

**Date: 28 / 03 /16**

# **RUSSIAN SPACE NUCLEAR POWER PLANT MODULES**

**A REPORT IN CONFIDENCE TO  
CST MEMBERS, ASSOCIATES  
AND CUSTOMERS**

**MARCH 2016**

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## Document Change Log

Revision	Description	Date
A	Initial draft	15 <sup>th</sup> March, 2016
B	Second Draft	Unissued
C	Third Draft	28 <sup>th</sup> March, 2016
D	Master	28 <sup>th</sup> March, 2016

Written	V
Edited	RO
Checked	AW
Authorised	AW
Doc No.	2016-CST-TR-NP
Issue	D
Date	28 <sup>th</sup> March, 2016

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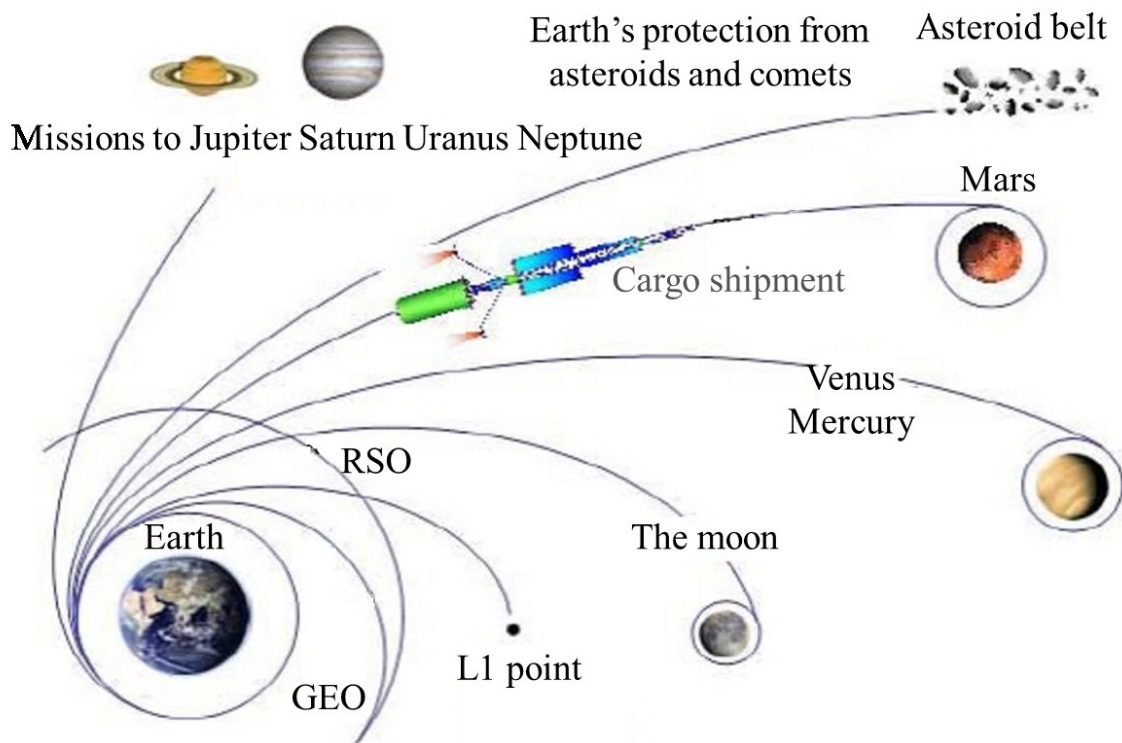
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## ACRONYMS AND ABBREVIATIONS

EPS	-	Electric Propulsion System
EPU	-	Electric Propulsion Unit
GEO	-	Geostationary Earth Orbit
ISS	-	International Space Station
LIDAR	-	Light And Ranging
MW	-	Mega Watt
NEP	-	Nuclear Electric Propulsion
NIKIET		
NPO		
NPU	-	Nuclear Propulsion Unit
NPPU	-	Nuclear Power Propulsion Unit
NRE	-	Nuclear Rocket Engine
NTP	-	Nuclear Thermal Propulsion
RSC		
RSO	-	Resident Space Objects
SAR	-	Synthetic Aperture Radar
UCN	-	Uranium Carbo-Nitride

## INTRODUCTION

Russia's current leadership is investing into long-term breakthrough technology projects for the country's future. One of these projects is megawatt-class nuclear space power systems for spaceflight. This project is viewed as crucial, if Russia wants to maintain a competitive edge in the space race. If successful, the project will lead to a whole range of challenging missions as illustrated in Fig. 1. Among those tasks are: cleaning Resident Space Objects (RSO); boosting heavy payloads to geostationary orbit (GEO); Lunar exploration; manned missions to Mars; missions to: asteroids and comets, Lagrangian points, other solar system planets and their moons, etc.



**Fig. 1. Prospective space transportation missions for nuclear vehicles. /0/**

In particular, near the Earth, a MW (Mega Watt) power level nuclear power propulsion unit (NPPU), can serve as an Earth/Moon SAR/LIDAR. A space vehicle with a NPPU can propel an inter-orbital tug, or be used for clearing orbital debris, as well as for diverting

approaching asteroids from the Earth. The advanced propulsive ability of a NPPU can be useful for Lunar exploration: delivering the crew and cargo for a lunar base. Nuclear power units (NPU) can serve as a power plant for many applications.

For interplanetary missions, applications of NPPU with specific impulses of 6000-9000 s /0/ will make possible manned missions to Mars, a solar polar orbiter, exploration of the Jovian moons Europa, Ganymede, and Callisto, Titan/Saturn sample return, Neptune/Triton probes, asteroid science, comet and Pluto rendezvous, interstellar probes as well as other missions within the solar system and beyond. /0/

This is why nuclear propulsion is expected to bring practical space exploration to a new level.

This report gives an update regarding the current status of the project. All information is from openly available material published in the media.

## REFERENCED CST REPORTS

(indicated in square brackets in the text)

## NON-CST REFERENCES

(indicated in slant brackets in the text)

1. Lovtsov A.S., Keldysh research center, Electric propulsion - an integral part of electric propulsion systems of the future, Presentation for Aerospace Science Week, 11/17-24/2014 (in Russian, А. С. Ловцов, Центр Келдыша, Электроракетные двигатели – составная часть электродвигательных комплексов будущего, 17-24.11.2014: [http://aeroweek.ru/docs/19.11.2014/lovtsov\\_keldysh.pdf](http://aeroweek.ru/docs/19.11.2014/lovtsov_keldysh.pdf) last accessed: on March 12, 2016)
2. NASA, Glenn research Center at Lewis field, High Power Electric Propulsion Program (HiPEP): <https://www.grc.nasa.gov/WWW/ion/present/hipep.htm> (last accessed: on March 12, 2016)
3. Vadim A. Zakirov, Vladimir A. Pavshook, “Feasibility of the Recent Russian Nuclear Electric Propulsion Concept: 2010”, Nuclear Engineering and Design, Vol: 241, Issue 5, May 2011, pp. 1520-1537, ISSN 0029-5493
4. Zakirov V.A., Pavshook V.A., “Russian Nuclear Rocket Engine Design for Mars Exploration”, Tsinghua Science and Technology Journal, Vol.12, No.3, 2007, pp. 256-260. ISBN 1007-0214, CN 11-3745 / N
5. Stanley Borowski, “An Overview of NTR/BNTR Propulsion Concepts, Vehicle Designs and Future Mission Applications”, Presentation at ANS/SNC Conference, San Diego, California, June 5-9, 2005

6. Russian officials again talk about a working lab prototype megawatt class nuclear propulsion system by 2017: <http://nextbigfuture.com/2016/03/russian-officials-again-talk-about.html> (last accessed: on March 12, 2016)
7. Nuclear engine for the spacecraft (in Russian, Ядерный двигатель для космолёта: <http://rusila.su/2014/08/22/yadernyj-dvigatel-dlya-kosmolyota/> last accessed: on March 12, 2016)
8. The first fuel element made for Russian nuclear space engine (in Russian, В России собран первый ТВЭЛ для ядерного космического двигателя: <http://vg-news.ru/n/110057> last accessed: on March 12, 2016)
9. RIA.ru news, Media: the RF receive a spacecraft with a nuclear engine in 2025, 1/18/2016, (in Russian, СМИ: РФ получит космический аппарат с ядерным двигателем к 2025 году, 18.01.2016: <http://ria.ru/science/20160118/1361219460.html> last accessed: on March 12, 2016)
10. Khrunichev State Research and Production Space Center, Angara Launch Vehicles Family: <http://www.khrunichev.ru/main.php?id=44> last accessed: on March 12, 2016)
11. RIA.ru news, The reactor for the nuclear space engine will be ready by the end of 2014, 01/29/2013 (in Russian, Реактор для космического ядерного двигателя будет готов к концу 2014 г, 29.01.2013: <http://ria.ru/science/20130129/920290779.html> last accessed: on March 12, 2016)
12. "Kommersant" news, Vladimir Teslenko, Space nuclear power installation is now possible only in Russia, 8/31/2015 (in Russian, газета «Коммерсант», Владимир Тесленко, Космические ядерные энергодвигательные установки сейчас возможны только в России, 31.08.2015: <http://www.kommersant.ru/doc/2810188> last accessed: on March 11, 2016)



13. Nuclear Reactors and Radioisotopes for Space, Updated February 2016:  
<http://www.world-nuclear.org/information-library/non-power-nuclear-applications/transport/nuclear-reactors-for-space.aspx> (last accessed: on March 12, 2016)
14. Novodti-Kosmonavtiki news, Afanasiev N., Nuclear tug development continues (in Russian, Афанасьев И., Разработка ядерного буксира продолжается: <http://novosti-kosmonavtiki.ru/mag/2013/1099/14567/> last accessed: on March 12, 2016)
15. The newspaper "Vzglyad", Completed technological tests of Russian nuclear reactor vessel for space, 11/18/2015 (in Russian, газета «Взгляд», Завершены технологические испытания российского корпуса ядерного реактора для космоса, 18.11.2015: <http://vz.ru/news/2015/11/18/778812.html> last accessed: on March 12, 2016)
16. NIKIET, Annual report of JSC "NIKIET" for the year of 2014 (in Russian, Годовой отчет АО «НИКИЭТ» о результатах деятельности в 2014 году.  
[http://www.NIKIET.ru/images/stories/NIKIET/about\\_us/publicmaterials/godovoy\\_otchet\\_2014.pdf](http://www.NIKIET.ru/images/stories/NIKIET/about_us/publicmaterials/godovoy_otchet_2014.pdf) last accessed: on March 12, 2016)
17. Wikipedia in Russian, Nuclear electric propulsion plant (in Russian, интернет-ресурс Википедия, Ядерная электродвигательная установка:  
[https://ru.wikipedia.org/wiki/%D0%AF%D0%B4%D0%B5%D1%80%D0%BD%D0%B0%D1%8F\\_%D1%8D%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D0%B4%D0%B2%D0%B8%D0%B3%D0%B0%D1%82%D0%B5%D0%BB%D1%8C%D0%BD%D0%B0%D1%8F\\_%D1%83%D1%81%D1%82%D0%B0%D0%BD%D0%BE%D0%B2%D0%BA%D0%B0](https://ru.wikipedia.org/wiki/%D0%AF%D0%B4%D0%B5%D1%80%D0%BD%D0%B0%D1%8F_%D1%8D%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D0%B4%D0%B2%D0%B8%D0%B3%D0%B0%D1%82%D0%B5%D0%BB%D1%8C%D0%BD%D0%B0%D1%8F_%D1%83%D1%81%D1%82%D0%B0%D0%BD%D0%BE%D0%B2%D0%BA%D0%B0) last accessed: on March 12, 2016)
18. ROSATOM news, The first fuel element for a nuclear power developed megawatt-class installation has been assembled, 4/7/2014 (in Russian, Произведена сборка первого твэла для разрабатываемой ядерной энергодвигательной установки мегаваттного

класса, 04.07.2014:

<http://www.ROSATOM.ru/journalist/news/10dd3d80449a721ab6a2b6e920d36ab1> last accessed: on March 12, 2016)

19. Fred Weir, Russians to ride a nuclear-powered spacecraft to Mars, The Christian Science Monitor, U.S.A., October 29, 2009: <http://www.csmonitor.com/World/Global-News/2009/1029/russians-to-ride-a-nuclear-powered-spacecraft-to-mars> (last accessed: on March 12, 2016)
20. RIANOVOSTI, Russia to start research into spacecraft nuclear engines in 2010, 20/12/2009: <http://en.rian.ru/science/20091220/157304824.html> (last accessed: on March 12, 2016) (in Russian, РИА Новости, Государство выделит 17 млрд руб на проект корабля с ядерным двигателем, 31/10/2009: <http://www.rian.ru/economy/20091031/191428867.html> last accessed: on March 12, 2016)
21. Anatoly Koroteev, "Nuclear Power is capable of breakthrough development in Cosmonautics", (in Russian, Академик Анатолий Коротеев: "Ядерная энергетика способна обеспечить качественный скачок в развитии космонавтики" <http://www.federalspace.ru/8996/> last accessed: on March 12, 2016)
22. Development of nuclear tug continues, 1/18/2014 (in Russian, Разработка ядерного буксира продолжается, 18.01.2014: <http://topwar.ru/38546-razrabotka-yadernogo-buksira-prodolzhaetsya.html> last accessed: on March 12, 2016)
23. ROSATOM news, NIKIET completed reactor control system test for nuclear space propulsion unit, 6/27/2014 (in Russian, НИКИЭТ завершил испытания системы управления реактором космической ЯЭДУ, 27.06.2014: <http://www.ROSATOM.ru/journalist/atomicsphere/f31dac804485ae6aad67ade920d36ab1> last accessed: on March 12, 2016)

24. In Russia, the world's first nuclear space engine is assembled (in Russian, В России собрали первый в мире ядерный космический двигатель: <http://wh24.ru/v-rossii-sobrali-pervyj-v-mire-yadernyj-kosmicheskij-dvigatel/> last accessed: on March 12, 2016)
25. In Russia, it assembled the world's first fuel element for space power plants, 07/04/2014 (in Russian, В России собран первый в мире тепловыделяющий элемент для космических энергетических установок, 04.07.2014: <http://scientificrussia.ru/articles/v-rossii-sobran-pervyj-v-mire-teplovydelyayushchij-element-dlya-kosmicheskikh-energeticheskikh-ustanovok> last accessed: on March 12, 2016)
26. Testing of the simulator "core" for the space reactor begins (in Russian, Начинаются испытания имитатора «ядра» реактора для космоса: <http://publicatom.ru/tag/%D1%8F%D0%B4%D0%B5%D1%80%D0%BD%D1%8B%D0%B9%20%D0%B4%D0%B2%D0%B8%D0%B3%D0%B0%D1%82%D0%B5%D0%BB%D1%8C/> last accessed: on March 12, 2016)
27. Lenta.ru news, Russia will create a nuclear engine for the conquest of outer space, 1/18/2016 (in Russian, Россия создаст ядерный двигатель для покорения дальнего космоса, 18.01.2016: <http://lenta.ru/news/2016/01/18/nuclear/> last accessed: on March 12, 2016)
28. Lenta.ru news, ROSCOSMOS has denied the information about the change of the Federal Space Program, 4/24/2015 (in Russian, Роскосмос опроверг информацию об изменении Федеральной космической программы, 24.04.2015: <http://lenta.ru/news/2015/04/24/ROSCOSMOS/> last accessed: on March 12, 2016)

29. Zoom to Mars in 6 weeks with new Russian nuclear-fission engine, 3/3/2016:  
<https://www.rt.com/news/334416-russia-space-nuclear-engine/> (last accessed: on March 11, 2016)
30. In Russia, the world's first nuclear space engine has been assembled (in Russian, В России собрали первый в мире ядерный космический двигатель: <http://ruskiy-malchik.livejournal.com/507897.html> last accessed: on March 12, 2016)
31. Lenta.ru news, In Russia have been successfully completed testing of the reactor vessel for space 11/18/2015 (in Russian, В России успешно завершены испытания корпуса ядерного реактора для космоса, 18.11.2015:  
<http://lenta.ru/news/2015/11/18/ROSATOM/> last accessed: on March 12, 2016)
32. Gazeta.ru news, In "ROSATOM" has successfully completed testing of the reactor vessel for space 11/18/2015 (in Russian, В «Росатоме» успешно завершены испытания корпуса ядерного реактора для космоса, 18.11.2015:  
[http://www.gazeta.ru/science/news/2015/11/18/n\\_7903187.shtml](http://www.gazeta.ru/science/news/2015/11/18/n_7903187.shtml) last accessed: on March 12, 2016)
33. The test reactor vessel to space successfully completed in Russia (in Russian, Испытания корпуса ядерного реактора для космоса успешно завершены в РФ:  
<http://sdelanounas.ru/blogs/70565/> last accessed: on March 12, 2016)
34. Lenta.ru news, Orbital pragmatism. What to expect from the reduced federal space program, 1/24/2016 (in Russian, Орбитальный прагматизм. Чего ждать от сокращенной федеральной космической программы, 24.01.2016:  
<https://lenta.ru/articles/2016/01/24/moon/> last accessed: on March 12, 2016)
35. Nick Stockton, Russia Thinks It Can Use Nukes to Fly to Mars in 45 Days—If It Can Find the Rubles,10/3/16: <http://www.wired.com/2016/03/russia-thinks-can-use-nukes-fly-mars-90-days-can-find-rubles/> (last accessed: on March 12, 2016)

36. RBK.ru news, Eugene Kalyukov, Economists have warned of the twisting spiral of recession in Russia, 2/26/2016 (in Russian, РБК, Евгений Калюков, Экономисты предупредили о закручивании спирали рецессии в России, 26.02.2016: <http://www.rbc.ru/economics/26/02/2016/56d04d2f9a7947563516ed8d> last accessed: on March 12, 2016)
37. НИКИЭТ completed reactor control system testing for space propulsion unit (in Russian, НИКИЭТ завершил испытания системы управления реактором космической ЯЭДУ: <http://2012god.ru/forum/forum-8/topic-2730/page-1/post-398666/> last accessed: on March 12, 2016)
38. RIA.ru news, ROSATOM starts testing simulator "core" of the reactor for space 1/22/2016 (in Russian, Росатом начинает испытания имитатора "ядра" реактора для космоса, 22.01.2016: <http://ria.ru/science/20160122/1363274454.html> last accessed: on March 12, 2016)