Welcome to the Principle Cabinet Design training module for the DCS800, ABB DC drives.
If you need help navigating this module, please click the Help button in the top right-hand corner.
To view the presenter notes as text, please click the Notes button in the bottom right corner.
The aim of this course is to highlight the important issues in cabinet engineering and installation, and to provide hints about the best practices.

These guidelines are just hints and suggestions - the final responsibility is always with the cabinet builder and designer.
The contents of this training module include:

- safety in cabinet design,
- serviceability and user friendliness,
- requirements of the right enclosure class,
- cooling of the cabinet,
- EMC and grounding,
- Important documents and
- Testing of a cabinet.
After completing this module, you will be aware of issues affecting the safety of cabinet design and assembly, know what serviceability means and be aware of the issues affecting the selection of the right enclosure class for different environments from the drive point of view.
Safety is the primary and most important matter.

- Every unit has high voltages that may cause death.
- In high-power units short-circuit currents can be significant.
Safety consists of two main points: first, the cabinet has been made safe to use and second, that the actual installation of the cabinet is carried out safely without personal injury. These issues are crucial particularly when dealing with larger modules as the short-circuit currents and weights of the units are greater.

Here is an example of what would happen if there were a short circuit in a cabinet that is connected to a 65 kA supply network without any fuse/circuit breaker protection.
Here is a list of hardware manuals for different drives including their safety issues.

- DCS800 - Hardware Manual describes all hardware components for DC Drives
- Safety and operating instructions for drive converters
- Manual regarding installation in accordance with EMC
- Further documents like user manuals, installation manuals for modules as well as cabinets
The manuals describe how to protect the drives and which kind of protection is necessary. For instance, if fuses that are too large are put into the drive, the protection may not work in the way desired.

Follow the guidelines! - It is not only a matter of drive protection, but also of your own personal safety!
Protection of the drive includes ensuring the safety of the busbars. For example, the busbars in front of the fuses and circuit breakers only have the same protection as the supply busbars and cables from the transformer to the drive. Note that the short circuit power may be very high.

If the mechanical support is not good enough, the busbars can loosen and touch the frame of the cabinet (due to mechanical force during short circuit).

View the next slide to see an example of properly supported busbars.
Here is an example of properly supported busbars. Take a look at the isolated distance bolts which are responsible for ensuring enough air distance to ground and other voltage levels. Do not overlook vibrations during operation and transportation!
Remember to always use doors in the cabinet.

In the event of a short circuit, the door prevents flames and particles from being ejected out of the cabinet.

The doors must be strong enough to withstand the pressure in case of a strong short circuit.

With high power levels, the forces in affect can be very high.

In this example the plexi doors do not provide enough protection in the event that a short circuit occurs.
The cabinet should be designed so that the cabinet guides the short circuit discharge pressure in the right direction. For example,

- the cabinet has holes large enough on top or in back, or
- the discharge pressure opens the cabinet roof.

When in operation the door must be prevented from opening.
Always remember to cover the live parts properly.
If the shroud is made of conductive material, pay special attention to its mechanical strength to prevent it from touching live parts at all. (also finger protection)
Here you can see an example of a cabinet and which parts must be covered.
- DC converter input,
- AC breaker/Contactor output,
- Line reactor terminals,
- Supply devices, e.g. fuse base,
- DC converter output,
- AC power supply busbars.
The actual installation of the module in the cabinet must be done safely. Some of the larger power modules may be especially heavy. You should therefore
• provide the right kind of tools for lifting and handling the units and
• remember that the centre of gravity may be quite high in the module so there is a high risk of it falling over.
The serviceability is very important for cabinet configuration.

- This affects the assembling of devices
- The marking of all components
- The general location of other devices
Serviceability is also a very important issue for cabinet design.

- It should be possible to pull out all components without removing other devices.
- In principle, that means devices should not be blocked from busbars or other components.
• Devices should be properly marked for easy identification. The CE sign requires cable marking class B.
• This applies for item designations, wire marking and cable as well as connector marking.
• Terminal strips should be marked with numbers which can be found in the single-line diagram.
• Also devices mounted in the front door should be marked with labels.
The location of other devices should be explained on this slide.

- For better use and safety:
  - Remember to leave enough cabling space. That means enough space for tools and, for large powers especially, many thick cables are used that are difficult to handle.
  - The switch fuse should be the first device in the cabinet after the cable connection. Busbars before the fuse switch should have sufficient short circuit tolerance.
  - The control and monitoring devices and the main switch handle must be at the right height. In Europe this is defined by the machinery directive.
The next issue is the selection of the right enclosure class.

• This depends on the official IP definitions,
• the place of installation and
• the humidity
Here you can see the definitions of some typical IP classes.

- **IP00** means unprotected
- **IP20** (twenty) means touch protected but no protection from water
- **IP21** means touch protected and protected from dropping water directly from the top
- **IP22** means touch protected and protected from dropping water even if tilted 15° to the arbitrary direction from the normal position
- **IP42** means protected against objects larger than 1 mm in diameter, protected from the dropping water even if tilted 15° to the arbitrary direction from the normal position
- **IP54** means dust protected, protected against splashing water
- **IP65** means dust protected, protected against water jets from all directions
- **IP66** means dust protected and protected against a strong water jet
Here are some issues which influence choosing the IP-class.

For example, corrosive gases can exist at sewage treatment plants, pulp mills and seaside locations due to salt.

If the incoming air contains conductive dust, it collects on the circuit boards and electrical components and causes short-circuits if there are sufficient amounts.

Other types of dust do not necessarily cause short-circuits, but they affect air circulation and therefore overheat the unit. However, if the dust gets moist, it may very well cause a short-circuit.

If the humidity is too high, there is a risk of condensation, short-circuit and corrosion.

Temperature changes, due to cold nights and warm days, may cause water to collect on the surfaces.

Hygiene and washing issues are typical in the Food & Beverage industry.

Direct sunlight may heat the equipment considerably.

Rodents may cause short circuits or block air flow.

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### Examples of Issues to be Considered

<table>
<thead>
<tr>
<th>Item</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Enclosure must be closed enough to prevent from touching live or moving parts and to prevent from the e.g. short circuit arcs</td>
</tr>
<tr>
<td>Corrosive gases</td>
<td>Corrupts e.g. PCBs and other electronics</td>
</tr>
<tr>
<td>Conductive dust</td>
<td>May cause a short circuit</td>
</tr>
<tr>
<td>Other dust</td>
<td>May block the cooling and if getting wet may cause a short circuit</td>
</tr>
<tr>
<td>Humidity</td>
<td>May cause a short circuit and corrosion</td>
</tr>
<tr>
<td>Temperature changes</td>
<td>May cause condensing</td>
</tr>
<tr>
<td>Hygiene</td>
<td>Cabinet must be made of material that does not cause problems from hygiene point of view</td>
</tr>
<tr>
<td>Washing by using water hose</td>
<td>Water may get into the cabinet causing short circuit</td>
</tr>
<tr>
<td>Vandalism</td>
<td>May heat the equipment considerably.</td>
</tr>
<tr>
<td>Sunshine</td>
<td>May cause short circuit or block air flow</td>
</tr>
</tbody>
</table>
Solutions for challenges.

Ways to cope with the issues:

- Use a good enough enclosure
- Locate the drives to a control room where issues have been taken care of

On the other hand, remember that higher enclosure classes normally increase the costs:

- Consider if the higher enclosure class is really necessary
Here are some examples of different solutions in challenging environments.

- **Safety protection** means an enclosure class of at least IP 20, a door in the cabinet and a cabinet and door structure and fixing which are sturdy enough.

- **Protection against corrosive gases** means a totally enclosed cabinet design as well as coated boards and busbars.

- **Protection against conductive dust** is doable with an enclosure class of at least IP 54 including air inlet filters and coated boards.

- **Humidity protection** must include a cabinet heater, mechanical filters, non-corrosive materials as well as coated boards and busbars.

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<table>
<thead>
<tr>
<th>Item</th>
<th>Examples of the solutions</th>
</tr>
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<tr>
<td>Safety</td>
<td>- At least IP20 enclosure class</td>
</tr>
<tr>
<td></td>
<td>- Door in the cabinet</td>
</tr>
<tr>
<td></td>
<td>- Strong enough cabinet and door structure and fixing</td>
</tr>
<tr>
<td>Corrosive gases</td>
<td>- Totally enclosed cabinet design (requires typically a heat exchanger)</td>
</tr>
<tr>
<td></td>
<td>- Coated boards and busbars</td>
</tr>
<tr>
<td>Conductive dust</td>
<td>- At least IP54 enclosure class</td>
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<tr>
<td></td>
<td>- Air inlet (and outlet) filters OR totally enclosed cabinet design</td>
</tr>
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<td></td>
<td>- Coated boards</td>
</tr>
<tr>
<td>Other dust</td>
<td>- See above</td>
</tr>
<tr>
<td>Humidity</td>
<td>- Cabinet heater (for stand-by situation)</td>
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<td></td>
<td>- If necessary, mechanical filters</td>
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<td></td>
<td>- Non-corrosive materials (e.g. galvanized steel)</td>
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<td></td>
<td>- Coated boards and busbars</td>
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</tbody>
</table>
### Example Solutions (2/2)

<table>
<thead>
<tr>
<th>Item</th>
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<tr>
<td>Temperature changes</td>
<td>- Cabinet heater (for stand-by situation)</td>
</tr>
<tr>
<td>Hygiene</td>
<td>- E.g. in food industry in certain areas the cabinet may have to be made of stainless steel</td>
</tr>
<tr>
<td>Washing by using water hose</td>
<td>- Good enough enclosure class (at least IP65 or IP66)</td>
</tr>
<tr>
<td>Vandalism</td>
<td>- Strong enough cabinet</td>
</tr>
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<td></td>
<td>- Locks on the door</td>
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<tr>
<td>Sunshine</td>
<td>- E.g. sun protection and/or double core construction in the cabinet</td>
</tr>
<tr>
<td>Rodents, insects etc.</td>
<td>- Insect screen in the air inlet and outlet</td>
</tr>
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</table>

- Temperature changes can create condensation and should be solved by a cabinet heater
- Hygiene guidelines which are important for the food industry require a stainless steel cabinet
- A sturdy enough cabinet with locked doors protects against vandalism
- Sunlight protection requires a double core construction in the cabinet
- Protection against rodents and insects is possible with an air inlet and outlet filter
The key points of this module are

- Safety of cabinet design and assembly
- Serviceability
- Selection of the right enclosure class
Additional information

- DCS800 Hardware Manual (3ADW000194)
- Safety instructions for DC drives