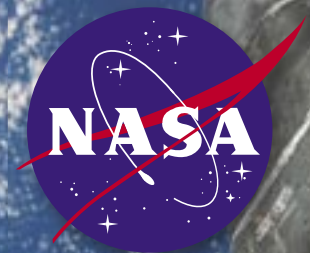


FLIR APPLICATION STORY



Astronaut Piers Sellers at work during the third spacewalk

Infrared thermography for on-orbit space shuttle maintenance : NASA uses modified FLIR Systems ThermaCAM S65 infrared camera for inspection of Discovery spacecraft

The NASA Langley Research Center has chosen ThermaCAM S65 as the preferred infrared camera system for its shuttle and International Space Station programs. The modified camera system was successfully used during the July 2006 STS-121 Discovery mission.

"Amazing", said astronaut Mike Fossum, while scanning parts of the International Space Station (ISS) and the orbiter with his infrared camera during a space walk 350 km above earth. That happened on July 12, 2006. It was the first use of infrared thermography in space. A joint effort by NASA and FLIR Systems made it happen.

One of the reasons for the 2003 Columbia space shuttle disaster was damage in the heat insulation on the leading edge of one of the wings. This failed to protect the shuttle and its

crew when they re-entered the atmosphere. The damages occurred shortly after take-off, when pieces of insulation peeled off from the external tank and hit Columbia's port (left) wing. The loss of Columbia and its crew 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, a camera developed and produced at FLIR Systems in Danderyd, Sweden.

TURNING THE THERMACAM S65 INTO A NASA EVA IR CAMERA

In January 2005, a joint cooperation project between NASA and FLIR was set up to turn

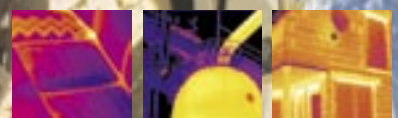


Astronaut Piers Sellers at work during the third spacewalk



The protective housing for the ThermaCAM S65 as developed by NASA

FLIR



the ThermoCAM S65 into space-hardened EVA (Extra Vehicular Activity) flight hardware. These modifications would 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.

Several development teams were formed. The NASA Langley Research Center (Hampton, Virginia) led the design and development of the project. NASA Langley together with FLIR Systems Sweden took care of the electro-optic sensing and software area, the Goddard Space Flight Center (Maryland) developed the EVA mechanical interfaces, while the Johnson Space Center (Houston, Texas) 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. The Langley Center built four identical systems based on the modified versions delivered by FLIR Systems, for support of STS-114, STS-121, and STS-115 as well as the International Space Station.

JULY 2005: STS-114 DISCOVERY MISSION CARRIES THERMACAM S65

For its July 2005 STS-114 Discovery mission, the space agency worked out a spacewalk inspection project in case damages would occur on the wings. As smaller cracks and delaminating cannot be seen with an ocular inspection, the FLIR camera system was flown on STS-114 as a contingency. Luckily, no damages occurred. The EVA IR system was then transferred to the International Space Station.

JULY 2006: STS-121 DISCOVERY MISSION SCHEDULES IR CAMERA TESTING

After some delay, STS-121, the Discovery with seven astronauts was launched into space on July 4, 2006. The mission delivered supplies,

equipment and German ESA astronaut Thomas Reiter to the ISS international space station.

The Discovery liftoff was the most photographed of any shuttle mission. The cameras captured the dislodging of small pieces of foam, but well after the critical first two minutes, when the aircraft is subject to maximum aerodynamic pressure. Later on this pressure decreases with altitude.

Three spacewalks were scheduled for STS-121. The third was intended to test orbiter heat shield repair techniques. The cargo bay of the Discovery contained a sample 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 also 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 Fossum held the detached LCD display in their hands to scan the objects in infrared, as many ThermoCAM S65 users also prefer to do.

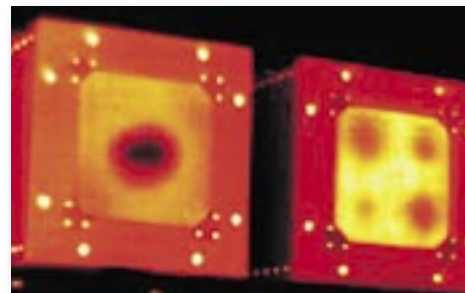
"WORKS LIKE A CHAMP"

"Works like a champ" said astronaut Piers Sellers to the Houston Control Center. A rare comment on flight hardware, according to NASA engineers. Piers Sellers and Mike Fossum, STS-121 Mission Specialists, have been training with the camera system for over a year. The flight and the extreme environment during the space walk indeed did not hinder the camera's performance. The images and videos were saved to a flash card and then transferred to a space-qualified laptop computer.

"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.

The camera flown on STS-121 and so successfully used during the spacewalk, remained onboard the ISS. Another demonstration has been scheduled by two of the ISS's astronauts. The Discovery crew returned another infrared camera with them, which was stored at the station but has not been used in space.

If NASA's Program Requirements Control Board



Unprocessed image of the damaged RCC samples. The internal damage (left) is clearly visible



Unprocessed IR image of one of the ISS radiators



STS-121 Discovery's safe touchdown at the Kennedy Space Center in Florida on July 17, 2006

certifies the infrared camera as operational, the camera will become a part of the astronaut's toolsets for future spacewalks. Until then, the US space agency will continue testing the infrared camera in space during upcoming missions.

Pictures courtesy to NASA, 2006

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