經濟部

經濟部二〇〇一年中俄技術合作計畫
研習人員考察報告

國際合作處

中 華 民 國 九 十 年 五 月

經濟部二〇〇一年中俄技術合作計畫
研習人員考察報告

研習主題：航太技術

研習人員：航太工業發展推動小組廠商服務組組長 雷震台

出國地點：俄羅斯莫斯科

目　　錄

壹、前言

為促進我國與俄羅斯的實質技術交流與合作，於民國八十四年五月經濟部頒訂「中俄技術合作計畫實施要點」，藉由經濟部國際合作處與俄羅斯國家科學院機械工程研究所共同主辦，每年選派我國技術人員赴俄羅斯參訪，以促進雙方之技術交流，所需差旅經費則由經濟部國際合作項下支應。

此技術交流參訪活動舉辦至今已是第六屆，本年度參訪行程從民國九十年元月二十七日(星期六)至二月九日(星期五)，共計十四天。參訪主題為航太技術，由航太工業發展推動小組派員參加。技術交流參訪活動主要之目的為瞭解俄方航太材料技術研究現況並蒐集可引進之技術項目。

參訪行程係由俄羅斯國家科學院機械工程研究所首席科學家 Lutsau 教授負責安排，在航太技術方面由航太工業發展推動小組廠商服務組雷震台組長參與。行程方面則主要由 Lutsau 博士負責協調安排。參訪俄羅斯期間，承蒙台北莫斯科經濟文化協調委員會(北莫協)駐莫斯科代表處經濟組的曹四洋組長與廖浩志商務秘書協助各項事宜，包括接機、旅館安排、行程接洽等等，在此謹對於北莫協經濟組的安排與協助致以謝意。另特別感謝經濟部國際合作處的吳德嵩科長與鄭斐瑜小姐於此活動所給予的鼎力協助。

貳、俄羅斯航太工業簡介

提到前蘇聯政權時代航太工業的研發，最著名的米格(米格)與蘇愷(Su)戰機的研發。米格-15 於 1948 年研發成功，並開始服役於前蘇聯空軍，接著陸續發展米格-17、米格-19 與米格-21。為了汰換日漸老舊的且數量龐大的米格-21、米格-23與米格-25(Foxbat)戰機群，於是由米格(Mikoyan Gurveich)設計局於 1972 年起秘密的展開了新一代戰機的研發工作，米格設計局參考了許多新進出廠的美國戰機(如 F-15、F-16等)的設計理念，於 1977 年起開始進行米格-29 原型機的試飛工作，1982 年進入量產，陸續進入前蘇聯空軍服役，並授權印度於當地量產。1986 年米格-29 戰機訪問芬蘭，西方國家才有機會揭開其神秘面紗。米格-29 一般歸類為空優攔戰鬥機，早期量產的米格-29 為支點 A 型，雙座型米格-29UB稱為支點 B 型，外銷型計有米格-29SE(支點 C)、米格-29SD，另外尚有米格-29K 艦載型，以及米格設計局改良後的米格-29M(米格-33)，對地攻擊衍生型米格-30，構成完整的家族系列。在現實世界中，米格-29 常和西方世界的 F-16、F-18相提並論。然而，藉著前蘇聯獨樹一格的科技水平，米格-29在近戰時甚至佔有更多的優勢。1992 年推出米格-31(Foxhoung)開始服役，並預計修改米格-33 為米格-35，但是目前計畫停止，全新戰機研發被蘇愷三十五(SU-35)取代。

蘇愷二十四(SU-24)與 F-111 同時期進行開發，自 1965 年開

始設計，但蘇愷二十四體積比較 F-111 小、動力比較大，具備極高之承載量。接著蘇愷(Sukhoi)設計局繼開發出蘇愷二十五(SU-25)蛙足式(Frogfoog)戰機、蘇愷二十七(SU-27,Flanker)、蘇愷三十三(SU-33)戰機側衛者 D 型(Flanker-D)等。蘇愷三十(SU-30)戰機是俄國製造的最優良戰機，更先進的蘇愷三十七戰機目的則仍在研發階段。蘇愷三十改良自蘇愷二十七、外形類似，於 1994 年柏林(Burlin)航展第一次公諸於世。蘇愷三十 MK 戰機，作戰航程可達 3,000 公里，空戰能力強，可掛 12 枚空對空飛彈，具備空中加油能力，可作快速急轉彎，同時執行空對空及空對地任務，飛行最高高度為 59,055 呎，最大速度為音速的 2.35 倍(M2.35)。西方軍事專家指出，蘇愷三十是一種變座、多用途戰機，是設計來與美國空軍的 F15 對抗。雖然蘇愷三十性能不錯，但俄羅斯空軍因為經費不足，至今未配備這型戰機，除中共外，印度已於 1996 年購買了 40 架蘇愷十戰機，這批戰機當時是在俄羅斯遠東地區裝配的。中共也是俄羅斯武器的最大客戶之一，目前已擁有 48 架蘇愷二十七型戰鬥機，並獲授權自行生產 200 架同型戰機。

俄國在歷經經濟改革與重整後，原有的航太工業實體紛紛獨立並成立合資公司，轉型成民營公司。為能爭取最大利益與生存的空間，在近幾年俄國航太工業的各研發與製造單位，莫不致力於將所生產的軍用航太產品推向國際軍火

市場，並且運用本身的科技帶動，將軍事研發轉為民航事業，製造生產民航客貨機，同時尋求國際合作以進入國際民用航空市場。

俄羅斯目前航太市場極度缺乏資金，未來隨著政策的開放，將有與俄羅航太工業進行技術合作的機會。雖然俄羅斯政府認為航太工業為策略性產業，但缺乏相關資金補助提昇其產業競爭力，近來俄政府正積極運用既有的高技術拉攏國外航太廠商進行合作，吸引外資投入俄羅斯活絡航太產業帶動經濟運轉，同時尋求切入國際航太廠的機會。

參、參訪報告

參加二十一世紀複合材料及新金屬合金研討會

本次研習主題在學習俄羅斯航太材料最新技術、在 IMASH 機構的 Lutsau 博士的建議之下，報名參加『二十一世紀複合材料及新金屬合金研討會』(Theory & Practice of Technologies of Manufacturing Products of Composite Materials and New Metal Alloys-the 21st Century)，舉行日期自一月三十日起至二月二日止(為期四天)假莫斯科大學舉行。會中邀請美國、奧地利、伊拉克及俄羅斯地區之複合材料及新金屬專家作專題演講。本次會議之演講專題涉獵範圍極廣，包括：複合材料產品製程電腦化最佳設計、網格化航太級複合材料結構分析、大型複合材料數位化結構及自動化製程、分析高溫離子衝擊零件製程、複合材料之磁性特質工程，俄製 AN 飛機結構的摩擦／非摩擦材料應用等專題。

目前鈦礦床主要分佈在巴西、印度、加拿大、挪威、南非、澳洲等。鈦合金可細分耐腐蝕性鈦合金及高強度鈦合金二種。

（一）耐腐蝕性鈦合金

鈦對酸化性空氣及鹽化物水溶液具有很強的耐腐蝕性，但對具還原性的耐酸腐蝕性較弱，只要添加鉬、鉬等金屬元素，就可改進其耐腐蝕性。Ti-0.3Mo-0.8Ni，在鹽化物環境

中有極優的耐腐蝕性。

耐腐蝕性鈦合金主要有的 Ti-0.15Pd、Ti-5Ta、Ti-0.3Mo-0.8 等。高強鈦合金又細分在室溫安定相存在的（α型稠密六方晶造）、β型（體心立方品構造）、α+β型等三種結構，主要 Ti-5AL-2.5Sn、Ti-6AL-4V、Ti-13V-11Cr-3Al 等。

（二）高強度鈦合金

1. 此合金包含兩種型態—型合金與α+β型合金：

   α型合金－不需要熱處理(heat treatment)，在高低溫皆具有極佳的安定性及熔接性等點。以 Ti-5AL-2.5Sn 為代表。

2. α+β型合金－因合金元素的種類和量的不同其具有特性也有很大的變化。代表性的合金有 Ti-6AL-4V。

3. 鈦合金的物理特徵

   鈦合金（Ti-6AL-4V）和其他金屬材料的物理性質相比較之下，有以下的特徵：

   (1)鈦合金熔點 1594℃，略比鐵高。

   (2)鈦合金比重 4.43、約為鐵的 60%、約為鋁的 1.7 倍

   (3)熱導導率較小，為 0.017cal/cm2.sec。

   (4)熱膨脹係為 88×10^{-6}，約為鋁的 1/3。

   (5)透磁率為 1.000，屬於非磁性體。

   (6)電氣阻力大為 171 μ-Ω-cm，約為鋁的 3 倍。

   (7)縱彈性係數小為 11.550kg/mm^2，鈦合金在加工成形方面具下列特徵：

   a. 除了少部份β型鈦合金外，其餘不易加工成線圈

狀。

b.可製成最薄 0.5mm 的平板。

c.鈦合金可製成線或圓棒形。

d.鍛模(Forging dies)通常只能達到 100kg。

鈦合金應用範圍，特別是引擎方面，鈦合金的應用範圍及開發，特別是引擎方面，例如葉片或部份的壓縮器方面都使用鈦合金。引擎上鈦合金的使用率約佔 1/4，在軍用機機體上的使用率方面約佔 1/5-1/4，民航機方面約佔 7%左右的比例。俄羅斯一直致力於鈦合金製程技術的研究改進。希能尋找出降低成本的過程。

可引進項目：未來可與俄羅斯著名鈦合金製造廠 V 公司進行鈦合金加工技術交流及轉移，可提昇國內引擎熱鍛之製造技術

參訪 IMASH：

IMASH 成立於民國 27 年(西元 1938 年)，成立目的在解決機械及機構上製造、設計上的任何問題。而 IMASH 是由俄羅斯地區最頂尖的機械專業人士所組成的。IMASH 為俄羅斯地區機械科學的領導中心，它在整個技術發展上如機械系統光學設計、先進的自動化系統、實驗機械、人因工程的生物力學......等各個領域均獲得世界各國極高的評價。

而 IMASH 基礎研發工作範圍廣及原子力學、航太工程、火箭工程、國防武器、化學、運輸工具、冶金技術、結構設計(如道路建造)及輕/重機械工程等各項應用。由於身為俄羅斯設計局的重要研發機構，IMASH 參與各項重要研發計畫，如原/核子熱反應爐、渦輪發電機、太空火箭系統、原子動力之潛水艇、飛行載具及飛行實驗風洞等各項設計研究工作。

IMASH 的研發工作在提供增加靜態結構的強度，可靠度及安全度，與減低動態結構的振動效應及研究新型複合材料應用層面，例如改善飛行力學的各種因子及發展機械人。

IMASH 各主要工作內容：

- 機械的結構、動態及靜態的綜合研究
    1. 傳動機械(Drive-mechanism-control)綜合理論計算學理，包括結構、力矩、質量、度量....等最佳化設計。
    2. 精密複雜機械的動力控制研究。
    3. 機械系統的理論研究。
    4. 機械系統的驗證及技術診斷的研究方法。
    5. 模擬機械結構運作的最佳化計算方法。
    6. 機械運動的模組化設計的最新法則。

- 提供機械安全運動的方法及其標準

1. 研究計算剪應力變形的數值方法。
2. 研發測試危險度高的機械裝置所需的替代實驗器材。

- 減低機械設備的摩擦損失及改善摩損能量
  1. 研究高效率機械裝置、計算高耐度、高可靠度摩擦裝置。
  2. 研究邊界層理論、液壓動力、潤滑系統。
  3. 研發高品質潤滑物質(電磁、液態及粉末狀物質)。
  4. 研發最佳化接合機構及接觸面摩擦之技術。

- 主要研發成果
  1. 機械傳動裝置及複雜結構運作的高可靠度。
  2. 研究新機械理論：第一次運用在人的步行裝置上，同時並發展多功能的運動機械上。
  3. 振動理論：研發在各種不同參數環境(包括動態及靜態)之傳動系統的振動研究工作。

- 太空與航空工業方面
  1. 重心引力方面所影響的機械的操作的分析。
  2. 太空載具的振動力學分析。
  3. 兩個太空載具於太空中相對運動的分析。

IMASH 的代表及各專業領域的專家與各國專業人士共同設立全球安全機械機構，共同致力研發分析機械運動理論，以期望創造出高性能、高安全性的機械裝置。

IMASH 不僅在俄羅斯工業中扮演一個重要角色，同時並與美國知名波音公司及麥道公司(現已被波音併購)進行各項太空計畫的合作。

可引進項目：IMASH 機構擁有完整複合材料及其他各項金屬材料的基本資料及研究測試報告，可做為國內改進材料性質的參考，惟該等資料對俄羅斯而言屬較為機密且寶貴資料，如可引進，需與俄方就此等資料洽談移轉費用。

參訪 NPO MOLINYA 集團：

NPO MOLINYA 集團（文後簡稱 M 集團）一九七六年成立，並開發出第一個可重複使用的太空載人載具。由於當時受限於技術之故，太空載具內所使用昂貴精密的推進系統及航電系統僅能使用一次，造成太空載具的開發費用極高，而 M 集團所研發出可重複使用的太空載具，對於當時七〇年代的技術而言，可說是一項創舉。而這樣的太空載具系統，蘇聯（現俄羅斯）稱之為冰風暴載具（BURAN Orbiter）。

M 集團成立之初主要有兩項研發計畫：第一是重型超音速飛機及飛彈之研發；第二是開發飛機所需的生產機具設計工作及飛機各項性能之實驗測試工作。
七〇年代蘇聯各項工業並未做過像冰風暴載具這樣大型的計畫，譬如在高速飛行，載具所使用的耐高溫材料在太空中所遇到如輻射等問題上沒有完整的研發經驗，有鑑於此，蘇聯政府投入大量的人力、物力，在 M 集團內建立全功能的實驗室，除了各項實驗設備外，更興建了全尺寸實體模型的測試裝備，作為冰風暴載具的動態及靜態測試之用。

冰風暴載具定位為高載重的飛行器，起飛酬載為三十噸，可以攜帶二十噸重的工具返回地球，其內部容量可承載十七公尺長、五公尺直徑太空工具，及搭載六名太空人，可謂「大容量」太空載具。

在經過近二十年研發及測試之後，冰風暴載具於一九八八年十一月完成首次飛行任務。同時在八０年代初期，M 集團著手進行另一項開發計畫：多功能太空載具系統(MAKS，Multipurpose Aerospace System）。這項系統除了具有高酬載、高運作效率及低營運成本等優點外，另一項特點是，它是由大型飛機上發射進入太空執行任務，故不受地面發射基地氣候因素限制，可隨時隨地由各機場起飛進入太空，因此對執行突發狀況的太空任務（如緊急修護工作或救援

工作）上更為彈性。MAKS 系統早在冰風暴載具執行首次任務前，即已開始進行研發工作，目前這項載具的結構、附掛油箱等均已完成開發工作，同時並進行推進系統的測試工作。MAKS 包含了兩個部分：太空載具和搭載太空載具的大型飛機。現階段用的是冰風暴載具及 An-225 MRIA 大型飛機。而冰風暴載具所用的是兩具高推力 RD-701 引擎及攜有液態氫、液態氧、柴油的附掛油箱，以便提供載具足夠的推力進入太空。

現階段 M 集團不僅在太空方面保有持續的研發工作，另外在新型飛機方面也開始進行設計工作，目前 M 集團已設計一系列其載重量自五百公斤至五噸的民用飛機，M 集團為了要切入民用飛機市場，因此在設計上有別於一般傳統的民用飛機造型，而研發出「三翼」飛機，其標榜的是「優異的氣動力、更安全、更省油且價格經濟實惠」的飛機。M 集團表示，三翼設計理念主要是改善飛機氣動力的損失，在飛機飛行中最危險的兩個過程：起飛及降落時，自動補正高角的氣動損失，相對更增加飛機操控的安全性。以下是三翼飛機的簡單介紹：

- MOLNIYA-1：六人座的螺旋槳小飛機，此型飛機在一九九三年獲 Eureka-93 全球發明獎之金獎，一九九五年獲得布魯塞爾最佳技術獎。目前此型飛機用作貨運、旅遊及私人飛行用，同時其高安全性之故，常被派遣至天氣

惡劣地區執行相關運輸任務。

- MOLNIYA-100：十五人座雙螺旋槳引擎商務客機，除可載送乘客及運輸貨物外，更可改裝成八人座的救護及救援用飛機。由於引擎安裝在機身尾端，因此大大減低噪音與振動方面的問題，提供乘客一個舒適及安靜的飛行過程。
- MOLNIYA-300：六人座雙噴射引擎商務客機，其功能如MOLNIYA-100 型飛機相同。
- MOLNIYA-400：目前 M 集團正進行開發的廣體客機，其載客量為二百五十人、載貨量可達五十噸之重。
- MOLNIYA-1000：雙機身的超級客機，其載客量可達一千二百人、載重量可達四百五十噸之重。由於其特殊設計，將類似附掛油箱的大型貨櫃裝置在兩個機身中間，除可進行運送一般大型設備，如大型引擎、化學反應、軍事裝備等外，更可輕易地運送太空載具及其發射相關設備，解決了運輸上的困擾。

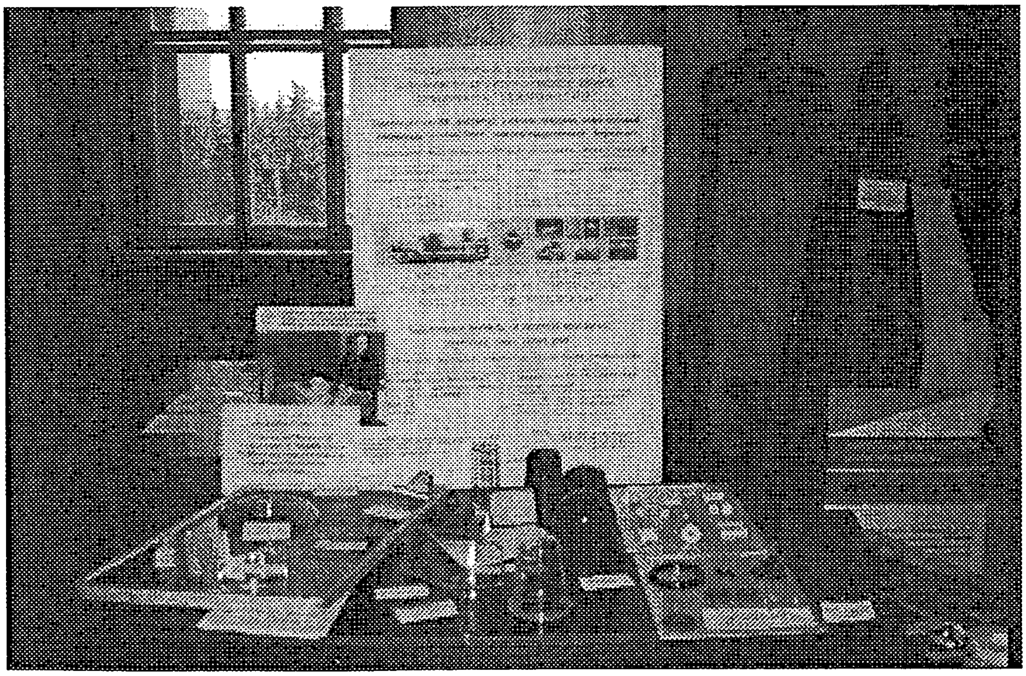
可引進項目：該公司所生產飛機之市場多屬俄羅斯及中亞地區，市場初步評估規模不大，但就 M 公司所擁有相關製造技術可進一步蒐集資料，以投資方式取得相關關鍵製造技術。

肆、結論

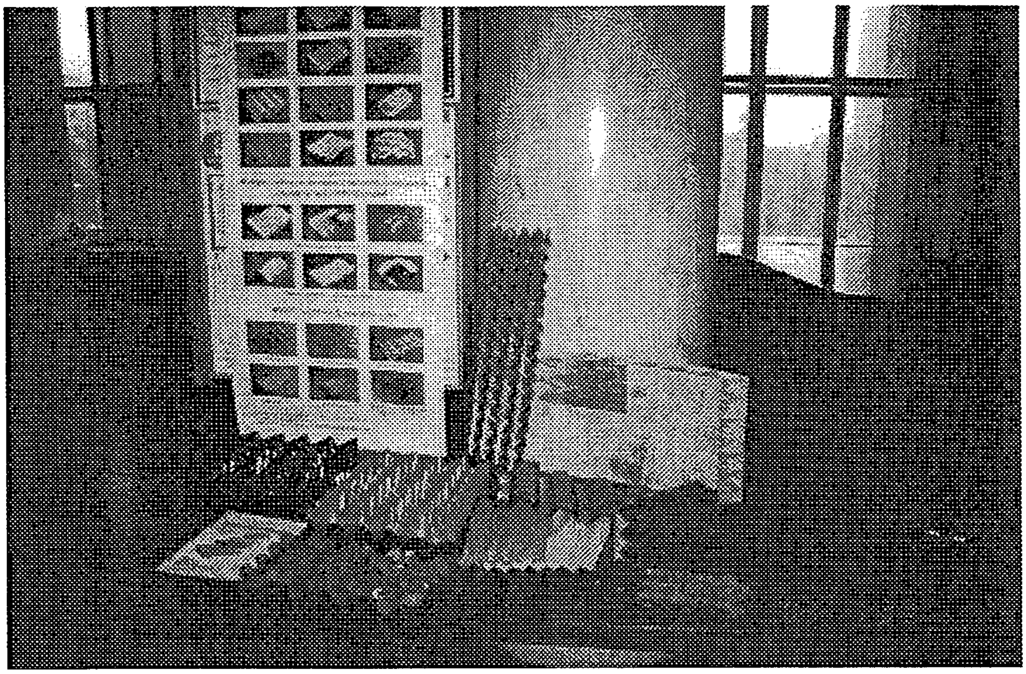
- 本次採納 IMASH 機構的 Lutsau 博士的建議，報名參加『二十一世紀複合材及新金屬合金研討會』，原認為可與各國從事複合材料及新金屬的研發機構進行廣泛的交流及蒐集技術來源，但從出席人數未超過五十人及大多數來自俄羅斯地區的研發機構來看，此類研討會屬地域性質的交流活動，就報名費用與實質獲得效益而言，有待商榷。建議下次訪俄羅斯行程儘量避免參加研討會，將研習時間多安排拜訪研發機構或航太廠商。
- 本次行程拜訪機構多在莫斯科地區，經與 Lutsau 博士洽談得知多數航太廠商位於莫斯科郊區，往返車程需數小時之久，但從研習技術程度來看，建議需至現場拜訪瞭解俄羅斯工廠管理及運作情形，始能得知其工業技術水準，才可進一步瞭解技術來源及洽談引進內容。
- 俄羅斯航太工業技術水準頗高，但距離商業化水準仍有一段距離，其所製造的軍機是屬軍事機密具是民航機市場多屬俄羅斯地區，因此現階段切入俄羅斯航太工業建議以技術移轉取得相關技術基礎資料，強化國內在基礎技術的資料庫作為研發改進之用。
- 有關研習時間，建議安排八、九月份秋季，可使增長每日研習時間，增加研習效果。

附件一：照片集錦

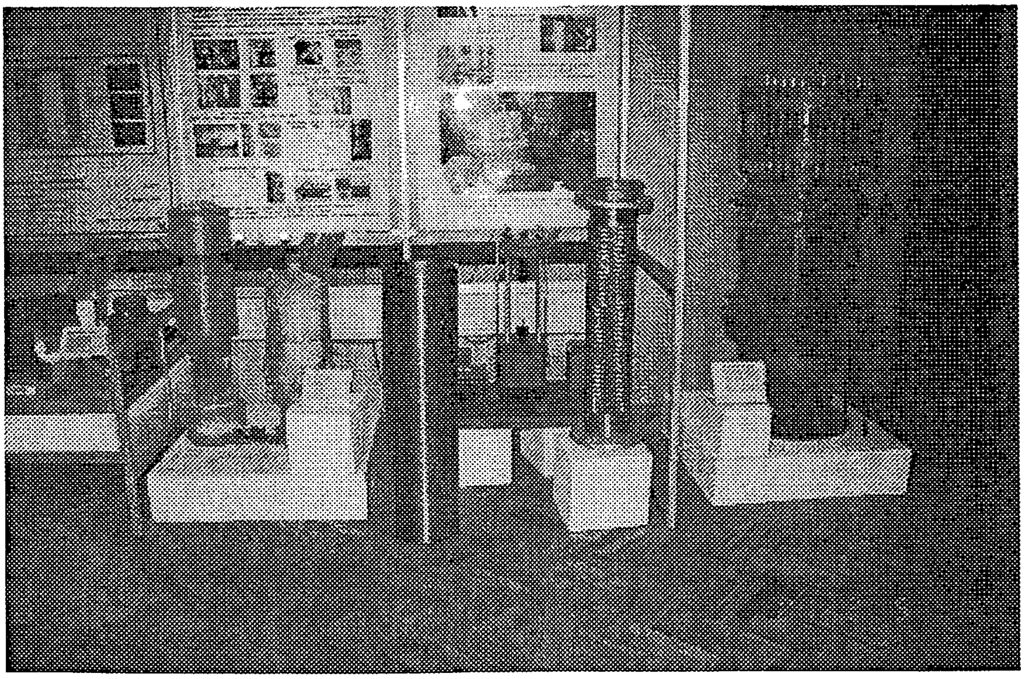
圖一：二十一世紀複合材料及新金屬合金研討會場新金屬產品展示



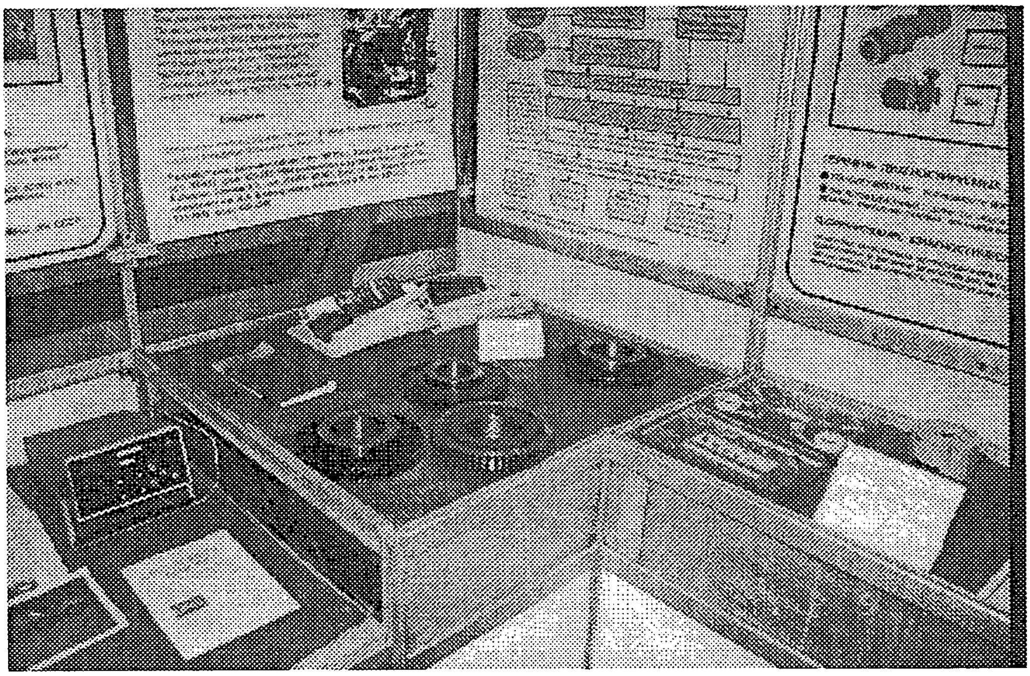
圖二：二十一世紀複合材料及新金屬合金研討會場複材產品展示



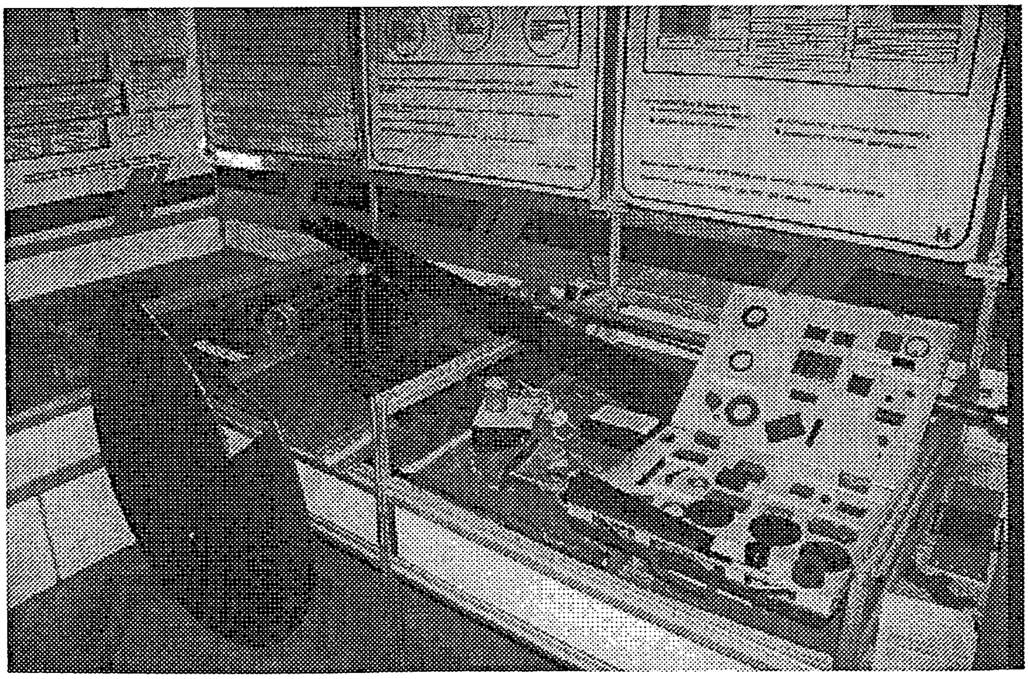
圖三：二十一世紀複合材料及新金屬合金研討會現場蜂巢結構展示



圖四：IMASH 機構研發完成的鈦合金材質引擎燃燒筒



圖五：IMASH 機構研發完成的鎂合金材質航太用齒輪



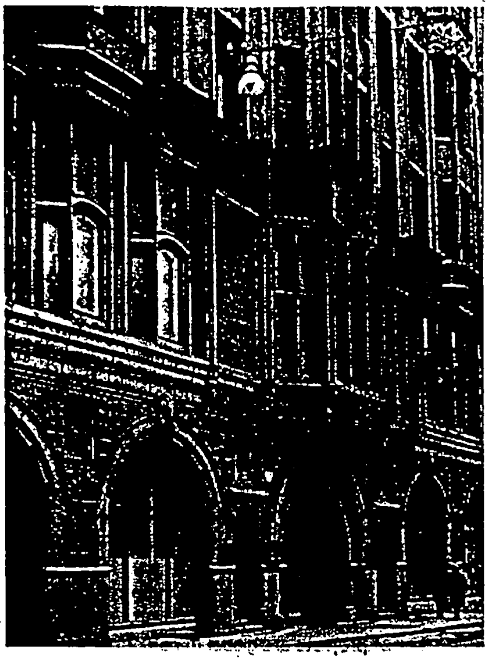
圖六：IMASH 機構研發完成的複合材料航太零組件

附件二：IMASH 機構簡介

ИНСТИТУТУ МАШИНОВЕДЕНИЯ (ИМАШ) им. А.А.Благонравова РОССИЙСКОЙ АКАДЕМИИ НАУК - 60 ЛЕТ

THE BLAGONRAVOV INSTITUTE OF MACHINE SCIENCE (IMASH) OF THE RUSSIAN ACADEMY OF SCIENCES IS 60

ИМАШ создан в 1938 году с целью комплексного решения научных задач, связанных с вопросами конструирования, производства и эксплуатации машин и механизмов. Становление и развитие института протекало под руководством выдающихся ученых в области машиноведения Е.А.Чудакова, И.И. Артоболевского, А.А.Благонравова. С 1975 институтом руководит академик К.В. Фролов.



The IMASH was set up in 1938 to solve complex tasks related to the problems of design, manufacture and operation of machines and mechanisms. The Institute's formation and development was directed by outstanding scientists in the field of machine science E.A.Tchudakov, I.I.Artobolevsky, A.A. Blagonravov. Since 1975 Academician K.V. Frolov has been heading the Institute.

Институт является ведущим научным центром страны в области машиноведения. Широкое признание в мире получили его достижения в таких областях технических знаний как оптимальное проектирование систем машин и автоматизация процессов проектирования, экспериментальная механика, виброакустика; биомеханика систем "человек-машина-среда", экология и информационное обеспечение.

Фундаментальные исследования и разработки **ИМАШ** имеют межотраслевое значение и их результаты находят прямое применение в атомном, авиационном, ракетно-космическом, оборонном, электротехническом, химическом, транспортном, металлургическом, строительно-дорожном, тяжелом и легком машиностроении.

ИМАШ принимал и принимает участие вместе с ведущими НИИ и КБ страны в крупнейших проектах по созданию атомных и термоядерных реакторов, турбогенераторов, ракетно-космических систем, атомных подводных лодок, летательных аппаратов и энергоустановок, автомобилей, уникальных аэродинамических труб, биопротезов, автоматизированного оборудования с числовым программным управлением.

The Institute is the leading Russian center in the field of machine science; its achievements in development in such fields of technical knowledge as optimal design of machines systems and automation of design processes, experimental mechanics, vibroacoustics; biomechanics of "man-machine-environment" systems, ecology and information support have gained wide recognition in the world.

Basic research and developments by the **IMASH** have interbranch significance and their results are directly applied in atomic, aviation, rocket-astronautic, defense, electro-chemical, chemical, transport, metallurgical, construction and road-building, heavy and light mechanical engineering.

Along with the leading research institutes and design bureaus of Russia the **IMASH** has been taking part in major projects to create atomic and thermonuclear reactors; turbogenerators, rocket-astronautic systems, atomic submarines, flying vehicles and power plants, automobiles, unique wind tunnels, bioprostheses, automated equipment with computer numerical control.

Исследования и разработки **ИМАШ** направлены на решение конкретных задач прочности, надежности, безопасности конструкций, динамической нагруженности и подавления виброакустических воздействий, применения новых конструкционных материалов, а также улучшения аэродинамических характеристик систем, создания робототехнических устройств.

ОСНОВНЫЕ НАПРАВЛЕНИЯ ДЕЯТЕЛЬНОСТИ

Структурный, кинематический и динамический синтез машин и механических систем

•теоретические и расчетные методы синтеза комплексов "привод-механизм-управление" с оптимизацией по структурным, энергетическим, массовым, метрологическим, скоростным и ресурсным показателям;
•исследования по динамике и управлению сложными механическими системами;
•развитие теории мехатронных систем;
•формирование методов технической диагностики и сертификации машин и механизмов;
•оптимизация структуры производственного оборудования на основе имитационного моделирования;
•новые принципы модульного построения технологических линий.

Подходы, критерии и методы обеспечения безопасности машин, конструкций, сложных технических систем, людей и окружающей среды

•методики, алгоритмы, программы расчетов напряженно-деформированного состояния, прочности и ресурса объектов с учетом условий нагружения, нелинейных эффектов и эксплуатационных рисков;
•стенды и аппаратура для экспериментального обоснования конструкторско-технологических решений принципиально новых высокорисковых машин и конструкций, новых материалов.

Снижение потерь на трение, повышение износостойкости машин и оборудования

•методы обеспечения работоспособности и средства прогнозирования долговечности и надежности узлов трения машин;
•развитие теории граничной, гидродинамической смазки;
•создание высококачественных смазочных материалов (магнитореологических, жидких и порошковых);
•физическое и математическое моделирование трибологических процессов, ускоренные испытания узлов трения и создание экспериментального стендового оборудования;
•методы и технологии повышения контактной прочности деталей машин за счет оптимизации геометрических сопряжений.

Защита человека и машины от вибраций

•аналитические модели и компьютерные технологии исследования динамических систем "человек-машина-среда",

Research and developments performed by the **IMASH** are aimed at solving concrete tasks of strength, reability, safety of structures, dynamic loading and suppression of vibroacoustic effects, application of new structural composite materials, as well as improvement of aerodynamic characteristics of systems, development of robotic devices.

MAIN AREAS OF ACTIVITY

Structural, kinematic and dynamic synthesis of machines and mechanical systems

•theoretical and computation methods of synthesis of "drive-mechanism-control" complexes with optimization by structure, power, mass, metrology, rate and resource indices,
•research in dynamics and control of complex mechanical systems,
•development of the theory of mechatronic systems,
•formation of methods of technical diagnostics and certification of machines and mechanisms,
•computer methods of optimization of processing equipment structure on the base of simulation,
•new principles of modular design of processing lines.

Approaches, criteria and methods of provision of safety of machines, structures, complex technical systems, man and environment

•development of methods, algorithms, programs for computation of stress-deformation state, strength and durability of objects with regard for real conditions of loading, nonlinear effects and operation risks,
•creation of stands and equipment for experimental substantiation of design and technology solutions for fundamentally new high-risk machines and designs, new materials.

Reduction in losses to friction, improvement in wear resistance of machines and equipment

•methods of ensuring efficiency and means of predicting durability and reliability of machines' friction units,
•development of theory of boundary, hydrodynamic lubricant,
•creation of quality lubricating materials (magnetorheological, liquid and powder ones),
•methods of physical and mathematical simulation of tribological processes, accelerated trials of friction units and development of experimental stand equipment,
•methods and technologies for improvement in contact strength of machine parts due to optimization of geometrical junctions.

Protection of man and machine from vibrations

•analytical models and computer technologies for research of "man-machine-environment" dynamic systems,

•поиск эффективных алгоритмов управления сложными техническими объектами, обеспечивающих наиболее комфортные условия для оператора;
•использование вибротактильных воздействий в качестве каналов передачи информации человеку, а также с целью профилактики, лечения и реабилитации;
•построение основ теории управления динамическими процессами (техногенными и природными катастрофами) с целью минимизации наносимого ущерба.

Создание машин и конструкций в малошумном исполнении

•научные основы проектирования малошумных машин и конструкций; теория формирования виброакустических полей, способы и меры борьбы с вибрациями в источниках их образования и на путях распространения акустических волн;
•методы виброакустических расчетов машин, механизмов и конструкций, активная и пассивная виброзащита; виброакустическая диагностика дефектов в упругих структурах;
•комплексы для модельных, стендовых и натурных статических и динамических исследований элементов кинематических пар тяжелонагруженных машин.

•search for efficient algorithms of control over complex technical objects providing the most comfortable conditions for the operator,
•analysis and use of vibrotactile effects as channels for information tranfer to man, and as means of prophylaxis, treatment and rehabilitation,
•elaboration of fundamentals of theory of dynamic processes control (simulating real technogenic and natural disasters) to minimize damage they inflict.

Designing machines and constructions low-noise modifications

•scientific fundamentals of designing low-noise machines and constructions; theory of formation of vibroacoustic fields, ways and means of vibrations suppression in the sources of their formation and on the ways of acoustic waves propagation,
•methods of vibroacoustic calculations of machines, mechanisms and constructions, active and passive vibroprotection; vibroacoustic diagnostics of defects in elastic structures,
•complexes for investigation in model, stand and field conditions of static and dynamic loading of elements of heavy-duty machines kinetic pairs.

ОСНОВНЫЕ РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЙ

Обеспечение надежности эксплуатации энергетических систем и сложных конструкций

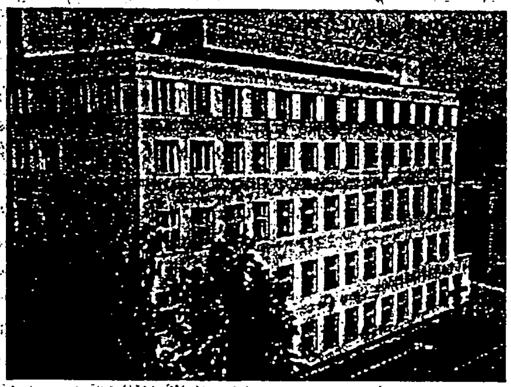
Системы технической диагностики напряженного состояния и расчетно-экспериментальные методы расчета.

Теория механизмов и машин

Общая схема походок шагающих устройств (создана впервые). Теория устойчивости многоногих шагающих машин и методы рационального выбора их основных параметров.

Теория колебаний

Методы исследования нестационарных и стационарных колебаний роторных систем с переменными инерционными параметрами, колебаний и устойчивости сложных упругих и гидроупругих систем применительно к элементам внутренней конструкции реакторов атомных электростанций и к тяжелым роторам гидроагрегатов мощных гидроэлектростанций. Динамика роторных систем для намотки композиционных материалов.



Лабораторный корпус / Laboratory facilities

MAIN RESULTS OF INVESTIGATIONS

Ensuring operational reliability of power-engineering systems and complex constructions

Systems for technical diagnostics of the strained state and computation-experimental methods.

Theory of mechanisms and machines

For the first time there has been developed the general scheme of walking devices gaits. The theory of multiped walking machines has been elaborated, methods of rational selection of their main parameters have been laid down.

Vibrations theory

Methods of investigating non-stationary and stationary vibrations of rotor systems with variable inertia parameters, vibrations and stability of complex plastic and hydroelastic systems as related to elements of inner design of atomic power plants reactors and heavy rotors of hydroelectric generating sets of high-power hydroelectric power stations. Dynamics of rotor systems for composition materials winding.

Космонавтика и авиация

Анализ поведения механических систем и человека в условиях микрогравитационных воздействий; мероприятия по медико-биологическому обеспечению безопасности и эффективности работы космонавтов. Математические модели вибронагруженности и демпфирования элементов космических кораблей.

Методы оценки влияния аэродинамических факторов на относительное движение орбитальных систем из двух связанных космических объектов. Опытный образец микрогравитационного акселерометра на основе волоконно-оптических датчиков. Программный алгоритм динамического расчета многослойных составных конструкций летательных аппаратов.

Робототехника

Работы по классификации, кинематике и динамике роботов. Перспективная система "очувствления" для адаптивных роботов. Опытный образец трехкоординатной автоматической измерительной системы для адаптивной системы управления станками с ЧПУ.

Биомеханика

Математическое обеспечение для исследования биомеханических характеристик оператора, эффективные методы и средства снижения вибрационных нагрузок, защиты от внешних воздействий среды. Вибрационные, компьютерные и лазерные стенды для изучения эргономических аспектов человека и машины в экстремальных условиях и прогнозирования процессов в системе "человек-машина-среда".

Прочность машиностроительных материалов и конструкций

Общие вопросы механики деформирования и разрушения твердого деформируемого тела и композиционных сред. Практическая реализация методов и средств исследования реальной нагруженности с помощью фотоупругих материалов и высокотемпературной тензометрии в условиях газовых, жидких и паровых сред, высокоскоростных потоков и радиации.

Методы расчетно-экспериментального исследования прочности и ресурса в детерминированной и вероятностной постановке при возникновении циклических упругих и пластических деформаций при механических и тепловых воздействиях. Экспериментальные и теоретические исследования ползучести армированных пластиков с учетом изменения температуры, изучение прочностных характеристик композиционных материалов при температурах до 20°К;

Испытательная машина с уникальной жесткостью силоизмерительной системы (запись диаграммы деформирования углеродных волокон диаметром 8-10 мкм при усилиях в несколько грамм и смещениях в несколько микрон), оригинальные установки для изучения динамических свойств волокон и пленок при температуре до 200°С.

Astronautics and Aviation

Analysis of behaviour of mechanical systems and man in microgravitation effects conditions; elaboration of medico-biological measures to ensure safety and efficiency of an astronauts. Design of mathematical models of vibration-loading and damping of spacecraft elements.

Methods of estimating effect of aerodynamic factors on relative movement of orbital systems from two connected space objects. The pilot model of a microgravitation accelerometer based on fiber-optical transducers. The programme algorithm for dynamical analysis of multilayer sectional designs of flying vehicles.

Robotics

Works on classification, kinematics and dynamics of robots. Development of a promising scheme of sensitization for adaptive robots. The first in Russia trial sample of a three-coordinate automatic measuring systems for an adaptive CNC machines control system.

Biomechanics

Software for investigation of biomechanical characteristics of the operator, efficient ways and means of vibration loads reduction, protection from the environment effects. Vibration, computer and laser stands to study ergonomical aspects of man and machine in extremal conditions and prognosis for development of processes in the systems "man-machine-environment".

Mechanical engineering materials and structures strength

General questions of mechanics of deformation and destruction of solid deformable body and composition media. Practical realization of ways and means of real loads investigation with the help of photoresilient materials and high-temperature strain measurement in conditions of gaseous, liquid and vapour media, high-rate flows and radiation.

Methods of computation-experimental research of strength and durability in determinate and probabilistic formulations with cyclic elastic deformations occurring at mechanical and thermal effects.

Experimental and theoretical research of reinforced plastics creep with regard for changes in temperature, studies in strength characteristics of composite materials at cryogenic temperatures (up to 20°K).

A trial machine with unique strength-measuring system rigidity (it enables to record diagram of deformation of carbon fibers 8-10 μm in diameter at several grams force and several μm displacement), original facilities to investigate dynamic properties of fibers and films at temperature up to 200°C.

Трибология

Теоретические основы проектирования узлов трения с различными видами смазок, изучение контактных взаимодействий при активных физико-химических процессах. Методы расчета работоспособности узлов трения на стадии проектирования. Высокоэффективные фрикционные и антифрикционные материалы и покрытия, материалы для работы в глубоком вакууме, при очень высоких и низких температурах.

Методы создания рабочих поверхностей подшипников с газовой смазкой. Теоретические и экспериментальные исследования быстропротекающих процессов трения.

База данных *"методы трибологических испытаний и ускоренной оценки фрикционных и антифрикционных характеристик материалов"*.

Влияние детергентов на фрикционные свойства углерод-углеродных композиционных материалов.

Вакуумные ионно-плазменные технологии нанесения износостойких покрытий из тугоплавких соединений.

Уникальный состав металло-керамического покрытия и лазерная технология его нанесения на поверхности трения, повышающие срок их службы в 20-30 раз.

Технология ионного травления регулярного профилированного микрорельефа на поверхности трения, обеспечивающая значительное повышение срока службы твердосмазочных покрытий.

Технологический процесс получения комбинированного металлофторопластового ленточного материала и подшипников скольжения из него, способных работать без смазки в широком диапазоне температур.

МЕЖДУНАРОДНОЕ СОТРУДНИЧЕСТВО

По инициативе **ИМАШ** представителями и специалистами научных, промышленных и общественных организаций ряда стран образован *Международный институт безопасности*, который объединяет и координирует деятельность ученых по формированию общей теории и концепции безопасности технических систем, методов и средств обеспечения безопасности наиболее потенциально опасных объектов и производств, внедрению и использованию безопасных технологий.

Институт принимает участие в работе технических комитетов международных организаций (ISO, IUTAMM, IFTOMM).

Tribology

Theoretical fundamentals of designing friction units with different kinds of libricants, study of contact interaction at active physicochemical process.

Methods of friction units efficiency calculation at design stage.

New highly-efficient friction and antifriction materials and coatings. Materials for work in extreme vacuum, at very high and low temperatures.

Newly developed methods of designing bearings working surfaces with a gas lubricant.

Theoretical and experimental research of quick-acting friction processes.

A database on *tribological trials methods and accelerated assessment of friction and antifriction characteristics of materials.*

Effect of detergents on friction properties of carbon-carbon composite materials.

Vacuum ion-plasma technologies of application of wear-resistant coatings from refractory compounds.

A unique composition of cermet coating and laser technology for its application on a friction surface increasing its service-life 20-30 times.

Technology for production by ion etching method of regular contoured microrelief on a friction's surface ensuring a significant increase in the solid lubricant coatings service-life.

A technological process for obtaining combined metal-fluor-plastic ribbon material and rolling bearings from it capable of working without a lubricant within a wide temperature range.

INTERNATIONAL COLLABORATION

At the **IMASH** initiative representatives and specialists of scientific, industrial and public organizations of a number of countries have set up an *International safety institute* uniting scientists and coordinating their activity in formulation of comprehensive theory and concept of technical systems safety, in development of ways and means of ensuring safety of specific, potentially the most hazardous, objects and manufactures, in implementation and application of safe technologies.

The Institute participates in work of technical committees of international organizations (ISO, IUTAMM, IFTOMM).

ИМАШ готов к широкому сотрудничеству в различных отраслях технических знаний — *IMASH is ready for wide-scale collaboration in different areas of technical knowledge*

附件三：NPO MOLINYA 集團簡介

NPO MOLNIYA WILL REMAIN THE AUTHOR OF BURAN ORBITER FOREVER AND FOR ALL

Whatever improved space vehicles NPO MOLNIYA will develop in future all of them will only be members of the same family in which the BURAN orbiter will remain the ancestor. It includes multi-purpose aerospace systems and NPO MOLNIYA working them out has gained vast knowledge and potential. NPO MOLNIYA is a unique research and industrial corporation developing aerospace programs in Russia.

NPO MOLNIYA is creating a number of triplane scheme aircraft - the background experience in developing the BURAN orbiter will guarantee their high reliability.

BURAN and MOLNIYA are our symbols of quality.

General Director *A.Bashilov*

General Designer
G. E. Lozino-Lozinsky

NPO MOLNIYA Research and Industrial Corporation was founded to create the first Russian manned reusable spacecraft in 1976. While the space transportation increased the development of such space vehicles that could considerably reduce the cost of space launch became of great necessity. The time when any price for a payload delivery to an orbit was paid has been over, specialists in rocket production throughout the world began to count money and their customers could not reconcile that superexpensive electronic systems and rocket engines were annihilated in result of the only launch. The development of reusable systems to put into an orbit was a logical step of technical engineering progress and in the seventies the USA and the USSR got down to development of the SPACE SHUTTLE systems. In the Soviet Union it was called the BURAN orbiter.

The head of a new firm G. E. Lozino-Lozinsky earlier worked at SPIRAL reusable aerospace system which dates back to the sixties.

NPO MOLNIYA was founded on the basis of two design bureaus: BUREVESTNIK (Chief Designer A. V. Potopalov) that had experience in the creation of heavy supersonic aircraft and anti-aircraft missiles and MOLNIYA (Chief Designer M. R. Bisnovat) which developed unmanned flight vehicles and an Experimental Machine-Building Plant (General Designer V. M. Myasischev) where heavy and high altitude aircraft were designed and tested.

A. V. Potopalov

M. R. Bisnovat

V. M. Myasischev

The main team for the BURAN orbiter designing came together with G. E. Lozino-Lozinsky from the design bureau ZENIT headed by A. I. Mikoyan and more than a hundred engineers from RADUGA (Dubna), those who had been working on the SPIRAL project there. Specialists from SALUT, ENERGIYA, TSNIIMASH and other rocket and aviation firms have been invited. The high standards of knowledge and intelligence of its staff is proved by the fact that more than 250 doctors and candidates of science worked there.

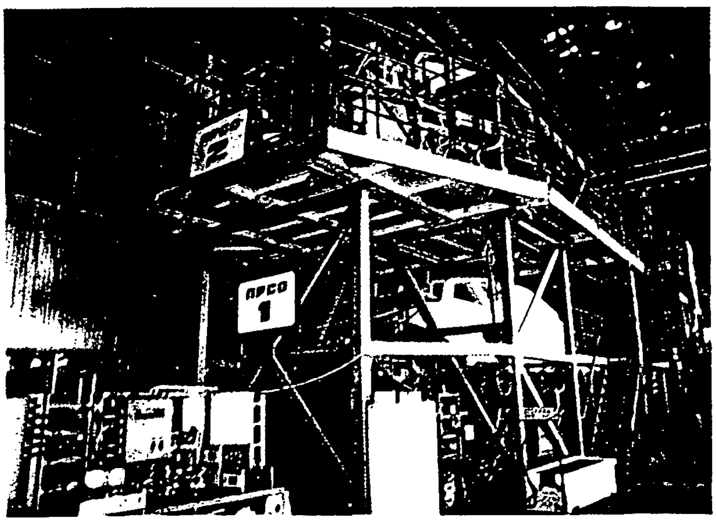
NPO MOLNIYA laboratories

Home industry has never made anything similar to the BURAN orbiter before. It was necessary to begin everything from the zero level without any previous attempts and experience in this field. Special features of the orbital vehicle - vast speed and altitude range not mastered by aviation by that time, intensive surface warming up when a spacecraft is entering dense layers of atmosphere, simultaneous exposition to vacuum, radiation and other factors of space and unusual automatic pilotless landing requirements - demanded a special approach even to such usual things, as flight tests.

The aviation practice allows identifying design and board equipment shortcomings in a manned flight supposing further bringing to perfection on land, but it is quite impermissible for an excessively expensive vehicle that with the minor defects has no possibility to return to the airfield. To exclude the risk the assembled vehicle and all its units, each taken separately, should be examined before the flight in conditions exactly imitating the real ones: beginning from mechanical, thermal or acoustic loads and including the effect of solar and other radiation. In NPO MOLNIYA the unique laboratory-stand base was created, flying laboratories were equipped, orbital flying models were designed and launched, and finally a full-scale prototype of the BURAN orbiter intended for modes of descending and landing working up was lifted into the air for this purpose.

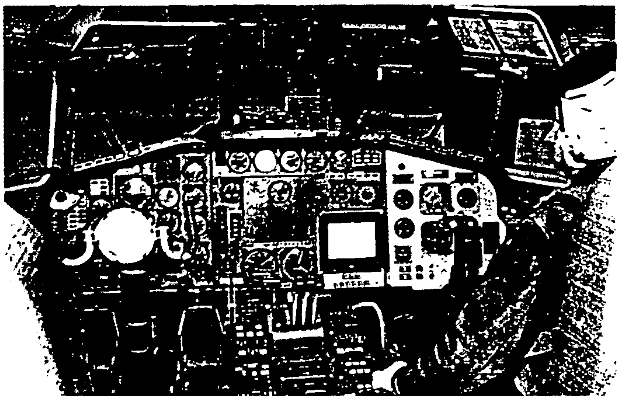
The main stands and laboratories included in field experimental base of NPO MOLNIYA are:

PRSO - a full-scale hardware stand allowing to produce a half-scale flight modeling on the stage of descend and landing in real time scale with imitation of hinge moments effecting on drives; the stand is a vehicle frame with installed real units and systems, it is intended for examining their interaction and for software working up.

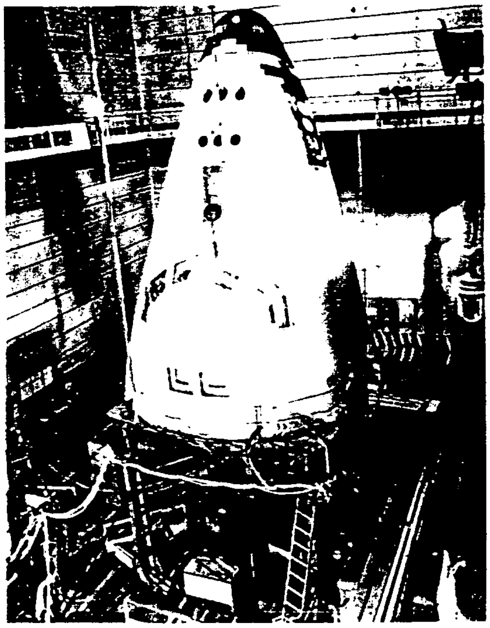


PRSO - full-scale hardware stand

PDST - a pilotage dynamic training simulator intended for a crew to work up skills of orbital flight control as well as in normal flight conditions and during abnormal situations. The simulator structure consists of a crew cabin control compartment mounted on a platform with six degrees of freedom. The board systems of the vehicle are presented by their mathematical models.



TU-154F crew cabin



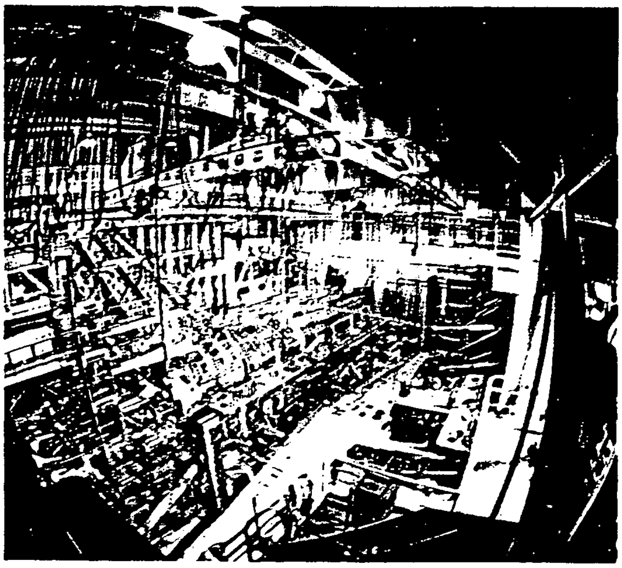
Dynamic load tests stand

PSS - a pilotage static stand intended for a crew training, for flight trajectory refining during the vehicle descent.

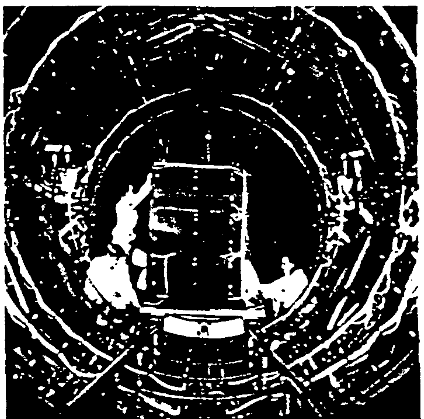
KSSH - a complex landing gear stand intended for landing gear function inspection and refining.

A static structural tests laboratory intended for producing static, structural and endurance tests of the vehicle frame within a wide temperature range and for tests of its mechanical systems under flight loads.

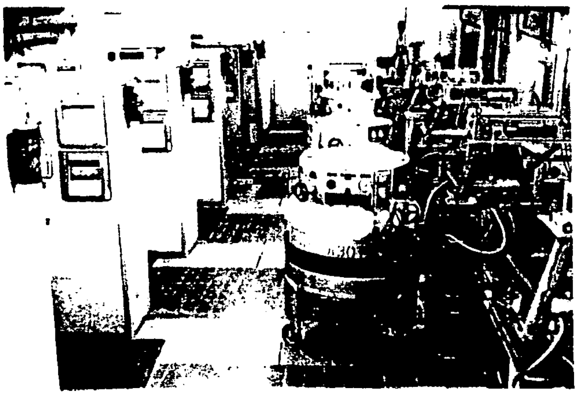
Dynamic load tests laboratory intended for tests of separate fuselage sections weighting up to 30 tons at dynamic loads at frequency up to 2000 Hz.



Static tests of BURAN orbiter



Cryo-thermo-vacuum complex

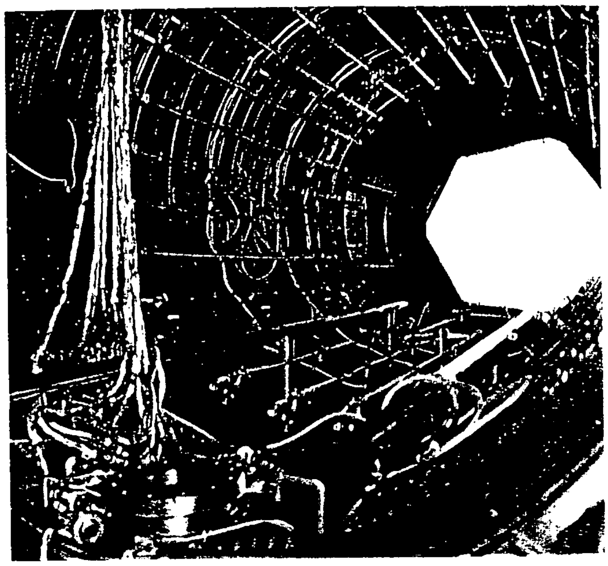


Tribological complex laboratory

A tribological complex for working up friction junctions of an orbital vehicle in the conditions of a space flight and for endurance tests, as well as for research of properties of antifriction materials, covers, lubricants.

The laboratory for vibro-acoustic and thermo-vacuum tests, hall of antenna-feeder devices and other things.

About 200 inventions were used only during the construction of the stands.



Sun radiation simulator

Cooperation of leading scientific and research institutes and manufactures was of great importance, but the main burden of field tests maintenance fell on the NPO MOLNIYA Experimental plant. Numerous BURAN orbiter models for wind tunnel test and full size construction components for other tests were manufactured here. The production of some regular units, first of all - an auxiliary power unit designed at NPO MOLNIYA was organized.

For the BURAN orbiter landing after the orbital flight at Baikonur space vehicle launching site there was built a landing complex with a 4500 x 84 m runway equipped with advanced navigation and radio-technical systems and capable to support the whole cycle of orbital vehicle after-flight maintenance. The landing complex can be used for aircraft of all kinds which is confirmed by landings of a heavy aircraft-carrier with an orbital vehicle or a rocket stage on it.

Simultaneously Zukovsky flight test centre runway was extended.

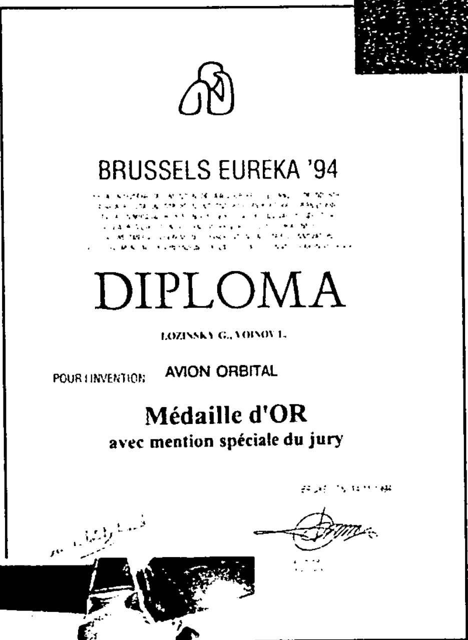
Research and industrial base of our corporation and the experience gained by the personnel in the course of BURAN orbiter designing and tests allow NPO MOLNIYA to continue the development of new space systems and to participate in any complex conversion programs.

SPIRAL

SPIRAL is the project opening the history of aerospace systems creation. The work at the project began in A. Mikoyan Bureau 4 years after Gagarin's space flight.

The SPIRAL reusable aerospace system (AKS) consisted of an orbital manned aircraft with a rocket booster and supersonic aircraft-carrier. The start of the orbital stage should occur at the altitude of 24-30 km at the speed of six times higher than sound speed. After flight completion a gliding descent in atmosphere with the aeroplane landing at an airfield was provided. For more precise landing approach a turbojet engine could be used.

With the whole system take-off weight of 115 tons a one-seat orbital aircraft had weight of 10 tons and was intended for scientific and technical experiments in space, remote Earth monitoring and space objects inspection. It was a vehicle with a load-bearing frame and wings tilting upward to exclude the direct effect of thermal flow in conditions of plasma formation as well as for roll control.

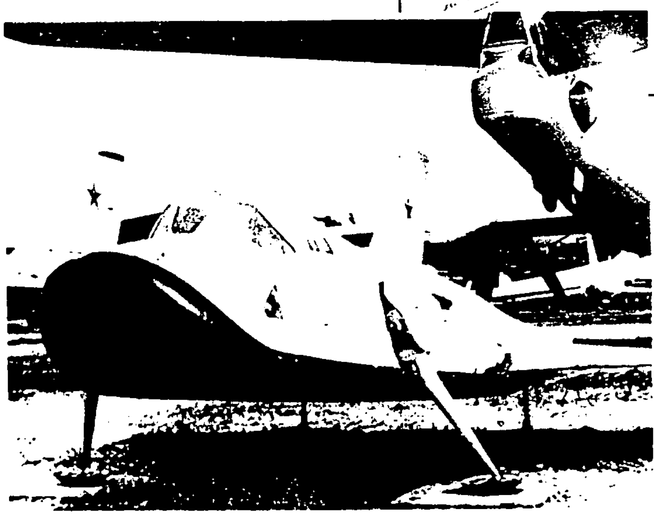


BRUSSELS EUREKA '94

DIPLOMA

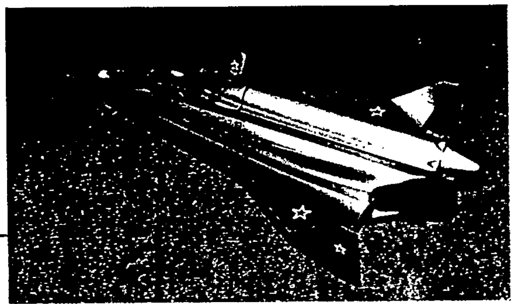
POUR L'INVENTION AVION ORBITAL

Médaille d'OR
avec mention spéciale du jury



Prototype of AKS SPIRAL orbital vehicle

The development of the hypersonic aircraft-carrier that had no analogues in the world required a considerable time and consequently during the tests and at the first phase of operation the orbital vehicle was supposed to be launched into space by a ballistic rocket.

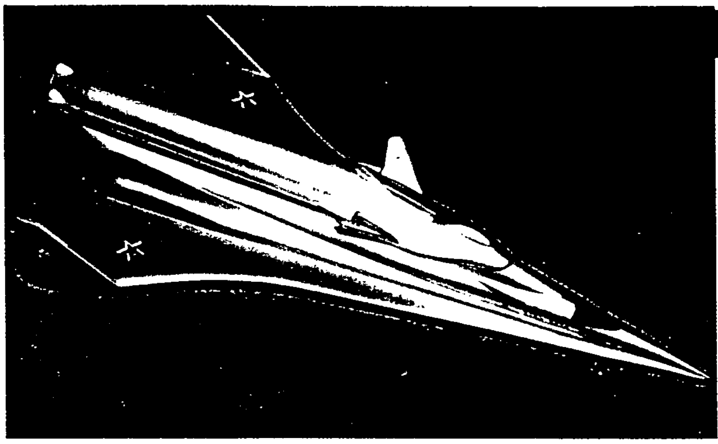


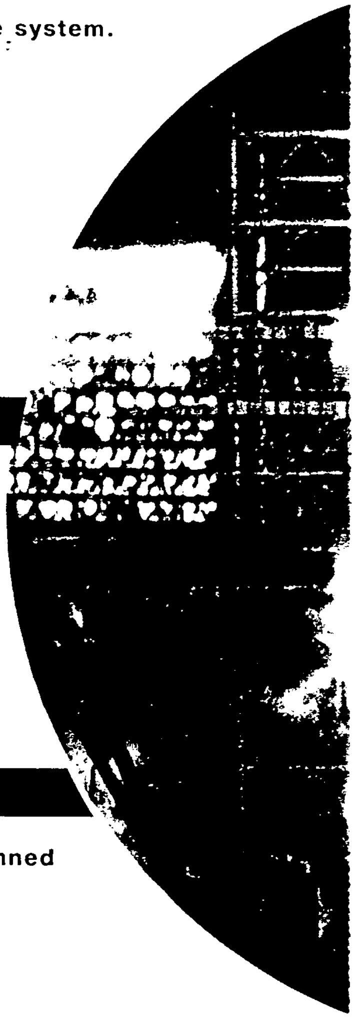
AKS SPIRAL model

For landing approach and landing working up as well as for stability, controllability and aerodynamic characteristics estimation the manned subsonic analogue of the orbital vehicle – "aircraft 105" – was build. In 1977 and 1978 it made 6 test flights with gliding on runway after being dropped from the Tu-95 bomber at the altitude of 5500 m.

Despite of NPO MOLNIYA suggestion to use the SPIRAL orbital vehicle scheme for ENERGIYA-BURAN system the leading system developer ENERGIYA insisted on the use of the configuration close to the USA Space Shuttle. Nevertheless, the experience of working at the SPIRAL system has considerably facilitated and speed up the BURAN orbiter creation and the technical ideas incorporated on the basis of the SPIRAL project have afterwards received their progress in a new aerospace system.

FROM SPIRAL TO MAKS





1965

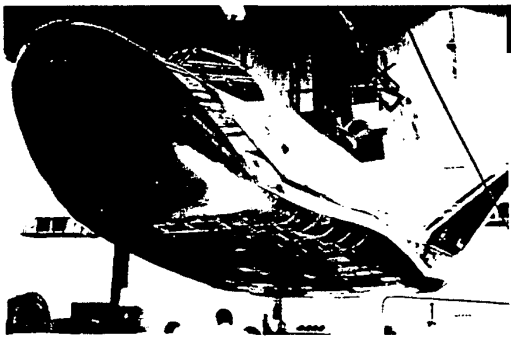
SPIRAL aerospace system.

Project.

1977-1978

Manned prototype of SPIRAL orbital vehicle.

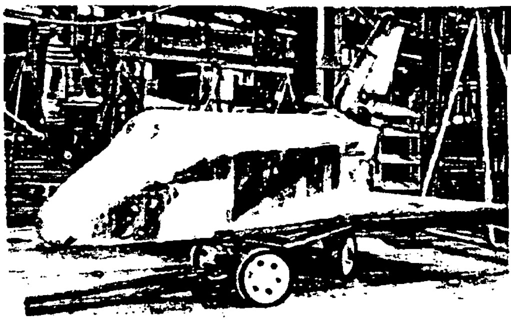
Flight tests.



1982-1984

BOR-4 orbital experimental unmanned flight vehicle.

Four test flights.



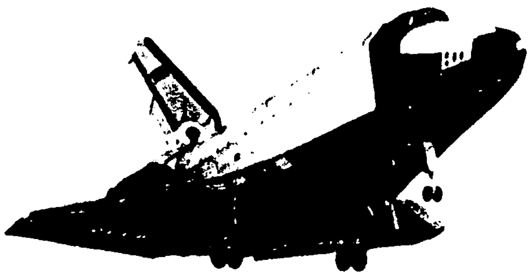
1984-1988

BOR-5 suborbital experimental unmanned flight vehicle.

Five test flights.

1985-1988

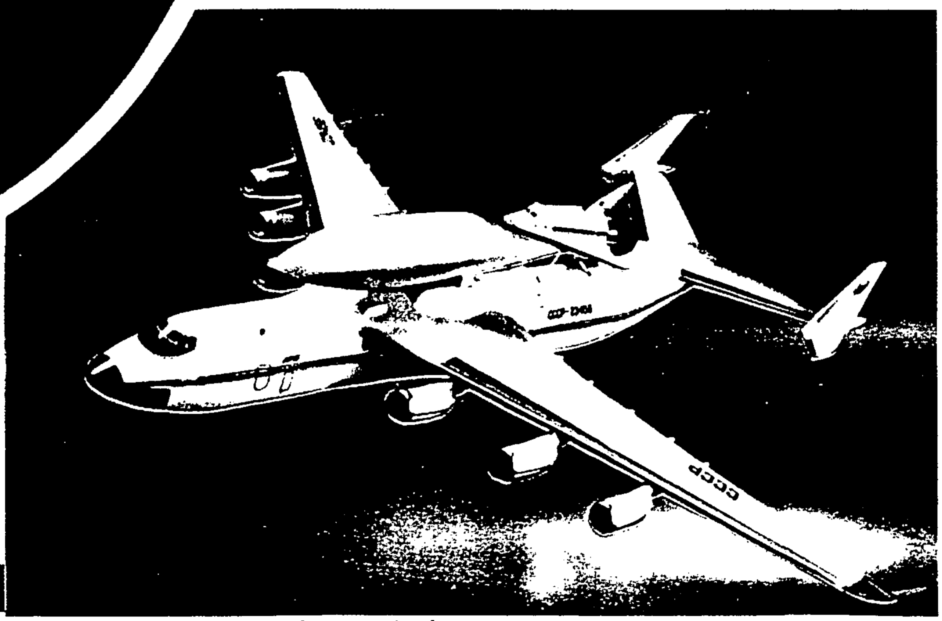
Manned prototype of BURAN orbiter.
Twenty four test flights.



1988

ENERGIYA-BURAN reusable space transport system.

Flight 15.11.88.



Multipurpose aerospace system (MAKS). Development phase.

BOR EXPERIMENTAL SPACE VEHICLES

n the course of the BURAN orbiter development, ;uborbital and orbital launches of BOR-4 and 3OR-5 flight vehicles have been produced for ıerodynamic analysis and working capacity of ·hermal protection structures verification.

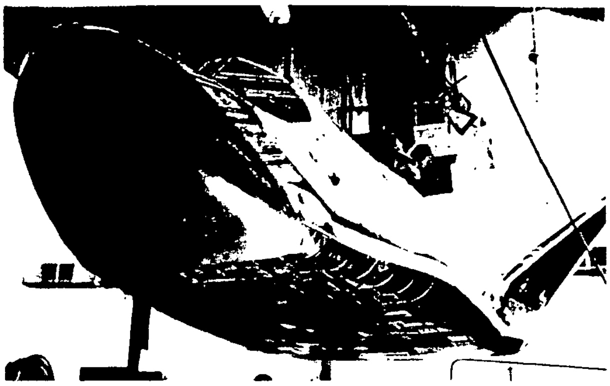
The BOR-4 flight vehicle is the scaled (1:2) copy of 'he SPIRAL. It has a tilting wing as well as the SPIRAL. During works at the SPIRAL system the 3OR-4 wasn't launched, but it was decided to use 'he BOR-4 for the BURAN orbiter thermal protection 'ests. The real construction components - flexible 'hermal protection, quartz fibrous tiles and fuselage nose cap made of "carbon-carbon" material - have been installed on it. The BOR-4 vehicle, 1,5 tons by weight, was put into the orbit of 225 km by 65M-RB5 ballistic rocket and after doing one circle around the Earth descended along a trajectory close to the BURAN trajectory.

The BOR-4 flight vehicle was totally launched 5 times: one suborbital launch for the whole complex examination, and 4 orbital launches, specified as:

COSMOS -1374 .... June, 4, 1982
COSMOS -1445 .... March, 16, 1983
COSMOS -1517 .... December, 27, 1983
COSMOS -1616 .... December, 19, 1984

In the first two launches the vehicles splashed down into the Indian Ocean about 900 km to the west of Australia, in the following two - into the Black Sea to the west of the Crimea peninsula. They failed to find one of the vehicles splashed down into the Black Sea, the others were raised on board by our military ships.

The BOR-4 flight vehicle essentially differed from that of the BURAN orbiter aerodynamic scheme and could not be used for aerodynamic researches. Thus the geometrically scaled (1:8) BURAN model was manufactured. It was specified as BOR-5.



BOR-4

BOR-4 after splashing down into the Indian Ocean

The main aerodynamic characteristics, thermal and acoustic loads were determined, stability was evaluated on this model. The BOR-5 flight vehicle was put into suborbit by K65M-RB5 rocket launched from Kapustniy Yar toward the lake of Balhash.

Five flying model launches were produced:

model 501 .... July, 6, 1984
model 502 .... April, 17, 1985
model 503 .... December, 27, 1986
model 504 .... August, 27, 1987
model 505 .... June, 27, 1988

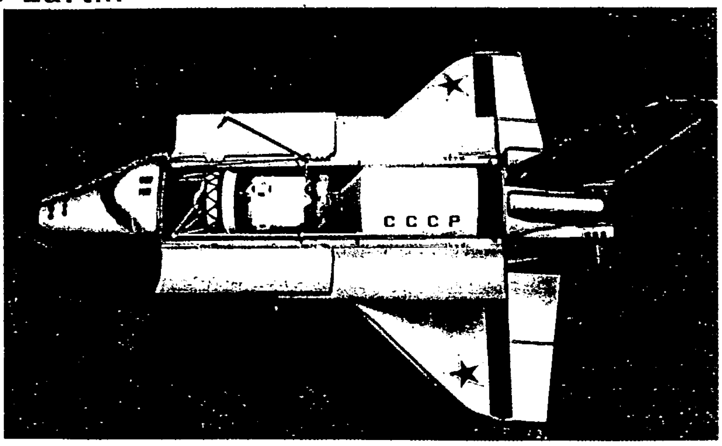
The flights of the SPIRAL prototype and BOR-4 and BOR-5 flying vehicles have allowed not only to speed up the BURAN orbiter development, but also to justify the choice of the aerodynamic scheme of the orbital stage of the advanced MAKS aerospace system.

BURAN ORBITER

The BURAN orbiter is the first reusable manned space vehicle in our country. The BURAN is our first vehicle capable not only to put payloads into Space, but also to provide their orbit maintenance and repair as well as return to the Earth.

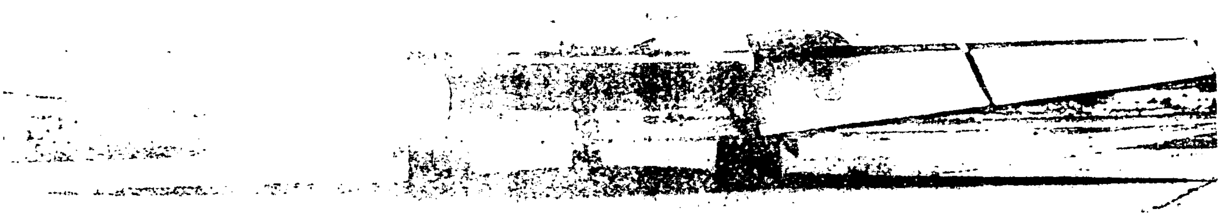
The BURAN predecessors could execute only separate roles: VOSTOK and SOYUS vehicles were intended only for crew flights, PROGRESS - for cargo delivery onto the orbital station. Put into the orbit by a rocket carrier of the average size they had modest transport potentials. Whereas the cargo flow on the Earth-orbit line increased and the development of a reusable vehicles of large carrying capacity has become inevitable.

The BURAN orbiter is able to put up to 30 tons into Space and to return up to 20 tons of payload to the Earth.

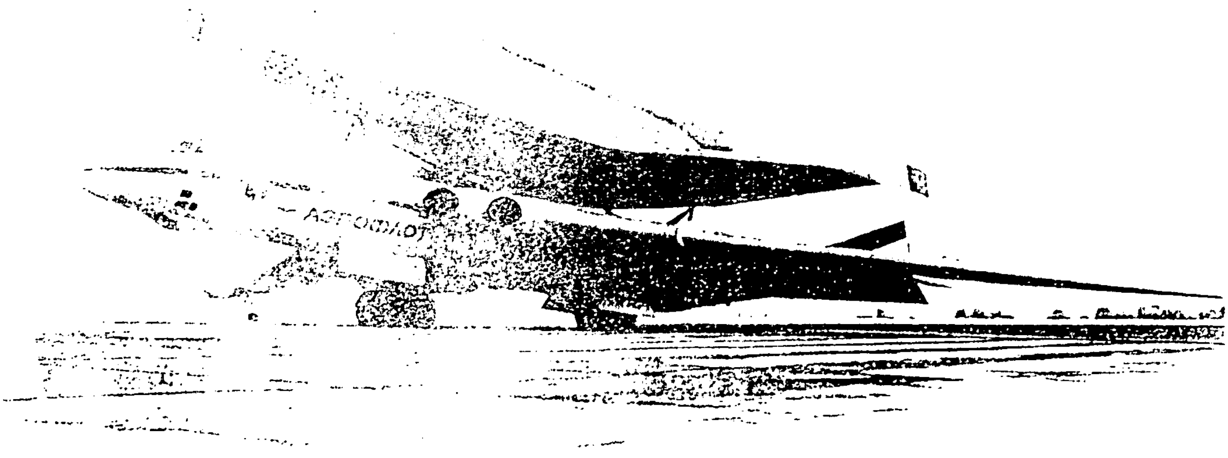


The availability of a cargo compartment of impressive sizes on the vehicle permits to transport orbital station modules or large structures up to 17 m long and 4,5 m in diameter and not only 2-4 crew members but up to 6 passengers can be accommodated in a crew cabin.

BURAN in mounting-test building of Baikonur space vehicle launching site



BURAN analogue (rear view)

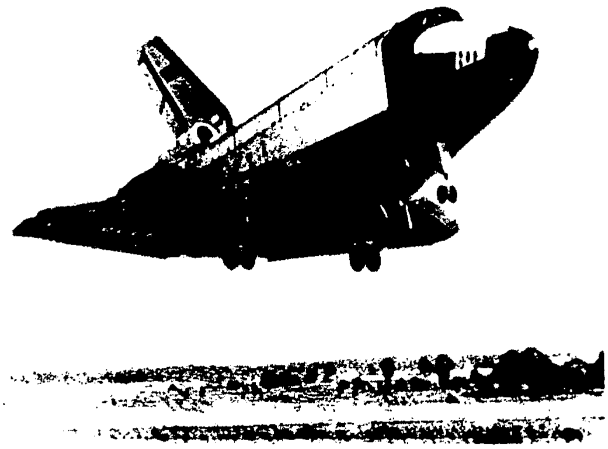


BURAN (transportation version) on 3M-T aircraft-carrier top

Expendable space vehicles perform a ballistic descent in the atmosphere and parachute landing. The necessity to provide a space vehicle return from the Space and to bring it to the airdrome forced the designers to decide many complex problems.

The gliding descent from the orbit through dense layers of atmosphere has stipulated the necessity to use a principally new reusable thermal protection system designed to sustain 100 flights. For the BURAN orbiter three kinds of thermal protection have been developed: "carbon-carbon" material with maximum operating temperature up to 1650 °C for the components with the highest thermal load – the fuselage nose and wing leading edge, ceramic tiles for parts heating up to 1250 °C, flexible material for surface parts with the temperature not higher than 379 °C. All of them surpassed by strength the materials used in the USA Space Shuttle construction.

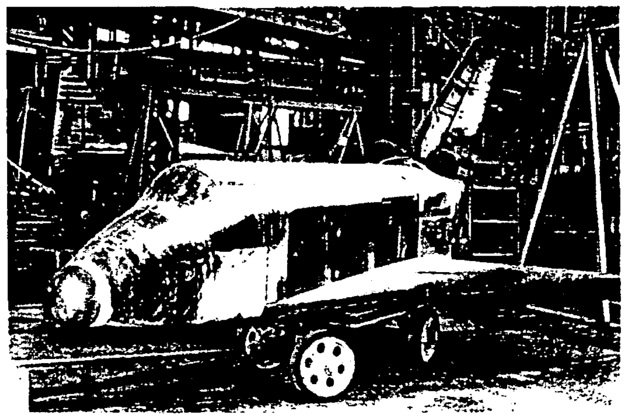
Each of almost forty thousand tiles of ceramic thermal protection had its original geometry differing from the others by planeform, side surfaces view and inside and outside surfaces curvature, availability of cuts and notches.



BURAN analogue over the airfield in Zhukovsky

The measurements of a real frame surface geometry under each tile in more than 100 points were made to ensure the tiles fitting closely. To execute all this manually was impossible. The special software was developed and as a result form building, manufacturing and installation of tiles were carried out completely on paperless technology without drawings and templates, using the bank data.

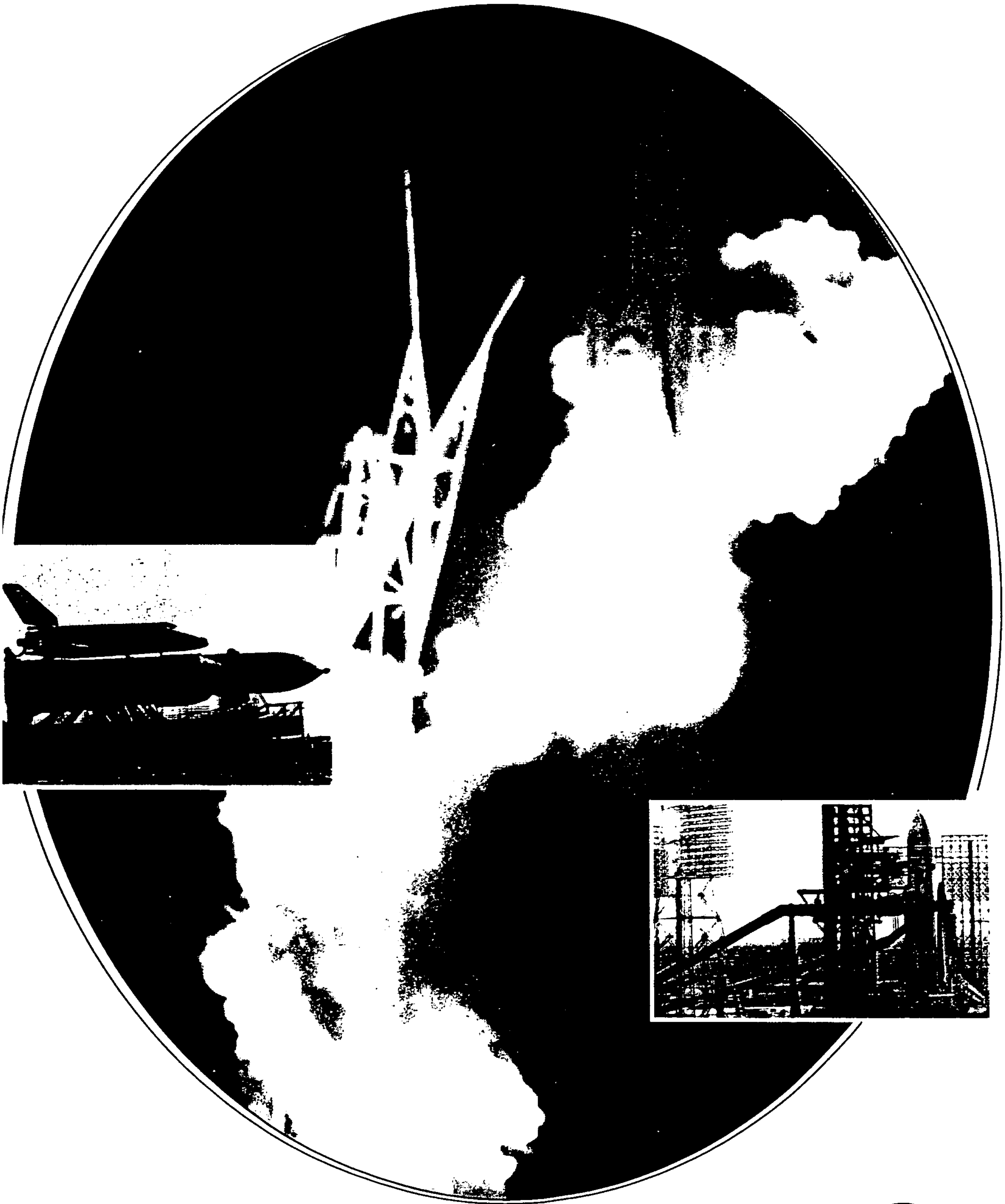
The BURAN descending from a space orbit passes all possible for an airplane flight performances in the atmosphere starting with large hypersonic (M=25) up to landing (M=0,2) speeds. In this connection the aerodynamic scheme without a horizontal tail, with a double swept wing, with elevons, rudder-aerodynamic brake and balance flap as control surfaces has been chosen . This assembly has been worked up during wind tunnel tests and evaluated in the BOR-5 suborbital flying model flights.



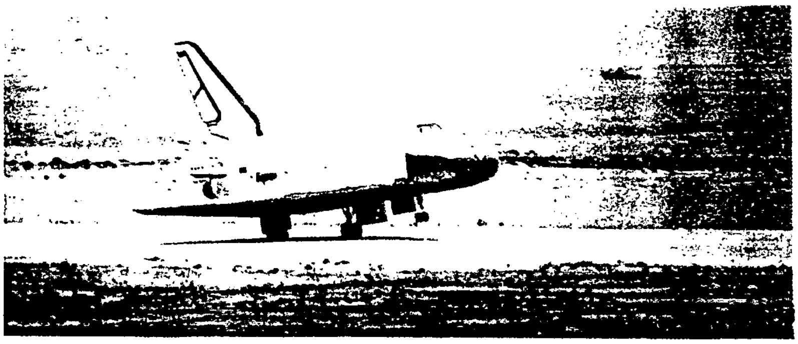
BOR-5

For working up the most responsible flight phase - landing approach and landing - the BURAN flying prototype was constructed. In general it distinguished from the orbital vehicle by installation of four turbojet engines and accordingly by capability of an independent takeoff from the airfield. 24 flights were executed on the prototype, in 15 of them completely automatic mode landing was made.

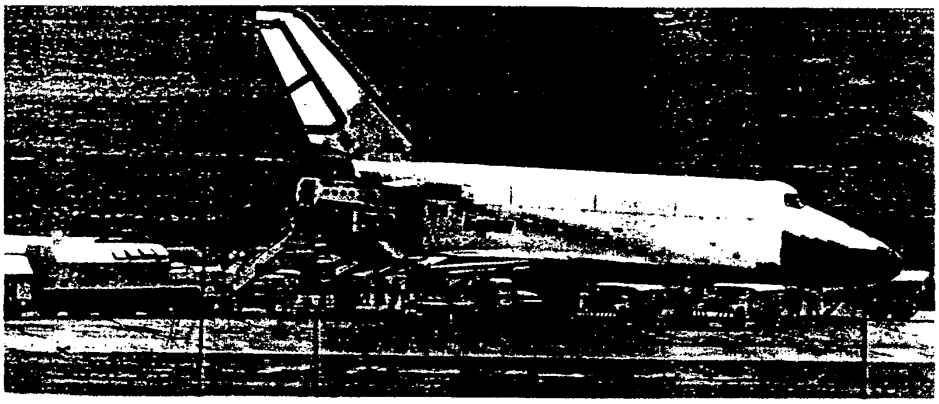
Results of intensive work were summed up by the BURAN orbiter first flight into Space on November, 15, 1988.



There was no pilot onboard the orbiter but it having made two turns around the Earth completely automatically controlled touched the runway with the accuracy which experienced pilots could envy. It was the first in the world automatic landing of a spaceplane. The SPACE SHUTTLE defaults it so far.

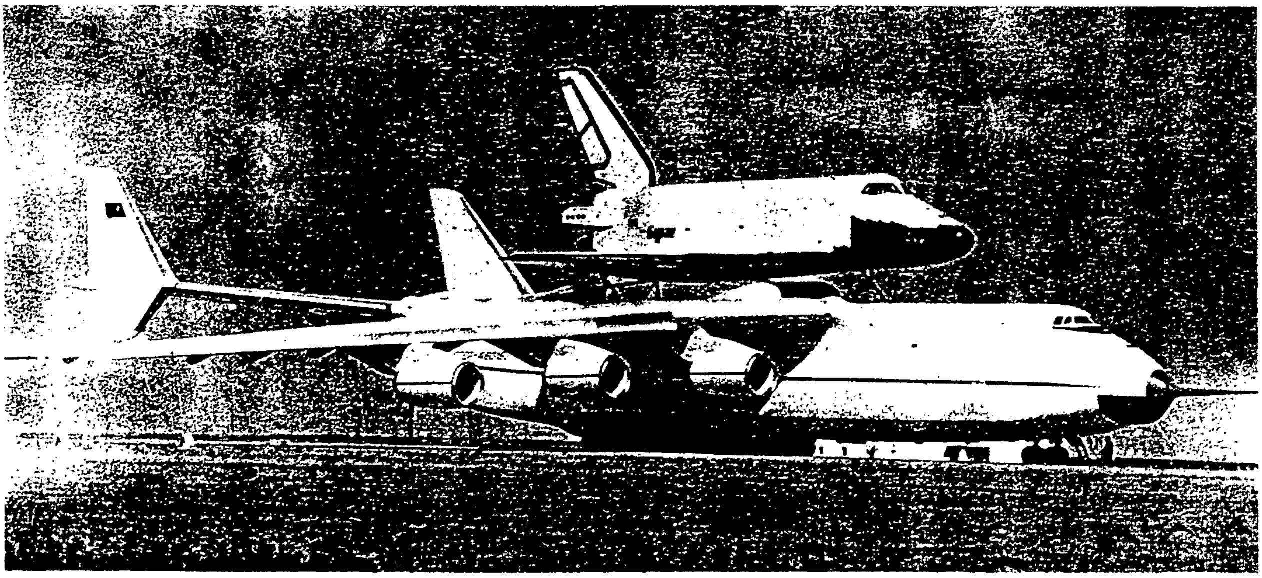


Touchdown is !



After landing

The BURAN orbiter flight was a necessary step in the space engineering progress but it has left its trace not only in this field. Born in the course of work on the BURAN project new materials, technologies, computer designing methods and equipment components find an application in far, at first sight, from Space branches of economy.



Before the flight to Le Bourget. July 1989.

РОССИЙСКОЕ КОСМИЧЕСКОЕ АГЕНТСТВО

I Февраля 1996г.

ЛИЦЕНЗИЯ

№ 205

на право деятельности по исследованию и использованию космического пространства и по предоставлению космических услуг

Заявитель Акционерное общество открытого типа "НПО Молния"
123459, г. Москва, ул. Новопоселковая, д. 6, телефон 493-5053
(наименование юридического лица, организационно-правовая форма, предпринимателя, адрес, телефон)

Разрешенный [illegible] вид космической деятельности Создание (включая изготовление, испытания, запуск), эксплуатация многоразовых аэрокосмических транспортных систем и их составных частей в интересах Федеральной космической программы

Особые условия

Общие условия

1. Действие лицензии распространяется только на указанный в ней вид космической деятельности.
2. Владелец лицензии не имеет права продавать или перепродавать ее другому юридическому или физическому лицу.
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Срок действия лицензии: с I февраля 1996 года по 31 декабря 1998 года

[illegible] Генеральный директор РКА В. В. Алавердов

КА № 243

AKS multipurpose aerospace system has a 'mber of fundamental advantages. In the first place is a capability of putting payloads into any :lination orbits, high operation efficiency and v operational cost and absence of necessity to enate areas under fields of fall of construction 'mponents.

ılike the rocket systems tied to few space vehicle ınching sites and limited in orbit choice, MAKS ay be used for emergency rescue of space object ews or for urgent aerial reconnaissance of regions technogene and natural extraordinary situations.

PO MOLNIYA began to realize the MAKS project in e 1980s before the BURAN orbiter first flight using e experience and results of work on the SPIRAL 'oject, the BOR experimental flight vehicles and the JRAN. Up to date the main components of the 'bital stage construction have been worked up, :ternal fuel tank mock-up has been made, gnificant work has been already done on the 'opulsion system.

MAKS consists of the subsonic carrier aircraft and an orbital stage with an external fuel tank mounted on it. As the first stage the An-225 MRIA aircraft originally intended for the BURAN transportation is used.

The second stage of the system has three modifications: MAKS-OS, MAKS-T and MAKS-M. The MAKS-OS second stage consists of a reusable orbital vehicle and an expendable fuel tank. The main propulsion engine includes two RD-701 engines using three-component fuel (liquid hydrogen, kerosene, and liquid oxygen). The base manned variant of the MAKS-OS vehicle has a two-seat crew cabin.

The MAKS versions for transport-technical provision are developed. TTO-1 version is equipped with a docking module and the second four-seat pressurized cabin. TTO-2 version is intended for delivery in an unpressurized equipment compartment mounted on the external side of orbital stations.

The MAKS-T modification with the expendable unmanned second stage is intended to put into orbit heavy (up to 18 tons) payloads. It uses the same external fuel tank, as in MAKS-OS, where the propulsion engine with payload closed by fairing is installed instead of the orbital vehicle.

The MAKS-M second stage is the reusable unmanned orbital vehicle. The MAKS-M fuel tanks are included in the vehicle construction.

MAKS-M - the development of which is connected with solving complex technological problems is regarded as possible further direction of MAKS concept when the first two modifications were fully developed.

As fast as MAKS-OS, -T and -M are created they should be incorporated into the joint operation on the basis of a common carrier aircraft and the ground infrastructure. Reusability of their components and the high degree of orbital stage unification provide achievement of the main aim for developers - drastical reduction of the transport space operation cost compared with the existing systems.

For decrease of technical risk of the full-scale MAKS creation and regular time distribution of financial expenditures the production of a comparatively inexpensive experimental technology demonstrator system was considered necessary.

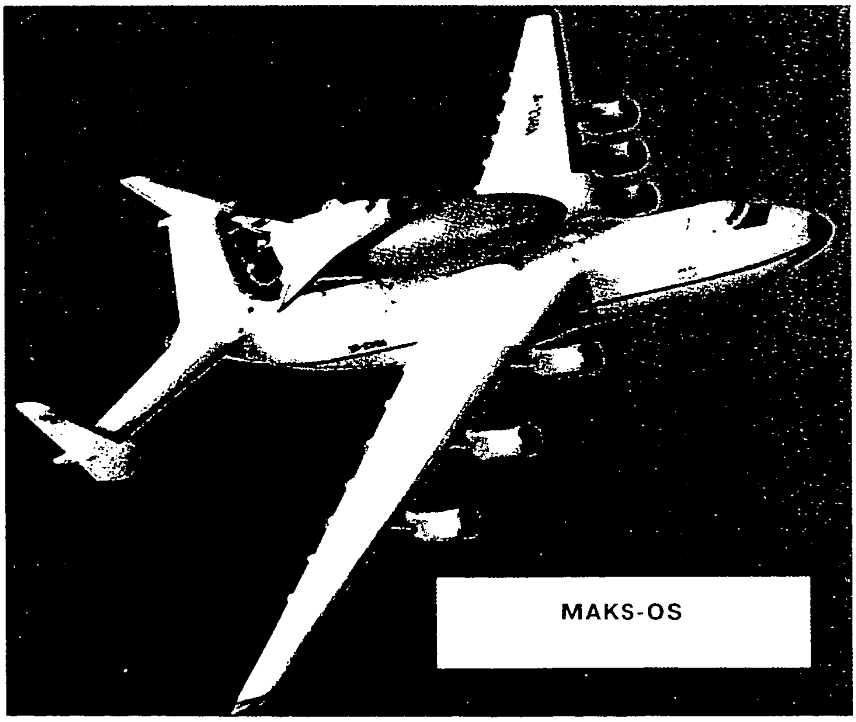
Researches on the first demonstrator version (RADEM) were carried out by NPO MOLNIYA together with British Aerospace, ANTK Antonov and TCAGI under sponsorship of the European Space Agency (ESA) in 1993-94.

The up-to-date version of the MAKS-D demonstrator was also developed using what was already done on the RADEM and on the basis of the MAKS-OS construction and aerodynamic configuration. The experimental vehicle takeoff weight - 62,3 tons, landing weight - 12,8 tons. Unlike RADEM, the MAKS-D suborbital vehicle propulsion engine consists of only one oxygen-kerosene engine that not only simplifies the project, but also increases the demonstrator power capability at the given tank volumes. Wide unification of MAKS-D and MAKS-OS vehicles onboard systems is stipulated.

With the aid of the demonstrator the technologies and components of the MAKS launch system will be worked up and the carrier prestart manoeuvre, stages separation, an initial phase of launch and the orbital stage automatic landing will be researched in real conditions. Besides it may be used as a flying laboratory for advanced air-breathing engine tests.

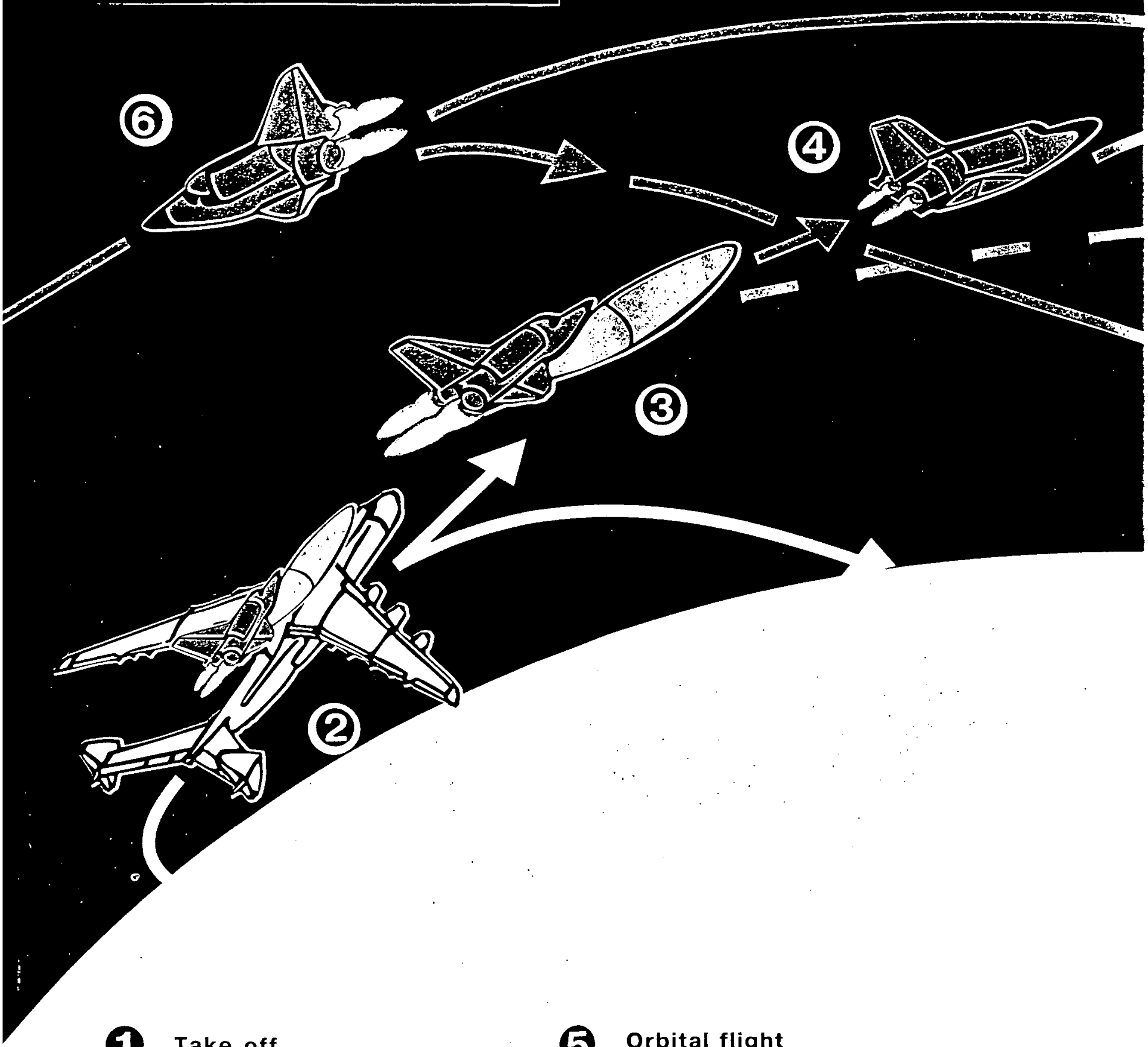
The accepted MAKS-D concept stipulates a possibility to use it for putting into orbit of small payloads. For this purpose the system is supplemented by a rocket stage.

Reusable aerospace systems are developed now in many countries; however, in opinion of a number of foreign experts Russia has advanced on this way farther than its competitors. The possession of such system as MAKS would help Russia to take firm position in the space service market at the beginning of the new century.

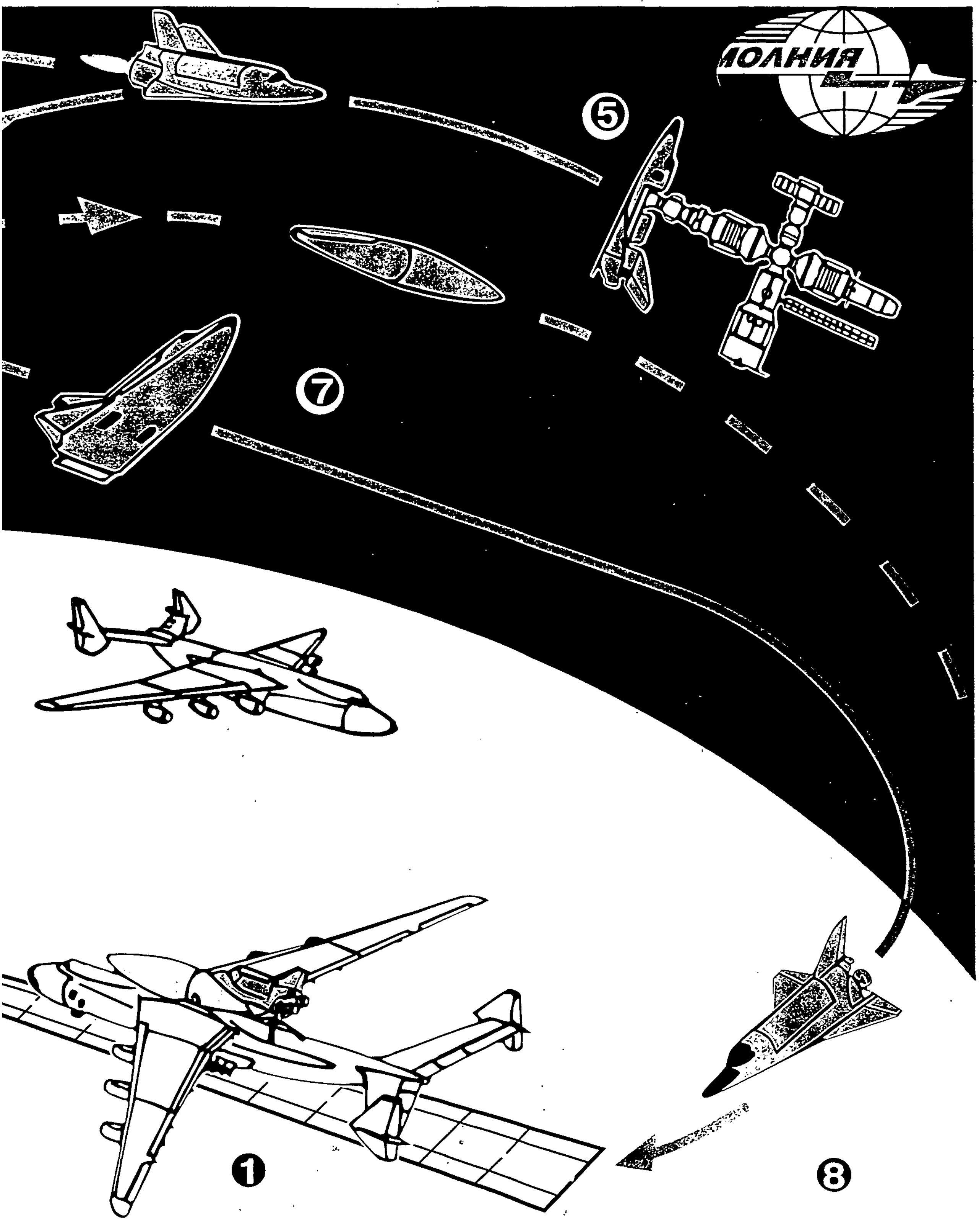


MAKS-OS

MAIN MAKS FLIGHT PHASES



1. Take off
2. Separation of 2-nd stage from carrier-aircraft
3. Second stage flight along the putting trajectory
4. Separation of orbital vehicle from fuel tank
5. Orbital flight
6. Deceleration for return from orbit
7. Flight along the descent trajectory
8. Orbiter landing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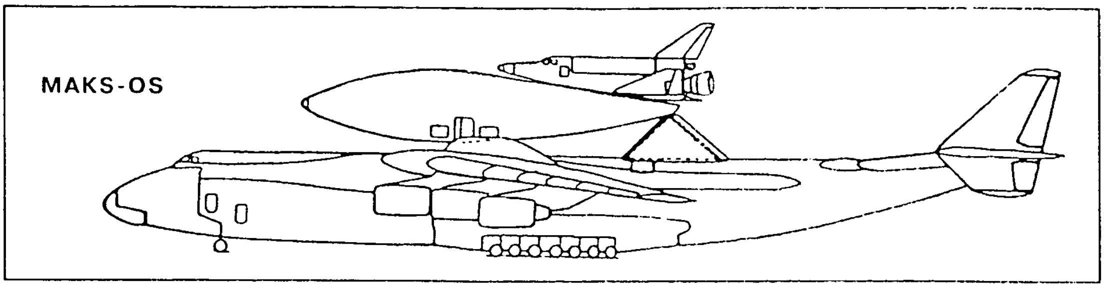
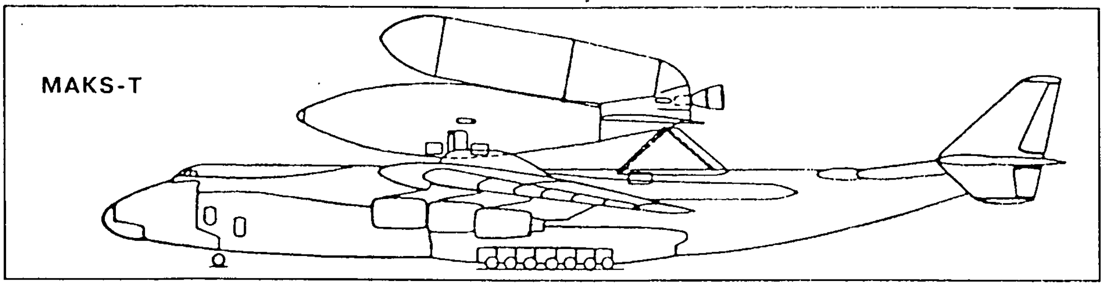
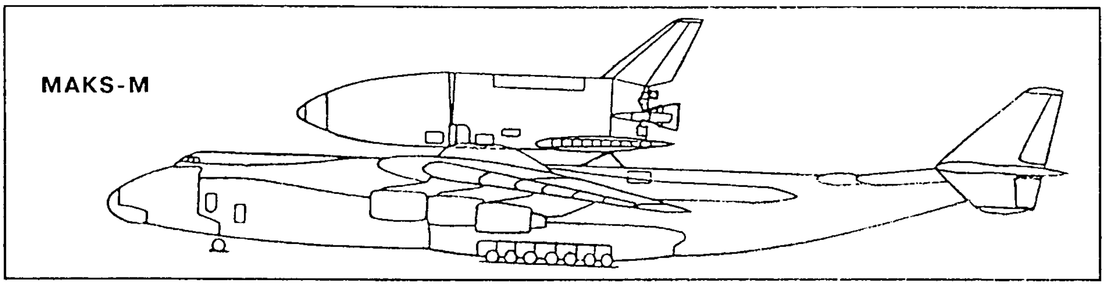




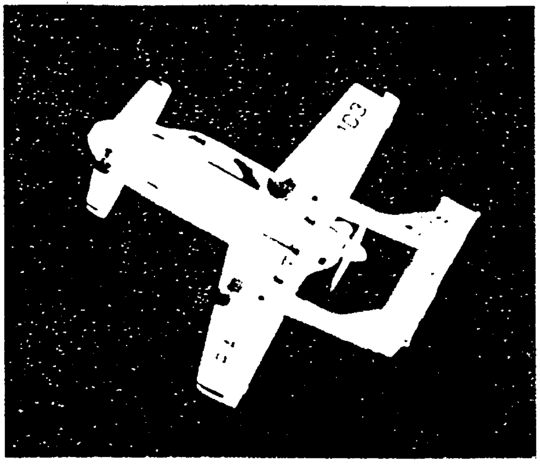


Main characteristics of the MAKS modifications

	MAKS-OS	MAKS-T	MAKS-M
Take-off mass, tons	620	620	620
Second stage mass, tons	275	275	275
Orbital vehicle mass, tons	27		
Orbital vehicle crew	2		
Payload compartment dimensions:			
length, m	6,8 (8,7)	13	7
diameter, m	2,6 (3,0)	5	4,6
Mass of payload (tons) put into orbit H=200 km with inclination angle:			
I = 51°	8,3 (9,5)	18	5,5
I = 0°		19,5	7,0
geostationary orbit		up to 5	

MOLNIYA TRIPLANE AIRCRAFT

At present NPO MOLNIYA is working not only in the space field but also on aircraft engineering. A series of civil aircraft with carrying capacity from 500 KGs up to 5 tons is being designed here. To appear on the world market of such engineering, where extremely rigid competition exists, is possible only with the products appreciably distinguished from the similar ones by their characteristics. Considering this NPO MOLNIYA has chosen a "triplane" aerodynamic scheme stipulating in comparison with traditional schemes the essential increase of flying safety and fuel economy of its aircraft.



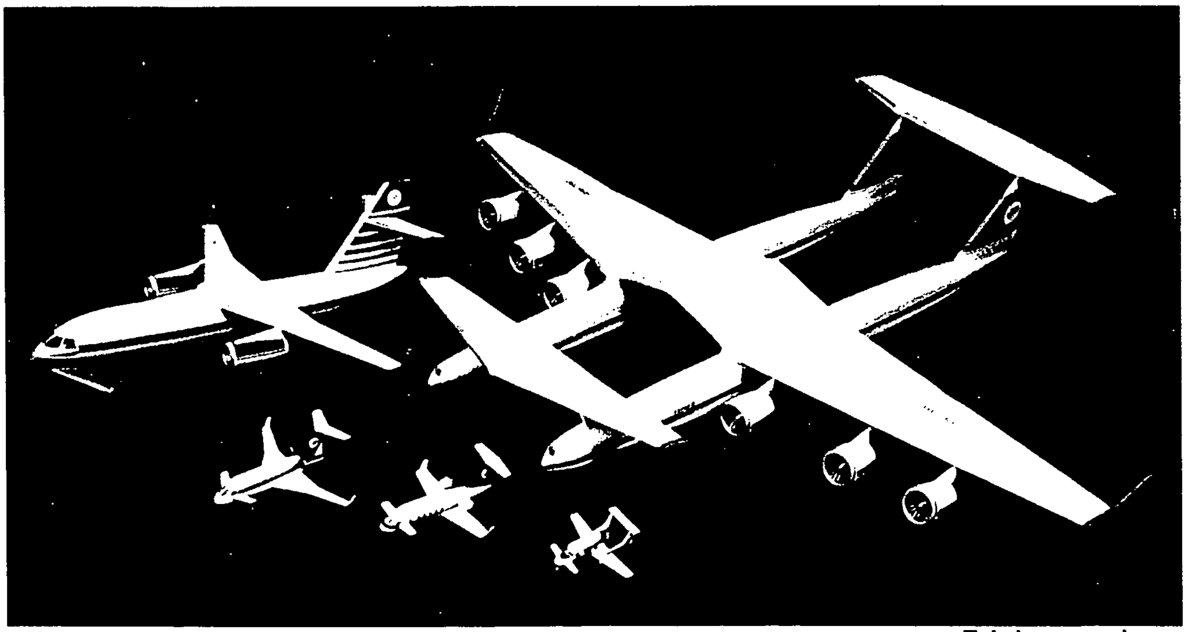
The first of triplane series MOLNIYA-1 in flight

The triplanes have advantages of canard and classical schemes, but are free from their faults. The use of all three planes carrying properties reduces loads on the construction providing significant (up to 20%) reduction of the aircraft weight and dimensions and therefore the reduction of fuel consumption and the whole vehicle cost. Besides the triplanes have the following advantages:

- the increased level of flying safety because at a high angle of attack a flow separation occurs on the foreplane prior to that on the main wing, that practically excludes the stall into a spin;

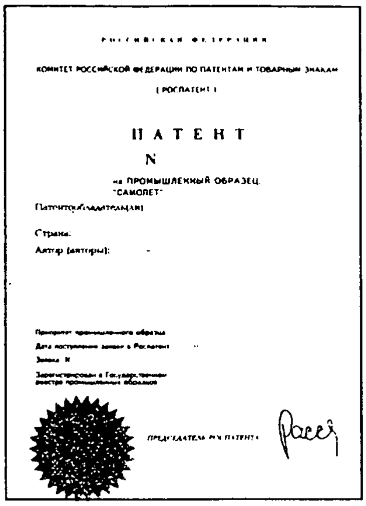
- the simplicity and easiness of the aircraft pilotage because of small loads on controls;

- the high lift-drag ratio in cruise flying mode and the improvement of take-off-landing performance stipulated by the reduction of aerodynamic balancing losses.



Triplane series

MOLNIYA-1


КОМИТЕТ РОССИЙСКОЙ ФЕДЕРАЦИИ ПО ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

(РОСПАТЕНТ)

ПАТЕНТ

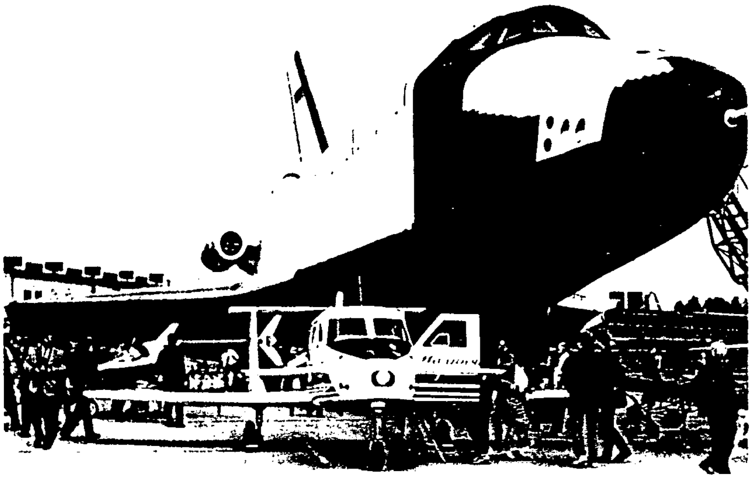
№

на ПРОМЫШЛЕННЫЙ ОБРАЗЕЦ "САМОЛЕТ"

Патентообладатель(ли)

Страна:

Автор (авторы):

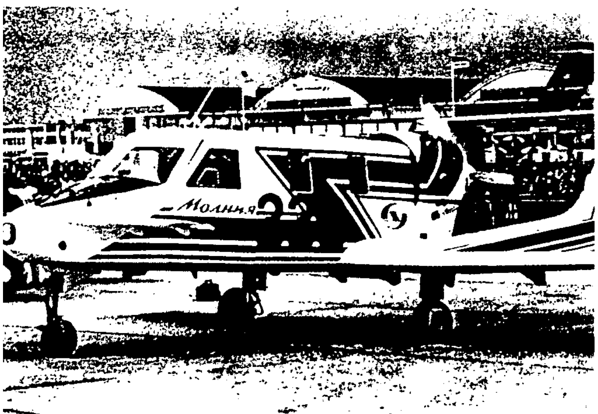


MAKS-95 International Aerospace Salon in Zhukovsky

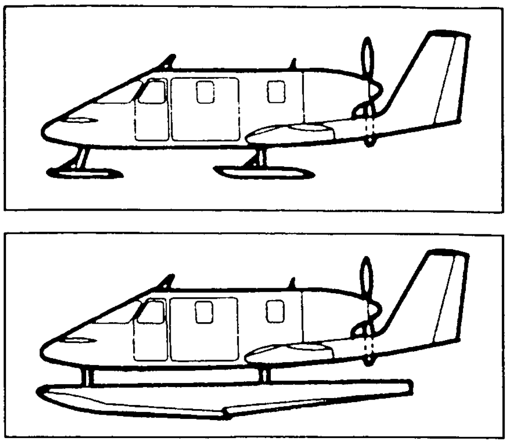
\ssembly shop of AVIAKOR airplane plant in Samara

The smallest of the triplane series is the MOLNIYA-1 six-seat aircraft, the design of which was awarded to Gold medal of Eureka-93 World Inventors, Scientific Research and Know-How Salon in Brussels, in 1995 it was shown in flight at the aeroshow in Le Bourget. The first batch of the aircraft has been produced at the airplane plant in Samara. The MOLNIYA-1 is intended for individual using, tourism, cargo and mail carrying, business flights and aerial photography and can be used in patrol and ambulance services. The high dynamic stability inherent to the triplane stipulates exclusive smoothness of flight and the aft location of the engine with a pusher propeller minimizes noise and vibration in the cabin.

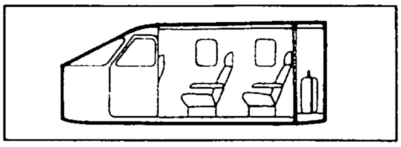
The MOLNIYA-1 aircraft can be supplied in versions adapted for operation in the tropics, the Arctic region and on the sea coasts, and the wheeled landing gear can be replaced with skis or floats. The application of low pressure tires and considerable power reserve permit to use it not only on the existing airdromes with artificial or ground coating, but on any even sites 500 meters and more long as well.



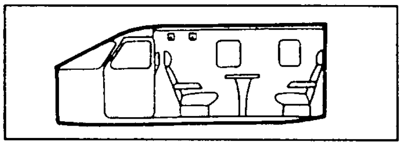
After the flight in Le Bourget airspace



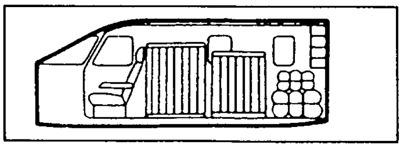
Variants with skis and float landing gear



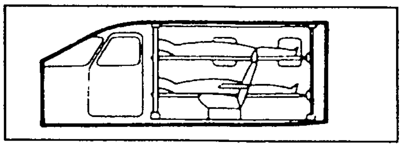
Passenger cabin



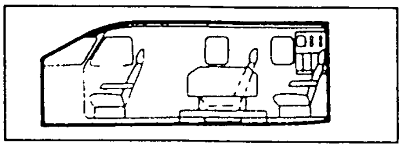
Administrative cabin



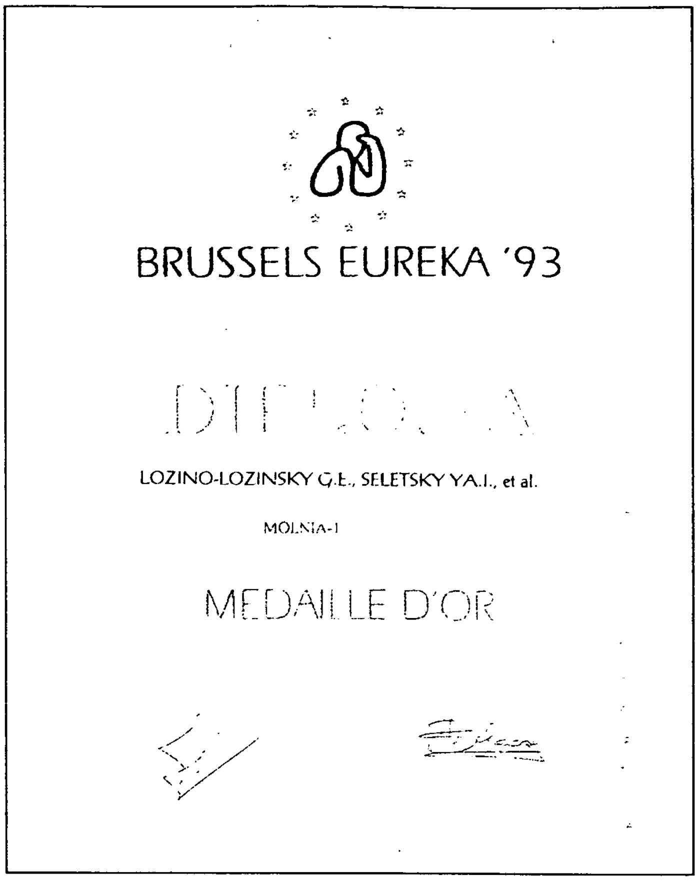
Cargo-mail cabin



Ambulance cabin



Cabin for aerial photography and reconnaissance of the region



BRUSSELS EUREKA '93

LOZINO-LOZINSKY G.E., SELETSKY YA.I., et al.

MOLNIA-1

MEDAILLE D'OR

MOLNIYA-1 aircraft Main Characteristics

Takeoff engine power, hp 360
Maximum payload, kg 500
Takeoff mass, kg 1740
Wing span, m 8,5
Length, m 7,86
Operational range, km:
- with maximum payload 500
- with maximum fuel load 1000

Speed, km/h
- cruising at an altitude 1500 m .... 225...285
- stalling .... 115...120
- landing .... 130...160
- take-off .... 145...170

Takeoff run (dry concrete), m 450
Landing run (dry concrete), m 350
Fixed service life .... 3000 hours, 6000 landings

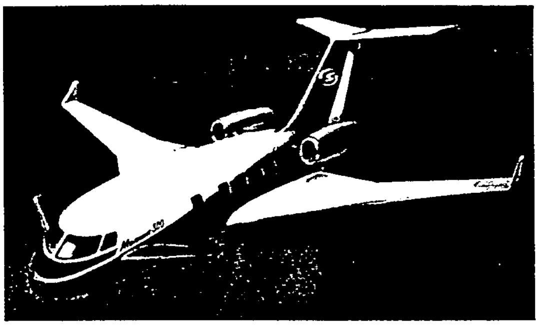
OLNIYA-100

' MOLNIYA-100 fifteen-seat, two-engine triplane lesigned for regional routes. This multipurpose :raft can be used for passenger and cargo ısportation, as well as for aerial photography or an eight-seat business, patrol or ambulance :raft. The use of pusher propeller minimizes noise l vibration in the cabin and provides passenger's ety during emplaning. The MOLNIYA-100 can ' airdromes with the artificial coating, as well as ground ones, and its navigation and nmunication equipment permits to fly at any time lay and year.

MOLNIYA-100 aircraft Main Characteristics

akeoff engine power, hp	2 x 435
laximum payload, kg	1500
akeoff mass, kg	4300
)perational range, km:	
with maximum payload	600
with maximum fuel load	2000
;peed, km/h:	
maximum	400
cruising	325...380
landing	130
'akeoff run, m	430
.anding run, m	350

MOLNIYA-300



Unlike the MOLNIYA-100 triplane roughly similar to it in dimensions the MOLNIYA-300 though is supplied with no piston, but turbojet engines. This is a six-seat business aircraft the cabin of which has all necessary conditions for rest or work. The location of the engines in the rear fuselage reduces noise and vibrations that makes multihour flights tireless. Like the MOLNIYA-100 this jet aircraft can use airdromes with the artificial coating, as well as the ground ones.

MOLNIYA-300 aircraft Main Characteristics

Takeoff engine power, kg	2 x 1220
Maximum payload, kg	1350
Takeoff mass, kg	6800
Maximum fuel reserve, kg	2100
Operational range, km:	
with maximum payload	2900
with maximum fuel load	5100
Speed, km/h:	
maximum	930
cruising at the altitude 3000 m	800
take-off	195
landing	160
Takeoff run, m	630
Landing run, m	460

MOLNIYA-400

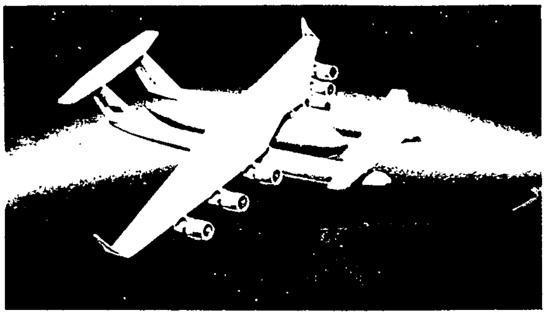
The next in dimensions aircraft of the conceived family is the MOLNIYA-400 wide fuselage triplane. This two engine aircraft is intended for transportation up to 30 tons of cargo in containers or on pallets or self-propelled machinery. In an overload variant its carrying capacity can reach 50 tons. There is a cargo-passengers modification of the MOLNIYA-400 designed for simultaneous transportation of 250 passengers with hand luggage on different decks and cargo in containers. The crew consists of two pilots, a panel operator and two operators.

The MOLNIYA-400 aircraft is equipped with an integral automated monitoring system, which while constantly analysing the board systems condition enables to reveal failures in due time and thus to cut the aircraft down time. The MOLNIYA-400 can be operated on airdromes with concrete coating and ground ones, and its pilotage-navigation complex enables to fly under difficult meteorological conditions and to land under ICAO second class.

MOLNIYA-400 aircraft Main Characteristics

Takeoff engine power, kg	2 x 16000
Overload takeoff mass, t	121,1
Normal takeoff mass, t	109,8
Payload with overload takeoff mass, t	50
Payload with normal takeoff mass, t	30
Wing span, m	42,7
Length, m	41,5
Operational range with 30 t payload and fuel reserve for 1 hr flying, km	5000
Operational range with overload takeoff mass, km	3000
Speed, km/h:	
maximum	930
cruising at the altitude of 11200 m	760...800
Takeoff run, m	1230
Necessary runway length, m	2600
Service life	60000 hours, 20000 landings

MOLNIYA-1000 (HERACLES)

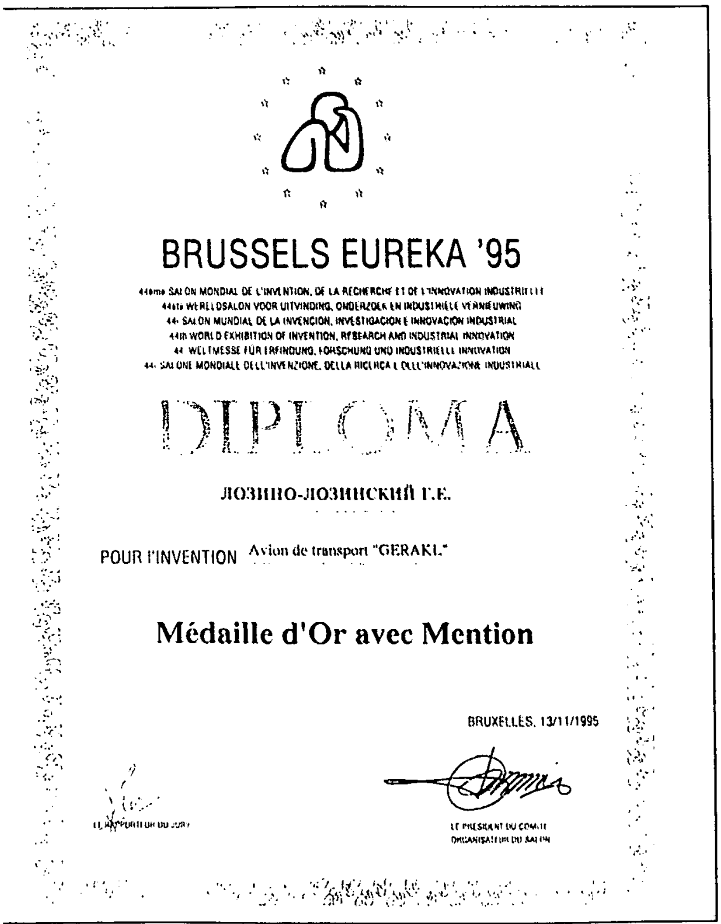


The heaviest of the designed triplanes is the HERACLES twin-body aircraft-transporter. Its chosen dimensions are identical to that of a well-known An-225 MRIYA so that it can be manufactured at the existing airplane plants in Russia without construction of new assembly shops, but the HERACLES has the carrying capacity one and a half higher than the MRIYA. It is intended for carrying large-sized cargo up to 450 tons or passenger modules with capacity up to 1200 persons at the external suspension. It can be used as an aircraft-carrier for aerospace systems.

HERACLES aircraft Main Characteristics

Takeoff engine power, kg	6 x 40000
Maximum payload (including suspension elements), t	450
Maximum fuel reserve, t	358
Takeoff mass, t	900
Wing span, m	90,4
Length, m	73,4
Maximum cargo dimensions, m:	
length	60
width	11
height	9,4
Cruising speed, km/h	840
Operational range, km:	
with max. payload	2300...3100
with max. fuel reserve	8300...11800
ferry	18000
Takeoff run, m	2350
Landing run, m	1000
Crew, number of persons:	
basic	4
shift	4

' cargoes are suspended between the HERACLES elages under the center wing section. They can replaceable quick-detachable modules, where go containers and pallets, or super heavy or 'rsized constructions and aggregates such as tro turbines, chemical reactors, petrol-chemical ustry equipment, etc., or containers or tanks with iid gas, dry substance goods and liquids luding water for fire extinguishing, or at last ;senger modules are placed. The system of lifting 1 lowering cargoes, available on the aircraft, 'tails the technological cycle and simplifies ding and unloading operations because there is need in bulky airdrome cranes.



BRUSSELS EUREKA '95

44ème SALON MONDIAL DE L'INVENTION, DE LA RECHERCHE ET DE L'INNOVATION INDUSTRIELLE
44ste WERELDSALON VOOR UITVINDING, ONDERZOEK EN INDUSTRIELE VERNIEUWING
44· SALON MUNDIAL DE LA INVENCION, INVESTIGACION E INNOVACION INDUSTRIAL
44th WORLD EXHIBITION OF INVENTION, RESEARCH AND INDUSTRIAL INNOVATION
44· WELTMESSE FÜR ERFINDUNG, FORSCHUNG UND INDUSTRIELLE INNOVATION
44· SALONE MONDIALE DELL'INVENZIONE, DELLA RICERCA E DELL'INNOVAZIONE INDUSTRIALE

DIPLOMA

ЛОЗИНО-ЛОЗИНСКИЙ Г.Е.

POUR l'INVENTION Avion de transport "GERAKL"

Médaille d'Or avec Mention

BRUXELLES, 13/11/1995

LE RAPPORTEUR DU JURY

LE PRESIDENT DU COMITE ORGANISATEUR DU SALON

'e HERACLES aircraft project was awarded with e Gold Medal at "Eureka-95" International Salon Inventors and Scientific Research in Brussels.

NPO MOLNIYA offers to use the HERACLES not only for separate trips, but in the air transport system structure with practically uninterrupted cargo turnover: as soon as the aircraft lands at the appointed stop of the route the suspended module will be immediately replaced and the aircraft will be ready to fly to a new destination, modules including passenger ones should be loaded in the special terminal just before the aircraft-transporter arrives.

After landing the aircraft should be taxied out at the working ground, where two loading-unloading self-propelled trolleys will come up to each aircraft: one empty for acceptance of the delivered module and its transportation to the terminal, the second with a new loaded module. Simultaneously with loading and unloading refuelling of the aircraft should be made. The free space between the HERACLES fuselages opened on the two sides permits to establish the order of the aircraft maintenance in a circle, always clockwise or counter-clockwise, to exclude a collision of heavy non-manoeuvrable trolleys. Such organization of operations will reduce the aircraft down time in airports and will make the system extremely effective economically. The introduction of the HERACLES base transport system will make the same revolution in the air transportation as the wide use of containers has made on the railway and water transport.

The HERACLES aircraft can be used on non-class as well as the first class airdromes with improved (if necessary) taxi ways. The use of low pressure pneumatics enables the aircraft operation from prepared ground airfields.

HERACLES TRIPLANE and AEROSPACE SYSTEMS

The key characteristics of two-stage aerospace systems are determined according to speed and carrying capacity of the aircraft-carrier used . The range of specified parameters can be extremely wide. So the SPIRAL system hypersonic carrier was expected to launch the second stage by weight 63 tons at a speed corresponding to 6M; whereas launching weight of the MAKS system orbital stage with the use of the An-225 MRIYA heavy subsonic aircraft reaches 275 tons, and the HERACLES aircraft - 450 tons. The HERACLES advantages are not only covered by its extreme carrying capacity, its arrangement, namely - chosen for its two-fuselage scheme, was of a great importance. Simplifying the separation of the second stage suspension under the aircraft permits to launch the stage during a cabrage flight, whereas the carriers of the conventional scheme with the top arrangement of orbiter require going into the negative normal acceleration in time of launching that results in the trajectory angle losses and the increase of power expenditure for moving out. The second stage launch of the HERACLES occurs with subsonic speed, however due to summation of all factors acting during the launch so the aircraft-carrier contribution in the increment of putting characteristical velocity reaches 570 m/s.

Comparing the characteristics of MAKS using various types of carriers it is possible to see that a completely reusable MAKS-M modification with integral fuel tanks at the start from Heracles can put the same payload into orbit altitude of 200 km as the MAKS-OS stage with a droppable external tank launched from the An-225 MRIYA.

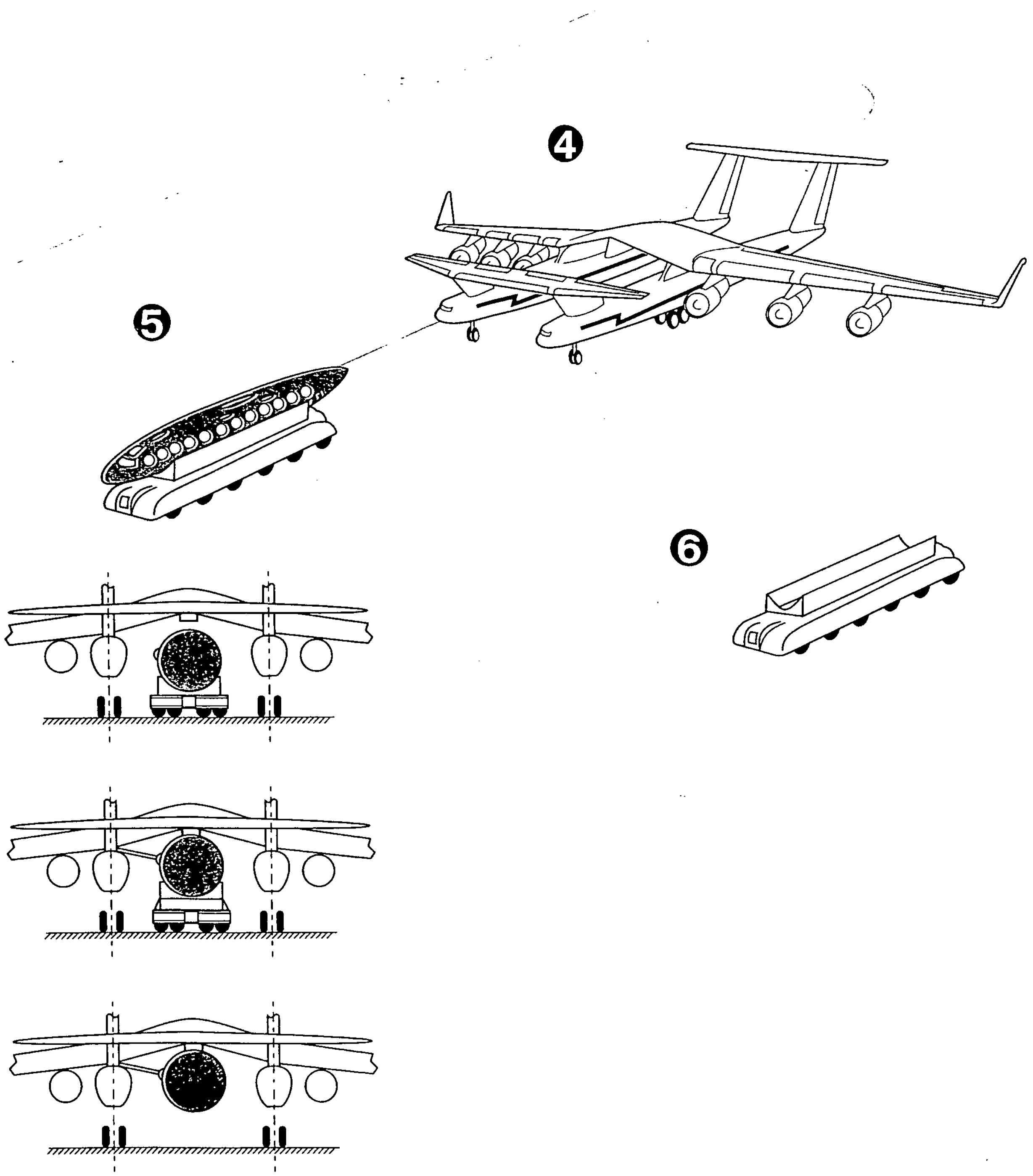
The MAKS-M reusable system with the HERACLES aircraft-carrier surpasses the single-stage-to-orbit (SSTO) of vertical launching carriers which are the basic variants of the USA shuttle space system (RLV) program, by its flight performance, development and manufacturing costs and economic efficiency. In particular, it has a smaller gradient of mass loss according to the orbit altitude that improves the system economic parameters. In addition, the American concept has got common shortcomings of rocket systems: limits of orbit inclination angles and necessity of building and maintenance of the expensive launching complex.

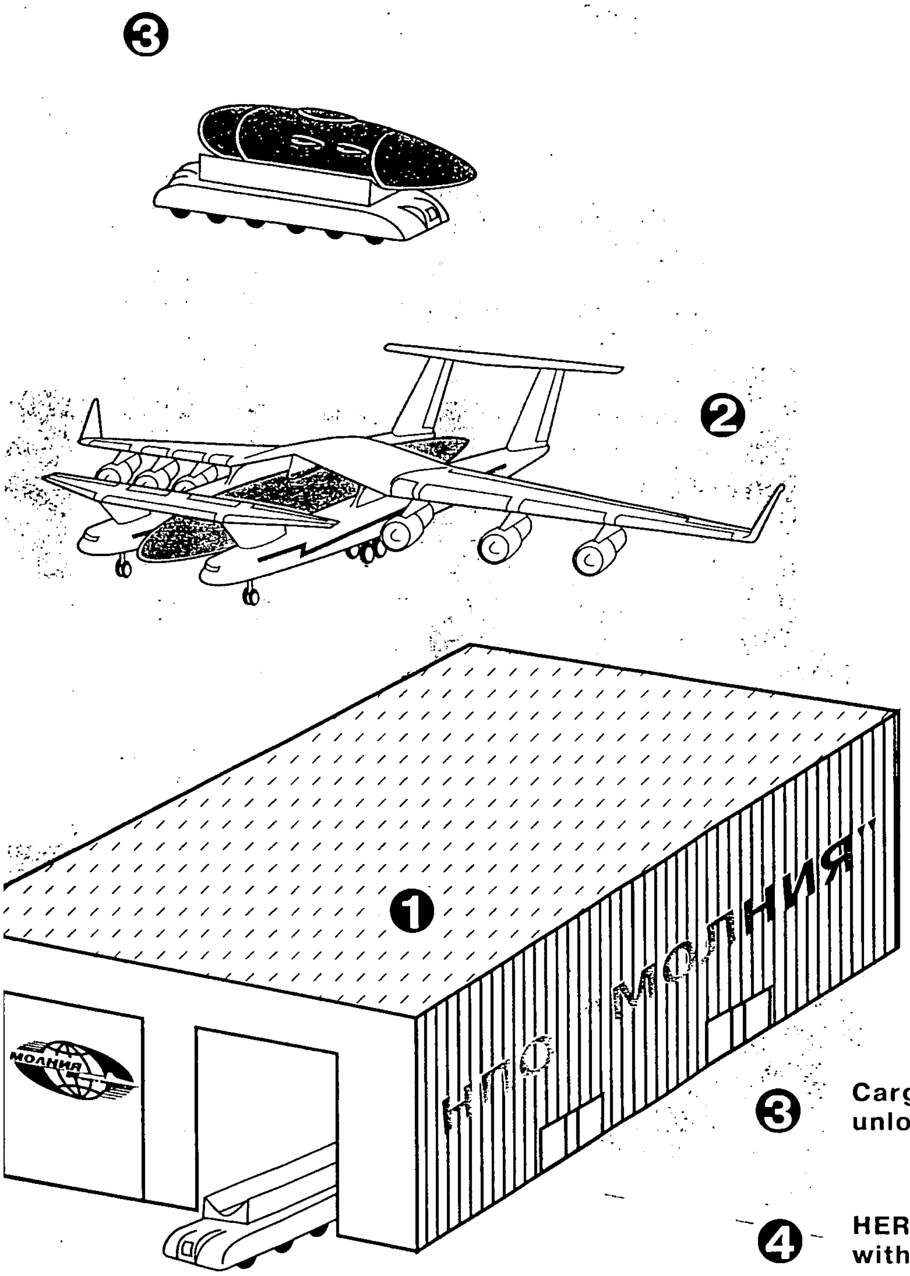
Though in order to approach the date of putting into operation the MAKS system it is necessary to use the already existing An-225 aircraft-carrier its opportunities will only be completely realized by the introduction of the HERACLES superheavy triplane in its structure. The simultaneous use of the HERACLES as a part of the extensive air transport system will allow to return a significant share of means spent on its development and manufacture.

Comparison of characteristics of the MAKS with An-225 and HERACLES aircraft-carriers (mass in tons)

Aircraft-carrier type	An-225			Heracles		
MAKS modification	M-OS	M-T	M-M	M-OS	M-T	M-M
Second stage takeoff mass	275	275	275	450	450	450
Payload mass on orbit:						
H = 200 km, i = 51°	8,3-9,5	18,0	5,5	13-14	28,0	8,0
H = 400 km, i = 51°	7,0-8,2	17,4	3,5	11-12	27,0	5,5
geostationary orbit	-	4,8	-	-	9,0	-

ERACLES SERVICE OPERATIONS ON THE AIRFIELD





1 Terminal

2 HERACLES aircraft-carrier with cargo module

3 Cargo module on loading and unloading trolley

4 HERACLES aircraft-carrier without cargo module

5 Passenger module on loading and unloading trolley

6 Loading and unloading trolley

PERSONIC ROCKETS-TARGETS

MOLNIYA has been designing rockets-targets ver 30 years using the great experience in crea- anti-aircraft guided rockets (AGR) for C-25M.

he basis of B-300 anti-aircraft rockets which ed their service life, there were designed, tested out into the serial production the following types he rocket-targets: KUNITSA (1965-1970), OL (1970-1975), BELKA (1975-1988), ZVEZDA '8-1993) and STRIZH (1994 to the present), all of them imitate flying-technical and mational characteristics of typical air targets in de altitude range (from 50 m to 30 km) and ds (from 50 to 1500 m/s) in flights according to programmed trajectory with the possibility of its controlled correction.

e same time the ground facilities for preparing launching the rockets-targets were designed put into operation in the form of the mobile nd complex (LISA-M), included into the ground ces of the control point, launching and technical tion.

cost of the rockets-targets constructed on the s of battle anti-aircraft rockets, sufficiently full ation of air targets characteristics, high reliability safety in service ensured their wide use in the em of air defence as a typical air target for battle ing, testing of anti-aircraft rocket complexes systems. Manufacturing of rockets-targets on basis of the expired-its-service-life anti-aircraft kets gives a considerable finance economy for state.

MAIN TACTICAL-TECHNICAL CHARACTERISTICS OF THE ROCKETS-TARGETS OF STRIZH TYPE

Dimensions, m:	
Length	12.0
Diameter	0.65
Wing span	2.6
Takeoff weight, kg	4000
Launch mode	vertical
Altitude, m	50...30000
Range of flight, km according to altitude	50...200
Speed, m/s	100...1300

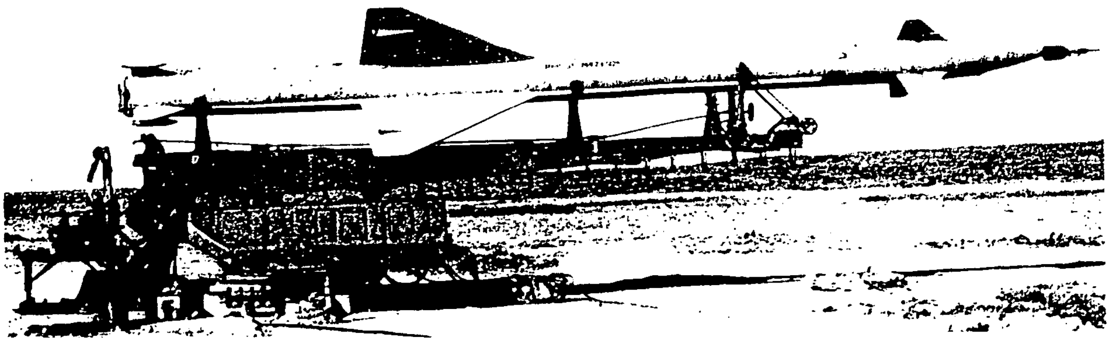
The power plant: a two regime liquid jet engine with two-component fuel.

The guiding system: autonomous with the radio-correcting program.

The special equipment: tracers for increasing infra-red radiation, Lyuneberg lens for increasing of effective surface dissipation and the apparatus to imitate the active radio-interference and signals of large size targets, the automated system for registration and estimation of fire results.

The flight safety system: destruction of the target at the prescribed time, by single radio-command, at the deviation of course or roll.

The mounting of the radio-altimeter on the rocket-target allows to fly at low altitudes of 50-1000 m enveloping of terrain relief and for the distance up to 50 km with the speed from 650 to 100 m/s.



Rocket-target placed on the launch stand

Prelaunch preparing, launching and controlling of a rocket-target flight are performed with the LISA mobile ground complex, containing the ground devices, specially designed on the base of the anti-aircraft rocket complex, and standard all-army facilities, including:

the ground facilities of the launch position, consisting of six launching devices, manufactured by means of developing standard launching devices of the basic anti-aircraft complex;

the command point ground facilities, consisting of a specially manufactured cabin with the station for transmitting commands and the panel for guiding rocket-target flight, standard all-army radar stations and communication facilities;

the technical position ground facilities, consisting of a specially manufactured control set to inspect the rocket-target, standard devices for loading with components of fuel and air, transport-loading facilities and a mobile electronic power station.

On the basis of many-year experience of designing rocket-targets NPO MOLNIYA developed an automated information-measuring system to registrate and estimate firing results intended for equipping rockets-targets in order to receive the trustworthy information:

about the parameters of mutual location of the target and the battle rocket shooting it;

about the parameters of catching and hitting the target with the piercing elements of the attacking rocket battle charge;

about the effective hitting target and the firing results according to the special criteria.

THE MAIN TACTICAL-TECHNICAL CHARACTERISTICS OF THE AUTOMATED SYSTEM OF REGISTRATION AND ESTIMATION OF THE FIRING RESULTS

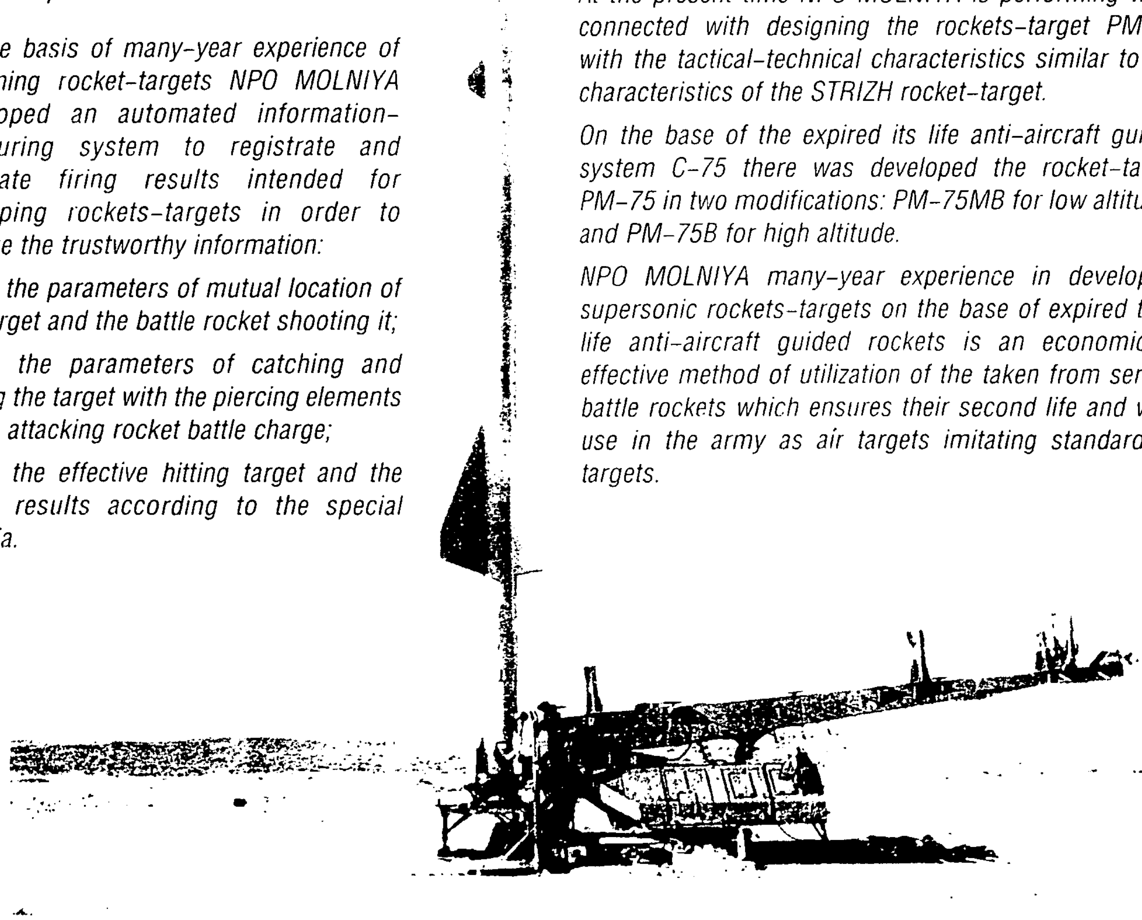
Measurable relative distance (range), m	10...90
Measurement errors of the up blasting angle of the battle charge, deg.	± 22,5
Quantity of sensors of piercing elements hitting	up to 128
Time registration error of the piercing elements hitting to the sensor, мks	±1
Time interval between the hitting, мks	5 and longer
Volume of the aboard equipment (in the container), cu dm	9

The analogue of this system successfully passed the state tests with the ZVEZDA-4 rocket-target.

At the present time NPO MOLNIYA is performing work connected with designing the rockets-target PM-75 with the tactical-technical characteristics similar to the characteristics of the STRIZH rocket-target.

On the base of the expired its life anti-aircraft guided system C-75 there was developed the rocket-target PM-75 in two modifications: PM-75MB for low altitudes and PM-75B for high altitude.

NPO MOLNIYA many-year experience in developing supersonic rockets-targets on the base of expired their life anti-aircraft guided rockets is an economically effective method of utilization of the taken from service battle rockets which ensures their second life and wide use in the army as air targets imitating standard air targets.



Rocket-target in the start position

technologies mastered by NPO MOLNIYA during its work on Buran got their her development in the conversion programs. This includes the direct use of ' materials and equipment and Know-How introduced in other branches of ıstry that are far from aviation as well as the ideas and experience.

'he mathematical program provision, formed for the 'ft making of thermoprotection tiles of the BURAN 'r, was used while manufacturing reflectors of large- radiotelescopes.

e manufacturing resistance laboratory s the thermoprotecting material is now . These ovens, used for heat treatment of ıls, for chemical analyses, in jewellery uction, in craft industry for kilning of elain and putting the decorative coating, v to reach temperatures of 1250 °C for 15 The ovens are provided with a control em with the digital indication. The ratory oven of 5 litre volume weights only g and consumes 220V and power less than V.

'her example of conversion - elastic heaters, developed ıe BURAN. At the present time they are used to heat ıs, car engines and cabins, different mechanisms and :es in the conditions of the Far North, to keep the 'erature of dry and liquid substances and as medical water bottles.

ether with MAI catalytic ovens PULSAR-1 were ufactured, their mode of operation is based catalytic (without open fire) fuel: decay heat ation. They are used to hothouses and plant ns, to dry lacquer and coloured coatings and eat car diesel engines.

e were also developed vapour-generating and water- 'ng units, working with liquid and gas fuel and, at low inertia, having heating power up to 5 mWt. Their ensions are 7-10 times less and their mass is 4-5 times than ordinary vapour generators and they have a better iency. Being convenient while mounting and oitation they are used in agriculture, in emergency city supply, at working out of oil layers and sulphur osits.

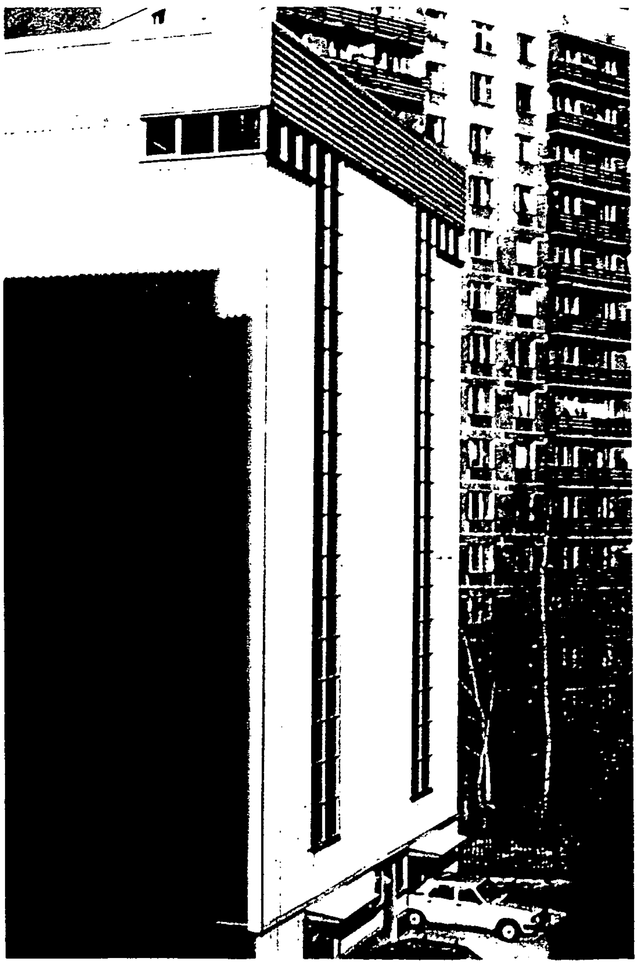
New technological decisions which first were intended for the BURAN, are used in designing the equipment to reprocess fruits and vegetables. The inter-field company Aviaagroprommechanizatsiya was organized at NPO MOLNIYA for distribution and production of this equipment.

Cellular many layer panels, designed to make Buran structure lighter, found their use in aviation, shipbuilding, radiotechnical and many other branches of industry. Made from metal foil or Kraft-paper they are used in the bases of large space telescopes mirrors and antennae for the large range communication, for the carrying structures of yachts, boats and windsurfings, in lighter walls, doors or thermo-neutralisers of harmful throws of industrial gases, in the extinguishers for fuel lines and as radiofilters.

Inertialess wheel hydraulic drives of the BURAN control system are used in whirlwind solar-wind power units, patented by Russian inventors in 40 countries. These units, being distinguished in small mass and simple mounting and maintenance, use not only wind energy but directly get the energy of the air flow uprising from the unit base heated by the Sun. Forming of wide fields of such ecologically pure energy units will allow to abandon the construction of many nuclear electric stations..

This experience, accumulated during designing the BURAN orbiter and acquired scientific-technical reserve may be widely and very effectively used in future in many branches of industry: from aviation to medicine.

The production capacity of NPO MOLNIYA permitted to organize manufacturing of automated multi-storey garages. Such garages with an elevating system are intended for stored cars in the regions with the high density of building. Occupying the area equal only to 49 sq. m., one section can contain up to 20 cars of VOLGA size. The garage is a frame made of light metal structures plated with sheet material. Inside the frame there is an elevator-manipulator for lifting and locating the trays with cars on the floors (or with cargoes in containers and tanks in case of using the garage as a store house). The garage module structure allows to blend it with any city landscape. It may be manufactured in two variants: the ground variant on a concrete slab and the underground one - in a reinforced concrete well.



Double block garage

SPECIFICATIONS

Capacity of cars, units.................25
Design car class ......VOLVO, VOLGA
Rated power, kW.........................14
Occupied area, sq. m..................49
Garage height, m 28,2
Car delivery cycle, sec..........30...90

As these garages can be built in the complex with other buildings, their construction can be the most efficient in the regions of intensive flow of people, such as near the airports, the railway stations, large offices, stadiums and etc. The first garages are built in Skakovaya street, Moscow.

HOWNEWS Paris '95

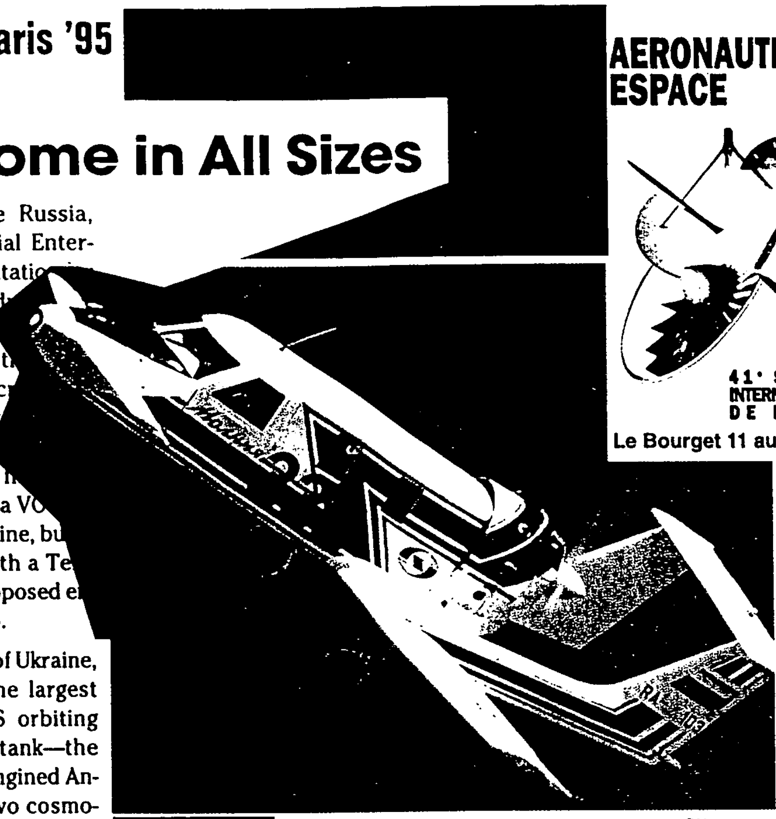
AERONAUTIQUE
ESPACE

41° SALON
INTERNATIONAL
DE PARIS
Le Bourget 11 au 18 Juin 1995

Iolniyas Come in All Sizes

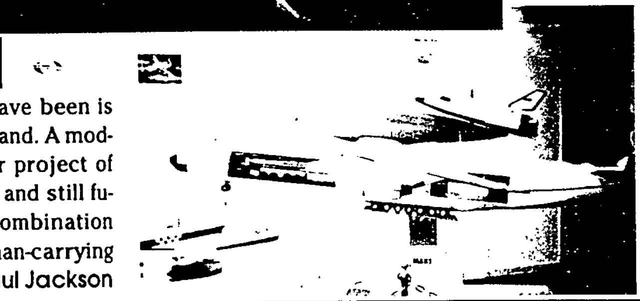
:hough little known outside Russia, ›lniya Scientific and Industrial Enter- ise has created for itself a reputati cellence in the design and pro Buran space shuttle.

Appearing for the first time in t Molniya-1 six-seat light airc w in late 1992 and has now en ction. Dwarfed in the aircra Tu-160 next door, Molniya's ntional aircraft is powered by a V 14 air-cooled radial piston engine, b inned to be available later with a Te ne Continental horizontally-opposed e ne or an Allison 250 turboprop.

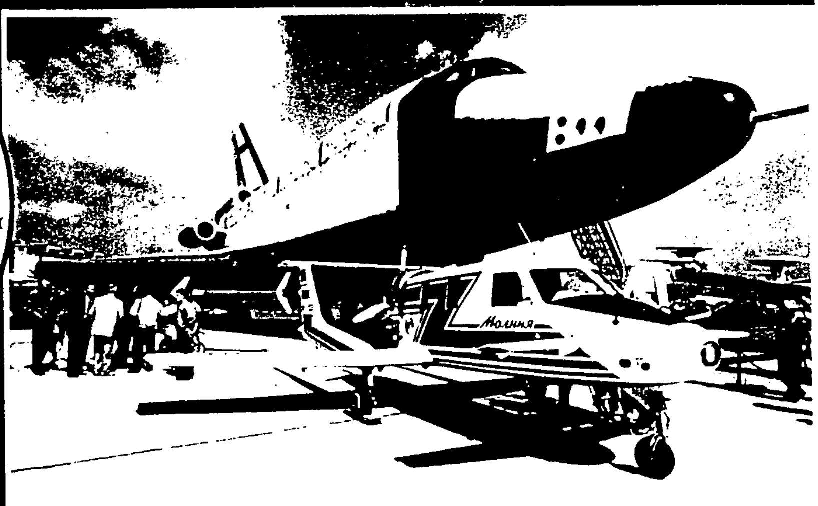


In conjunction with Antonov of Ukraine, olniya is showing perhaps the largest odel in the show: the MAKS orbiting uttle sitting on a giant fuel tank—the o carried by the mighty, six-engined An- 5 Myria. MAKS could place two cosmo- uts and 10 tonnes of payload into low- rth orbit.

A glimpse of what might have been is also available at the Molniya stand. A model of the 50-50 space launcher project of 1965 shows a remarkably neat and still futuristic-looking piggy-back combination that would have put a small, man-carrying craft into orbit. — Paul Jackson



МЕЖДУНАРОДНЫЙ АВИАКОСМИЧЕСКИЙ САЛОН
1995
Moscow, Zhukovsky,
August, 22-27



Russians Seek $2.5 Billion to Finance Space Shuttle Program

The Russians are at Farnborough this year with a reusable space vehicle concept dubbed Molniya—lightning. A small shuttle, capable of being launched from the back of the 620-ton spacecraft carrier Mira (an Antonov An-255), Molniya is claimed to have a service life of 100 flights. The aircraft can deploy satellite payloads directly from the customer's country, from any 4.5-kilometer runway. Powered by rocket fuel stored in a 250-ton drop tank, the 27-ton Molniya will fly to space with 8.3 tons of payload in a manned configuration, or 9.5 tons in cargo-only mode. The spacecraft will drop its external tank at an altitude of 80 kilometers and enter low-Earth orbit at 200 kilometers—or continue into geostationary orbit on its own power. The Russians cl... ch cost could be as low $1,500 to $2,000 per kilogram, about a fifth of the U.S. Space Shuttle's cost. But afte... y still need $2.5 billion to get the program to space.