

TECHNICAL REPORT #2

INCUBATOR COMPONENTS

INVOLVED WITH

THE

"CHIX IN SPACE"

EXPERIMENT

SE83-9

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SPONSOR: KENTUCKY FRIED CHICKEN CORPORATION

The hardware for the Chix In Space (CIS) experiment has been designed to house and protect the eggs throughout the duration of the Space Shuttle flight. It is basically an incubator which has been designed to carefully control its own internal environment at optimum conditions for the development of the chicken embryos. Special precautions have been taken to isolate the eggs from the shock and vibration associated with the launch and landing and to make sure the experiment does not pose a hazard to the Crew at any time during the Mission.

The CIS incubator has several systems which have been integrated to perform key roles in the experiment. These systems include:  
(1)Environmental Control, (2)Shock/Vibration Isolation, (3)Data Acquisition, (4)Safety Assurance, and (5)Integrated Systems Housing. Each of these systems have been discussed below with regards to their function and Crew interaction capabilities.

## 1) Environmental Control System (ECS)

The function of the Environmental Control System is to regulate temperature within the CIS incubator. The heart of the ECS is the sub-panel on-off temperature controller located inside the incubator directly behind the handle. The controller utilizes a terminal-mounted thermistor which typically has a switching differential of less than 0.1 degree F. Such a system provides an extremely tight range of control over the temperature and also provides frequent cycling of the heaters.

Upon sensing temperature below the controller setpoint, the thermistor opens, causing the relay to close, which in turn allows 28 Volt DC power to reach the heaters. When temperature requirements have been satisfied, the thermistor closes, the relay opens, and the heaters are deenergized.

The source of heat in the CIS incubator consists of five(5) resistance element strip heaters connected in parallel and powered by the standard 28 VDC power source. Each 12 watt heater is constructed from fine resistance wires which have been spiralled around a fiberglass cord, then vulcanized between two(2) thin layers of fiberglass-reinforced silicone rubber. The heaters have been permanently bonded to anodized aluminum plates and mounted approximately 1/8-inch away from the side walls to optimize heat transfer. These heater assemblies have been strategically located in order to produce uniform temperatures throughout the incubator.

The final component of the ECS is the 28 Volt DC-powered circulation fan which is rated for 1000 hours under continuous use. The 4000 RPM circulation fan basically serves two functions: First, the fan is designed to improve circulation of the conditioned air over the eggs. This will result in better oxygen exchange across the shell and will insure that uniform temperatures are maintained around each egg. Tests with the incubator and fan arrangement have shown that the temperature differential between all of the eggs can be minimized by the circulating effects of the fan. Secondly, the fan will help with the removal of heat from the heaters to improve their efficiency during zero gravity conditions when natural convection cannot be relied upon. Tests have also verified that the normal temperature stratification due to varying density of the heated air can be minimized by the fan. And even though this stratification problem will not exist under zero gravity conditions, it still must be contended with during pre-launch and post-landing conditions.

## 2) Shock/Vibration Isolation System (SVI)

The function of the Shock/Vibration Isolation System is to eliminate the effects of the "ride" into earth orbit. Basically, this system would only be required during launch and landing; however, since it has not been designed to be turned on and off, and since its effects should be negligible while orbiting, the SVI will remain activated throughout the flight.

The heart of the SVI System is the polyurethane, pyrell foam which will be used to cushion and retain the eggs in the egg rack. The foam has been precision cut to allow the eggs to be delicately cradled and yet firmly held in place to prevent collisions between eggs. Each egg nests into the foam along its major diameter to minimize the egg's contact with the foam and to place the egg in a position with its strongest (longitudinal) axis taking the majority of the impact. Laboratory experiments have proven this type of retention system provides the necessary support without loss of the much needed shell surface area required for osmosis across the shell interface.

The foam strips slide into place in the four(4) shelves created by the anodized aluminum egg rack. Once the eggs and foam have been installed in the rack, the rack covers can be installed to assure that the foam/egg assembly does not move. Each shelf has been designed to hold eight(8) eggs, which provides a total capacity of thirty-two(32) eggs for the experiment.

The egg rack is suspended along its three(3) major axes by a system of stainless steel springs. These springs have been carefully selected to provide the isolation from the shock and vibration associated with the launch and landing. The springs used along the vertical axis of the rack have a slightly higher spring constant than the springs of the other axes because the larger forces will be taken along this line of action during launch.

In conjunction with the springs, air shocks have been installed along the same axes to dampen the oscillation of the springs. The air shocks utilize ambient air which is forced through an orifice to dissipate the kinetic energy stored in the springs. Each air shock consists of a piston and cylinder arrangement which is double acting to provide the required dampening action in both directions.

### 3) Data Acquisition System (DAS)

The Squirrel Meter/Logger provides the means for monitoring the environmental conditions of the experiment. It has been mounted on the underneath side of the transparent cover to provide easy access by the Crew. The Squirrel (so called because it retrieves and stores data just as a squirrel stores nuts) can be used as a meter to allow the Crew to check temperature and humidity conditions within the incubator. It will also be used to record and store the temperature and humidity conditions at predesignated intervals throughout the duration of the experiment. This data can then be retrieved and uploaded for analysis at the end of the Mission. The Squirrel is powered by a 9-volt alkaline battery and is capable of operating without attention throughout the duration of the flight.

Two temperature probes and two humidity probes will provide the data to be monitored by the Squirrel. The temperature probes are located on the front and rear sides of the egg rack to obtain the most accurate egg environment temperature. The humidity probes are located in diagonally-opposite corners of the incubator.

#### 4) Safety Assurance System (SAS)

The entire CIS incubator has been carefully designed with the safety of the Crew in mind. Every possible precaution has been taken to assure that safety hazards will be nonexistent. The major safety features include:

- \* On/Off power switch
- \* Power-On light
- \* Hot Hands temperature sensitive decal to forewarn of a surface exhibiting a high temperature condition
- \* Fused circuits for all major electrical components
- \* High Temperature Thermostat which deenergizes heaters if temperatures reach 113 deg F in CIS incubator

#### 5) Integrated Systems Housing (ISH)

All of the CIS incubator systems described above are contained in an anodized aluminum housing which measures approximately 19.5"x15"x9.125". Aluminum was chosen for the ISH because it was lightweight, which allowed the hardware to remain below its weight limitations, and yet strong enough to provide the properties necessary to meet the demands of the SVI system. The unibody construction of the ISH allows it to function both as anchoring point for the SVI System and as the primary sealing device for maintaining the desired environmental conditions. In conjunction with the transparent polycarbonate cover, the incubator housing provides virtually an air-tight container to isolate the experiment from the cabin environment. A cutout in the cover will allow the Crew access to the Squirrel meter/logger by way of a flexible transparent membrane which has been installed to maintain the integrity of the sealed system.

The removable hatch, with four(4) quick-release fasteners, provides the only means of access to the interior of the CIS incubator. The hatch is located on the face of the transparent cover and has a gasketed sealing surface to maintain the air-tight seal. The primary function of the removable hatch door is to provide the essential recharge of oxygen into the CIS incubator. With the assistance of the Crew, this hatch door will be removed at designated intervals to provide the necessary addition of oxygen and outflow of carbon monoxide.

A secondary function of the hatch door is to recharge the CIS incubator with the moisture necessary to maintain the desired humidity. Moisture will be added by way of a capillary pad which is installed on the underneath side of the hatch door. With the fan constantly circulating warm air over the capillary pad, water vapor will be displaced from the pad to the air to increase the CIS incubator humidity. Once the pad has been depleted of water, it can be easily removed and replaced with a fresh one simply by opening the hatch door, removing the depleted pad, and attaching a fresh capillary pad by means of its Velcro strip. The fresh capillary pads will come pre-charged with the proper quantity of water in an air-tight package. The supply of fresh capillary pads will be found secured to the outside of the CIS incubator by Velcro strips.

A handle has been provided on the nameplate end of the CIS incubator to facilitate easy removal of it from the locker. It is recommended that this handle not be used to transport the CIS incubator under 1G conditions.