Usual and unusual service (operating) conditions

Siemens Integrated Drive Systems ensure Motor / VFD / Gearbox compatibility for all types of service and environmental conditions

What are usual/unusual service conditions, and why is this important?

Explanation of service conditions
There are many abnormal or unusual service conditions that are a result of the surrounding ambient conditions or interfaces with the equipment. These conditions have a direct impact on a system’s performance, and affect the system’s long term reliability. These surrounding conditions include ambient temperatures, large temperature swings, high altitudes, contamination or moisture, excessive vibration, or unusual forces acting directly on the system. If not properly considered, any one of these may lead to premature failure and unacceptable downtime. The system integrator must be aware of how these environmental conditions and their changes affect the performance of the system. The system integrator also must ensure that these conditions are communicated to each of the product providers, and ensure the different components work well together. This can be quite complicated and require the end user, who is acting as the system integrator, to acquire extensive knowledge of each product. The end user will normally find this responsibility to be error prone and time consuming. Siemens, on the other hand, can provide a more reliable and complete system, with experts that already have extensive knowledge of Siemens motors, Variable Frequency Drives (VFDs)*, and gearboxes.

In any case, we must first establish and understand what the normal or usual service conditions are. They are listed below for discussion and consideration. Siemens can design to unusual service conditions when specifically requested. Any deviation from usual service conditions listed here must be communicated in writing, so they can be evaluated and included in the solution.

* Variable Frequency Drive (VFD) maybe used interchangeably with Adjustable Frequency Drive (AFD).
Summary of normal/usual service conditions

A. Motors, VFDs and Gearboxes

1) Ambient temperatures
   a) Maximum ambient temperatures not greater than 40 °C
   b) Minimum ambient temperatures (Motors and Gearbox only) should not be less than -15°C for machines equipped with grease lubricated bearings, or less than 0°C for machines equipped with oil lubricated bearings. Minimum ambient temperature should be less than 5°C when water cooling is used.
   c) Swing in ambient temperature from cold-to-hot not greater than 15°C.

2) Ventilation of the machine should not be hampered by close surroundings that could block air flow or recirculate hot air to product air inlets. Installation in a supplementary enclosure such as a pit, or poorly ventilated room also can inhibit ventilation.

3) Not subjected to damaging high velocity winds.

4) No lint or dirt in the environment that could accumulate and interfere with normal ventilation or cooling.

5) No excessive moisture in environment
   a) Standard Humidity Levels (non-offshore; non-marine)

6) No unusual contamination in cooling air such as radiation, salt, oil vapor or other damaging chemicals

7) Not located in a very dry location, or where there is radiant heat, or possibility of vermin infestation, or a damp atmosphere conducive to the growth of fungus

8) Non-hazardous Area
   a) No exposure to: Combustible, explosive, abrasive, or conducting dusts
   b) No chemical fumes, flammable or explosive gases

9) Installation on a rigid mounting surface

10) No abnormal loading or external forces such as: shock, vibration, excessive external, lateral, or torsional vibration, axial or side loading, or mechanical loading from external sources

11) The rating of any component in the Integrated Drive System (IDS) cannot be outside of the published ratings in the Siemens catalog.

B. General VFD Specific Usual Service Conditions plus all of A above

1) 0-95% Humidity, non-condensing

2) All power cells operating; no Power Cells bypassed

3) Motor operating within nominal power rating of VFD

4) The overload requirement on the VFD output current does not exceed 110% of the nameplate current, 1 min / 10 min (1 min out of every 10 min)

C. SINAMICS GH180 MV VFD Specific Usual Service Conditions plus all of A above

1) 47°C maximum coolant inlet temperature for Water-cooled VFDs

2) Installation altitude not greater than 3300 feet (1000 meter)

3) Installation on a level mounting surface

4) Nominal Medium Voltage input +10, -5% @ rated frequency ±5%

5) Input MV main power quality to VFD (less than .03 HVF calculated per MG1 Part 30.1.2.1)

6) Power source stiffness must be able to withstand inrush current
   a. Typically greater than 10 times the rated input current for at least 2 cycles
7) Air-cooled GH180 VFD does not have regenerative capabilities. Regenerative capability is an option on the Water-cooled GH180. However, this must be specified.

8) Operating range of the VFD output frequency is 0.1Hz - 330Hz. Continuous operating VFD output frequency range is 10Hz - 167Hz.

9) Power, signal and safety grounds per Siemens GH180 Perfect Harmony VFD.

10) Overmodulation is not used.
    a. This would increase torsional to 3%

11) VFD output cable length not exceeding 2.2 km for GH 180.

12) Design of the Perfect Harmony GH-180 is not intended for applications where speed coordination among multiple VFDs or motion control are required.

13) Due to its compact integrated design, the Perfect Harmony GH-180 can be easily installed in Control Houses.

D. SINAMICS LV VFD Specific Usual Service Conditions plus all of A above

1) Proper grounding is done on the front end of the VFD

2) Installation altitude not greater than 6600 feet (2000 meter)

3) Continuous operating VFD output frequency range is 10Hz - 100Hz.

4) For SINAMICS G120, output cable length does not exceed 100m. For SINAMICS G150, output cable length does not exceed 300m.

5) Non-regenerative capability is standard. Some LV VFDs also have regenerative capabilities. However, these must be specified.

E. Motor Specific Usual Service Conditions plus all of A above

1) 30°C maximum Inlet temperature for water-cooled motors where available

2) Installation altitude not greater than 3300 feet (1000 meter)

3) Balanced voltage levels (Defined as less than 1% voltage unbalance)

4) Power system connected to motor is solidly grounded (see MG 1) or Phase to Ground Voltage is not greater than +10% of rated voltage.

5) Operation departure from rated voltage or frequency does not exceed 10% individually or sum of both when connected directly to utility power (see 12.44 for alternating current motors)

6) Unbalance of supply voltage does not exceed 1% (see 12.45 and 14.36)

7) Not operated in an inclined position.

8) Installation is on a massive foundation per MG 1 Part 7.6.3

9) Clean Power signal coming to motor (Less than .03 HVF per MG1 Part 30.1.2.1)

10) Motor, gearbox alignment within .002 inch TIR

11) No resonances of the foundation within ±10% of rotational frequency or ±5% of two times rotation frequency, or one- or two- times electrical line frequency as defined in MG 1 Part 7.6.3

12) No operation where there are/is:
    a. Torsional impact loads
    b. Repetitive abnormal overloads
    c. Operation at speeds above the highest rated speed
    d. Reversing or electric braking
    e. Frequent starting (see 12.55)
    f. Out-of-phase bus transfer (see 14.45)
    g. Frequent short circuits
    h. Operation at standstill with any winding continuously energized

F. Gearboxes Specific Usual Service Conditions plus all of A above

1) Starts & Stops Per Hour ≤ 5 or continuous duty

2) Reversing Per Hour ≤ 5

3) Service Factor ≤ 3.5

4) Input Speeds ≤ 1800 rpm

5) External Vibration ≤ 10mm/s

6) Minimum Overhung and Thrust Loading

7) Motor, gearbox alignment within .002 inch TIR

8) No resonances of the foundation within ±10% of rotational frequency or ±5% of two times rotation frequency

9) No Operation where there are/is:
    a. Torsional impact loads
    b. Repetitive abnormal overloads
    c. Operation at speeds above the highest rated speed
**Problem solution**

It is important to understand that the above list of usual service conditions are the fundamental basis for the product design and compatibility of the entire system when no other information is provided. Therefore, it is crucial to verify that all these usual service conditions are met or any and all unusual service conditions are communicated so the design can be modified as necessary to ensure reliability.

If this task seems difficult, Siemens has the expertise to help the end-user identify all the appropriate concerns, and come up with the most cost-effective solution and most reliable option. Siemens will internally process a technical Limits of Authority (LoA) to all the internal experts to ensure the impacts on the design and delivery are included in the final solution.

By addressing unusual service conditions you can optimize your integrated drive train and will ensure system compatibility, uptime, reliability and performance. The alternative is premature system failure and unacceptable downtime.

**Qualification**

Siemens must be made aware of any Unusual Service Conditions or special design considerations at the time of proposal in order to include them in design, price and delivery impacts. Without them, Siemens responsibility is limited to the product compatibility under Usual Service Conditions, excluding the interaction with the driven equipment. System responsibility for any Unusual Service Conditions must be specifically stated in the Request for Proposal or Request for Quotation.

* Refers to the horizontal integration of Siemens Integrated Drive Systems: Functional, mechanical and energy-efficient integration of the drive train – motor, gear unit, coupling, and converter – along the power flow. This does not cover the vertical integration aspect (based on Totally Integrated Automation).