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Towards the

space tug

A

NASA CONTRACT worth $1-3 million to Rocketdyne Division of Rockwell International for work on ad-vanced propulsion in connection with the space tug indi-cates that this third component of the space shuttle is still progressing, albeit at an apparently low key. The contract calls for Rocketdyne to design, build, test and deliver high-pressure liquid oxygen and liquid hydrogen pumps and gas-generators to be used in conjunction with an 80,0001b-thrust engine aimed at space tug application. Nasa and the USAF were due to have agreed on a development programme for the space tug by the end of last year, and also on which agency was to be respon-sible for it. Last November aerospace companies in America were submitting their reports on alternative concepts for the vehicle which is needed to transfer pay-loads from the shuttle, orbiting the Earth at 100 miles altitude or so, to the altitude needed by the payload satellite, which will frequently be at the geostationary height of 23,300 miles. Five possibilities for the space tug configuration have been discussed. They are: —

(1) The use of an existing upper stage, for example as used with Centaur, Agena, Delta, Scout, Burner
II and Transtage to lift payloads up to 12,0001b to geostationary height. Development would take
$30 million-$100 million, and the cost per flight
could vary between $2 million and $10 million for
the stage itself.

(2) The use of modified recoverable upper stages for Centaur, Agena and Transtage would introduce extra complexity and would reduce payloads to 3,500Ib-5,0001b. Development costs would increase
to $100 million-$300 million, but reduce the cost per flight by $1 million-$3-5 million.

(3) Initial development of an entirely new unit, with 5,0001b capabilities, with a recoverable upper stage only.

(4) Final new development comprising an upper stage which could place a 6,5001b satellite into stationary orbit and return empty, or retrieve a 4,5001b satel-lite from the same orbit without flying another satellite on the way out, or both place and retrieve 4,1001b satellites in the same orbit.

(5) Advance technology stages which could place 8,0001b satellites at stationary height or bring back 4,0001b satellites, or place and retrieve two 3,0001b craft.

These are the options available. If the tug and the shuttle were a purely Nasa-sponsored project, it is prob-

This picture of Jupiter, taken by Pioneer 10 some time before its closest approach to the planet, shows the Red Spot and the complicated system
of bands which encircle it

able that financial constraints would rule out, at least for the next few years, any solution involving a lot of de-velopment. However, the presence of the USAF introduces some uncertainty because it is not clear what its ambi-tions are or how much money it will be prepared to put into the tug. On balance, with so little Nasa money avail-able to buy a programme involving not inconsiderable technical risk, it seems likely that one of the less ambitious options will be selected, with a technically more desirable solution following later.

1976 LAUNCH FOR LAGEOS

Nasa is planning to launch Lageos (the Laser Geodynamic Satellite, see Flight for December 6, page 963) in 1976. It will provide the first opportunity for tracking the Earth with respect to a satellite, rather than the traditional method of tracking a satellite in relation to the Earth. This technique will enable quite small movements of the Earth's crust to be measured to an accuracy of about

s4in.
Small relative movement of the crust indicates the presence of stresses which can cause earthquakes, frac-tures or subsidence. Measurements made with the help of the satellite will be fed into mathematical models of the Earth so that major disturbances of a catastrophic nature can be predicted. Many types of crust movements take place at the rate of about 2in a year and, although a few satellites are already equipped with laser reflectors, the impossibility of predicting their orbits with sufficient accuracy prevents the attainment of the precision neces-sary to measure these small changes.
Lageos will be used in conjunction with ground-based tracking stations which will beam laser pulses at the satellite and measure very accurately the movement which takes place in the siting of the transmitter over a period of time. The key to high accuracy lies in the stability of the satellite's orbit 3,420 miles above the Earth. The satellite itself will be a solid sphere of depleted uranium, 2ft in diameter and weighing 8351b. The idea is to provide a very high ratio of mass to cross-sectional area, so as to reduce the effect of atmospheric drag (and thus prevent rapid changes in the shape and height of the orbit) as much as possible. The Marshall Space Flight Centre, which is managing the programme, hopes that the satellite will provide a position reference for between 50 and 100 years.