



# In Step With Capintec

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Spring 2007

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## The Mystery of CPM, DPM, CF, EFF and MDA: Back to Basics

by Art Hall, CNMT, FSNMITS

CPM, DPM, CF, EFF, and MDA are the alphabet soup of radiation detection and reporting - and for many, an incomprehensible mystery.

Today, it is not enough to place a wipe sample in a counter and report the numbers displayed on the screen. Inspectors of state and federal regulatory agencies require that displayed counts, reported as cpm, be converted to something called dpm - a term that translates back to the actual activity found on the wipe sample. Unfortunately for many, the concepts learned in our radiation physics classes have long ago been buried in the cobwebs of our minds, making it difficult to understand what is required to convert cpm to dpm. Nothing is ever easy in the world of physics, so let's get back to basics and walk through this process step by step beginning with a translation of the alphabet soup:

**CPM:** Counts per minute - energy from a radioactive source that is detected by the sodium iodide crystal. Note: Background is always in CPM when not associated with a region of interest.

**DPM:** Radioactive decay as disintegrations per minute, calculated at a constant rate of  $2.22 \times 10^9$  disintegrations per minute or  $3.7 \times 10^7$  disintegrations per second per 1 millicurie.

**EFF:** Efficiency - the ratio of detected counts measured by the system to the actual rate of decay, or disintegrations per minute for a specific nuclide or region of interest.

**CF:** Conversion factors - constants used to convert measurements in cpm to dpm

**MDA:** Minimum detectable activity - the smallest activity that can be detected by an instrument for a specific nuclide or region of interest.

The sodium iodide crystal in Capintec's well counters measure counts per minute from a given sample. Then, using a formula, converts the counts per minute to disintegrations per

minute. Understanding the relationship between CPM, EFF, and CF will help the user understand how this conversion process is performed.

Radiation is emitted in all directions. Some radiation is emitted upward; some radiation will pass through a counter without being detected and all radioactive interactions are affected by geometry, or the placement of a source in the detector; thus, only a portion of energy from any given sample is detected by the sodium iodide crystal. For this reason, the counts per minute from a measured source must be corrected by a factor, known as the conversion factor to calculate the number of disintegrations per minute in that sample.

Conversion factors are affected by the decay scheme of the isotope and the counter used to measure activity; therefore, conversion factors will be different for individual isotopes as well as the instrument used to count the wipe sample.

The conversion factor is calculated as:

$$CF = \frac{\text{Disintegration per minute}}{\text{Counts per minute}}$$

Example: 1  $\mu\text{Ci}$  of Co-57 emits energy at a constant rate of 37,000 disintegrations per second, or 2,220,000 disintegrations per minute.

If the counts per minute for that source measure 1,750,000, then the conversion factor would be calculated as:

$$CF = \frac{2,220,000}{1,750,000} = 1.27$$

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Back to Basics (...Continued from Page 1)

Once the conversion factor is known, the efficiency for that isotope can be calculated as the inverse of the correction factor:

$$EFF = \frac{1}{CF} = \frac{1}{1.27} = .78 * 100 = 78\%$$

The final piece to the puzzle is the calculation of the MDA for that instrument. Regulatory guidelines in some states require that the user determine the minimum level of activity that can be detected by the instrument used to perform the wipe tests for that institution.

Capintec routinely receives calls requesting the MDA value for units such as the CAPRAC or well counters found on the CRC-15 series or the Captus units. The important point to remember is that MDA is dependent on the location of the instrument, the counting time and room background. For these reasons, it is not possible for Capintec to publish an MDA for a well counter and recommends that users determine the appropriate counting time based on the required MDA limit for their application as well as the ambient background activity where the instrument is located.

The following summarizes one of the formulas that can be used to calculate the MDA of a unit:

$$MDA = \frac{f(\sqrt{N} + C)}{(Eff * T)}$$

- f** = Precision Factor
- C** = Correction Factor
- Eff** = Efficiency
- T** = Counting time

<b>f</b> = 4.65
<b>N</b> = Number of counts
<b>C</b> = 2.71
<b>Eff</b> = Efficiency as a decimal value
<b>T</b> = Counting time

In most states, regulatory guidelines require the user to report wipe samples in dpm. This discussion was designed to help Capintec users understand how this calculation is performed and provide them with information that can help them determine the MDA for their instruments. Fortunately, for those that are still not clear about how the calculations are performed, once the conversion factors for individual isotopes are stored in the detector, Capintec's software will quickly and accurately perform and record the dpm for the wipe sample. Using the printed information from the instrument and the formula above, the health physicist or RSO can easily determine the MDA for that instrument ■

## Bioassays - Yesterday and Today

by Kathy Thomas, MHA, CNMT, PET

In today's clinical environment, bioassays are most often performed with a small neck probe such as the Captus 3000 or Captus 600 on radiation workers exposed to unsealed sources of radioactive iodine; however, bioassays and whole body counting of yesterday provided much different information to the medical community.

In a recent visit to the Veterans Administration Hospital, Los Angeles, California, Art Hall, CNMT and Kathy Thomas, CNMT had an opportunity to compare bioassay instruments (Figs. 1-3) and to learn from the masters in the field, Drs. William H. Blahd, Stuart Mirell and Ralph Lake about bioassay procedures of yesterday.

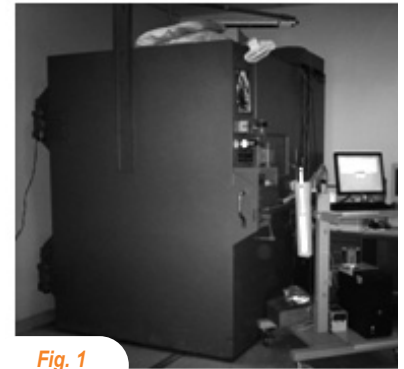


Fig. 1

The VA Medical Center's Steelweld whole body counter, designed by Drs. Benedict Cassen and William H. Blahd, is an amazing instrument that has 5 inch steel walls with ¼ inch lead lining and internal dimensions of 4 feet wide by 6 feet long by 6 feet high. It weighs approximately 25 tons. The internal probe has a 4 x 8 inch sodium iodide crystal and three photomultiplier tubes in the photomultiplier assembly.

The radiation analyzer includes 50 one-volt channels. The counting period for each human bioassay was reported to be 40 minutes.



Fig. 2

Clinical applications of whole body counters in the late 1950's and early 1960's included measurements of naturally occurring radioactive potassium present in the body and the absorption, retention and biological turnover of tracers including I-131 for

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**Bioassays (Continued from Page 2)**

thyroid metabolism, Co-60 to assess B-12 absorption, Ca-47 and Sr-85 for bone metabolism and I-131-labeled proteins for protein metabolism.

Important clinical findings from this instrument included the identification of moderate to severe depression of body potassium in patients with muscle disease and the relationship between body potassium and water. The findings of this study determined that intracellular potassium deficiency may be a critical factor in the dystrophic process.<sup>1</sup>

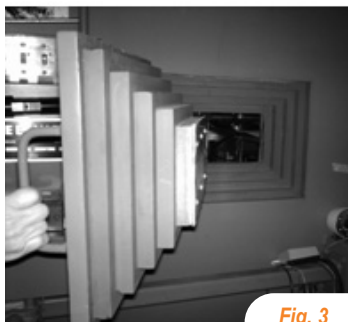


Fig. 3

of the fused composition of the fission particulates that renders them metabolically inert and prevents the extraction of entrapped fission products and deposition into tissues where they may be retained for long periods of time.<sup>2</sup>

Our thanks to Drs. Blahd, Mirell and Lake for the opportunity to take a walk down memory lane and learn of the important contributions of bioassay procedures of yesterday ■

A more recent study performed on this instrument was the long term fission product retention study performed on the American tour group exposed in Kiev to the initial Chernobyl reactor incident. The findings of this study were different from the published reference values of the International Commission of Radiological Protection (ICRP). The report concluded that ingestion of particulate fission products generated from a nuclear reactor explosion (and from nuclear weapons explosions) appear to have a relatively short retention because

- <sup>1</sup> Blahd, WH, Body Potassium Content in Muscle Disease, 6th International Congress of Nutrition, Edinburgh, 1963.
- <sup>2</sup> Mirell, SG, Blahd, WH, Biological Retention of Fission Products from the Chernobyl Plume, Vol 57, No. 4, 1989.

**Count on Capintec for Your Cabinetry Needs**

Everything about Capintec's lead-lined cabinetry conveys quality. Capintec's lead-lined cabinetry has been specifically designed for use in all areas where radionuclides and radioactive sources are stored, handled, or used. You can choose from a selection of standard cabinet configurations, or have lead-lined cabinets manufactured to your exact specifications. Lead-lined cabinetry is available in your choice of 1/4", 1/2" or 1" lead shielding to meet your radiation shielding requirements - select models available in 2" thickness for PET.

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**Capintec Meeting Schedule: Spring '07**

March 9 - 11	<b>GNYC SNM</b>	Atlantic City, NJ
March 9 - 11	<b>Central Chapter SNM</b>	Chicago, IL
March 17 - 18	<b>Pacific Northwest Chapter SNM</b>	Portland, OR
March 30 - April 1	<b>Southwest Chapter SNM</b>	Fort Worth, TX
April 7	<b>Pittsburgh Chapter SNM</b>	Pittsburgh, PA
April 21 - 22	<b>Pacific Southwest Chapter SNM</b>	Tucson, AZ
April 29 - May 2	<b>ICNC 8</b>	Czech Republic

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## Important Notice: Daylight Savings Time Adjustment

The U.S. Energy Policy Act of 2005 extended Daylight Savings Time (DST) by approximately four weeks. Beginning in 2007, DST will start three weeks earlier on March 11, 2007 and will end one week later on November 4, 2007. A summary of time change conditions for Capintec products is provided for your reference.

Many Capintec instruments contain a date/time function. These include dose calibrators, Caprac well counters, and thyroid uptake systems. Because our customers are world wide, and reside in many different time zones, Capintec firmware does not incorporate an automatic adjustment for time zones or daylight savings within any microprocessor based system. It is the responsibility of the end user to adjust the date and time to correctly reflect their individual local conditions. Detailed instructions for changing the date and time are provided in the product Owner's Manuals.

**Caution:** Changing the date or time while a timed test is in progress (for example, a 24 hour thyroid uptake test), might affect the results or introduce an error. Care should be taken to evaluate any potential impact for ongoing tests before changing the date or time.

A special condition exists for the Captus 3000 Thyroid Uptake and Well Counter System. Since this product is a PC based system, Captus 3000 software uses the date/time function provided by the Windows® operating platform. When the date or time is changed at the operating level, it will be reflected as a revised date and time in the Captus 3000 software and for any tests or measurements. Windows® also allows the user to activate an automatic time adjustment for daylight savings.

**As stated in the cautionary note above, changing the date or time while a test is ongoing may introduce an unexpected error.**

For this reason, we recommend that the automatic daylight savings feature is NOT active on your Captus 3000 system. The date and time should be changed manually, as required by local conditions, only after confirming the status and impact on any ongoing tests or measurements.

To check the status of the automatic daylight savings adjustment on your PC, perform the following keystrokes:

- Right click on the displayed time located in the lower right corner of the Windows® toolbar.
- Select Adjust time/date from the menu.
- Select the Time Zone tab
- Inspect the box to the left of the statement "Automatically adjust clock for daylight savings changes"
- A check mark in the box indicates the automatic adjust is activated. To deactivate, click on the box to *remove the check mark*.

See the image to your right, which identifies the daylight savings activation box ►

If you require any additional information or assistance, please contact the Capintec customer support staff at 1-800-631-3826, or email [kpage@capintec.com](mailto:kpage@capintec.com).

