Synchronous Motors Start up as Induction Motors

(So why typically no torsional problems with Induction Motors?)

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Induction Motor Torsional Problem

- Coupling failure after installing “Soft Start” on motor drive
- Could this explain why Induction Motors typically do not have torsional problems

Recycle Compressor in Gasoline Refining Process

- 5 stage barrel compressor
- Speed Increasing Gear Box
- 2250 hp 3-phase Induction Motor
- Contoured Diaphragm High and Low Speed Couplings

Reliability Improvement Effort

- Use “Soft Start” to improve reliability of medium voltage motors throughout plant
- Did not get rotating equipment engineer involved
- Started project with subject motor.

Reliability Improvement Effort

- Train commissioned in 1982
- No previous failures
- “Soft Start” installed on motor in 2002
- Two subsequent fatigue failures of the low speed coupling diaphragm

Synchronous versus Induction

Possible reasons Induction Motors are not typically problematic

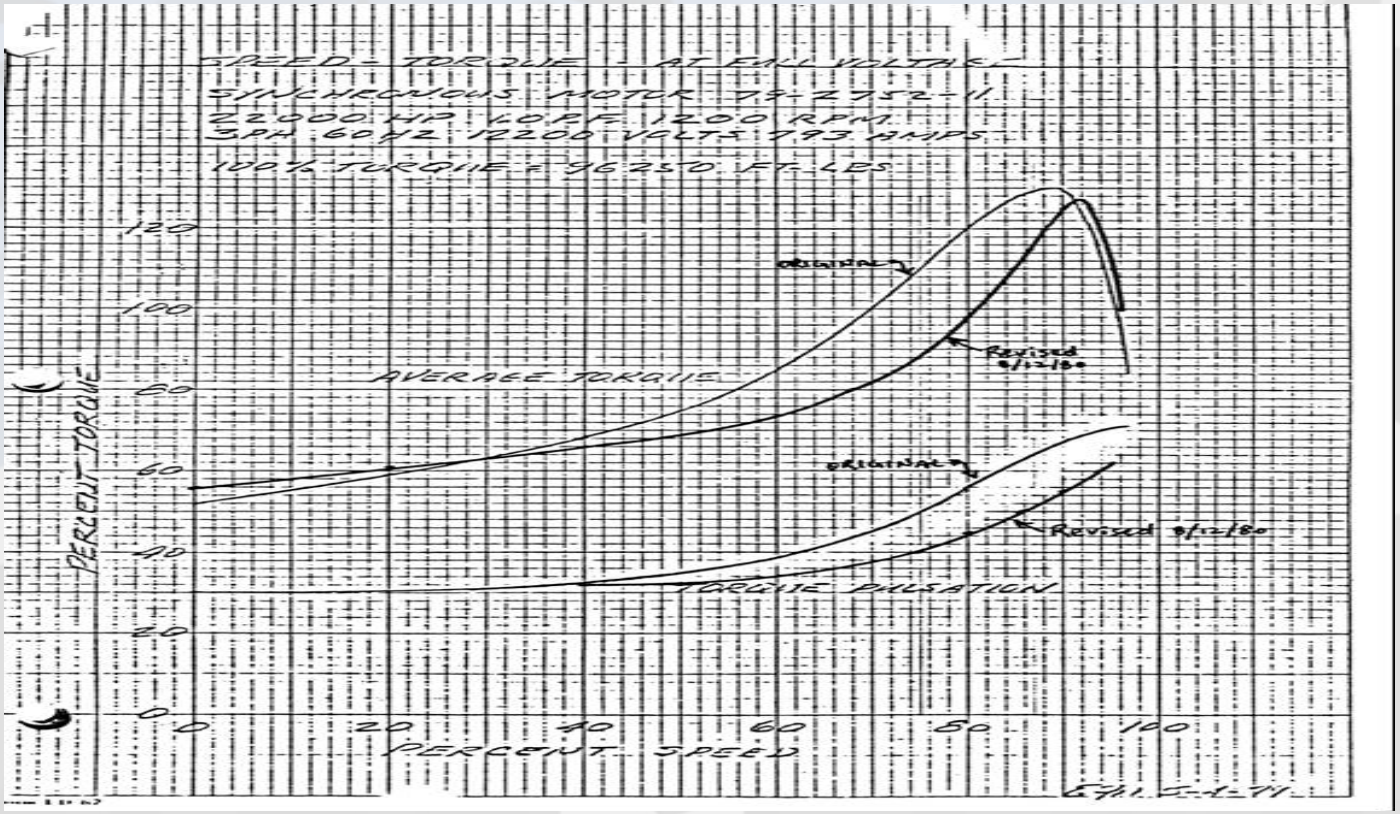
- Different Torque Curves
- Synchronous drives large trains

Motor Startup Torque

- Mean Torque
- Oscillating Torque
  - 2 times slip frequency

Synchronous Torque Curve

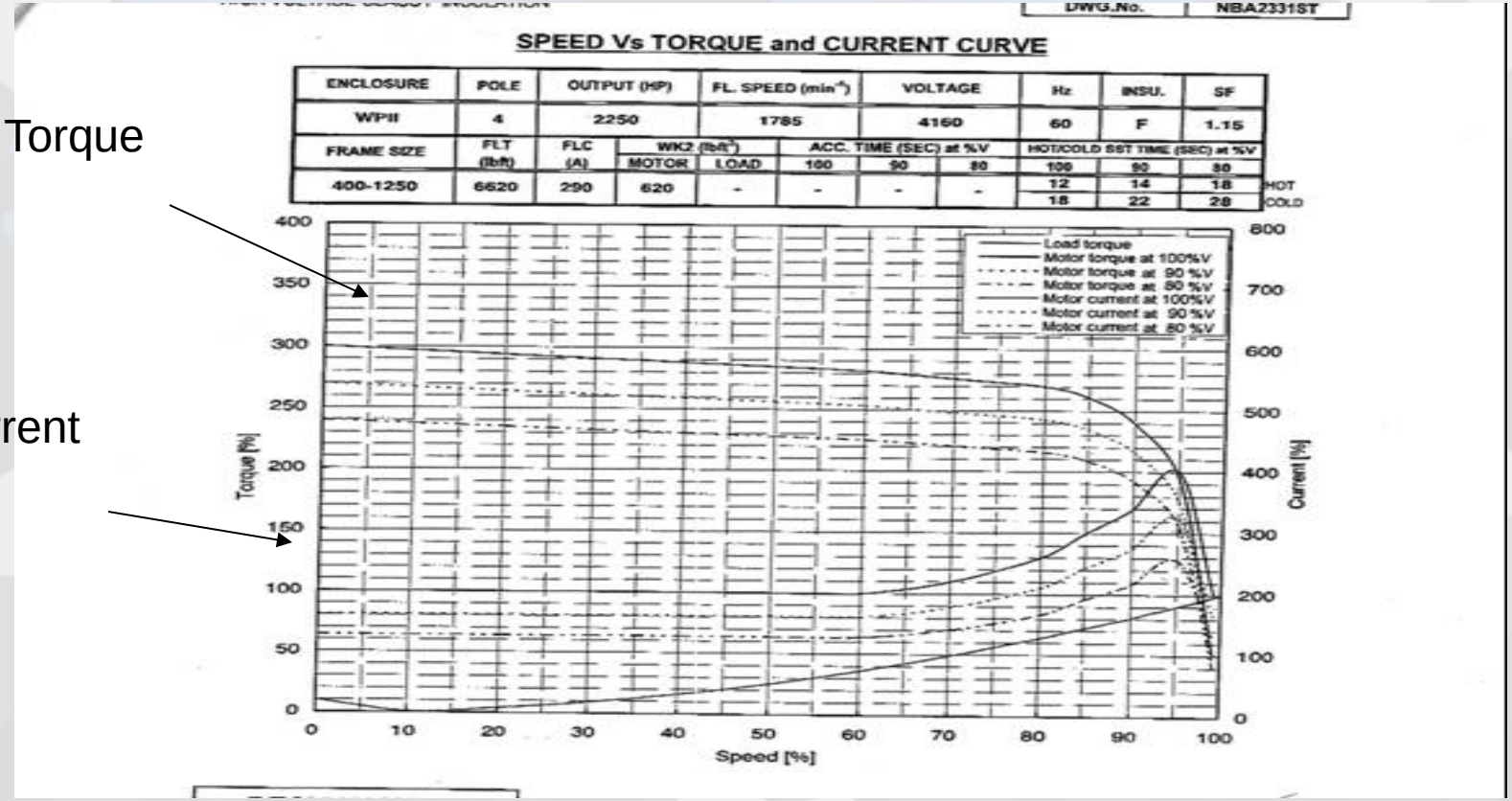
Courtesy of E.I. DuPont



Induction Torque Curve

Torque

Current



Soft Start Program

- Initial Setting of 50 % to 100 % voltage in 12 seconds (25 % to 100 % Torque)
- Final Setting of 80 % to 100 % voltage in 8 seconds (64% to 100 % Torque)

Motor Startup Time

- Before “Soft Start” installed 3.5 seconds
- After Installation 7.0 seconds

“Soft Start” Effect?

- Increases dwell time at natural frequency
- Possibly causes amplification of oscillating torque

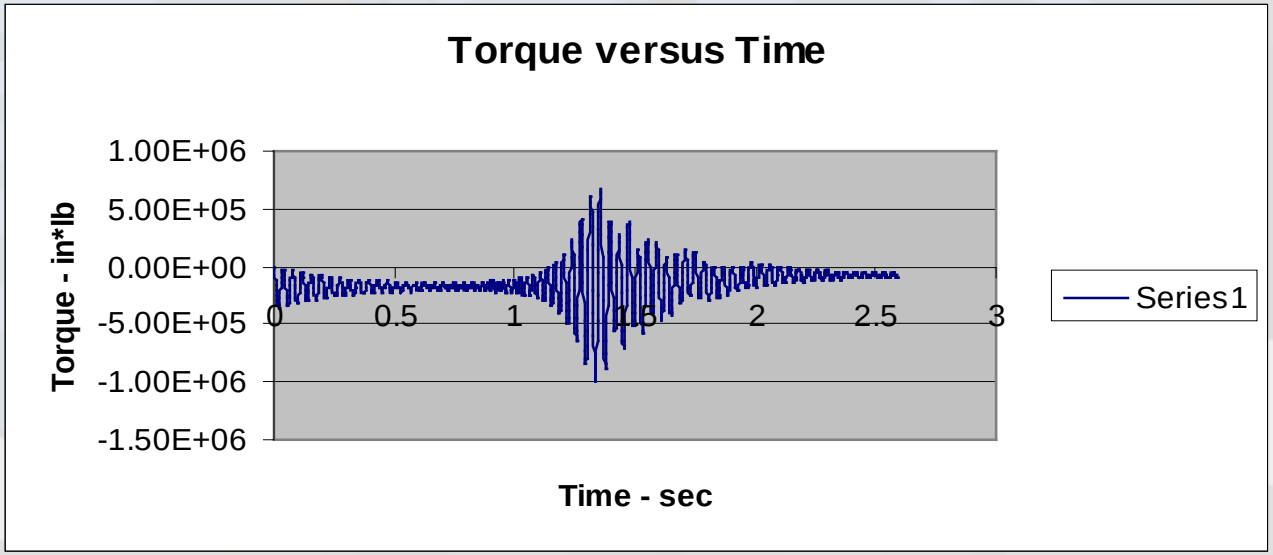
Dwell Time at Natural Frequency

- Reduced Starting Torque
- Unit started with lower hydrogen content
- Analysis shows increased Dwell Time alone not the issue

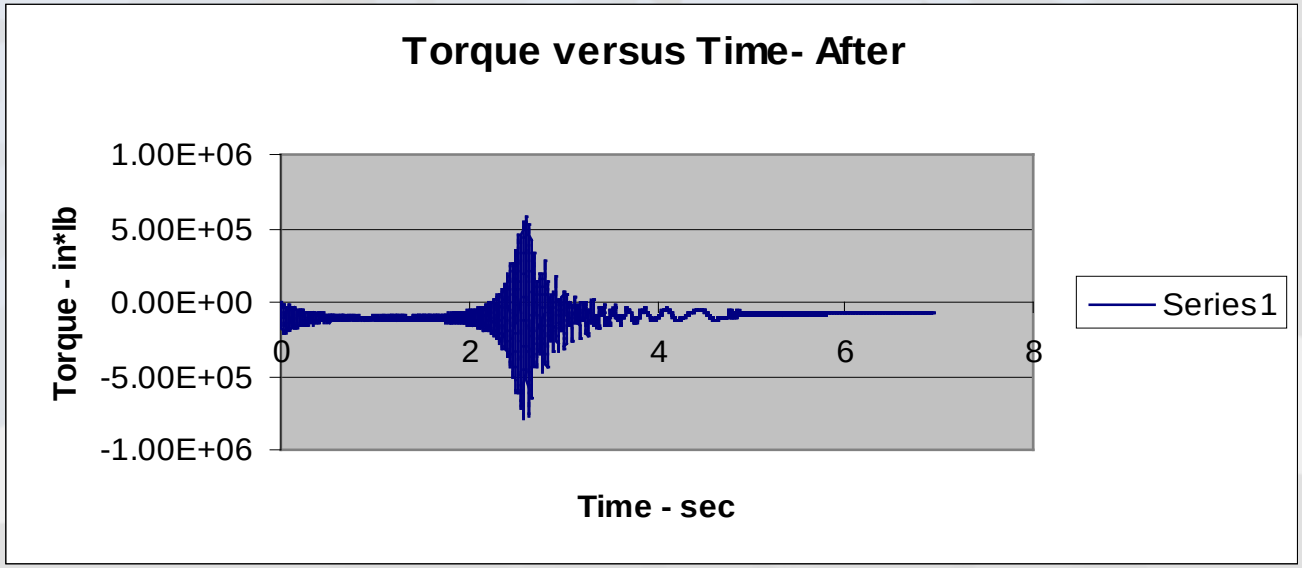
Cause of Failure

- Initial thought was longer dwell time
  - Analysis proves negative
- Soft Start might alter Oscillating Torque
  - Further Testing required

Transient Torsional Before



Transient Torsional After



Strain Gage Data on Couplings

Courtesy of E.I DuPont