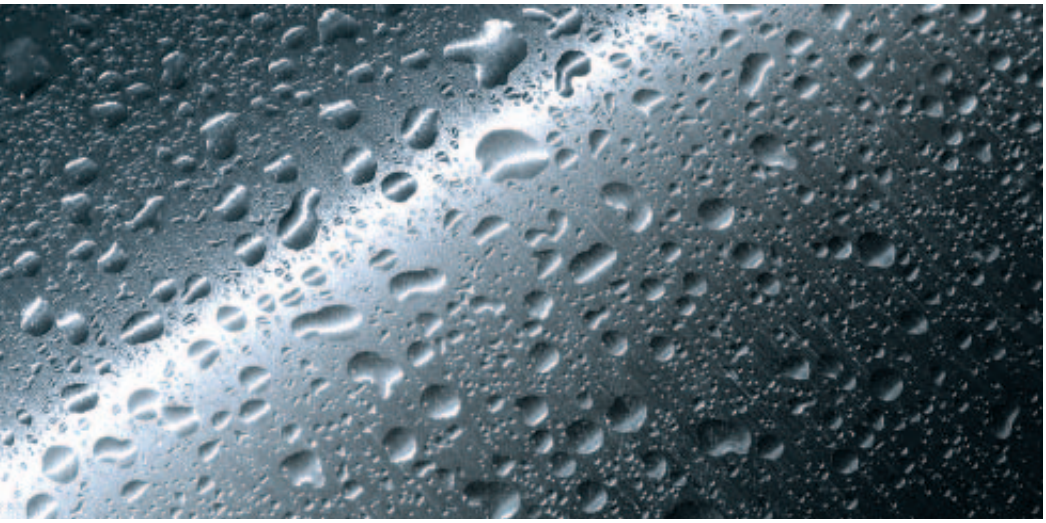
# Climate & humidity protection for fans

Production, inspection, assignment to an appropriate protection class



## Optimum protection systems for every application and at every location

The engineer's choice

ebmpapst

# Global commitment: against corrosion, for the environment

*Right round the globe ebm-papst is renowned for its superlative product quality. This is not only based on attributes such as innovation and efficiency, but also on our maintaining the highest standards of reliability in our air and drive technology sectors. The expectations of our customers on the length of service life of a fan made by ebm-papst are high, right across a tremendously diverse range of applications and, not infrequently, under extreme ambient conditions. We therefore dedicate particular attention to the corrosion resistance of our fans, with regard to both their external and their internal components. In everything we do in development, production or trials, we are committed to being "against corrosion, for the environment". This is because we feel ourselves to be the guarantors of the highest standards of quality, and are also totally committed to protecting the environment.*

**Exemplary:**

**Setting standards with environmentally compatible standards!**

Those new standards are not only set in terms of fan or motor technology – they are also set in our manufacturing processes: an approach entirely typical of ebm-papst! For example, back in 1998 we achieved pioneering status in terms of fan technology with the introduction of cathode dip painting (CDP), a trailblazing painting and corrosion protection process with superlative environmental and quality credentials. This unusually environment-friendly method not only enables us to achieve a very uniform coating on the external components of a fan, right down to the tiniest of cavities, but also delivers maximum utilization of paint, i.e. a level in excess of 95 %. This contrasts favorably with conventional wet-painting processes where utilization levels achieved only amount to between 60 and 70 %. The so-called "overspray" technique achieves only 30 to 40 % and has an adverse impact on environment and cost-effectiveness.

For parts not suited to CDP coating, we employ electrostatic powder coating. We are one of the world's first companies to use an ultra-thin powder coating (UDS). All this for a very good reason, because this other entirely solvent-free process places the primary emphasis on corrosion protection, and is firmly centered on the need to achieve high environmental standards.

**Typical:**

**Counteracting exceptional loading with extraordinary means!**

Extreme operating locations are not uncommon for our fans: in industrial environments with aggressive media, in coastal regions with a high salt content in the air or in climate zones with high levels of humidity. Take for example the new ebm-papst energy-saving motors, including the ones installed in refrigeration equipment for the Central American market. To protect the fan stators from the humid conditions prevailing in tropical and sub-tropical countries, they are coated with epoxy resin. Just one example among many of how we seek to counteract exceptional adverse factors with extraordinary equipment.

***For maximum quality, we test under extreme conditions: in a desert climate, in freezing cold and in sub-tropical humidity.***

**Extreme:**

**Endurance trials under the harshest of conditions**

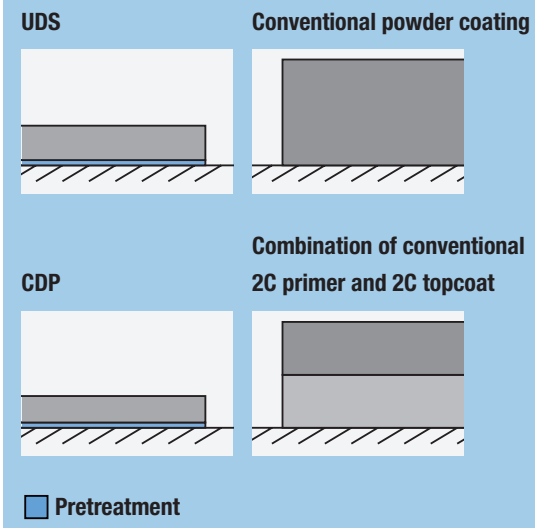
Naturally, ebm-papst fans need to be able to withstand extensive laboratory tests to verify their protection class, but this is by no means all they have to accomplish. Due to the fact that our fans also need to be suitable for use in external environments, we carry out endurance tests all over the world under the “least favorable” climate conditions imaginable.

In Arizona, the test specimens are tested in a dry, hot desert climate where they are exposed to extremely high levels of direct sunlight. In Siberia, extremely low temperature conditions are tested. And finally, in Singapore, our products encounter typical tropical operating conditions: high temperatures, high humidity levels and heavy precipitation. At all three test locations, fans are operated on a cyclical basis during which their functions are continuously monitored and recorded. Data are transmitted via GSM module to the development centers in Germany. The information gleaned from these tests is incorporated straightway into further development work and optimization of materials, products and manufacturing processes.

**Worth knowing:**

**Less is more – also true of layers of paint**

Apply thickly? Long gone are the days when this was need to assure optimum corrosion protection. At the end of the day, using the very latest processes such as CDP or UDS painting, substantially less paint needs to be employed than in conventional processes in order to apply a uniform and superlative coating film of paint. These reduced layer thicknesses are not just a bonus for the environment. They also enable higher quality standards to be reached because irregular or excessively thick layers of paint which adversely affect the balancing quality of the fan are now firmly relegated to the past. Moreover, the layer thickness of the paint only affects the quality of corrosion resistance to a level of about 30 %. The substantially higher proportion of protection, i.e. 70 %, is delivered by the way material is pretreated in up to 9 zones – forming the substrate for a uniform, aesthetically pleasing and high-quality coating.



# First paint, then assemble: optimum protection for external components

*The key requirement is to provide optimum protection for all external fan components and attachments such as protective grilles or wall rings. Only once all cavities, connecting and locating points are "sealed" down to the tiniest detail can a fan contend with whatever the ambient conditions at its operating location have in store for it – a fan no longer needs to fear humidity and dirt. The principle of "paint first, then assemble" therefore guides the painting process employed at ebm-papst: the cathode dip painting process being one, and the electrostatic painting process using an ultra-thin coating of powder being the other. Both processes are preceded by a thorough pretreatment process extending over as many as 9 different zones. No wonder, since this process accounts for the major proportion (70 %) of your fan's ability to withstand corrosion, with the actual painting process accounting for just 30 %. Moreover, this pretreatment process is an essential prerequisite in conserving paint, i.e. using less of it and thereby protecting the environment.*

**The cathode dip painting (CDP) process**

Since 1998 we have been coating most of our products in a CDP unit – also commonly used in the automotive sector. The basis for high levels of corrosion protection is delivered by this pretreatment process, comprising 9 zones. Through a process of thorough degreasing, activating, zinc phosphatizing and multiple rinsing cycles with fully desalinated water, a suitable substrate is created on which to apply a uniform coating on fan components. After this, components are completely immersed in the dip tanks. Even on complex workpiece geometries, no areas can escape the paint application, and no drips can form. The total volume of paint consumed during the CDP process is only one fifth of the volume used in conventional wet painting processes.

| Technical overview | |
|---|---|
| **Suitable components** | • Maximum dimensions L 800 mm x W 600 mm x H 1100 mm<br>• Steel<br>• Galvanized steel plate<br>• Aluminum<br>• Aluminum alloys |
| **9-zone pretreatment** | • Multi-stage degreasing<br>• Cleaning and activating<br>• Zinc phosphatizing<br>• Multiple rinsing with fully desalinated water |
| **CDP epoxy resin** | • Layer thickness approx. 20 microns<br>• Paint is burned on<br>• Color shade: RAL 9005 black<br>• Minimum solvent content < 2 %<br>• Paint recuperation<br>• Waste water preparation using separating plant |
| **Features/Properties** | • Uniform and complete coating<br>• No drip formation<br>• Very good chemical and mechanical resistance levels<br>• Good overpainting capability |
| **Typical applications** | • For external applications<br>• Air, refrigeration and climate technology<br>• Automotive and rail technology<br>• Outdoor station, telecommunications |

***Left: on the cathode dip line, fan components are sealed down to the tiniest detail.***

***Right: with electrostatic powder coating, components are coated with an ultra-thin layer of powder.***

**The electrostatic powder coating process (UDS)**

As one of the world's first companies in this field, we paint parts which are not suitable for the CDP process by applying an ultra-thin layer of powder. This painting process shares common ground with CDP: a thorough 5-zone pretreatment process and thinner layer thicknesses ensure double levels of protection. Protection against corrosion and protection for the environment. This entirely solvent-free process also scores highly through its ability to recuperate high volumes of paint and its pretreatment process during which no waste water is generated.

| Technical overview | |
|---|---|
| **Suitable components** | • Maximum dimensions L 800 mm x W 500 mm x H 1200 mm<br>• Steel<br>• Galvanized steel plate<br>• Aluminum<br>• Aluminum alloys |
| **5-zone pretreatment** | • Degreasing<br>• Iron phosphatizing<br>• Multiple rinsing with fully desalinated water<br>• Passivization |
| **Epoxy polyester ultra-thin layer powder mixes** | • Layer thickness approx. 35 microns<br>• Color shade: RAL 9005 black<br>• 100 % solvent-free<br>• Paint recuperation |
| **Features/Properties** | • Ultra-thin powder coating<br>• Uniform coating<br>• No drip formation<br>• Very good chemical and mechanical resistance levels<br>• Waste water-free operation through use of an evaporation technique<br>• Limited scope for overpainting |
| **Typical applications** | • In interior and exterior locations<br>• Industrial technology<br>• Mechanical engineering<br>• General air and climate technology<br>• Energy technology<br>• Switch cabinet and refrigeration systems<br>• Computer industry<br>• Controller construction |

**Protect together what belongs together:**
**The peripherals of the fan**

Specifically for attachment parts, e.g. protective grilles, effective corrosion protection is particularly significant; after all, corrosion is highly visible on these externally mounted components. Since conventional processes are not suitable for use with complex component geometries, including a range of different welding points, corrosion protection in these areas is once again assured by means of processes such as CDP and polyester coating. By combining plated coatings with CDP or powder coating processes, the properties of both processes plus their associated pretreatment processes deliver superlative standards of protection capable of contending with even the toughest of ambient conditions during daily operations.

**Last but not least:**
**External protection always stands or falls on the quality of screw connections**

For connecting elements such as screws we use the very latest and most resistant corrosion protection methods of the kind commonly employed in the automotive industry. The aim is always to deliver the highest levels of protection having the least possible effect on screw-in parameters. Depending on product requirements, we can choose between a wide variety of coatings or materials (e.g. zinc thick-layer passivization, zinc lamellar coating, zinc-nickel or stainless steel). Depending on which version is employed, these plated coatings can achieve values which would otherwise only be obtainable using grades of stainless steel.

# Dropping, curing, impregnating, encapsulating: optimum protection for “inner values”

*The heart of a fan is its drive unit, and electronics are its brain. It is especially important to provide adequate protection to these particularly sensitive “internal values”. This is achieved in a number of ways, including coil impregnation which, alongside mechanical fixing and improvement to electrical insulation, also helps to protect against humidity. ebm-papst sets the highest standards with all its materials and processing techniques. Depending on the requirement and type of motor, various different processes can be used here, as we will seek to demonstrate to you in the following section. Moreover, we pay particular attention to all the electronics. Here, the measures employed range from humidity-protective paint or plastic resin compounds for components ranging from printed circuit boards to housings which completely protects the electronics from external factors.*

**The “dropping” process: standard on AC motors**

Dropping is the standard method for coil impregnation on AC motors employed at ebm-papst. In this process, the coils are “drizzled” with a high-quality grade of polyester resin in insulation class “H” and are then hardened on modern rotary tables or linear systems. The heat required for this hardening process is generated directly inside the coil by a precisely controlled level of electrical current. As well as a high level of process reliability and optimum product quality, this process delivers convincing energy consumption levels because heat is only introduced where it is really required. Through a process of rapid heating and hardening, low emissions, high dry resin intake and low drip and evaporation losses are incurred. This makes this process compliant with our own environmental targets.

**The curing process: an important issue on EC motors**

Curing is a very environment-friendly, robust and cost-effective production process, used primarily in EC motors across a voltage range of up to 230 VAC. The configuration of coils or coil strands (single-terminal coils) delivers the requisite phase separation. This dispenses with the need for conventional phase isolation and therefore eliminates the need for wet impregnation. The curing process then runs fully automatically. The coil is heated by means of a controlled temperature-monitored application of electrical current. At approx. 200 °C the baked-on paint on the wire softens and “glues up” the coil.

***During the dropping process, coils are impregnated with a high-quality coating of polyester resin.***

**Vacuum impregnation:**
**Comprehensive protection for the entire stator**
In this process, the entire stator is immersed under vacuum conditions. The aim here is also to impregnate those areas which do not directly form part of the actual coil. This ensures that small gaps and capillaries are sealed which the dropping process was unable to reach. To reliably reach this area, one sometimes difficult for resin impregnation to reach, the impregnation process is performed under vacuum conditions. This enables the resin to penetrate without obstruction into the evacuated cavities. Ventilation of chambers while the objects are still immersed delivers additional pressure (atmosphere) and this forces resin back into the cavities. An additional benefit is the good protection that provides against the ingress of moisture. This process is applied when stringent requirements apply, e.g. humidity with condensation.

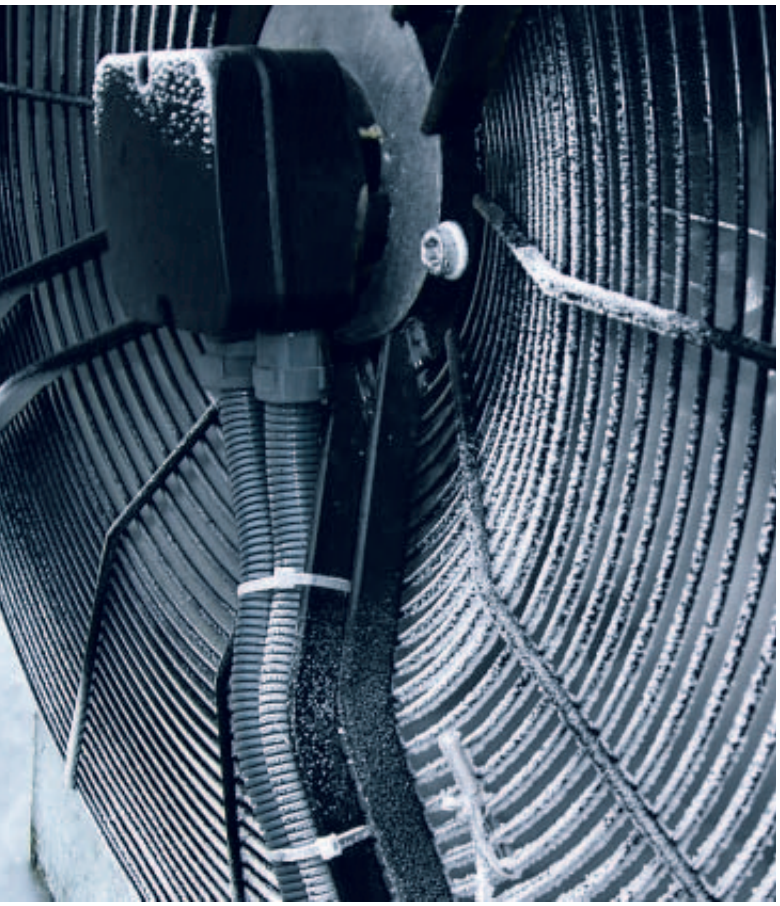
**An all-round casting:**
**To suit the most challenging of requirements and for special applications**
To achieve maximum protection for the coil against water and humidity, there is the option of encapsulating the entire coil in a casting compound. This either takes the form of casting or press-molding. This process is available for specific customer requirements and/or specialist applications.

**Protection of the electronics:**
**To ensure "that the brain does not rust up"**
Protecting the "intelligence" of the fan reliably from external factors – this task is performed by comprehensive protection of the printed circuit boards. This involves applying an effective protective coating in the form of an environmentally compatible RoHS-compliant layer of humidity-preventing paint. With the so-called "PCB encapsulation" process, PCBs are quite literally molded into a synthetic resin shell. Finally, the electronics are completely encapsulated in a housing which protects them superbly from external factors.

*For maximum protection of fan intelligency, the PCBs are encapsulated in a synthetic resin.*

# Optimum protection suitable for each application: the ebm-papst protection classes

Selection of the right type of protection for the operating location of a fan involves making a very careful choice. In individual cases, the selected measures do not provide adequate security against the actual climate conditions. In other cases, this gives rise to an excessively high classification at unnecessarily high costs. What is important for us is to become fully aware of your local ambient conditions and your individual requirements in terms of function, safety and corrosion protection. This is followed by a definition of protection class – the elementary first step to choosing the right course of action and process to adopt for your fan. The adjacent table provides an approximate overview of the most important protection classes with a range of typical applications. “If in doubt”, it can’t however be a substitute for a personal talk with our engineers who are always delighted to advise you.



*ebm-papst products deliver good climate and humidity protection "ex-factory"! Naturally enough, though these products will be exposed on a long-term basis to a tremendously wide range of climatic and application-specific conditions, such as those at your chosen location. Humidity, heat, cold or aggressive media such as acid "gnaw" at the surface. To assure optimum protection – subject to type of loading – against prevailing factors, ebm-papst products are divided into a range of different protection classes. Each of these protection classes (with the exception of F0 – zero humidity) is linked to an appropriate set of test procedures and conditions, and you will find a detailed description of these on the next page.*

| Protection class[1] | Ambient conditions | Typical applications and environments |
|---|---|---|
| **F0** | **No humidity** | Interior use of products at constant temperature and low humidity, e.g. power technology plant, switch cabinets, computer industry, household appliances, air technology. |
| **F1** | **Humidity without condensation** | Interior use of products in applications with medium ambient humidity and/or average industrial atmosphere, e.g. drain and pipework fans, switching and power system technology, interior areas of outdoor stations, climate equipment, evaporators. |
| **F2** | **Humidity with condensation** | Exterior and interior use of products at fluctuating temperatures with high humidity or open air apertures with harsher industrial atmosphere, e.g. evaporators, condensers, air coolers in refrigeration technology, fans for climate technology. |
| **F3** | **Spray water** | Exterior and industrial use of products subject to high loads from airborne humidity and industrial atmosphere, e.g. car washes, steam cookers, mobile refrigeration systems, automotive and rail technology. |
| **F4** | **Salt spray** | Exterior and industrial applications for products subject to severe corrosion and humidity loads, and use in conjunction with aggressive and abrasive media, e.g. shipbuilding, chemicals industry, laboratories, automotive, sea atmosphere, battery stations, offshore systems. |
| **F5** | **Customer-specific definition of special requirements** | Here, on a joint basis with the customer and the specific intended application, and with due regard to products and basic material, a specific corrosion and motor protection system is defined and agreed, e.g. in biotech, the foodstuffs industry and the medical sector. |

***[1] internal designation at ebm-papst***

**Explanation of the nomenclature**

Once – in accordance with your specific application – corrosion protection requirements have been defined (this takes place at an early stage between ebm-papst sales and yourselves), your fans are assigned to a defined protection class. The ID code for each of these protection classes is an indicator of the functional, safety and corrosion protection requirements each one covers, e.g.:

**F2-1**

"F2" describes the level of impact from environment and surrounding area.

"-1" signifies: basic corrosion protection, solely intended for function and safety.

"-2" signifies: extended corrosion protection with additional requirements on visual appearance.

# Protection class F1: humidity without condensation

*Protection class F1 is usually assigned to products used indoors. In these applications, products may encounter average humidity levels and/or moderate industrial atmospheres. Typical examples would be drain and pipework fans, switching and power system technology, interior areas of outdoor stations, climate control equipment and evaporators.*

| | |
|---|---|
| **Test description** | **Humid heat, constant**<br>DIN EN 60068-2-78 verification of protection level for “humidity without condensation” |
| **Test configuration** | The test specimens are inspected in what is for them an unfavorable situation. This designation is usually applied in accordance with shaft configuration (horizontal, vertical with rotor at top, vertical with rotor at bottom). |
| **Test sequence** | The test is always sub-divided into initial measurement, test loading and final measurement. The test specimens are not in operation while the test load is being applied. |
| **Test conditions** | Air temperature: 40 ±2 °C, relative humidity: 93 +2/–3 % |
| **Test duration** | 14 days |
| **Evaluation** | **Safety:**<br>• Leakage current and electrical strength acc. to § 16 from DIN EN 60335-1<br>• Protective wire protection acc. to § 27 from DIN EN 60335-1<br><br>**Function:**<br>• Power and current intake acc. to § 10 from DIN EN 60335-1<br><br>**Corrosion:**<br>• Definition of limit values not required |

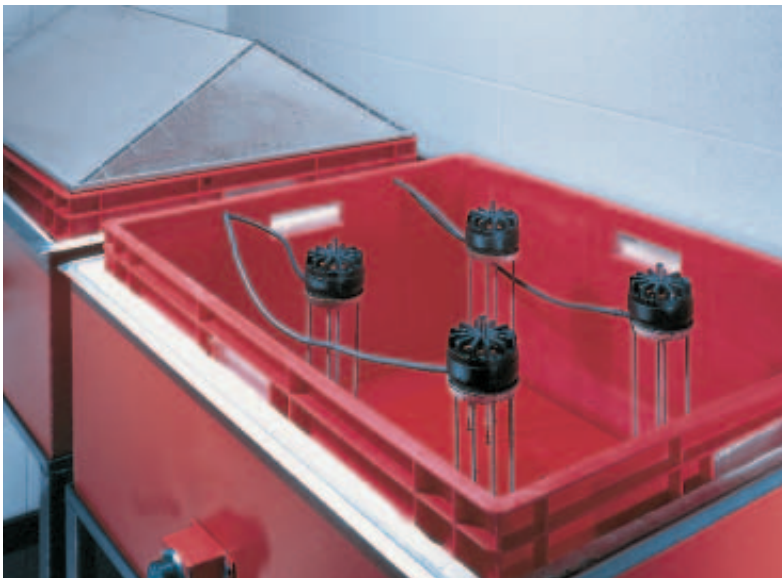
***F1 products are exposed to humid heat in our test facilities for a period of 14 days.***

# Protection class F2: humidity with condensation

*Protection class F2 covers products used outdoors or under cover, exposed to fluctuating temperatures and higher levels of ambient humidity, also in open-air sites with adverse industrial atmospheres. Examples are: fans in evaporators, condensers, air coolers in refrigeration systems or in climate control systems.*

| | |
|---|---|
| **Test description** | **Condensate test climate**<br>DIN EN ISO 6270-2 verification of protection level “humidity with condensation” |
| **Test configuration** | The test specimens are inspected in what is for them an unfavorable situation. This designation is usually applied in accordance with shaft configuration (horizontal, vertical with rotor at top, vertical with rotor at bottom). |
| **Test sequence** | The test is always sub-divided into initial measurement, test loading and final measurement.<br>The test specimens are operated in a cyclical manner during the test loading process; cycle duration = 8 hrs (7 hrs off, 1 hr on). The test loading process should always end after one hour of live operation. |
| **Test conditions** | Air temperature: 40 ±2 °C, relative humidity: 100 % dewpoint on test specimens |
| **Test duration** | 14 days |
| **Evaluation** | **Safety:**<br>• Leakage current and electrical strength acc. to § 16 from DIN EN 60335-1<br>• Protective wire protection acc. to § 27 from DIN EN 60335-1<br><br>**Function:**<br>• Power and current intake acc. to § 10 from DIN EN 60335-1<br><br>**Corrosion:**<br>• Criteria need to be agreed |

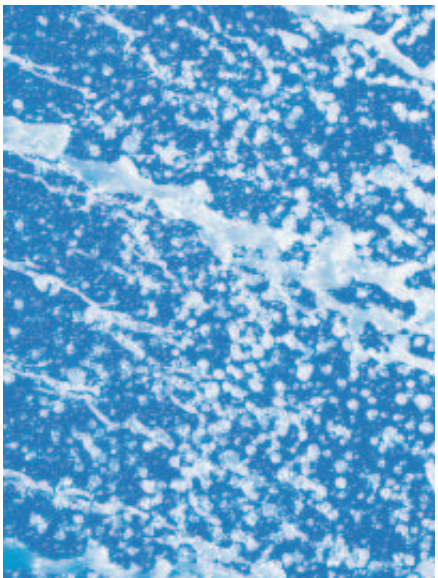
***The test conditions in protection class F2 assume that the products are 100 % thawed.***



# Protection class F3: spray water

*Products exposed in exterior locations or industry to very severe humidity and/or industrial atmospheres are assigned to protection class F3 "spray water". Typical applications include car washes, steam cookers, mobile refrigeration systems or applications in the automotive or rail sectors.*

| | |
|---|---|
| **Test description** | **Spray water loading acc. to**<br>DIN EN 605295 verification of water protection |
| **Test configuration** | The test specimens are tested in three installation positions: shaft horizontal, shaft vertical – rotor at top, shaft vertical – rotor at bottom |
| **Test sequence** | This test is divided into a test loading and a seal integrity check stage.<br>The test specimens are inspected in their least favorable operating condition. If this status is not known then the unit is tested while in operation, then again while not in operation. |
| **Test conditions** | Spray water: bore apertures in pipework: ±90°, tube swivel range: ±180° |
| **Test duration** | 14 days |
| **Evaluation** | **Safety:**<br>• Leakage current and electrical strength acc. to § 16 from DIN EN 60335-1<br>• Protective wire protection acc. to § 27 from DIN EN 60335-1<br><br>**Function:**<br>• Power and current intake acc. to § 10 from DIN EN 60335-1<br><br>**Corrosion:**<br>• Criteria need to be agreed |



***In protection class F3 our products are tested for seal integrity, i.e. leakage, while exposed to severe levels of water spray.***

# Protection class F4: salt spray

*Protection class F4 "salt spray" includes products which operate in external locations or in industry where they are subjected to high levels of corrosion and humidity – this in conjunction with aggressive and abrasive media. Typical applications: ship-building, chemical industry, laboratories, automotive, sea atmosphere, battery stations or offshore facilities.*

| | |
|---|---|
| **Test description** | **Salt spray loading**<br>DIN EN 60068-2-11 verification of protection level for "Salt spray protection"<br>(DIN 50021-SS, ASTM B117, Bellcore TA-NWT-000487) |
| **Test configuration** | The test specimens are inspected in what is for them an unfavorable situation. This designation is usually applied in accordance with shaft configuration (horizontal, vertical with rotor at top, vertical with rotor at bottom). |
| **Test sequence** | The test is always sub-divided into initial measurement, test loading and final measurement. In each case, 2 test specimens are tested while in operation and 2 test specimens are tested while not in operation. |
| **Test conditions** | Salt solution: 5 % NaCl, test room temperature 35 ±2 °C |
| **Test duration** | 14 days |
| **Evaluation** | **Safety:**<br>• Leakage current and electrical strength acc. to § 16 from DIN EN 60335-1<br>• Protective wire protection acc. to § 27 from DIN EN 60335-1<br><br>**Function:**<br>• Power and current intake acc. to § 10 from DIN EN 60335-1<br><br>**Corrosion:**<br>• Criteria need to be agreed |

***Test specimens in protection class F4 are tested in "salt spray" for up to 30 days.***

# Protection class F5: individual customer requirements

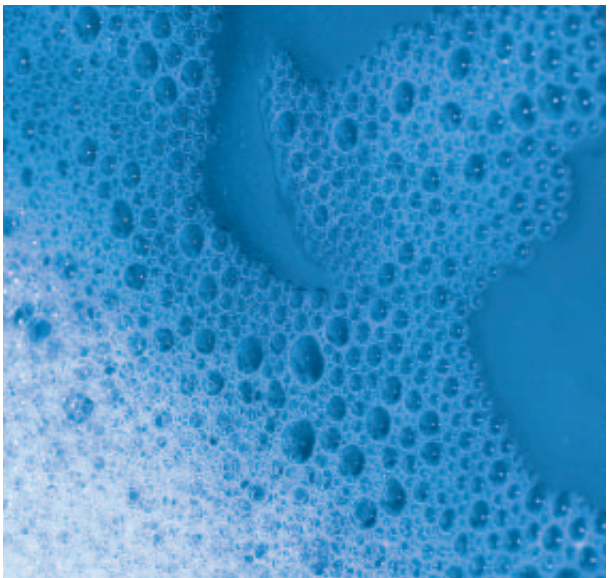
*In special cases, fans may be exposed to loadings which our inspections for protection classes F1–F4 can't take sufficient account of, or even simulate effectively. Take for example an environment subject to the use of aggressive chemical media or to the effects of extreme water pressure. For this, special tests are required and we conduct this in close consultation with our customers.*

**Individual tests – for individual protection**

One example among many would be the products used in washer-driers. In appropriate test facilities, we can simulate the seal integrity of fans to cleaning agents such as washing lye or other aggressive media.

In other tests, we test the extreme loadings to which our products may be exposed when being cleaned with high-pressure jets.

All these specialist tests are of course agreed in a customer-specific manner. Whether these applications are in the field of biotech, the foodstuffs industry or the medical sector, we work closely with our customers to define individually tailored corrosion and motor protection systems for specific applications, taking due account of the products and basic materials involved in each process.



***Individual test procedures simulate the influence of factors such as high-pressure cleaning or seal integrity, i.e. no leakage, when subjected cleaning agents.***

# Classification of corrosion

**At ebm-papst, classification of corrosion levels comes as standard in protection levels F2, F3 and F4. This forms the basis for an agreement on test and evaluation criteria.**

The test and evaluation criteria to be agreed include the load-application period to which the products are exposed. Here, values commonly range from 6 hours to 720 hours, i.e. 30 days.

For classification of corrosion, another key factor is the type of visible corrosion: from initial signs of red or white rust at the onset of rusting on smooth, unproblematic surfaces to the initial signs of rust at problem areas (e.g. welding areas, contact points, locating points and threads).

Another criterion is the scope of visible corrosion, and here the test period is quoted up to the starting point of visible corrosion.

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We take great pleasure in providing you with an overview in this brochure of the various processes and actions which both the external and internal components of an ebm-papst fan contribute to the related issues of climate and humidity protection. Furthermore, we provide an insight into the definition and verification of ebm-papst humidity classes F0 to F5 – and provide comprehensive answers to the frequently asked question: which protection class do I need for my specific application? Do not hesitate to contact us with any questions you may have: our specialists will be delighted to assist you.

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