

SURFACE & SUBSURFACE SOIL CHARACTERIZATION FOR THE RELEASE PROCESS AT JOSÉ CABRERA NPP

ISOE WGDECOM 5th Meeting, Spain 25- 28 April 2017

**Cristina Correa Sáinz
Jose Luis Leganes Nieto**

1. Documentary Framework
2. Release Units, RU's, at Jose Cabrera NPP
3. Release Levels, RL's.
4. Reference Residual Levels, RRL's.
5. RU's Complementary Characterization
6. Characterization by using Geostatistics
7. Remediation
8. Final characterization: MARSSIM + additional features
9. Devices

☐ **Planning**

- Remediation Activities Description: 060-PL-JC-0033.
- Source Term: 060-ET-EN-0001.
- Scaling Factors: 060-IF-IN-0039.
- Release Levels, RL's: PRE 060-RE-EN-0001.
- Residuals Reference Levels, RRL's: 060-IF-JC-1721.
- Classification of Release Unit, RU's: 060-PC-JC-0430.
- List of Existing RU's: 060-LI-JC-0012.
- Buried Structures & Pipes: 060-LI-JC-0010.
- Reference Areas: 060-IF-JC-1806.
- Area Factor: 060-IF-JC-1807.

☐ **Design**

- Methodology of Release Soils Determination: 060-PC-JC-0444.
- Measurement Methodology: 060-PC-JC-0443.
- Quality Assurance Verification: 060-PC-JC-0441.

☐ **Measure**

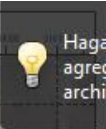
- Calibration and Test of Equipment: 060-PC-JC-0395.
- Release Measurement Test.
- Sampling Process for Subsurface soils: 060-PC-JC-0446.
- Sampling Process for Surface Soils : 060-PC-JC-0445.
- Measures of Remediated Terrains: 060-PC-JC-0448.

☐ **Performance**

- Control and Managing of RU's: 060-PC-JC-0439.

☐ **Assessment**

- Measures Assessment: 060-PC-JC-0447.
- Actions for the Rejected UR's: 060-PC-JC-0442.



PROYECTO:	INGENIERÍA PRINCIPAL DE P.D.C. DE C.N.J.C.
INSTALACIÓN:	CENTRAL NUCLEAR JOSÉ CABRERA
TÍTULO DE TRABAJO:	FIGURA 1 DELIMITACIÓN DE LAS UNIDADES DE LIBERACIÓN
CLIENTE:	 enresa
CÓDIGO DE DOCUMENTO:	060-PC-JC-0430
FECHA:	...
REV:	...

Release Unit	Description	Kind	Class	Surface	Expected Contamination	Buried Structures	Pitches	Boreholes	Material
UL-AT1-aa1	Zona controlada ATI 1	AE	1	589	no	no	3		impermeable
UL-AT4-aa1	Zona controlada ATI 2	AE	1	1730	no	no	8		impermeable
UL-AT5-aa1	Zona controlada ATI 3	AE	1	1730	no	no	8		impermeable
UL-AU1-aa1	EDIFICIO AUXILIAR	Ed.	1	1058	no	si			Edificio
UL-CO1-aa1	EDIFICIO DEL REACTOR	Ed.	1	903	no	si			Edificio
UL-EA1-aa1	EXPLANADA ALMACENAMIENTO BIDONES 1 (Edificio)	AE	1	369	no	no	2		edificio
UL-EA2-aa1	EXPLANADA ALMACENAMIENTO BIDONES 2 (Campa)	AE	1	504	no	no	3		impermeable
UL-EF1-aa1	EXPLANADA POSTERIOR FOSAS ALM II 1	AE	1	1801	si	no		9	Permeable
UL-EF2-aa1	EXPLANADA POSTERIOR FOSAS ALM II 2	AE	1	1191	si	no		6	Permeable
UL-ER1-aa1	EXPLANADA ALMACÉN III CHATARRAS 1	AE	1	1682	si	no		8	Permeable
UL-EV1-aa3	EDIFICIO DEL EVAPORADOR	Ed.	1	305	no	no	2		Edificio
UL-EX1-aa1	EXPLANADA SUR ED REACTOR 1 (zona tanques)	AE	1	537	si	no		3	Permeable
UL-EX2-aa1	EXPLANADA SUR ED REACTOR 2	AE	1	1140	si	no		6	impermeable
UL-EX3-aa1	EXPLANADA SUR ED REACTOR 3	AE	1	147	no	no			impermeable
UL-EX4-aa1	EXPLANADA SUR ED REACTOR 4	AE	1	318	no	no	2		impermeable
UL-IN1-aa1	ISLA NUCLEAR 1	AE	1	2296	si	no		11	Permeable
UL-IN2-aa1	ISLA NUCLEAR 2	AE	1	2100	si	no		10	Permeable
UL-IN3-aa1	ISLA NUCLEAR 3	AE	1	1882	si	no		9	Permeable
UL-IN4-aa1	ISLA NUCLEAR 4	AE	1	1690	si	no		8	Permeable
UL-RC1-aa2	ALMACÉN III DE CHATARRAS	Ed.	1	923	no	no	5	-	Edificio
UL-RI1-aa1	ALMACEN I DE RESIDUOS	Ed.	1	1266	no	si		6	Edificio
UL-RL1-aa1	ALMACÉN II RESIDUOS	Ed.	1	2464	si	SI		11	Edificio
UL-RT3-aa1	RUTA TRANSPORTE MAT RAD 3	AE	1	1656	no	no	8		impermeable
UL-AT2-aa2	Zona Vigilada ATI	AE	2	1869	no	no	5		impermeable
UL-CN1-aa2	CANAL DE DESCARGA 1	AE	2	3924	no	no	10		Agua f/odos
UL-EC1-aa2	EXPLANADA CASETAS RECARGA 1 (Zona antiguos Trafos)	AE	2	1518	no	no	4		impermeable
UL-EC2-aa2	EXPLANADA CASETAS RECARGA 2 (Cerca subestación)	AE	2	1958	no	no	5		Permeable
UL-EC3-aa2	EXPLANADA CASETAS RECARGA 3 (Entre turb y ed diesel)	AE	2	1442	no	no	4		impermeable
UL-EC4-aa2	EXPLANADA CASETAS RECARGA 4 (ed diesel y tanque)	AE	2	1120	no	no	3		Permeable
UL-EF3-aa2	EXPLANADA POSTERIOR FOSAS ALM II 3	AE	2	1092	no	no	3		Permeable
UL-ER2-aa2	EXPLANADA ALMACÉN III CHATARRAS 2	AE	2	2650	no	no	7		Permeable
UL-ER3-aa2	EXPLANADA ALMACÉN III CHATARRAS 3	AE	2	599	no	no	2		Permeable
UL-ER4-aa2	EXPLANADA ALMACÉN III CHATARRAS 4	AE	2	2971	no	no	8		Permeable
UL-JA1-aa2	JARDINES EDIFICIOS PRINCIPALES 1	AE	2	2081	no	no	6		Permeable
UL-JR1-aa2	JARDINES CERCANOS ALMACÉN II RESID. 1	AE	2	3131	no	no	8		Permeable
UL-JR2-aa2	JARDINES CERCANOS ALMACÉN II RESID. 2	AE	2	663	no	no	2		Permeable
UL-RT1-aa2	RUTA TRANSPORTE MAT RAD 1	AE	2	1068	no	no	3		impermeable
UL-RT2-aa2	RUTA TRANSPORTE MAT RAD 2	AE	2	2096	no	no	6		impermeable
UL-ZD1-aa2	ZONA ANEXA ALMACÉN I 1	AE	2	341	no	no	1		Permeable
UL-ZD2-aa2	ZONA ANEXA ALMACÉN I 2	AE	2	96	no	no	1		impermeable
UL-ZD3-aa2	ZONA ANEXA ALMACÉN I 3	AE	2	98	no	no	1		impermeable

Release Unit	Description	Kind	Class	Surface	Expected Contamination	Buried Structures	Pitches	Boreholes	Material
UL-ZE1-aa3	ZONA ANEXA EXPLANADA REACTOR 1	AE	2	642	no	no	2		impermeable
UL-ZE2-aa3	ZONA ANEXA EXPLANADA REACTOR 2	AE	2	394	no	no	1		impermeable
UL-ZI1-aa2	ZONA ANEXA A LA ISLA NUCLEAR 1	AE	2	2703	no	no	7		Permeable
UL-ZI2-aa2	ZONA ANEXA A LA ISLA NUCLEAR 2	AE	2	1535	no	no	4		Permeable
UL-ZI3-aa2	ZONA ANEXA A LA ISLA NUCLEAR 3	AE	2	7191	no	no	18		Permeable
UL-AC1-aa3	ALMACÉN GENERAL	Ed.	3	785	no	no	1		Edificio
UL-AG1-aa3	ARCHIVO GARANTÍA CALIDAD	Ed.	3	188	no	no	1		Edificio
UL-AT3-aa3	Resto del ATI	AE	3	7300	no	no	9		impermeable
UL-CN2-aa3	CANAL DE DESCARGA 2	AE	3	2486	no	no	3		Permeable
UL-CN3-aa3	CANAL DE DESCARGA 3	AE	3	2057	no	no	3		Permeable
UL-CN4-aa3	CANAL DE DESCARGA 3	AE	3	413	no	no	1		Permeable
UL-DV1-aa3	Zona de Vigilancia del Doble Vallado1	AE	3	1164	no	no	2		Permeable
UL-DV2-aa3	Zona de Vigilancia del Doble Vallado2	AE	3	3510	no	no	4		Permeable
UL-DV3-aa3	Zona de Vigilancia del Doble Vallado3	AE	3	5305	no	no	6		Permeable
UL-ED1-aa3	EDIFICIO DIESEL	Ed.	3	178	no	no	1		Edificio
UL-EE1-aa3	EDIFICIO ELÉCTRICO	Ed.	3	307	no	no	1		Edificio
UL-ER5-aa2	EXPLANADA ALMACÉN III CHATARRAS 5	AE	3	5171	no	no	6		Permeable
UL-ET1-aa3	EXPLANADA TALLERES Y GARAJES 1	AE	3	2195	no	no	3		impermeable
UL-ET2-aa3	EXPLANADA TALLERES Y GARAJES 2 (Jardin)	AE	3	310	no	no	1		Permeable
UL-ET3-aa3	EXPLANADA TALLERES Y GARAJES 3	AE	3	958	no	no	2		Permeable
UL-JA2-aa3	JARDINES EDIFICIOS PRINCIPALES 2	AE	3	742	no	no	1		Permeable
UL-JA3-aa3	JARDINES EDIFICIOS PRINCIPALES 3	AE	3	356	no	no	1		Permeable
UL-OF1-aa3	EDIFICIO DE OFICINAS	Ed.	3	632	no	no	1		Edificio
UL-SB1-aa3	SUBESTACIÓN 220KV	AE	3	15508	no	no	18		Permeable
UL-SP1-aa3	Servicio de Protección Radiológica II	Ed.	3	138	no	no	1		Edificio
UL-TG1-aa3	TALLERES GARAJES 1	Ed.	3	379	no	no	1		Edificio
UL-TG2-aa3	TALLERES GARAJES 2	Ed.	3	922	no	no	2		Edificio
UL-TG3-aa3	TALLERES GARAJES 3	Ed.	3	199	no	no	1		Edificio
UL-TL1-aa3	ZONA DEL TANQUE DIESEL	Ed.	3	167	no	no	1		impermeable
UL-TM1-aa3	TALLERES Y SERV MÉDICO PLANTA BAJA	Ed.	3	997	no	no	2		Edificio
UL-TU1-aa3	EDIFICIO AUXILIAR DE DESMANTELAMIENTO	Ed.	3	1334	no	si	2		Edificio
UL-VA1-aa3	VIAL DE ACCESO AL ATI	AE	3	5516	no	no	7		impermeable
UL-VE1-aa3	VIALES ACCESO A EDIFICIOS 1	AE	3	1743	no	no	2		impermeable
UL-VE2-aa3	VIALES ACCESO A EDIFICIOS 2	AE	3	1012	no	no	2		impermeable
UL-VG1-aa3	EDIFICIO VIGILANCIA ACCESO	Ed.	3	214	no	no	1		Edificio
UL-VT1-aa3	VIALES ZONA TALLERES 1	AE	3	674	no	no	1		impermeable
UL-VT2-aa3	VIALES ZONA TALLERES 2	AE	3	572	no	no	1		Permeable
UL-VT3-aa3	VIALES ZONA TALLERES 3	AE	3	2112	no	no	3		impermeable
UL-VT4-aa3	VIALES ZONA TALLERES 4	AE	3		no	no	0		Permeable
UL-ZB1-aa3	ZONA ALMACEN BIDONES INFLAMABLES Y GEST RES TOXIC	AE	3	654	no	no	1		impermeable
UL-ZI4-aa3	ZONA ANEXA A LA ISLA NUCLEAR 4	AE	3	2991	no	no	4		Permeable
UL-ZI5-aa3	ZONA ANEXA A LA ISLA NUCLEAR 5	AE	3	637	no	no	1		Permeable
UL-ZI6-aa3	ZONA ANEXA A LA ISLA NUCLEAR 6	AE	3	9199	no	no	11		Permeable

ISOTOPE	RL (Bq/g)	MOST RESTRICTIVE SCENARIO
Am-241	8,83E+00	Obras/Mantenimiento
C-14	1,26E+02	Agrícola-residencial
Cm-244	1,91E+01	Obras/Mantenimiento
Co-60	1,39E-01	Obras/Mantenimiento
Cs-134	2,51E-01	Obras/Mantenimiento
Cs-137	5,97E-01	Obras/Mantenimiento
Fe-55	4,13E+04	Agrícola-residencial
H-3	3,54E+03	Agrícola-residencial
Nb-94	2,10E-01	Obras/Mantenimiento
Ni-59	5,86E+03	Agrícola-residencial
Ni-63	2,47E+03	Agrícola-residencial
Pu-238	9,75E+00	Obras/Mantenimiento
Pu-239	8,90E+00	Obras/Mantenimiento
Pu-241	3,68E+02	Obras/Mantenimiento
Sr-90	1,92E+00	Agrícola-residencial
Tc-99	6,19E+00	Agrícola-residencial

RERERENCE RESIDUAL LEVELS

- ☐ Useful for defining the Lower than Detection Limit Values.
- ☐ For deciding whether or not there is contamination.
- ☐ Their influence on the Radiological Criteria is lower than 10%.

- ❑ Remediation is going to be systematically performed when residual activity is above RL's, with the main objective, insofar as possible, of leaving soil with activity below the RRL's.
- ❑ Before the backfilling process, MARSSIM methodology is to be applied to the exposed soil in order to decide whether or not the RU is release.
- ❑ When no remediation is required, MARSSIM methodology is directly applied to the RU to assess the release process.
- ❑ In addition to the MARSSIM approach, when applied, a number of pits has to be collected in the location of the N measurements to provide that no subsurface residual values are involved.

- ❑ Dynamics analysis of the Release Unit covering 100% of its surface.
- ❑ Systematic pits in those RU's in which are not expected to have, by operational information and the initial characterization, residual values in depths greater than the ones achieved by this technics.
- ❑ Additional boreholes in those RU's in which are expected to have, by operational information and the initial characterization, residual values in depths greater than the ones achieved by pits. Or in those RU's which harbor buried structures and pipes with radiological functions.

- ☐ Dynamics analysis of class 2 RU covering up to 50% of its surface.
- ☐ Dynamics analysis of class 3 RU covering up to the 10% of its surface.
- ☐ Pits in those class 2 RU's in which are expected to have some fraction of the release levels as residual activity.
- ☐ Pits in those class 3 RU's in which are expected to have some small fraction of the release levels as residual activity.

☐ Class 1 RU's :

- A first approach with a grid of 15 m of length side to identify/quantify the places to be remediated.
- Increase the density of measurement decreasing the size of the grid in the location to be remediated, just to best define the boundary that change from the clean area to the contaminated one.
- **The size of the grid should be greater than the size of the means used to remediate.**

☐ Class 2 RU's :

- A first approach with a grid of 20 m of length side to identify/quantify the places to be remediated.

☐ Class 3 RU's :

- A first approach with a grid of 30 m of length side to identify/quantify the places to be remediated.

All these information will be used to better define the N measurements to be taken in the **Final Status Survey**.

- ❑ Its main goal is to quantify as best as possible the amount of terrain to be remediated.
- ❑ One additional objective is to estimate the residual activity of the terrain that is going to be left, that have to be lower than the limits with a fixed confidence interval. But in any case, this terrain is going to be measure in a detail manner later on in the **Final Assessment** phase.
- ❑ **Geostatistics** is a valuable tool when **data are structured**.

Processes that follow physical laws of contaminants transport in which it is expectable to show correlation among them in different places.

- ❑ When **data** are **not structured**, there is **no difference between geostatistics and classical statistics** (e.g. MARSSIM).

In a trench that had packages, there is no expected correlation among the activity of different places inside the trench with distance.

Or after a systematic scarified of surfaces in buildings, the residual activity is not expected to show correlation.

❑ **Structured Data**

- From a detailed estimation by using geostatistics in order to infer the activity of each container. Additional non systematic in situ measurements as a verification tool.
- With no previous analysis. The classification is done during the remediation process by means of systematic in situ measurements.
- Both, the more current cases, a pre-classification by using geostatistics and in situ measurements to definitely classify the remediated material..

❑ **No structured data**

- It is not possible to have a detailed previous estimation unless there is a large number of pits/boreholes, non operative process.
- Directly remediate/classify the materials.

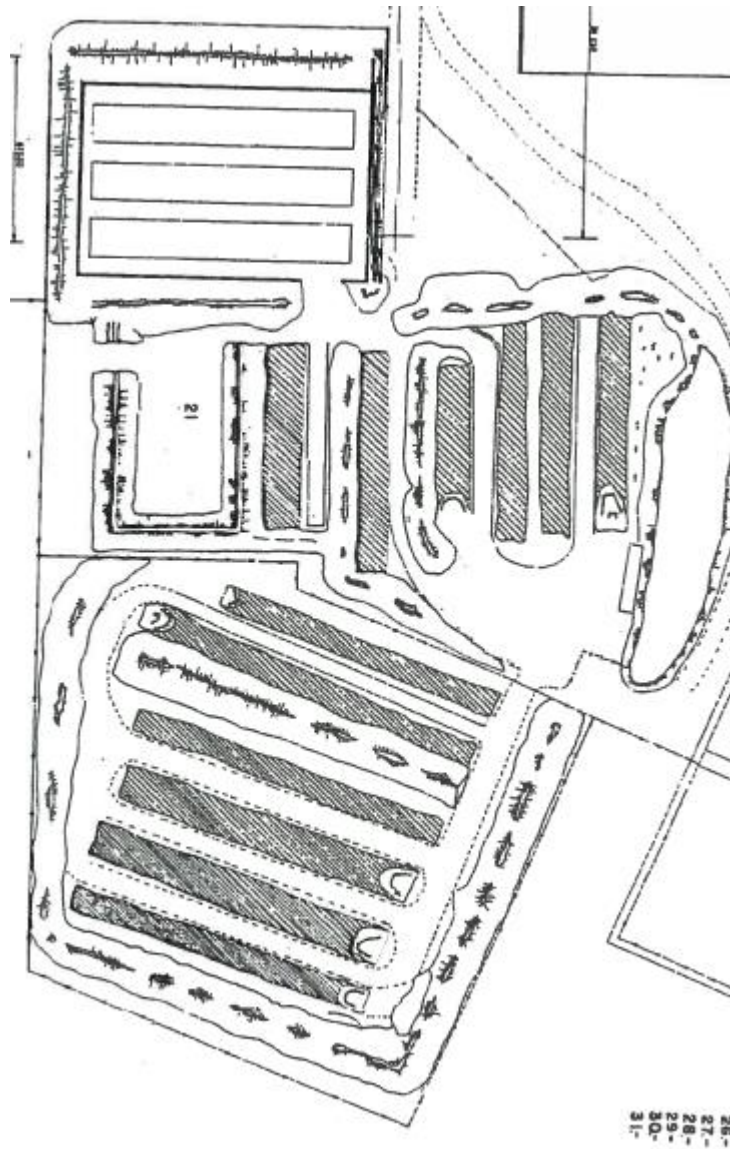








CODE	ID	Depth (m)	Diameter (mm)	Coordetates		GPS Error (cm)
				X (m)	Y (m)	
EF1-01-1-SU-3	EF3	3	82	509882.38	4466519.48	±10
EF1-01-1-SU-4	EF4	3	76	509884.47	4466531.42	±10
EF1-01-1-SU-5	EF5	3	76	509885.11	4466529.45	±10
EF1-01-1-SU-9	EF9	9	76	509882.61	4466554.73	±10
EF1-01-1-SU-10	EF10	9	76	509887.02	4466545.68	±10
EF1-01-1-SU-11	EF11	9	76	509886.42	4466520.39	±10
EF1-01-1-SU-12	EF12	8,3	76	509894.09	4466513.09	±10
EF1-01-1-SU-13	EF13	6,94	97	509880.47	4466561.44	±10
EF1-01-1-SU-14	EF14	6,37	97	509878.34	4466545.72	±10
EF1-01-1-SU-15	EF15	6,85	97	509874.68	4466521.10	±10
EF1-01-1-SU-16	EF16	6,86	97	509882.06	4466528.44	±10
EF1-01-1-SU-17	EF17		97	509887.35	4466534.16	±10
EF1-01-1-SU-18	EF18	6,91	97	509883.23	4466521.75	±10
EF1-01-1-SU-19	EF19	7,01	97	509891.38	4466521.82	±10
ER1-01-1-SU-3	ER3	3	76	509887.08	4466629.40	±10
ER1-01-1-SU-4	ER4	3	76	509827.01	4466619.68	±10
ER1-01-1-SU-15	ER15	9	76	509876.17	4466607.17	±10
ER1-01-1-SU-16	ER16	8	76	509820.24	4466592.21	±160
IN1-01-1-SU-6	IN6	3	82	509938,78	4466555,59	±10
IN1-01-1-SU-7	IN7	3	82	509931,84	4466604,84	±10
IN1-01-1-SU-8	IN8	7,6	76	509936,07	4466605,02	±10
IN1-01-1-SU-9	IN9	7,6	76	509930,05	4466571,26	±10
IN1-01-1-SU-11	IN11	5,84	97	509899,58	4466581,38	±10
IN1-01-1-SU-12	IN12	6,5	97	509905,45	4466550,66	±10
IN1-01-1-SU-13	IN13	6,28	97	509915,81	4466540,92	±10
IN1-01-1-SU-14	IN14	5,92	97	509911,8	4466570,29	±10
IN1-01-1-SU-15	IN15	5,86	97	509929,27	4466579,98	±10
IN1-01-1-SU-16	IN16	5,82	97	509943,62	4466569,91	±10
IN1-01-1-SU-17	IN17	5,83	82	509955,48	4466580,5	±10
IN1-01-1-SU-18	IN18	6,22	82	509958,75	4466548,51	±10
IN1-01-1-SU-19	IN19	6,1	76	509970,02	4466563,6	±10
IN1-01-1-SU-20	IN20	6,14	82	509964,63	4466595,6	±10
IN1-01-1-SU-21	IN21	5,94	97	509956	4466573,53	±10
IN1-01-1-SU-22	IN22	6	97	509942	4466583	±10
IN1-01-1-SU-23	IN23	5,96	97	509952,54	4466591,24	±10
EX1-01-1-SU-11	EX11	3	87	509767,76	4466345,81	±10







- ☐ We operate with two BOX COUNTER and two ISOCS.
- ☐ In situ measurements before remediation in addition to geostatistics tools would be useful for estimating the activity in blocks size comparable to the means and containers to be used.
- ☐ In situ measurements during the extraction process are required. Ratemeters, total Beta/Alfa devices, INa Gamma devices.
- ☐ VLLW containers or BIG BAG to be send to the washing process.
- ☐ Clearable containers to the BOX COUNTER measurements.
- ☐ In situ measurement to the left terrain in order to check the suitability of the remediated process, otherwise keep remediating.
- ☐ Washed terrains will be measure by BOX/ISOCS devices.
- ☐ The final waste of the washing process, dried finer part of VLLW will be measure by ISOCS.
- ☐ In situ measurement in the washing process in order to check and track its efficiency.

☐ Remediated RU's

- Before backfilling.
- Dynamic scanning with 100% coverage.
- N detailed static measurements.
- N pits.

☐ Non remediated RU's

- Dynamic scanning with a coverage in accordance with their class.
- N detailed static measurements.
- N pits.

☐ With clean material from outside.

- Sand.
- Rubble crashed.

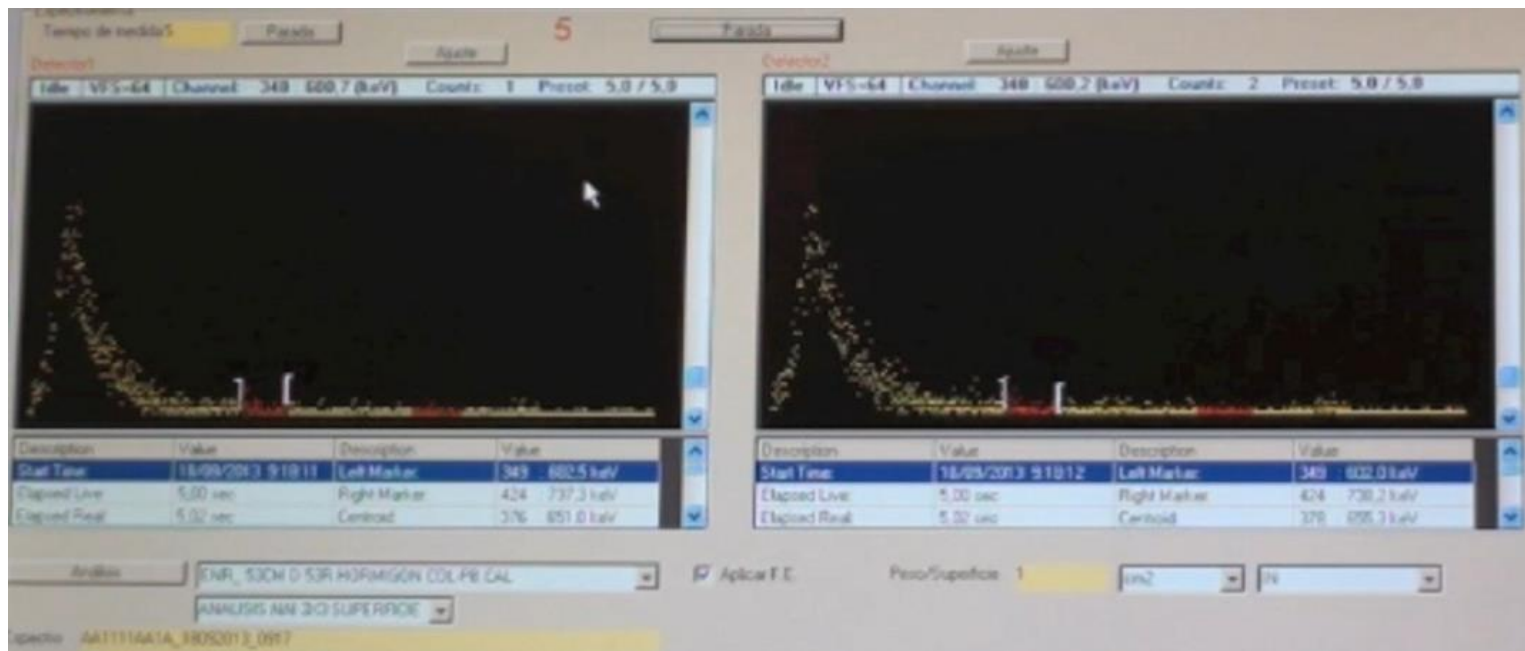
☐ With released material.

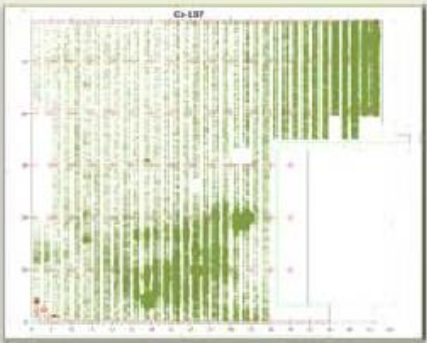
- Soils unconditionally released.
- Rubble conditionally release and properly diluted with clean rubble as RP113 requires

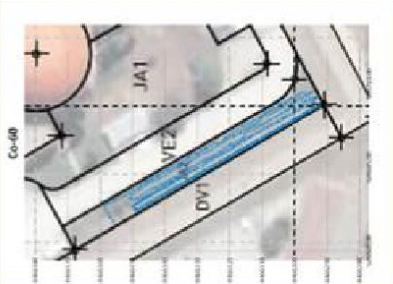
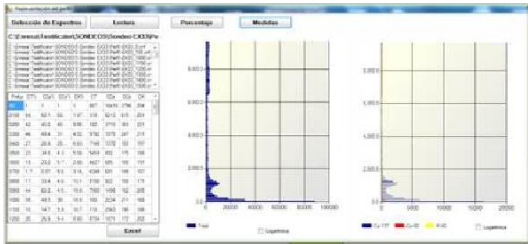


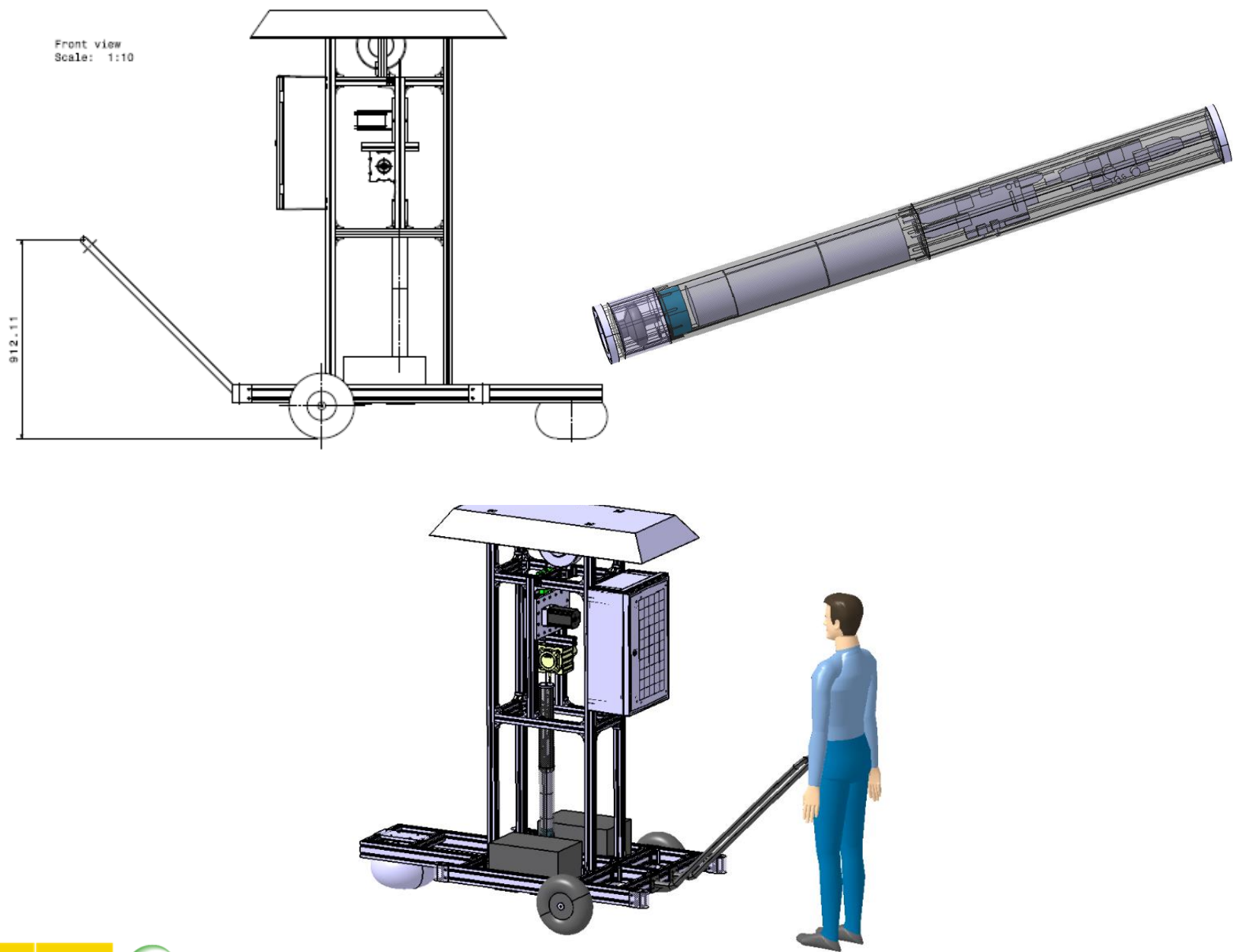


Detector1							Detector2						
Tm	V1	V2	V3	V4	V5	V6	Tm	V1	V2	V3	V4	V5	V6
8.1	686.3	5.14.7	10.3	4.4	2.7	4.2	3.8	686.6	16.1	12.0	9.7	3.1	5.2
1.0	688.0	10.7	9.4	9.1	3.0	5.6	2.1	688.7	10.0	8.6	9.7	3.0	8.1
2.3	679.3	14.2	12.9	8.3	3.4	2.2	2.1	681.0	16.3	13.5	9.8	4.3	7.7
2.3	679.3	15.0	13.1	5.7	4.4	7.0	3.1	694.0	12.2	11.7	9.4	3.9	4.4
2.3	681.5	14.3	10.8	5.2	3.9	3.0	2.1	690.4	18.1	15.9	2.9	4.3	6.7
8.2	694.3	15.1	11.3	8.3	4.0	4.2	8.3	672.4	14.3	12.5	4.5	4.1	7.4
2.3	683.2	14.3	8.3	3.8	6.8	3.8	2.1	686.9	13.9	12.0	3.8	1.4	7.4
2.1	1086.7	277.6	285.5	118.7	95.0	8.0	1.9	686.4	14.7	11.0	4.2	2.6	5.8
2.3	684.3	648.2	702.5	277.5	222.2	7.5	2.0	684.9	14.3	9.6	7.2	2.9	4.3
2.2	388.7	685.7	700.7	302.8	263.9	19.4	2.1	634.0	11.1	9.2	5.8	1.9	6.3

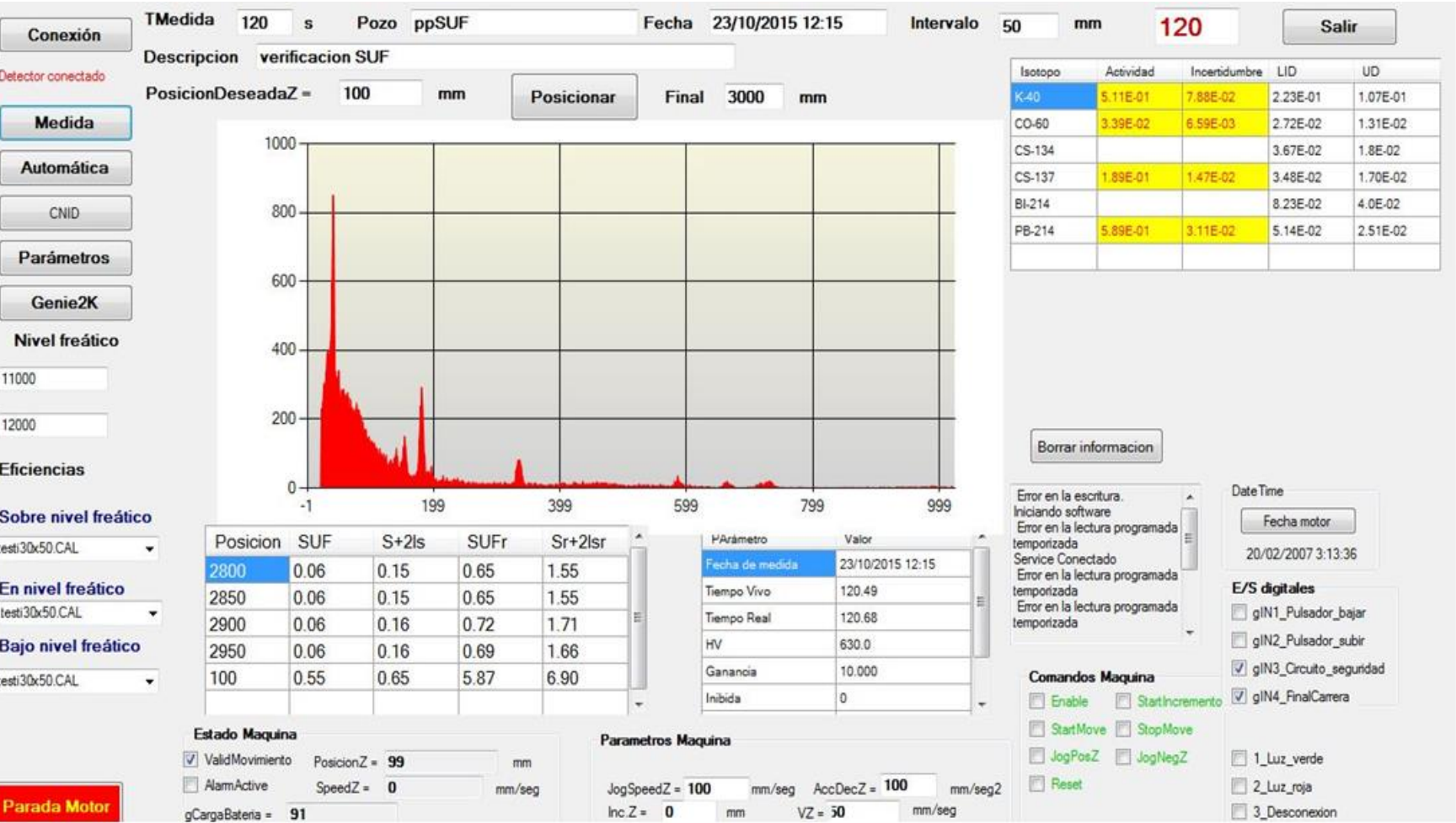














testi_30x50ajustado.geo

File Edit View Help

Geometry

ISOCS Well or Marinelli Beaker

Liner - side

Liner - end

Source - side

Source - end

Detector

Edit dimensions - Well or Marinelli Beaker

Description: testi_30x50ajustado

Comment: arlite

Units: ☒ mm ☐ cm ☐ m ☐ in ☐ ft

No.	Description	d.1	d.2	d.3	Material	Density	Rel. Conc.
1	Liner - side	8	100	500	pvc	1.39	
2	Liner - end	20			lead	11.35	
3	Source - side	300			dirt1	1.6	1.00
4	Source - end	0			(none)	0	0.00
5	Source-Detector	200	0				

OK

Cancel

Apply

Help

View Drawing...

Template Drawing

WELL OR MARINELLI BEAKER

☒ Fit to Window

Close

Help



THANK YOU VERY MUCH FOR YOUR ATTENTION



GOBIERNO
DE ESPAÑA

MINISTERIO
DE INDUSTRIA, ENERGÍA
Y TURISMO

