Common Prefixes

The activity level shown on shipping papers and on the radioactive label is required to be listed in becquerels. The becquerel (Bq) is a very small amount of activity. To account for this, prefixes are often used to change the size of the unit. For example, 2.2 MBq denotes 2.2 million Bq or 2.2 million disintegrations per second. Many of the commonly used prefixes are shown in the table below.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Prefix Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>kilo = 1 thousand</td>
</tr>
<tr>
<td>M</td>
<td>Mega = 1 million</td>
</tr>
<tr>
<td>G</td>
<td>Giga = 1 billion</td>
</tr>
<tr>
<td>T</td>
<td>Tera = 1 trillion</td>
</tr>
<tr>
<td>P</td>
<td>Peta = 1 quadrillion</td>
</tr>
</tbody>
</table>

Initial Response/Scene Size Up
From a distance, try to identify the following:
- Spills, leaks, or fire
- Victims needing rescue
- Type of vehicle and containers involved
- Placards, labels, or package markings
- Container/package damage
- Any person knowledgeable of the scene
- Location of shipping papers
- Proper protective clothing needed for entry

For radioactive materials, establish an initial isolation zone of 75 feet in all directions. Priorities for rescue, life-saving, first aid, fire control and other hazards are higher than the priority for measuring radiation levels. Attempt to detain uninjured personnel who may be contaminated until they can be surveyed by local Radiation Authority.

Vehicle Placards

Standard Placard
Vehicle placarding is required when transporting:
- Packages with Yellow-III labels
- Exclusive Use LSA/SCO shipments
- Highway Route Controlled Quantity Shipments

Highway Route Controlled Quantity (HRCQ) Placard
HRCQ is a high activity shipment transported in a Type B package. The package will always have a Yellow-III label regardless of radiation level. HRCQ shipments by highway will require the standard placard on a white square background with a black border as shown at left.

Package Labels

Radioactive White-I
Expect up to 0.5 mrem/hr at surface of package
No Transport Index associated with this label

Radioactive Yellow-II
Expect > 0.5 mrem/hr up to 50 mrem/hr at surface of package
Maximum Transport Index is 1 or 1 mrem/hr at 1 meter

Radioactive Yellow-III
Expect > 50 mrem/hr up to 200 mrem/hr* at surface of package
Maximum Transport Index is 10 or 10 mrem/hr at 1 meter*

Fissile Label
For packages containing fissile material, this label will appear with one of the three labels shown above. Criticality Safety Index on label is used by shipper to limit the number of packages on a conveyance

EMPTY Label
For packages that previously contained radioactive material. Package may still contain internal contamination

Shipping Paper Information
Look for the following information on shipping papers for radioactive material:
- Emergency contact telephone number
- Proper Shipping Name and UN ID
- Name of radionuclides (e.g., Cs-137)
- Radioactivity level per package in MBq, GBq, etc. (will be listed as “activity”)
- Category of label applied (i.e., White-I, Yellow-II, Yellow-III)
- Transport Index (for Yellow-II and III labels)
- The letters “RQ” if material is a Reportable Quantity of hazardous material
- Package Type (e.g., Type A, Type B, etc.)
- Physical & chemical form of material (if not special form)
- “Fissile Excepted” or Criticality Safety Index (for fissile materials only)
- “Exclusive Use” if shipment is being made under exclusive use provisions
- Highway Route Controlled Quantity or “HRCQ” (if shipment is HRCQ)

Symbol Prefix Value
- k kilo = 1 thousand
- M Mega = 1 million
- G Giga = 1 billion
- T Tera = 1 trillion
- P Peta = 1 quadrillion

* May read up to 1,000 mrem/hr at package surface and up to 10 mrem/hr at 2 meters (6.6 feet) if package is transported in a closed transport vehicle under exclusive use provisions. Shipping papers will denote “Exclusive Use.”
Radiological Protection Principles

**Radiation** cannot be detected by the human senses. A radiological survey conducted with specialized equipment is the only way to confirm the presence of radiation. Radiation survey instruments typically measure mR/hour or R/hour.

**Contamination** occurs externally when loose particles of radioactive material are deposited on surfaces, skin, or clothing. Internal contamination occurs when radioactive particles are inhaled, ingested, or lodged in an open wound. Contamination should not be suspected unless radioactive material packages are damaged and/or you suspect they have been breached. Contamination survey instruments typically measure in counts per minute (CPM) or kilo counts per minute (kCPM).

**Decontamination** involves removing radioactive contamination from personnel or equipment. Patient treatment takes priority over radiological controls.

For **life-threatening injuries**, decontamination is not a priority. Implement contamination controls as the situation allows but do not delay patient treatment. Attempt to contain contamination on patient using a blanket or sheet and notify the hospital as soon as possible.

For **non life-threatening injuries** where you suspect patient contamination:
- Carefully cut away and remove patient’s outer clothing
- Treat injuries as necessary
- Package patient on backboard using double blanket method
- Notify hospital as soon as possible

**Responder Safety** involves wearing proper PPE and minimizing radiation exposure:
- Minimize time in radiological area
- Maximize distance from radiation sources
- Place shielding between you and source of radiation (e.g., vehicle)

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**EPA Guidelines for Control of Emergency Exposures**

<table>
<thead>
<tr>
<th>Dose Limit</th>
<th>Activity Performed</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 rem</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>10 rem</td>
<td>Protection of major property</td>
<td>Where lower dose limit not practicable</td>
</tr>
<tr>
<td>25 rem</td>
<td>Lifesaving or protection of large populations</td>
<td>Where lower dose limit not practicable</td>
</tr>
<tr>
<td>&gt; 25 rem</td>
<td>Lifesaving or protection of large populations</td>
<td>Only on a voluntary basis to personnel fully aware of the risks involved</td>
</tr>
</tbody>
</table>

**Becquerel (Bq):** A measure of the quantity of radioactivity. One becquerel is equal to 1 nuclear disintegration per second. See chart on other side for common prefixes used with the becquerel.

**Fissile Material:** Except for natural/depleted uranium, any material containing U-233, U-235, Pu-239 or Pu-241. Packages of fissile material requiring criticality controls will have the fissile label.

**Industrial package:** Designed for shipments of low activity material and contaminated objects, which are usually categorized as radioactive waste. They contain non life-endangering amounts of radioactive material. There are three categories of industrial packages: IP-1, IP-2, and IP-3.

**LSA/SCO:** Low Specific Activity (LSA) material means the radioactive material is distributed throughout a substance to such an extent that it poses little hazard even if released in an accident. Examples would include uranium and thorium ores. Surface Contaminated Object (SCO) means a solid object which is not itself radioactive but which has radioactive material distributed on its surface. Examples would include contaminated tools and equipment.

**Millirem (mrem):** A unit of radiation dose equivalent to one-thousandth of a rem (which stands for roentgen equivalent man). It measures the amount of damage to human tissue from a dose of ionizing radiation. The average annual exposure for the general population is about 360 mrem.

**Special Form:** Radioactive material in an accident-tested, non-dispersible form.

**Type A package:** Designed to survive normal transport conditions (minor mishaps and rough handling). Type A packages contain non life-endangering amounts of radioactive material.

**Type B package:** Designed to survive severe accidents (impact, fire, water immersion) conditions. Life threatening conditions may exist only if contents are released or if package shielding fails. The designations “(U)” or “(M)” (e.g., Type B (U) or Type B (M) Package) refer to unilateral (U) or multilateral (M) approval of the Type B package design. Unilateral means the package design is approved by the country of origin. Multilateral means the package design is approved by each country through or into which the package is to be transported.

**Gamma Dose Rate**

<table>
<thead>
<tr>
<th>Rate</th>
<th>1 rem</th>
<th>5 rem</th>
<th>10 rem</th>
<th>25 rem</th>
<th>100 rem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mR/hour</td>
<td>6 weeks</td>
<td>30 weeks</td>
<td>1 year</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5 mR/hour</td>
<td>200 hours</td>
<td>6 weeks</td>
<td>12 weeks</td>
<td>30 weeks</td>
<td>2 years</td>
</tr>
<tr>
<td>100 mR/hour</td>
<td>10 hours</td>
<td>50 hours</td>
<td>100 hours</td>
<td>250 hours</td>
<td>6 weeks</td>
</tr>
<tr>
<td>1 R/hour</td>
<td>1 hour</td>
<td>5 hours</td>
<td>10 hours</td>
<td>25 hours</td>
<td>100 hours</td>
</tr>
<tr>
<td>10 R/hour</td>
<td>6 minutes</td>
<td>30 minutes</td>
<td>1 hour</td>
<td>2.5 hours</td>
<td>10 hours</td>
</tr>
<tr>
<td>100 R/hour</td>
<td>36 seconds</td>
<td>3 minutes</td>
<td>6 minutes</td>
<td>15 minutes</td>
<td>1 hour</td>
</tr>
</tbody>
</table>

**Stay Time Table**

<table>
<thead>
<tr>
<th>Stay time to receive this dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mR/hour</td>
</tr>
<tr>
<td>5 mR/hour</td>
</tr>
<tr>
<td>100 mR/hour</td>
</tr>
<tr>
<td>1 R/hour</td>
</tr>
<tr>
<td>10 R/hour</td>
</tr>
<tr>
<td>100 R/hour</td>
</tr>
</tbody>
</table>

This Quick Reference Sheet was produced by the U.S. Department of Energy Transportation Emergency Preparedness Program for additional information, visit the TEPP website at: www.em.doe.gov/otem or phone (301) 903-7284