SHUTTLE 2: THE WHITE-GLOVE TEST

How clean a ride faces the space shuttle's future payloads?

BY JONATHAN EBERHART

On duty in earth orbit, the space shuttle cruises with its doors open. Not the little port-side hatchway to the crew compartment, but the doors to the craft's cavernous cargo bay, which must stay open to dispose of the heat generated by all the human beings and electronic equipment aboard. Thus the huge hold, 60 feet long and 15 in diameter, will be exposed throughout most of each mission to the cold vacuum of space.

It is not quite as cold as space itself, however — all that heat is being vented through it from within — and a typical shuttle altitude of slightly more than 150 miles is still deep enough in earth's atmosphere to experience perhaps a trillionth of the pressure at sea level. In addition, there are stray traces of exhaust from the craft's propulsion system and attitude-control jets, firing occasionally from just a few yards away, to say nothing of the odd billion molecules or so left clinging to various surfaces from the ascent to orbit.

For most purposes, the difference between such transient wisps and a vacuum is zero. But among the shuttle's future payloads are such devices as the Space Telescope, designed to study targets including some of the faintest stars in the universe, and the European Spacelab research module, equipped in various configurations with whole suites of ultrasensitive sensors, which have made the expensive journey to orbit just to escape the earth's contaminating air. The Space Telescope will merely ride the shuttle to and from orbit; Spacelab will stay aboard for a week or more. For such instruments, it could be essential to know accurately the difference between the cargo bay's atmosphere and true emptiness.

On its upcoming second flight, still pegged as of this writing for Sept. 30, the space shuttle Columbia will carry a 794-pound package of sensors designed to answer that specific question. Called the Induced Environment Contamination Monitor (IECM), it will be mounted in the cargo bay, affixed to a pallet that also carries the test instruments studying the flight responses of the shuttle itself. (Also occupying the hold will be another pallet loaded with scientific equipment for a group of earth-resources studies [SN: 5/9/81, p. 292], as well as the remotely controlled maneuvering arm—getting its first shakedown in space—which will be used in the future to transfer payloads between the cargo bay and "outside.")

Ten instruments comprise the IECM:

- A humidity monitor will record conditions during the "wet" parts of the five-plus-day mission — the ascent and descent through earth's atmosphere, beginning even before liftoff, since the sensors that will benefit from the information would face a similar holding period.
- A dew-point hygrometer will provide similar data, recording the temperature required to begin condensation on a mirror. Such information, in fact, may turn out to be relevant in determining the thermal design characteristics of a number of mirror-equipped devices such as telescopes.
- Air-sample bottles will be opened automatically by a preprogramed sequencer to catch samples of the cargo-bay atmosphere at different stages in the flight. Two will be opened for a minute each at launch, another just after the shuttle's solid-propellant boosters are jettisoned during the ascent, and two more during re-entry.
- A device called a "cascade impactor" will measure the concentration and size-distribution of particle contaminants by recording the voltage variations produced by their minuscule impacts onto a piezoelectric quartz crystal.
- An array of 48 samples of optical glass will record the total amount of contamination that simply settles on them in the course of the mission.
- Six more optical samples will be used to measure the amount of pollution present at any given time, as part of an instrument that measures the light transmission and scattering through them about every nine and a half minutes.
- Another array of quartz-crystal microbalances will help analyze the different sources of molecular contamination (exhaust gases, adsorbed atmospheric constituents, etc.) by periodically raising the temperature of each of its five sensors to clean off the previously deposited material.
- A specially cooled microbalance, aimed straight "up" through the cargo-bay opening will measure the water ice and other contamination that may form on future sensors whose operations require long periods of "cold-soaking" during their operations.
- A pair of movie cameras, shooting only 24 frames per hour, will provide sequences of stereo photographs to measure the particle environment and background brightness in the cargo bay, which one day will carry instruments such as an infrared telescope that could be distracted by stray particles as small as 0.5 microns.
- A mass spectrometer will measure and identify the various molecules given off by other equipment in the cargo bay, defining the gas cloud through which optical experiments must look. Not all of the pollution will necessarily come from the shuttle itself, notes IECM project scientist Edgar R. Miller of NASA's Marshall Space Flight Center in Alabama; some payloads may contaminate one another.

On the upcoming flight, the IECM will do all its work inside the cargo bay. The subsequent mission, however, calls for the astronauts to grasp the device with the re-

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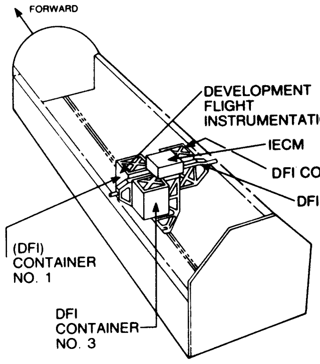
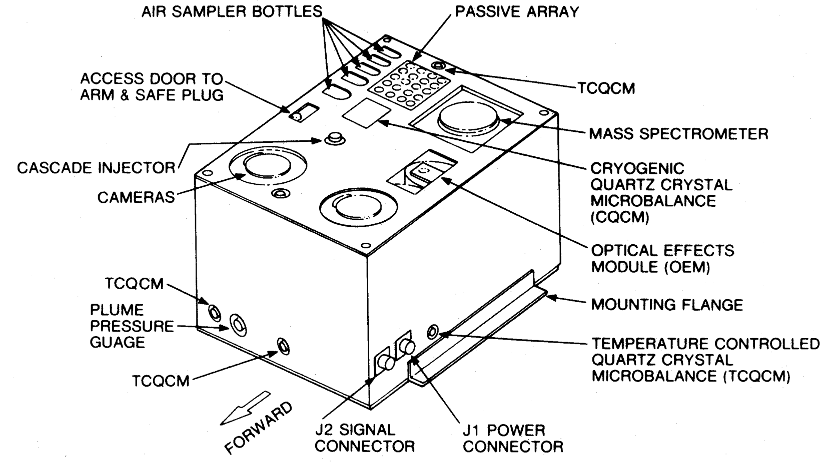
Box of ten instruments (right) will be mounted in the space shuttle's cargo bay (below) to evaluate sources of contamination that could affect future payloads.





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mote manipulator arm and extend it as far as 50 feet out of the hold for studies of the space *around* the shuttle. This could reveal traces of contamination from such sources as the crew cabin and over-wing areas. On the flight after that — the last of the shuttle's four scheduled test flights — the IECM will be equipped with an eleventh instrument: a plume-pressure gauge, to be held outside the cargo bay to monitor the exhaust pulsations of the shuttle's attitude-control rockets at various distances and directions from the nozzles.

Besides the IECM, the upcoming mission will carry a second instrument package dedicated to the welfare of future payloads. Called DATE, the Dynamics, Acoustic and Thermal Environment experiment consists of accelerometers and force gauges to measure dynamic loads, microphones for acoustic vibration effects, and thermal sensors. The DATE results may help engineers in deciding how various payloads must be insulated or shock-mounted, or where they should be placed in the cargo bay.

The IECM, meanwhile, will not retire after the shuttle's final test flight. It is also scheduled to accompany the first two Spacelab missions (so far booked on shuttle flights #9 and #21 in 1983 and 1984), in effect to calibrate the environment through which the myriad Spacelab sensors will be conducting their research.

Even "empty," the shuttle's cargo bay is far from a perfect vaccum. The IECM is to find out how far. □

... Letters

erate electricity). It could make the United States energy independent and even a net energy exporter by selling reflected radiant energy to owners of foreign ground sites. Such a happy situation could reverse our negative balance of payments as well as the drift toward economic stagnation in this country. One study (Billman, "Recent SOLARES Results," 7/24/79) showed that the initial capital investment on a world SOLARES system could be recouped every two and a half years. But we may never know SOLARES's full potential, since short-sighted public servants cut off the last dime of SOLARES funding shortly after this study was completed.

Max Gordon Phillips
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The National Research Council committee which evaluated the solar power satellite concept should be commended for their courage. Most of us crystal-ball gazers would not dare to claim that any energy technology still in the research and development stage will be economically uncompetitive as a source of energy 20 years from now.

The real irony is the NRC conclusion that no money should be spent on development of the solar power satellite concept, while simultaneously recommending periodic review of progress in new concepts and technologies that might bear on the idea. Hopefully the NRC will avoid study of nuclear fusion and other possible future energy sources, or we may find the United States waiting for others to do the development work so that we can periodically review progress in new concepts and technologies which might bear on these other energy alternatives.

James Ransom
Los Angeles, Calif.

It was with pleasure that I read that the National Research Council has had the good sense to recognize that solar-power satellites do not deserve further funds even for preliminary developmental planning.

The idea of enormous arrays of solar cells transmitting billions of watts of power to earth is technology run amok. The proponents of this outrage would have us sink $3 *trillion* in a project of uncertain feasibility at a time later in the century when parts of the world will quite possibly be facing starvation. All of this in order to provide the industrialized nations with electrical power more brilliantly to advertise their fried chicken and run their air conditioners.

As for the glorious beauty of the night sky, with SPS future generations would have to appreciate it through the accounts and photographs of their forebears, since the solar arrays would so fill the sky with light pollution. And that would be but a trivial side effect compared to other, potentially deadly, hazards of the system.

Imagine what it would mean for our nation to invest $3 trillion in energy conservation.

Denis Dutton
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Correction: The research reported in "Convincing consumers to conserve" (SN: 7/25/81, p. 58) originally appeared in the spring Journal of Social Issues.