DELIVERABLE REPORT

FINAL PUBLISHABLE SUMMARY

Document code:

Deliverable ☒ Technical report ☐ Other ☐

Project title: open rotor Engine WELDed parts inspection using MIniautizable NonDestructive Techniques			
Project acronym:	WELDMINDT		
Grant Agreement number:	CS-GA-2012-01-SAGE-323427		
CS JU Project officer: Vittorio Selmin			
Task Number	6.2	Name	Project Management
Work package Number	6	Name	Project Management, dissemination and exploitation
Date of delivery Contractual	M33	Actual	M35
Period covered:	From M16 to M33 (November 2012 ï July 2015)		
Status	Status draft ☒ final ☐ Version Number and Date: final,2015-09-28		
Nature	Prototype ☐ Report ☒ Specification ☐ Tool ☐ Other ☐		
Name of the scientific representative of the project's co-ordinator[1], Title and Organisation:	Dr. Jaime Ochoa European Projects Manager IK4-LORTEK Arranomendia kalea, 4A, E-20240 Ordizia, Gipuzkoa (Spain) Tel: +34 943 882 303 Fax: +34 943 884 345 E-mail: jochoa@lortek.es		

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

Declaration by the scientific representative of the project coordinator

Jaime Ochoa, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate) [2]:

  ☐ has fully achieved its objectives and technical goals for the period.

  ☒ has achieved most of its objectives and technical goals for the period with relatively minor deviations.

  ☐ has failed to achieve critical objectives and/or is not at all on schedule.
- The public website, if applicable

  ☐ is up to date

  ☐ is not up to date
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 3.2.3 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Name and Signature of scientific representative of the Coordinator: .

JAIME OCHOA

Date: 28/09/2015

For most of the projects, the signature of this declaration could be done directly via the IT reporting tool through an adapted IT mechanism.

[2] If either of these boxes below is ticked, the report should reflect these and any remedial actions taken.

1. Publishable summary

Non Destructive Tests (NDTs) are necessary in order to inspect every single welded part, avoiding statistical approaches, in accordance to the ñ*zero defects and zero failures*ò policy.

In addition, during aircraft engines life some factors (fatigue, stress, wear, extreme temperature changes, cycles é) can affect the integrity of different parts, being the rotating the most affected ones. Welded parts are subjected to high temperatures during welding process, and in most of the cases, melting temperature is achieved. The high temperature reached in the Heat Affected Zone (HAZ) modifies material properties and turns this area into a weak point of the component. Therefore, in order to ensure the engine life and flight safety, **regular inspections of engine welded parts** are crucial to detect weld defects (flaws, poresé).

The complexity of aircraft engines geometry has increased drastically. Future engine architectures, as Open Rotor engines, make the inspection access to certain parts difficult or even impossible with currently available inspection techniques. Taking this into account, WELDMINDT project will deal with the development of innovative NDTs, with capability of being:

- **Miniaturized**, allowing the access to previously inaccessible parts.
- **Automated for industrial and in field applications**.

During WELDMINDT project, the development as well as the capability of three novel non-destructive testing techniques (Active Thermography, Shearography and Laser Ultrasonics) was analysed. At the beginning of the project representative samples were manufactured which consisted of welds containing defects that resemble real conditions. The initial developments were assisted by Finite Element Modelling in order to better understand the underlying physical phenomena. As a result of extensive laboratory work for finding the best excitation and detection system some relevant conclusions were drawn. Laser Ultrasonics was found to be a very promising technique for surface defect detection, although its maturity is not as high as in the other techniques. With respect to Shearography, a novel procedure was suggested that allows inspecting thin plates from the back side (opposite side of defects location). This is really advantageous for hidden areas inspection since the miniaturization of the system is not required. Finally, an automated inspection system was build based on Active Thermography as a proof of concept of the benefits of this technique for the project goals. This was performed in a relevant environment and over representative samples (part of a turbine). In addition, a miniaturization concept was suggested and proved at a lab scale.