Radiation Reference Guide

Topics: Symptoms and Reducing Exposure

During a massive solar storm, Space Station Alpha may be exposed to high doses of dangerous radiation. Fortunately, NASA is able to monitor the levels of radiation and reduce the danger using several emergency procedures:

Use this reference guide to find out:

- **symptoms** of exposure to radiation at different levels
- **options** for reducing radiation exposure on the space station

Symptoms

Effects of Radiation on the Human Body

Radiation can have dangerous effects on the human body. The digestive system is very sensitive to radiation. Nausea and vomiting can occur immediately after exposure. The circulatory system is often the hardest hit, but antibiotics and blood transfusions can help a victim recover.

Severe radiation damage to the immune system (helps with the body's resistance to disease) can cause severe infections. Our nerves and the brain are more resistant to radiation, but exposure can still result in nervous system damage.

The following tables summarize the effect and symptoms of radiation on the body with different amounts of exposure. (Remember: A **rem** is a unit for measuring amounts of radiation.)

Use these tables during the mission to find out if the astronauts are being exposed to dangerous levels of radiation.

Mild: Under 75 rems	
Effects	**Symptoms**
Cells die; abnormal cells are produced	Cells could become cancerous Temporary hair loss 2-3 days after exposure
Digestive system	Nausea, vomiting
Reduced resistance	Changes in blood cells
Eyes	Eye membranes swell
Thyroid gland	Tumors can form
Later symptoms: weight loss, loss of appetite, infections, and bleeding	
Serious: 75 - 360 rems	
Effects	**Symptoms**
Blood system, Spleen	Bone marrow and blood cells change
Digestive system	Nausea, vomiting, fatigue, fever, dehydration, bleeding ulcers
Nervous system	Nervousness, confusion
Death may occur 1-2 months after exposure if not medically treated.	
Critical: 360 - 550 rems	
Effects	**Symptoms**
Blood system	Bone marrow is almost completely destroyed.
Thinking ability	Inability to do even routine tasks.
Life Threatening: 550 rems and more	
Effects	**Symptoms**
Digestive system	Intestine lining is destroyed, nausea, vomiting, and diarrhea
Blood system	Destruction of bone marrow
Death within several weeks even with medical treatment.	

Options for Reducing Exposure

ALARA
Medical practitioners use a principle called **ALARA** to limit radiation exposure during an event like a solar storm. **ALARA** stands for:

As **L**ow **A**s **R**easonably **A**chievable

That is, you cannot totally eliminate radiation exposure, but you can bring the exposure down using some reasonably achievable strategies.

The ALARA Strategies: Shielding, Time, and Distance

Shielding—Increase shielding. Barriers slow or block the radioactive particles. The thicker the barrier, the better, but you have to be reasonable.

Shielding strategies:

- Reorient the space station so the bulk of the station serves as a barrier to the radioactive particles.
- Use water (H_2O). Anything high in hydrogen atoms acts as a good barrier. Water bags may be used to absorb or reflect radiation. Build a barrier with them or build a "cave" to crawl into. **There are 40 cube-shaped water bags stored in the Zarya.**
- Use polyethylene. Polyethylene is high in hydrogen atoms. There are 96 tiles of polyethylene **in the Destiny module**. Using straps and duct tape, the one-foot by one-foot by one inch tiles are used to construct a sleeping platform.
- Use another human. Humans are mostly water and are therefore high in hydrogen atoms. An astronaut can shield another by using his or her own body mass as a shield. (Of course, this only helps the shielded astronaut.)

Note: Space suits have little shielding protection

Time—Limit the time of exposure. The space station spends almost 60 minutes of every orbit fully exposed to the sun's rays. This cannot be prevented or reduced.

Strategies to Limit the Time of Exposure

• Reduce the amount of time spent outside any protected or shielded areas.

Distance—Increase the distance from the source of radiation.

Strategies to Increase Distance

The astronauts cannot change their distance from the sun very much since the space station is in orbit. As a last resort, astronauts may leave the station and return to earth using a crew transport vehicle such as the space shuttle.