Radio Thermoelectric Generators

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Why in News?

Recently, **Indian Space Research Organisation (ISRO)** in collaboration with the **Bhabha Atomic Research Center (BARC)**, has embarked on the joint development of **Radio thermoelectric generators (RTGs)**, an innovative approach aimed at surpassing the constraints of conventional **chemical engines** for interplanetary voyages.

- Chemical engines work well for satellite thrusters, but they are **inadequate for deep space travel due to fuel limitations and lack of solar power in distant regions.**
- RTGs have been successfully employed by US spacecraft such as the Voyager, Cassini and Curiosity, to power missions with exceptional achievements.

What are the Radio Thermoelectric Generators (RTGs)?

- **About:**
  - RTGs are innovative power sources designed to **address challenges in deep space missions.**
  - RTGs utilize radioactive materials, such as ***Plutonium-238 or Strontium-90,*** **which emit heat as they decay over time.**
  - This **heat is harnessed and converted into electricity,** enabling the propulsion and power of spacecraft.
- **Components of RTGs:**
  - **Radioisotope Heater Unit (RHU):**
    - The RHU is responsible for **generating heat through the decay of** radioactive materials.
    - It initiates the process by **releasing** thermal energy**,** which serves as the foundation for electricity generation.
  - **RTG (Heat-to-Electricity Conversion):**
    - The RTG component transforms the **heat generated by the RHU into usable electricity.**
    - This conversion takes place through a **thermocouple**, a material that generates **voltage when subjected to a temperature gradient.**
    - The voltage produced by the thermocouple is utilized to **charge batteries onboard the spacecraft.**
    - These batteries, in turn, power various systems, including propulsion mechanisms, enabling interplanetary travel.
- **Advantages of RTGs for Space Missions:**
  - **Independence from Solar Proximity:**
    - Unlike solar-powered systems, RTGs operate effectively regardless of the **spacecraft's distance from the sun.**
    - This characteristic **eliminates constraints related to launch windows and planetary alignment.**
  - **Reliability and Consistency:**
    - RTGs offer a **consistent and reliable source of power,** essential for sustaining

prolonged deep space missions.
- The gradual decay of radioactive materials ensures a continuous supply of heat and electricity.

Bhabha Atomic Research Centre

- BARC is India’s premier **nuclear research** facility based in Mumbai, Maharashtra.
- It is a multi-disciplinary research center with extensive infrastructure for advanced research and development.
- Its core mandate is to sustain peaceful applications of nuclear energy, primarily for power generation.