4th International Workshop on Verification and Testing of Space Systems

Session 10
TEST FACILITIES

The Russian Facility for Testing of Space Systems: Current Status and Development Plan

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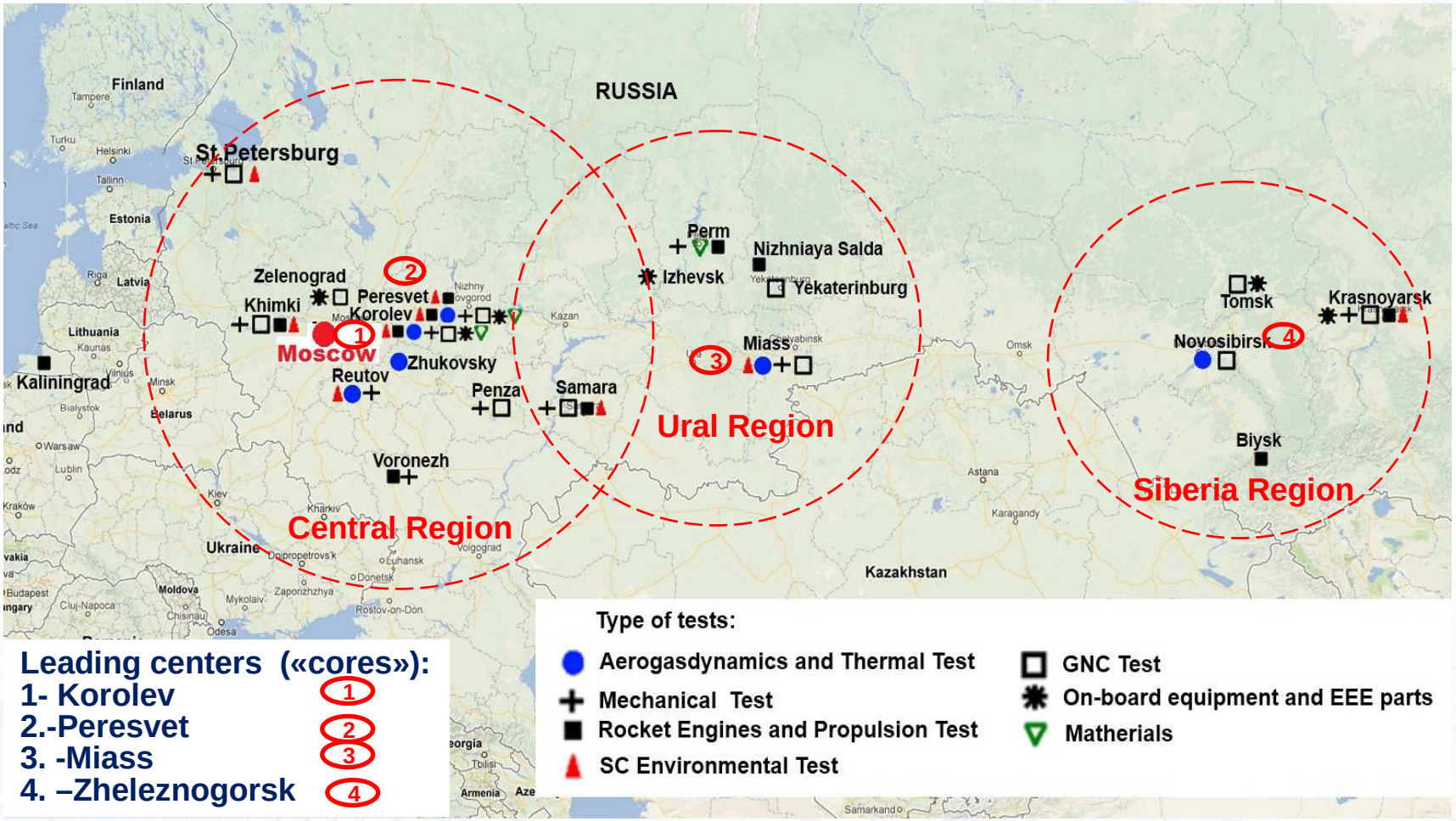
Summary

- The Russian Space Industry Test Centers:
  - Aerogasdynamics, Thermal Control and Mechanical Tests
  - Space Environmental Tests
  - Rocket Engine Test Facility
- Test Grades vs. Product Breakdown Matrix
- Operation Life of Test Facility
- Basic Problems of Test Facility Development
- Basic Statement of Development Plan
- General Technical Items of Development Plan
- Conclusions

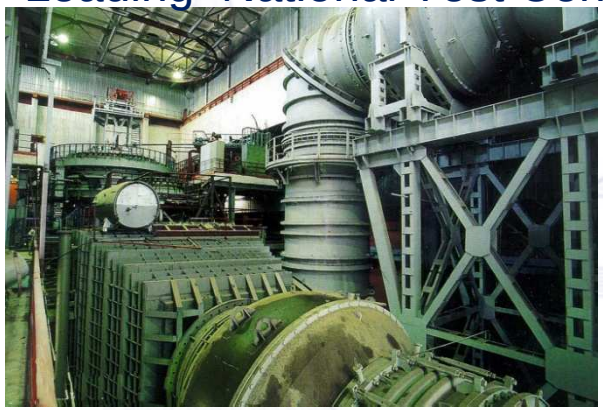
The Russian Space Industry Test Centers



Leading centers («cores»):
1- Korolev
2.-Peresvet
3. -Miass
4. –Zheleznogorsk

Aerogasdynamics Ground Test

Leading National Test Centers: TSNIIMASH, TSAGI

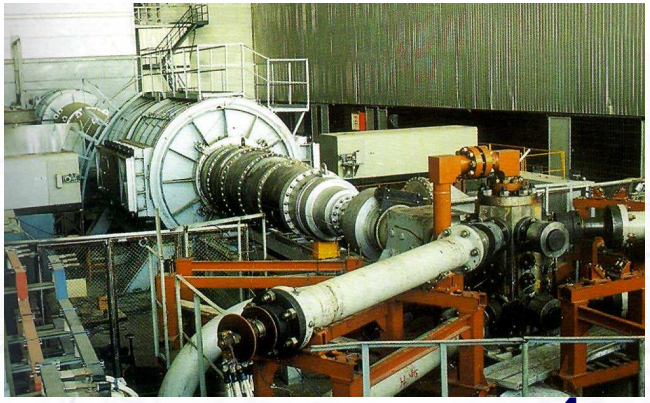


U-22

Shock Tube

M=0.1- 20
Re/L=10-10^6
Angels of attack - 0-360°
Models sizes:
-length up to 1,5 m
-span up to 0,5 m

U-306-3



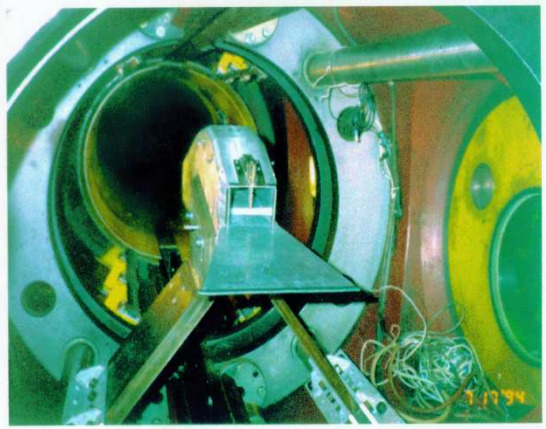


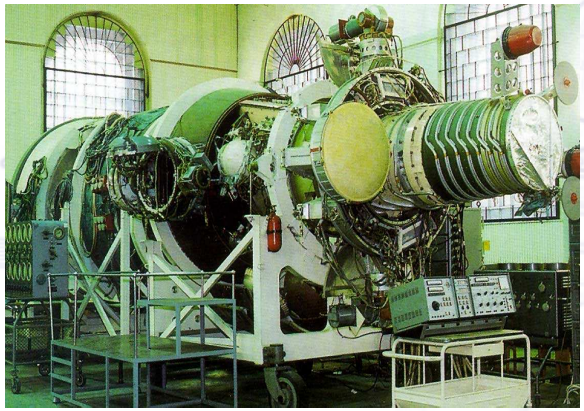
Fig. Front view of NASA GASL model mounted in PGU-11 test section.

Hypersonic
Piston Tube

Thermal Tests

Leading test center: TSNIIMASH

HF Plasmatron U-13



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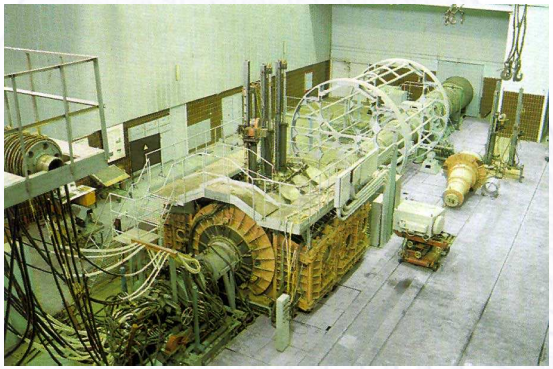
-Temperatures 4.2-12 000 K

-Output Power from 3 to 50 Mwatt

-Stagnation Temperatures

- 700 – 12 000 K

-Stagnation Pressure > 50 atm



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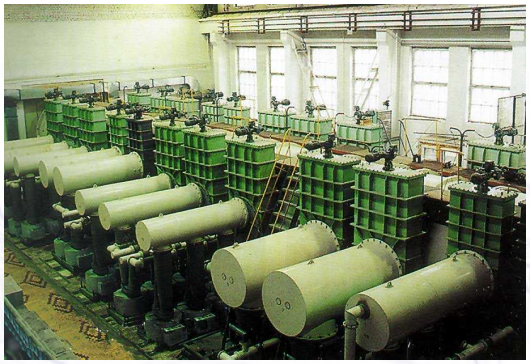

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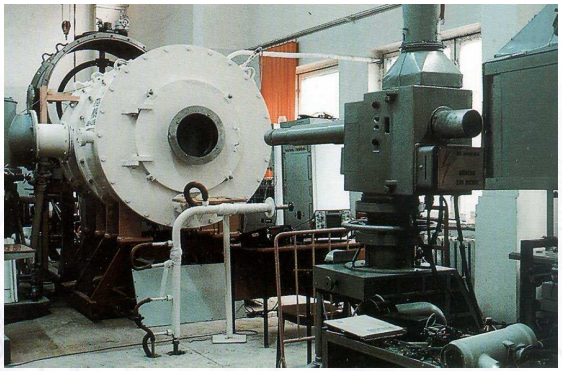

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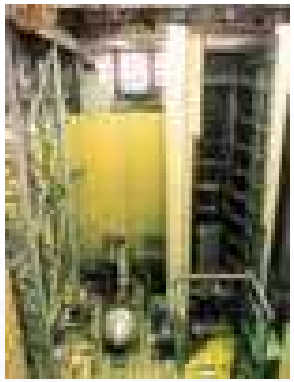
Mechanical Tests

Totally more than 40 centers. Leading test center: TSNIIMASH

Static loads up to $4x10^5$ kN
T =77-1500 K
Inner pressure up to 250 MPa
Test object max sizes:
-d =16 m h=20m
Dynamic loads:
Excitation force up to 200 kN
Frequency 0-2000 Hz
Test object: d =6 m h=30m
Weight = 500kN



Space Environment Simulation

Total number of TVC - 36 Net volume – from 2 to 2400 m^3
Leading test centers: NIC RKP (Peresvet, Moscow Region): ISS (Krasnoyarsk Region)

Integration and test complex

KVI 8500 inside

Fobos Grunt tests

KVI-8500

Test object parameters(max):
- diameter - 6 м
-height - 22 м
-mass - 100 t
Total volume – 8500 m^3
Net volume - 2376 m^3;
Cryopanel surface (LN. GHe)
Pressure - 10^{-6} torr
Solar simulator
Rotating table
Loading – from the top

Rocket Engines and Propulsion Tests

Number of RE Test Centers -11. Leading test center: NIC RKP (Peresvet, Moscow Region): from main stage to upper stage LRE; altitude simulation tests; propulsion integration tests; cryogenic plant; lifetime test;

Angara Universal Propulsion Module (URM-1) Firing Tests;

Orbital module resource test

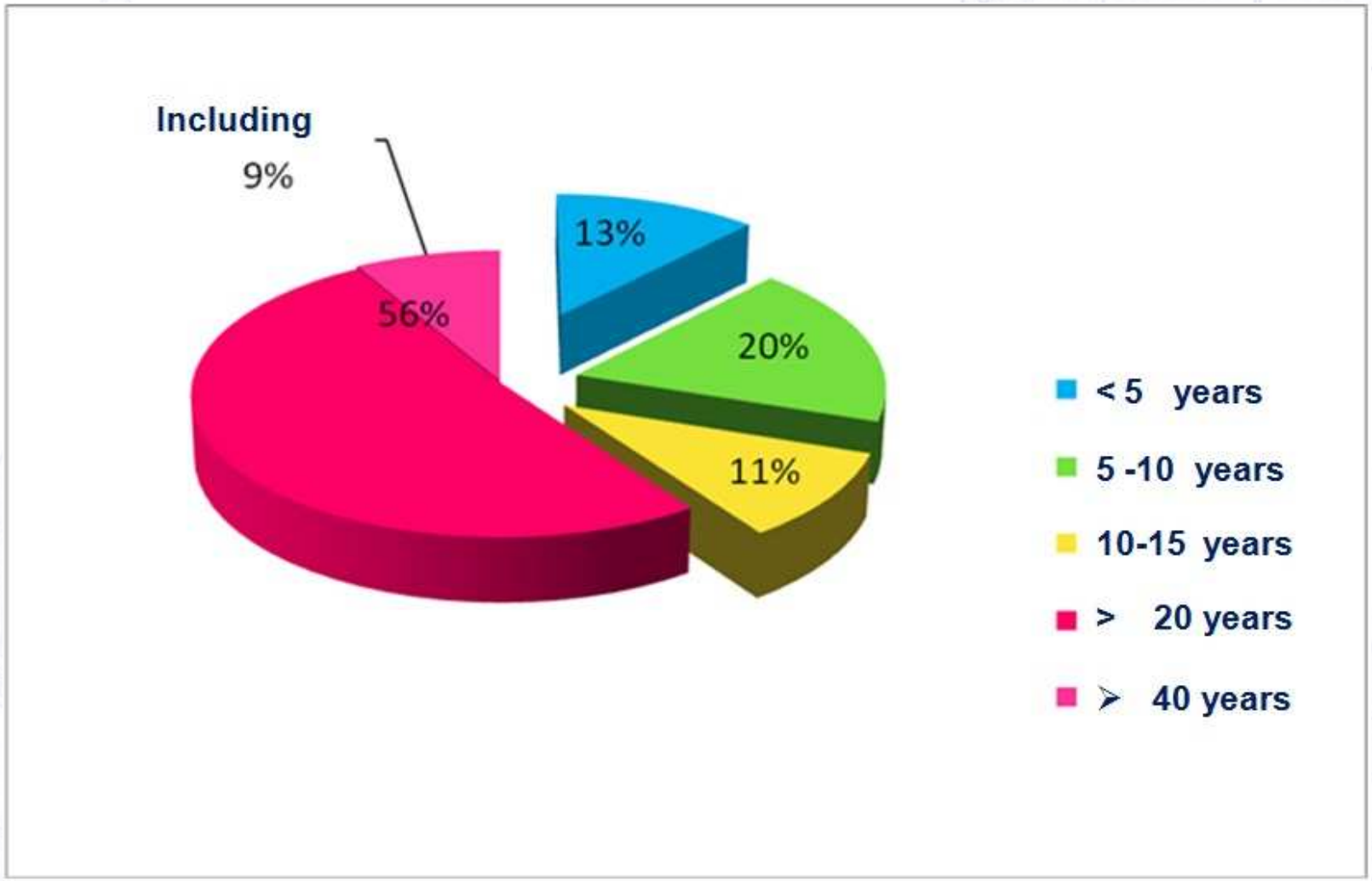
Test Grades vs. Product Breakdown Matrix

National Test Assets

N	Test Grade	Spacecraft	Space Transportation	Launch Complex
1	System as a whole	-Integration and Complex tests at Environment Impact -Weighting test	-Aerogasdynamics -Thermal Control -Mechanics -Environmental tests	-Aerogasdynamics -Thermal Control -Mechanics -Environmental tests
2	Subsystems	-Propulsion/RE -GNC -Therm.Control Sys. -Power Control Sys. - Onboard payload	-Propulsion/RE -GNC -Therm.Control Sys. -Power Control Sys. - Onboard facility	-Assembling Building -Launch pad -Propellant Facility -Launch Control - Power Supply
3	Units and aggregates	- Frame/Structures -Gyro -Battery -Pressure tanks etc.	- Structure -Fairing -Turbopump - Gas generator etc.	-Towers - Tanks - Lifting Facility - Control panels etc.
4	Components Materials	-Structural elements -EEE part etc.	- Structural elements - TPS etc.	-Structural elements -Propellant comp. etc.

Industrial Test Assets

Operation Life of Test Facility



Basic Problems of Test Facility Development

- Over sizing in terms of quantity of large-mid-scale test facility (>1500, including strength – 400, RE - 300, onboard equipment - 200, environmental - 400) and duplication of costly facility at low test demand.
- Widespread location in space industry (44 companies)
- Obsolete test hardware (60%), data handling and data processing systems
- Insufficient computational capability and tools for test planning and test analysis
- Insufficient budget for maintenance, operation and development of all the facilities
- Imperfect cost effectiveness and utilization
- Scarcity and ageing of high-qualified test staff, skills reduction

Basic Statement of Development Plan

- Test Facilities maintenance and development program is the priority of Russian space activity ("Entry barrier to space activity"). Test rating sector consumes over 50% of R&D expenditures annually.
- Test Facilities capability have to be optimized but sufficient to cover the needs of National Space Strategy roadmap, advanced and key technology development plan, current Space Programs and projects objectives at long –mid – short term prospective.
- The unique Test Facilities for governmental R&D needs and scientific research to be consolidated under the State property (even nationalized if private) as the National Assets and fully provided by State budget for maintenance and operation at "replacement cost" principle.
- Four "Core" National Test Centers (CNTC) to be established in next 5 years: 2- Central region (Moscow area); 1- Ural region; 1- Siberian region.
- Optimization and consolidation has to provide cost effectiveness and utilization of test facilities, growth of skills, boosting the implementation of advanced test technologies
- The test facility utilized in a value chain for serial commercial production and servicing need to be privatized. Its keeping has to be depreciated in the cost of product/service.
- PPP principles (government owned – private operated) to be developed for test centers operation. Establishing the one or two united test operation companies is preferable in short-term prospective.

General Technical Items of Development Plan

- Establishing the two-level test structure in the Russian space Industry
  - Core National Test Centers (1)
  - Industrial Test Centers (2)
- Boosting the computing performance at new generation world-class level:
  - test simulation,
  - test instrumentation
  - data handling, processing and analysis/the united industrial test data base
- Upgrading test facilities and gaining the new test capability with focusing to:
  - Rocket Engines and Propulsion (altitude test; LRE; Electric Thrusters; Nuclear Propulsions)
  - Mechanical Tests (High temperature and Cryogenic Strength and Dynamic Tests)
  - Aerogasdynamics (large scale models hypersonic tests at M > 10; transonic tests with nature Re)
  - Environmental Test (the new “under one roof” SC integration and test complex; multisource complex simulation of natural and anthropogenic space environment impact to avionics and sensors)
  - GNC (test beds for flight program verification)
  - Test beds for optic - electronic end-to-end path
  - EEE parts verification and test
- Developing the FSS-KT (certification and certification test centers network)
- Developing the industrial standards dedicated to different types of testing and QA of TF

Conclusion

- The existing test facility capability is sufficient to satisfy the current demand of Russian space industry and its near terms needs.
- Restructuring of test resources is required to be competitive, cost effective, utilized, supplied with skill staff and advanced test technologies
- The Test resources development foresees two-level structural consolidation (National and Industrial), appropriate regular financial support, essential upgrading the test hardware, technology and computing capability
- Certification and test certification centers network to be developed drastically for improvement of test centers capability and test quality, related industrial standards to be developed in near term future
- Centralized management body of test resources, united all-industrial test data base forming and deep analysis of test facility long term demand are the nearest steps of the Action Plan
- International cooperation is welcoming in the frame of Test Facility Development Plan

THANK YOU FOR ATTENTION!