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Oracle Environmental Controls – Factory Qualification and Maintenance

Document Number and Revision: 923-7051939 Rev 05

Overview

This document details the Oracle environmental controls policy for qualifying and maintaining printed circuit board assembly (PCBA) and system assembly factories.

> **This requirement is general purpose for PCBA manufacturing, Systems Integration and Assembly factories and HDD aftermarket production areas.**

Audience

This document is intended for anyone internal or external to Oracle who is involved in the qualification of a new factory or on-going production of Oracle products within a partner factory where environmental monitoring is required.

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INTRODUCTION

Oracle requires its external partner/manufacturer to have in place environmental controls when building Oracle hardware, the intention of which is to aid in the prevention of product damage from adverse environmental conditions.

It is required that the external manufacturer monitor readings taken by environmental sensors and react accordingly to ensure that the monitored manufacturing environment is kept within the control limits outlined within the body of this document.

It is expected that the partner site will monitor the following environmental factors:

1. Air Quality via particulate count

2. Temperature

3. Humidity

Environmental monitoring is applicable to the following distinct phases:

1. Factory Bring up

Before any product is manufactured, the factory will be qualified so that it meets the standard required to build Oracle product. During this period, readings will be taken to monitor the difference between the external environment and that within the factory. In addition, the complete floor will be analyzed to identify hotspots/cold spots, high/low humidity, and high levels of airborne particles. This qualification process is intended to ensure that the HVAC systems are adequate, and the areas targeted for Oracle production meet the defined standards.

HVAC capacity should be calculated based upon the product being manufactured and the operations being performed. For example, during testing operations where components are stress tested, the power usage will increase and thus produce more heat. As such the HVAC system being installed or in place must have calculations approved by Oracle which ensure that ventilation will be adequate during maximum production runs.

2. Continual Monitoring

Once a factory is in full production mode, it must carry out continual monitoring of the areas specific to Oracle products by installing environmental sensors. These sensors will provide real time environmental readings at intervals outlined within this doc.

The EM or IM partner is responsible for the maintenance of the sensors. They must ensure that they are providing accurate data at defined intervals. This data must be published to Oracle as defined within OpenApi/Swagger specification provided through Doc AQP-10024.

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> **Note:**
>
> **It is understood that there is a requirement on manufacturing partners to write a software solution to comply with these requirements. Oracle will accept environmental readings manually uploaded in spreadsheet format (detail here a spreadsheet format to indicate that the temp humidity and particle readings) on a daily basis (uploaded to the partners' cloud share location) until the automated process interfacing with Oracles cloud API is fully in place.**

ENVIROMENTAL POLICY

FACTORY QUALIFICATION

It is expected that the partner has a documented environmental policy for temperature, humidity, and particulate monitoring. These policies should have control limits to which the partner adheres to. These limits must meet Oracles defined limits.

The supplier's documented environmental policy must accommodate final assembled product requirements as well as component level requirements such as board level.

During factory qualification, environmental data must be recorded for the following types of area.

Storage

Areas where oracle components of high values are stored. It is important that readings are taken as components can be damaged due to high levels of humidity.

Incoming Inspection

Areas where any component may be exposed to the atmosphere should be monitored.

Assembly

Any operation which requires the physical placement of components has a high risk of contamination and as such should be closely monitored. Contamination due to airborne particles is very high risk in this type of operation.

Test Operations

Any system test operation will be monitored. Specifically with respect to temperature and humidity which can have high, detrimental impact on the unit under test.

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When relevant, any Oracle hardware being used within the test infrastructure must also be part of the ongoing environmental monitoring process.

Suface Mount

Any areas connected to surface mount operation should have monitoring to ensure external contaminants cannot affect the overall process.

Packaging

Due to the nature of the materials used within the packaging operations, it is important that these are strictly monitored for air quality.

Entrances and Exits

Entrances to the manufacturing floor must implement robust controls to eliminate externally sourced contaminants and prevent extreme fluctuations in temperature (*temperature spikes and drops*) which could impact Oracle product quality.

> **Note:**
>
> **These areas will be verified and validated by Oracle Supplier Engineering as part of the Technical Capability CDM review.**

Measurement and Time Study for Air Particle Qualification

The particulate count measurements for factory qualification must be carried out with readings being taken using the following guidelines.

Measurement A – Environment and Ventilation System

1. Measure the external air quality particle count outside the building within 10m of the Oracle manufacturing building.
2. Record the time, date, and weather conditions at the time of reading taking place.
3. Take a temperature and humidity reading.

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4. Record the particle count for greater than or equal to 0.5 microns, greater than or equal to 5 microns.

The trend of the particle count inside a building often correlates to the trend of the count outside the building. As soon as practical after the above measurement, measure the air output from the ventilation system to the factory floor in the area closest to the place where the work is done. Record as per that taken externally.

> **Note:**
>
> The output from the HVAC system is typically the cleanest air in the factory. If this measurement does not meet the limit required for the factory, improve the ventilating system. This measurement must be made after a period of at least 72 hours of zero precipitation. Record the particle count for greater than or equal to 0.5 microns, greater than or equal to 1 micron and greater than or equal to 5 microns.

Measurement B – Workstation Environment

Determine the workstation that likely has the highest particle count by doing the following:

1. Measure the particle count at each workstation.
2. Record the count on a production floor layout map.
3. Look for trends that show a gradient from top to bottom or side to side of the production floor.
4. Use this information to identify, and if possible, eliminate the source of particulate contamination.
5. Repeat the measurements once the sources of contaminants are minimized.
6. Record the particle count for greater than or equal to 0.5 microns, greater than or equal to 1 micron and greater than or equal to 5 microns.

Measurement C – Time Study

1. Once the most contaminated area is identified, set up the particle counter to collect data at least every 10 minutes for a period of one week.
2. Record the particle counts for greater than or equal to 0.5 microns, greater than or equal to 5 microns.

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3. Also record the temperature and humidity values at a rate of 1 reading per 10 minutes.

4. Collate and graph the results at the end of this monitor period.

Clear procedures will be available to address situations where particle counts exceed established limits. These procedures will require documentation of the specific actions taken, including the date, time, and individuals involved.

CONTINUAL ENVIRONMENTAL MONITORING

The supplier must have a documented environmental policy which defines process for temperature, humidity and particulate monitoring and control within their factory. This policy should be inclusive or already meet Oracle's environmental policy guidelines.

The supplier's documented environmental policy accommodates final product requirements as well as component level requirements.

The supplier's documented environmental policy meets human safety requirements as well as environmental requirements for chemicals, electronic, non-electronic materials, and systems.

Controls are in place to take immediate action to bring any out-of-bound conditions within acceptable levels and to notify Oracle of the out-of-bound conditions.

Systems are in place for traceability to material experiencing the out-of-bound conditions.

MINIMUM PARTICLE METER SPECIFICATIONS FOR CONTINUAL MONITORING

You must have at least one particle sensor capable of being calibrated annually against a known standard, such as the ones produced by Setra ™.

This sensor should be calibrated on a yearly basis and certificates should be obtained showing this calibration has been performed.

Multiple installed particle sensors can be of a different type, but need to meet the following requirements (some of these requirements can be met via software):

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- Provide a sum of all particles that are:
    - >0.5 microns
    - >5 microns
- Provide a sampling rate of at least 1 sample every 10 minutes.
- Be capable of taking readings continuously without human intervention.
- Be capable of having data uploaded from it without human intervention.
- Provide the data in particle count per cubic meter.
- Transmit the data to an Oracle provided REST endpoint.

> *Note*:
> **Document AQP-10024 details the Open API specification for generating client software to communicate with the Oracle REST services for environmental data submission.**

The particle sensors that you choose need to return measurements within 20% of your calibrated unit on average at the same location, for all channels utilized, over 24 hours of readings. Checks against the calibrated unit should be done annually. Units which do not meet this standard need to be re-calibrated or replaced.

Particle Sensor placement requirements:

For sites with established environmental monitoring in place prior to January 1st, 2024, there should be a minimum of one particle sensors per room where boards, systems or rack units are assembled. After January 1st, 2024, there should be two such sensors per room.

The installed particle sensors should be placed in a manner that meets these requirements:

- Particle sensors should be within 5m of operations which include optical cable insertion, component insertion (including but not limited to- DIMM insertions, PCI card insertion, CPU insertions), and any debug activity involving particle-sensitive interfaces such as DIMM, CPU, PCI card or optical cable insertions.
- The particle sensors must be installed as close as possible to the elevation at which the component insertion activity is taking place.

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PARTICULATE LIMITS

Oracle's air particle limits for monitoring are as follows:

> The Oracle limit is 150% of the particle count required for ISO class 8 or the Federal Standard 209E class 100,000 clean room for particles greater than or equal to 0.5 micron and particles greater than or equal to 5.0 microns. The limit is a count of 150,000 per cubic foot (5,280,000 particles per cubic meter) for particles that are greater than or equal to 0.5 micron and 1249 particles per cubic foot (43,950 particles per cubic meter) for particle sizes 5.0 microns and above.

Table 1 Particulate Count Limits All values are in m³

Standard	Max $\geq 0.5\mu m$	Max $\geq 5\mu m$	Comment
	$\geq 0.5\mu m$	$\geq 5\mu m$	
ISO 8	3,520,000/m³	29,300/m³	Class 100,000
ORACLE	5,280,000/m³	43,950/m³	
ISO 9	35,200,000/m³	293,000/m³	Room Air

MINIMUM TEMPERATURE/HUMIDITY SENSOR REQUIREMENTS:

> Many sensors measure both temperature and humidity in a single device. In the case that these are separate devices, the Sensor Requirements section applies to both temperature and humidity sensors. These sensors should be placed as close as possible to each other in each location.

> These requirements can be met either via the device or through software that interfaces with the device (I.E unit conversion, communication to the Oracle Cloud, etc. can be done outside of the device if required)
>
> - There must be a minimum of one sensor per area.
> - Provide a sampling rate of at least one sample every 10 minutes.
> - Be able to take readings unmonitored and continuously.

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- Be placed at a static location within a particular area.

- Transmit the data to an Oracle provided cloud endpoint.
  TDMS API REST services (doc number AQP-10024)

- Devices should be placed between 1.2 – 3m elevation.

- Devices should be placed every 20m except for L10 / L11 test areas, where the following applies:

    o Floor coverage should be that devices are placed every 5m or less.

    o The device should be located on the "cool" isle, I.E should measure the inlet air feed.

    o Devices should be placed between 1.2 – 2.2m elevation. Where physically possible, the height of temperature sensors should be set to the level of the air intake of the units at the tops of racks.

Temperature:

- Temperature should be sent in degrees Celsius.

- With allowable tolerance of ± 2 degrees Celsius.

Humidity

- Humidity should be sent in terms of percentage of relative humidity.

- With allowable tolerance of ± 5% RH.

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TEMPERATURE AND HUMIDITY LIMITS

Any excursions out with the following limits for an extended period of more than 8 hours should initiate an immediate investigation of which Oracle should be notified.

Table 2 Temperature and Humidity Limits

Environmental Reading	Lower limit	Upper limit	Unit of measure
Temperature	16	29	Celsius
Humidity	25%	70%	Relative Humidity

Be aware that during the qualification of a factory the heating, air filtering, and air conditioning (HVAC) requirements must be calculated on a maximum capacity basis such that during production, the environmental limits are easily maintained without burdening the installed HVAC systems.

FAILURE TO MAINTAIN ORACLE THRESHOLDS

It is expected that a partner will monitor the data being gathered from the environmental sensors on a continual basis and will initiate alarms to which they will adopt a process to act upon in the appropriate manner to address and rectify all excursions from Oracle environmental limits.

All excursions of a duration more than 8 hours should be escalated to Oracle via the allocated site engineer.

During continual monitoring

- Document the measurements taken and the sources of contamination that were minimized or eliminated.
- Document the sources that cannot be minimized or eliminated.
- Explain why Oracle must qualify the facility despite failure to meet spec limits.
- The issues will be added to the weekly quality review agenda and discussed and minuted.

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Contaminant Protection for Sensors

In the event of construction work being performed in the buildings and areas where Oracle boards and systems are being tested and manufactured, Oracle products and the environmental monitoring sensors supporting them will be protected from potential debris and contaminants. Oracle will be informed of the impact and duration of construction work.

Sensor Calibration

It is the responsibility of the partner to calibrate and/or measure the accuracy of all sensors against an externally calibrated reference sensor (such as a handheld sensor) to verify the accuracy of the data being collected.

This calibration exercise should be recorded and tracked by the partner site and made available to Oracle as and when requested with a rolling retention period of 1 year.

Auditing for Environmental monitoring

Since Oracle is receiving the environmental readings on a continual basis, Oracle may request that existing sensors be moved, or possibly more sensors be added as part of its ongoing audit of the data being streamed.

Additionally, Oracle may request that an audit of an area be carried out either by an Oracle person or individual from the partner site, to validate sensor readings and/or effectiveness of the readings for the area.

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Document History and Approvals

Dash	Rev	Date	Description of Change	Originator
01	A	12 Jun 2012	Initial release.	N/A
			Fusion History	
02	A	01 Aug 2020	**Amended** title. **FROM:** Oracle Factory Qualification Particulate Guideline **TO**: Oracle Environment Controls - Factory Qualification and Maintenance **Amended** overview. **FROM**: This document details the existing Oracle policy for particle count for qualifying and maintaining printed circuit board assembly (PCBA) and system assembly factory. **TO:** This document details the Oracle environmental controls policy for qualifying and maintaining printed circuit board assembly (PCBA) and system assembly factories. **Added** 'running' to Audience section. **Removed** Introduction **Added**: General Section Environmental Policy Section **Updated** Factory Qualification Section **Removed** 'If available on the counter' throughout document. **Changed** Section 1, Oracle particulate Count Guideline Limit, second paragraph. **FROM**: The Oracle guideline limit is 150% of the particle count required for ISO class 8 or the Federal Standard 209E class 100,000 clean room for particles greater than or equal to 0.5 micron. The guideline limit is a count of 150,000 per cubic foot for particles that are greater than or equal to 0.5 micron. **TO:** The Oracle guideline limit is 150% of the particle count required for ISO class 8 or the Federal Standard 209E class 100,000 clean room for particles greater than or equal to 0.5 micron and particles greater than or equal to 5.0 microns. The guideline limit is a count of 150,000 per cubic foot (5,280,000 particles per cubic meter) for particles that are greater than or equal to 0.5 micron and 1249 particles per cubic foot (43,950 particles per cubic meter) for particle sizes 5.0 microns and above.	N/A

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			Removed Section 1, 3rd paragraph, HEPA filter statement. **Added** to Table 2-1 ISO 14644: 43,950/m³ to Oracle Limit row, Class column. **Amended** Note 4 to include 5.0 microns. Added to Section 2: requirement that counter must be able to take readings unmonitored and continuously. **Added** to Section 4, Particle Count Meter:1.0 micron and 5.0 microns to first bullet on counter measurement. **Removed** second bullet on counter measurement. **Removed** reference to blank figure 4-1 **Added** Factory Maintenance Section **Removed** reference to 923-2001 **Added** High dollar storage areas to 3 Factory Qualification and Factory Maintenance, Particulate count. **Added** statement on taking readings during their quarterly audit statement to 6 Particulate Count Measurement Method for Factory Qualification	
02	B	24 Sept 2020	**Re-wrote document in order to expand scope to monitoring particle, temperature and RH metrics after factory qualification.**	
03	A	3 March 2021	**Renamed document to reflect guidance on temperature and RH in addition to particulate.** **Changed** lower humidity specification to 25% RH. **Added** section on references regarding temperature, RH and particulate limits.	
04	A	12 May 2023	**Changed** upper temp limit to 29℃	
05	A	13 Feb 2024	**Document restructured to bring in line with new DMG specifications.**	

Accompanying Information

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References

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