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# Environmental design criteria

Use these environmental design criteria to ensure that your data center environment provides optimal conditions for your server operation.

The following environmental specifications are based on an altitude 1800 m (5906 ft above sea level). Some IBM® systems have more restrictive requirements on temperature, moisture, and altitude. For more information, see the individual system specifications.

Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors such as humidity or temperature might pose a risk to the server. Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the server to malfunction or cease functioning altogether. The environmental specifications set forth limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer. In the absence of specific limits that are set forth in the environmental specifications, you must implement practices that maintain particulate or gas levels that are consistent with the protection of human health and safety. If IBM determines that the levels of particulates or gases in your environment have caused damage to the server, IBM may condition provision of repair or replacement of servers or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility.

Table 1. Operating environment

| | **Operating environment[1, 5]** |
|---|---|
| Temperature | 18 degrees C (64.4 degrees F) – 27 degrees C (80.6 degrees F)[4] |
| Low-end moisture | 5.5 degrees C (41.9 degrees F) dew point |
| High-end moisture | 60 percent relative humidity or 15 degrees C (59 degrees F) dew point |
| Gaseous contamination | Severity level G1 as per ANSI/ISA 71.04-1985[2] which states that the reactivity rate of copper coupons shall be less than 300 Angstroms per month (Å/month, ≈ 0.0039 µg/cm2-hour weight gain).[6] In addition, the reactivity rate of silver coupons shall be less than 300Å/month (≈ 0.0035 µg/cm$^2$-hour weight gain).[7] The reactive monitoring of gaseous corrosivity should be conducted approximately 2 inches (5 cm) in front of the rack on the air inlet side at one-quarter and three-quarter frame height off the floor or where the air velocity is much higher. |
| Particulate contamination | Data centers must meet the cleanliness level of ISO 14644-1 class 8. For data centers without airside economizer, the ISO 14644-1 class 8 cleanliness may be met simply by the choice of the following filtration:<br>• The room air may be continuously filtered with MERV 8 filters. |

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|---|---|
| | • Air entering a data center may be filtered with MERV 11 or preferably MERV 13 filters.<br><br>For data centers with airside economizers, the choice of filters to achieve ISO class 8 cleanliness depends on the specific conditions present at that data center.<br><br>The deliquescent relative humidity of the particulate contamination should be more than 60% RH.[3]<br><br>Data centers must be free of zinc whiskers.[8] |

**Notes:**

1. The class 1 and class 2 temperature and moisture limits, measured at the IT equipment air inlet, are from ASHRAE Thermal Guidelines for Data Processing Environments, second edition (2009). Maximum recommended ambient temperature reduces 1 degree C (1.8 degrees F) for every 300 m (984 ft) over 1800 m (5906 ft). The ASHRAE class 1 allowable ranges are 15 degrees C – 32 degrees C, 20 percent – 80 percent relative humidity, and the class 2 allowable ranges are 10 degrees C – 35 degrees C, 20 percent – 80 percent relative humidity. For extended periods of time, IT manufacturers recommend that data center operators maintain the recommended environment for maximum reliability. The allowable environment is where IT manufacturers test their equipment operation in order to verify that the equipment operates. This is not a statement of reliability, but one of functional IT equipment.
2. ANSI/ISA-S71.04. 1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*, Instrument Society of America, Research Triangle Park, NC, 1985.
3. The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.
4. For ambient temperatures exceeding 25 degrees C (77 degrees F), the acoustical noise levels of the system might increase as the speed of the air moving devices increase.
5. The IT equipment acclimation period is 1 hour per 20 degrees C (68 degrees F) of temperature change from the shipping environment to the operating environment.
6. The derivation of the equivalence between the rate of copper corrosion product thickness growth in Å/month and the rate of weight gain assumes that $Cu_2S$ and $Cu_2O$ grow in equal proportions.
7. The derivation of the equivalence between the rate of silver corrosion product thickness growth in Å/month and the rate of weight gain assumes that $Ag_2S$ is the only corrosion product.
8. Surface debris is randomly collected from 10 areas of the data center on a 1.5-cm diameter disk of sticky electrically conductive tape on a metal stub. If examination of the sticky tape in a scanning electron microscope reveals no zinc whiskers, the data center is considered free of zinc whiskers.

Table 2. Non-operating environment

| | |
|---|---|

| | **Non-operating environment[2]** |
|---|---|
| Temperature | 5 degrees C (41 degrees F) – 45 degrees C (113 degrees F) |
| Relative humidity | 8 percent – 80 percent |
| Dew point | Less than 27 degrees C (81 degrees F) |
| Gaseous contamination | Severity level G1 as per ANSI/ISA 71.04-1985[1] which states that the reactivity rate of copper coupons shall be less than 300 Angstroms per month (Å/month, ≈ 0.0039 µg/cm$^2$-hour weight gain).[3] In addition, the reactivity rate of silver coupons shall be less than 300Å/month (≈ 0.0035 µg/cm$^2$-hour weight gain).[4] The reactive monitoring of gaseous corrosivity should be conducted approximately 5 cm(2 in.) in front of the rack on the air inlet side at one-quarter and three-quarter frame height off the floor or where the air velocity is much higher. |

**Notes:**

1. ANSI/ISA-S71.04. 1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*, Instrument Society of America, Research Triangle Park, NC, 1985.
2. The IT equipment acclimation period is 1 hour per 20 degrees C (68 degrees F) of temperature change from the shipping environment to the operating environment.
3. The derivation of the equivalence between the rate of copper corrosion product thickness growth in Å/month and the rate of weight gain assumes that $Cu_2S$ and $Cu_2O$ grow in equal proportions.
4. The derivation of the equivalence between the rate of silver corrosion product thickness growth in Å/month and the rate of weight gain assumes that $Ag_2S$ is the only corrosion product.

Table 3. Shipping environment

| | **Shipping environment** |
|---|---|
| Temperature | -40 degrees C (-40 degrees F) – 60 degrees C (140 degrees F) |
| Relative humidity | 5 percent – 100 percent (no condensation) |
| Wet bulb | Less than 29 degrees C (84.2 degrees F) |
| Shipping package | IBM-approved vapor barrier bag with desiccant |

Table 4. Storage environment

| | **Storage environment** |
|---|---|
| Temperature | 1 degree C (33.8 degrees F) – 60 degrees C (140 degrees F) |
| Relative humidity | 5 percent – 80 percent (no condensation) |
| Wet bulb | Less than 29 degrees C (84.2 degrees F) |
| Shipping package | IBM-approved vapor barrier bag with desiccant |

## Air quality

Many IBM systems are installed in environments other than the typical data center, business office, or clean industrial location. These environments might exhibit various temperatures, relative humidity, and levels of airborne particles or corrosive gases. IBM systems are designed to work within the environmental specifications shown in the previous tables unless otherwise noted on an individual system specification.

An environment is considered unacceptable when the temperature, relative humidity, corrosive gases, or solid particles in the air exceed specific limits set by IBM. Equipment that operates in environments classified as unacceptable might be subject to degraded performance and permanent damage if the equipment is not designed for such environments.

## Contaminants

IBM systems are being installed in increasingly diversified industries. Some of these industries, as a by-product of their processes, cause the atmosphere to contain measurable quantities of gases and solid particles that are potentially harmful to electronic equipment. Urban areas that are highly industrialized might have levels of gases and solid particles that cause an unacceptable environment exposure to exist throughout an entire area.

IBM is concerned with two classes of atmospheric contaminants; solid particles and gases. Solid particles in the air are referred to as particulates. Water vapor can combine with these tiny, solid particles and form compounds. Such matter is said to be hygroscopic. It can be harmful, depending on the particulate composition. Gases can form harmful acids or bases when combined with water. Because of the ability to absorb moisture, the relative humidity and temperature are significant factors in an unacceptable environment.

High concentrations of gases, such as sulfur dioxide, nitrogen dioxide, ozone, and acidic gaseous chlorine, which are associated with industrial processes, are known to cause corrosion and failure of electronic components. In addition to gases, some industrial processes produce particulate contamination. These particles can settle (in the form of dust) in surrounding areas even though the process producing the particles might be some distance away.

Industries engaged in processing petroleum, chemicals, primary metals, food, mining, and paper have a higher probability of encountering an unacceptable environment. However, contamination can be a result of construction, cleaning, or other activities that can occur anywhere.

A visual inspection is the first step in determining the likelihood of contamination. Some indicators of an unacceptable environment might include corrosion of metal such as door handles and hinges. Often, the presence of contaminants can be determined by odor as in the case of chlorine or sulfur, which have a distinctive smell. Observe whether a heavy layer of dust settles on surfaces, especially in the primary metals industry. This dust is often conductive and can create electrical arcing or short circuits if drawn into electronic equipment.

To determine adherence to IBM requirements for gases and particulates, laboratory techniques are necessary. Testing for gases and particulates involves special equipment and procedures. Contact your IBM installation planning representative for guidance.

If the environment is contaminated, IBM can also provide guidance on remediation, prevention, and control. Recommended solutions might include, but are not limited to, room pressurization, tighter relative humidity control, filtration, maintenance, and monitoring.

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