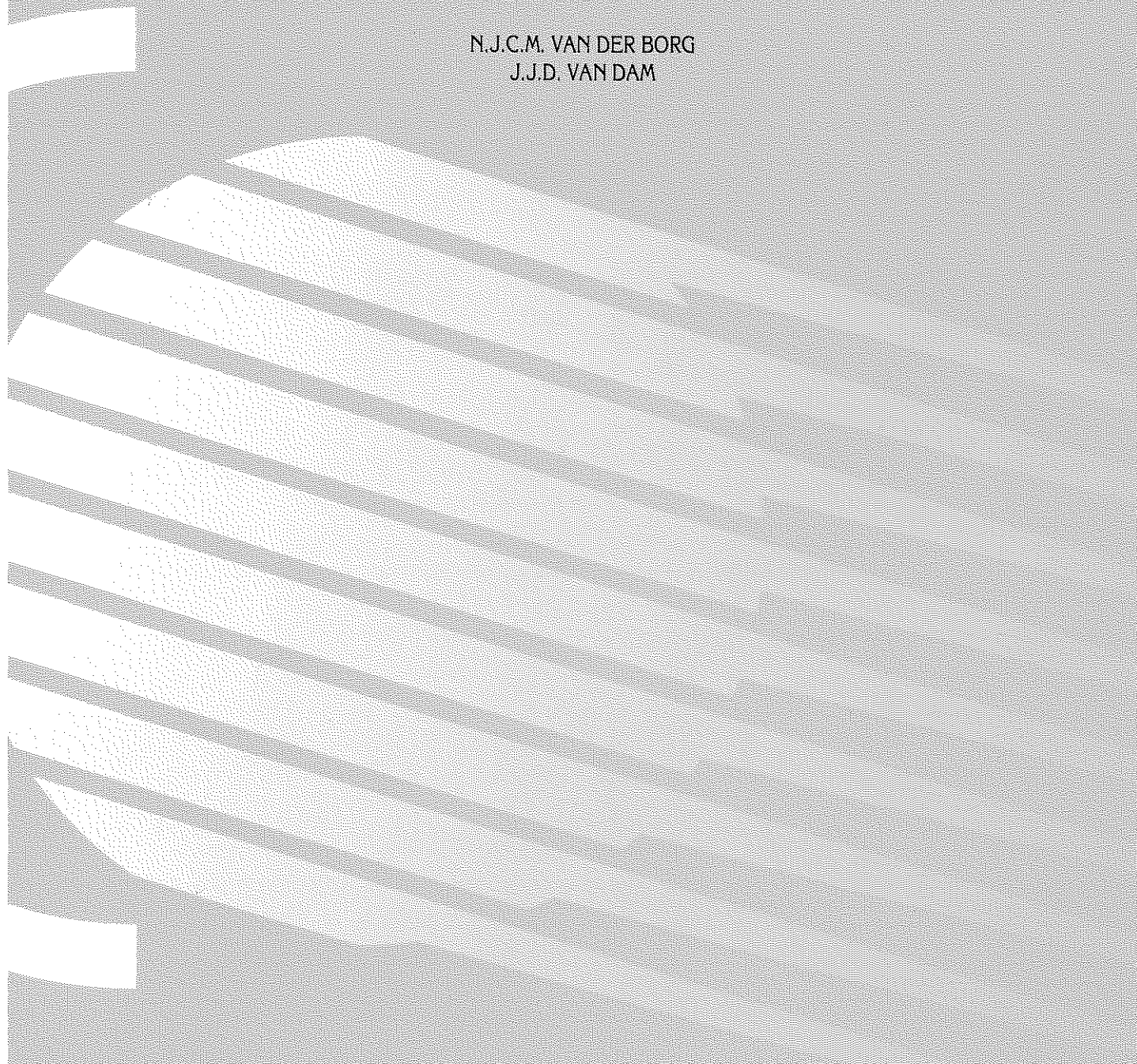


PROPOSED PROCEDURE FOR THE EVALUATION OF UNCERTAINTIES IN LOAD MEASUREMENTS ON WIND TURBINES

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LIST OF SYMBOLS

A	coefficient in calibration matrix
a	“maximum error”
c (sub)	combined
c(super)	during calibration
cal	due to calibration uncertainty
D	coefficient in inverted calibration matrix
e	edgewise
f	flatwise
F	calibration force
i	index (general)
L	distance between calibration load and strain gauge
M	bending moment
n	index in Monte Carlo procedure
N	number of entries per bin
r	correlation coefficient
Ran	random value
Req	equivalent load range
stdev	standard deviation
sig	due to signal uncertainty
S	signal
s	type A uncertainty
u	type B uncertainty
U	standard uncertainty in final result
v	wind speed
*	modified value in Monte Carlo procedure
α	direction of calibration load w.r.t. blade axis
δ	partial derivative
θ	direction of calibration load w.r.t. blade chord

SUMMARY

In the framework of the EC-programme "Standards, Measurements and Testing, SMT" a project called "European Wind Turbine Testing Procedure Development" is being carried out by various European partners. Subtask 3 of the project ("Wind Turbine Load Measurement Instrumentation") will result into an improved knowledge of sources of uncertainties that occur during load measurements. The various sources of uncertainties all contribute to the uncertainty of the final results of the measurements.

One of ECN's tasks in the project was to draft a procedure that can be used to combine the various sources of uncertainty into the overall uncertainty of the final result. The proposed procedure is described in this report. The proposed procedure follows the general approach laid down in the ISO-guide for expression of uncertainty in measurement. In situations where the ISO-guide fails to give a practical procedure (e.g. in case of Rain Flow Counting) an alternative procedure is described. Using the proposed procedure some examples concerning load measurements on wind turbine blades are worked out in more detail.

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