



COMPLETE
WIND
CORPORATION

Reducing Turbine Operating Costs Through Comprehensive and Targeted Rotor Blade Inspections

Mike Jeffrey, President
Complete Wind Corporation

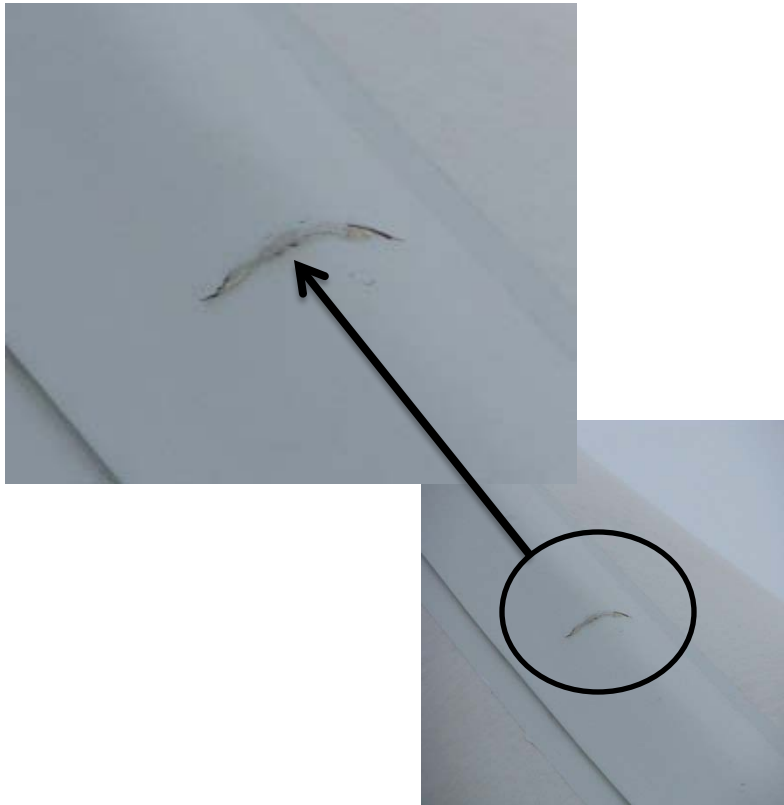


COMPLETE
WIND
CORPORATION

AWEA Conference 2012 Turbine Reliability - Lessons from the Real World – June 3 - 6, 2012 – Atlanta, GA

About CWC...

- We can fix this.....
- We cannot fix this.....








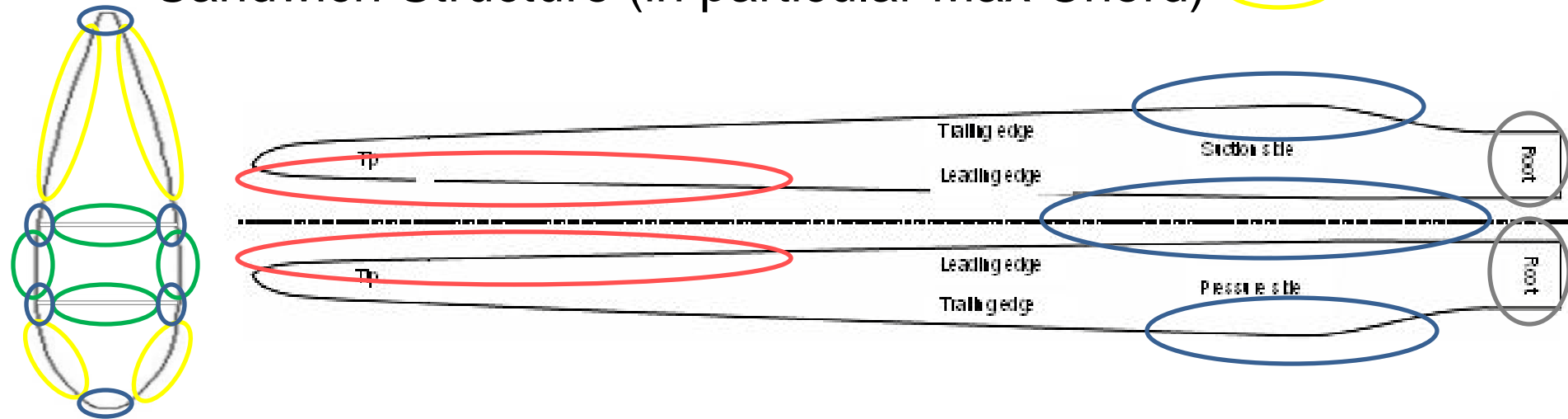
Why Perform Rotor Blade Inspections?

- Blades are typically designed for a 20 year service life
- Blades are wear components that require routine inspection and repair
- Insufficient service/inspection will lead to costly blade repair and potential unplanned replacement
- Manufacturer variability – due diligence



Critical Areas for Inspection

- Bond-lines: SW'(s), LE and TE in particular Max Chord 
- Root and Flange Area 
- Tip (bottom 1/3 of LE) and Aerodynamic Elements 
- Main Structural Components 
- Sandwich Structure (in particular Max Chord) 



What is involved?

Inspection Type	Frequency	Primary Findings
Exterior From Ground	Annually	Exterior Wear/Operational defects, Lightning Strikes, Serious Manufacturing Anomalies
Up-tower Interior/Exterior	At End of Warranty, subsequent, every 2 – 3 years	Interior & Exterior Wear/Operational defects, Interior and Exterior Manufacturing Anomalies
Lightning Protection System	Following OEM or IEC 61400-24 recommendations	Confirmation of down conductor connection, receptor inspection
Dynamic Rotor Balancing	At commissioning , subsequent tests every 2 – 3 years	Mass and Aerodynamic Imbalance

What is a Wear Related Defect?

Some common wear/operational related defects;

1. LE Erosion
2. Cracking along Bondlines and/or Blade Shells
3. Lightning Striking



What is a Manufacturing Defect?

Some common Manufacturing defects;

1. Wrinkles
2. Dry Spots
3. Missed Re



Inspection Statistics

The findings of inspections performed between 2008 and present were used to establish general inspection finding trends.

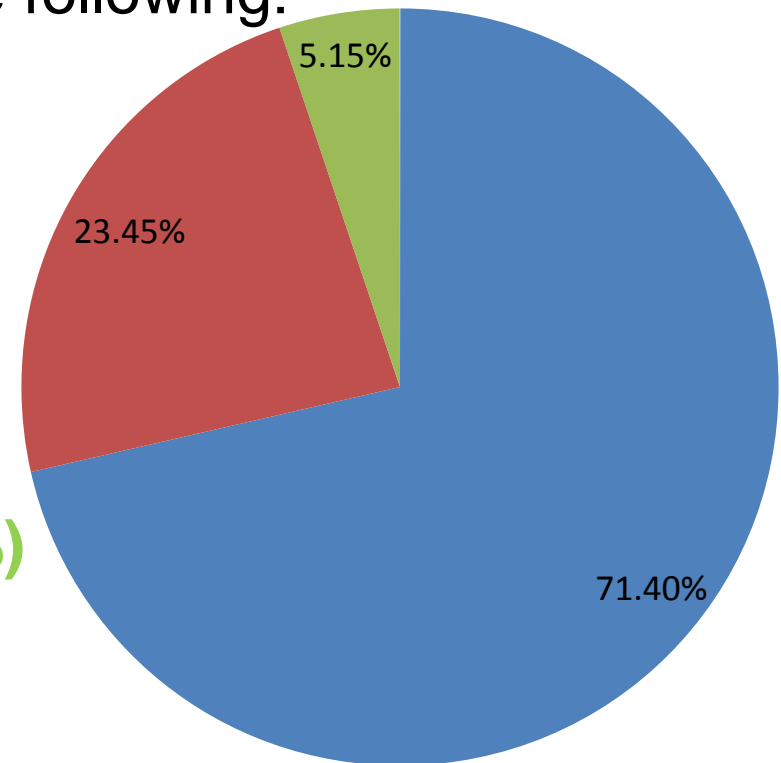
- # of Blades in Population: **1,228**
- # of Turbine Manufacturers: **6**
- Turbine Size: **0.75MW – 2.5MW**
- % of Population Identified with Defects: **~76%**
- Average number of defects per blade: **~7**
- All statistics shown in charts are relative to number of blades affected not relative to defects per blade

Defect Type Breakdown

Total # of Defects discovered through Inspections: **8,311**

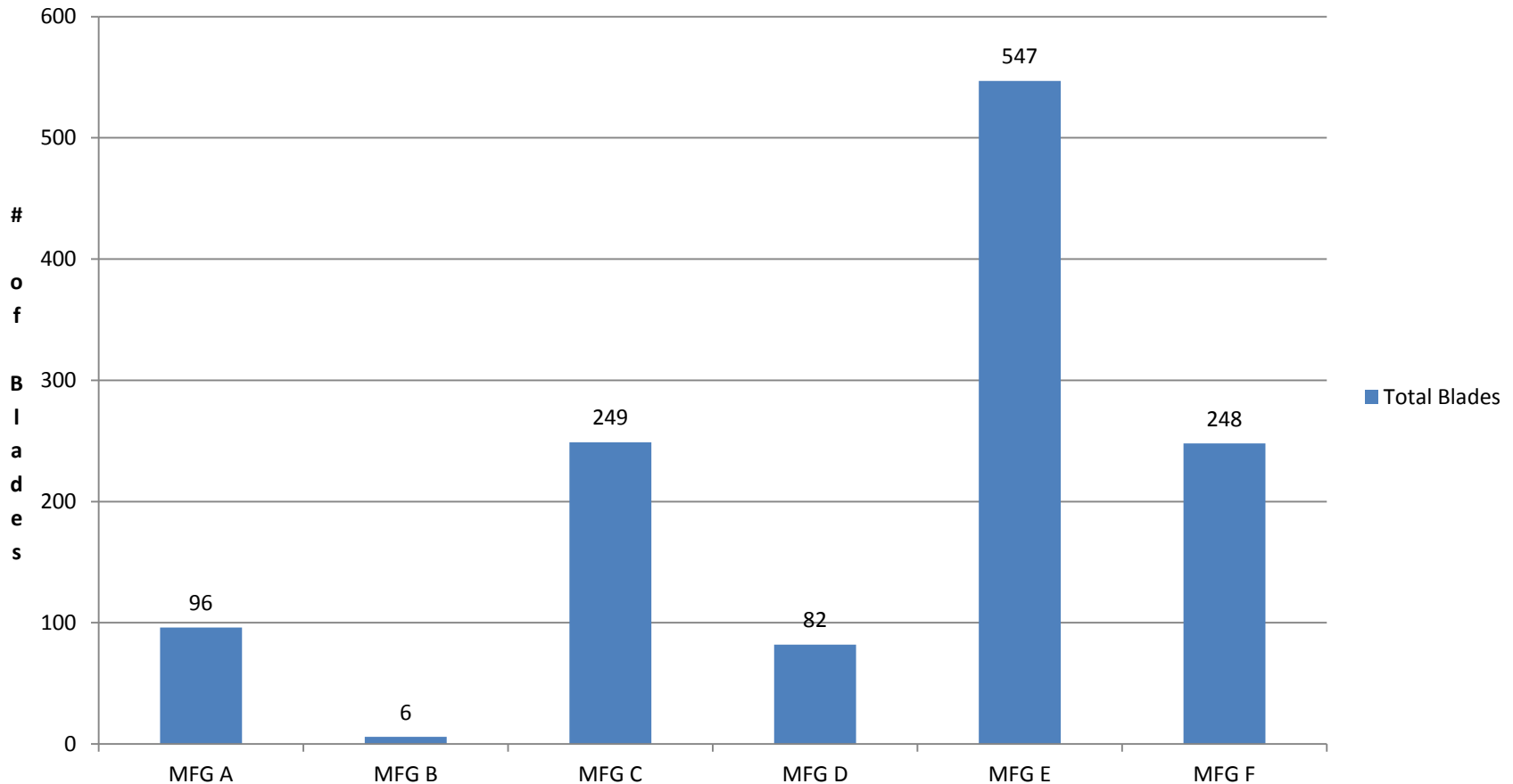
Defects were categorized by the following:

1. Manufacturer (**~71%**)
 - a. Fabrication
 - b. Serial
 - c. Other
2. Wear (**~24%**)
3. Transport/Construction (**~5%**)



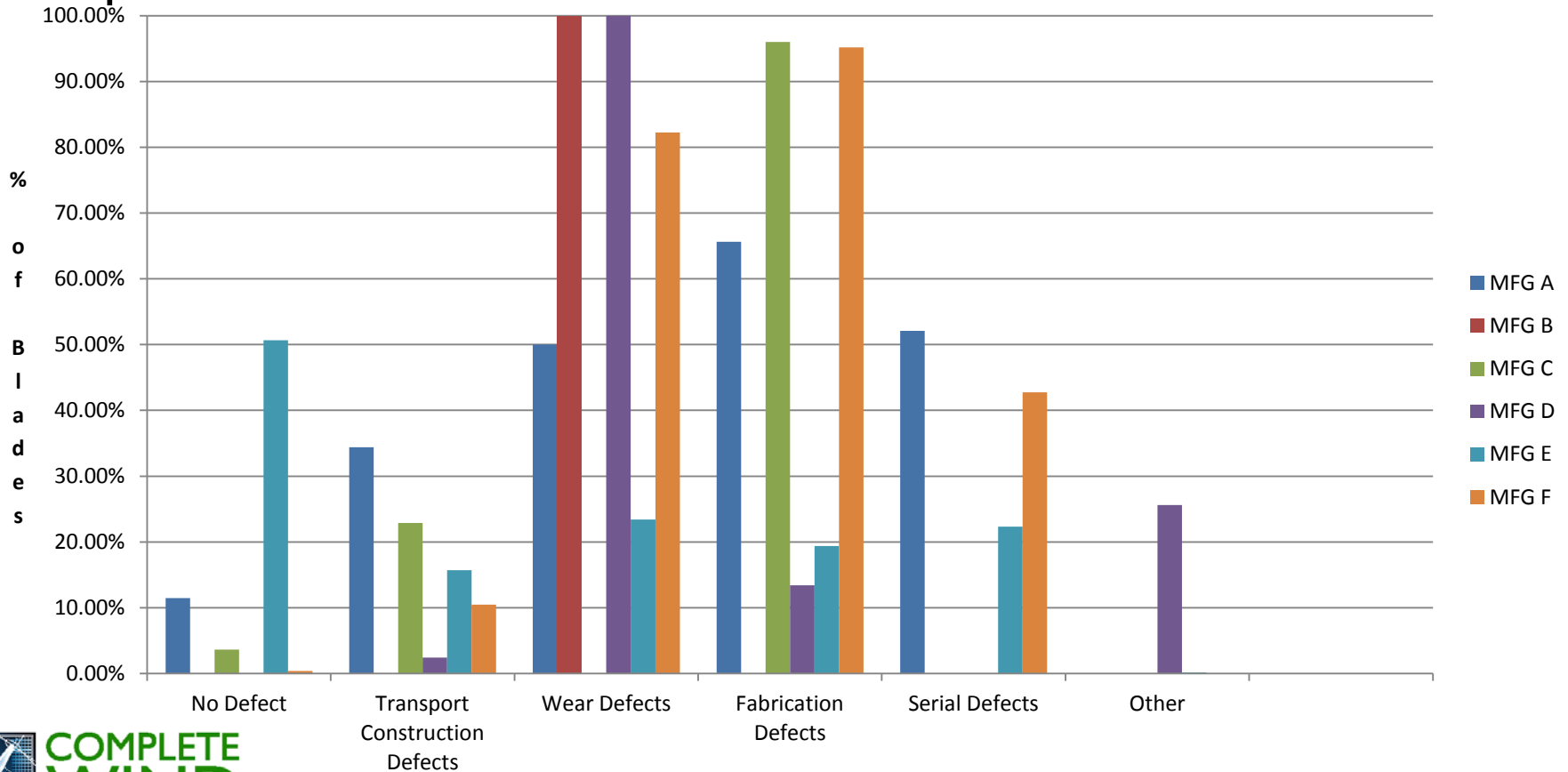
Blades Inspected by Manufacturer

A breakdown of the blades inspected by Manufacturer:



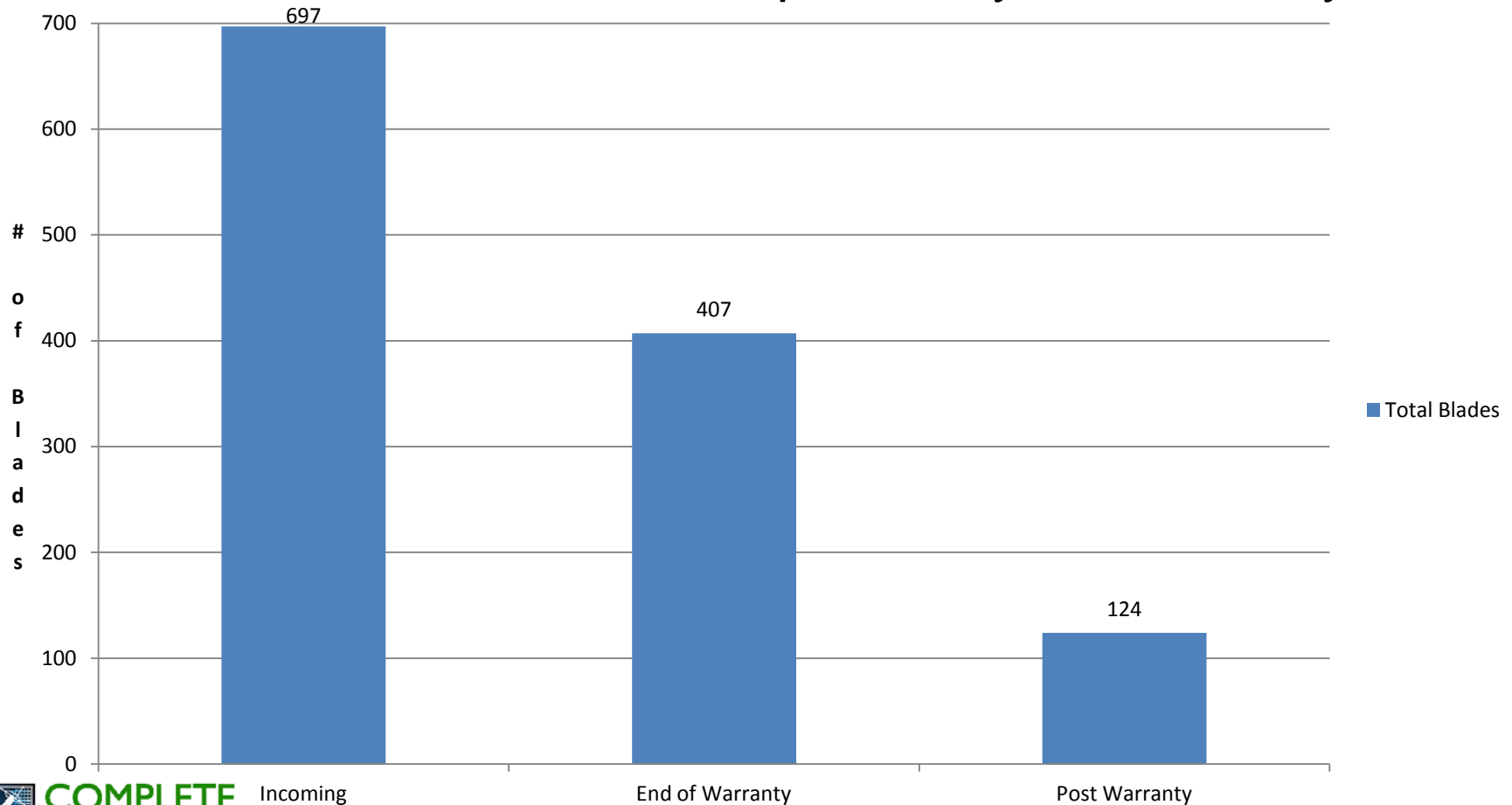
Defect by Manufacturer

Blades from 6 different Turbine Manufacturers were inspected:



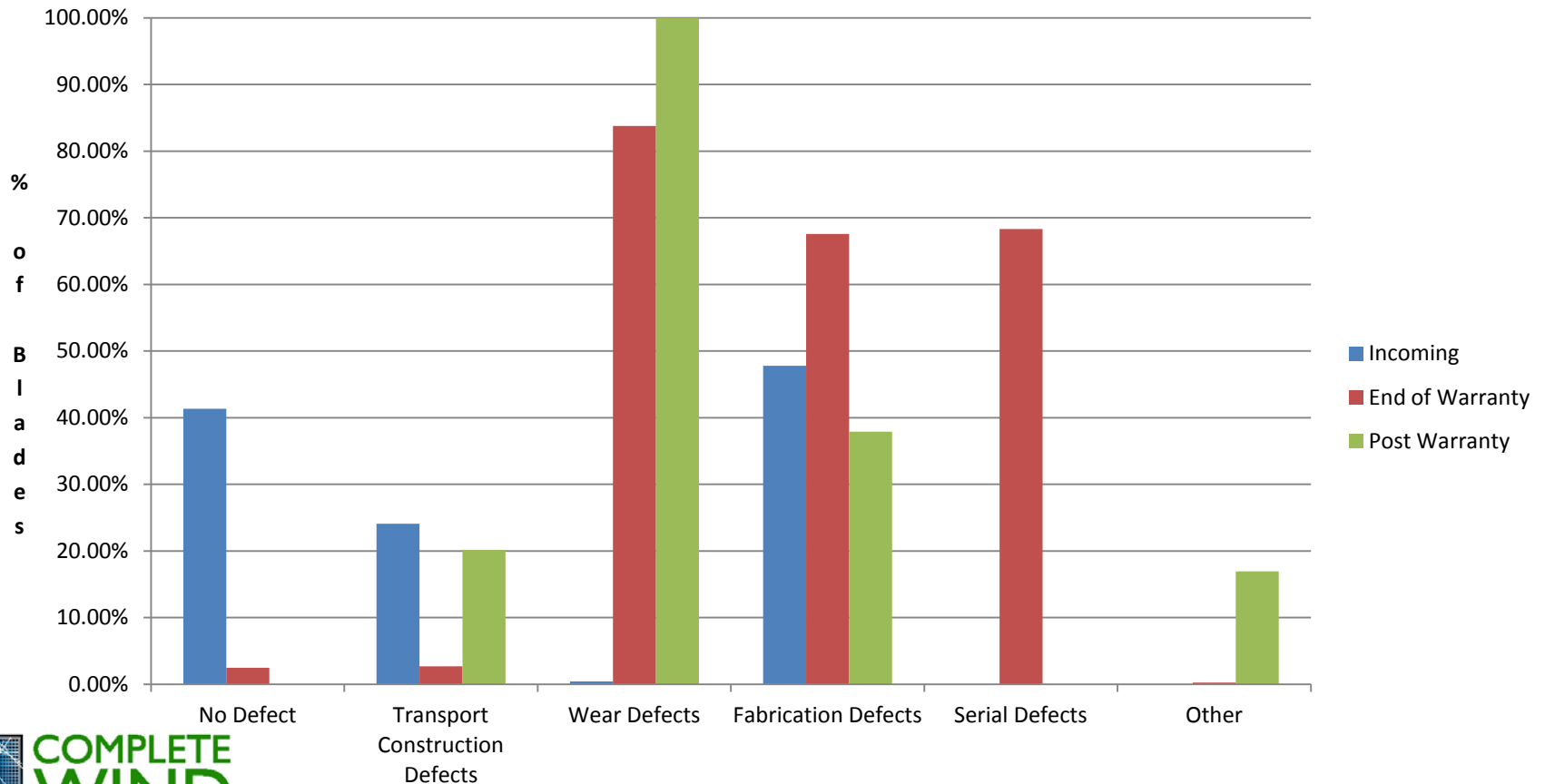
Blades Inspected by Turbine Lifecycle

A breakdown of the blades inspected by turbine lifecycle:



Defect by Turbine Lifecycle

Blades from 6 different Turbine Manufacturers were inspected:



Conclusions

A number of important points can be drawn from a brief overview of inspection findings:

1. 100% of blades inspected Post Warranty had defects defined as Wear/Operational
2. Greater than 65% of blades inspected during End of Warranty were found with fabrication related defects
 - a. Greater than 80% when blades with Fabrication and Serial Manufacturing Related Defects are considered
3. Addressing defects as they appear, allows efficient scheduling of repairs allowing turbines to remain online longer.

Thank you for your attention.

Mike Jeffrey, President

mjeffrey@completewind.com

Complete Wind's Core Management group has:

- Been active in the Wind Industry for 18+ years
- Managed teams of technicians for repair, refurbishment and remediation of large scale wind turbine projects
- Supported owner/operators in USA and Canada on Inspections, including but not limited to consultation with OEM
- Worked collectively with owner/operators to develop a rotor blade preventative maintenance program for their own Operations and Maintenance post warranty

