Xcel Energy®
RESPONSIBLE BY NATURE™

COMANCHE
ACC
IMPROVEMENT PROJECT

Xcel Energy – Comanche Station Pueblo, Colorado

- **Coal Fired Plant**
- **(2) 350 MW (Units 1 & 2)**
- **(1) 800 MW (Unit 3)**
- **Unit 3, Utilizes Hybrid Cooling with a GEA 45 Cell, 9X5 ACC**
- **Unit 3, Commercial Operation July 2010**

Discussion Topics

- ACC Issues During Start-up
- ACC Challenges After Commissioning
- Fan Blade Attachment
- Fan Blade Cracking
- Gear Box Modifications
- Addition of Fan Shroud Stiffening Rings
- Installation of a Wind Screen and Structural Bracing
- Tube Cleaning

ACC Challenges During Start-up

- **Vacuum Leaks Within the Condensate System**
- **Mechanical Failures of Gear Box Oil Pumps and Pump Couplings**
- **Input Shaft Seal Leaks**
- **Output Shaft Seal Leaks**
- **Wind Milling of Fan Blades in the Reverse Direction of Normal Rotation**

ACC Challenges After Commissioning

- **Howden Fan Blade Attachment Fan/Hub Loosening Problems**
- **Howden Fan Blade Cracking Issues**
- **Continued Input and Output Shaft Seal Leaks**
- **Continued Oil Pump/Coupling Failures**
- **Loss of Interference Fits on Shafts for Bearings and Bull Gear**

ACC Challenges After Commissioning

- Oil Leaks via the Output Shaft Keyway
- Overheating of the Gear Box Oil
- Switching from Mineral Based Oil to Synthetic
- Under Designed Hoists and Monorail Beams on all 9 Streets
- Inoperative Tube Cleaning System

GEA Engineering Study

- **Due to the Ongoing Problems, GEA Conducted an Engineering Study with GEA State Side and European Engineers**
- **On Site Evaluation of the present ACC, Structure, etc. was completed**
- **Recommendations submitted to Comanche from GEA**

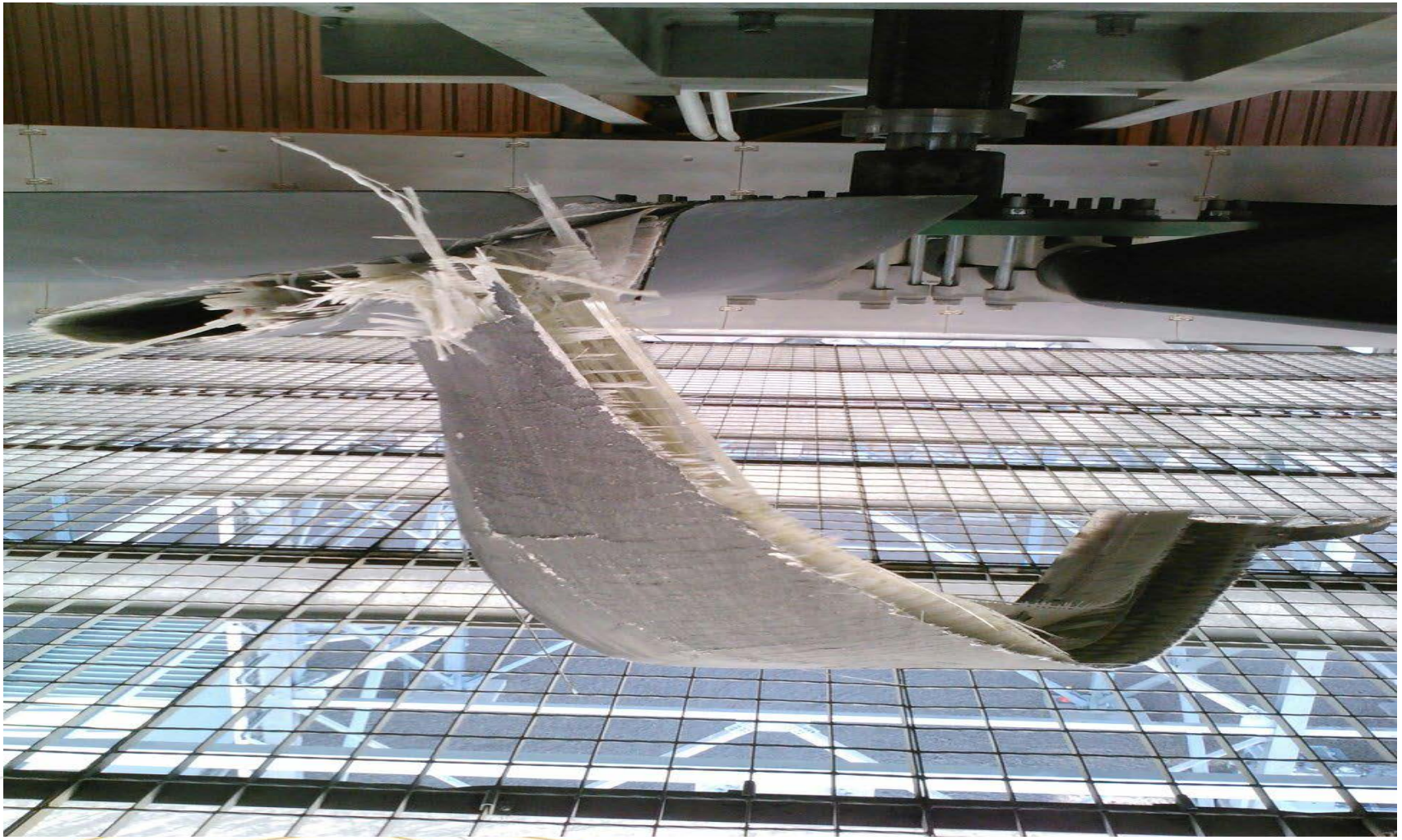
ACC Resolutions – Fan Blades

- **Fan Blade Attachment Modification**
- **Fan Blade Cracking Minimization and Increased PM Program**
- **Installation of a Personnel Protective Fence**

Re-Designed *Blade Clamp*

Cracked Blade

Catastrophic Blade Failure



Perimeter Fence

ACC Resolutions – Gear Box Lifting

- **Engineering Evaluation of the Monorail Lifting Beams**
- **Stiffening of the Monorail Beams on all 9 Streets**
- **Elimination of the 2 Ton Hoist and Purchase and Installation of 3 Ton Electric Hoists on all Streets**

3 Ton Monorail Hoist

ACC Resolutions – Gear Box Failures

- **Combined Effort Between Amarillo Gear, In-Pro Seal, Chesterton Seal and Comanche**
- **Addition of Extended Bearing Housings with Carrier Bearings**
- **Modification of the Input Shaft Lip Seal to an In-Pro Mechanical Seal with New Seal Carriers**
- **Modification of the Output Shaft V-Seal to a Reinforced Viton Seal**

Motor and Gear Box

Motor Removal

Motor on Stand

Fan Hub Removal

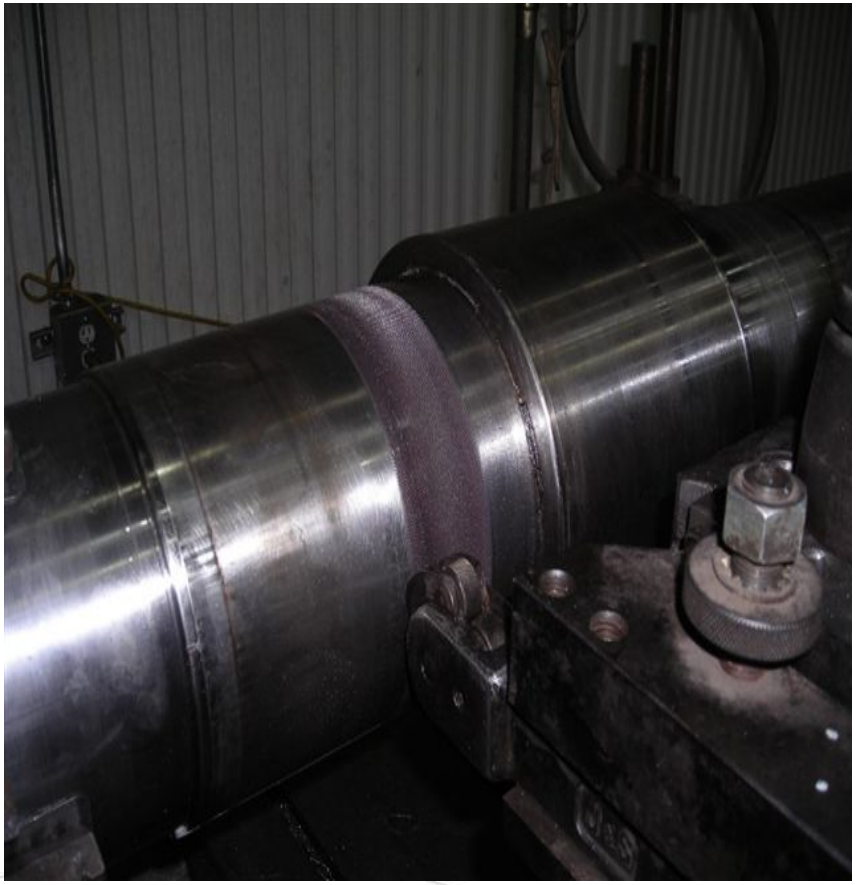
Fan Removed

Lowering Gear Box

Machining Output Shaft

Dimensional Check

Knurling Output Shaft

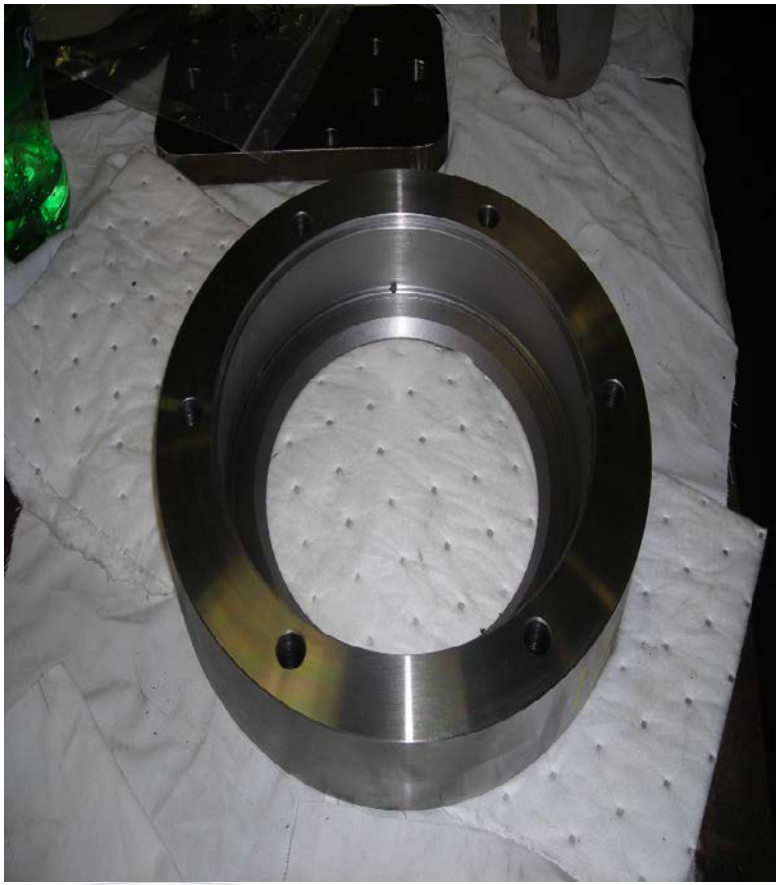


Output Shaft Extension Housing

Extension Housing Flange

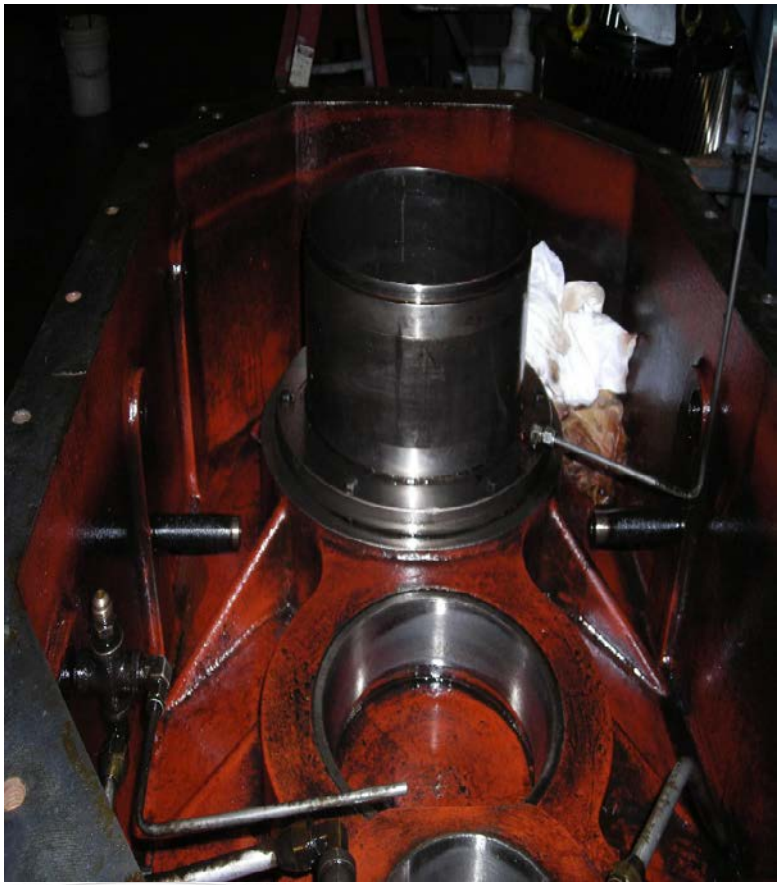
Installation of Extension Housing

Carrier Bearing Housing



Old Style Input Shaft Lip Seals

Output Shaft Seal Can



New & Old Output Shaft Lip Seal

Hub Gear Heating

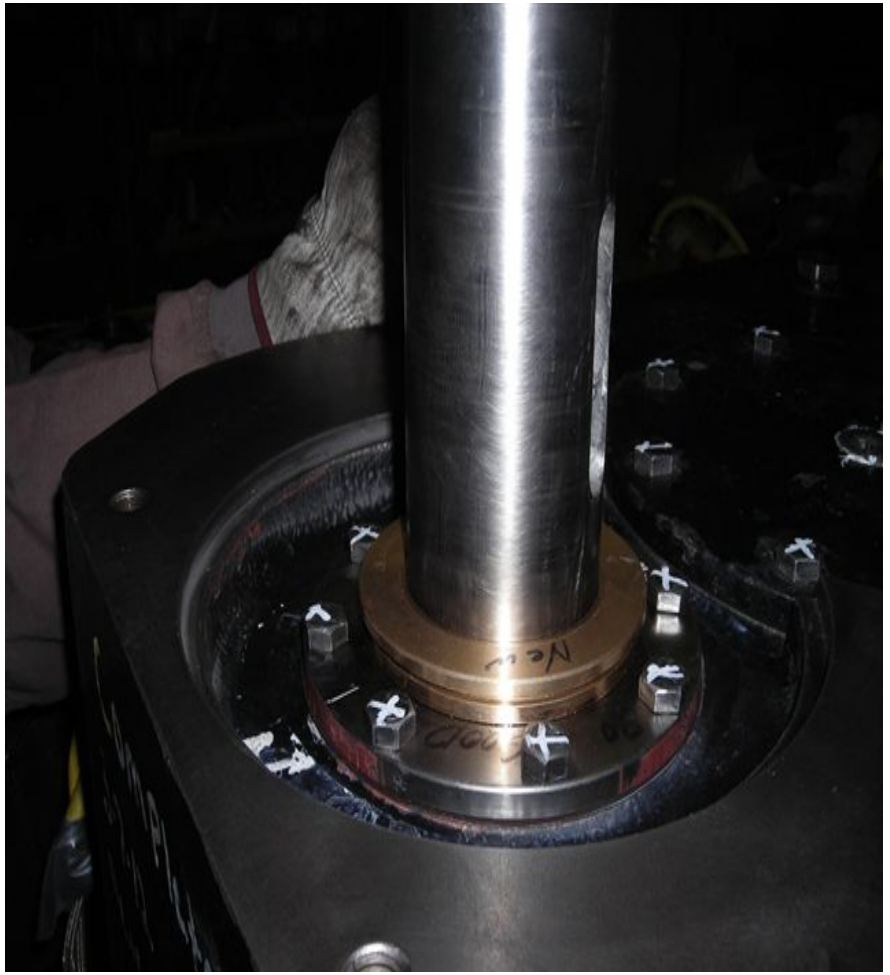
Hardened Anti-Rotation Plate Installed

Bull Gear Installation

Output Shaft Installation

Input Shaft, In-Pro Seal

In-Pro Seal Installed



ACC Resolution – Gear Box Failures

- **Redesigned Retaining Ring on Top and Bottom of Hub Gear Utilizing an O-ring to Eliminate Keyway Oil Leaks**
- **Removal of the Shaft Driven Oil Pumps**
- **Addition of Externally Mounted Viking Electric Driven Oil Pumps**
- **Changed to Synthetic Oil rather than Mineral Based**

Hub Gear Retaining Rings

Old Shaft Driven Oil Pump

Shaft Driven Oil Pump Wear Area

Elec. Oil Pump Modification Plate

Viking Electric Oil Pump

Oil Pump

Output & Intermediate Shaft Install

Gear Box Upper Case

Completed Gear Box

Gear Box Staged for Installation

Gear Box Lift

Gear Box Installation

Gear Box In Place

Motor Housing Installed

ACC Resolutions – Gear Box Failures

- **(6) Month Oil Sampling Program**
- **On-line Filtering Program**
- **(6) Month PM Program for Blade Torque, Blade Crack Inspections and Gear Box Bolting**
- **Seasonal Shut Off of Gear Box Heaters**

Gear Box Oil Heater Fouling

ACC Resolutions – Fan Shrouds

- **GEA's Engineering Study Concluded Excessive Fan Shroud Movement**
- **Evaluated Stiffening Ring Quotes from Howden**
- **Utilized a Local Contractor to Fabricate and Install Stiffening Rings**

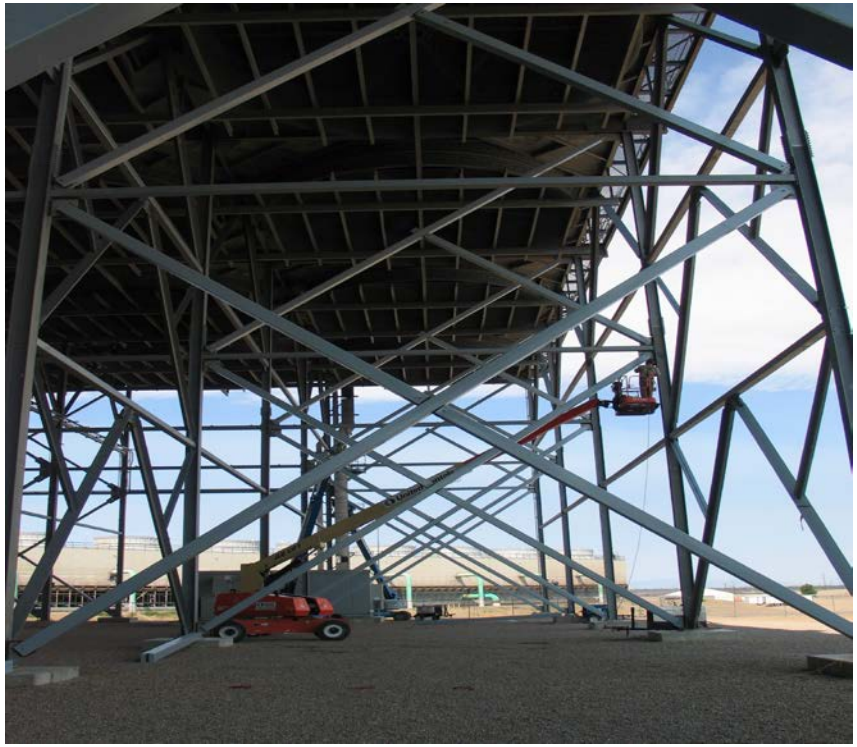
Fan Shroud Stiffening Ring

ACC Resolutions – Wind Screen Installation

- Goal was to Minimize Fan Blade Cracking
- Worley-Parsons Engineering Study Conducted on the ACC Structure
- Results Concluded that Extensive Cross Bracing was needed for any type of Wind Screen Material
- Bracing Installed
- Non-movable Screen Installed

ACC Wind Screen Installation

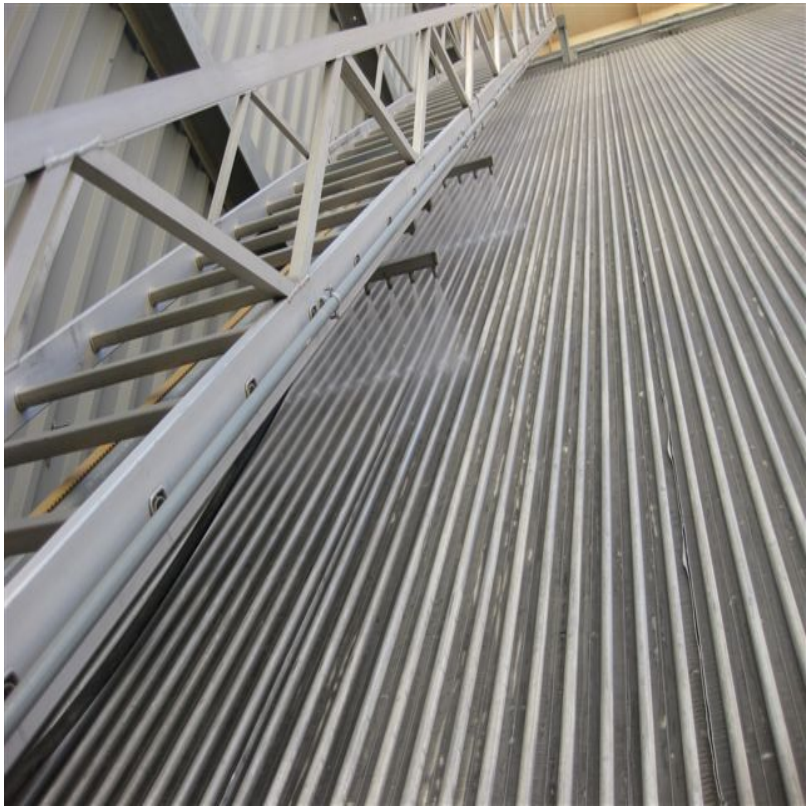
ACC Wind Screen Installation



ACC Resolutions – Tube Cleaning

- **Tube Cleaning System Was Never Completed and Commissioned by Shaw**
- **Extensive Oil Film on Tubes from Seal Leaks Which Increased the Amount of Dirt and Build-up on Tubes**
- **Significant Performance Loss of ACC Due to Lack of Cleanliness**
- **Tube Cleaning Performed Summer 2013**

Tube Cleaning



Questions?