laminar displacement flow
- No induction of indoor air pollutants in the clean zone
- Degree of contamination in operating zone < 0.1
- Stable jet pattern already at discharge velocities of 0.2 m/s
- Low air velocities and temperature differences in the occupied zone
- Tested to DIN 4799
- Air discharge element either split (with built-in surgical lighting) or undivided (with external operating lighting)
- Air outlet frame made of stainless steel and air discharge element made of fine-meshed laminar fabric
- Air outlet housing made of stainless steel and filter housing of galvanized sheet steel 2) with powder coating
- HEPA filter cell H14 to DIN-EN 1822-1
- Connection for pressure differential measurement, particle sampling on the untreated air side and leakage testing to DIN 1946, Part 4
- Air outlet housing available in the three options: for installation flush with ceiling with protruding air discharge element (standard), built onto ceiling or fully built into ceiling
- Easy access for maintenance
- Low height
- Airtight dampers to DIN 1946, Part 4, with built-in electric servomotor, alternative shutoff dampers built on with external servomotor
- Discharge height 2.5 to 3.5 m

**Features**

- Operating zone free of germs and aerosols through laminar displacement flow
- No induction of indoor air pollutants in the clean zone
- Degree of contamination in operating zone < 0.1
- Stable jet pattern already at discharge velocities of 0.2 m/s
- Low air velocities and temperature differences in the occupied zone
- Tested to DIN 4799
- Air discharge element either split (with built-in surgical lighting) or undivided (with external operating lighting)
- Air outlet frame made of stainless steel and air discharge element made of fine-meshed laminar fabric
- Air outlet housing made of stainless steel and filter housing of galvanized sheet steel 2) with powder coating
- HEPA filter cell H14 to DIN-EN 1822-1
- Connection for pressure differential measurement, particle sampling on the untreated air side and leakage testing to DIN 1946, Part 4
- Air outlet housing available in the three options: for installation flush with ceiling with protruding air discharge element (standard), built onto ceiling or fully built into ceiling
- Easy access for maintenance
- Low height
- Airtight dampers to DIN 1946, Part 4, with built-in electric servomotor, alternative shutoff dampers built on with external servomotor
- Discharge height 2.5 to 3.5 m
### Type code

<table>
<thead>
<tr>
<th>Type code</th>
<th>Function/Kind:</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP - ____ - ____</td>
<td>Air discharge element:</td>
</tr>
</tbody>
</table>

#### Air discharge element:
- E = undivided (external surgical lighting)
- Z = divided (with throughfeed for surgical lighting)

#### Size
1. 1 = 2400 mm x 1400 mm
2. 2 = 2400 mm x 1800 mm
3. 3 = 2400 mm x 2200 mm
4. 4 = 2400 mm x 2400 mm

#### Example
Operating theatre outlet, size 2, with divided discharge element for lighting throughfeed:
**OP - Z - 2**

---

### Tender text

**Unit**
Air outlet for the supply of sterile air to the operating zone using the laminar flow principle, consisting of:
- **Housing**
  - without lighting throughfeed,
  - with throughfeed for surgical lighting at customer's expense.
- Air discharge element with fine-meshed fabric for laminar displacement flow.
- Air-tight filter housing to accommodate filter cells, with built-in sealing frame and surrounding test groove to DIN 1946, Part 4.
- Connection for leakage detector and measurement point for pressure differential and particle sampling on the untreated air side.
- Rectangular connection spigot,
- with air-tight shutoff dampers to DIN 1946, Part 4 including
  - electrical spring-return motor.
  - HEPA filter cells, Filter class H14, DIN EN 1822-1.
- Built-in lighting 1)
- Surrounding lighting 2)

#### Technical data:
- **Volume flow rate:** ................. l/s (m³/h)
- **Perm. sound power level:** .......... dB(A) ref. 10⁻¹² W
- **Total pressure loss for uncontaminated filter cell:** ......................... Pa

#### Materials
- **Air outlet housing:** Stainless steel, 1.4301
- **Filter housing:**
  - Galvanized steel 3) with powder coating
- **Air outlet frame:** Stainless steel 1.4301
- **Air discharge element** (laminar fabric): Polyester
- **Ceiling connection profile:** Stainless steel, 1.4301
- **Air-tight shutoff dampers:** Galvanized steel

#### Dimensions:
- **Air outlet housing A x B:** ........ mm x ........ mm
- **Total height:** ......................... mm
- **Filter cells:** ........ mm x ........ mm
- **Make:** KRANTZ KOMPONENTEN
- **Type:** OP - ____ - ____

Subject to technical alterations!

---

[1] Housing for sizes 3 and 4 is split
[2] On request
[3] Stainless steel on request