Management Report
Period 1-1-2004 to 30-6-2004

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Confidential

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17. GE Wind Energy GmbH	(DE)
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REPORTING PERIOD: FROM 1-1-2004 TO 31-06-2004

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1. OVERVIEW OF PROGRESS.

The technical research activities within the project are performed by Task Groups (TG), each of which performs a cluster of comprehensive Work Packages (WP).
The WP1 and WP 2 are the related to respectively the Steering Committee and the Technical Committee activities. These WPs are not part of one of the TG's activities. Furthermore the WP 16, "Production of test specimens" is not part of a TG because the test specimens are produced for all relevant WP's. Since the activities are performed in different WPs, the progress during the reporting period is given per WP.

1.1. Summary of objectives for the relevant period

WP3 (TG1)

- Finish the benchmarking of the lifetime prediction methods after repeating the calculations based on the various models.
- Continue the establishment of the load levels for constant amplitude fatigue testing.
- Start variable amplitude tests with the load spectra tests.

WP4 (TG1)

- Finish the final report on the Wisper Synthesis, after all comments have come in.
- Each of the data supplying parties (CRES, DEWI, ECN) will process their data to a defined degree.
- Continue the work on the data processing tools and on the data itself

WP6 (TG2)

- Carry out as many as possible bi-axial tests in order to reduce delays observed in the modified time schedule.
- Continue testing of standard OB coupons in parallel in several test rigs.
- Carry out an FE analysis of a real blade, compare with measured data and beam analysis.

WP8 (TG3)

- Continue testing of reference material at extreme conditions according to the updated time planning.
- The phenomenological modelling and damage analysis will continue parallel with testing.
- Most tests should be done by the end of this period.

WP10 and WP11 (TG4)

- Continue testing, now that the long and repaired test specimens have become available.
- WMC will test the first series of repaired specimens from Polymarin and CRES will continue testing the next series of repaired specimens from Gamesa and repaired specimens from LM (WP11).

WP13 (TG5)

- Carry out as many as possible tests, in view of the severe delays encountered by TG5, which needed the S-N lines by TG1 in order to able to start.
- Priority will be placed on the shorter nominal target lifetime (1.0e3, 5.0e4, 1.0e6) tests, to establish as full a test matrix at as early a stage as possible.

WP16

- Produce the standard Optimat Blade test specimens.
- Start production of the cruciform specimens and the first series of tubular specimens. This last activity has been taken over from Nordex

1.2. Overview of the progress including survey of the work carried out during the reporting period and its main results

WP3 (TG1)

Most static work has been done. The constant amplitude fatigue data for the major stress ratios has been established. The benchmarking of the lifetime prediction methods is still ongoing, almost completed. A few variable amplitude tests were done. The validity of test results is considered and the lowest number of cycles is raised from 1000 to 5000 cycles, in order to avoid buckling and semi-static failures.

WP4 (TG1)

All data has been collected and is being processed, the analysis is underway. Reporting shall be concluded before the next regular meeting on which the results of WP4 will be presented.

WP6 (TG2)

The geometry and manufacturing problems for cruciform and tubular test specimens were solved and a number of cruciform specimens and tubes were tested successfully. Testing of standard OB specimens is ongoing, good progress has been made. The comparison between blade test data, FE analysis and beam analysis results has been started by supplying measured and calculated strains.

WP8 (TG3)

The testing of reference material at extreme conditions was finished at Risø (except for the specimens subjected to 12 months submersion in sea water) and started at the other partners of TG3. Work on the phenomenological modelling and damage analysis has begun and will continue as the partners deliver their test results.

WP10 (TG4)

Work on 4 point bending was carried out by WMC.

WP11 (TG4)

CRES continued testing the next series of repaired specimens from LM.

WP13 (TG5)

A few residual strength tests have been done. The lower limit is changed from 1000 cycles to 5000 cycles. For the same reason, work will concentrate on 50% of the fatigue life.

WP16

Production of specimens is mostly done, extra specimens will be produced where needed and a few special test specimens will be made. Currently, LM has some 600 specimens in stock.

1.3. Comparison of planned activities and actual work accomplished during the reporting period

In this period, after solving major problems with the definition of the test specimen, production of enough test specimens and lower than expected fatigue test frequencies in 2003, the work is progressing at full speed. Work in TG1 is going OK, TG2 is going strongly as well, now that the problems with the biaxial test specimens are solved. Work in TG3 is progressing well. In TG4 delays with the thick specimens have occurred, while work on the repaired specimens is going well. In TG5 a major delay will force a change in detailed plan of action. WMC has ordered extra test machines in order to help combat the delays incurred so far.

Table 1 Progress made in tests to date

Test type	Original plan	Current plan	Tests done	%	Cycles planned	Cycles done	%	Time planned	Time used	%
Static	1153	878	475	**54%**	-					
Constant Amplitude	731	675	446	**66%**	2.36E+08	2.1E+08	**89%**	24152143	47000000	**195%**
Variable Amplitude	315	300	12	**4%**	1.05E+08	1000000	**1%**	10734286	1000000	**9%**
Residual strength	684	720	114	**16%**	2.52E+08	21000000	**8%**	25762286	3900000	**15%**
Total Fatigue	1730	1695	572	**34%**	5.94E+08	2.32E+08	**39%**	60648714	51900000	**86%**
RST fatigue failure		35	31%		5400000	26%		1300000	33%	

Constant Amplitude (CA): fatigue test where the test specimen is subjected to a load ranging between a defined minimum and maximum load.
Variable Amplitude (VA): fatigue test where the test specimen is subjected to a variable loads.
Residual Strength (RST): after a number of CA cycles, the test specimen is tested statically, unless the specimen failed already during the fatigue test (show as RST fatigue failure in the table above).

1.4. Planned activities for the next period including any proposed revisions to the Work plan

The work plan will be revised in order to deal with the delays experienced to date, as well as for the second phase of the project. It is possible that the duration of project will either have to be extended, or the work to be done cut back further in order to meet to original deadline.

WP2 (TC)

Update the TIP, using E-tip

WP3 (TG1)

The work on static tests will be finished, as well as the constant amplitude fatigue tests for the major stress ratios. Work on other stress ratios has less priority than work on variable amplitude, such as block tests. Work on life time prediction comparisons will be completed in this period.

WP4 (TG1)

It is expected that the work WP4 will be finished at the end of this period.

WP6 (TG2)

Work on biaxial tests will continue at full speed in order to reduce delays observed in the modified time schedule. Testing of standard OB coupons will continue in several test rigs, while the analysis on blade models will be carried out.

WP8 (TG3)

Most tests under extreme conditions will have been done and the analysis well under way.

WP10 (TG4)

The tests on thick specimens will be shifted to Phase II. This also makes the tests for specimens in thickness direction less urgent. The FE analysis for 4 point bending will be carried out.

WP11 (TG4)

WMC will test the first series of repaired specimens from Polymarin when they arrive, while CRES will work on specimens by GAMESA and LM. Work on the thick test specimens will possibly be transferred to Phase II.

WP13 (TG5)

Here the most work remains to be done, due to the delay in the establishing of S-N lines in TG1. testing can now start here too, but the WP will likely need major revision, probably resulting in shifting of a large number of tests to Phase II.

WP15 (TG6)

The work on the design recommendations will start at the end of this period, as enough test data is available to get started by that time.

2. MANAGEMENT AND CO-ORDINATION ASPECTS

2.1. Co-ordination activities

- A fruitful meeting was held at the University of Patras in June. The validity of fatigue tests carried out to date was discussed and a procedure for establishing the validity of tests was determined. The results of the universal OPTIMAT geometry were compared to specialized ISO test specimens, and found to be performing well. Acceptance criteria were established for fatigue results and the general test specification further discussed.
- The database of the tests, OPTIDAT, was discussed and all tests specimens by LM should be included, even those that are lost, invalid etc.
- For the upcoming MTA, the major issue at hand will be the go/no go decision. All partners present at the meeting at UP strongly agreed that the project is doing quite well and are in favour of continuation, even in view of the major problems encountered and overcome.
- An extension of the project by twelve months would be necessary in order to carry out all the work, after the initial delays.
- Communication between coordinators and other partners and between partners themselves is excellent, with a strong network forming out of the OPTIMAT partners.

2.2. Publications to date and planned

[1] Arno van Wingerde, Rogier Nijssen, Don van Delft, Bert Janssen, Povl Brondsted, Geoff Dutton, John Heijdra, Christoph Kensche, Theodore Philippidis, Torben Jacobsen, “Poster on Optimat Blades”, EWEC 2003, Madrid Spain (*Best of conference poster award*).

[2] Arwen Smits, Danny Van Hemelrijck, “Optimization of a cruciform test specimen for bi-axial loading of fibre reinforced material systems”, Student seminar of 25th International SAMPE EUROPE conference / JEC, Paris, France, April 2004 (*poster*).

[3] Arwen Smits, Danny Van Hemelrijck, Theodore Philippidis, Arno van Wingerde, Albert Cardon, “Optimization of a cruciform test specimen for bi-axial loading of fibre reinforced material systems”, ECCM, 11th European Conference on Composite Materials, Rhodes, Greece, May 2004, p.166-167 Vol.II in book of abstracts.

[4] Arwen Smits, Danny Van Hemelrijck, Theodore Philippidis, Arno van Wingerde, Albert Cardon, “Study of the usability of various cruciform geometries for biaxial testing of fiber reinforced composites, ICTAM, XXI International Congress of Theoretical and Applied Mechanics, Warsaw, Poland, August 2004, p. 293 in abstract book.

[5] Arwen Smits, Danny Van Hemelrijck, Theodore Philippidis, “The digital image correlation technique as full field strain technique on biaxial loaded composites using cruciform specimens”, ICEM 12, International Conference on Experimental Mechanics, Bari, Italy, September 2004.

2.3. Planned publications

[6] During the EWEC in London, a paper on OPTIMAT BLADES and related projects will be presented during a special workshop to be organised on Tuesday 23rd November morning at the Contractors Meeting.

[7] Christoph W. Kensche, “Fatigue of composites for wind turbines”, in “Third International Conference on Fatigue of Composites”, 13 – 15 September, 2004, Kyoto, Japan.