SUPER DRY®
Totech

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COMPREHENSIVE MSD MANAGEMENT

Many companies have purchased dry cabinets for different reasons. They know the issues about oxidation and de-lamination which can occur and are especially prevalent in lead free soldering processes. They have read the IPC standard IPC-J-STD-033B.1 & 020C and thus are aware of MSD and MSL component levels.

Super Dry by Totech has extensive experience designing and manufacturing dry cabinets for companies like Siemens, Bosch, Foxconn, Ericsson, Flextronics and has also conducted MSD test research in conjunction with numerous companies. Others have asked us to document for them a comprehensive MSD process, called MSD Management.

Super Dry's products are built around this MSD Management concept by designing and manufacturing different kinds of drying & storage performance cabinets, specially built dry rooms, feeder cabinets, vacuum machines & bags, and also track and trace systems. We understand the need for a total range of drying and storage solutions.

MSD Management starts at the warehouse or even earlier, at the desk of the purchasing department. The purchaser who is buying components (and PCBs) should be obliged to search for suppliers who are able to deliver dry and oxidation free components packed in a moisture barrier bag (MBB)with the highest possible MVTR (moisture vapor transmission rate) If the supplier cannot guarantee this, other suppliers should be sourced.

There are numerous examples of suppliers who are shipping components in an ESD pink poly bag or in a shielding bag or even in plain plastic bags. Components must be shipped in a MBB with a very good MVTR, which, according to IPC standards is < 0.002 gm/100 in^2 in 24 hrs/40 degree C, or even better quality bags as Totech is selling (MVTR of < 0.0006 gm/100 in^2 in 24 hrs/40 degree C. The higher the barrier, the longer that moisture can be kept out of the bag.

Unfortunately, many component suppliers, and especially brokers, are unconcerned about drying. They buy large quantities and repack them without taking notice of the humidity and oxidation problems. Some suppliers indicate that they do not care at all, by

packing MSD components in plain plastic bags or a shielding bag because it resembles an MBB bag. Competent suppliers and brokers would know that every batch sent to customers must be dried until the components have reached <0.1Wt% to be sure that the critical saturation level has not been reached. After that the products should be packed along with a Humidity Indicator Card with the use of a vacuum chamber machine with or without the use of N2 to remove the moisture out of the MBB Bag.

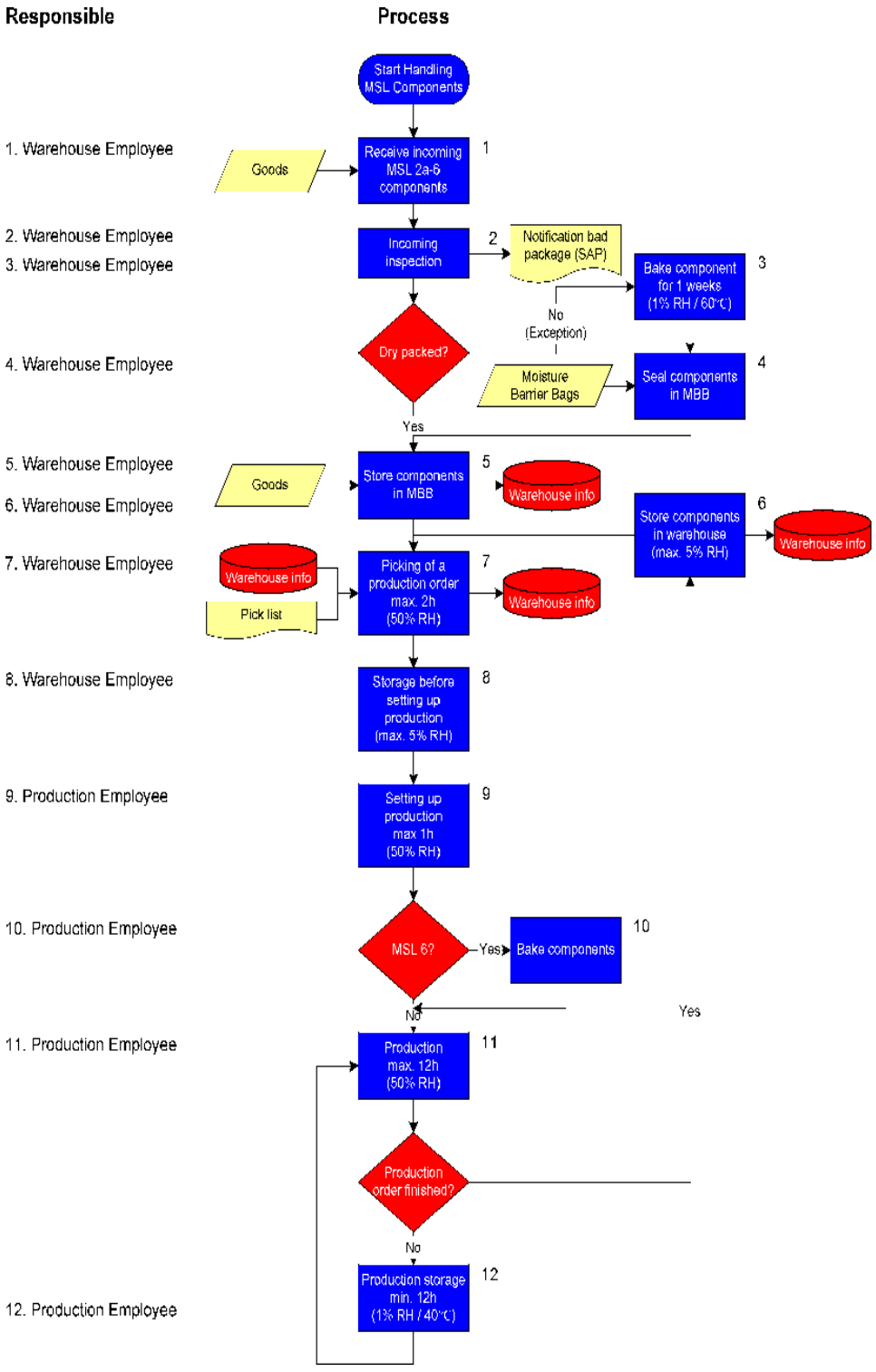
Our experiences implementing robust ESD Management Procedures demonstrated that this is a matter of time and training before the proper level of knowledge becomes mainstream.

Therefore many companies take their own responsibility to dry and store components over their entire process.

See one example below :

2. Process description

The process below describes the way to handle MSL 2a - 6 components. MSL 1 and 2 components are treated as normal components. Almost every MSL level can be treated the same, only MSL 6 has a different process. The MSL 6 components need to be low temperature baked before use. The key to this process is to ensure that the moisture in a component never reaches a critical weight percentage (≈ 0.1%). In Figure 1 the process for handling MSL components is displayed, and in Figure 2 the flow of MSL components is displayed schematically.


Responsible
Process
Start Handling MSL Components
1. Warehouse Employee
Goods
Receive incoming MSL 2a-6 components
1
2. Warehouse Employee
Incoming inspection
2
Notification bad package (SAP)
3. Warehouse Employee
Bake component for 1 weeks (1% RH / 60°C)
3
No (Exception)
4. Warehouse Employee
Dry packed?
Moisture Barrier Bags
Seal components in MBB
4
Yes
5. Warehouse Employee
Goods
Store components in MBB
5
Warehouse info
6. Warehouse Employee
Store components in warehouse (max. 5% RH)
6
Warehouse info
7. Warehouse Employee
Warehouse info
Pick list
Picking of a production order max. 2h (50% RH)
7
Warehouse info
8. Warehouse Employee
Storage before setting up production (max. 5% RH)
8
9. Production Employee
Setting up production max 1h (50% RH)
9
10. Production Employee
MSL 6?
Yes
Bake components
10
No
Yes
11. Production Employee
Production max. 12h (50% RH)
11
Production order finished?
No
12. Production Employee
Production storage min. 12h (1% RH / 40°C)
12

2.1. Incoming MSL components (step 1)

The MSL 2a - 6 components are received with the normal goods. The MBB may not be removed here.

2.2. Incoming Inspection (step 2)

The incoming MSL 2a - 6 components get an incoming inspection. By this inspection the dry pack (e.g. MBB) is checked. The package can fail on two points, a damaged dry pack or no dry pack at all. A damaged dry pack is not vacuum anymore, this is visible with the naked eye. Both failures need to be baked out and sealed again.

Also it is important to make a notification to the supplier that there packaging wasn't correct, so they can improve this in the future deliveries.

2.3. Bake components (step 3)

When MSL components are delivered without a proper dry package, it is unknown how long a component has been exposed to ambient (not dry) conditions. Because of this the component is considered as wet and need to be dried. To dry a component, it needs to be baked dry. Baking components can be done in different ways, in an oven or in a dry cabinet.

Our process is based on drying in a low bake dry cabinet. Historically drying in an oven was based on a high temperature (125°C), in our lead free process we do not want that components or PCB's will be baked higher then 60 °C due to the oxidization and therefore risks of wettability problems. Also not all the components and there packages can handle 125°. Drying in a dry cabinet is based on a low %RH (≤ 5% RH) and a lower temperature max (60°C). To shorten the needed drying time, the %RH and temperature in the dry cabinets used in the process are different then required, < 1% RH at 60°C. This makes it possible to low bake all components dry within 1 week.

To indicate the time a component is in the baking cabinet, a sticker with the starting date need to be placed on the component.

2.4. Sealing components (step 4)

Storing components in dry cabinets is relatively expensive, this has several reasons. The main reasons are that the dry cabinet self is expensive and the storage efficiency (e.g. tapes/m^3) is less than the normal storage locations. Because of this the decision is made to store the incoming MSL components (new tapes etc.) in a MBB at a normal storage location. Also the components that have been baked dry, need to be sealed in a MBB and stored at a normal storage location.

The sealing of components can be done with a sealing machine, the SDV-46, and a MBB. There are several sizes of MBB's to seal the components efficiently.

Figure 3: SDV-46

2.5. Store components in MBB (step 5)

The components sealed in a MBB are stored at a normal location (not a dry cabinet). This is to prevent the need of many dry cabinets.

2.6. Store components in warehouse (step 6)

When components return from production, they are stored in dry cabinets at the warehouse. These are Storage cabinets without heating, because this storage is long term based and doesn't have to dry a component within 12 hours. A 5% RH cabinet with no heating is enough for the warehouse.

2.7. Picking a production order (step 7)

When picking a production order, the components in a dry cabinet must be used first. This is to handle the components FIFO, because a component only goes in a dry cabinet when it's an opened package. Also it's important to pick all the MSL components at once to reduce the time the dry cabinet is open, and the time the components are in ambient conditions.

When a component is removed from a MBB, a dry storage sticker need to be placed on the component's package to indicate that the component is MSL sensitive.

2.8. Storage before setting up production (step 8)

After the order is picked the MSL components on tape are stored in a dry cabinet at the production setup location (where the tapes are placed on feeders). The other MSL components as trays and stick components are stored in a dry cabinet at production.

2.9. Setting up production (step 9)

When setting up production, the needed tapes are placed on the feeders and stored at production in a feeder dry cabinet. The other components of the order are placed in a normal dry cabinet at production. When a component is removed from a MBB, a dry storage sticker need to be placed on the component's package to indicate that the component is MSL sensitive.

Every feeder that contains a MSL component, need to be marked with a MSL indicator card.

2.10. Bake components (step 10)

When a component has MSL 6, the component needs to be baked out every time before production. This can be done the same way as described in step 2 .

2.11. Production (step 11) and production storage (step 12)

When the MSL components reach production, they enter a cycle of production (ambient) and drying (production storage). This cycle depends on the time the components are in production and in the dry cabinets. When the times of 12 hours are maintained for each step, the weight percentage of a component never reaches a critical limit. The process is based on a stable cycle, were the moisture that enters a component in 12 hours during production is dried out at night during dry storage (1% RH at 40°C). This temperature and low % RH is needed to realize enough drying speed to ensure the working of the process.

When a component is removed from a MBB, a dry storage sticker need to be placed on the tape to indicate that the component is MSL sensitive.

3. Drying conditions

The MSL process depends on several drying condition as % RH, temperature and time. As described in the process steps, different values for % RH, temperature and time are used. The reason for these values is described below.

4.1. Baking

When baking a component, the target is to get as many moisture as possible out of the component in a short time. This can be done by baking a component under special condition for a certain time. In the IPC-J-STD-033B.1 standard these conditions and times are described. Different components and MSL's have different time of baking, but to make the process universal, the maximum time is used. The maximum time to bake is 79 days at 5% RH at 40°C. For reducing the time there are several possibilities, increasing the temperature or lowering the RH. To bake the MSL components in an acceptable time, while guarding against oxidation,the cabinet needs to reach 60°C and less than 1% RH.

To calculate the new time with these conditions, the following rule is used. Every +10°C the time halves and with half the % RH the time also halves. When recalculating the 79 days from the IPC-J-STD-033B.1, only 5 days[1] remain. To be safe for every component, the decision is made to bake for 7 days (1 week).

4.2. Warehouse

In the warehouse the components are often stored for a relative long time. That is why the cabinets don't have to dry at a high speed. Also the components that arrive at the warehouse are dry, when the process is executed properly. Therefore the cabinets used at warehouse are simple, they have no heaters. The humidity in the cabinets reaches 1% RH, but after opening a door, the recovery time may be >30minutes This isn't a problem for the cabinets in the warehouse that are accessed infrequently..

4.3. Setting up production

Here applies the same reasoning as at the warehouse, the components that arrive are already dry. Therefore the cabinets here also don't have any heaters. The humidity in the cabinets reaches 1%RH but because they are accessed more frequently, a faster recovery time is more critical.

4.4. Production

When a component reaches the production, it enters a cycle of 12 hours drying and 12 hours wetting. This will only work when a component never reaches the critical 0.1 Wt%. In Figure 4 /5 the behavior of wetting and drying of a component is displayed.

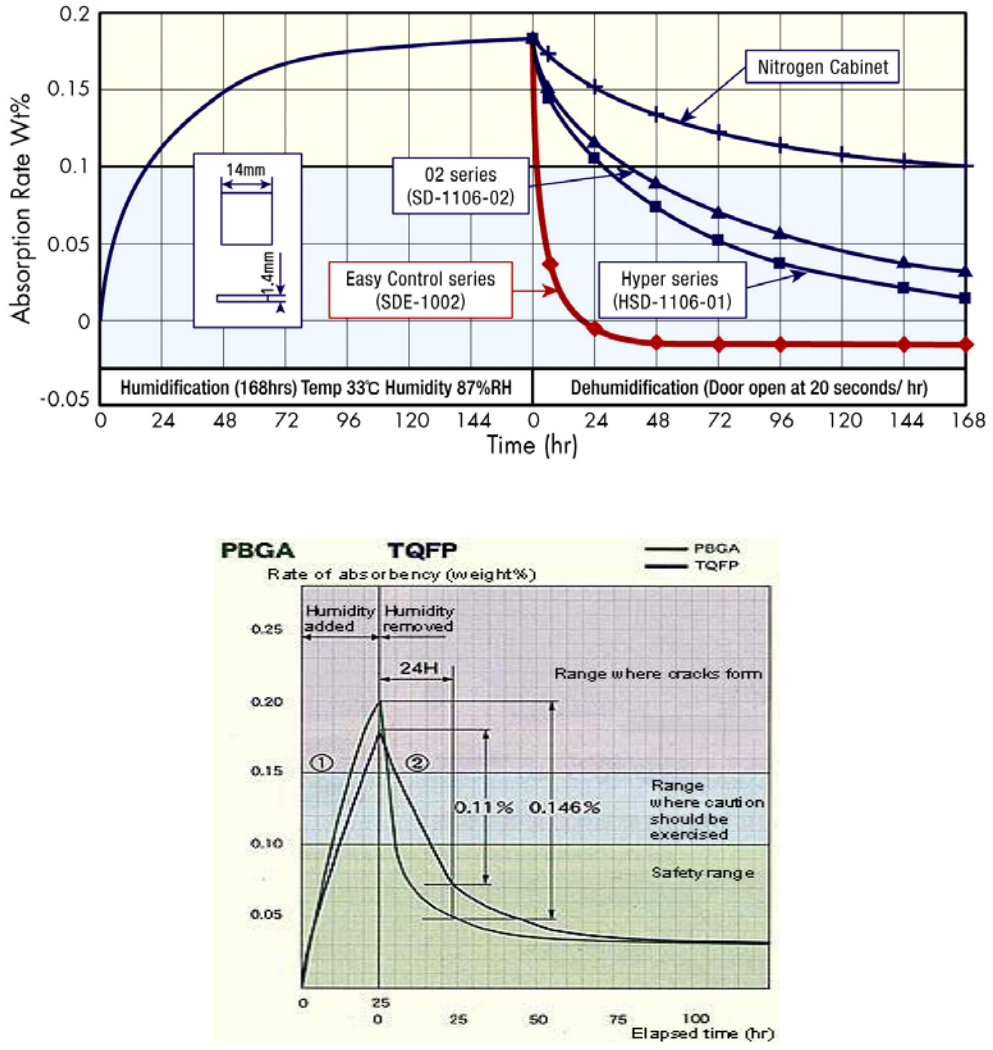


Figure 4/5: Behavior of wetting and drying

With this information and some help of a drying expert, the drying condition for the drying cycle could be defined. When the cabinets at production are less then 1% RH and are heated up to 40°C, the components can be dried back far enough to stay under the critical limit. The course of the weight percentage of a component is displayed in Figure 6, this is only a sketch of the real course.

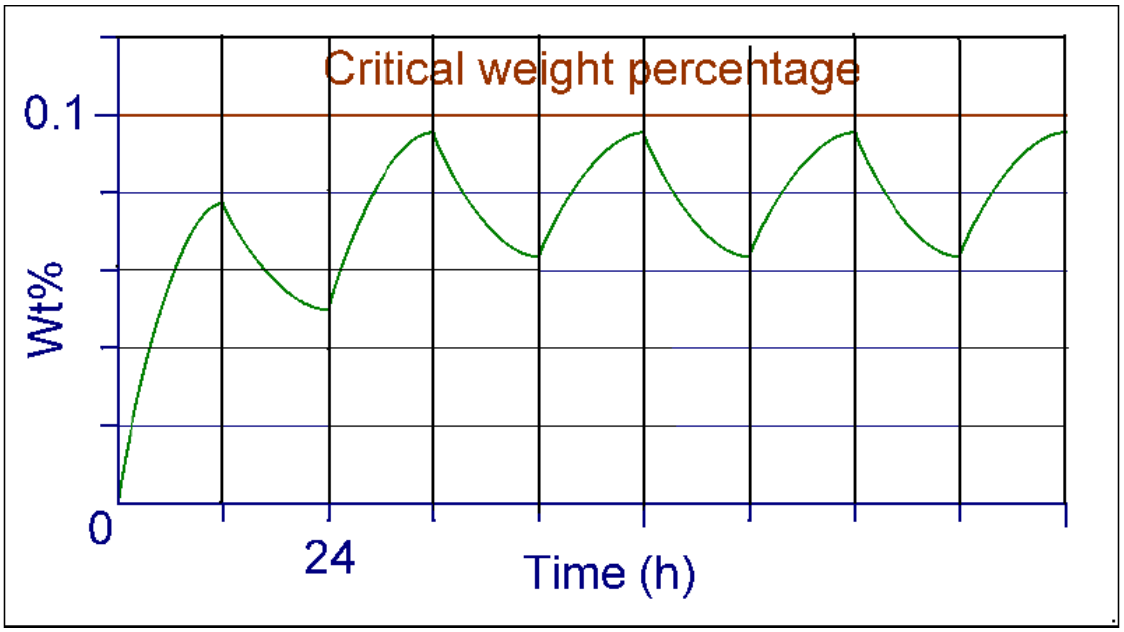


Figure 6: Weight percentage of components in the drying cycle

5. Dry cabinets

To effectively store the MSL components, several kinds of dry cabinets are utilized. This is because of the different demands, different packages and the feeders used in the production line.

5.1. Warehouse

In the warehouse, most components are on tape or in a tray. For storing the trays, there is a dry cabinet with normal shelves. The cabinets used for tray components are the HSD-1406 and the HSD-1404. The shelves of these cabinets are adjustable in height and extra shelves can be added. For the tapes, a difference can be made between small and big tapes. The small tapes can be stored in the same cabinets as the trays, only the shelves need to be adjusted. For the small tapes sliding shelves with springs are needed. The big tapes cannot be stored effectively in the HSD cabinets, these tapes can be stored in a MSD-1202 or a MSD-1212 cabinet. The shelves in this cabinet also have springs placed on them. The small tapes can also be stored in these cabinets when necessary.

Figure 10: HSD-1406-52

Figure 11:MSD1202/1212

The baking of components will also take place in the warehouse, this happens in a heated dry cabinet. The cabinet used for baking components can be a XSD-702 of a XSD-1404, these are cabinets with a less then 1% RH and a heater up to 60°C.

Figure 10: XSD-702

Figure 11: XSD-1404

5.2. Setting up production

At the place where the tapes are placed on the feeders (setting up production), only tapes are stored. Because of the lower quantity of tapes a small cabinet is placed here to store the tapes. The SD-703-31 is used, this is a cabinet with normal shelves.

5.3 Production

Cabinets for storing components at the production have an extra requirement, the cabinets need to be lower, so you can overlook the entire line. There are a few lower cabinets as the SD-532, but these cabinets cannot dry fast enough and feeders don’t fit in there. This is why two custom cabinets are made. One of these cabinets is especially for feeders and tapes, the other on is made for trays, tapes and PCB’s