A90-24940 Cleopatra crater on Venus—Venera 15/16 data and impact/volcanic origin controversy. A. T. BAZILEVSKII and B. A. IVANOV, *Geophysical Research Letters* (ISSN 0094-8276), Vol. 17, Feb. 1990, pp. 175–178. 19 Refs.

The morphology and morphometry of the 100-km diameter, 2.4-km deep Cleopatra crater on Venus are examined using Venera 15/16 images. The Cleopatra crater is compared to circular structures on Venus, Mercury, Mars, the earth and the moon. Consideration is given to the possible causes for the genesis of the Cleopatra crater. It is concluded that Cleopatra has a clear impact basin morphology with an anomalous crater depth.

A90-21815 Heat transfer by a meridional circulation cell and the static stability of the atmosphere on a slowly rotating planet (Perenos tepla meridional'noi tsirkuliatsionnoi iacheikoi i staticheskaia ustoichivost' atmosfery na medlenno vrashchaiushcheisia planete). S. S. ZILITINKEVICH, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 27, Nov.–Dec. 1989, pp. 932–942. 22 Refs.

Equations are derived for determining the equator-pole temperature contrast and the static-stability parameter in a planetary atmosphere in which the main heat-transfer mechanism is ordered meridional circulation. The results obtained are used to estimate the atmosphere heat-adaptation periods, the wind-velocity scales, and other circulation characteristics on Venus.

A90-12655 Spatial variations in thermal and albedo properties of the surface of Phobos. L. V. KSANFOMALITII, V. I. MOROZ, J. P. BIBRING, A. SOUFFLOT, M. COMBES et al., *Nature* (ISSN 0028-0836), Vol. 341, Oct. 19, 1989, pp. 588–591. 9 Refs.

Analysis of Mariner 9, Viking 1 and 2, and ground-based experimental data has led to the conclusion that the surface layer of Phobos consists of fine-grained material with a composition close to that of carbonaceous chrondrites. Observations of the mean Phobos diameter obtained by the Phobos 2 mission with a resolution of 1/20-1/40 are presented here which show, for the first time, inhomogeneities in the thermal and spectral properties of the surface of Phobos.

A89-42522 Spreading on Venus (Spreding na Venere). ALEKSEI L. SUKHANOV, ALEKSEI A. PRONIN, *Priroda* (ISSN 0032-874X), May 1989, pp. 27–37.

With reference to Venus imagery obtained by Venera 15 and 16 orbital stations and other observations, it is argued that the Venus range belts are analogs of the spreading phenomenon on the earth, an important element in plate tectonics. The discussion covers the structure of the valleys, problems involved in the interpretation of Venus surface imagery, the range belt relief and patterns, volcanoes in the range belts, and the breakdown of the range belts. Evidence is presented in support of the conclusion that the Venus range belts represent zones of tension rather than compression.

A89-36513 Ridged belts on Venus as extensional features. A. L. SUKHANOV and A. A. PRONIN, *Proceedings of the 19th Lunar and Planetary Science Conference,* Houston, TX, Mar. 14–18, 1988, (A89-36486 15-91). Cambridge/Houston, TX, Cambridge University Press/Lunar and Planetary Institute, 1989, pp. 335–348. 28 Refs.

Some characteristics of ridged belts on Venus are difficult to explain by compressional folding. Occurrences of massive linear swells with partly collapsed roofs, volcanoes and ring structures, unusual relationships at belt intersections and terminations, the position of some belts in large valleys, and their symmetrical or rhombical patterns, all suggest the belts could be constructed of linear intrusions, dikes and extrusions emplaced as a result of regional extension. The fan-like system of belts located within the northern hemisphere from 150-250 degappears to have been produced by the formation and spreading of new crust that has divided the older highlands, possibly as part of the spreading system that includes Aphrodite Terra. The mechanism of Venusian spreading seems to be different from that of the earth as it produced multiple low-amplitude ridged belts instead of midoceanic ridges with orthogonal transform faults.

A90-21808 A method for constructing the limit region of admissible initial positions of a spacecraft during its descent from orbit into a planetary atmosphere (Metod postroeniia predel'noi oblasti dopustimykh nachal'nykh polozhenii apparata pri ego spuske s orbity v atmosfere planet). G. A. VINOGRADOVA and S. A. VOEVODIN, *Kosmicheskie Issledovaniia* (ISSN 0023-4206), Vol. 27, Nov.–Dec. 1989, pp. 867–876.

The paper examines the problem of searching for a region limited by the set of initial points of optimal descent trajectories in a planetary atmosphere, from which it is possible to bring the vehicle to a given landing site either under nominal flight conditions or in the presence of disturbing factors. A general method for constructing this region is proposed, and a calculation example involving quasi-optimal control is presented.

A89-54651 Computer-aided identification and analysis of lineaments on the basis of radar images of Venus (Avtomatizirovannoe vydelenie i analiz lineamentov po radiolokatsionnym izobrazheniiam Venery). A. IA. DANIL'CHENKO, M. S. MARKOV, M. V. OSTROVSKII, and IU. S. TIUFLIN, *Geodeziia i Kartografiia* (ISSN 0016-7126), July 1989, pp. 23–26. 6 Refs.

An algorithm is developed for the computer-aided identification and analysis of lineaments on radar images. The algorithm was implemented in the VENERA program, and used for the computer-aided processing and analysis of radar images of the Venus surface obtained with the Venera 15 and 16 probes. Lineament maps were then constructed.

A89-42539 Stratified rocks of Venusian plains in the light of Venera 15 and 16 data (Sloistye porody venerianskikh ravnin v svete dannykh 'Venery-15, -16'). O. V. NIKOLAEVA, *Geokhimiia* (ISSN 0016-7525), April 1989, pp. 478–485. 31 Refs.

The lithological characteristics of the extremely low-strength stratified rocks found on Venus at the landing sites of Venera 9, 10, 13, and 14 are examined in the light of the new geological data obtained by Venera 15 and 16. Based on these data, these rocks are interpreted as deposits of volcanic basalt ash. If this is the case, the observable properties of the stratified rocks indicate that basalt ashes on Venus were produced by eruptions of the Hawaiian and Strombolian types associated with small domes. The chemical erosion of basalt ashes on Venus involves the formation of surface films on glass particles.

A89-38822 On the surface composition of the M-type asteroids. D. F. LUPISHKO, and I. N. BEL'SKAIA, *Icarus* (ISSN 0019-1035), Vol. 78, April 1989, pp. 395–401. 21 Refs.

Photometric and polarimetric observations of the largest M-type asteroids conducted over the period 1978-1986 are presently interpreted in view of results from laboratory photometric and polarimetric measurements of meteoritic, terrestrial silicate, and metallic samples. The samples, including among its 13 meteorites suitable representatives of iron, chondrite, and achondrite types, are of similar structure, with grain sizes smaller than 50 microns. An analysis of all data extant indicate that the surfaces of the largest M-type asteroids, namely 16, 21, 22, 69, and 110, cannot consist of pure metal; they must instead include silicate component-like stony-iron and enstatite chondrite meteorites.

A89-35550 The relief of the crust-mantle boundary and strain-compression stresses in the crust of Venus (O rel'efe granitsy kora-mantiia i napriazheniiakh rastiazheniia-szhatiia v kore Venery). K. I. MARCHENKOV and V. N. ZHARKOV, *Pis'ma v Astronomicheskii Zhurnal* (ISSN 0320-0108), Vol. 15, Feb. 1989, pp. 182–190. 15 Refs.

A joint analysis of the topography and nonequilibrium part of the gravitational field of the Venus was carried out for spherical harmonics with $n = 3 - 18$. The characteristics of the crust-mantle boundary and of the strain-compression stresses in the crust were revealed for a series of realistic models of Venus with allowance for the asthenosphere. In general, the crust-mantle boundary of Venus is sufficiently smooth. The stresses vary from +600 bars (strain) to −700bars (compression) as a function of the model of the planet's interior.

Japanese Aerospace Literature
This month: *Propulsion System Configurations/Designs*

A91-13768 The design and orbital operation of Space Flyer Unit. K. KURIKI, N. NINOMIYA, M. NAGATOMO, N. TSUYA, M. KAWACHI et al., IAF, 41st International Astronautical Congress, Dresden, Federal Republic of Germany, Oct. 6–12, 1990. 12 pp. (IAF Paper 90-055).

The Space Flyer Unit (SFU) is an unmanned, reusable multipurpose platform to be launched by the Japanese H-II rocket and retrieved by the U.S. Space Shuttle. The SFU core system and payloads are described, and the SFU target mission and performance are summarized. SFU operation is examined, including the launch phase, early orbit phase, mission operation phase, preretrieval phase, retrieval phase, proximity operation phase, and return phase.

A90-24950 'HYREFS series codes' users' manual. K. VISWANATH REDDY and TOSHI FUJIWARA, *Nagoya University, Faculty of Engineering Memoirs* (ISSN 0027-7657), Vol. 41, No. 1, 1989, pp. 39–92. 14 Refs.

The basic theoretical principles and application procedures of HYREFS, a set of computer programs for the numerical simulation of hypersonic reacting flows, are presented in a manual for potential users. The formulations of the governing equations and the solution algorithm are outlined; the FORTRAN 77 numerical implementation is explained; and the subroutine code structures and input-output procedures are examined in detail. Graphs, flow charts, tables of numerical data, and sample HYREFS graphics are included.

A91-41689 Battleship tank firing test of H-II launch vehicle—First stage. ATSUTARO WATANABE, MAMORU ENDO, ISAO YAMAZAKI, TAKASHI MAEMURA, and TATSUO NAMIKAWA, AIAA, SAE, ASME, and ASEE, 27th Joint Propulsion Conference, Sacramento, CA, June 24–26, 1991. 9 pp. (AIAA Paper 91-2051).

The H-II launch vehicle capable of placing 2-ton-class payloads on geostationary orbits is outlined, and focus is placed on its propulsion system. The development status of the project, including component development, preliminary battleship tank firing test (BFT-1), battleship tank firing test (BFT-2), and flight-type tank firing test (CFT) is discussed. The configuration and schematic diagram of BFT-2 are presented, and the firing test results of BFT-2 first series are analyzed, including engine performance, interface compatibility, and pressurization of subsystems.

A91-38231 Ducted rocket propulsion technology. NAMINOSUKE KUBOTA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 446, 1991, pp. 99–106. 8 Refs.

Ducted rocket propulsion technology is considered, with emphasis on the combustion characteristics. Chemical reactions of the solid propellant are described.

A91-38227 Japanese launch vehicles and technology transfer in the space applications area. MASAFUMI MIYAZAWA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 39, No. 445, 1991, pp. 55–68. 10 Refs.

The configurations of the N-I, N-II, and H-I rockets are described and compared. The Japanese space program (especially the launch vehicles) is discussed in connection with space applications, technology transfer, and cooperation between the United States and Japan in space.

A91-14046 Engineering Test Satellite-VI and future applications. K. NAKAMARU, S. TANAKA, H. KITAHARA, T. KATAGI, T. AKAEDA et al., IAF, 41st International Astronautical Congress, Dresden, Federal Republic of Germany, Oct. 6–12, 1990. 10 pp. 7 Refs. (IAF Paper 90-455).

The major design features, technologies employed, and current development status of ETS-VI are discussed. Among the main objectives are the establishment of a 2-ton-class three-axis-stabilized spacecraft bus technology, confirmation of the launch capability of the H-II rocket, and on-orbit experiments and tests of the measurement equipment. Emphasis is placed on the spacecraft configuration, module design, payload mass and mounting area, lightweight structure, electrical power, attitude control accuracy, and telemetry and command channels. The ETS-VI mission payloads consist of six communications payloads and five bus experimental payloads. A development schedule extending into 1993 is presented, and the proposed areas of enhancement such as the adoption of Ni-H2 batteries, power supply to the ion engines from the batteries, and the reduction of the total mass structure by installing the propulsion system in the bus module are covered.

A91-12225 Design and performance tests of a low power dc arcjet thruster. MICHIO NISHIDA and KEN-ICHI TANAKA, *Kyushu University Technology Reports* (ISSN 0023-2718), Vol. 63, Aug. 1990, pp. 351–357.

In this paper a quasi-one-dimensional flow model of a propellant in an arcjet thruster is described. This model is intended to be used for the design of the arcjet thruster. Owing to the simplicity of the model, the performance characteristics of the thruster can be calculated easily to find optimum dimensions of the thruster which is suitable for various missions. In order to verify adequacy of the model, a thruster was fabricated and its performance characteristics were measured. The experimental results were compared with the calculational results predicted with the model. Both are in satisfactory agreement and it is concluded that this flow model is a useful tool for the design of the arcjet thruster.

A90-44716 Development of MPD thruster EM for a space test (engineering model). K. SHIINA, H. SUZUKI, K. UEMATSU, T. OHTSUKA, and K. TOKI, AIAA, DGLR, and JSASS, 21st International Electric Propulsion Conference, Orlando, FL, July 18–20, 1990. 8 pp. 8 Refs. (AIAA Paper 90-2558).

An engineering model (EM) of MPD thruster has been developed for a space test on board the first Space Flyer Unit (SFU-1). A thermal vacuum test was conducted, and the following results were obtained: (1) a thermal mathematical model of MPD thruster EM was established, (2) sizing data of thruster heaters were obtained, and (3) thermal characteristics of the MPD thruster EM were confirmed to meet the requirement. The data are going to be reflected in designing a protoflight model of MPD thruster.

A90-20583 A new type of non-rigid airship system. M. ONDA, 8th AIAA Lighter-Than-Air Systems Technology Conference, Jacksonville, FL, Oct. 5–7, 1989, Technical Papers (A90-20576 07-01). Washington, DC, American Institute of Aeronautics and Astronautics, 1989, pp. 45–52. (AIAA Paper 89-3175).

The novel airship structural design presented is distinguished by a concentric axial duct, carrying the propulsion system for the craft and conducting its throughflow to an exhaust nozzle, extending from bow to stern. The improved steering performance characteristics sought through the thrust vectoring facilitated by this propulsion system geometry have been demonstrated with a scale model of the configuration. The flow of the propulsion system's intake and exhaust airflow is controlled by changing the orientation of the control surfaces located at the bow and stern openings of the axial duct.

A90-42601 Performance characteristics of plasmajets and ion sources using resonant-cavity microwave discharge. H. TAHARA, K. ONOE, T. YOSHIKAWA, T. YASUI, and M. ABUKU, AIAA, DGLR, and JSASS, 21st International Electric Propulsion Conference, Orlando, FL, July 18–20, 1990. 11 pp. 9 Refs. (AIAA Paper 90-2633).

Two plasma sources using resonant-cavity microwave discharge are studied in order to obtain the fundamental operational characteristics. In a high-pressure plasma source, electric fields on the inner wall of the resonant cavity are measured, along with plasma properties in the discharge tube. Emphasis is placed on coupling efficiency, plasma parameters, quality factors, and cavity length effects. The values obtained in experiments are shown to agree with those calculated using the cold plasma theory. In an ion source, ion currents and plasma parameters are measured, and ion production costs and mass utilization are estimated for variable mass flow rate, microwave absorbed power, and discharge tube length, and plasma densities and electron temperatures are obtained.

A90-42545 Thruster performance and acceleration mechanisms of a quasi-steady applied-field MPD arcjet. H. TAHARA, Y. KAGAYA, T. YOSHIKAWA, and M. SASAKI, AIAA, DGLR, and JSASS, 21st International Electric Propulsion Conference, Orlando, FL, July 18–20, 1990. 10 pp. 9 Refs. (AIAA Paper 90-2554).

A quasi-steady magnetoplasmadynamic (MPD) arcjet with applied axial magnetic fields has been investigated in high specific impulse levels to improve the thruster performance and to understand the complex acceleration mechanisms with both the self-induced magnetic field and applied one. Axial-field application was found to achieve higher thrust efficiencies at same specific impulses and to achieve stable operations at higher specific impulses with less electrode erosion. Furthermore, the measured pressure characteristics near the electrodes and current density patterns showed that the total thrust increased in spite of decrease in the electromagnetic pumping thrust and small contribution of Hall acceleration. Thus additional thrust components due to the axial field were expected to exist.

A90-40400 The cryogenic wind tunnel as a testing tool for airframe/propulsion systems. KEISUKE ASAI, Presented as Paper at the 27th Japan Society for Aeronautical and Space Sciences, Aircraft Symposium, Kyushu University, Kasuga, Japan, Oct. 18–20, 1989, 4 pp. 6 Refs.

A new approach to the simulation problems of hot jet exhausts is presented. This method uses the advantages of cryogenic temperatures in wind tunnel testing. Simple theoretical analyses show that hot jet exhausts can be simulated in a cryogenic environment by using a gas at ambient or moderately elevated temperatures. Also, it is shown that in cryogenic wind tunnels, all the similarity parameters including the jet-temperature-related parameters and the Reynolds numbers can be matched to the full-scale flight values. The potential advantages of the cryogenic approach are discussed with emphasis on its applications to the testing of airframe and propulsion systems.

A90-29466 Dynamics of the Exos-D satellite—Effects of various flexible appendages. MICHIHIRO NATORI, ICHIRO NAKATANI, KEIKEN NINOMIYA, TOSHIHIRO KURII, and KEN MAEDA, AIAA, ASME, ASCE, AHS, and ASC, 31st Structures, Structural Dynamics and Materials Conference, Long Beach, CA, Apr. 2–4, 1990. 7 pp. 6 Refs. (AIAA Paper 90-0993).

The Japanese Exos-D satellite is examined, noting the satellite's deployable appendages for scientific measurements. The spacecraft configuration is illustrated and preliminary in-orbit data for the initial operation phase are presented. Consideration is given to the orbital parameters, attitude control system, and analytical investigations performed to predict the in-orbit behavior of the Exos-D. Wire antenna appendages such as a three-axis orthogonal loop antenna and coilable longeron extendible masts are used as electric field, VLF wave, and plasma wave detectors. The initial data on the effects of these appendages are presented, including changes in spin rate and spin period before and after deployment of the antennas.

A90-13364 Development status of Japan's new launch vehicle—H-II rocket. M. MIYAZAWA and Y. FUKUSHIMA, IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 12 pp. 6 Refs. (IAF Paper 89-195).

The H-II launch vehicle is being developed by NASDA to meet the demands of Japan's applications satellite users for cost-effective, heavy-lift launches in the 1990s. This paper describes the present status of the design and development of the H-II launch vehicle. Special attention is given to the test results of the solid rocket booster and the payload fairing. The updated overall configuration and system descriptions are also presented.

A89-47133 Carbon dioxide breathing propulsion for a Mars airplane. S. YUASA and H. ISODA, AIAA, ASME, SAE, and ASEE, 25th Joint Propulsion Conference, Monterey, CA, July 10–13, 1989. 7 pp. (AIAA Paper 89-2863).

The combustion characteristics of the metals in the pure CO2 atmosphere are examined. The performance characteristics of the turbojet and ramjet engines are evaluated using thermodynamic cycle analysis. The results suggest that Mg is a desirable metal as a fuel due to its easy ignitability and high burning rate.

A90-23871 Reynolds number effects on the performance of a turbofan engine. MASAO KOZU and SATOSHI YASHIMA, ASME, Gas Turbine and Aeroengine Congress and Exposition, Toronto, Canada, June 4–8, 1989. 7 pp. 9 Refs. (ASME Paper 89-GT-199).

Reynolds number effects on the matching performance of a small twin-spool turbofan engine were investigated through altitude tests on the F3-30 engine which was developed to power the T-4 intermediate trainer. Analyzing the test results made it clear that the change of the aerodynamic characteristics of the low pressure turbine due to Reynolds number effects is as significant as those of fan and compressor, and it caused the difference between the predicted and measured engine performance at high altitudes. Correlation factors on the Reynolds number for each of the component characteristics (pressure ratio, airflow and efficiency of fan and compressor, and gasflow and efficiency of low pressure turbine) were obtained, and simulation of the engine performance using these factors coincided well with the test data which were obtained from the altitude tests of the F3-30.

A90-19941 Numerical simulation of hypersonic viscous flow for the design of H-II orbiting plane (HOPE). YUKIMITSU YAMAMOTO, TOSHIO AKIMOTO, and NAOYUKI SUZUKI, AIAA, 28th Aerospace Sciences Meeting, Reno, NV, Jan. 8–11, 1990. 16 pp. 12 Refs. (AIAA Paper 90-0601).

The H-II orbiting plane (HOPE) is an unmanned winged vehicle for space transportation whose current baseline configuration is that of a double delta wing with tip fins. Hypersonic CFD analysis is performed for the four types of proposed HOPE configurations, and aerodynamic and aerothermodynamic characteristics are investigated. Numerical computations are carried out for the HOPE 62A, 62B, and 62C models at Mach 7, Reynolds number 2.5×10 to the 6, and at angles of attack from 0-40 degrees. The aerodynamic characteristics are compared with experiments performed in a hypersonic wind tunnel. For the HOPE 63 model, calculations are made at the above conditions at angles of attack up to 50 degrees. In addition, Reynolds and Mach number effects are also analyzed for this model. Numerical results of heat transfer distributions are compared with experimental data obtained by the phase change paint methods.

A90-13430 Bipropellant performance of N2H4/MMH mixed fuel in a regeneratively cooled engine. SHUICHI UEDA, HIROSHI MIYAJIMA, and TAKUO KUWAHARA, IAF, 40th International Astronautical Congress, Malaga, Spain, Oct.7–13, 1989. 11 pp. 11 Refs. (IAF Paper 89-286).

Experimental regeneratively cooled bipropellant engines, with a vacuum thrust of 2000 N at a chamber pressure of 0.98 MPa and an area ratio of 240:1, were fired with hydrazine-MMH mixed fuels to evaluate potential performance and cooling improvements. Regeneratively cooled engine tests were conducted with 80 percent hydrazine-20 percent MMH mixed fuels as well as with MMH single fuel, utilizing optimized injectors for each fuel. The chamber pressure was varied in a range from 0.6 to 0.9 MPa. Long duration firing tests of 160 s were conducted to evaluate heat soak back level and demonstrate safe shutdowns of a mixed fuel regeneratively cooled engine. The peak specific impulses of the mixed fuel was more than 322 s, while that of MMH was 308 s. Regenerative cooling with the mixed fuel seemed to be particularly advantageous in that the temperature increase through the cooling channels was smaller than that of MMH; this reduced performance degradation due to reactive stream separation ('blow apart') at higher chamber pressures.

A90-13298 Equipment exchange system for Japanese experiment module of Space Station. GAKUMEI HATTORI, FUMIAKI SANO, KATSUMI FUSEGI, SHINICHI MORI, YOSHITERU YAMAMOTO et al., IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 7 pp. (IAF Paper 89-082).

A preliminary design study established the baseline configuration of the equipment exchange system and equipment exchange unit (EEU) for the Japanese experiment module of the Space Station (Phase B). The EEU research and development project started in July 1985. In 1986, preliminary tests were carried out to study the feasibility of the EEU concept and operation of resource connectors used in the EUU in a vacuum environment. The EUU's technical feasibility and basic performance were verified by the model test results. Various test will proceed to solve the technical issues which are already identified (Phase C/D).

A89-47006 A comparison of scramjet engine performances of various cycles. TAKESHI KANDA, GORO MASUYA, YOSHIO WAKAMATSU, NOBUO CHINZEI, and AKIO KANMURI, AIAA, ASME, SAE, and ASEE, 25th Joint Propulsion Conference, Monterey, CA, July 10–13, 1989. 10 pp. 19 Refs. (AIAA Paper 89-2676).

An airframe-integrated hydrogen fueled scramjet engine is assumed in order to compare engine performances of various engine cycles: an expander cycle, a staged-combustion cycle, a coolant-bleed cycle, and a gas-generator cycle. Each engine was regeneratively cooled by liquid hydrogen. Effects of flight Mach number, flight dynamic pressure, and fuel injection-to-air dynamic pressure ratio were examined as related to propellant feed-line power balance. The system pressure of the closed loop cycle becomes high, while the specific impulse of the open loop cycle becomes low, when the flight Mach number, the flight dynamic pressure, or the fuel injection to airdynamic pressure are high, i.e., when the fuel injector manifold pressure is high. Of the four cycles, the coolant-bleed cycle shows the most well-balanced performance.

A90-19703 Thermally and chemically nonequilibrium flow analyzed by Park's two-temperature model. K. V. REDDY, T. FUJIWARA, and T. MURAYAMA, AIAA, 28th Aerospace Sciences Meeting, Reno, NV, Jan. 8–11, 1990. 12 pp. 22 Refs. (AIAA Paper 90-0142).

This work deals with a flow around a reentry hypersonic vehicle at flight speeds Mach = 15, 25, and 30 and at altitude 70 and 80 km under a thermally and chemically nonequilibrium concept. As a thermally nonequilibrium model, Park's two-temperature model is adopted. For the transport properties, Yos's formulation is used to treat both temperatures accurately. The governing equations in conservation-law form are solved using noniterative, approximately-factored implicit finite-difference scheme. Both fully-catalytic and noncatalytic walls are treated under the laminar boundary layer around a rocket body configuration.

A90-13457 H-II launch vehicle development status in terms of vibration, shock, and acoustic. KENJI TOMIOKA and YUJI KOHSETSU, IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 7 pp. (IAF Paper 89-327).

The status of the Japanese H-II launch vehicle is presented with reference to the vibration, shock, and acoustic environments. The structural systems design and development of the H-II is based on the concept of the mechanical environments configured launch vehicle (MECLV). The major points described include the structural design concept to restrain the inflight mechanical environments; the establishment of the component design requirements in the early phase of the vehicle development; selection and verification of the vehicle structures to satisfy vibration, shock, and acoustic requirements. The National Space Development Agency of Japan has been developing the H-II to commercialize low costs and high reliability expandable launch vehicle.

A90-13445 Development study of air turbo-ramjet for future space plane. NOBUHIRO TANATSUGU, TAKEKAZU HONDA, YOSHIMASA SAGIYA, and KAZUYUKI HIGASHINO, IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 7 pp. (IAF Paper 89-311).

The airturboramjet (ATR) engine presently discussed as a candidate propulsion system for prospective aerospaceplanes employs a hydrogen-cooled expander cycle and is accordingly designated ATREX. The engine configuration involves a hydrogen-heatsink precooler for intake air as well as a combustion chamber heat exchanger. It is projected to be capable of furnishing superior specific thrust from sea level/static to 30-km/hypersonic (Mach6) flight conditions. Attention is given to the test conditions and performance characteristics of the ATREX engine, the materials required for its critical components, and the test apparatus employed.

A90-13437 Idle mode operation of LE-5A engine. YOJIRO KAKUMA, KENJI KISHIMOTO, KEIICHI HASEGAWA, RYUICHI SEKITA, and YUKIO KOYARI, IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 8 pp. (IAF Paper 89-297).

The LE-5A engine is now under development for the 2nd stage of H-II launch vehicle. Its qualification test has begun in this summer. Two engineering model engines (EM engine) were already tested in 1988 and early 1989, and the results of its 40 hot firings—52 starts involving the restart, and 3311 seconds of total duration—proved 12.4 tonf thrust and 452 second Isp at mixture ratio 5.0 in vacuum. According to feasibility study on hot firing tests of the idle mode operation, its adoptable operation rating was determined, and hot firing tests in this condition were conducted successfully.

A90-13436 LE-7 engine development status. EIJI SOGAME, AKIRA KONNO, YOSHIHIRO TORII, KENJI KISHIMOTO, KEIICHI HASEGAWA et al., IAF, 40th International Astronautical Congress, Malaga, Spain, Oct. 7–13, 1989. 8 pp. (IAF Paper 89-296).

The development of LE-7, the first stage main engine of the H-II launch vehicle, is at the final stage of the prototype-I phase. Two engines were fabricated and about 40 firing tests were carried out. Accumulated duration of the tests was approximately 370 seconds. Several technical problems, which had occurred in the breadboard model tests and the fuel turbopump tests before the prototype-I phase, were all resolved. Those results were reflected in the design of the prototype-I engine. The development schedule was delayed because of the difficulties in the prototype-I engine, especially in the high speed operation of the fuel turbopump.

A89-46733 Feasibility study of air-breathing turbo-engines for horizontal take-off and landing space plane. M. MINODA, K. SAKATA, T. TAMAKI, T. SAITOH, and A. YASUDA, AIAA, ASME, SAE, and ASEE, 25th Joint Propulsion Conference, Monterey, CA, July 10–13, 1989. 9 pp. 6 Refs. (AIAA Paper 89-2296).

Various concepts of air-breathing engines (ABEs) that could be used for a horizontal take-off and landing SSTO vehicle are investigated. The performances (with respect to thrust and the specific fuel consumption) of turboengines based on various technologies, including a turbojet with and without afterburner (TJ), turboramjet, and air-turbo-ram jet engines are compared. The mission capabilities of these ABEs for SSTO and TSTO vehicles is examined in terms of the ratio of the effective remaining weight (i.e., the weight on the orbit) to the take-off gross weight, using two-dimensional flight analysis. It was found that the dry TJ with the turbine inlet temperature 2000C is one of the most promising candidates for the propulsion system of the SSTO vehicle, because of its small weight and high specific impulse.