booster in spite of its costing less than $7 million per flight, compared with $8 million for a BRB. The renewed interest in the expendable booster arises from a development figure which would keep peak programme expenditure below $840 million per year, or at least 15 per cent less than the cost of the BRB. It could, however, cost as much as $24 million per launch to operate.

The solid-fuel booster is now conceived as a cluster of up to four 150in, 3.8m-diameter cores developing a total of seven million pounds thrust, enough to launch the orbiter independently. The cluster may alternatively comprise six 120in, 3m cores. On the other hand, the selection of a BRB will mean the development of a water-recoverable vehicle which could be refurbished and used a number of times. TRW and Aerojet General are now studying under contract the feasibility of suitable pressure-fed engines (Flight, December 25, 1971, page 1020).

The matter of propulsion arrangements is the main point now under consideration. All phase-B contractors are examining both parallel-burn and series-burn shuttles. Parallel burn means the use of both orbiter and booster engines at lift-off, while series-burn refers to conventional sequenced staging. Two different sizes of engine are under study for the two concepts. In the parallel-burn configuration the booster is attached to the under-surface of the orbiter, while for series-burn the vehicles are stacked conventionally. The parallel arrangement favours solid boosters and would stand 170ft, 52m high and weigh some 4,800,000lb, 2,177 tonnes. The pressure-fed, water-recoverable booster is considered more suitable for the series-burn concept. Together, this would be about 300ft, 91m high with a lift-off weight of about seven million pounds, 3,175 tonnes.

The orbiter is the only element for which the basic configuration is fairly settled—with jetisonnable tanks for both fuel and oxidant. A significant new development is the increase in the number of engines in the orbiter from two to three following reduction in the SSME thrust specification from 550,000lb, 2,440kN to 415,000lb, 1,845kN. The size of the cargo bay and the payload capacity have, however, yet to be resolved. The original specification was for a cargo bay measuring 60ft×15ft, 18.3m×4.6m, and for the ability to carry 65,000lb, 29,500kg in a due-east launch or 40,000lb, 18,000kg into polar orbit. NASA is also examining the possibilities of a 14ft×45ft, 4.3m×13.7m cargo bay and a due-east payload capacity of 45,000lb, 20,400kg which NASA believes may be adequate for most of its missions. The US Air Force, however, potentially likely to supply more than half the shuttle's missions, considers this too small for its own needs and is pressing for the larger capacity.

UK RADIO AND SPACE RESEARCH 1968-70

Significant re-orientation of the work of the UK Science Research Council's Radio and Space Research Station, Ditton Park, Bucks, has taken place during the period covered by the station's triennial report*, published last week. Expansion of work for practical and economic purposes is the main outcome. This includes research on the propagation of millimetre waves, needed for the extension of communications. A major project, in collaboration with the UK Post Office, concerns the absorption of millimetre wavelengths in rain and the planning of route-diversity networks to avoid the worst effects.

Services in support of space science research in Britain, mainly in the universities and in collaboration with NASA, comprised about one quarter of the station's effort. The report also gives details of the research programmes and indicates conclusions resulting from basic investigations in space science, upper-atmosphere physics, solar/terrestrial relationships and radiometeorology, all of which continued to figure prominently in the station's programme.

The station was involved in several aspects of Ariel IV and, during 1970, began work with other groups in the UK and abroad on 12GHz satellite communications. Italy's Sirio geostationary satellite will be used in this work.

RSRS has overall responsibility to NASA for the Space Tracking and Data Acquisition Network (Staden) station at Winkfield. Among various services, the station has been sending predictions of satellite orbits to more than 30 camera stations in 14 European countries for geodetic purposes. Data on solar radio bursts at millimetre wavelengths have also been issued monthly to about 190 observatories and other organisations throughout the world.

The 82ft, 25m dish aerial at Chilbolton has been used mainly to study the meteorological causes of variations in radio-wave propagation at centimetre wavelengths, but stations have been maintained overseas for satellite observation. The report records the decision to close the Singapore station during 1971, but that there is a continuing requirement for the facilities in the Falkland Islands, including the Esro station operated by RSRS.

US AEROSAT DOUBTS

A new reticence appears to be growing in the United States towards signing the recent agreement with Europe for a co-operative air traffic control satellite (aerosat) programme (Flight, January 6, page 36). The agreement, which was re-negotiated with the US Federal Aviation Administration last autumn after responsibility was transferred from NASA, is considered binding by Esro even though formal signature has yet to take place.

The chief influence is pressure by the US Comsat Corp on the US Government to organise aerosat development by an international consortium similar to Intelsat. Meanwhile, Congress has delayed approval of US finance for the project. The lack of FAA resolution on the matter in this is reported to be the prime cause of Esro concern.

INTELSAT TARIFF-CUT POSTPONED

The International Telecommunications Satellite Consortium is not to go ahead with the intended reduction in circuit rental tariff rates originally planned for early this year. Intelsat's manager, Comsat, notified the US Federal Communication Commission last week that Atlantic traffic had fallen substantially short of levels forecast last year. In addition, Comsat pointed out the inability to reach a firm position in the light of continuing uncertainties over traffic-sharing arrangements between satellites and undersea cables.

LAUNCH DATES SET FOR HEOS AND TD-IA

The launch of the European Space Research Organisation's Heos-A2 scientific satellite is now rescheduled for 1525 GMT on January 20 from Vandenberg Base, Calif. Originally due for launch on November 12, Heos-A2 was delayed because of extended NASA investigation into the launch failure of an Itos-B satellite. A similar vehicle, a three-stage DSV-3L Delta, is to be used for Heos. Esro's sixth and largest satellite to date, TD-IA, is now scheduled for a February 24 launch date. TD-IA will also be launched from Vandenberg by a long-tank Delta-N vehicle. The satellite, weighing nearly half a ton, carries seven experiments from six countries for stellar ultraviolet spectroscopy and for study of solar and cosmic rays.

DR VIKRAM SARABHAI

India's space research leader, Dr Vikram A. Sarabhai (52), died on December 30, 1971. As chairman of the Indian Atomic Energy Commission since May 1966, he was responsible for organising space research in India and was the first chairman of the Indian National Committee for Space Research, set up by the Department of Atomic Energy.