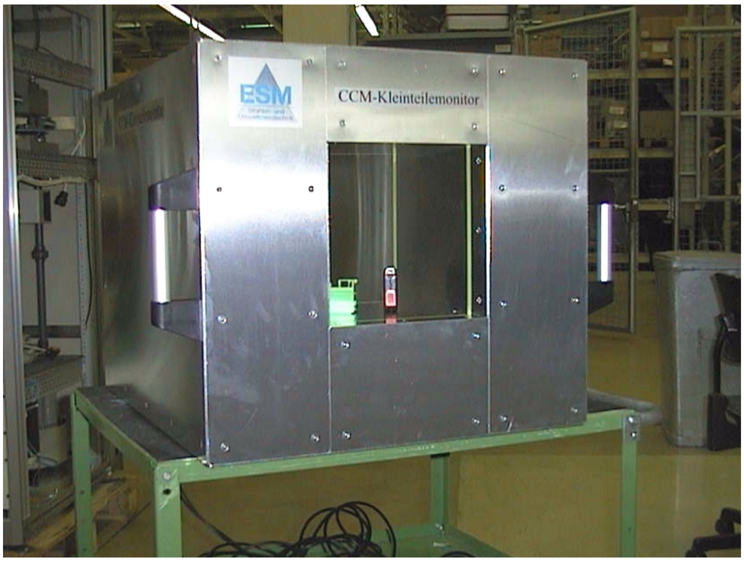
Thermo Eberline ESM

Excellence in Measurement

FHT 3020 CCM Tool Monitor



- **Nuclide specific measurement of Co-60 contamination**
- **No cross-sensitivity against varying Co-60 doserate**
- **No lead shielding necessary**
- **Tremendous enhancement of signal-to-noise-ratio**
- **Simultaneous integral gamma measurement**

General

By virtue of the newly developed CCM method (Cobalt Coincidence Method) extremely low detection limits at very short sampling times and an excellent spatial focusing can be achieved. The method can also be applied where conventional gross counting or spectroscopy are hampered by temporal variations of the external gamma field or by natural radioactivity of the measured object itself.

Contrary to spectroscopy also Compton-scattered gamma quanta contribute to the measuring effect.

Therefore the CCM method is very suitable for the Co-60 measurement in matrix material of low Z (aluminum, inflammable waste etc.).

Other relevant gamma emitters, e.g. Cs-137, Sb-125 and Ru-106 can simultaneously be tracked at comparable detection limits, via an integral measurement (in absence of natural radiation of the measured object).

Depending on sampling time, ambient radiation, size and distance of the detectors typical detection limits range between 100 Bq and 1000 Bq of Co-60.

Comparison to other Methods

Especially at older nuclear sites Co-60 is the leading nuclide, i.e. the total activity of a contaminated part is inferred from a Co-60 measurement and the known nuclide vector determined once by gamma spectroscopy.
A nuclide specific measurement is usually carried out by high resolution Ge-detectors. The relatively high costs and the long spectrum acquisition times are major disadvantages of these detectors.

Superiority in the detail

In-situ measurements are generally degraded by ambient radiation: The detector cannot discriminate, whether the radiation arises from the object itself or from the environment, especially in case of the same nuclide. For reasons of weight and costs, lead shieldings can overcome this problem only for small-sized samples, but not for larger machine components or barrels.

Low-priced detectors with poor spectroscopic properties (e.g. NaI(Tl) scintillation detectors and organic scintillation detectors) suffer from the additional problem that they cannot discriminate fission and activation products from natural radioactivity of the sample.

Beta measurements are suitable for highly localized surface contamination detection, but suffer from absorption effects - in the object of interest, fragmented surface structures etc..

Theory of Operation of CCM

Upon each radioactive decay, Co-60 simultaneously emits two gamma quanta at 1173 keV and 1332 keV, respectively. Using large area detectors with high gamma efficiency, the appropriate electronics can measure both the single and the coincident count rate. Setting correct energy windows for both detectors avoids the acquisition of real coincidences caused by natural radionuclides (U-238, Th-232 with their respective progeny, K-40) or of cosmic irradiation.

The expectation value of stochastic coincidences, S, accounts to

$$S = R_1 \cdot R_2 \cdot t_c$$

with R_1 and R_2 denoting the single countrates in the two energy windows and t_c the coincidence time window (app. 1 µs).

The real coincident countrate, C, results as

$$C = M - S$$

with M denoting the total measured coincidence. The relationship between C and the Co-60 activity, A, being looked for reads

$$C = \varepsilon_1 \cdot \varepsilon_2 \cdot A$$

The single detection probabilities ε_1, ε_2 (cps/Bq) have to be determined for the respective detector size and distance utilising a reference source. For Co-60 contaminations not residing in between the detectors, the real coincident countrate is inversely proportional to the 4^{th} power of the distance.
This can be put down to the known inverse distance square proportionality of the single detection probabilities ε_1 and ε_2. Any interfering source being apart by a distance of the order of magnitude of the detector size cannot systematically degrade the described CCM method. Only the stochastic coincidences reduce the level of statistical significance. Inside the measuring cavity outlined by the detector cross sectional area and distance, a very homogenous sensitivity is achieved.
Detector size and distance are about the dimension of the measured object. The detector thickness ranges between 5 and 10 cm, typically.

Technical Data

- Mechanics made of extruded aluminum profiles covered by panels.
- Detector unit comprising 4 ea plastic scintillation detectors 220 x 220 x 100 mm with integrated PMT and voltage divider.
- CCM efficiency: app. 0.01 cps/Bq
- CCM background: app. 1 cps
- Limit of detection: 100Bq in 10s, 5 % error probability for false alarm and non-detected contamination, respectively.
- Signal-to-noise-ratio s/n: s/n (CCM) > 100 · s/n (integral) at 1 µSv/h related to Co-60
- Electronics: FHT8000 with CCM multi coincidence logic and 9" LC display.
- Measuring range activity: 10^2 to 10^5 Bq
- Ambient and operation temperature: + 15 °C to 40 °C
- Humidity: 20 to 80 % RH, non-condensing
- Cross-sensitivity against ambient doserate: no systematic influence up to 1 µSv/h
- Mains supply of monitor 85 - 264 VAC, 50/60Hz
- Power consumption: FHT8000 incl. detector unit 75W
- Dimension

Length:	614 mm
Width:	528 mm
Height:	488 mm
Cavity:	210 x 210 mm
Weight:	app. 40kg (without electronics)

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