

Component Fatigue Strength Project:

“CFS Phase I”

Consortium Agreement

Issued 16 May 2011

The Project – “*CFS Phase I*” as defined in Annex 1

The Contractors – „Institut für Prozess- und Anwendungstechnik Keramik (IPAK) an der RWTH Aachen e. V., Templergraben 55, 52062 Aachen, “: IPAK

The Coordinator – The European Powder Metallurgy Association EPMA

The Members - **paid up corporate EPMA members*** funding the Project

The Participants – The Contractors and the Members

UV = unanimous vote of Members and Contractors; MV = majority vote of 2/3 members or higher

Heads

1. The Members and Contractors agree to cooperate in order to complete the Project according to Annex 1.
2. All information generated under the Project will remain confidential to the Members during the Project and for 5 years after delivery of the final written report to Members, and may only be disclosed to third parties (e.g. for dissemination purpose in PM Congress) with UV.

For **IPAK**: Under the relevant provisions of the Universities Act NRW (Hochschulgesetz NRW), the contractor is obliged to publish in the usual scientific form the results of studies undertaken during performance of the project. The client gives his fundamental consent to such publication. In particular, the client will allow publication in connection with the taking of doctorates. The contractor will inform the client beforehand of any planned publication and will give him the opportunity of commenting upon it within a reasonable period, at latest ten (10) weeks after submission of the text intended for publication. A Member is entitled to refuse his consent to a publication if it is intended to publish company related data or, in connection with the granting of patent rights, if it is intended to publish any anticipatory information likely to constitute a bar to novelty. In such cases, the contracting parties will, without delay, seek to reach a special agreement governing the form and timing of rapid publication and taking due account of the legitimate interests of both parties.

3. The Contractors agree to not carry out a similar project on component fatigue strength with organisations other than the Members until the completion of the project (delivery of the final report). The aforementioned obligation shall not apply to other entities of RWTH other than its performing entity IPAK.
4. The Members agree **to share equally the cost of the Project** (EUR 12 800) through a Project Fee of maximum **EUR 3 200** per Member according to the Payment Schedule detailed in 6. The required minimum number of Members is **four** unless the Members agree to exceed the maximum Project Fee.
5. The Members also undertake to provide the Contractors with the necessary materials (powders, specimen etc...) for the project. If no agreement on in-kind contribution between the industrial partners can be found, the EPMA will coordinate this task "WP 0" and charge equally each Member to cover the cost plus an administrative fee of 10%.
6. **Payment Schedule:**
For the Work Package 0: Full payment within one month after invoice if necessary.

For CFS Phase 1 Project:
 - **25% at the start,**
 - **25% at the middle,**
 - **50% after completion** of the project and delivery of the report(s).
7. New paying members may be admitted during the Project by UV on payment of an additional reasonable premium (10%). The premium will be used to decrease the Project Fee for the CFS Phase 1 Consortium Members.
8. Except for the deliverables of the Annex 1, each Participant will retain the Intellectual Property for any other outcomes of the project.
9. Warranty. The contractor's warranty extends solely to the use of due scientific diligence and to compliance with accepted engineering practice. The contractor does not guarantee that the desired objectives of the research and development project will be achieved.
10. Liability. The contractor is liable solely for wilful actions and gross negligence. Liability for proven damage is limited to the amount of the contractual sum.

Except for the terms 0, 9, 10, all the terms of this agreement may be changed by UV.

Coordination will be by the EPMA, who will have responsibility for invoicing, day to day liaison with the Contractors and keeping Members informed. The EPMA will operate under the same confidentiality agreement as Members and the EPMA President will be arbitrator for unresolved disputes.

Signatures: signed individually by all Members and Contractors

ORGANISATION:

NAME:

(Date signed)

***If you are not an EPMA member please contact Dr Olivier Coube, EPMA Technical Director, oc@epma.com**

Annex 1: Component Fatigue Strength Project: CFS Phase 1

Background

The fatigue strength at constant stress ratio R can be summarized in a material master curve expressed by a simple equation derived from a density modified three parameter Weibull distribution comprising the effects of density, loading mode, size and geometry or notches. First component test results confirm this approach to fatigue performance and fit into the scheme established with laboratory samples. The fatigue strength can be predicted, if the following items are known:

- mathematically formulated material master curve,
- the so-called highly loaded volume of the component from an FE analysis and
- the ratio of external load and highest first principal stress from an FE analysis

Task

To make this new method a viable tool for component performance predictions, material master curves must be established for common sintered steels. Beyond the two steels which have been investigated in a recent nationally funded project, there is enough experimental evidence to establish a master curve also for Fe-1.5 % Cu-0.6 % C at least for the stress ratio $R = -1$, if a limited number of additional S-N curves is generated.

Deliverables

Final Report on data evaluation: The results of the study will be summarized in a detailed report on data evaluation, deduction of the master curve equation, list of experimental and corresponding FE results of Fe-1.5 % Cu-0.6 % C, regression coefficients of master curve equation for

- Fe-1.5 % Cu-0.6 % C; stress ratio $R = -1$
- Fe-4 % Ni-0.5% Mo-1.5 % Cu-0.6 % C; stress ratios $R = -1$ and $R = 0$
- Fe-1.5 % Mo-2 % Cu-0.65 % C; stress ratios $R = -1$ and $R = 0$

(the two latter from existing publications)

and the corresponding master curves.

Demonstration: IPAK Aachen will demonstrate the viability of the method with a component which the members of the Consortium can propose. The loading situation should not be too complicated in order to keep the work load on IPAK's side moderate (to be agreed at the beginning of the project). A suitable application would e. g. be an injector clamp for common rail systems, which are typically loaded in bending and which can rather easily be FE analysed. In order to prepare a demonstration in Aachen IPAK would need a lead time of about four to six weeks. The steel of the clamp must be one of the steels which IPAK have a sufficient amount of data on. On request IPAK can demonstrate both ANSYS and ABAQUS solutions for the component in question.

Roadmap Report on further steps: In addition to the Report on data evaluation, A Roadmap report will be also provided to the Consortium to suggest further phases of the project of the CFS Project.

Time Frame

After finalizing the details of the project, the final and Roadmap reports will be delivered within 6 months.

A demonstration meeting could be organized in Aachen within 2 months after signing the Consortium agreement.

Financing Required

Evaluation of existing data	€ 500
Two additional S-N curves	€ 8000
Final and Roadmap Reports	€ 600
Demonstration	€ 2500
Management fee EPMA 10 %	€1200
Total	<u>€ 12800</u>