Large Load Characteristics & Risks

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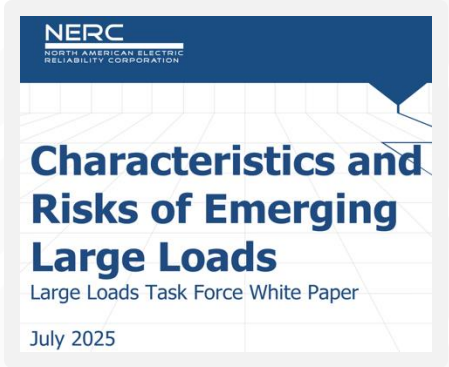
pulse on the power market

2025 GENERATION SYMPOSIUM

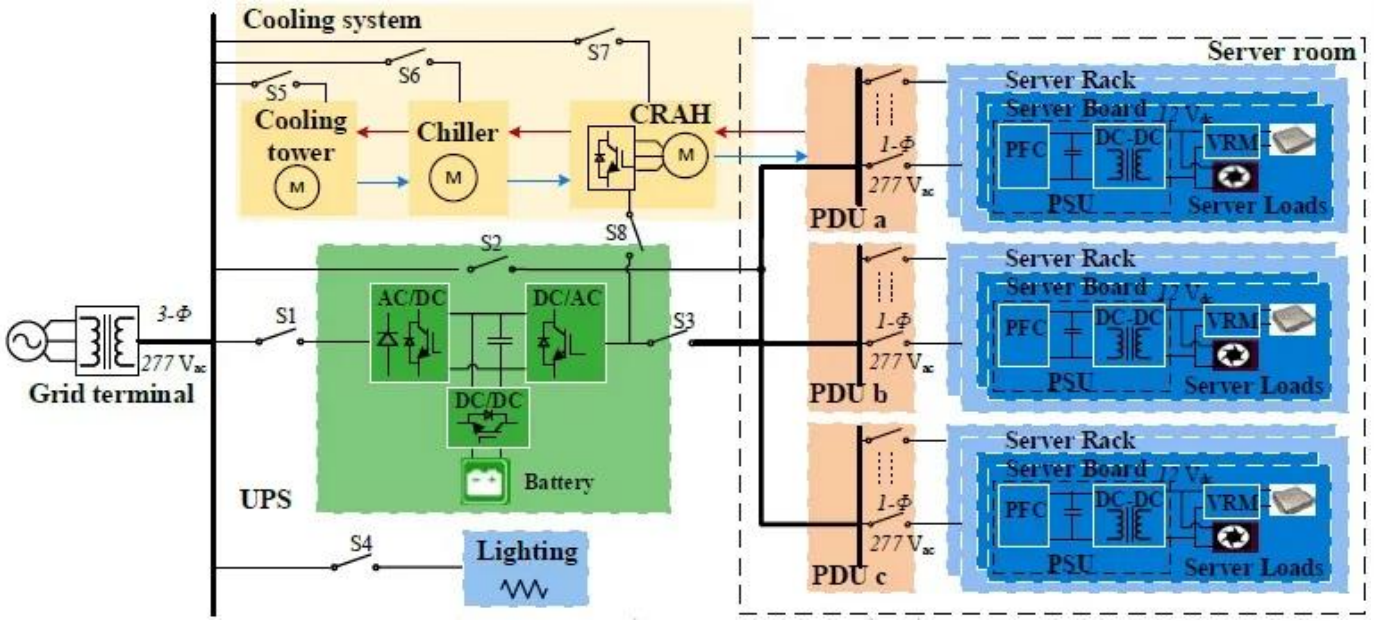
UTILITY CONSULTING SESSION

Large Load Trend

- Data centers are increasing in size.
- Interconnection requests are becoming as speculative as generator interconnections.
- Developers want to bring new loads online faster (within six months to two years.)
- Utilities and RTO/ISOs are developing new technical requirement & study processes.
- NERC issued a white paper: *Characteristics and Risks of Emerging Large Loads*.
- NERC issued an Alert 2 regarding large load.



Large Load Characteristics



Analyzing Data Center Load Characteristics with a Converter-Based Real-Time Power Emulator

Typical MW load split:

- Power electronics (UPS and Server Racks): 60%
- Cooling system: 35%
- Aux power: 0.5%

Large Load Characteristics

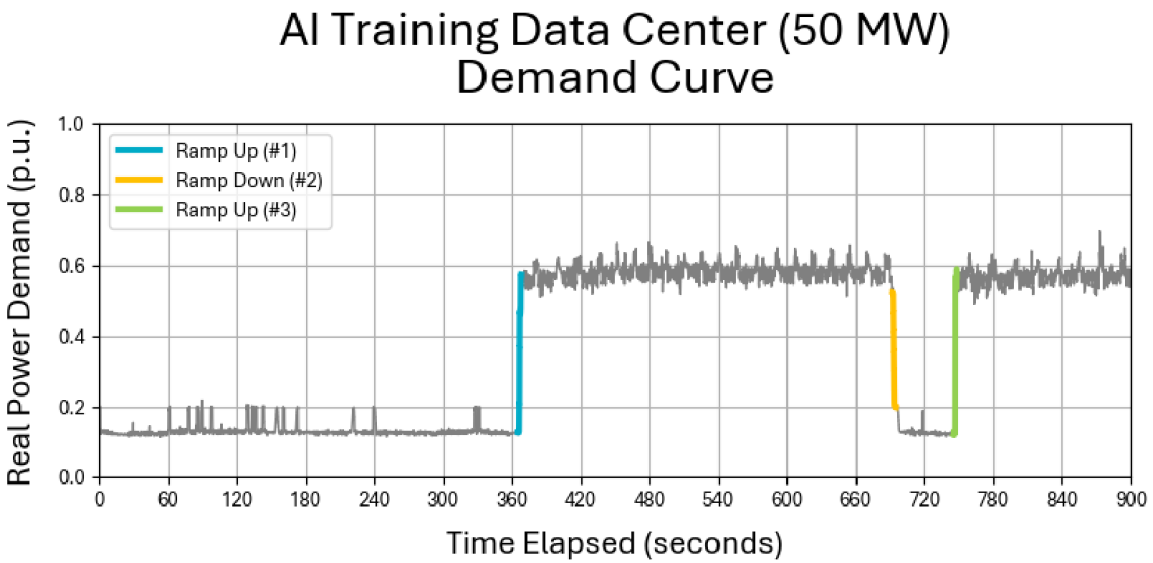


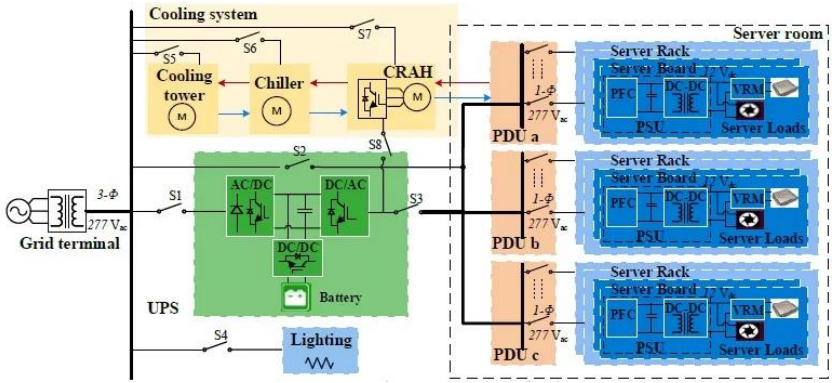
Figure 2.2: An AI Training Data Center Begins a Training Run (EdgeTunePower)

NERC white paper: Characteristics and Risks of Emerging Large Loads, July 2025

Periodic pulsing (fluctuation or jitter):

- Alternate between compute-heavy phases (high power draw) & communication / aggregation or synchronization phases (lower power draw)
- 0.1 Hz to a few Hz (i.e. periods from ~10 seconds down to sub-second)

Large Load Risks



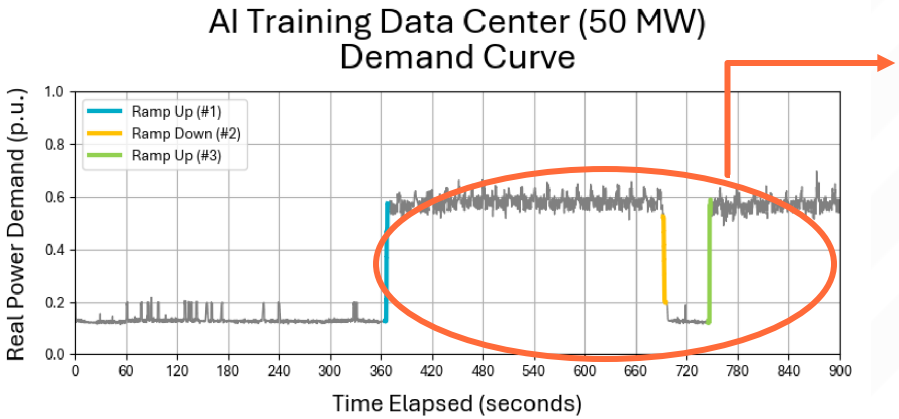


Figure 2.2: An AI Training Data Center Begins a Training Run (EdgeTunePower)

- **Power fluctuation**
- **Harmonics**
- **Sub-synchronous resonance torsional interaction (SSR-TI)**

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Virginia narrowly avoided power cuts when 60 data centers dropped off the grid at once

Energy grid regulator reveals near-miss last summer

March 20, 2025 By: Matthew Gooding Have your say

Ride Through Requirement

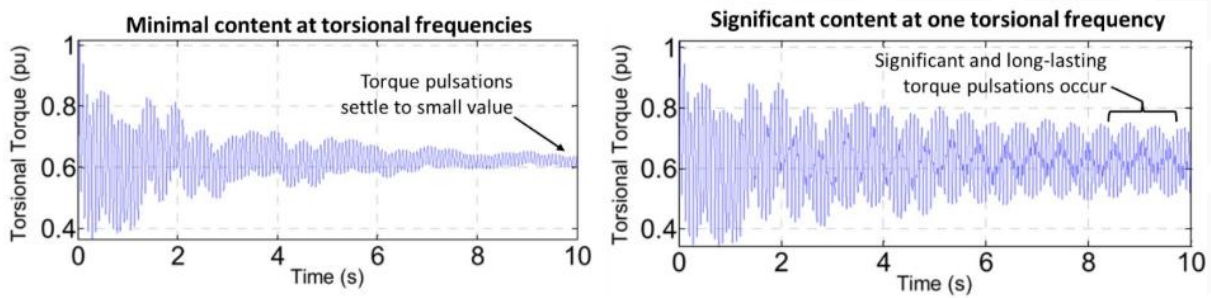


Figure 3.10: Torques Produced in a Steam Turbine for EAF Loads That Do Not (Left) and Do (Right) Contain Frequency Content at the Steam Turbine's Torsional Modal Frequency

NERC White Paper: Characteristics and Risks of Emerging Large Loads, July 2025

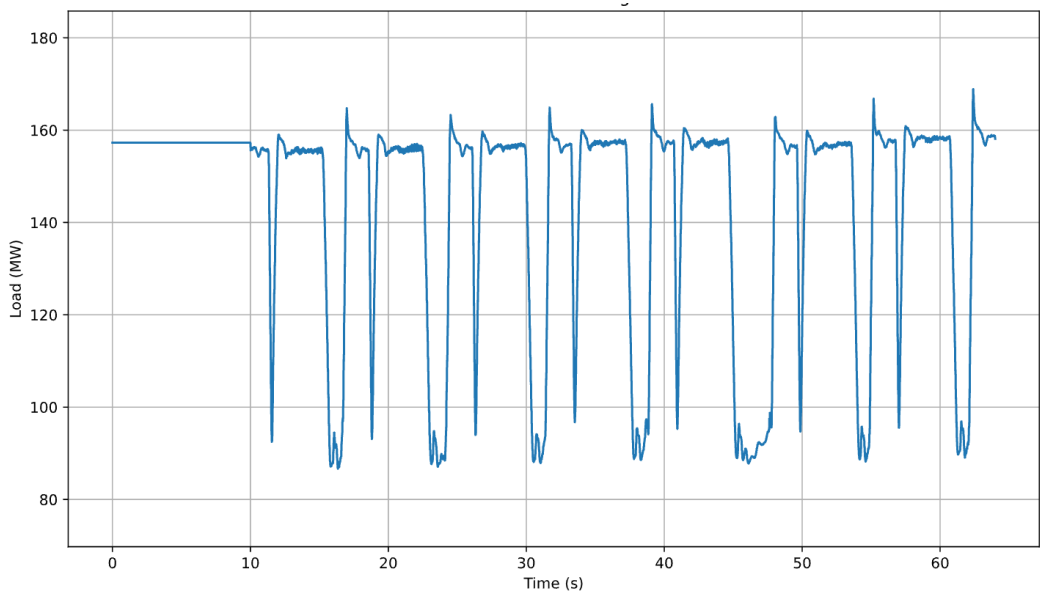
Require Data to Develop Multi-Mass Torsional Shaft Model

1898 & CO. | BURNS McDONNELL

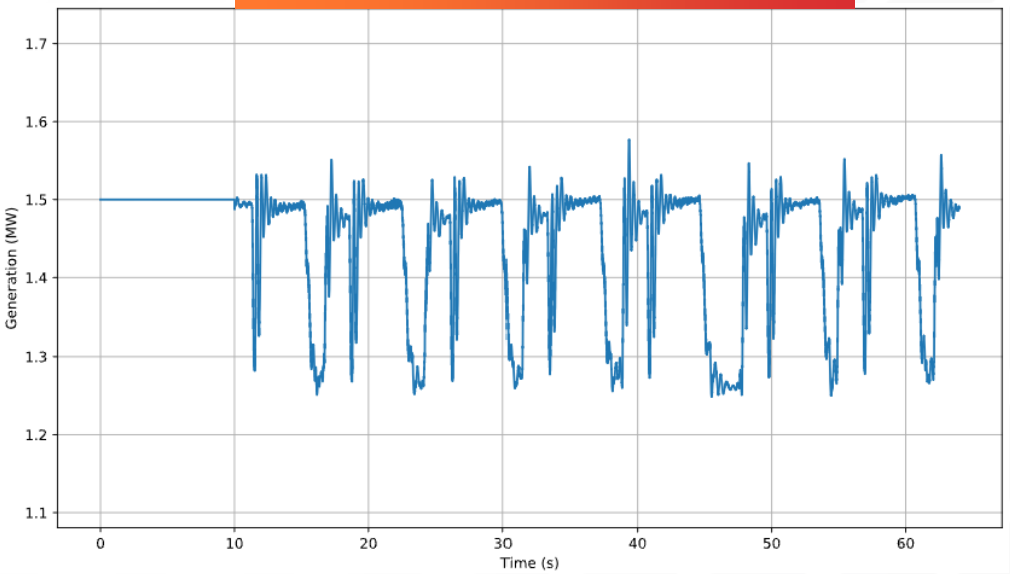
Large Load Risks

Example from Islanded Operation

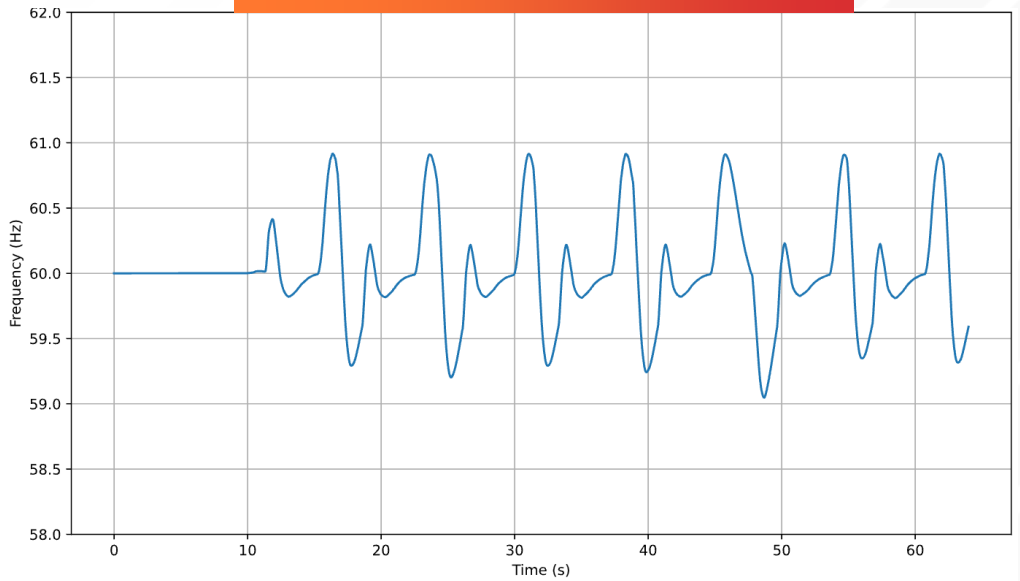
How much oscillation (magnitude and frequency) can your generator handle?
Is the limit validated with the vendors?
Do you need mitigation to minimize oscillation?



On-Site Generation



Frequency



Key Takeaways

- Large load introduces risks to the power system and generators nearby.
  - Large load drop drives over-frequency trip
  - Power quality
  - Sub-synchronous resonance torsional interaction (SSR-TI)
  - Power / frequency oscillation
- Technical requirements need to be developed to address potential risks.
- Power system studies will be required to evaluate the impact of the large load interconnection.
- The study will require detailed generator data such as mode, damping and limit. May require field testing during outage or vendor validation.