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# Development Nuclear Gas Core Reactor in Russia

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**After a gap of several years, there is a revival of interest in the use of nuclear fission power for space missions.[1] While Russia has used over 30 fission reactors in space, the USA has flown only one - the SNAP-10A (System for Nuclear Auxiliary Power) in 1965. Research and development Nuclear Gas Core Reactor (NGCR) for rockets in Russia (USSR) started at Keldysh Center since 1954. The NGCR consists of the fissile fuel with highly enriched uranium (U-235 or U-233) in a gas phase jet at pressure up to 1000 atm (100 MPa) and temperature up to 70000 K. For high specific impulse hydrogen is used as propellant and for radiation energy transfer to gas hydrogen is riched by alkali metal vapors like Li. The shape of the considered fissile gas core is cylindrical. NGCR can provide much higher specific impulse than solid core nuclear rockets because their temperature limitations are in the nozzle and core wall structural temperatures, which are distanced from the hottest regions of the gas core. Consequently, nuclear gas core reactors can provide much higher temperatures to the propellant. Development of the NGCR project could be realized with the basic research in the field of high energy density matter as the nonideal plasma where Coulomb interaction more than thermal particle energy, radiation in dense Uranium plasma, turbulent mixing at high Re numbers between Nuclear Core and surrounding propellant, influence of magnetic field to mixing and Rayleigh-Taylor instability of gravity and inertial forces, etc. These problems have been investigated in Keldysh Center and MIPT, partially published by Ievlev (1964),[2] Ievlev (1975),[3] Martishin (1975),[4] Handbook on Thermophysical Properties of Working Media Nuclear Gas Reactor (1980),[5] Ievlev, Son (1985),[8] Son (1979),[9] comprehensive books edited by Koroteev (2002),[76] and presented in the report. Due to the inability to perform live testing on earth, research is focused on experiments with solid state reactors IGR developed by Kurchatov Institute in Russia. Results of these investigations in basic science are reported.**

## I. Introduction

Nuclear Gas Core Reactor (NGCR) is a conceptual type of rocket that is propelled by the exhausted coolant of a gaseous fission reactor. The considered nuclear fission reactor core is in a plasma state. It may be capable of creating specific impulses of 3 000 - 5 000 s (30 to 50 kNs/kg) and thrust which is enough for relatively fast interplanetary travel. Heat transfer to the working fluid (propellant) is by thermal radiation, mostly in the ultraviolet, given off by the fission gas at a working temperature of around 50000 K. Early on, from 1959-73 there was a US nuclear rocket program - Nuclear Engine for Rocket Vehicle Applications (NERVA) which was focused on nuclear power replacing chemical rockets for the latter stages of launches. NERVA used graphite-core reactors heating hydrogen and expelling it through a nozzle. Some 20 engines were tested in Nevada and yielded thrust up to more than half that of the space shuttle launchers. Since then, "nuclear rockets" have been about space propulsion, not launches. The successor to NERVA is today's nuclear thermal rocket (NTR). Another early idea was the US Project Orion, which would launch a substantial spacecraft from the earth using a series of small nuclear explosions to propel it. The project commenced in 1958 and was aborted in 1963 when the Atmospheric Test Ban Treaty made it illegal, but

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