

Case Study Flir Systems GmbH / National Aeronautics and Space Administration (NASA)

Internationale Fachmesse
für industrielle Instandhaltung

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Safety of Space Travel Enhanced by Infrared Preventive Maintenance Equipment

Categories

1. Maintenance service
2. Infrared systems, thermography
3. Safety equipment

Market Sector

Aeronautics and Space Flight

Brief Description

- Surveillance of safety critical parts, damage prevention early warning system and diagnosis procedure using infrared camera ThermaCAM S65 made by FLIR Systems.
- Mobile infrared thermography for on-orbit space shuttle maintenance with regard to the space shuttles' thermal protection shield.

Task

Modification and delivery of mobile high performance thermographic system ThermaCAM S65 for on-orbit maintenance service for space shuttle flights and on the International Space Station (ISS).

Preliminary Events and Preparation

The critical moment for space shuttles is the re-entry of earth's atmosphere. Approximately 70 kilometres above sea level, temperatures on the leading edge of the space shuttle wings reach up to 1600° Celsius (2912 °F). The Columbia space shuttle disaster developed from damage in the heat insulation of one of the shuttle wings. This failed to protect the shuttle and its crew on re-entry. The damages had occurred shortly after take-off, when pieces of insulation peeled off from the external tank and hit Columbia's port wing. The loss of Columbia prompted NASA to find and develop methods to increase the safety of its missions. The NASA Langley Research Center considered thermal imaging as a solution that should be able to inspect and report damages to the heat shield. After a thorough evaluation of all infrared cameras available on the market, NASA engineers chose **ThermaCAM S65**, an infrared camera developed and produced by FLIR Systems. In January 2005, a joint cooperation project between NASA and FLIR Systems was set up to turn ThermoCAM S65 into a space-hardened EVA (Extra Vehicular Activity) flight hardware.

Implementation

*Space travel doesn't allow for errors. Therefore NASA's Langley Research Center needed a high-performance thermographic system to identify material faults on the heat isolation of space shuttle wings and cladding of the ISS. NASA decided to opt for a thermographic system made by **Flir Systems**:*

Several development teams were formed. The NASA Langley Research Center led the design and development of the project. The modifications were to enable the camera to stand mechanical kick load, cosmic and intense sun radiation, fire hazard, shock, vibration, electromagnetic compatibility and severe temperature requirements. Moreover, the crew had to be provided with a camera which could operate on a space-certified battery pack, and which could be used with big gloves during spacewalk inspection rounds in a zero gravity environment. NASA Langley together with FLIR Systems took care of the electro-optic sensing and software area, the Goddard Space Flight Center developed the EVA mechanical interfaces, while the

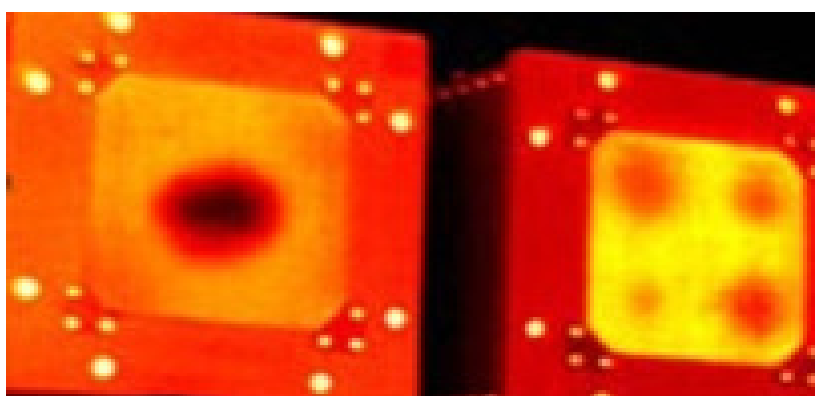
Johnson Space Center conducted astronaut evaluations and training. There was a lot at stake for NASA and its supplier: both were expected to provide the best possible instrument to detect shuttle impact damage, to protect the crew and to do it in a very short timeframe. After the rebuild and the tough and extensive testing by engineers and last but not least by the astronauts, the camera system was declared suitable for use in space. FLIR Systems delivered in total eleven modified cameras to NASA.



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Auditing of the heat shield by astronaut Piers Sellers on the 12th of July 2006 during Discovery flight STS-121 using ThermaCAM S65

The first on-orbit use of ThermaCAM S65 by astronaut Piers Sellers occurred on 12th of July 2006 during space shuttle mission STS-121 (07/04 to 07/17/2006). The mission delivered supplies, equipment and German ESA astronaut Thomas Reiter to the ISS international space station. During Discovery lift-off the cameras had captured the dislodging of small pieces of foam. The third spacewalk scheduled for STS-121 was intended to test orbiter heat shield repair techniques. The cargo bay of the Discovery contained a box with an array of 10 pre-damaged Reinforced Carbon-Carbon (RCC) samples. These samples were used to test new adhesive repair techniques, but they were also imaged by the EVA IR camera. The astronauts used the camera, which was attached to their spacewalk tool belt, to scan the wing leading edge of the shuttle and the radiators of the ISS. Sellers and Mike Fossum, STS-121 Mission Specialists, held the detached LCD display in their hands to scan the objects in infrared, as many ThermaCAM S65 users also prefer to do.



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Unprocessed image of the pre-damaged RCC samples; the internal damage on the left RCC sample is clearly visible

“Works like a champ” said astronaut Piers Sellers to the Houston Control Center. A rare comment on flight hardware, according to NASA engineers. The astronauts had been training with the camera system for over a year. The flight and the extreme environment during the space walk did not hinder the camera’s performance. “This success provided the shuttle program with the tools to further inspect for damage”,

said Michael Gazarik, EVA IR Camera Principal Investigator and head of the development teams.

Customer's Benefit

- Space-hardened, robust, easy to use, and cost-efficient method to identify material damages in safety-critical space mission systems.
- Mobile maintenance application for use in extreme environments.
- Precise, exact spatial identification of defects at an early stage supports clear diagnostics and helps evade errors during problem-solving processes.

Ordering Party

National Aeronautics and Space Administration (NASA), operational on October 1, 1958, one year after the Soviets launched Sputnik 1, the world's first artificial satellite. NASA was successor to the National Advisory Committee for Aeronautics established 1915. NASA conducts civil and military R & D programs, and also set up the Mercury, Gemini and Apollo missions, which led to the first Moon landing on July 10, 1969. At present NASA is operating the space shuttle missions and is taking a leading part in the assemblage of the International Space Station ISS in co-operation with ESA, Japan, and the Russian Federation. Current space exploration is done by satellites, space telescopes, laboratories (e.g. Chandra X-ray Observatory, Hubble, Skylab) and space probes launched for Mars and other planetary objects (e.g. the Cassini-Huygens Mission). Future NASA projects include the Constellation program (developing the Ares rocket and Orion capsule), which shall lead to a return to the Moon after 2015 and space travel to Mars after 2020, or the Prometheus project, which includes developing new boosting technologies such as ionic propulsion or high-temperature nuclear reactors for space applications to send future space craft even beyond Mars. In 2006 NASA had funds of approximately \$ 16,5 billion.

Internet: <http://www.nasa.gov>

Contractor

FLIR Systems GmbH is a subsidiary of FLIR Systems, Inc., global market leader for thermographic systems and infrared cameras for civilian and military use. The Group posted sales of \$ 575 million in 2006. FLIR Systems GmbH offers infrared cameras for use in preventive maintenance, for tasks in the field of building physics and for checking compliance with energy savings regulations. Also, infrared camera systems are used for high-level scientific problem solving in R & D, laboratory analysis, and during product design. Intelligent infrared multisensor technique and infrared industry cameras are used in the field of machine vision for industrial assembly and handling technologies, robotics, control, and positioning systems. Thermal imaging is used for surveillance and law enforcement purposes as well as for fire security systems.

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Maintain 2007

The 3rd International Trade Fair for Industrial Maintenance will be staged from October 16th to 18th 2007 at the M,O,C, trade fair centre in Munich. As MAINTAIN is the only specialized international trade fair for industrial maintenance in the world, it gives visitors a look at the latest trends in all sectors and furnishes them with information about state-of-the-art solutions that can be used to repair, maintain, inspect and improve their production facilities. For decision-makers and experts, that makes it the most important business gathering that deals with all aspects of industrial maintenance. Special fora on maintenance as a core factor for production and up-to-date information on MAINTAIN's web pages add to the event itself.

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