MR. WATTLES

$30 million is equally divided between AEC and NASA.

It was dictated by over-all ceilings imposed on the NASA and AEC budgets by the Budget office and fatalistically defended last week by Low and Dr. Glenn T. Seaborg, chairman of AEC. Low said reductions in Rover had been coordinated with reductions in the space shuttle program so that the shuttle would be timed for operation in 1979 and the Nerva vehicle, serving as an upper stage, would follow.

"Nerva needs the shuttle, but the shuttle doesn't need Nerva," Low said.

The reduction from $110 million to $30 million in Rover compared with the reduction from $190 million to $100 million for the shuttle.

Milton Klein, manager of the AEC-NASA space nuclear systems office, estimated that a one-year holding action during Fiscal 1972 will add from $100 to $125 million to the cost of Rover. This would include materials and personnel termination costs and costs of re-assembling and training new teams.

A. P. Zechella, general manager of the Westinghouse Astronuclear Laboratory, told the committees that the additional $100 to $125 million cost will be the same whether the holding action lasts one, two, or three years, because the same termination and reactivation expenses would still be involved.

Low said that when Rover is put back on course to a flight goal depends on NASA's total budgets in future years. He said he hoped for a substantial increase in NASA's budget for Fiscal 1973. "We will pick up Nerva at the time it makes the most sense."

Sen. Howard Cannon (D.-Nev.) argued for a $110 million Fiscal 1972 appropriation on the ground it would be a saving of at least $20 million. In addition to the $30 million in the President's plan, $80 million would be required. The $80 million, Cannon claimed, should be balanced against the $100 to $125 million additional in slow-down and start-up costs.

As an alternative to the $110 million Fiscal 1972 program, Zechella of Westinghouse and A. L. Feldman, president of Aerojet Nuclear Systems, proposed the establishment of an orderly stretchout plan for Rover to avert wholesale disbanding of nuclear rocket know-how.

Even continuation of the $88 million in Fiscal 1971 funding for Fiscal 1972, Zechella and Feldman said, would involve dropping some key personnel. This is because a greater portion of Fiscal 1972 funds will be for hardware.

Army, Hughes Demonstrate OH-6 Modified into 'Quiet' Helicopter

By Robert R. Ropelewski

Los Angeles—Modified OH-6 light observation helicopter, conspicuous for its lack of typical rotor and powerplant noises, is being demonstrated by Hughes Tool Co. and Army engineers.

The extensively modified Hughes OH-6 is the product of a quiet helicopter program funded by the Defense Dept.'s Advanced Research Projects Agency (ARPA) and managed by the Army (AW&ST Sept. 15, 1969, p. 33). Aim of the program is to reduce noise output of helicopters in order to improve their combat survivability.

A Kaman HH-43B and a Sikorsky SH-3A also were used in an earlier phase of the program, but only Hughes was contracted for further studies.

Most significant modifications are:

- A new five-bladed main rotor and four-bladed tail rotor, replacing a production four-bladed main rotor and two-bladed tail rotor on the conventional OH-6.
- Trapezoidal tips on main rotor blades with a 2-deg. twist, or washout, to reduce vortex noise.
- Soundproofing of the engine compartment, engine intake and exhaust, and the engine itself.
- A sound-damping coating on gear teeth and other transmission components.
- Reduction of rotor rpm. by 33%.

Initial tests of the OH-6 concentrated on elimination of the buzz-saw sound of the tail rotor, identified as the dominant noise source on the aircraft. A low-speed tail rotor gear box was installed, thereby reducing tail rotor rpm. from 3,030 at 100% main rotor rpm. (N_2) to 1,899.

Even lower speeds were achieved by reducing rotor system operation from 100% N_2 to 70%. For the main rotor, this meant slowing from 468 rpm. to 328 rpm. For the tail rotor, speed declined to 1,329 rpm.

To compensate for a loss of effective rudder control that accompanied slowing of the tail rotor, engineers experimented with a two-bladed rotor on which the chord of the symmetrical blades had been doubled, and a four-bladed rotor with a 7-in. increase in diameter over the conventional two-bladed OH-6 helicopter tail rotor.

Results in this area were sufficiently effective that researchers became very aware of noises from the main rotor, engine and transmission once the tail rotor had been quieted. A change order was added to the Hughes contract to include research into these areas. A five-bladed main rotor was designed, and the trapezoidal and rectangular blade tips with varying degrees of twist were selected for study.

The five-bladed rotor was adopted because it provides greater lift than the four-blade design, thus compensating somewhat for the performance loss due to reduced rotor speeds. Normal operating limits on the conventional OH-6 are 97-105% rotor rpm. While the first phase of testing brought the lower limit to 70%, the final test series further reduced rotor speeds to 67%, or about 314 rpm. on the main rotor.

Rotor rpm. is selected by the pilot with the use of a beep trim switch on the collective pitch lever. A fuel control governor then maintains the selected rpm. Allison Div. of General Motors, manufacturers of the T63 turboshaft engine powering the OH-6, provided a special Bendix fuel control governor capable of operating at the new lower limit of 67% and below.

While both the two-bladed and four-bladed tail rotors will be tested, engineers are showing a preference for the four-bladed design. Optimum phase angle for blades on the four-bladed rotor remains undetermined. In addition to normal 90-deg. phasing between blades, a 60/120-deg. and a 75/105-deg. arrangement are being studied. The 75/105-deg. arrangement has been selected for initial testing.

Transmission components also were modified because transmission noise was found to be quite distinct after tail rotor noise was reduced. Gear teeth tolerances were reduced considerably so that they mesh more smoothly, and gears were plated with a softer outer skin.

The modifications have increased the empty weight of the OH-6 by only 150 lb., but maximum allowable gross weight has declined from 2,400 lb. to about 1,600 lb. because of reduced rotor speeds. Empty weight of the aircraft, including modifications, would be about 1,300 lb. Top speed would also be reduced at the lower rotor rpm. settings from 128 mph. to 100 mph.

These limitations, however, would be imposed only at the lower rotor speeds. Tests have shown an actual increase in performance capabilities when the aircraft is operated at normal rotor speeds with the modifications, even though noise levels remain below those of a similar OH-6 without the alterations.

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