# Radiation Team
# Mission Day Instructions

## Overview

The health and safety of astronauts is always NASA's top priority. Outside of the earth's protective atmosphere, astronauts are exposed to the hostile environment of space. Because of the extended stay of the astronauts in the space station, radiation levels are constantly monitored. In addition to hourly and daily levels, 30-day, yearly, career, and lifetime radiation limits for each astronaut must be considered.

The Tissue Equivalent Proportional Counter (TEPC) monitors the amount of radiation that astronauts are exposed to in the space station. There are two TEPCs on board the station, one that is stationary, located in the Destiny Module and another which is portable. When radiation levels are a concern, the astronauts carry the portable TEPC with them at all times to monitor their direct exposure to hazardous radiation.

### Your Task

- Learn to analyze real-time data from the two TEPCs, record it, graph it, and make calculations.
- Once the readings are graphed, you must check the human exposure limits in the Reference Guide. Determine the effects this level of exposure might have on the astronauts. If the exposure is dangerously high, recommend a course of action to Mission Control.
- Review the information that you studied during specialist training. Study your notes on radiation and its effects on the human body, examine the tables on career and life exposure limits.
- Review the ALARA guidelines and how they may be applied on the space station.. Learn the names and locations of the station's various modules and what shielding options are available on board if emergency measures need to be taken.

To do its job effectively, the Radiation Team should be able to:

1. Determine how much radiation the astronauts are receiving on the space station.
2. Understand the difference between rems and rads of radiation.
3. Identify a dangerous level of radiation.
4. Identify the ALARA guidelines and be able to apply them in a dangerous situation.
5. Identify possible shielding materials that can be used by the astronauts.

### Mission Day Materials

On mission day it will be critical to be prepared to assist the Space Station crew if it becomes necessary. To do this effectively your team will need the following:

- One computer to receive real-time radiation data from the Space Station
- One or more copies of the Space Station Reference guide (found at http://www.wju.edu/clc/ssa/ssrefguide.htm)
- Mission Day Materials packet (one per team member):
    - Mission Day Instructions
    - Radiation Data Tracking Tables
    - Radiation Data Graphs
- 15 Blank Report Forms (see Mission Day Materials packet) on colored paper to deliver to the Communications Team

- Calculators for each team member
- Rulers for plotting data on graphs
- Ballpoint pens or pencils of various colors (optional)

**Job Assignments**
The following tasks must be completed during the mission. Next to each task, assign a team member.

| Team Member(s) Assigned To This Task | Task |
|---|---|
| _____ | **Data Recording**: Monitors real-time data for new readings and bulletins from mission control. The URL for the real-time data will be given by Mission Control at the start of the mission. This may be combined with other tasks. |
| _____ | **Data Analysis (TEPC1)**: Records real-time data in data tracking tables. Conducts analyses using data tracking worksheet. Completes Report Forms every five to six minutes or as needed. |
| _____ | **Data Analysis (TEPC2)**: Records real-time data in data tracking tables. Conducts analyses using data tracking worksheet. Completes Report Forms every five to six minutes or as needed. |
| _____ | **Data Graphing**: Records real-time data and projections on graphs. Uses ruler to make predictions. May be combined with Data Analysis tasks. |
| _____ | **Crisis Management**: Makes sure all data is analyzed every five to six minutes. Determines priority level, whether there are any concerns, and helps team decide on any recommendations. Takes this information to the Crisis Management Team for further discussion. |
| _____ | **Data Runner**: Gathers report forms every five to six minutes. Prioritizes any urgent recommendations. This may be combined with Crisis Management Tasks. |
| _____ | **Research and Reference**: Assists team in finding necessary information to make recommendations to Mission Control. Reads and understands information provided in the Reference Guide. This may be combined with other tasks above. |
| _____ | **Reporter**: Assists team in recording the situation as the mission progresses. Tracks emergencies, options, choices, successes, and areas for improvement. |

## Radiation Team— Data Tracking Instructions

You will be receiving readings every five to six minutes from the TEPCs. The data will have information on radiation levels currently being experienced on board the station. It is imperative that your team is familiar with the data and that you are able to analyze it quickly and efficiently.

Using the instructions below and the attached spreadsheet, you should be able to conduct all the necessary calculations. Note: Since we are working with large numbers here, there is no need to use decimals-- **round to the nearest whole number**. You will need two sets of tracking sheets, one for each TEPC. Make sure you indicate which TEPC (stationary or portable) is associated with each tracking sheet.

*First, find the spreadsheet labeled Radiation Team Data Tracking Table - TEPC 1 or TEPC2*

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Column A: Coordinated Universal Time (UTC)
The time will be included in the data from the stationary or portable TEPC. Record the time in UTC units in Column A.

Time is given in Coordinated Universal Time (UTC), a universal standard. To eliminate any errors, we use a 24-hour clock with no "am" or "pm". On a 24-hour clock, 00:00 or 24:00 is midnight and 12:00 is noon. 23:59 is one minute before midnight. One o'clock in the morning is 01:00. Four-twenty in the afternoon is 16:20, etc.

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Column B: Real-Time Data
Record the real-time dose rate data in Column B. This information will also be plotted on graphs, one for the stationary TEPC and another for the portable TEPC.

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Column C: Cumulative Dose
Monitor the cumulative exposure every reading. This is the actual exposure the crew would be receiving. To calculate cumulative dose, add the cumulative dose from the previous reading with the current 20 minute dose, and record this value. For the first reading, assume a dose of zero previously.

C = Column B + Previous Column C

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Column D: Dose Rate
To determine how fast things are changing, you will need to find the rate of change. To do this, you need to take the current reading from Column B and divide by the amount of time that has elapsed between the two readings. This gives the rate of change in millirems (mrem) per minute. Record this number in Column D.

$$D = \frac{\text{Column B}}{20 \text{ min}}$$

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Column E: Time to Criticality: Minutes
In this column, you must record the time to criticality. In order to find this number, take the critical value (100,000 mrems or 100 rems- see Reference Guide) and subtract from it the current reading from Column C. Divide this answer by the rate of change you calculated in Column D. This is the amount of time the crew has before they enter into danger levels.

Note: At a dosage of 100 rems, you might start to see the first physiological symptoms as well as performance decreases.

$$\text{Col E} = \frac{100{,}000 - \text{Column C}}{\text{Column D}}$$

This gives you the time to criticality.

Note, this equation comes to us from the general equation for the slope of a line: $y = mx + b$
If we convert this equation to solve for x, we get this $x = \frac{y - b}{m}$

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Column F: Time to Criticality: Hours
In this column, convert the time to criticality from minutes to hours. To do this, take the number you recorded in Column E and divide it by 60 minutes.

$$F = \frac{\text{Column E}}{60 \text{ minutes}}$$

Column G: 24 Hour Projected Total- mrems
This column contains your prediction of the total 24-hour dose at each TEPC so precautionary steps can be taken if needed. To determine this value, start with the current cumulative dose from Column C. Add this to the product of the current dose rate (Column D) and the number of minutes in a day. There are 1440 minutes in a day, so multiplying the current dose rate by 1440 results in the predicted 24 hour mrem dose.

G = Column C + (Column D x 1440) (min. in a day)

Column H: 24 Hour Projected Total: Rems
There are 1000 millirems in a rem. To understand impacts to the human body of the exposure, we need the 24 hour projection in rems. Therefore, for column H, divide the value in column G by 1000.

$$H = \frac{\text{Column G}}{1000}$$

## Instructions for Graphing the Data

You will be creating a total of four graphs.

- TEPC1 Dose Rate as a Function of Time

Use the data from Column B for the y-axis values and plot them along the x-axis according to the correct UTC time. The scale for the y-axis values is 0-3,600 mrem for the TEPC1 data

- TEPC2 Dose Rate as a Function of Time

Use the data from Column B for the y-axis values and plot them along the x-axis according to the correct UTC time. The scale for the y-axis values is 0-12,000 mrem for the TEPC2 data.

- TEPC1 24-Hour Projected Total Dosage

Use the data from Column H for the y-axis values and plot them along the x-axis according to the correct UTC time. The scale for the y-axis values 0-300 rem for the TEPC1 data. *Draw heavy lines across from left to right at 100 to represent the "danger zone" and label them.* See the reference guide for what these zones represent.

- TEPC2 24-Hour Projected Total Dosage

Use the data from Column H for the y-axis values and plot them along the x-axis according to the correct UTC time. The scale for the y-axis values 0-1,200 rem for the TEPC2 data. *Draw heavy lines across from left to right at 100, 400, 600, and 1000 rems to represent the "danger zones" and label them.* See the reference guide for what these zones represent.

**Radiation Team – Data Tracking Table**
**Circle One: TEPC1 (Portable) TEPC2 (Stationary)**

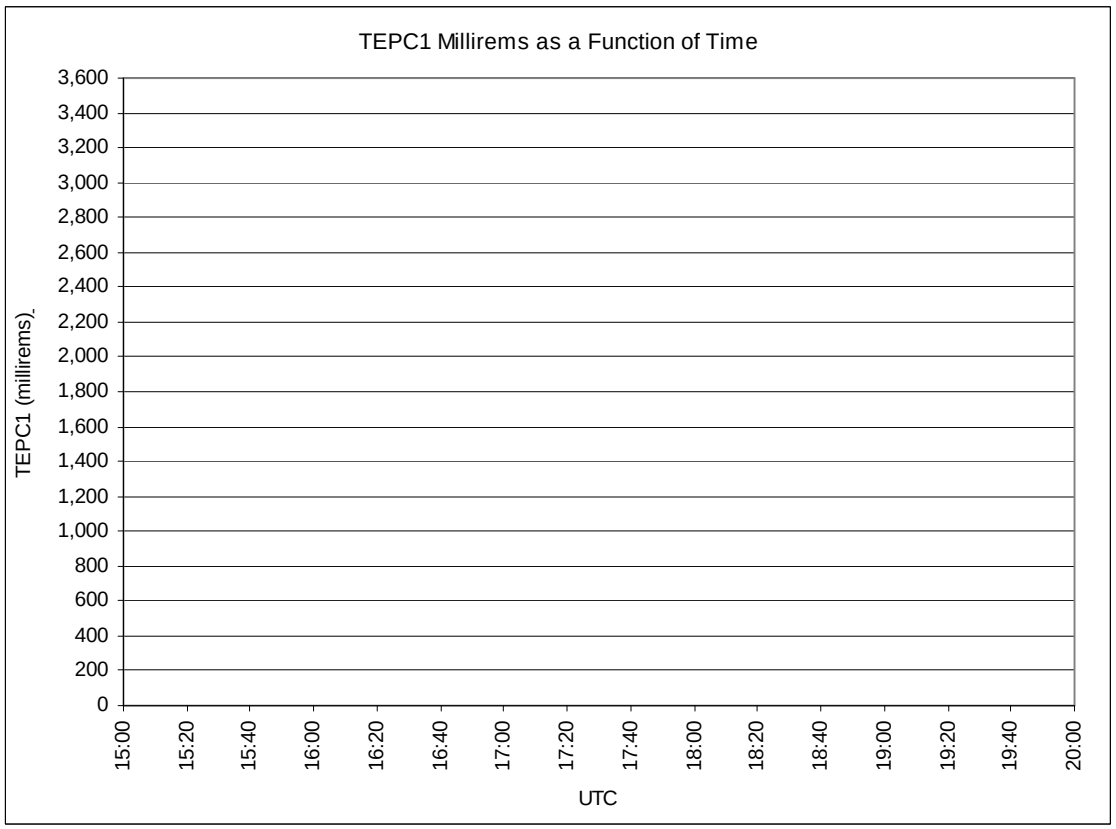
| Column | A | B* | C | D | E | F | G | H* |
|---|---|---|---|---|---|---|---|---|
| Table Headings | UTC | 20 min Dose Total | Cumulative Dose | Dose Rate | Time to Criticality | Time to Criticality | 24 hour Projected Total | 24 Hour Projected Total |
| Units | 24 Hour Clock | mrems | mrems | mrem/min | minutes | hours | mrems | rems |
| Calculations | From Data | From Data | C= B+ Previous C | D= $\frac{B}{20\ min}$ | E = $\frac{100{,}000 - C}{D}$ | F= E / 60 min | G = C+ (D X 1440) | H = G/ 1000 |
| Example | 19:00 | 2,339 | 26,353 | 117 | 629 | 10 | 194,833 | 195 |
| | 15:00 | | | | | | | |
| | 15:20 | | | | | | | |
| | 15:40 | | | | | | | |
| | 16:00 | | | | | | | |
| | 16:20 | | | | | | | |
| | 16:40 | | | | | | | |
| | 17:00 | | | | | | | |
| | 17:20 | | | | | | | |
| | 17:40 | | | | | | | |
| | 18:00 | | | | | | | |
| | 18:20 | | | | | | | |
| | 18:40 | | | | | | | |
| | 19:00 | | | | | | | |
| | 19:20 | | | | | | | |
| | 19:40 | | | | | | | |

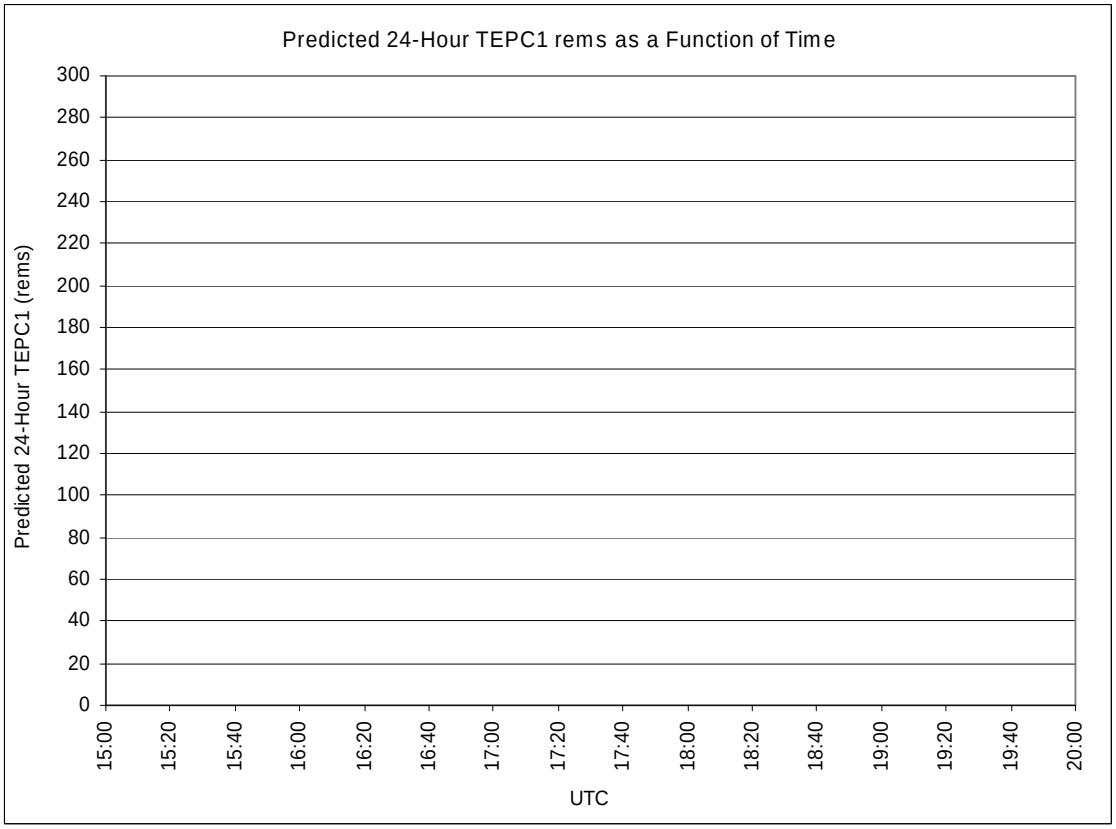
* Graph this column.

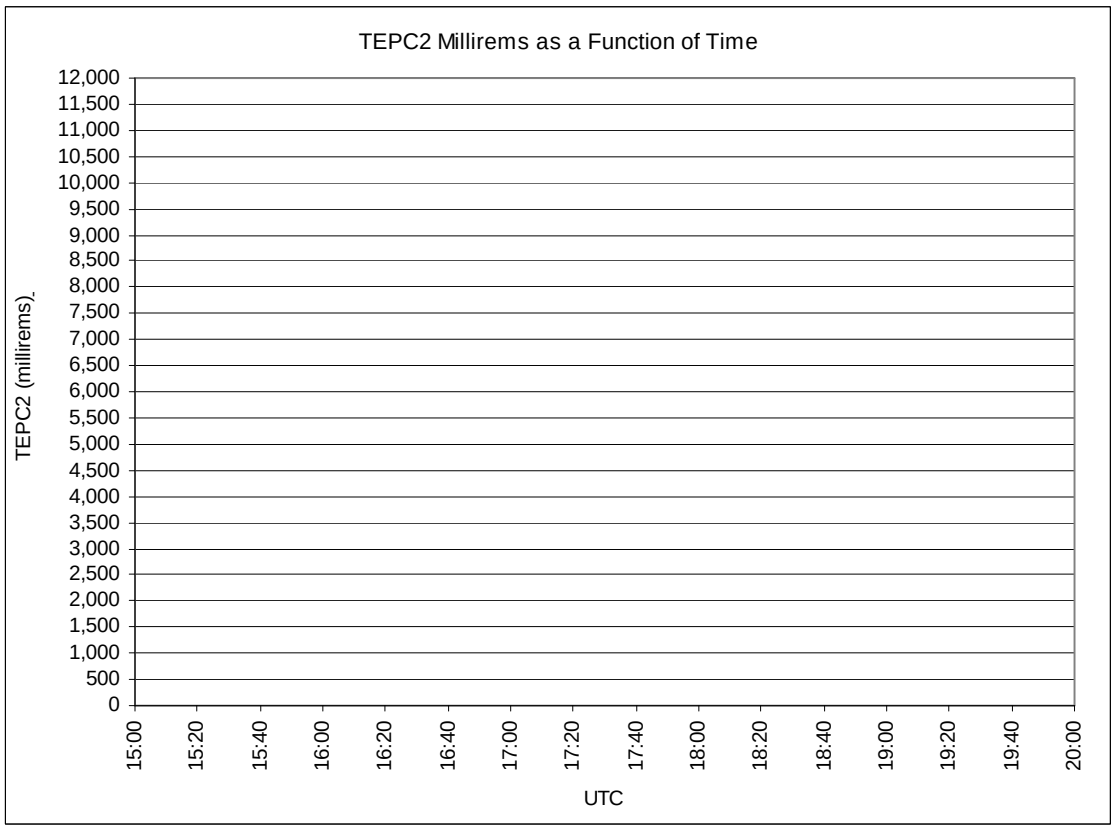
**Radiation Team – Data Tracking Table**
**Circle One: TEPC1 (Portable) TEPC2 (Stationary)**

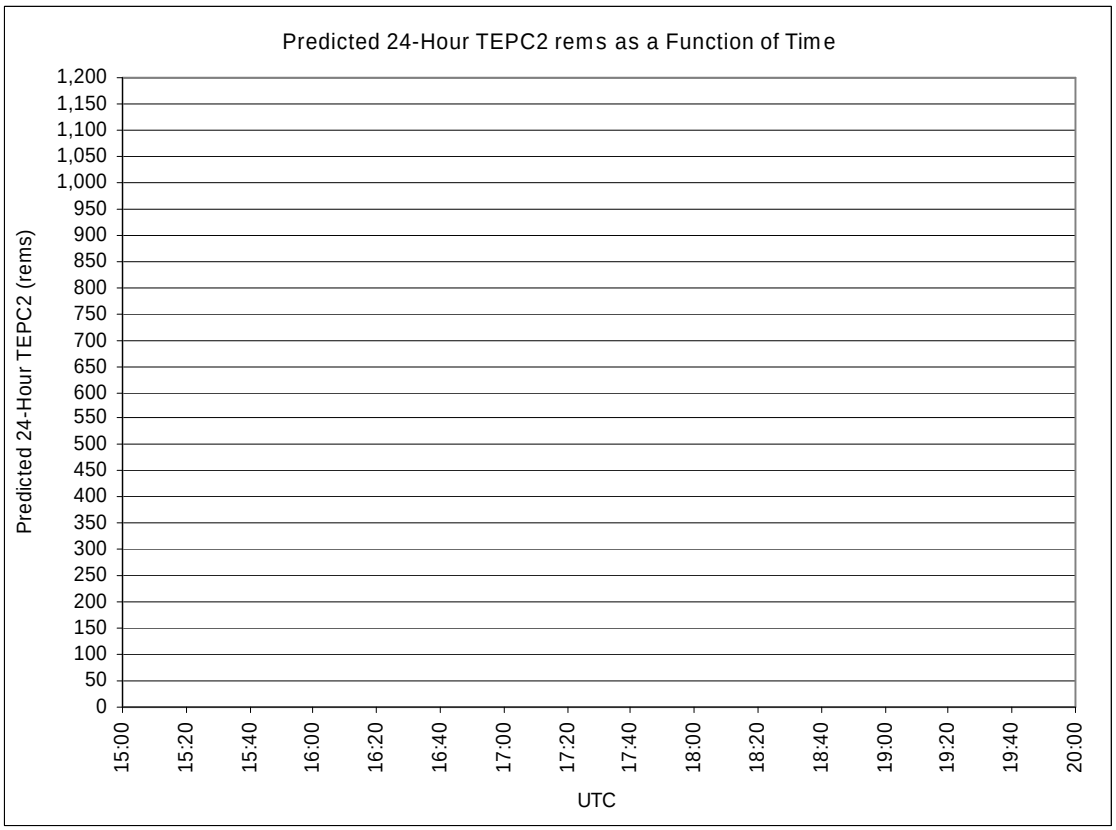
| Column | A | B* | C | D | E | F | G | H* |
|---|---|---|---|---|---|---|---|---|
| Table Headings | UTC | 20 min Dose Total | Cumulative Dose | Dose Rate | Time to Criticality | Time to Criticality | 24 hour Projected Total | 24 Hour Projected Total |
| Units | 24 Hour Clock | mrems | mrems | mrem/min | minutes | hours | mrems | rems |
| Calculations | From Data | From Data | C= B+ Previous C | D= $\frac{B}{20\ min}$ | E = $\frac{100{,}000 - C}{D}$ | F= E / 60 min | G =C+ (D X 1440) | H = G/ 1000 |
| Example | 19:00 | 2,339 | 26,353 | 117 | 629 | 10 | 194,833 | 195 |
| | 15:00 | | | | | | | |
| | 15:20 | | | | | | | |
| | 15:40 | | | | | | | |
| | 16:00 | | | | | | | |
| | 16:20 | | | | | | | |
| | 16:40 | | | | | | | |
| | 17:00 | | | | | | | |
| | 17:20 | | | | | | | |
| | 17:40 | | | | | | | |
| | 18:00 | | | | | | | |
| | 18:20 | | | | | | | |
| | 18:40 | | | | | | | |
| | 19:00 | | | | | | | |
| | 19:20 | | | | | | | |
| | 19:40 | | | | | | | |

* Graph this column.


TEPC1 Millirems as a Function of Time
TEPC1 (millirems)
3,600
3,400
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
19:20
19:40
20:00
UTC


Predicted 24-Hour TEPC1 rems as a Function of Time
Predicted 24-Hour TEPC1 (rems)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
19:20
19:40
20:00
UTC


TEPC2 Millirems as a Function of Time
TEPC2 (millirems)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
19:20
19:40
20:00
UTC


Predicted 24-Hour TEPC2 rems as a Function of Time
Predicted 24-Hour TEPC2 (rems)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
15:00
15:20
15:40
16:00
16:20
16:40
17:00
17:20
17:40
18:00
18:20
18:40
19:00
19:20
19:40
20:00
UTC

**Practice Data**
**Radiation**

| UTC | TEPC1 | TEPC2 |
|---|---|---|
| 15:00 | 697 | 1,512 |
| 15:20 | 964 | 2,373 |
| 15:40 | 1,068 | 1,851 |
| 16:00 | 649 | 1,152 |
| 16:20 | 1,737 | 3,073 |
| 16:40 | 2,632 | 5,997 |
| 17:00 | 2,602 | 6,901 |

**Radiation Team Report Form**

Priority Level (circle one): **1** Urgent – Inform Mission Control Immediately **2** Potential Danger—Monitor Closely **3** Maintaining Normal Levels

**Please fill in ALL blanks in case Mission Control needs the information.**

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| **TEPC1** | UTC | 20 minute Dose Total | Cumulative Dose | Rate of Change | Time to Criticality (minutes) | Time to Criticality (hours) | 24 Hour Projected Total -mrems | 24 Hour Projected Total-rems |
| | | | | | | | | |
| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| **TEPC2** | UTC | 20 minute Dose Total | Cumulative Dose | Rate of Change | Time to Criticality (minutes) | Time to Criticality (hours) | 24 Hour Projected Total -mrems | 24 Hour Projected Total-rems |
| | | | | | | | | |

*Communication Team: Please do NOT report the shaded areas to Mission Control.*
Recommendations:

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**Radiation Team Report Form**

Priority Level (circle one): **1** Urgent – Inform Mission Control Immediately **2** Potential Danger—Monitor Closely **3** Maintaining Normal Levels

**Please fill in ALL blanks in case Mission Control needs the information.**

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| **TEPC1** | UTC | 20 minute Dose Total | Cumulative Dose | Rate of Change | Time to Criticality (minutes) | Time to Criticality (hours) | 24 Hour Projected Total -mrems | 24 Hour Projected Total-rems |
| | | | | | | | | |
| | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** |
| **TEPC2** | UTC | 20 minute Dose Total | Cumulative Dose | Rate of Change | Time to Criticality (minutes) | Time to Criticality (hours) | 24 Hour Projected Total -mrems | 24 Hour Projected Total-rems |
| | | | | | | | | |

*Communication Team: Please do NOT report the shaded areas to Mission Control.*
Recommendations:

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