

\$3 million would be needed in the next academic year and more than \$10 million in 1975–1976. Eventually, the organization would become self supporting, with the repayment of its earlier loans, but for the next decade, at least, considerable outside financing must be necessary to build up this facility.

Among the other factors which work against prospective entrants to the medical profession is the lack of information not only about possible sources of finance but also about career opportunities. This would be overcome, the report says, by the network of regional centres which would provide an information service. Yet another difficulty is the lack of sufficient places. The report argues that the limiting factor is the small size of existing classes in medical schools, and that this could be overcome most easily by increasing the class size. These changes should assist not only the determined medical students but also others who are at present diverted from medical education into other educational pathways—this is a serious source of loss.

APOLLO 13

Sixty-five Volt Mishap

THE cause of the explosion in the Apollo 13 oxygen tank which nearly ended three astronauts' careers and halted the April mission halfway to the Moon, has almost certainly been established. The head of the official investigation panel, Dr Edgar M. Cortright, the engineer in charge of NASA's Langley Research Centre (in Virginia), said last week at Houston that two thermostat switches in the tank heater were inadvertently welded solid when pre-flight testers applied 65 volts to the unit instead of the 30 volts maximum, during a simulated countdown on the launch pad a fortnight before liftoff. A "special procedure" had been adopted to drain the tank of liquid oxygen. Draining had been giving trouble and to speed things up the technicians had applied the voltage to the heater to gasify the liquid. Although permission had been given to use this technique, it was not clear to the panel whether the excess voltage had occurred through faulty ground support facilities or because the procedural documents were not properly prepared. There was uncertainty about how many people of those involved knew what the voltage rating of the switches was.

"I think it is clear a mistake was made," commented Dr Cortright last week. But he refused to say the ground technicians had let NASA down or that the quality control arrangements were inadequate. "We have found out that quality assurance is about as rigorous as any we have seen."

The full report of the panel was due to be delivered to the head of the National Aeronautics and Space Administration (NASA), Dr Thomas Paine, on Monday, June 8. Delivery had already been postponed for a week. It has now been postponed again and is not expected until June 15. But there does not seem to be very much left to say.

An involved sequence of events is now postulated as the most likely cause of the mishap. The effect of the switch failure would have been to allow the temperature in the tank to rise as high as 1,000° F, instead of hold it at 80° or below. A complicated series of effects would then have been started. The Teflon insulation

on other electrical circuits within the tank would have baked off to leave bare wires. Some of these eventually shorted out and set fire to further insulation causing a "local furnace" burning upward to ignite a bunch of wires that passed through a 2-inch diameter hole in the top of the tank. It seems that a rupture may have started in the tank structure here. Photographic evidence of the shape of the hole in the tank side seen as the service module separated before mission re-entry is consistent with an entire side-panel having been forced off through venting gas rather than through an explosion in the normal sense of the term. "A total rupture of the tank wall would have blown a hole in the panel instead of tearing the whole thing cleanly from the service module's side," Dr Cortright remarked. Further tests are now being run to see whether an even slower venting of pressurized oxygen combined with an electrical arc might have blown the panel off in the same way.

With no recovered hardware to study, the investigating panel has been simulating various possible causes of pressure rise in the affected oxygen chamber and comparing the type of damage and sequence of events with known facts. The sequence initiated by the jammed thermostat switches (and the discovery that an excess voltage was applied to them) provides the best match with the evidence available. The accident investigation has been going on since April 20. Apollo 13 took off on April 11 and the accident occurred on April 13, rather more than halfway to the Moon.

During the press conference Dr Cortright indicated that the investigating board assumed that the Teflon insulation in the tank was "in bad shape at launch". He was unable to explain why a short circuit and pressure rise did not take place earlier in the mission. There would have been a good probability of this every time one of the affected circuits was switched on. These had been operated several times in flight before the disaster occurred.

Whether any blame will be apportioned or changes in design or procedures recommended in the final report remains to be seen. But the picture that is being presented in gradually greater detail is one of a genuine accident that is unlikely to be repeated even without the expected tightening up on checking procedures. Sometime in advance of Dr Cortright's report to the press, NASA had announced the new launch date for Apollo 14. This is December 4, corresponding to a two-month delay on the original date, or approximately the same length of time that the accident investigation will have taken.

But there is no denying that the Apollo 13 adventure has made a serious inroad into the lunar exploration schedule. There are now only four journeys to the Moon before autumn 1972 when the engineers at the Cape and in Houston turn their attention to the Skylab programme—the renamed Apollo applications programme—followed by the final two journeys to the Moon in 1974. Some kind of vehicle with a range of a few kilometres is expected to be carried from Apollo 16 onwards. With the discussion about the interior of the Moon hinging on the nature of the mascons, Apollos 16 and 18 are each to release a small 80 pound lunar satellite which as well as carrying magnetometers and particle detectors will say more about the shape of the mascons and about whether mascons are present beneath the hidden surface of the Moon.