# Mitigating the Risk of Harm From Radiation Exposure

**The Necessity of the Radiation Emergency Assistance Center/Training Site for the Successful Launch of Mars 2020**

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**Abstract – In July of 2020, NASA is sending another advanced rover to Mars: a mission that will re-ignite national enthusiasm for planetary exploration and investigate the Martian surface. The success of this launch is crucial, as this data collected on Mars will lay the groundwork for future human exploration. To this end, NASA has enlisted the assistance of several partners to ensure a safe and successful mission. The rover, named "Perseverance," carries a nuclear-powered thermoelectric battery that may pose a radiological safety hazard in the event of a launch anomaly. In light of this, the Radiation Emergency Assistance Center/Training Site is playing a critical role in preparing for any event that could pose additional risk to launch personnel or the surrounding communities.**

## 1 Background

The Radiation Emergency Assistance Center/ Training Site (REAC/TS) has been operating continuously as an emergency response center since July of 1976. [1] During the height of the Nuclear Age, the Oak Ridge Institute for Science and Education (ORISE) created REAC/TS for the purpose of providing emergency medical response, training, and consultation for the burgeoning number of projects with radiological hazards. It has since proved to be a vital resource for non-government and government agencies alike.

The Oak Ridge Associated Universities (ORAU) operates REAC/TS for the US Department of Energy, maintaining REAC/TS as the only Collaboration Centre in the country for the World Health Organization and the Pan American Health Organization. [2] As a product of this collaboration, radiation emergency management protocols and trainings are developed to prepare for any future incidents involving radiation exposure. REAC/TS also coordinates international radiation emergency response through the International Atomic Energy Agency. The organization's knowledge has been called upon for cases all around the world, from space missions to nuclear reactors. REAC/TS also maintains the Radiation Accident Registry, which catalogues the details of past radiation exposure incidences. [5]

One of the core purposes of REAC/TS is to educate and prepare health-care professionals and emergency workers for the possibility of a radiological incident. Preparedness is critical for the safety of all involved people in the event of radiation exposure. To this end, REAC/TS holds classes to train medical workers on how to handle patients who have been exposed to radiation. Many of the participants in these classes have never taken such a course before. [4] REAC/TS provides not only knowledge, but active physical support. REAC/TS specialists are on-call 24/7 and are prepared to deploy internationally to provide emergency medical advice during radiological incidents. They have decades of experience consulting as well as providing on-the-ground medical support globally.

In addition to emergency consultation and training efforts, REAC/TS conducts cutting-edge research on the effects of radiation exposure, disaster readiness, and radiation exposure treatments. One of the original purposes of REAC/TS was to investigate the biological effects of radiation, and they have contributed to this field for over 40 years. Recent publications span from a pilot study of a disaster triage video game for first responders to niche biological experiments exploring DNA damage. [10] REAC/TS runs one of only three American biodosimetry laboratories, where advancements in radiation dose assess-

ment technologies are made. [1]

## 2 Capabilities and Necessity

### 2.1 Emergency Response

REAC/TS is an expert in emergency response. REAC/TS has supplied emergency medical assistance all over the world, consulting at Chernobyl, Goiania, and Fukushima. In the event of an emergency, REAC/TS has the capability to deploy in under four hours for a domestic incident, and under six hours for an international incident. [1] Their staff of health physicists and medical professionals excel at emergency medical support in the event a radiological accident has already occurred. The REAC/TS team also specializes in planning for incidents in order to mitigate health effects in exposed people. The network of radiological response resources and knowledge that REAC/TS has developed is often called upon by organizations around the world, and will continue to support NASA's space exploration missions. They have spent years preparing hospitals and local officials for the unlikely event of a launch anomaly that might expose people to radiation. [9] Furthermore, REAC/TS will have a physical presence at the Mars 2020 launch. They will send a health physicist and a physician to the Kennedy Space Center to be available in the event of an emergency. [9]

### 2.2 Education and Training

In the organization's mission to educate members of the medical field about radiation exposure treatment, REAC/TS has developed a multitude of courses in radiation emergency medicine. These courses, which have been taught around the world, offer specialized training in the medical management of radiation-exposed patients. These courses, which are taught around the world, include topics such as "Radiation Emergency Medicine," "Health Physics in Radiation Emergencies," and "Advanced Radiation Emergency Medicine." Classes offered by REAC/TS are accredited by the American College of Emergency Physicians (ACEP), the American Academy of Health Physics (AAHP) and the Accreditation Council for Continuing Medical Education (ACCME).[4]

### 2.3 Sources of Risk

REAC/TS is necessary partner for the Mars 2020 launch due to the type of generator powering the rover. Perseverance is powered by a MMRTG (Multi-Mission Radioisotope Thermoelectric Generator). The MMRTG's source of power is 10.6 pounds of plutonium dioxide, a radioactive compound that produces heat as it decays. The heat, in turn, is converted into electricity that charges the rover's two lithium ion batteries. These two batteries power Perseverance if the rover's energy needs surpass the amount that the MMRTG provides. [8] The engineers and administrators behind the MMRTG have taken several precautions to mitigate the risk of radiation exposure in the event of a launch anomaly. The plutonium dioxide is incorporated in such a way as to reduce the risk of aerosolization: it is manufactured as a ceramic material, which would fracture rather than aerosolize in the event of an accident. Plutonium dioxide fuel is also protected by shells of iridium and graphite, which are heavily impact resistant and thermally resistant. These physical protection systems should ensure the safety of the radioactive fuel in the unlikely event of a fire or a crash. [8] Although the probability of radioactive material being released is extremely low (according to Sandia National Laboratory's calculations, it is 1 in 11 million), NASA has also taken non-mechanical steps to prepare for any anomalies: they have enlisted the assistance of REAC/TS to plan for any issues that arise with the radioactive battery upon launch. [11]

While the amount of radioactive material within the rover is small, plutonium dioxide can cause lung damage and increased rates of cancer and respiratory issues when directly inhaled. The oddss of individuals experiencing health effects in the event of radioactive material release is low (the probability, summed across all residents of the projected impacted area, is 0.0759), but it is important that those closest to the launch receive prepared, effective medical care in the event plutonium dioxide is released.[11] The plan developed by REAC/TS is absolutely critical for the safety of all nearby people, as it will allow hospitals to be fully versed in radiation exposure treatment and be as ready as possible in the event of a radiation exposure incident.

### 2.4 A Proven Record

The knowledge base and planning skill provided by REAC/TS is critical to ensure the safety of all personnel during the Mars 2020 launch. REAC/TS

has a strong history of providing support to the Mars missions. In 1997, the organization provided support for the launch of the deep space probe "Cassini." [9] Prior to the launch, REAC/TS taught medical radiation accident preparedness workshops at five hospitals near the launch site and at the Kennedy Space Center itself. Nearly a decade later, REAC/TS prepared military and emergency staff in the same manner before the launch of New Horizon in 2006. Both of these probes were powered by radioactive plutonium, and carried similar health risks to the Mars 2020 launch. In 2011, REAC/TS prepared first responders for the launch of Curiosity by training them for a radiation exposure incident. [6] [7]

During 2018, REAC/TS representatives repeatedly travelled to the Kennedy Space Center to discuss how the Department of Energy and National Nuclear Security Administration would provide support for Mars 2020. REAC/TS health physicist, Dr. Mark Jenkins, has visited multiple hospitals near the Kennedy Space Center to formulate a presentation to the Mars 2020 Radiological Contingency Planning Meeting. The knowledge he gained from visiting nearby hospitals (where, in the event of radiation exposure, workers would be treated in 2020) informed the education and outreach strategy that REAC/TS has since implemented. This plan includes teaching local hospitals about radiation exposure, decontamination procedures, and the basics of Perseverance's MMRTG and how it is relevant in patient care. The extensive educative work done by REAC/TS in preparation for possible radiological accidents has been, according to Jenkins, "about eliminating fear." [9]

The partnership of REAC/TS is necessary not only to ensure the safety of personnel, but to protect the trust Americans place in their space program. If there were a launch failure that resulted in radiation exposure, and the situation was poorly handled, the public's trust of the American space program would be shattered. This may impact future funding and public engagement. Therefore, it is vital to have a capable and proven organization managing the planning for a radiological accident.

## 3 Conclusion

For decades, REAC/TS has been conducting groundbreaking research, educating medical professionals, and working to save lives on-site during radiological incidents. The organization's proven history in the medical management of radiation exposure cases makes its partnership a requirement for the launch of Mars 2020. As the space program advances, and NASA begins to launch more complicated and larger nuclear power systems, NASA's partnership with REAC/TS will only become more important. Due to the efforts of REAC/TS, and other organizations like it, it can proudly be said that "no member of the public has ever been injured in a NASA launch." [8]

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