FEDERAL STATE UNITARY ENTERPRISE

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Federal State Unitary Enterprise R&D Institute of Mechanical Engineering (R&DIME) was founded in 1958. The Institute was a branch of R&D Institute of Thermal Processes (Moscow) up to 1981. In 1981 R&DIME was established as an enterprise of Russia rocket industry in the field of development and manufacture of low thrust rocket engines (LTREs) for space vehicles of various applications including manned space ones and also as a scientific-and-experimental test complex of up to 3000 kN oxygen+hydrogen liquid rocket engines for launch systems.

In 1970 the initial production batch of the R&DIME's own development engines was delivered for the Salyut first-world long-term manned orbital station. At present the investigations, development and manufacture of LTREs are being kept as basic directions of the Institute. More than 30 types of the engines have been developed and passed a flight operation as parts of the spacecraft (S/C) Salyut, Almaz, Mir, the expansion modules Kvant, Krystall, Spectr, Priroda, the manned S/C Soyuz, Soyuz-TM, the cargo S/C Progress, Progress-M and Progress-M1, the Buran cargo shuttle. R&DIME's LTREs provide an on-orbit flight control of the International Space Station Modules: the Zvezda service module and the Zarya functional cargo module; such types of the S/C as Kosmos, Yantar, Molnya and also the boosters Breeze and Rokot. Totally more than 12 thousand LTREs designed and manufactured by R&DIME have provided successful operational use over 900 S/C with the actual life from 3 to 15 years.

In 1980 a unique test complex was put into operation to test the cryogenic liquid H_2+O_2 rocket engines. A principal scope of works on the operational development of the Energya launch vehicle sustainer engine (more than 500 firing tests) and equipment and technologies for liquid hydrogen systems of the launch vehicle and its start complex was performed at this complex. The 201 and 301 cryogenic test stands have no analogs in respect of their parameters within the home industry.

R&DIME STRUCTURE

- scientific-and-production complex of investigations, development and smal-scale series manufacture of LTREs for spacecraft
- scientific-and-industrial complex for testing large-scale cryogenic systems and technologies, high thrust rocket engines with liquid H_2+O_2 and methane propellants

BASIC DIRECTIONS OF R&DIME'S ACTIVITIES

- scientific investigations of processes in LTREs, propulsion systems and elecron-detonation electric rocket engines
- design, development, manufacture and operational use accompanying of LTREs and propulsion systems
- experimental stand development of space hardware
- development, manufacture and operational use of test stand equipment
- production of air separation products and liquefied natural gas
- nature-protection activities

THE FOLLOWING UNIQUE TECHNOLOGIES HAVE BEEN BROUGHT BY R&DIME TO A COMMERCIAL LEVEL IN PILOT AND COMMERCIAL PRODUCTION

- ion-plasma application of thermal-protected coatings on complex-shaped articles
- rotary drawing of parts made of high-temperature alloys
- execution of micro-orifices characterized by measured flows of working mediums
- machine processing with high accuracy and roughness of fine-size parts surface at N/C machine tools
- fabrication of Teflon-metal flow-latching couples having high leak-proofness and long-term in-space life (up to 20 years)

PARTICIPATION IN SPACE PROGRAMS AND PROJECTS

- national programs: Salyut, Mir, Soyuz, Progress, Kosmos, Yantar, Molnya, Energya-Buran, Briz, Rokot
- international programs: Mir-Shuttle, International Space Station, Ikar
- project programs: Space Shuttle System Angara, Burlak, Kondor

SERIAL COOL GAS LOW THRUST ROCKET ENGINE MD08

Operating medium	nitrogen/helium
Average nominal thrust, N	0.8/0.73
Average specific impulse in steady state, s	73/169
Operating inlet pressure, MPa	1.77±0.3
On-time, s	0.050…100
Maximum length, mm	93
Maximum mass, kg	0.25
Cycle capability, start	80,000
Operating voltage, V DC	27±5

The thrusters were in operational use as parts of spacecraft of the Cosmos and Express series

SERIAL COOL GAS LOW THRUST ROCKET ENGINE MD5

Operating medium	air/nitrogen
Average nominal thrust, N	4.9
Average specific impulse in steady state, s	70
Operating inlet pressure, MPa	1.23±0.4
On-time, s	0.012…3,000
Maximum length, mm	91
Maximum mass, kg	0.35
Cycle capability, start	250,000
Operating voltage, V DC	27±5

The thrusters were in operational use as parts of cosmonaut's vehicles and the 12 cryogenic booster for the Indian GSLV launcher

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 17D58E

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.2
Average nominal thrust, N	13.3
Average specific impulse in steady state, s	274
Operating inlet pressure, MPa	1.47
Maximum inlet pressure	3.43
Minimum inlet pressure	0.78
On-time, s	0.030…10,000
Maximum length, mm	137
Maximum mass, kg	0.55
Cycle capability, start	450,000
Operating voltage, V DC	27±5

The thrusters were in operational use as parts of the Orbital Manned Space Stations Almaz and Mir (modules Kvant, Kristall, Spectr, Priroda); at present they are in flight operation as parts of the Zarya functional cargo module (ISS), and the Molnya communications satellite

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 11D457

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Average nominal thrust, N	55
Average specific impulse in steady state, s	259
Operating inlet pressure, MPa	1.05…1.35
On-time, s	0.03…300
Maximum length, mm	231
Maximum mass, kg	1.2
Cycle capability, start	100,000
Operating voltage, V DC	27

The thrusters were in operational use as parts of spacecraft of the Cosmos series, at present they are in flight operation as parts of the Resours-DK spacecraft

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 11D428A

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.05
Average nominal thrust, N	130.5
Average specific impulse in steady	291
state, s	1.77±0.4
Operating inlet pressure, MPa	0.030…2,000
On-time, s	274
Maximum length, mm	1.5
Maximum mass, kg	500,000
Cycle capability, start	27±7
Operating voltage, V DC	

The thrusters were in operational use as parts of the Orbital Manned Space Stations Salyut and Mir; at pvesent they are in flight operation as parts of the Service module Zvezda (ISS), the Soyuz manned spacecraft (S/C) and the Progress cargo S/C and the Gamma astrophysical observatory.

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 11D458

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.05
Average nominal thrust, N	400
Average specific impulse in steady state, s	252
Operating inlet pressure, MPa	1 - 2
On-time, s	0.1…3,000
Maximum length, mm	365
Maximum mass, kg	2.5
Cycle capability, start	33,000
Operating voltage, V DC	27

The thrusters were in operational use as parts of the Orbital Manned Space Stations Almaz and Mir; (modules Kvant, Kristall, Spektr, Priroda); at present they are in flight operation as pars of the Zarya functional cardo module (ISS) and the Bris boosters.

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 11D458M

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Thrust at operating pressure	392.4^{+23}_{-45}
Specific impulse in steady state, s	302^{+5}_{-20}
Operating inlet pressure, MPa	$1.47^{+0,50}_{-0,20}$
On-time, s	0,05…1000
Maximum length, mm	461±6
Maximum mass, not over, kg	3
Cycle capability y, start	10,000
Operating voltage, V DC	27±7

The thrusters are in operational use as parts of the Bris-M boosters

SERIAL BIPROPELLANT LOW THRUST ROCKET ENGINE 17D16

Propellant, fuel/oxidizer	kerosene/O_2(gas)
Average nominal thrust, N	196.10
Average specific impulse in steady state, s	257
Maximum inlet pressure, MPa	5.89/1.96
Minimum inlet pressure, MPa	2.45/1.37
On-time s	0.06…100
Maximum length, mm	360
Maximum mass, kg	6.3
Cycle capability, start	40,000
Operating voltage, V DC	27±7

The thrusters were in operational use as parts of the Buran reusable orbiter.

EXPERIMENTAL LOW THRUST ROCKET ENGINE RDMT3

Propellants, Fuel/Oxidizer	UDMH/NTO
Mixture Ratio	1.85±0.2
Average Nominal Thrust, N	3
Average Specific Impulse, Steady State , s	283
Nominal Inlet Pressure, MPa	1.47
Maximum Inlet Pressure, MPa	2.0
Minimum Inlet Pressure, MPa	0.98
Minimum Impulse Bit, N·s	0.07
On-time, s	0.020…600
Nozzie Expansion Ratio	127
Maximum Thruster Length,mm	137
Maximum Mass, kg	0.35
Total Impulse, kN·s	1.8
Cycle Life, Number of starts-up	450,000*
Nominal Voltage, VDC	27
Voltage Range, VDC	20…34
Pull-in Current, A	0.2

*Forecast to be verified at ground experimental development

EXPERIMENTAL LOW THRUST ROCKET ENGINE RDMT10

Propellants, Fuel/Oxidizer	UDMH/NTO
Mixture Ratio	1.85±0.2
Average Nominal Thrust, N	12
Average Specific Impulse, Steady tate , s	295
Nominal Inlet Pressure, MPa	1.47
Maximum Inlet Pressure, MPa	2.0
Minimum Inlet Pressure, MPa	0.98
Minimum Impulse Bit, N·s	0.2
On-time, s	0.020…10,000
Nozzie Expansion Ratio	295
Maximum Thruster Length, mm	164
Maximum Mass, kg	0.35
Total Impulse, kN·s	120
Cycle Life, Number of starts-up	450,000*
Nominal Voltage, VDC	27
Voltage Range, VDC	20…34
Pull-in Current, A	0.03

Forecast to be verified at ground experimental development

EXPERIMENTAL LOW THRUST ROCKET ENGINE RDMT 50M

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.05
Average nominal thrust, N	54
Average specific impulse in steady state, s	290
Operating inlet pressure, MPa	1.18±0.2
On-time, s	0.030…300
Maximum length, mm	253.1
Maximum mass, kg	1.3
Cycle capability, start	100,000
Operating voltage, V DC	27±5

EXPERIMENTAL LOW THRUST ROCKET ENGINE RDMT100-OH

Propellant, fuel/oxidizer	H^2(gas)/O^2(gas)
Mixture ratio	1.6…1.7
Average nominal thrust, N	100
Average specific impulse in steady state, s	378
Operating inlet pressure, MPa	1.1±0.1
On-time, s	0.01…20
Maximum length, mm	270
Maximum mass, kg	1.2
Operating voltage, V DC	27±5
Drain current in operating mode, not over	
- solenoid valves	1
- ignition system	1

EXPERIMENTAL LOW THRUST ROCKET ENGINE RDMT2600

Propellant, fuel/ oxidizer	ethyl alcohol/ O_2(gas)
Mixture ratio	1.2
Average nominal thrust, N	2,600
Average specific impulse in steady state, s	265
Operating inlet pressure, MPa	4.5…5.7
On-time, s	0.015…15
Maximum length, mm	464
Maximum mass, kg	5
Cycle capability, start	1,000
Operating voltage, V DC	27±7
Drain current in operating mode, A, not over	
- solenoid valves	2
- ignition system	1

PROPOSALS OF DEVELOPMENT

BIPROPELLANT LOW THRUST ROCKET ENGINE RDMT100A

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Average nominal thrust, N	98
Average specific impulse in steady state, s	308
Operating inlet pressure, MPa	2.06±0.4
On-time, s	0.030…3,000
Maximum length, mm	317
Maximum mass, kg	1.5
Cycle capability, start	500,000
Operating voltage, V DC	27±7

BIPROPELLANT LOW THRUST ROCKET ENGINE RDMT135MA

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Average nominal thrust, N	130.5
Average specific impulse in steady state, s	310
Operating inlet pressure, MPa	2.06±0.4
On-time, s	0.030…2,000
Maximum length, mm	376
Maximum mass, kg	1.8
Cycle capability, start	500,000
Operating voltage, V DC	27±7

BIPROPELLANT LOW THRUST ROCKET ENGINE RDMT200A

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Average nominal thrust, N	196
Average specific impulse in steady state, s	312
Operating inlet pressure, MPa	2.06±0.4
On-time, s	0.037…2,000
Maximum length, mm	376
Maximum mass, kg	2.0
Cycle capability, start	250,000
Operating voltage, V DC	27±7

BIPROPELLANT LOW THRUST ROCKET ENGINE RDMT500A/1

Propellant, fuel/oxidizer	UDMH/NTO
Mixture ratio	1.85±0.15
Average nominal thrust, N	490
Average specific impulse in steady state, s	315
Operating inlet pressure, MPa	2.06±0.4
On-time, s	0.050…3,000
Nozzle expansion ratio	150
Maximum length, mm	600
Maximum mass, kg	3.5
Cycle capability, start	150,000
Operating voltage, V DC	27±7

SOLENOID VALVES

11D428.200.00-04 SOLENOID VALVE

Nominal clear opening diameter, mm	1.6
Pressure drop (at water flow rate, g/s), MPa, not over	0.2 (22.5)
Inlet pressure, MPa, up to	2.5
Temperature of working fluid, °C	-5 …+40
Supply voltage, VDC	21…34
Max drain current at U=34 VDC, T=20°C, A, not over	0.36
Opening/closing time, s, not over	0.035/0.025
Max starting frequency, Hz	10
Guaranteed life cycles, starting	505,000
Mass, kg, not over	0.2

SOLENOID VALVES OF PT.200 TYPE

	2PT.200.00	2PT.200.00-01	26PT.200.00
Nominal clear opening diameter, mm	1.7	2.1	3
Pressure drop (at water flow rate, g/s), MPa, not over	0.15 (22)	0.35 (80)	0.06 (71)
Inlet pressure, MPa, up to	3	3	3
Temperature of working fluid, °C	-15 …+40	-15 …+40	-15…+50
Supply voltage, VDC	21…34	21…34	20…34
Max drain current at U=34 VDC, T=20°C, A, not over	0.45	0.74	0.83
Opening/closing time, s, not over	0.030/0.025	0.030/0.025	0,030/0,025
Max starting frequency, Hz	12	12	12
Guaranteed life cycles, starting	310,000	60,000	10,000
Mass, kg, not ove	0.18	0.18	0.18

SOLENOID VALVES OF 12PT.200 TYPE

	12PT.200.00	12PT.200.00-01
Nominal clear opening diameter, mm	0.5	0.7
Pressure drop (at water flow rate, g/s), MPa, not over	0.13	0.039
Inlet pressure, MPa, up to	3.5	3.5
Temperature of working fluid, °C	-15 …+50	-15 …+50
Supply voltage, VDC	20…34	20…34
Max drain current at U=34 VDC, T=20°C, A, not over	0.083	0.220
Opening/closing time, s, not over	0.015/0.013	0.015/0.013
Max starting frequency, Hz	25	25
Guaranteed life cycles, starting	500,000	500,000
Mass, kg, not ove	0.035	0.035

SOLENOID VALVES OF 18PT.200 TYPE

	18PT.200.00	18PT.200.00-01
Nominal clear opening diameter, mm	0.5	0.8
Pressure drop (at water flow rate, g/s), MPa, not over	0.5	0.2
Inlet pressure, MPa, up to	11.0	3.6
Temperature of working fluid, °C	-10 …+50	-10 …+50
Supply voltage, VDC	22…34	22…34
Max drain current at U=34 VDC, T=20°C, A, not over	0.7	0.7
Opening/closing time, s, not over	0.001	0.001
Max starting frequency, Hz	300	300
Guaranteed life cycles, starting	100,000	100,000
Mass, kg, not ove	0.01	0.01

SOLENOIDS OF VALVE 6PT.200 TYPE

	6PT.200.00	6PT.200.00-01	6PT.200.00-02
Nominal clear opening diameter, mm	5.1	2.5	1.9
Pressure drop (at water flow rate, g/s), MPa, not over	0.35(500)	0.25(80)	0.25(25)
Inlet pressure, MPa, up to	0.1…6.0	0.1…6.0	0.1…6.0
Temperature of working fluid, °C	-15 …+70	-15 …+70	-15…+70
Supply voltage, VDC	20…36	20…36	20…36
Max drain current at U=34 VDC, T=20°C, A, not over	0.17	0.17	0.17
Opening/closing time, s, not over	0.025/0.020	0.025/0.020	0.025/0.020
Max starting frequency, Hz	20	20	20
Guaranteed life cycles, starting	500,000	500,000	500,000
Mass, kg, not ove	0.16	0.16	0.16

SOLENOID VALVES OF 16PT.200 TYPE

	16PT.200.00	16PT.200.00-01	16PT.200. 00-04
Nominal clear opening diameter, mm	5.0	2.3	4.4
Pressure drop (at water flow rate, g/s), MPa, not over	0.35(500)	0.25(80)	0.25(310)
Inlet pressure, MPa, up to	0.1…3.5	0.1…3.5	0.1…3.5
Temperature of working fluid, °C	-15 …+70	-15 …+70	-15…+70
Supply voltage, VDC	23…36	23…36	23…36
Max drain current at U=34 VDC, T=20°C, A, not over	0.17	0.17	0.17
Opening/closing time, s, not over	0.025/0.020	0.025/0.020	0.025/0.020
Max starting frequency, Hz	20	20	20
Guaranteed life cycles, starting	26,000	26,000	26,000
Mass, kg, not ove	0.16	0.16	0.16

28PT.200 SOLENOID VALVE

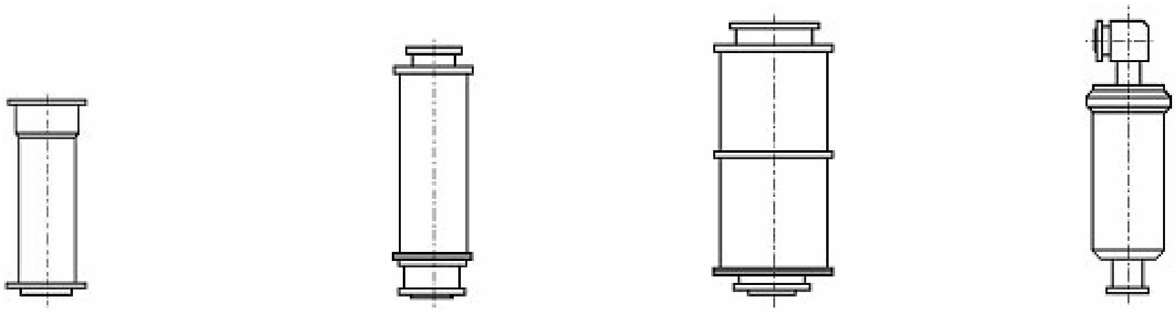
Nominal clear opening diameter, mm	0.9
Pressure drop (at water flow rate, g/s), MPa, not over	0.1
Inlet pressure, MPa, up to	34.3
Temperature of working fluid, °C	-50…+50
Supply voltage, VDC	22…34
Max drain current at U=34 VDC, T=20°C, A, not over	0.5
Opening/closing time, s, not over	0.030
Max starting frequency, Hz	12
Guaranteed life cycles, starting	10,000
Mass, kg, not over	0.5

30PT.200 SOLENOID VALVE

Nominal clear opening diameter, mm	0.5
Pressure drop (at water flow rate, g/s), MPa, not over	0.5
Inlet pressure, MPa, up to	5.5
Temperature of working fluid, °C	-10…+70
Supply voltage, VDC	
- at opening	5.7…6.3
- at keeping out mode	2.0…2.4
Max drain current at U=34 VDC, T=20°C, A, not over	
- at opening	0.5
- at keeping out mode	0.2
Opening/closing time, s, not over	0.02/0.02
Max starting frequency, Hz	25
Guaranteed life cycles, starting	0.035

MASS FLOW STABILIZERS

When the operating mediums pressure at the stabilizer inlet is changed 2.5 times the operating medium flow rate is kept up within ± 5 % and less



Operating mediums			
Components of propellant			Air, nitrogen, oxygen, hydrogen, etc.
Mass flow rate, g/s			
water			air
2.41…2.45	22.4…24.6	62.1…65.9; 85.4…90.6 335…355; 456…484	55.8…64.2
Inlet pressure, MPa			
2.4…6.0	2.4…6.0	2.4…6.0	2.4…5.9
Pressure drop, MPa			
0.2…3.25	0.2…3.25	0.2…3.25	0.3…3.7
Mass, kg			
0.025	0.039	0.09	0.200

PROPULSION SISTEM KDU414NS

The propulsion system (PS) KDU414NS is designed for a generation of a thrust force for an attitude control of a communication satellite at a high-elliptic orbit.

The module type PS includes self-contained propellant storage system, pressurized reservoirs for gas-pressure supply system, a propellant flow control automatic system that does not require special control and regulation during PS operational use as a part of a satellite.

The PS can provide a thruster operation within a wide combination range of on-time and off-time.

Propellants, Fuel/Oxidizer	UDMH/NTO
Propellant mass, kg	42.3±0.3
Dry mass, kg	56.0±0.5
Total Impulse BIT over operational life, N·s, no less	79,100
Thruster characteristics	
Thrust, N	13.30±0.59
Specific impulse, s	274
Total operational time, s, not over	7,000
Maximum thrusting command duration, s	1,500
Supply voltage, VDC	27±7
Drain current, A, not over	0.2
Start-up/cut-off time, ms, not over	30/65

EXPERIMENTAL PROTOTYPE OF REACTIVE CONTROL SYSTEM MODULE

- universal module reactive control systems for stabilization and orientation of different space vehicles, their attitude and motion control including their transfer to safe orbits or providing controllable descent in case of vehicle injection into off-design orbits or in case of service life termination. The Reactive Control System Module is designed for:
- capsules for information and cargo delivery from spacecraft to the Earth and other planets;
- orbital maneuvering vehicles (space tugs) to high-altitude orbits, to the Moon, etc;
- removal of space vehicles from their operating orbits at the end of service life and making other operations;

If a command duration is 0.005 s and more, low thrust rocket engines (LTRE) generate the guaranteed thrust pulse.

Types and a number of LTRE, power and dynamic characteristics, overall dimensions and mass will be determined in the process of RFP agreement.

Depending on customer's demand the reactive control system modules on the long-term storage propellants could be supplied filled-up.

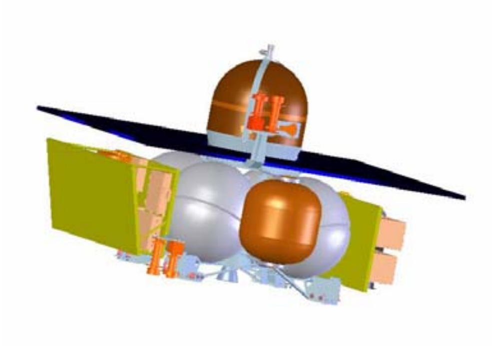
Propellant:	UDMH/NTO
Propellant mass, kg	10
Dry mass, kg	4
LTRE characteristics	
Sustainer LTRE (1 unit):	600
Thrust, N	10
Pitch, yaw, roll LTRE (4 unit):	
Thrust, N	10
Vacuum specific impulse of one LTRE, s	**300**
Total operating time, s	40
Supply voltage, V DC	27
Drain current of each LTRE, A, not over	1
Start-up/cut-off time of each LTRE, ms, not over	7

FOBOS-GROONT Program

RETURN VEHICLE PROPULSION SYSTEM

The propulsion system includes a 130.5 N cruise engine, 16 0.8N gaseous nitrogen thrusters. Its pressurized feed system is composed of 4 monopropellant tanks with hard separating diaphragms and 2 gaseous nitrogen bottles. A bottle liner power winding is made of an Armos orfganoplastic tape assembly. The nitrogen thruster offers the cycle life characteristic of ≥ 80,000.

- Lifting of the return vehicle from a surface of the Fobos, that is a Mars satellite, and a transfer of the vehicle to Martian intermediate orbits designed.
- Transition of the vehicle to a Mars-Earth flying path.
- Vehicle spatial orientation.
- Flying path correction at the commands from the Earth.



Main Performance:

Dry mass, kg	48
Propellants mass, NTO/UDMH, kg	135
Gaseous nitrogen mass, kg	6.46
- for orientation thrusters	3
- for propellant tank pressurization	3.46
Mass mixture ratio	1.85±0.5
Supply voltage, V, DC	7
Cruise engine inlet pressure, MPa	1.6

CORRECTION THRUSTERS CRUISE UNIT

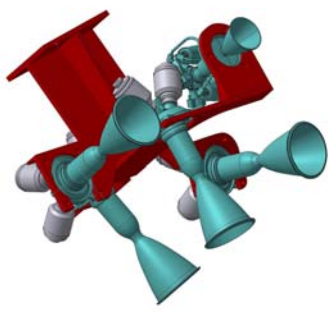
The unit is used as a part of a trip module. It includes 4 11D458F thrusters, operating with the NTO/UDMH propellants.

11D458F Thruster:

Average Nominal Thrust, N	392.4
Mixture ratio	1.85±0.1
Average Specific Impulse, Steady State, s	302
Nominal inlet pressure, MPa	1.47
Inlet pressure range, MPa	1.27…1.97
Average Minimum Impulse Bit, N·s	19.62
Time of start-up, s	0.05…1,000
Nozzle Expansion ratio	100
Maximum mass, kg	3
Cycle Life, Number of starts-up	10,000
Nominal Voltage, VDC	27
Pull-in Current, A	0.20…0.30

LOW THRUSTERS UNIT

The unit is used as a part of a trip module. It is designed for making control actions during spacecraft stabilization and orientation. The unit operates with the NTO/UDMH propellant.



11D457F Thruster:

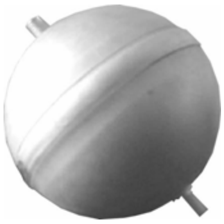
Average Nominal Thrust, N	53.9
Mixture ratio	1.85±0.15
Average Specific Impulse, Steady	
State, s, no less than	290
Nominal inlet pressure, MPa	1.2
Time of start-up, s	0.03… 200
Maximum mass, kg	1.2
Cycle Life, Number of starts-up	100,000
Nominal Voltage, VDC	27
Amount of thrusters	4

HIGH PRESSURE VESSELS

FILAMENTARY COMPOSITE - REINFORCED SHELL VESSEL

Working media	nitrogen, air, helium
Thin-walled liner material	AMr6 aluminum alloy
Overwrapped material	Armos organoplastic tape assembly
Capacity, m^3	$1.84 \cdot 10^{-3}$
Mass, kg	0.25
Operating pressure, MPa	≤ 9.81
Collapsing pressure, MPa	> 18.6

ALL - METAL VESSEL



Working media	nitrogen, air, helium
Material	AMr6 aluminum alloy
Capacity, m^3	$2 \cdot 10^{-3}$
Mass, kg	≤ 1.07
Operating pressure, MPa	7.85
Collapsing pressure, MPa	≥ 23.5

FILAMENTARY COMPOSITE - REINFORCED SHELL VESSEL

Working medium	nitrogen, air, xenon
Thin-walled liner material	BT1-0 (OT4-1) titanium alloy
Overwrapped material	Armos organoplastic tape assembly
Capacity, m^3	$25 \cdot 10^{-3} \ldots 60 \cdot 10^{-3}$
Mass, kg	5.5…14
Operating pressure, MPa	≤ 16.68
Depressurization pressure, MPa	≥ 22.4

VESSEL FOR STORAGE OF GASES AND LIGUIDS

Material	T1-O titanium alloy (It is possible to adapt the technology for other alloys)
Capacity, m^3	(38.2 ± 0.2)□10^{-3}
Mass, kg	2.7 ± 0.1
Operating pressure, MPa	0.981

PROPELLANT TANKS

MONOPROPELLANT FILAMENTARY COMPOSITE REINFORCED SHELL TANK WITH EXPULSION DIAPHRAGM

Propellant components	NTO or UDMH
Thin-walled liner material	AMr6 aluminum alloy
Diaphragm material	АД1 aluminum alloy
Overwrapped material	Armos organoplastic tape assembly
Capacity, m^3	$1.74 \cdot 10^{-3}$
Mass, kg	0.31
Operating pressure, MPa	≤ 9.8
Collapsing pressure, MPa	≥ 18.6

The tank versions with increase of propellant component capacity up to $120 \cdot 10^{-3}$ m^3 can be fabricated.

BIPROPELLANT ALL-METAL TANK WITH EXPULSION DIAPHRAGMS

Propellant components	NTO / UDMH
Case material	Mr6 aluminum alloy
Diaphragm material	АД1 aluminum alloy
Capacity (NTO/UDMH), m3	$21 \cdot 10^{-3}/20 \cdot 10^{-3}$
Mass, kg	≤ 16
Operating pressure, MPa	≤ 3.14
Collapsing pressure, MPa	≥ 5.59

TEST COMPLEX FOR TESTING CRYOGENIC LIQUID H_2+O_2 ROCKET ENGINES

Test stand 201 was built in 1978 by the program of Energya launch vehicle creation for РД-0120 H_2+O_2 liquid rocket engine testing.

Firing test of LRE

Test stand 301 was built in 1987 by the program of Energya launch vehicle creation for РД-0120 H_2+O_2 liquid rocket engine testing.

Subsystems providing operation of test stand