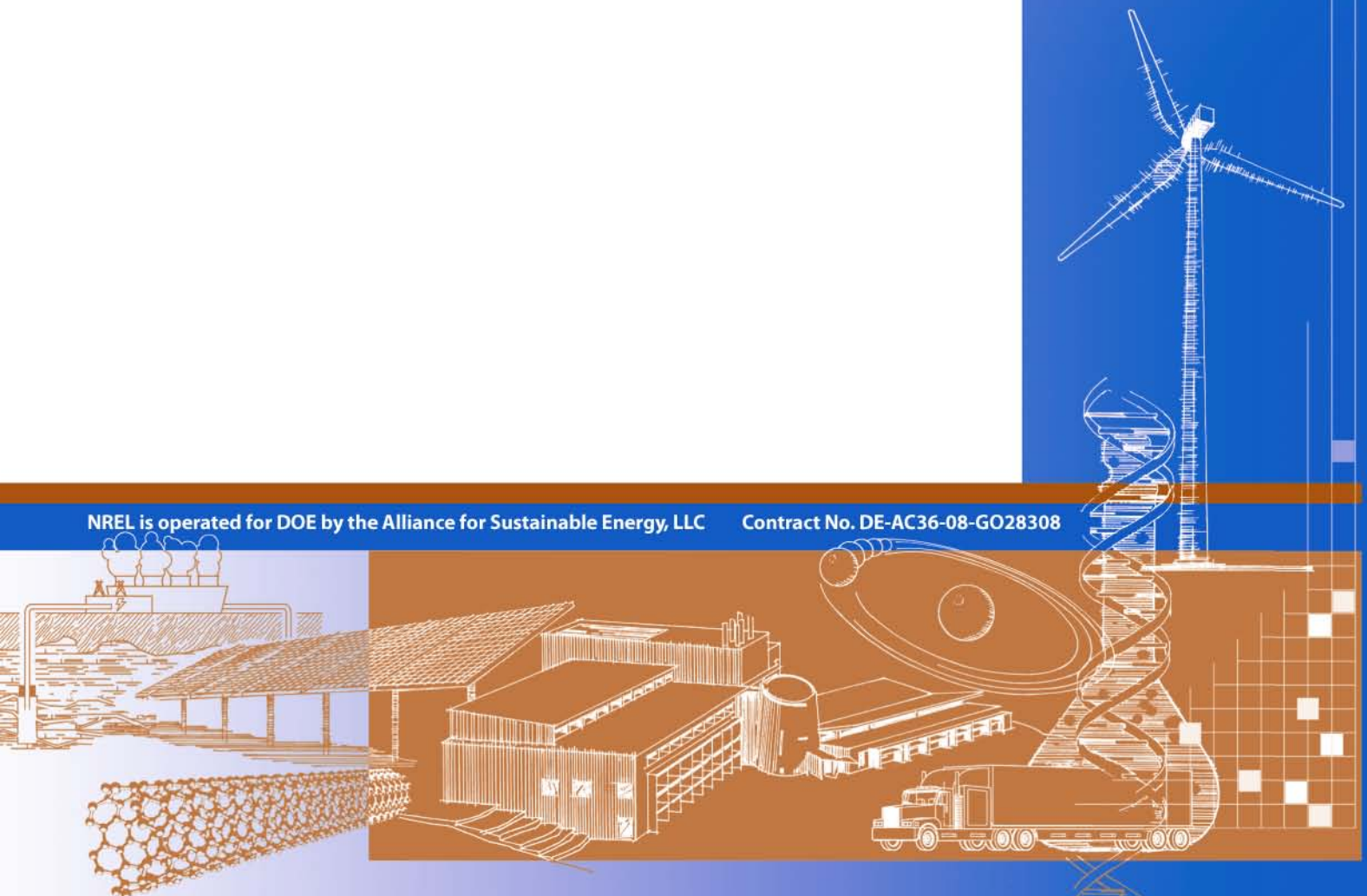
National Renewable Energy Laboratory
A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Innovation for Our Energy Future

Gearbox Reliability Collaborative: Gearbox Inspection Metadata

Kristin Munch and Mark McDade

Technical Report
NREL/TP-500-49133
September 2010



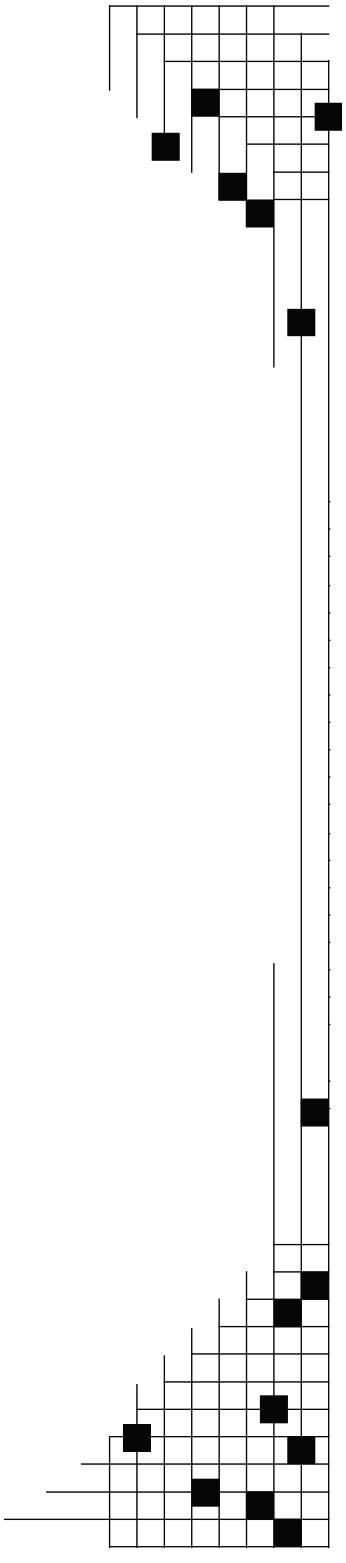
NREL is operated for DOE by the Alliance for Sustainable Energy, LLC Contract No. DE-AC36-08-GO28308

Gearbox Reliability Collaborative: Gearbox Inspection Metadata

Technical Report
NREL/TP-500-49133
September 2010

Kristin Munch and Mark McDade

Prepared under Task No(s). WE10.1132



National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

Contract No. DE-AC36-08-GO28308

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

NREL/NWTC Gearbox Reliability Collaborative Database *GearFacts* Software

The Gearbox Reliability Collaborative (GRC) is a U.S. Department of Energy (DOE)/National Renewable Energy Laboratory (NREL) project to identify and understand premature failure of components in wind turbine gearboxes. These failures are a leading source of unplanned expense in the operation of commercial wind turbines. Analysis and root cause correction of these failures is critical to enhancing the commercial viability of wind power as a sustainable energy source. A key component of the overall GRC effort is the creation of a database of gearbox failure history. To this end, NREL has developed a software application called *GearFacts* that will be distributed to Database Collaborative participants to capture failure information when gearboxes are rebuilt. This publication names and describes each field used in *GearFacts* and can be used as a reference to the software's design.

GearFacts software will be used at the time of a rebuild to guide rebuilders in defining and entering gear and bearing failure details including a photographic record of failure mechanisms. The owner of the gearbox will be able to use any information they have entered to maintain their own rebuild records and to produce reports on their fleet of gearboxes. The research community will be able to use aggregated data from the database to develop statistics on gearbox failure mechanisms, failure timing and, in some cases, costs. The aggregated reporting system will be secured and 'sanitized' to remove identifying data which might convey ownership (or other proprietary) information. In addition, participants in the collaborative will be able to access and utilize data from the testing and analysis portions of the GRC.

For more information about the GRC and its background and proposed research agenda, please see "Improving Wind Turbine Gearbox Reliability" (NREL conference paper CP-500-41548), May 2007. You can access this paper at: http://www.nrel.gov/docs/fy07osti/41548.pdf.

MetaData Collection Elements

The list below describes the metadata elements associated with a gearbox inspection in the Gearbox Reliability Collaborative.

Field name	Field description
Rebuilder name	Group or individual rebuilding gearbox.
rebuild site	Where rebuilt.
gearbox owner	
gearbox responsible contact	Owner contact.
Gearbox responsible contact phone	
Wind site name	
Wind site address 1	
Wind site address 2	
wind site city	
wind site state	
Wind site zip	
Wind site country	
Site turbulence intensity	Using standard nomenclature as available.
Site capacity factor	Actual generation over potential generation.
Operating power	Turbine rated output.
Gearbox install date	The date the gearbox was installed on this turbine.
Gearbox startup date	The date this gearbox first went into operation.
Gearbox shutdown date	The date this gearbox was shutdown due to fault.
Gearbox removal date	The date this gearbox was removed from the turbine.
Cumulative run time hours	The total amount of time this gearbox has run since last rebuild.
Turbine OK hours	SCADA data which may be unavailable during rebuild.
Production since new or rebuilt	Total production in kWh since new (or last rebuilt if not new).
Line loss stops	SCADA data which may be unavailable during rebuild.
Emergency stops	SCADA data which may be unavailable during rebuild.
Wind site comments	
Oil cooler installed	Is an oil cooler installed?
Max online filter size	in microns
Max offline filter size	in microns
Sample collection point	Where on gearbox was oil taken?
Sample collection date	The date the sample was collected, after the failure?
Has dessicant breather	Is a dessicant breather installed?
Lubricant comments	
Failure date	Date of the failure
How discovered	Short description of how the failure was discovered.

Unusual conditions	
SCADA data available	Is SCADA data available for this gearbox?
SCADA data output format	If SCADA data is available, what is its format?
Similar failed	The number of similar gearboxes that have failed on this site?
Similar running	The number of similar gearboxes that are running on this site?
Site terrain description	A short description of the terrain of this site.
Terrain surrounding turbine	A short description of the terrain around the turbine where this gearbox was installed.
Site climate	Desert, ocean, or inland.
Inspection comments	
Gearbox name	
Manufacturer	
Model	
New or rebuilt?	When last installed.
Rebuild location	If rebuilt, above - shop, tower, unknown?
Power rating	
Gear ratio	
Serial number	
{Image of the gearbox ID tag}	
Storage	Please indicate whether the gearbox was stored indoors or outdoors after removal from turbine.
Mount	Number of mount points.
Inspection date	
Lead investigator	
Assisting investigator	
Attached images	Images may be attached to any of the above areas and are critical to the usefulness of an incident report.
Enter data for lubricant:	
Manufacturer	Manufacturer of the lubricant used in this gearbox.
Type Grade	Type and grade of lubricant used in this gearbox.
Last change date	The date the lubricant was last changed
Lab analysis available	Is a lab analysis report available for this lubricant?
Analysis frequency	How frequently was the lubricant analyzed?
Lab used	The name of the lab that analyzed the lubricant.
Oil temperature control low set-point	Fahrenheit/centigrade
Oil temperature control high set-point	Fahrenheit/centigrade
Enter for each gear:	
Gear type	Helical/spur.
Teeth	The number of teeth on this gear.
Gear handedness	Left/right

Outside diameter	The outer diameter of the gear.
Face width	The face width of the teeth.
Whole depth of teeth	
Tooth thickness span	
Tooth thickness top land	
Gear comments	Comments concerning the inspection of this gear
Failure classification	Choose a classification category, and a sub-classification.
Enter for each bearing:	
Bearing type	
Bearing orientation	
Bearing set orientation	
Make	Maker of this bearing.
Country	Country of make of this bearing.
Inner race outside diameter	
Inner race inside diameter	
Outer race outside diameter	
Outer race inside diameter	
Width	
Number of rollers	
Roller profile	
Roller diameter	
Roller length	
Cage type	
Cage material	
Comments	Comments concerning the inspection of this bearing
Failure classification	Choose a classification category, and a sub-classification

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 2010	Technical Report	

4. TITLE AND SUBTITLE
Gearbox Reliability Collaborative: Gearbox Inspection Metadata

5a. CONTRACT NUMBER
DE-AC36-08-GO28308

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
K. Munch and M. McDade

5d. PROJECT NUMBER
NREL/TP-500-49133

5e. TASK NUMBER
WE10.1132

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

8. PERFORMING ORGANIZATION REPORT NUMBER
NREL/TP-500-49133

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
NREL

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
NREL has developed a software application called GearFacts that will be distributed to Database Collaborative participants to capture failure information when gearboxes are rebuilt. This publication names and describes each field used in GearFacts and can be used as a reference to the software's design.

15. SUBJECT TERMS
wind; gearboxes; GRC; database; failure analysis; failure history.

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (*Include area code*)
Unclassified	Unclassified	Unclassified	UL		

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18