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WHAT IS THE CONDITION OF YOUR ACC SYSTEM?

HOW TO DISCERN THE CONDITION OF YOUR ACC SYSTEM ACCURATELY AND EFFECTIVELY,
USING CONDITION BASED MAINTENANCE, ROOT CAUSE ANALYSIS, AND OTHER PROACTIVE
MAINTENANCE APPROACHES.

Condition Based Maintenance

- We have a solid CBM program at Higgins. Part of it's success is in regularly scheduled meetings.
- The CBM program utilizes Predictive maintenance tools, PM's or regularly scheduled maintenance, Root Cause Analysis, Continuous Performance Improvement, and a lot of individual effort and input.

The CBM meeting agenda

- ⦿ Overview of maintenance history.
- ⦿ Operator interview's
- ⦿ Safety issues
- ⦿ Operational Issues
- ⦿ Maintenance Issues
- ⦿ Root Cause Analysis results
- ⦿ Possible continuous improvements
- ⦿ Action Items/dates
- ⦿ Individual responsibilities

Some of the 'finds' from CBM meetings about the ACC

- ⦿ Safer gear reducer change-out utilizing a fixture.
- ⦿ A way to remotely monitor gear-reducers and motors.
- ⦿ Planned and scheduled maintenance PM's that go the extra step.
- ⦿ A better way to secure hub with blades attached during gear reducer change-outs.

What the CBM program has produced to date.

- All oil changes are dictated by oil sampling. Sampling is done prior to filtering. The gear-reducer lube is filtered biannually.
- Blade angle and condition is checked annually. The blade angle is checked at the hub and at the tip, a record kept of both readings. (Annual PM)
- Weekly walk-downs of the ACC system by mechanical staff include equipment and structure inspections

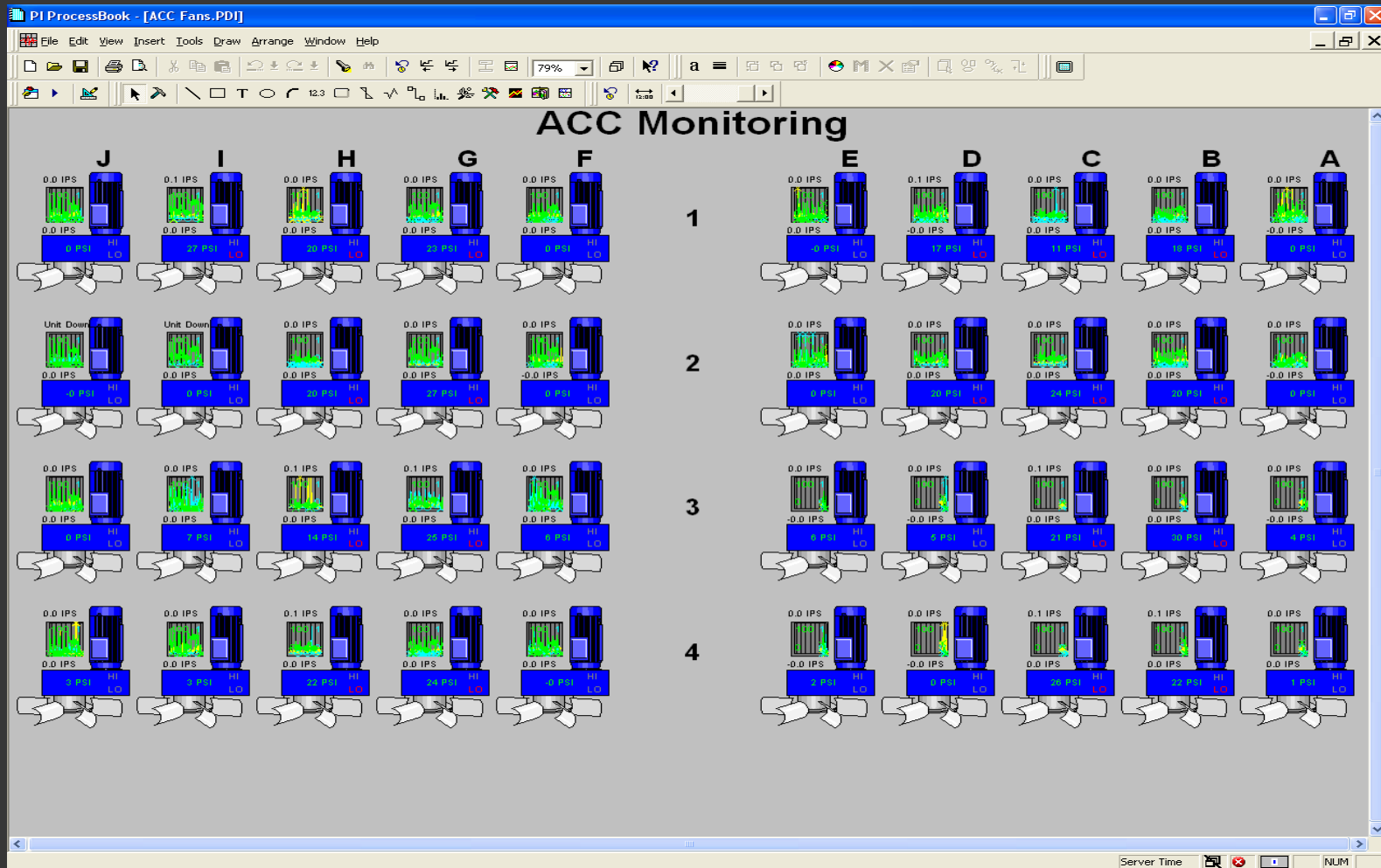
Other CBM items developed

- We found a need to monitor vibration and oil pressure remotely.
- It was determined that one accelerometer on the motor and one on the gear-reducer would monitor vibrations sufficiently enough for a warning as well as sending data to PI
- Oil pressure is monitored through a digital pressure gauge that allows data to be sent to PI.
- PI screen for ACC is utilized during weekly walk-down inspections so trends can show a need for closer inspection on equipment.

Oil pressure and vibration



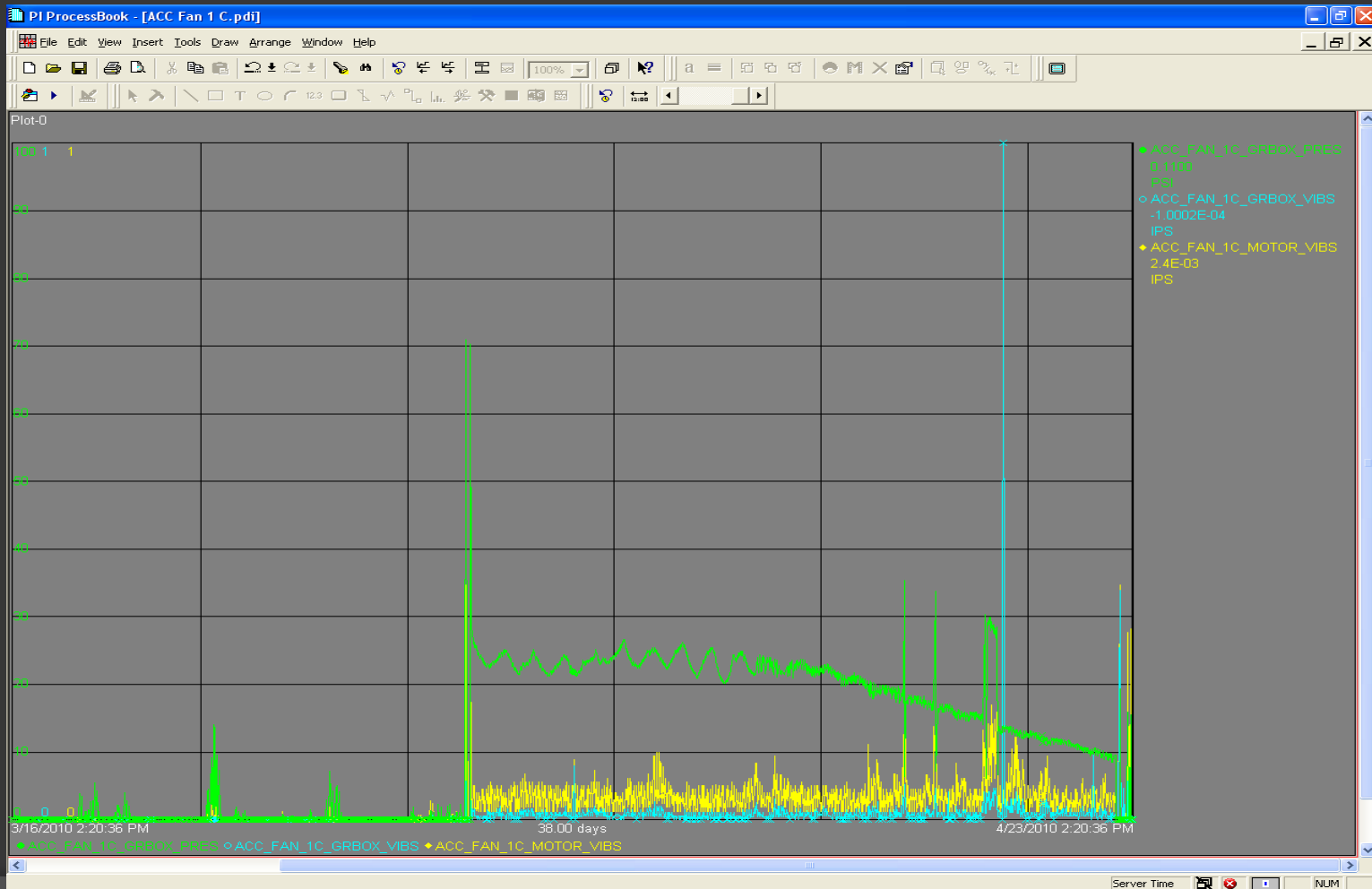
PI screen for ACC



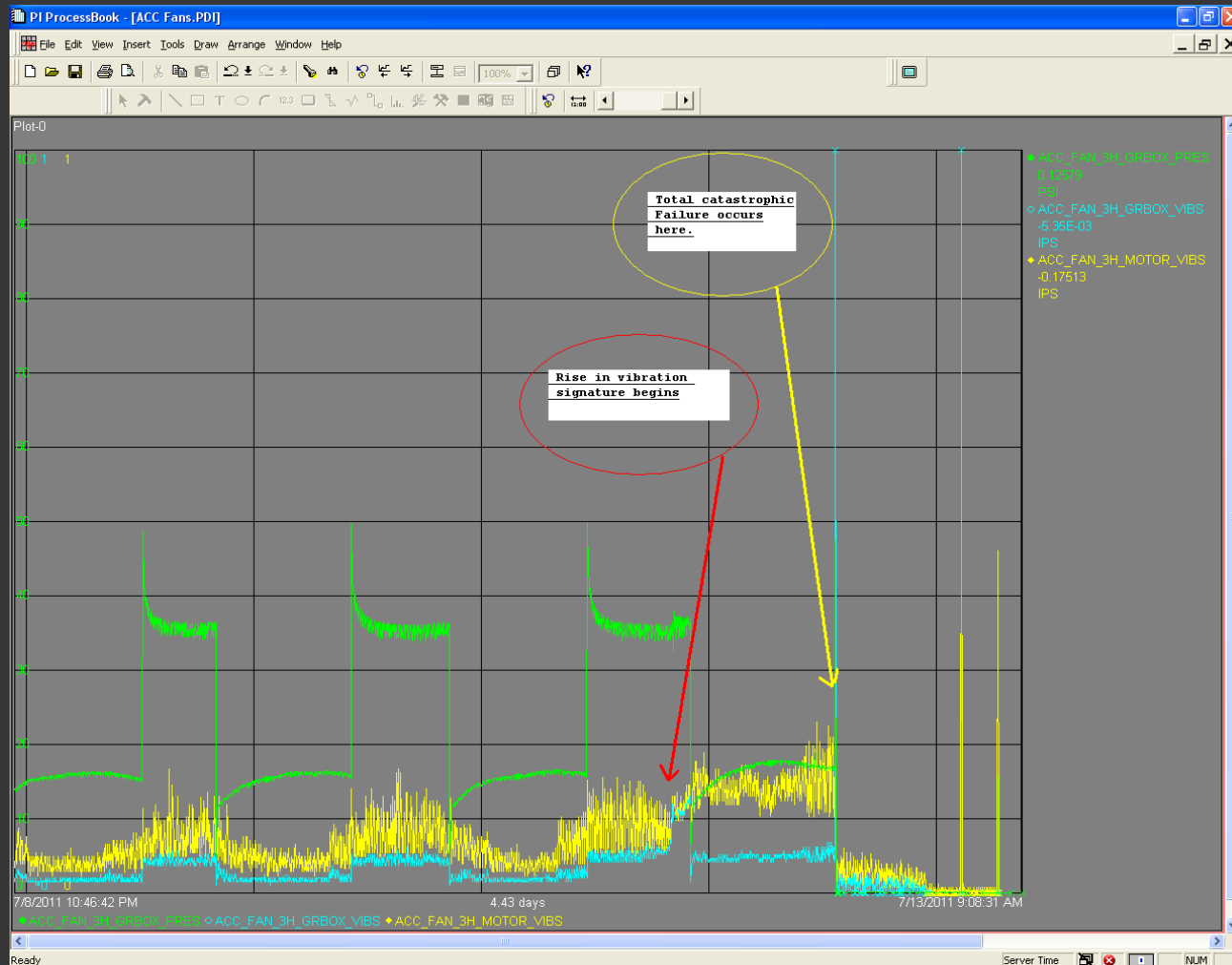
Monitoring catches

- Right after installation of the oil pressure/vibration units we caught a gear-reducer oil pump failure.
- We've trended eight gear-reducer filter clean/change's. (as seen in next slide)

Typical trend showing lube oil pressure drop off due to clogging filter.



Catastrophic Gear reducer failure



How did this help?

- ⦿ Because we can monitor our ACC unit's individually, we were able to trend this issue two weeks before failure.
- ⦿ The time gained allowed us to gear up for the change, ensure parts were onsite and set up outside assistance for the job and to schedule unit for down time.
- ⦿ Gave us a background on vibration and oil pressure signatures for future troubleshooting.

Filtering

- The COMO oil filtering unit removes water as well as final filters to 25 microns.
- It handles the Mobil gear oil SHC XMP ISO 320 well, though this lube is very 'stiff', (high viscosity) even when warm.
- We filter long enough to allow for a minimum of eight 'changes' of lube.
- We now plan to change the oil out at the five year mark due to physical changes in the chemical makeup of the oil.

Filtering lube oil



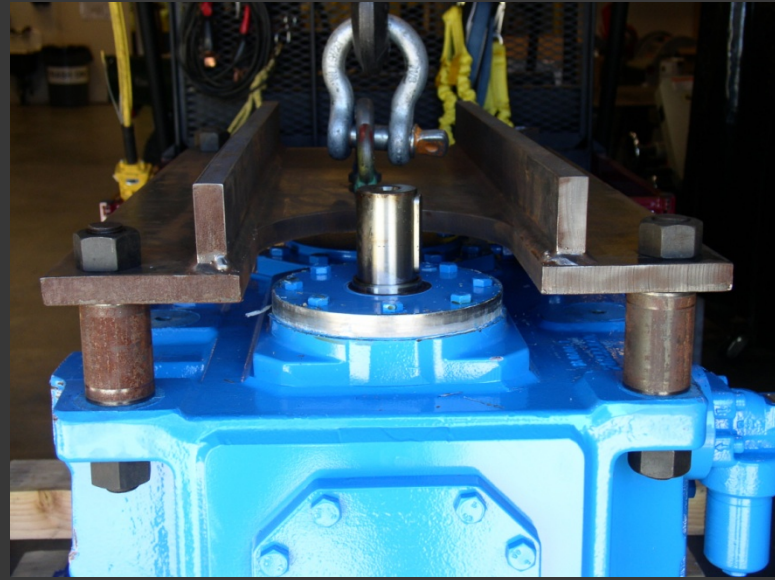
Lifting fixture enhances safe handling of gear-reducers

- The fixture lowers rigging height by a substantial amount, allowing gear-reducer to be moved safely without removing doors or headers in each cell.
- Picking eyes mounted on fixture allows for a positive and safe rigging change from hoist to crane while suspending gear-reducer.

Lifting fixture for gear-reducers



Lifting fixture in use



SAFE HANDLING OF REDUCERS



TRANSFERRED TO MOBILE CRANE SAFELY AND EFFICIENTLY



Weekly Walk-down inspections



Weekly walk-down inspections

- ⦿ Inspection of structure and equipment has caught many issues over time.
- ⦿ Puts maintenance specialist 'on deck' for visual checks
- ⦿ Helps determine solutions to various issues that come up.
- ⦿ Insures reliability

Decking issue caught by walk-downs



Repair procedure for decking (CBM related fix)



- A 3/8" hole drilled in deck plate.
- A 1/4" pan head bolt threaded into deck support beam.
- A 'Fender-washer' used to complete fastening, allows for movement between deck plate and support beam
- Bolt is lock-tite held in position

Finding structural issues



- Noted that over time turnbuckles loosen up. Walk-downs catch these and repairs are scheduled to fix.
- Lock nuts on turnbuckles are marked when tightened now for easier visual check.

Other issues found during walk-downs

- ⦿ Sealing media falling out of position between tube bundles and cell walls.
- ⦿ Door hinges failing.
- ⦿ Lights not working
- ⦿ Windsock condition / repairs needed
- ⦿ Structure bolting, missing, loose.
- ⦿ Decking or grating fastened properly and in place.
- ⦿ General cleanliness and clean up /pickup

Procedures and tools developed at Higgins

- ⦿ Have added value.
- ⦿ Save time when performing work.
- ⦿ Save time when troubleshooting.
- ⦿ Cut overall costs to maintenance.
- ⦿ Increased safety.
- ⦿ Lowered downtime.
- ⦿ Increased availability.
- ⦿ Increased reliability.

Thank you



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