Validating A Clearance Approach For Containerized Materials And Big Items

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1. INTRODUCTION

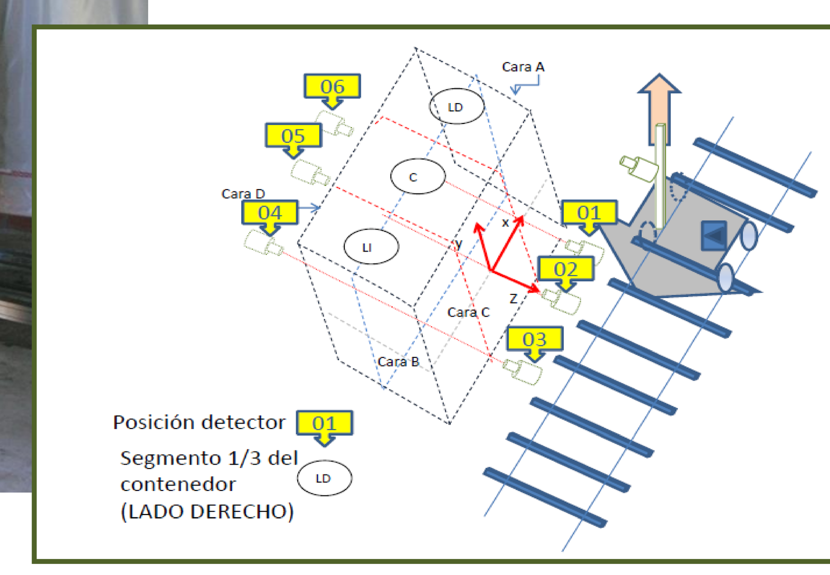
Some years ago, a clearance methodology, based on non - parametrical statistics and MARSSIM, was developed to demonstrate the compliance with the EU standards for scraps release (using Radiation Protection – 89 clearance levels) . This methodology was applied using a standard commercial multi - probe gamma device Box-Counter type . Now, this methodology has been updated and applied on a single portable gamma spectrometer with Monte Carlo calibration software. A set of tests were designed to ensure the compliance with a set of Data Quality Objectives and to improve the Clearance Standard Operating Procedures and to use ISO 11929:2010.

2. OBJETIVES

To validate measurement methods for:

1) Demonstrate compliance with the Spanish Clearance Regulations

2) Develop a set of Standard Operating Procedures for the future routine works.



3. METHODS

PLANNING USING DQO´s

DQO1 Minimum detectable concentration (MDC) will be lower than 50% of Clearance Level.
DQO2 Calibration will be performed for Cs-137 and Co-60 (key nuclides) . The detector calibration is performed in supplier facility but routine tests included checks with exempted sources and background determinations
DQO3 Each individual clearance measurements will not average over more than 1 m^2, or 1 m^3 or 1 t.
DQO4 Minimum detectable concentration (MDC) will be determined over "blanks" with the same material.
DQO5 Gamma spectrometer calibration (efficiency) will be compared with field reference materials (blanks with traceable sources).
DQO6 Relative Analytical Uncertainty will be lower then 10% average, without background uncertainty.
DQO7 Analytical relative bias will be lower than 10 %.
DQO8 Valid measurement percentage will be higher than 90 %.

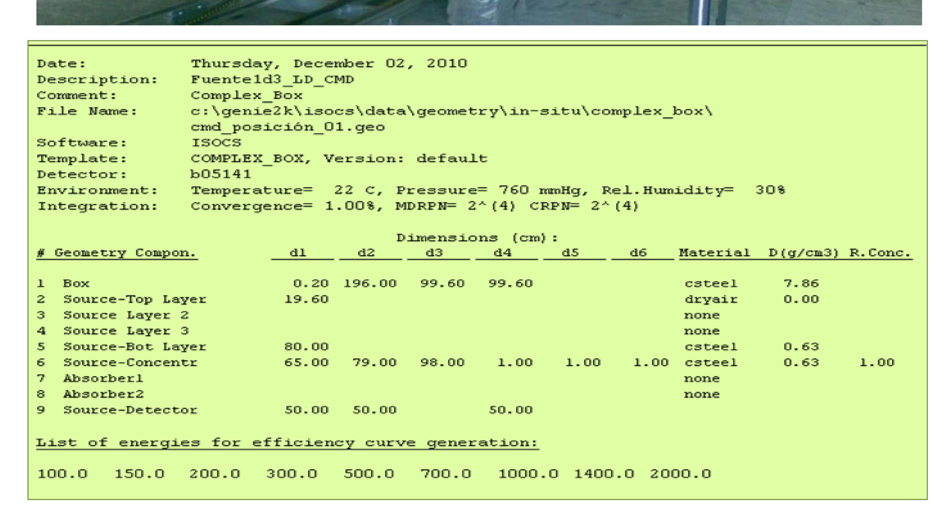
IMPLEMENTATION

The testing protocol use the AAS (Adding- A- Source) approach:

- The container (around 2 m^3) test was performed inserting in the inner volume of a "clean" container Co-60 and Cs-137 sources (5.29E+06 Bq of Co-60 and 1.68E+05 Bq of Cs-137) separately. Those sources were placed in 15 different positions and gamma spectra were obtained. The whole container volume (around 2 m^3) was divided in three parts and the detector was placed in six places (three on each side) (see enclosed figure 1) . With this configuration two gamma spectrometric measurements corresponding one container third were obtained.
- Big items tests were performed placing sources on different locations (se enclosed figure 2) and separately and, as the previous case, on the surface of a big massive part and the corresponding gamma spectra were obtained. Also the measurement were mathematically calibrated with commercial code. **The surface is covered by a triangular array (see figure)**

ASSESSMENT

All results were statistically analyzed, specifically in container measurements the lognormal Transmission Factors were characterized, evaluated and the applicability and usual calculation of uncertainties were analyzed according on well sounded statistical methods based in Sampling theories.



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Date:           Thursday, December 02, 2010
Description:    Fuente1d3_LD_CMD
Comment:        Complex_Box
File Name:      c:\genie2k\isocs\data\geometry\in-situ\complex_box\
                cmd_posición_01.geo
Software:       ISOCS
Template:       COMPLEX_BOX, Version: default
Detector:       b05141
Environment:    Temperature=  22 C, Pressure= 760 mmHg, Rel.Humidity=  30%
Integration:    Convergence= 1.00%, MDRPN= 2^(4) CRPN= 2^(4)

                                  Dimensions (cm):
# Geometry Compon.       d1     d2     d3     d4     d5     d6   Material  D(g/cm3) R.Conc.

1  Box                  0.20 196.00  99.60  99.60                csteel     7.86
2  Source-Top Layer    19.60                                     dryair     0.00
3  Source Layer 2                                                none
4  Source Layer 3                                                none
5  Source-Bot Layer    80.00                                     csteel     0.63
6  Source-Concentr     65.00  79.00  98.00   1.00   1.00   1.00  csteel     0.63     1.00
7  Absorber1                                                     none
8  Absorber2                                                     none
9  Source-Detector     50.00  50.00         50.00

List of energies for efficiency curve generation:

100.0  150.0  200.0  300.0  500.0  700.0  1000.0 1400.0 2000.0
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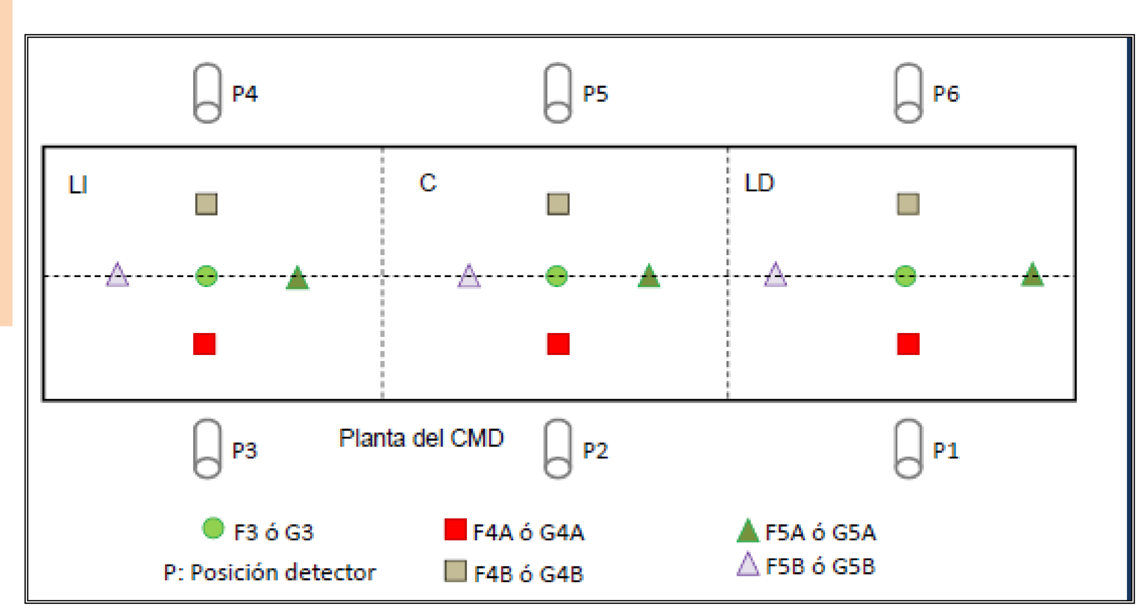
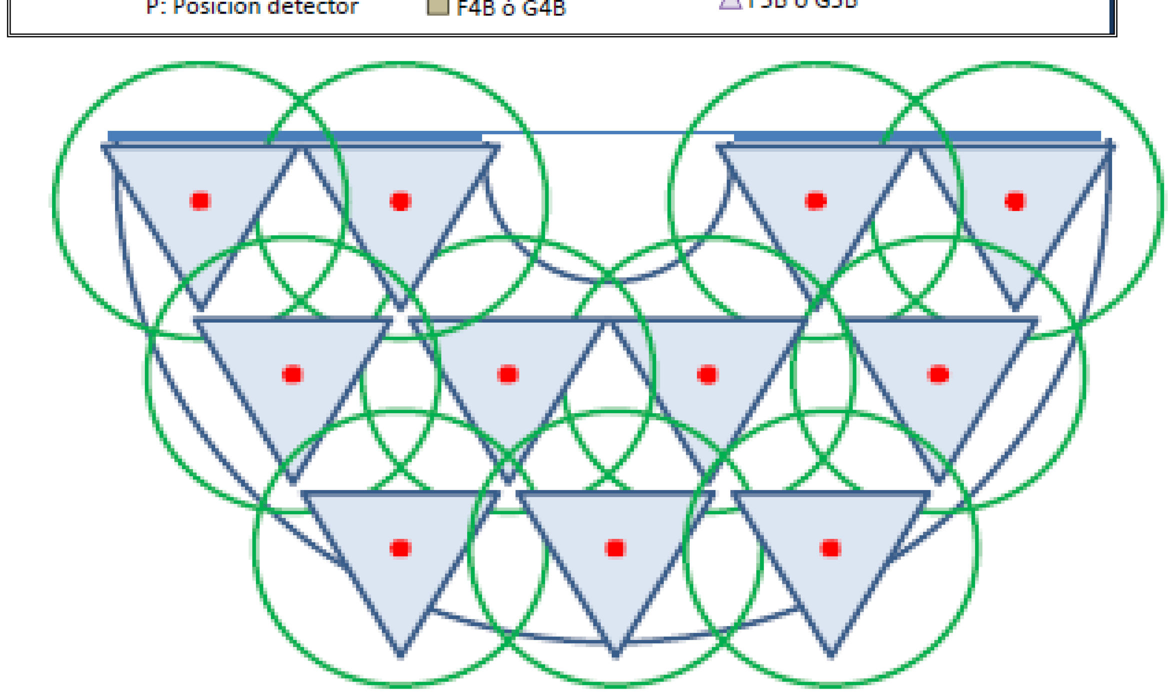
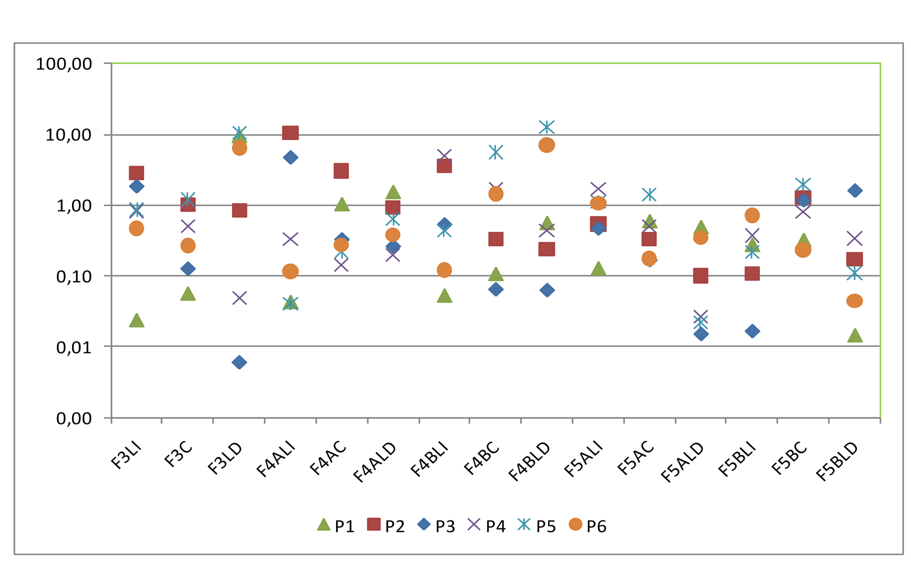




4. MAIN RESULTS

Tests in reference container (Transmission factors, T) :

T(Co-60)=Am/As **T(Cs-137)=Am/As**



1) The Co-60 activity is overestimated in 13 positions and in 2 of 15 it is underestimated . However adding expanded uncertainty it is overestimated in this 2 positions. In these cases positive bas is conservative..
2) The Cs-137 activity is overestimated in the 15 source positions
Test in reference singular item gives the similar results.
Test (ANOVA) for measurement time selection were performed (see table)
Uncertainty calculations for containers were performed :

$$u_{\bar{c}} = \frac{\overline{c}}{\sqrt{n}} \sqrt{\varphi^2_{sampling+}\varphi^2_{anal.+}\varphi^2_{transmission}}$$

CLEARANCE UNIT	GEOMETRICAL MODEL	MEASUREMENT TIME (SINGLE) (s.)
CONTAINER CMD	"Complex Box" on 1/3 volume of the container (CC1d3)	300
Singular item (disc or diaphragm)	"Circular Plane Template"	600
Singular item (simple or complex cylinder)	"Round Tube Int/Ext Contamination"	600

Finally special software , with Sign-test and elevated measurement comparison to clearance of materials was tested.

5. CONCLUSIONS

1. A new measurement device and protocols have been successfully tested to be used in scrap clearance

2. The "worst case" ,using single elevated activity sources, has been implemented to test this device satisfactorily.