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General Guideline for Radiation Portal Monitors at Border Applications

Introduction

The successful search for hidden radioactive material at borders is currently typically carried out in three steps:

1. Detection of a potential threat
2. Location of the source
3. Identification of the source

This document provides support for the first step: “Detection of a potential threat”. The following information refers to technical criteria for radiation portal monitors for truck and train applications.

The technical aspects to scan for radioactive material in passing vehicles often conflict with local conditions to insure a convenient flow of traffic.

Three major points should be considered:

1. Width of the radiation portal monitor between the detection pillars
2. Speed of the passing vehicles
3. Influence of the natural radiation background

Distance between the pillars containing the radiation detection probes

A radioactive source that is regarded as a threat is typically a physically small item, a so called “Point Source”. This point source creates a surrounding radiation field that gets stronger as closer the point of source is approached.

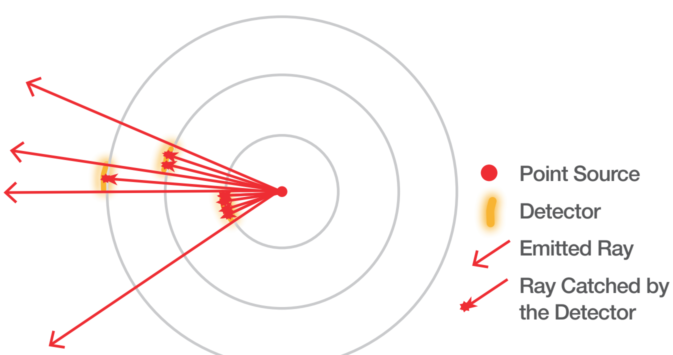


Figure: 2 Radiation field around a point source (2D-Sketch)

Figure: 1 Radiation Portal Monitor Installation for Trucks

The radiation detection signal gets quickly weaker if the distance to a point source is increased. The two dimensional sketch shows this effect in principle. The real three dimensional scenario leads to the following law:

“If the distance to a point source is doubled, the signal is reduced to a quarter.”

In mathematical terms, the following equation can be used:

$$Signal_{Dis\tan ceB} = Signal_{Dis\tan ceA} * r_A^2 / r_B^2$$

$$r = Distance\ to\ point\ source$$

Example:

The width of a radiation portal monitor was planned for 4.2 m. Due to concerns about the traffic situation at the planned location the width shall be increased to 6.8 m.

Referring to a point source moved through the radiation portal monitor, the furthest distance to a detector is the center line between both pillars: r(location A)=2.1m, r(location B)=3.4m.

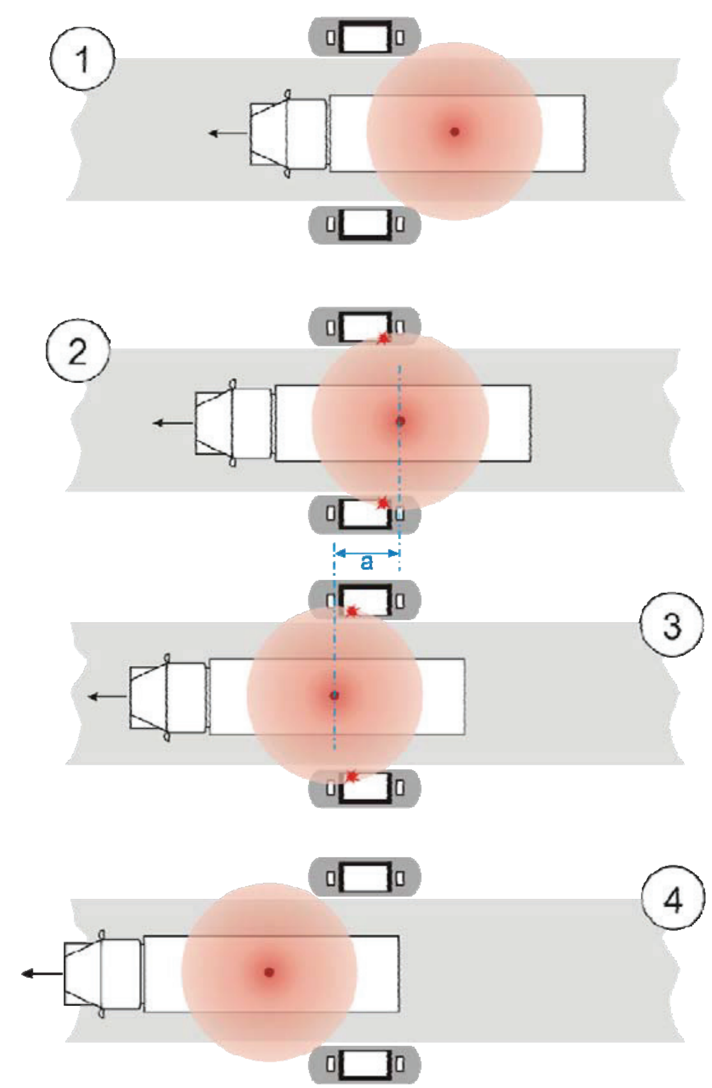
signal from a point source (6.8 width) = signal from a point source (4.2) * 0,38

Only 38% of the signal strength can be expected due to the increased gate width, referring to a point source moved through the center of the radiation portal monitor.

Vehicle Speed

A radiation portal monitor basically counts radiation events, recognized by its detectors, per time interval. The common unit is "cps" = counts per second.

Figure 3 shows an example of a passing radiation source. The radiation source is only visible for the detectors, if the source is moving along the section "a". The radiation signal strength depends directly to the time, the source can be seen from the detectors. Here, this time depends on the speed of the source (vehicle) and the length of the section "a".

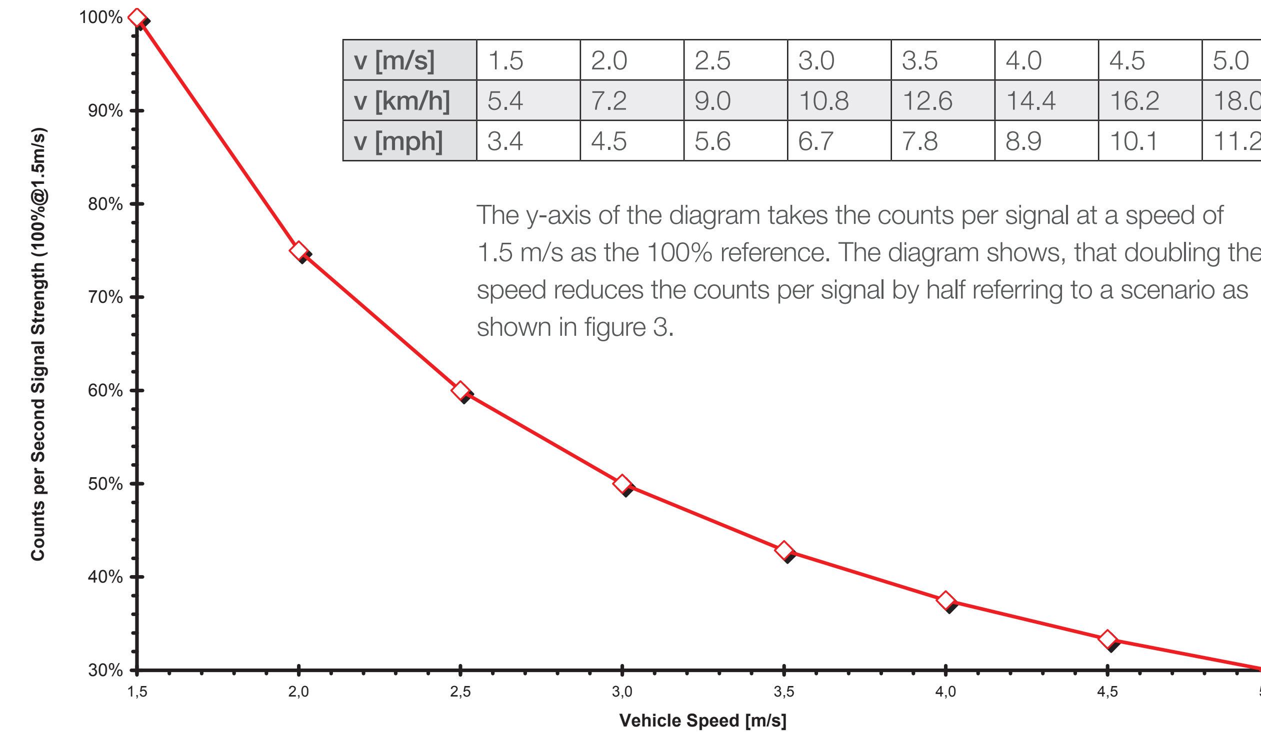


time = distance "a" / speed

Figure: 3 Source passing a portal, view from top

Example:

Assumption: Distance "a" =1.5 m



v [m/s]	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
v [km/h]	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
v [mph]	3.4	4.5	5.6	6.7	7.8	8.9	10.1	11.2

The y-axis of the diagram takes the counts per signal at a speed of 1.5 m/s as the 100% reference. The diagram shows, that doubling the speed reduces the counts per signal by half referring to a scenario as shown in figure 3.

Figure: 4 Signal Strength versus Speed

Secondary Screening

We offer a number of handheld options for secondary screening to pinpoint the location and identify the type of radiation.

RadEye SPRD-GN

The Thermo Scientific™ RadEye™ SPRD-GN Spectroscopic Personal Radiation Detector offers gamma detection, gamma ID and neutron detection in a small handheld pager.

We offer a wide range of telescoping poles to ensure you can reach all areas of the cargo.

RIIDEye X

The Thermo Scientific™ RIIDEye™ X Handheld Radiation Isotope Identifier is ideal when it's critical to know the exact isotope and precise location of the radioactive material to quickly initiate a plan of action.

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Influence of the natural radiation background

A certain level of natural Gamma radiation can be found at all locations for radiation portal monitors. This natural radiation level is causing a basic radiation signal level in the radiation portal monitors. Depending on the location, different level can be found.

The level does not only depend on the geographical position, but also on weather conditions like rain, snow or melting of frozen ground. The reason is that a large portion of the natural radiation level comes from the radioactive gas Radon. Radon originates as a decay product under ground, finds its way to the surface and moves into the air, where it contributes to the background radiation effect on the Gamma radiation detectors. If it starts to rain or to snow, Radon can be washed out from the air and sums up at ground, where the higher content on Radon increases remarkably the level of natural radiation.

The nature of radiation does not provide a constant signal in terms of a 'counts per second' approach, but a signal that shows permanent variations in a typical range around an average value.

To reduce the influence of natural radiation, Gamma radiation detectors are typically shielded with lead at the sides that do not face the gate. The construction material of the lane and surrounding constructions should checked, to not further contribute to the natural level of radiation due to used naturally radioactive contents.

Figure: 5 Background Radiation Level

In that respect, a radiation portal monitor has to identify an extra contribution from a moving source within a fluctuating background radiation signal. Therefore, it is essential, that this extra contribution to the background signal is not reduced to meaninglessness by high vehicle speed, large portal width, or an unnecessarily high radiation background.

Find out more at **thermofisher.com/radiationmeasurement**

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