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Challenge in the industry: Start-up behavior of ACC Drivetrain

➢ **Component selection/sizing versus lifetime**

1. Evolution of high efficiency motors:
   Byproduct = High starting torque

2. High starting torque:
   Byproduct = “Spring-loading” in drivetrain by fan high mass of inertia

3. Outcome:
   Higher starting torque and service factor of gearing

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Solution → **Drivetrain with Soft–Start:**
More safety, Less exposure

1. Controlled start-up:
   Lower starting torque of the motor

2. Less shock loads:
   Eliminate “Spring loading” in drivetrain by high mass of inertia of the fan

3. Optimizing gear unit selection:
   Avoid over-sizing based on starting torque

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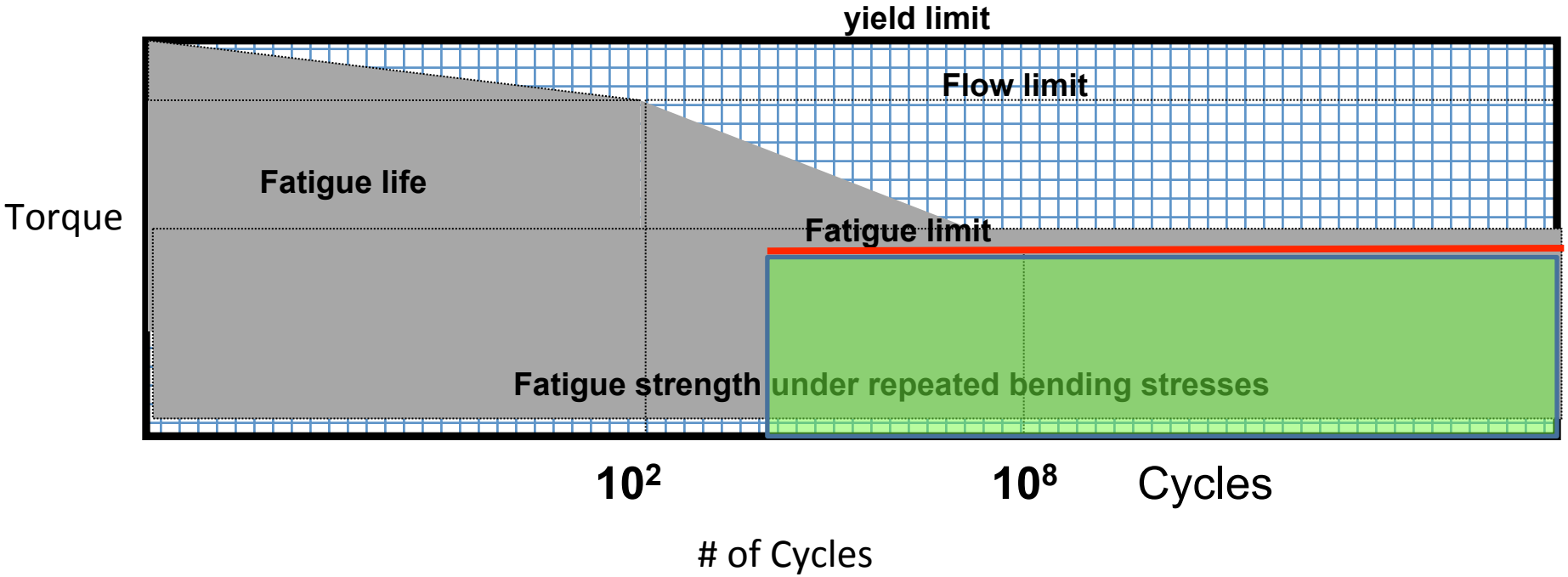
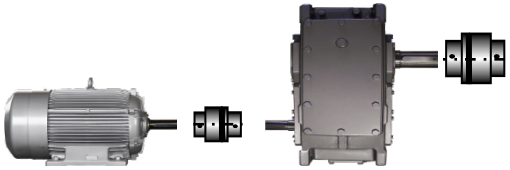
The general selection of gear reducer is made by torque!

Material stress curve



Catalog torque is based on the fatigue limit line



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What is considered when selecting gear unit for a fan drive??

The nominal torque of the fan drive has to be calculated according the technical specification. For example:
PM = 100 KW
n fan = 47,8 rpm
T2 (effective torque) = 20000 Nm (177,000 in-lbs)

Effective
T2 output torque
= 20.000 Nm
(177,000 in-lbs)

Typical service factor according AGMA => 2 based on motor or fan power
SF = 2
T2 (design torque) = 40000 Nm (354,000 in-lbs)

Safety
SF =2
+ 20.000 Nm
(177,000 in-lbs)

The Selected Gear unit must have a nominal catalogue torque of => 40.000Nm (354,000 in-lbs).
The gear unit must have 2x safety factor based on the **fatigue strength under repeated bending stresses**

catalogue torque capacity
= > 40.000 Nm
(354,000 in-lbs)

- Start-up behavior of the complete driven system (motor/gear unit/ fan) has to be considered due to high mass of inertia the fan.
- Gear units are designed to handle short time starting torque 2x nominal torque, but also limited by the number of cycles.

Fatigue life with max. short time torque
< 80.000 Nm
(708,000 in-lbs)

Typical starting curve of a fan drive with TRADITIONAL motor:

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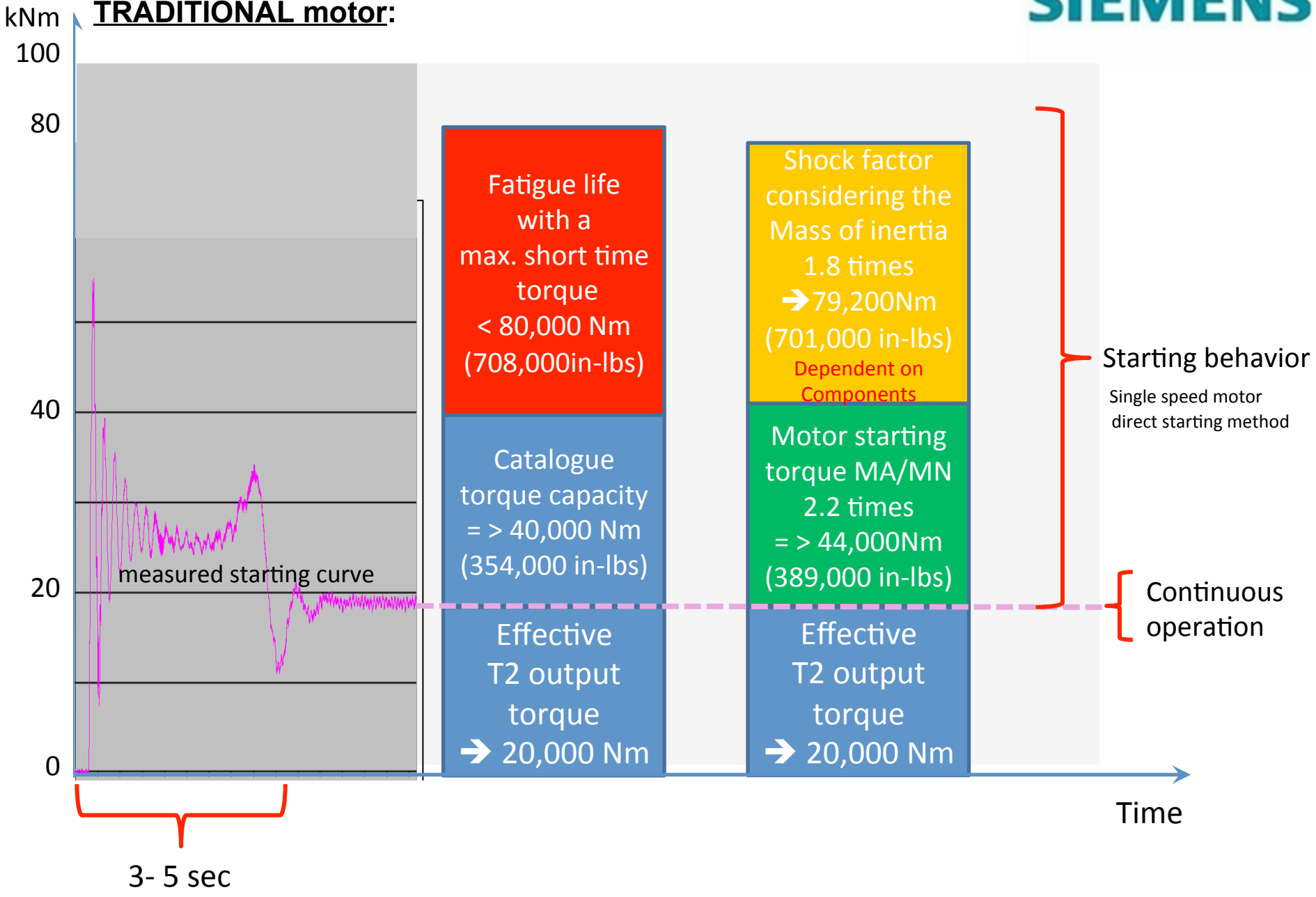

Gear Unit selection based on starting behavior (TRADITIONAL motor):

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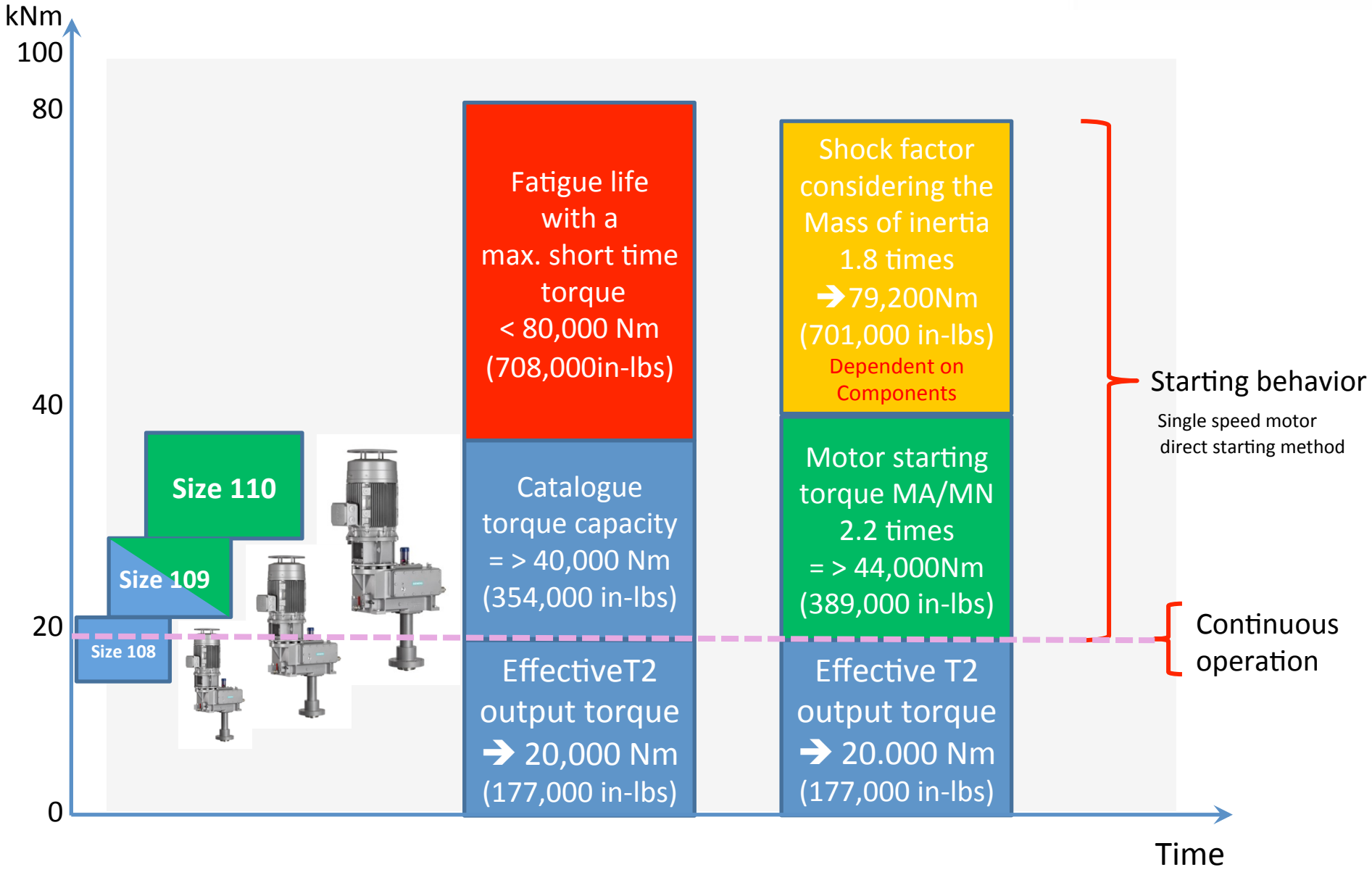

Larger **Gear Unit selection based on starting behavior (HIGH EFFICIENCY motor):**

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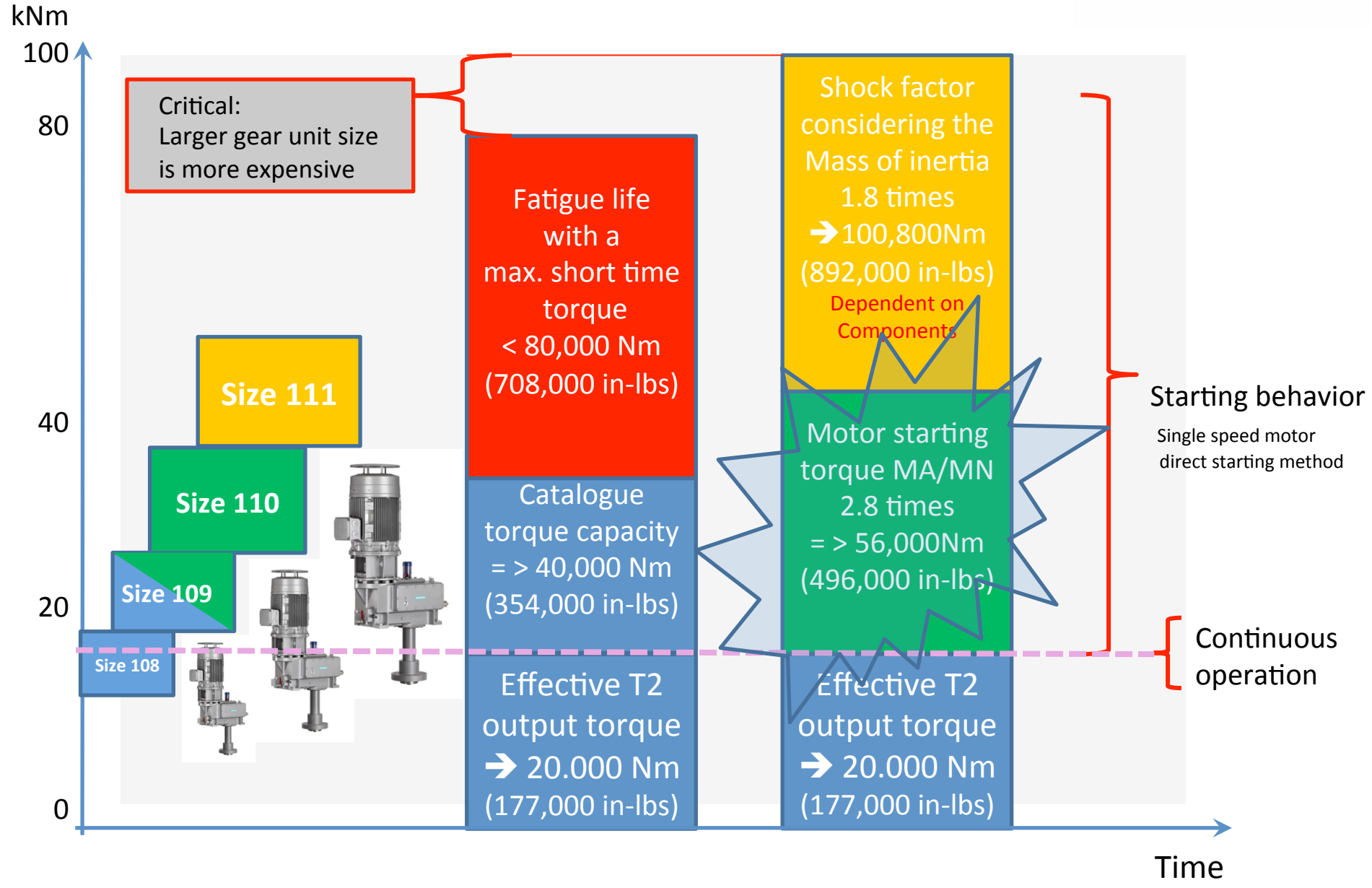

History of starting torques MA/MN

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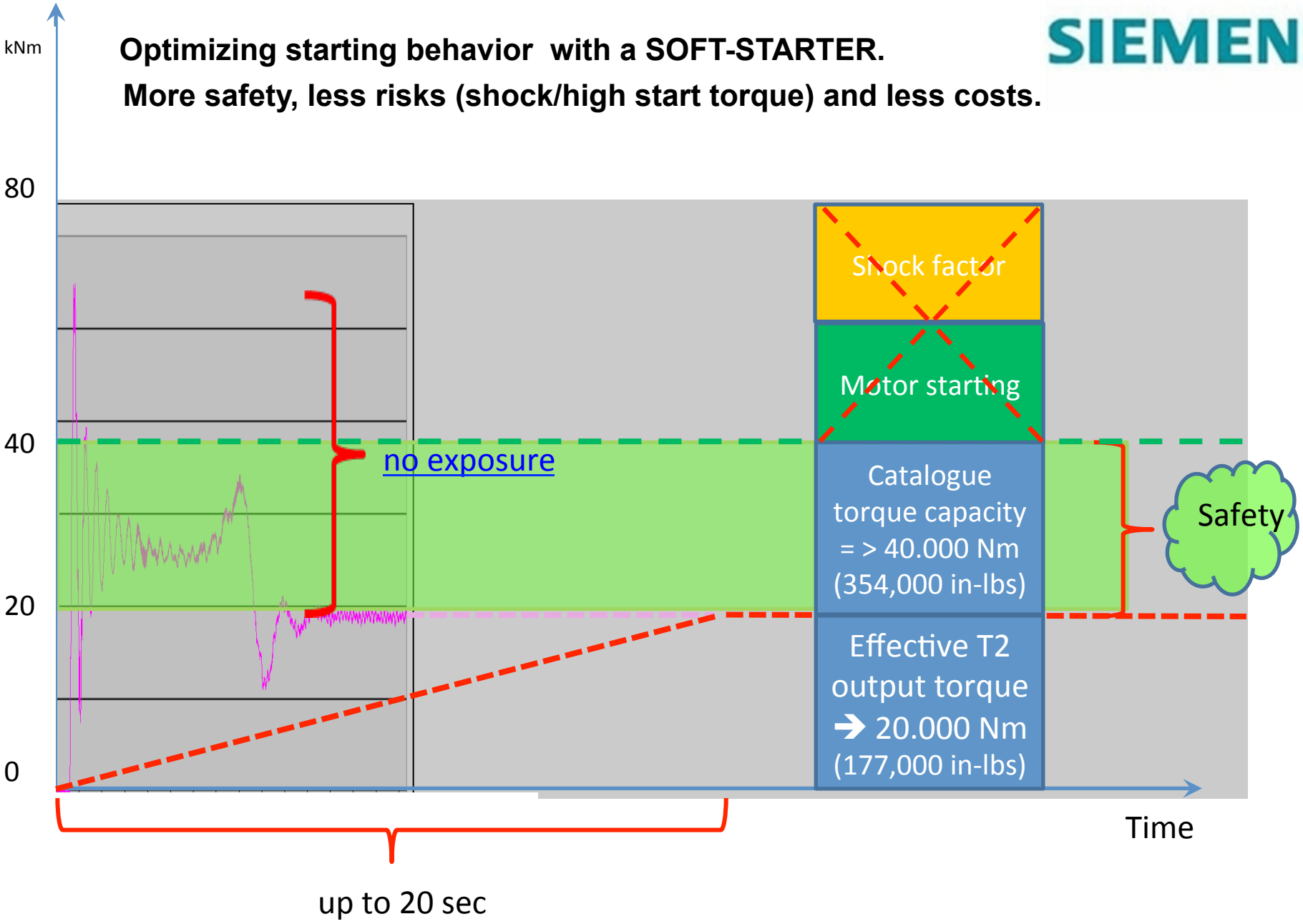
Starting torque of high efficiency motors has become *more aggressive* and must be considered for direct started machines.

IE1 = Standard Efficiency
IE2 = High Efficiency
IE3 = Premium Efficiency

Proper installation is the responsibility of the system manufacturer. But, the supplier of components needs to *integrate the behavior of entire system (IDS)*.

Optimizing starting behavior with a SOFT-STARTER.

More safety, less risks (shock/high start torque) and less costs.



Soft – Starter instead of Contactors

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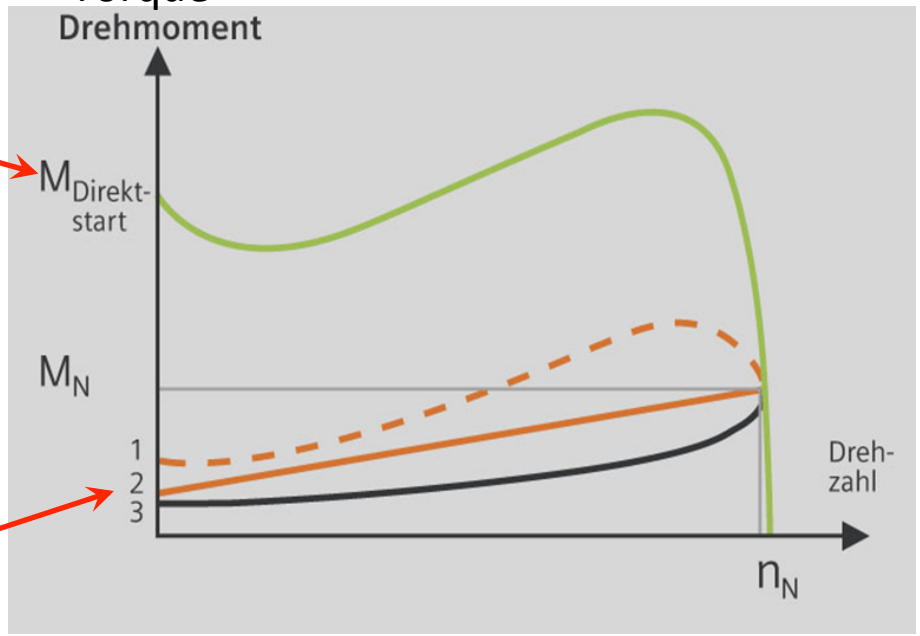
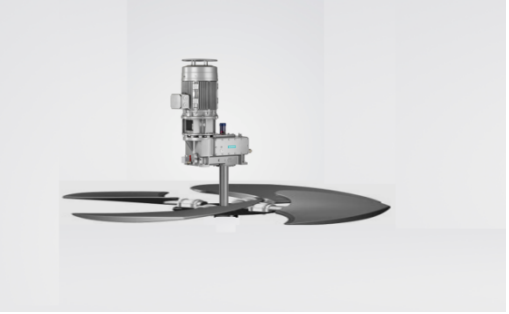
Siemens contactor

Torque



Speed

Siemens Sirius Soft-Starter



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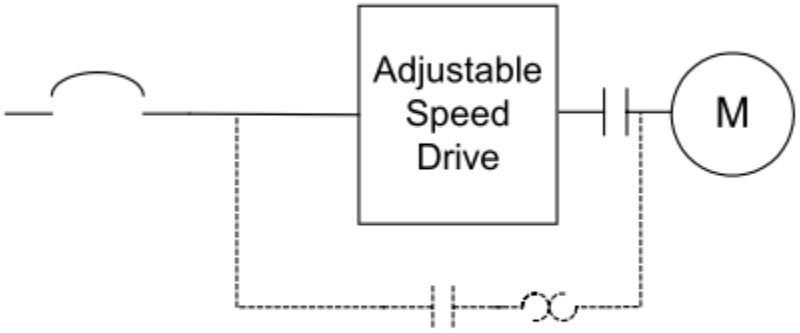
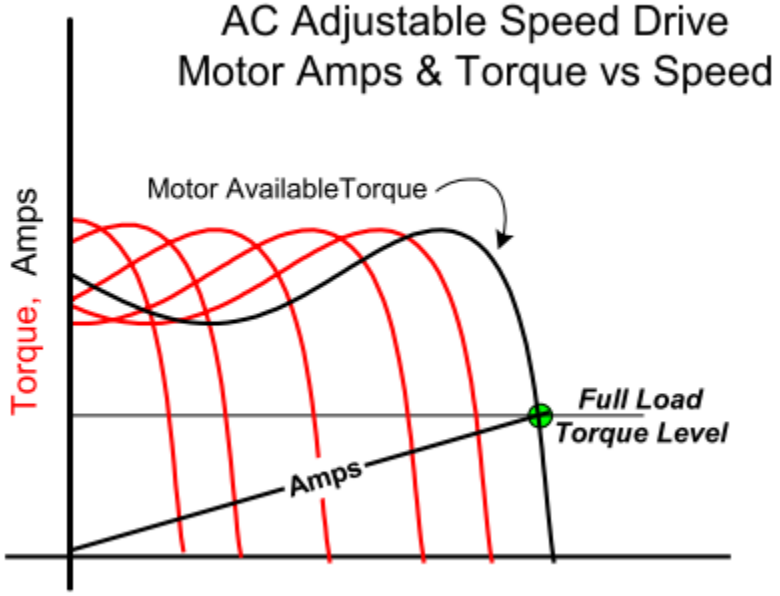
Soft-Start Operating Principles:

- Frequency and Voltage are controlled
- True Speed and Torque control
- Rated full load torque available from very low speed (usually less than 1 Hz) up to full speed



No Starting Inrush amps,
Torque & Volts Controlled to
Match Load



Conclusion:

Lower initial cost

Optimized component selection

Less down time

Longer product life

Integrated solution (IDS)