PROVIDA Project - Minutes of the 3rd Progress Meeting

Cambridge, 10.00am, 23rd September 2014

Attending

Bill Clyne twc10@cam.ac.uk	TWC	Cambridge (MSM)
James Dean jd362@cam.ac.uk	JD	Cambridge (MSM)
Catalina Taltavull ct463@cam.ac.uk	CT	Cambridge (MSM)
Margaret Hartley meh43@cam.ac.uk	MEH	Cambridge (ES)
Sai Gu s.gu@cranfield.ac.uk	SG	Cranfield
HoseinTorabmostaedi h.torabmostaedi@cranfield.ac.uk	HT	Cranfield
Zihang Zu z.zhu@cranfield.ac.uk	ZZ	Cranfield
Rory Clarkson Rory.Clarkson@rolls-royce.com	RC	Rolls Royce
Beth Majewicz Beth.Majewicz@rolls-royce.com	BM	Rolls Royce
Matthew Lunt MJLUNT@dstl.gov.uk	MJL	DSTL
Adam Durant adam.durant@geo.uio.no	AD	U. of Oslo
Daniel Mack d.e.mack@fz-juelich.de	DEM	IEK-1 Jülich
Shrikant Joshi svjoshi@arci.res.in	SJ	ARCI (via telelink)
Sivakumar Govindarajan gsiva.arci@gmail.com	SG	ARCI (via telelink)
Uwe Schulz uwe.schulz@dlr.de	US	DLR Köln

For Information

Ian Davies Ian.Davies2@easyJet.com	ID	EasyJet
Graham Pearce Graham.Pearce@easyJet.com	GP	EasyJet
Matthew McGilvray matthew.mcgilvray@eng.ox.ac.uk	MM	U. of Oxford
David Gillespie david.gillespie@eng.ox.ac.uk	DG	U. of Oxford
Andreas Vogel avo@nilu.no	AV	Nor. Inst. Air Res.
Robert Vassen r.vassen@fz-juelich.de	RV	IEK-1 Jülich
Varunjay Ahluwalia (VJ) vahluwalia@dstl.gov.uk	VA	DSTL
Fred Prata fp@nicarnicaaviation.com	FP	Nicarnia Aviation
Helen Thomas ht@nicarnicaaviation.com	HT	Nicarnia Aviation
Graham Bulman graham@monitorcoatings.com	GB	Monitor Coatings
Amy Kelly amy@monitorcoatings.com	AK	Monitor Coatings
Bennie van de Goor email@amtjets.com	BVDG	AMT
Bryan Allcock bryan@monitorcoatings.com	BA	Monitor Coatings

3.1 Welcome & Introductions

TWC welcomed everyone, particularly those attending their first meeting (ZZ, MJL, AD, DEM & US).

3.2 Apologies for Absence

There were none, beyond what had been agreed in advance (ie those in the "For Information" list) above.

3.3 Minutes of last meeting (18th June 2014)

These were approved as a correct record.

3.4 Summary of Recent Work at Cambridge

CT gave a brief update concerning recent work on characterising the ashes being studied and use of the Combustion Chamber Simulation Rig to study adhesion of ash particulate. The presentation, and all of the others made at the meeting, will shortly be uploaded to the PROVIDA website. In summary, adhesion of the Hekla ash, which is fully amorphous, but apparently has a very high T_g value, was found to occur less readily the Laki ash, confirming (at least provisionally) the considerable significance of T_g concerning adhesion for many of these (highly amorphous) ashes. There were some discussions about the factors that determine the T_g value and whether it can be predicted from the composition. It was agreed that more measurements are needed of T_g values, particularly for the 4 ashes on which attention is now being concentrated in the project.

3.5 Summary of recent work at Cranfield

SG and HT reported the outcomes of preliminary modelling work at Cranfield, mostly focussed on in-flight behaviour of ash particles and some of the phenomena occurring during impact. There were some interesting discussions about how such modelling can be correlated with the experimental work in Cambridge (and at ARCI). It was noted that the prime interest is in exactly how the impact and spreading occurs, and whether some predictive capability can be developed regarding the likelihood of adhesion. It's therefore suggested that modelling of in-flight effects (heat and momentum transfer) can be carried out in Cambridge, while Cranfield concentrates on the more difficult process of impact and spreading (on surfaces with different roughness levels and orientations).

It was also noted that it's probably not acceptable to treat the particles as being composed of a solid core and a surrounding liquid annulus (or vice versa): in practice, while radial symmetry will have to be assumed (until the point of impact), the particle will probably be either "liquid" throughout (but with a viscosity that is a strong function of T) or some sort of "mushy" mixture of crystalline and liquid regions. Of course, modelling the mechanical behaviour of such material presents major challenges. It was agreed that more experimental information will be obtained in Cambridge by CT, concerning the morphology of "splatted" particles and their internal microstructure.

3.6 Summary of recent work at Hyderabad

SJ reported that the project funding has finally been approved in India and work is under way. SG has been in touch with CT about the problems of alumina substrates becoming cracked during spraying and CT has conveyed various technical recommendations. One of the problems seems to be associated with the extended spraying periods needed with the SPS process to build up coating thicknesses in the range of interest. Work in this area is ongoing.

3.7 Sourcing of targeted VA types in Iceland

MH reported on her recent successful trip to Iceland, where she obtained approximately 10 kg of each of the 4 ashes being investigated. These are: Hekla (100% glassy), Askja (85%), Laki (70%) and Eldgja (25%). There were various discussions about their source, composition, formation mechanisms, effects of hydration etc. These samples are now in the process of being dried, crushed, milled and classified. Some new milling equipment will shortly be acquired in Cambridge. This processing will take a little while, but hopefully sufficient powder will emerge from the operation for the requirements of the rest of the project. It was also noted that MH will be taking up a lectureship in Manchester soon after Christmas, although this will not prevent her from continuing to participate in the project.

MH and CT have kindly been invited by RC and BM to visit Rolls Royce at Derby, and this visit will take place shortly.

3.8 Update on EasyJet plans for VA deposition tests in large engines

ID and GP were unable to make the meeting, but conveyed some information beforehand. There had been a meeting with GE in Paris, at which the planned trials were discussed. GE are supportive in principle, but feel that the preparation period may need to be extended somewhat, since there needs to be complete clarity about how the individual runs will be carried out and what will be obtained from them. Provisional plans for the series of trials are therefore that they are likely to take place late in 2015, or possibly in 2016, rather than in mid-2015, as originally envisaged.

3.9 Update on VERTIGO project

AD described some recent activities within VERTIGO, a large EU project (20 partners) focussed on improved understanding of volcanic eruptions and the detection of resulting ash (and other airborne particles, such as ice). He also noted that AV is doing a PhD with him and aims to focus some of this work on (modelling of) airflow through aeroengines and effects arising from the ingestion of CMAS particulate. It was agreed that it should be beneficial for some close liaison with Cambridge, and also with Rolls and EasyJet, in this area. Discussions are currently in progress about the possibility of AV spending a short period in Cambridge.

3.10 Update on AVOID project

HT and FP were both unable to attend, so there was no specific update in this area.

3.11 Summary of recent work at DLR Köln

US gave a brief overview of relevant work and facilities at DLR, where there is considerable interest in ash and other CMAS particulate. US also described some very interesting work using a small jet engine, involving injection of ash particles into the air intake. It was agreed that there is considerable scope for synergy between the PROVIDA project and ongoing work at Köln.

3.12 Summary of recent work at IEK-1 Jülich

DEM gave a presentation about ongoing work at Jülich. There is an outstanding set of facilities there, including a number of burner rigs and advanced plasma spray capabilities (including very low pressure operation). DEM also outlined a number of microstructural investigations, including some relating to the creation of phases resistant to the acceleration of sintering by CMAS (including volcanic ash).

3.13 Project Plans, Milestones and Deliverables

TWC briefly summarised the immediate objectives. The PROVIDA website is now fully functional, although in need of updating with respect to the uploading of meeting presentations, publications etc. It was requested that everyone with a document for uploading should send it to TWC/CT/JD. It was again noted that TWC will be visiting Hyderabad in November, and visiting ARCI. There will shortly be liaison concerning the opportunity this will provide for specimen exchange etc..

3.14 Date of next meeting

The next meeting is planned for sometime around Easter 2015. The date will be fixed before Christmas, probably via a Doodle Poll.