SAFETY

Apollo safety requirements in space and on the ground required new hardware and procedures in Block II (lunar mission type) spacecraft. Major changes affect the command module's test and pre-launch atmosphere, the hatch, the use of non-metallic materials, cabin emergency oxygen and fire-fighting provisions, wiring protection, and monitoring of crew and command module interior during hazardous ground tests.

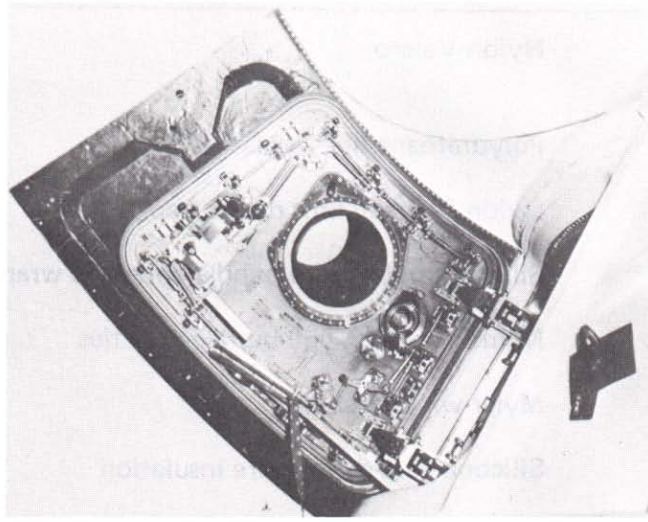
GROUND ATMOSPHERE

The atmosphere in the cabin of the command module for tests on the launch pad and at launch will be 60-percent oxygen and 40-percent nitrogen (60/40) rather than pure (100-percent) oxygen. The new mixed-gas atmosphere is supplied by ground equipment. Astronauts breathe pure oxygen in their space suits from Apollo's on-board systems. After launch, the cabin atmosphere is vented at a controlled rate, then replenished with pure oxygen so that in 4 to 6 hours it is approximately 95-percent oxygen. The safety of the modified spacecraft was judged acceptable in the 60/40 mixed-gas atmosphere of 16 psi, and in a pure oxygen atmosphere at the space pressure of about 6 psi after extensive tests at NASA's Manned Spacecraft Center.

SIDE HATCH

A one-piece door replaces the two-cover hatch system on the command module. The side hatch is made of aluminum with fiberglass and ablative material. The door deployment mechanism has a gas-operated counter-balancing device that offsets gravity and permits easy opening on the ground. The hatch can be unlatched and opened by the flight crew in less than seven seconds and by the ground crew in about 10 seconds.

On the ground and during the early part of boost, the command module is shielded from boost heating by the boost protective cover. This cover, which is attached to and jettisoned with the launch escape tower, also has a hatch. As the unified hatch is opened from the inside, it activates a release mechanism between it and the boost protective cover hatch. The mechanism releases the single latch of the cover hatch and the two hatches swing open together.



New hatch with boost protective cover hatch opening
P-281

MATERIAL

All materials in the spacecraft command module have been re-evaluated. Non-metallic materials were subjected to a rigid series of flammability tests and were replaced as required.

Among the more important changes are the use of stainless steel tubing instead of aluminum for the astronauts' high-pressure oxygen system. Aluminum solder joints of lines carrying water-glycol liquid for cooling or heating have been reinforced with protective armor where necessary. Protective plates cover coolant lines and also protect wiring against wear or accidental damage. Stowage boxes are made of aluminum.

Flammable materials are stowed in fireproof containers (metal or polyimide fiberglass storage boxes and Beta Cloth stowage bags).

Nylon Velcro material, used to grip or hold objects in the weightlessness of space, has been replaced with a new Teflon and polyester Beta fiberglass product, and wherever practical, mechanical fasteners are used to "button down" or hold equipment. A new flame-resistant material called Ladicote has been introduced and is applied by brush to potted connections.

Significant material changes include:

Old	New
Nylon Velcro	Teflon Beta fiberglass (for the pile); polyester Beta fiberglass (for the hook)
Polyurethane line insulation	Molded glass fibers
Nylon Raschell knit debris trap	Aluminum coverings
Silicone rubber wire bundle antichafe wrap	Teflon sheet
Nomex (nylon) wire bundle spot ties	Teflon-coated Beta fiberglass
Mylar window shades	Aluminum sheeting (not roll-up type)
Silicone heat-shrink wire insulation	Teflon heat-shrink wire insulation
Trilock couch padding	A new fabric couch pad made of Teflon-coated fiberglass
Most plastic knobs and switch levers	Aluminum
Polyolefin coaxial cable	Wrapped with aluminum foil tape; later spacecraft to have Teflon cable
Plastic switches in main display panel	Metal
Silicone oxygen umbilical hose	Covered with Fluorel
Crewman's communications umbilical (silicone rubber)	Molded Fluorel
Epoxy laminate food boxes	Polyimide laminate
Silicone laminate panel scuff covers	Polyimide laminate covers
Electroluminescent panels	Covered with copper overcoat
Silicone rubber spacers	Covered with Beta fabric
Nylon zipper on space-suit bags	Metal
Circuit breakers of diallylphthalate (DAP) and Melamine, both resins	Covered with Ladicote
Epoxy laminated structures	Polyimide structures
Postlanding vent duct (silicone laminate)	Metal and Fluorel impregnated glass fabric

Old	New
Felt filters in lithium-hydroxide canisters	Teflon felt
Uralane foam (cushion material for mirrors, etc.)	Fluorel foam
Fiberglass tape	Aluminized tape
Nylon webbing (such as hook on CO_2 absorber)	Beta webbing
Dacron cloth in the environmental control system	Armalon cloth
Aluminum high-pressure oxygen lines of environmental control system	Stainless steel

CABIN PROVISIONS

An emergency oxygen system with three masks and an independent oxygen supply would protect the crew from toxic fumes. Special fire-fighting provisions include a portable fire extinguisher, protection panels to isolate a fire, and special ports where the extinguisher's nozzle is inserted to douse a flame behind a panel.

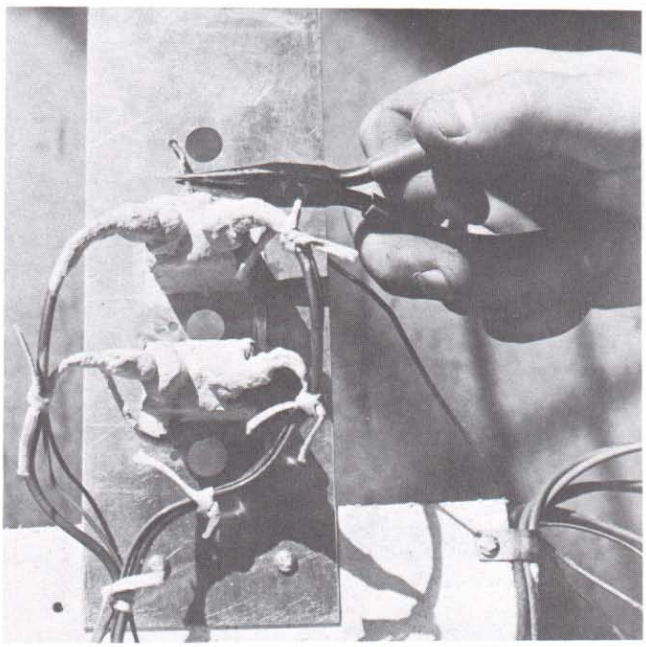
WIRING PROVISIONS

A number of changes makes the estimated 15 miles of wiring safer in Block II spacecraft. Some circuit breakers were added and others reduced in capacity to improve wiring protection. Teflon wrapping separates power wires from others in a bundle. Aluminum enclosures protect wire runs in the crew compartment.

Ladicote, a special fire-resistant material which is applied by a brush, coats terminals, metallic electronic components, and circuit breakers. Ladicote was developed by chemists at North American Rockwell's Los Angeles Division.

MONITORING

Hazardous ground tests are more closely controlled by monitoring of biomedical data from the three crew members and observation through closed-circuit television of the command module interior.



Wire terminals coated with Ladicote fire retardant

P-282

EARTH LANDING SUBSYSTEM

The earth landing parachute system has been modified to handle the increased weight of the command module. Its two drogue parachutes were expanded from 13.7 to 16.5 feet. A dual-reefing feature was added to permit the three main chutes to open more slowly.

P-283

Astronaut Wally Schirra leaves CM after Downey test of Block II spacecraft