modifications were intended to serve a variety of purposes, including improving fabrication, reducing thermal-expansion mismatch stresses, increasing strength-to-weight ratios of some components, and improving cooling of some components. The second report discusses (1) the origin of stress in the mismatch between the thermal expansions of the Ir/Re liner and a niobium sleeve and flange attached to the carbon/carbon shell and (2) a modification intended to relieve the stress. The modification involves the redesign of an inlet connection to incorporate a compressible seal between the Ir/Re liner and the Nb flange. A nickel alloy was selected as the seal material on the basis of its thermal-expansion properties and its ability to withstand the anticipated stresses, including the greatest stresses caused by the high temperatures to be used in brazing during fabrication.

This work was done by Brian E. Williams and Shawn R. McNeal of Ultramet for **Johnson Space Center**. *For further information, contact the Johnson Innovative Partnerships Office at (281) 483-3809.*
MSC-22981/82

Modeling and Diagnostic Software for Liquefying-Fuel Rockets

A report presents a study of five modeling and diagnostic computer programs considered for use in an integrated vehicle health management (IVHM) system during testing of liquefying-fuel hybrid rocket engines in the Hybrid Combustion Facility (HCF) at NASA Ames Research Center. Three of the programs — TEAMS, L2, and RODON — are model-based reasoning (or diagnostic) programs. The other two programs — ICS and IMS — do not attempt to isolate the causes of failures but can be used for detecting faults. In the study, qualitative models (in TEAMS and L2) and quantitative models (in RODON) having varying scope and completeness were created. Each of the models captured the structure and behavior of the HCF as a physical system. It was noted that in the cases of the qualitative models, the temporal aspects of the behavior of the HCF and the abstraction of sensor data are handled outside of the models, and it is necessary to develop additional code for this purpose. A need for additional code was also noted in the case of the quantitative model, though the amount of development effort needed was found to be less than that for the qualitative models.

This work was done by Scott Poll, David Iverson, Jeremy Ou, Dwight Sanderfer, and Ann Patterson-Hine of **Ames Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Innovative Partnerships Division, Ames Research Center, (650) 604-2954. Refer to ARC-15341-1.

Spacecraft Antenna Clusters for High EIRP

Several documents in a collection discuss a proposal to use clusters of appropriately phased, relatively small microwave antennas to obtain high levels of effective isotropically radiated power (EIRP) for transmission of data from spacecraft to Earth during exploration of distant planets. The advantages of such a cluster, relative to a single larger antenna of equivalent EIRP, would include the following:

- The cluster would have less mass and volume.
- Power densities in amplifiers, waveguides, and other transmitting components feeding the antennas would be lower. Therefore, problems of preventing overheating and high-voltage breakdown would be less severe.
- Phases could be made electronically adjustable for beam steering to increase pointing accuracy.
- Failure of one antenna or its feed system would reduce the EIRP but would not disable the entire transmitting system. Beam-steering capability would remain as long as at least three antennas (and their feed systems) in a triangular arrangement remained functional.

The documents summarize the applicable basic principles of antenna design and requirements that would govern the design of an antenna cluster for a specific proposed mission [the Jupiter Icy Moons Orbiter (JIMO)]. Candidate design concepts for realizing the aforementioned and other advantages for JIMO are analyzed.

This work was done by Robert Clauss, Richard Lovick, Narayan Mysoor, and John Zitzelberger of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
NPO-40729