Rancho Seco Nuclear Generating Station Decommissioning Technical Basis Document	DTBD–05-010 Revision No. 0 DPT 05-079 RIC 2A.900

Beta Detection During Rancho Seco Nuclear Generating Station Characterization or Final Status Surveys (Including Beta Energies and Source Efficiency, Es)

PREPARED BY: _____ Author — 1/25/06 Date

REVIEWED BY: _____ Technical Reviewer — 1-26-2006 Date

REVIEWED BY: _____ QA Reviewer — 1/9/06 Date

APPROVED BY: _____ Principal Radiological Engineer — 6-2-06 Date

1.0 PURPOSE

The purpose of this Decommissioning Technical Basis Document (DTBD) is to establish the beta emitting nuclides detectable by site instrumentation as well as adjustments to detection efficiency for Source Efficiency (Es) and the presence of coatings on surfaces being surveyed.

2.0 DISCUSSION

Detection of beta particles depends on the energy of the beta particles emitted from materials being surveyed and the thickness of the detector window. The efficiency of the detector for beta particles is determined by exposing the detector to a known activity level of beta particles of a given energy and recording the resulting count rate (Ei). In order for the efficiency calibration to be accurate, the energy of the calibration source must be similar to the energy of the source to be measured in the field.

Assuming that the calibration source is of appropriate energy, other adjustments may need to be made to the efficiency in order to accurately determine true source activity. These adjustments include source efficiency due to surface conditions (Es) and beta attenuation caused by coatings/coverings placed on the source.

3.0 DEFINITIONS

Ei or instrument efficiency is the detector net response to a known surface emission rate in betas per minute for a 2 pi geometry.

Es or source efficiency is the ratio between the number of beta particles per minute emerging from the source surface and the number released within the source.

Et or total efficiency is the actual efficiency of a detector for a particular source and is the product of Ei and Es.

4.0 TECHNICAL POSITION

The calibration source used for gas-flow proportional detectors is appropriate for the average energy of beta particles emitted from the surface of structures and components at Rancho Seco. The Es adjustment made to Ei in order to calculate the detector Et has been properly determined. The need for adjustment of efficiency for surface coatings has been recognized and the method described in NUREG-1507 has been used where necessary to compensate for beta attenuation by surface coverings.

5.0 LIMITATIONS

Application of the Et is limited to surface or near surface activity conditions.

6.0 TECHNICAL BASES

6.1 Beta Energy and Detection

Gas flow proportional detectors (Ludlum model 43-68) have been proposed as the primary instrument for performing surface surveys of concrete. The detectors are calibrated using a NIST traceable anodized aluminum foil Cs-137 source. The detector window consists of a thin sheet of mylar.

During site characterization, several concrete samples were collected and analyzed onsite or sent for offsite analysis. These samples were some of the highest activity samples collected and thus were the best samples to be used for detection of the hard to detect radionuclides including the beta emitters.

The results of the hard to detect analyses were used to determine the nuclide fractions of the representative samples of structure concrete. Once the nuclide fractions were determined, the beta energy of a typical beta particle emitted from RSNGS concrete could be determined. The building samples were combined to provide the mean nuclide fraction for structures. The mean fractions were then multiplied by the maximum and average beta energies of each nuclide (Attachment 8.1). (Beta particles with very low abundances were typically omitted because they would not contribute significantly to the maximum beta energy.) The maximum and average beta energies were summed for the nuclides in the structure nuclide suite from DTBD 04-004. Many of the beta emitting nuclides in the suite were listed as an MDA value because they were not positively detected. The non-detected beta nuclides were removed and the maximum and average beta energies were determined for the remainder. There was not much difference between these two iterations because the low activity nuclides do not contribute significantly to the beta fraction.

The positively detected nuclides were further reduced to take into account the ability of the beta particles to penetrate the mylar window of the detector. The density thickness of the window is stated by the manufacturer as being 0.8 mg/cm^2 (two 0.4 mg/cm^2 layers). The energy of a beta particle required to penetrate this thickness of mylar is approximately 0.018 MeV. Beta emitting nuclides with energies below 0.018 MeV were next removed from the nuclide fraction and the maximum and average energies of the remaining nuclides were multiplied by the nuclide fraction and summed to arrive at the maximum and average energies of the typical beta particle found on the surface of RSNGS concrete. The maximum beta energy was 0.464 MeV with a standard deviation of $\pm$ 0.171 and the average beta energy was 0.166 MeV with a standard deviation of $\pm$ 0.063.

The results of the beta energy determination show that the detector is capable of detecting the beta emitting nuclide mixture in RSNGS concrete and that the use of the Cs-137 calibration source AEA LZ 503 (average beta energy of 0.188

MeV) is appropriate. The 43-68 gas flow proportional detector is therefore suitable for concrete structure surveys.

6.2 Source Efficiency (Es) Determination

Concrete samples were collected and analyzed for gamma emitters by on site analysis and for hard to detect emitters by off site analysis. Gross beta count rates were also obtained. This data was used to determine the source efficiency, Es, for structure surfaces for application to FSS surveys following the methods outlined in ISO Standard 7503-1.

Instrument efficiency, Ei, was first determined using a NIST traceable Cs-137 source (AEA LZ 503) having an active source area of 150 cm^2. The 43-68 detector has a window of 126 cm^2. Ei was determined by dividing the average net count rate for 21 observations (3208.6 c/m) by the source emission rate in betas per minute (7740 betas/min, Attachment 8.2) adjusted for the detector size for a value of 0.494.

Es was empirically determined by taking beta measurements of structure surfaces then removing the surface material and determining the total beta activity through either hard to detect analyses or gamma spectroscopy because Cs-137 and Co-60 are the predominant beta emitters. (Table 1 below shows the change in Es as the relative Co-60 and Cs-137 values are varied.) By dividing the total beta activity in dpm of the sample by the count rate, the total efficiency (Et) is determined for each sample. When the individual Et values are averaged and the average value is divided by Ei, the site-specific Es value is obtained.

Table 1
Es Variability versus Nuclide Fraction
Using ISO-7503-1 Values and Estimated Et

Nuclide Fraction		Weighted Es	Weighted Et*	Percent Et* Change
Co-60	Cs-137			
0.00	1.00	0.500	0.247	--
0.05	0.95	0.488	0.241	-2.4
0.15	0.85	0.463	0.229	-7.3
0.20	0.80	0.450	0.222	-10.1
0.30	0.70	0.425	0.210	-15.0
0.40	0.60	0.400	0.198	-19.8
0.60	0.40	0.350	0.173	-30.0
0.80	0.20	0.300	0.148	-40.1
0.90	0.10	0.275	0.136	-44.9
1.00	0.00	0.250	0.124	-49.8

*Assumes Ei as determined for Cs-137 is the same for Co-60.

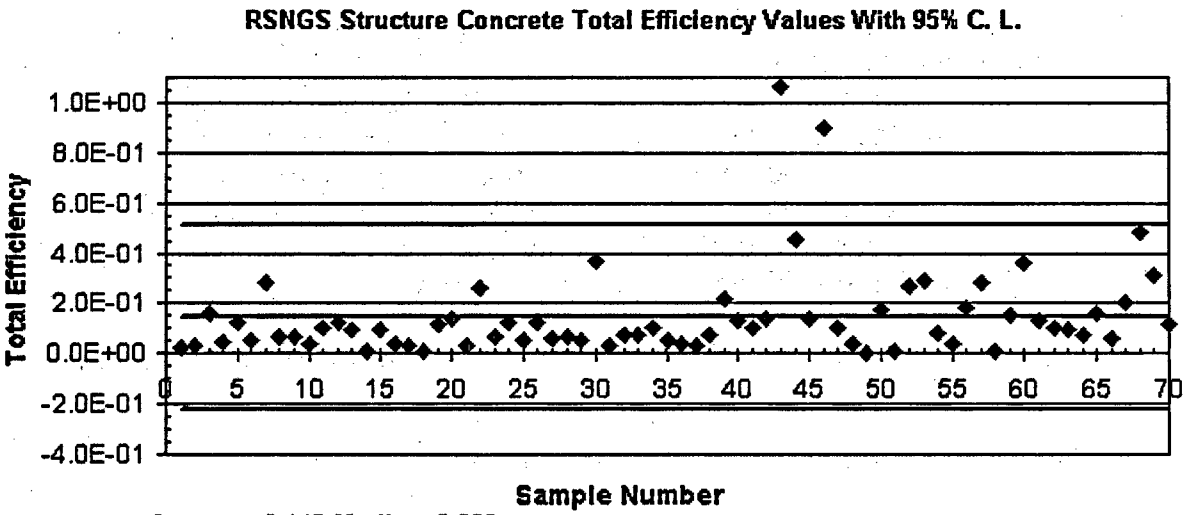
Concrete Samples

Concrete cores were collected primarily from the Containment Building floors and scabble samples were acquired from the Auxiliary, Turbine, and Spent Fuel Buildings. These samples were collected to both characterize the radionuclide constituents of the building surfaces and to determine to the extent practical, the depth to which contaminants penetrated the concrete. Determination of the concrete surface efficiency was also considered.

Concrete cores were typically collected from locations exhibiting the highest observed beta surface contamination. Prior to removal, the core location was beta surveyed and the measurement recorded. The core was resurveyed using the Ludlum 43-68 detector and the beta results recorded. This information provided the observed beta count rate for the core. The solid core was weighed and on site gamma spectroscopy analysis was performed. Three Containment Building cores were pulverized and the concrete from each core was analyzed for the RSNGS nuclide suite, including the Hard-To-Detect-Nuclides (HTDN). By analyzing the entire core material, the total beta activity for the core could be determined. The total beta activity in dpm was divided into the observed count rate that was measured on the core surface prior to vendor laboratory submission. The result was the Et for the sample.

Concrete scabble samples were typically acquired from room locations that exhibited the highest observable beta activity. The initial scabble depth was ~0.32 cm. The scabbled surface media was collected and the region resurveyed. If beta activity above background was observed on the scabbled surface, the results were recorded and a second scabble sample was collected. The nominal depth of the second scabble was ~0.48 to 0.64 cm. The collected samples were analyzed by on site gamma spectroscopy. Three samples from the Auxiliary building were submitted for vendor analysis. As with the concrete core samples, the concrete scabble samples were analyzed for the RSNGS nuclide suite that included the HTDN. By analyzing the homogenized scabble sample, the total activity for concrete was determined. The results were examined for the principle beta emitters that were positively reported. The total beta activity in dpm was divided into the observed count rate that was observed prior to sample homogenization. The result is the sample Et. Table 2 presents the total and surface efficiency results for the cores and scabble samples.

Figure 1
Et Values for Concrete Core and Scabbled Samples



Average: 0.146 **Median:** 0.098
Standard Deviation: 0.185
UCL: 0.509 **LCL:** -0..217

Figure 1 shows the Et values for the various concrete samples. Table 2 indicates that the average surface efficiency for concrete from the Auxiliary and Containment Buildings is very close to the default value of 0.50 recommended in ISO-7503-1. By comparing the results to Table1 above it may be noted that the observed Es value for the core and scabble samples is 10.6 percent lower than the ISO-7503-1 value which is slightly more conservative than the default value.

Table 2
Examination of Et Values for Concrete Core and Scabbled Samples (No HTDN)

	Core	Core	Core	Scabble	Scabble	Scabble
	RB-27 IC	RB-27WT	RB-27WT	AB-20 EDHCR	AB-20EDHCR	AB-47EDHPR
	SA8110411	SB110250	SD8110351	SB8130670	SB8130710	SB81130030
	SC01A	SC01A	SC01A	SC02A1	SC02A1	SC02A1
	867 g	838 g	778 g	100 g	100 g	100 g
Nuclides	Total dpm	Total dpm	Total dpm	Total dpm	Total dpm	Total dpm
Co-60	1.981E+7	1.817E+5	2.349E+5	9.191E+5	2.020E+4	4.642E+3
Cs-134	3.445E+3	6.441E+3	3.903E+3	1.106E+3	2.686E+3	4.671E+3
Cs-137	1.732E+6	7.613E+6	2.919E+6	8.458E+4	1.756E+6	2.122E+2
Total dpm	2.155E+7	7.802E+6	3.158E+6	1.005E+6	1.779E+6	6.861E+4
Obs cpm	4.680E+5	1.680E+6	1.230E+5	1.910E+5	5.750E+5	3.930E+4
Et	2.172E-2	2.153E-1	3.895E-2	1.901E-1	3.232E-1	5.728E-1
		Mean Ei= 0.494	MeanEt= 0.227	MeanEs= 0.460		

6.3 Beta Attenuation By Surface Coatings

Many of the structure surfaces to be surveyed are covered by one or more layers of paint, dirt, water or other material which can reduce the detector response to the beta contamination on the structure. NUREG-1507 describes a method to use to determine the correction to Es for various beta-attenuating materials found on structure surfaces. The correction to be applied for epoxy paint-covered surfaces according to NUREG-1507 methodology is shown below. This method will be used, as necessary, during the performance of FSS surveys to determine the beta attenuation resulting from surface coatings.

Coating Material: epoxy-polyamide (material data provided by one manufacturer, Attachment 8.3)

Dry film thickness: 40-50 um or 0.004-0.005 cm

Paint density (ratio of 20 kg paint to 3 kg hardener):

Paint 1.61 g/cm^3 , hardener 0.88 g/cm^3 ; combined 1.4 to 1.5 g/cm^3

Density thickness: density 1.5 g/cm^3 x thickness 0.005 cm $\simeq$ 8 mg/cm^2

Adjustment to Es per NUREG-1507:

Tc-99 betas Tl-204 betas

Es (exp-0.093x) Es (exp-0.033x)

Where x is the paint film density thickness in mg/cm^2

Tc-99 beta ave is 0.085 MeV; Tl-204 beta ave is 0.267 MeV

Rancho Seco beta ave is approximately 0.166 MeV therefore the actual beta attenuation factor is between 0.093x and 0.033x.

Using a conservative factor of 0.093x yields the following for epoxy paint.

Paint Layers	Es	Resulting Et
0	0.45	0.222
1	0.21	0.106
2	0.10	0.023

3	0.05	0.011
4	0.02	0.005
5	0.01	0.002

7.0 REFERENCES

7.1 ISO 7503-1, Evaluation of Surface Contamination

7.2 Beta Energies ENDF/B-VI Decay Data, Los Alamos National Laboratory

8.0 ATTACHMENTS

8.1 Average Beta Energy For Concrete Surfaces

8.2 E_t Values for Concrete Core and Scabble Samples

8.3 Source Certificate Cs-137 LZ 503

8.4 Manufacturer's Paint Specification

9.0 RESPONSIBLE INDIVIDUAL

George Pillsbury

Attachment 8.1
Average Beta Energy Concrete

All Beta Emitters in Nuclide Suite

Beta Nuclide	Sump#5 pCi/g	Dryer #6 pCi/g	Sump#5 Fraction	Dryer#6 Fraction	Mean Fraction	Beta Max	Beta Ave	Mean Beta. Max	Energy Ave
H-3	7.53	25.64	0.0055	0.0022	0.0039	0.018	0.005	6.96E-05	1.93E-05
C-14	4.42	21.09	0.0033	0.0018	0.0025	0.156	0.049	3.94E-04	1.24E-04
Co-60	35.4	310.8	0.0261	0.0265	0.0263	0.318	0.096	8.36E-03	2.52E-03
Ni-63	1110	7043	0.8175	0.6003	0.7089	0.066	0.017	4.68E-02	1.21E-02
Sr-90	1.4	4.02	0.0010	0.0003	0.0007	0.546	0.196	3.75E-04	1.35E-04
Nb-94	0.36	5.4	0.0003	0.0005	0.0004	0.471	0.157	1.71E-04	5.69E-05
Tc-99	3.6	3.67	0.0027	0.0003	0.0015	0.294	0.085	4.36E-04	1.26E-04
Sb-125	1.75	15.5	0.0013	0.0013	0.0013	0.622	0.099	8.12E-04	1.29E-04
Cs-134	0.48	2.57	0.0004	0.0002	0.0003	0.658	0.158	1.88E-04	4.52E-05
Cs-137	171	4126	0.1259	0.3517	0.2388	0.513	0.188	1.23E-01	4.49E-02
Pm-147	6.47	6.71	0.0048	0.0006	0.0027	0.225	0.062	6.00E-04	1.65E-04
Eu-152	1.4	23.1	0.0010	0.0020	0.0015	1.86	0.296	2.79E-03	4.44E-04
Eu-154	0.84	10.7	0.0006	0.0009	0.0008	1.85	0.228	1.42E-03	1.74E-04
Eu-155	0.91	10.3	0.0007	0.0009	0.0008	0.253	0.046	1.96E-04	3.56E-05
Pu-241	12.3	124.3	0.0091	0.0106	0.0098	0.021	0.005	2.06E-04	4.91E-05
Sum	1357.86	11732.8	1	1			Sum	1.85E-01	6.10E-02

Non Detects Removed

Beta Nuclide	Sump#5 pCi/g	Dryer#6 pCi/g	Sump#5 Fraction	Dryer#6 Fraction	Mean Fraction	Beta Max	Beta Ave	Mean Beta Max	Energy Ave
H-3	7.53	25.64	0.0057	0.0022	0.0039	0.018	0.005	7.10E-05	1.97E-05
C-14	4.42	21.09	0.0033	0.0018	0.0026	0.156	0.049	4.02E-04	1.26E-04
Co-60	35.4	310.8	0.0266	0.0270	0.0268	0.318	0.096	8.52E-03	2.57E-03
Ni-63	1110	7043	0.8347	0.6108	0.7228	0.066	0.017	4.77E-02	1.23E-02
Sr-90	1.4	4.02	0.0011	0.0003	0.0007	0.546	0.196	3.83E-04	1.37E-04
Cs-137	171	4126	0.1286	0.3578	0.2432	0.513	0.188	1.25E-01	4.57E-02
Sum	1329.75	11530.55	1.0000	1.0000			Sum	1.82E-01	6.09E-02

43-68 Doubtful Nuclides Removed

Beta Nuclide	Sump#5 pCi/g	Dryer#6 pCi/g	Sump#5 Fraction	Mean Fraction	Beta Max	Beta Ave	Mean Beta Max	Energy Ave
C-14	4.42	21.09	0.0208	0.0128	0.156	0.049	0.0020	0.0006
Co-60	35.4	310.8	0.1668	0.1182	0.318	0.096	0.0376	0.0114
Sr-90	1.4	4.02	0.0066	0.0037	0.546	0.196	0.0020	0.0007
Cs-137	171	4126	0.8058	0.8652	0.513	0.188	0.4439	0.1627
Sum	212.22	4461.91	1.0000			Sum	0.4855	0.1754

Attachment 8.1
Average Beta Energy Concrete (Continued)

All Beta Emitters in Nuclide Suite

Beta Nuclide	Aux #7 pCi/g	Aux #8 pCi/g	Aux #9 pCi/g	Aux #7 Fraction	Aux #8 Fraction	Aux #9 Fraction	Mean Fraction	Beta Max	Beta Ave	Mean Beta Max	Energy Ave
H-3	15.4	14.5	25.7	0.00053	0.0015	0.0445	0.0155	0.018	0.005	0.0003	7.76E-05
C-14	522	19.2	3.17	0.01787	0.0020	0.0055	0.0085	0.156	0.049	0.0013	4.14E-04
Co-60	4140	91	20.5	0.14173	0.0095	0.0355	0.0623	0.318	0.096	0.0198	5.98E-03
Ni-63	23900	1440	162	0.81821	0.1509	0.2805	0.4165	0.066	0.017	0.0275	7.08E-03
Sr-90	14.9	5.89	34.1	0.00051	0.0006	0.0590	0.0201	0.546	0.196	0.0110	3.93E-03
Nb-94	9.15	0.75	0.22	0.00031	0.0001	0.0004	0.0003	0.471	0.157	0.0001	4.04E-05
Tc-99	2.7	5.06	2.27	0.00009	0.0005	0.0039	0.0015	0.294	0.085	0.0004	1.29E-04
Sb-125	29.7	14.4	1.97	0.00102	0.0015	0.0034	0.0020	0.622	0.099	0.0012	1.96E-04
Cs-134	4.98	12.1	0.94	0.00017	0.0013	0.0016	0.0010	0.658	0.158	0.0007	1.61E-04
Cs-137	381	7910	303	0.01304	0.8286	0.5247	0.4555	0.513	0.188	0.2337	8.56E-02
Pm-147	2.92	2.34	2.72	0.00010	0.0002	0.0047	0.0017	0.225	0.062	0.0004	1.04E-04
Eu-152	5.74	10.8	1.48	0.00020	0.0011	0.0026	0.0013	1.86	0.296	0.0024	3.84E-04
Eu-154	7.88	1.94	0.86	0.00027	0.0002	0.0015	0.0007	1.85	0.228	0.0012	1.49E-04
Eu-155	3.63	5.74	1.05	0.00012	0.0006	0.0018	0.0008	0.253	0.046	0.0002	3.90E-05
Pu-241	170	12	17.5	0.00582	0.0013	0.0303	0.0125	0.021	0.005	0.0003	6.23E-05
sum	29210	9545.72	577.48	1.00000	1.0000	1.0000			sum	0.3004	1.04E-01

Non Detects Removed

Beta Nuclide	Aux #7 pCi/g	Aux #8 pCi/g	Aux #9 pCi/g	Aux #7 Fraction	Aux #8 Fraction	Aux #9 Fraction	Mean Fraction	Beta Max	Beta Ave	Mean Beta Max	Energy Ave
H-3	15.4	14.5	25.7	0.00053	0.0015	0.0468	0.0163	0.018	0.005	0.0003	8.14E-05
C-14	522	19.2	3.17	0.01789	0.0020	0.0058	0.0086	0.156	0.049	0.0013	4.19E-04
Co-60	4140	91	20.5	0.14185	0.0096	0.0373	0.0629	0.318	0.096	0.0200	6.04E-03
Ni-63	23900	1440	162	0.81892	0.1516	0.2949	0.4218	0.066	0.017	0.0278	7.17E-03
Sr-90	14.9	5.89	34.1	0.00051	0.0006	0.0621	0.0211	0.546	0.196	0.0115	4.13E-03
Nb-94	9.15	0	0	0.00031	0.0000	0.0000	0.0001	0.471	0.157	0.0000	1.64E-05
Tc-99	2.7	5.06	0	0.00009	0.0005	0.0000	0.0002	0.294	0.085	0.0001	1.77E-05
Sb-125	29.7	0	0	0.00102	0.0000	0.0000	0.0003	0.622	0.099	0.0002	3.36E-05
Cs-134	0	12.1	0.94	0.00000	0.0013	0.0017	0.0010	0.658	0.158	0.0007	1.57E-04
Cs-137	381	7910	303	0.01305	0.8328	0.5515	0.4658	0.513	0.188	0.2390	8.76E-02
Pu-241	170	0	0	0.00582	0.0000	0.0000	0.0019	0.021	0.005	0.0000	9.71E-06
Sum	29184.85	9497.75	549.41	1.00000	1.0000	1.0000			Sum	0.3009	1.06E-01

43-68 Doubtful Nuclides Removed

Beta Nuclide	Aux #7 pCi/g	Aux #8 pCi/g	Aux #9 pCi/g	Aux #7 Fraction	Aux #8 Fraction	Aux #9 Fraction	Mean Fraction	Beta Max	Mean Beta Ave	Energy Max	Energy Ave
C-14	522	19.2	3.17	0.1032	0.0024	0.0088	0.0381	0.156	0.049	0.0059	0.0019
Co-60	4140	91	20.5	0.8185	0.0113	0.0568	0.2956	0.318	0.096	0.0940	0.0284
Sr-90	14.9	5.89	34.1	0.0029	0.0007	0.0945	0.0327	0.546	0.196	0.0179	0.0064
Cs-137	381	7910	303	0.0753	0.9855	0.8399	0.6336	0.513	0.188	0.3250	0.1191
Sum	5057.9	8026.09	360.77	1.0000	1.0000	1.0000			sum	0.4428	0.1558

Attachment 8.2
E_t Values for Concrete Core and Scabble Samples

	1	2	3	4	5	6	7	8	9
	scabble Turbine Condenser Pit	scabble Turbine Condenser Pit	scabble Turbine N. Grade Level	scabble Turbine N. Grade Level	scabble Turbine N. Near Air Compressors	scabble Turbine NE Grade Level	scabble Letdown Filter Rm -20 El.	scabble Flash Tank Pump Rm -20 El.	scabble Waste Conc Tk Rm -20 El.
	81260060 SC01	81260060 SC02	SA8260140 SC01A	SA8260140 SC03A	SA8260130 SC01A	SB8260150 SC01A	SB8130130 SC01A	SB8130120 SC01A	SB8130320 SC01A
	11/25/03	11/25/03	7/19/2005	3.855E+04	7/19/2005	7/20/2005	12/02/03	12/02/03	12/09/03
	167.8 g	171.1 g	148.0 g	152.0 g	147.0 g	138.0 g	156.0 g	140.0 g	154.0 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	3.768E+03	5.628E+03	2.980E+04	4.011E+03	3.592E+03	8.664E+03	1.362E+05	8.613E+04	3.260E+05
Co-60	1.595E+02	1.508E+02	4.133E+03	1.531E+02	7.535E+01	3.986E+02	8.585E+03	2.632E+04	1.582E+04
Cs-137	1.409E+05	1.657E+05	1.848E+05	8.834E+04	2.891E+04	1.693E+05	4.713E+05	1.290E+06	5.036E+06
ttl dpm	1.410E+05	1.658E+05	1.889E+05	8.849E+04	2.899E+04	1.697E+05	4.799E+05	1.316E+06	5.052E+06
E_t	2.671E-02	3.394E-02	1.577E-01	4.532E-02	1.239E-01	5.107E-02	2.838E-01	6.543E-02	6.453E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

	10	11	12	13	14	15	16	17	18
	scabble Flash Tank Rm -20 El.	core (top) Flash Tank Rm -20 El.	scabble Spent Resin Tk Rm -20 El.	core (top) Spent Resin Tk Rm -20 El.	scabble E. Decay HRC Rm -20 El.	scabble E. Decay HRC Rm -20 El.	scabble Retension Basin North	scabble Retension Basin North	scabble E. Decay HRC Rm -20 El.
	SB8130140 SC01A	SB8130140 SC02A	SB8130650 SC01A	SB8130650 SC02A	SB8130690 SC01A*	SB8130690 SC02A*	SA8488007 SC01A	SA8488007 SC03A	SB8130690 SC03A*
	12/02/03	11/20/03	11/20/03	11/20/03	02/09/04	02/09/04	08/01/05	08/01/05	02/09/04
	160.0 g	802.0 g	146.0 g	850.0 g	153.8 g	151.6 g	149.0 g	156.0 g	132.6 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	1.991E+04	2.010E+03	9.023E+03	1.457E+03	1.090E+05	5.845E+05	1.840E+03	1.555E+03	1.910E+05
Co-60	1.515E+04	5.194E+03	6.343E+03	2.147E+03	9.478E+03	1.590E+04	4.849E+03	3.273E+03	1.512E+07
Cs-137	5.438E+05	1.417E+04	6.460E+04	1.327E+04	8.809E+06	6.028E+06	4.591E+04	4.506E+04	2.269E+06
ttl dpm	5.590E+05	1.937E+04	7.094E+04	1.542E+04	8.819E+06	6.044E+06	5.076E+04	4.833E+04	1.739E+07
E_t	3.562E-02	1.038E-01	1.272E-01	9.451E-02	1.236E-02	9.871E-02	3.625E-02	3.218E-02	1.098E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

	19	20	21	22	23	24	25	26	27
	scabble E. Decay HRC Rm -20 El.	scabble Rx Coolant Drain Tk Rm -47 El.	scabble Seal Return Cooler Rm -20 El.	scabble Seal Return Cooler Rm -20 El.	scabble Crud Tank Pump Rm -20 El.	scabble Crud Tank Pump Rm -20 El.	scabble Crud Tank Pump Rm -20 El.	scabble Crud Tank Pump Rm -20 El.	scabble East Decay Heat Clr Rm -20 El.
	SB8130730 SC01A	SB8130050 SC01A	SB8130640 SC01A	SB8130640 SC02A	SB8130670 SC01A	SB8130670 SC02A	SB8130660 SC01A	SB8130660 SC02A*	SB8130710 SC01A*
	02/09/04	12/08/03	03/16/04	03/16/04	01/12/04	01/12/04	01/08/04	01/12/04	02/11/04
	127.8 g	144.6 g	140.0 g	116.0 g	132.0 g	124.4 g	138.0 g	122.3 g	146.2 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	5.852E+04	3.468E+04	7.093E+04	8.147E+04	1.970E+04	1.91E+05	1.149E+04	5.077E+05	5.750E+05
Co-60	1.813E+02	8.715E+03	2.183E+05	2.905E+05	1.459E+05	1.41E+06	2.597E+04	3.372E+06	3.218E+04
Cs-137	5.039E+05	2.467E+05	1.937E+06	2.457E+04	1.387E+05	1.35E+05	1.835E+05	6.160E+05	1.014E+07
ttl dpm	5.041E+05	2.554E+05	2.155E+06	3.151E+05	2.846E+05	1.545E+06	2.095E+05	3.988E+06	1.017E+07
E_t	1.161E-01	1.358E-01	3.291E-02	2.586E-01	6.921E-02	1.237E-01	5.484E-02	1.273E-01	5.655E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

Attachment 8.2
E_t Values for Concrete Core and Scabble Samples (Continued)

	28	29	30	31	32	33	34	35	36
	scabble East Decay Heat Clr Rm Ht -20 El.	scabble East Decay Pump Rm Ht -20 El.	scabble East Decay Pump Rm Ht -20 El.	scabble West Decay Cooler Rm Ht -20 El.	scabble West Decay Cooler Rm Ht -20 El.	scabble Misc Waste Filter Rm -20 El.	scabble Misc Waste Filter Rm -20 El.	scabble Misc Waste Filter Rm -20 El.	scabble Misc Waste Filter Rm -20 El.
	SB8130710 SC02A	SB8130030 SC01A*	SB8130030 SC02A	SB8130760 SC01A	SB8130760 SC02A	SB8130350 SC01A	SB8130350 SC02A	SB8130350 SC03A	SB8130350 SC04A
	02/11/04	12/08/03	12/08/03	01/22/04	01/22/04	12/10/03	12/10/03	12/11/03	12/11/03
	144.0 g	149.3 g	148.0 g	162.0 g	122.0 g	134.0 g	138.0 g	158.0 g	156.0 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	1.731E+05	1.409E+06	3.925E+04	1.141E+05	4.230E+04	2.142E+05	2.560E+04	3.120E+04	1.246E+04
Co-60	2.995E+04	3.656E+05	6.164E+03	3.272E+04	8.515E+04	5.402E+04	2.196E+05	1.355E+04	2.847E+05
Cs-137	2.597E+06	2.725E+07	1.003E+05	3.956E+06	1.085E+06	2.960E+06	3.603E+04	5.644E+05	4.516E+04
ttl dpm	2.627E+06	2.761E+07	1.064E+05	3.989E+06	1.170E+06	3.014E+06	2.556E+05	5.779E+05	3.298E+05
E_t	6.590E-02	5.103E-02	3.688E-01	2.861E-02	7.277E-02	7.106E-02	1.001E-01	5.399E-02	3.778E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

	37	38	39	40	41	42	43	44	45
	scabble Radwaste Pump Alley -29 El.	scabble Radwaste Pump Alley -29 El.	scabble Spent Regen Tank Room -29 El.	Spent Regen Tank Room -29 El.	Spent Regen Tank Room -29 El.	Spent Regen Tank Room -29 El.	scabble rx Wall exterior A D-ring SE +60	scabble Spent Fuel upender flr I6	scabble Spent Fuel upender flr J4
	SB8130460 SC01A*	SB8130460 SC02A*	SB8130540 SC01A	SB8130540 SC02A	SB8130540 SC03A*	SB8130540 SC04A	SB8110001 SC14A	SA8120090 SC04A	SA8120090 SC05A
	06/22/04	06/22/04	07/21/04	07/27/04	07/27/04	07/27/04	04/28/05	09/22/04	09/22/04
	140.1 g	155.9 g	140.8	146.8	132.0	128.0	153.0 g	141.0 g	145.0 g
	total dpm	total dpm	total dpm	total dpm	pCi/g	pCi/g	total dpm	total dpm	total dpm
pre cpm	3.499E+05	1.164E+06	3.538E+05	7.699E+04	6.382E+05	1.713E+05	1.023E+03	2.500E+03	2.330E+03
Co-60	6.177E+04	2.639E+04	1.184E+03	6.401E+02	2.033E+04	7.294E+04	8.855E+01	2.334E+03	7.761E+02
Cs-137	1.164E+07	1.518E+07	1.839E+06	5.736E+05	6.081E+06	1.195E+06	8.716E+02	3.136E+03	1.595E+04
ttl dpm	1.170E+07	1.521E+07	1.840E+06	5.742E+05	6.101E+06	1.208E+06	9.601E+02	5.470E+03	1.672E+04
E_t	2.990E-02	7.653E-02	2.157E-01	1.341E-01	1.046E-01	1.351E-01	1.065E+00	4.570E-01	1.393E-01
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

	46	47	48	49	50	51	52	53	54
	scabble Spent Fuel upender flr J4	scabble Spent Fuel upender flr M8	scabble Spent Fuel upender flr M6	scabble Spent Fuel upender flr M5	scabble Spent Fuel upender flr M5	scabble Rx Bldg -27 hoore chase floor 0.125	scabble Rx Bldg +40 S D-ring N wall 0.125	scabble Rx Bldg +40 S D-ring N wall 0.25	scabble Spent Fuel upender flr F6
	SA8120090 SC06A	SA8120090 SC07A	SA8120090 SC08A	SA8120090 SC09A	SA8120090 SC10A	SD8110411 SC01A*	SD8110001 SC01A	SD8110001 SC02A	SA8120090 SC01A
	09/22/04	09/23/04	09/23/04	09/23/04	09/23/04	04/19/05	04/18/05	04/18/05	08/23/04
	147.0 g	146.0 g	160.0 g	150.0 g	163.0 g	139.0 g	120.0 g	120.0 g	157.0 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	6.200E+02	5.576E+04	3.500E+02	6.730E+03	2.700E+02	9.330E+04	2.676E+04	1.161E+03	1.840E+04
Co-60	1.303E+02	6.106E+03	1.872E+02	3.579E+05	1.483E+02	1.563E+06	4.265E+02	1.031E+02	3.980E+03
Cs-137	5.574E+02	5.270E+05	8.408E+03	1.436E+07	1.378E+03	8.134E+06	9.915E+04	3.892E+03	2.233E+05
ttl dpm	6.877E+02	5.331E+05	8.605E+03	1.472E+07	1.526E+03	9.697E+06	9.958E+04	3.995E+03	2.273E+05
E_t	9.015E-01	1.046E-01	4.068E-02	3.893E-04	1.769E-01	9.622E-03	2.688E-01	2.906E-01	8.094E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

Attachment 8.2
E_t Values for Concrete Core and Scabble Samples (Continued)

	55	56	57	58	59	60	61	62	63
	scabble	scabble	scabble	scabble	scabble	scabble	scabble	scabble	scabble
	Spent Fuel upender flr F6	Spent Fuel upender flr I6	S of S entry to B D-ring -27 El.	S of S entry to B D-ring -27 El.	B D-ring 2nd B-shield -27 El.	B D-ring 2nd B-shield -27 El.	B D-ring Pri B-shield -27 El.	B D-ring Pri B-shield -27 El.	Wall above IC chase -27 El.
	SA8120090 SC02A	SA8120090 SC03A	SB8110001 SC01A	SB8110001 SC02A	SB8110001 SC03A	SB8110001 SC04A	SB8110001 SC05A	SB8110001 SC06A	SB8110001 SC07A
	08/23/04	09/22/04	04/20/05	04/20/05	04/20/05	04/20/05	04/21/05	04/21/05	04/27/05
	162.0 g	139.0 g	147.0 g	156.0 g	147.0 g	153.0 g	133.0 g	130.0 g	146.0 g
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	1.660E+03	2.338E+04	9.082E+03	2.149E+03	3.626E+05	2.331E+04	1.695E+05	3.151E+04	1.227E+05
Co-60	6.650E+02	1.274E+03	7.055E+02	4.393E+04	1.120E+03	1.213E+02	7.898E+03	1.364E+03	7.118E+04
Cs-137	4.747E+04	1.258E+05	3.192E+04	2.834E+05	2.339E+06	6.433E+04	1.270E+06	3.013E+05	1.267E+06
ttl dpm	4.814E+04	1.271E+05	3.262E+04	3.273E+05	2.340E+06	6.445E+04	1.278E+06	3.027E+05	1.338E+06
E_t	3.448E-02	1.840E-01	2.784E-01	6.565E-03	1.507E-01	3.516E-01	1.327E-01	1.041E-01	9.169E-02
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

	64	65	66	67	68	69	70
	scabble	scabble	scabble	scabble	scabble	scabble	scabble
	Wall above IC chase -27 El.	Wall exterior B D-ring Grade	Wall exterior B D-ring Grade	Wall exterior B D-ring NW +60	Wall exterior B D-ring NW +60	Wall exterior B D-ring SE +60	Spent Fuel Bldg Floor +40 El.
	SB8110001 SC08A	SB8110001 SC09A	SB8110001 SC10A	SB8110001 SC11A	SB8110001 SC12A	SB8110001 SC13A	SA8120030 SC01A
	04/27/05	04/27/05	04/27/05	04/27/05	04/27/05	04/28/05	08/01/05
	146.0 g	130.0 g	151.0 g	142.0 g	136.0 g	144.0 g	05/07/00
	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm	total dpm
pre cpm	1.061E+04	6.010E+04	1.386E+03	9.636E+03	1.547E+03	9.282E+03	7.646E+04
Co-60	1.543E+04	9.025E+01	7.620E+01	1.463E+03	2.219E+02	1.441E+02	1.583E+03
Cs-137	1.275E+05	3.703E+05	2.204E+04	4.666E+04	3.006E+03	2.990E+04	6.715E+05
ttl dpm	1.430E+05	3.704E+05	2.212E+04	4.812E+04	3.228E+03	3.005E+04	6.730E+05
E_t	7.418E-02	1.623E-01	6.266E-02	2.003E-01	4.793E-01	3.089E-01	1.136E-01
mean	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01	1.458E-01
UCL	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01	5.087E-01
LCL	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01	-2.171E-01

Attachment 8.3

Source Certificate

DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für Messgrößen der Radioaktivität
Calibration laboratory for measurements of radioactivity
Akkreditiert durch die / *accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)

AEA Technology QSA GmbH
Gieselweg 1
38110 Braunschweig, Germany
Phone +49 5307 932-0, fax +49 5307 932-194
Source No. LZ 503

DKD-K-06501

012537
DKD-K-06501
03-09

Kalibrierschein
Calibration Certificate

Kalibrierzeichen
Calibration label

Gegenstand *Object*	Beta Wide Area Reference Source
Hersteller *Manufacturer*	AEA Technology QSA GmbH
Typ *Type*	CDR07812
Strahler-Nr. *Source number*	LZ 503
Auftraggeber *Customer*	AEA TECHNOLOGY QSA INC. US MA 01803 BURLINGTON
Auftragsnummer *Order No.*	89245
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	2
Datum der Kalibrierung *Date of calibration*	22 September 2003

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Der DKD ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Akkreditierungsstelle des DKD als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit.
This calibration certificate may not be reproduced other than in full except with the permission of both the Accreditation Body of the DKD and the issuing laboratory. Calibration certificates without signature and seal are not valid.

Stempel *Seal*	Datum *Date*	Leiter des Kalibrierlaboratoriums *Head of the calibration laboratory*	Stellvertreter *Deputy*	Bearbeiter *Person in charge*
Deutscher Kalibrierdienst DKD-K-06501	28 September 2003	Dr. Tilerne	i.A. Schot	i.A. T. Lehmacher Lehmacher / Linke / Scholl / Schott / Schüler

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Beta Wide Area Reference Source

Source no.	LZ 603
Drawing	VZ-0628/1
Nuclide	Caesium-137
Activity	4 Hz 206 Bq (x60 = 12360 dpm)
Beta surface emission rate	2 Hz 129 s^{-1} in 2 π steradian
Reference date	22 September 2003 at 12.00 GMT
Dimensions of active surface	150 mm x 100 mm
Overall dimensions	170 mm x 120 mm x 3 mm
Leakage and contamination test	The amount of the removable activity is less than 0.1 % of the total activity but does not exceed 200 Bq. (Wipe test according to ISO 8978, no. 8.3.1)
Date of wipe test	26 September 2003
Construction	Cs-137 is incorporated into the surface of an anodized aluminium foil of 0.3 mm thickness. The thickness of the activated layer is approximately 6 µm. The activated foil is mounted into a holder.
Measuring method	The activity was determined by comparison with a reference source of the same construction. The beta surface emission rate was measured using a windowless proportional counter.
Traceability	Additional to the direct traceability to the PTB through the DKD this product complies with the requirements for traceability to NIST specified in the American National Standard "Traceability of Radioactive Sources to the NIST and Associated Instrument Quality Control (ANSI N42.22-1995)". As a requirement of the ANSI N42.22-1995 AEA Technology QSA GmbH participates in the NEI/NIST Measurements Assurance Program of the Nuclear Power Industry.
Uncertainty	The relative uncertainty of the activity is 5 %, the relative uncertainty of the beta surface emission rate is 8 %. The reported uncertainty, determined according to the DKD-3 report is based on the standard uncertainty multiplied by a coverage factor of k = 2, providing a level of confidence of 95 %. (Ref. NIST Technical Note 1297"Guide to the Expression of Uncertainty in Measurement" ISO Guide, 1995)
Radioactive impurities	Related to Cs-137 (equal 100 %) the following radioactive impurities were detected: none
Quality assurance system	The quality assurance system of AEA Technology QSA GmbH was certified by Lloyd's Register Quality Assurance (LRQA) according to ISO 9001, issue 1994. Isotrak products meet the requirements of 10CFR50 Appendix B in the USA.
Uniformity	The uniformity of the surface emission rate is better than 10 %.
Remark	According to ISO 8769 this is a Class 2 reference source.

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Attachment 8.4

Manufacturer's Paint Specification

EPOXY PRIMER

This product is 2 component epoxy polyamide primer . Its film dries by chemical reaction which gives a very hard and resistant coating , resistant to abrasion , humidity and impact it can be used on steel structurse , storege tanks , piers , and on any surface requiring resistance to mechanical stress and humidity.

TECHNICAL DATA

Type of paint : epoxy primer
Color : gray
Type of pigment : light and humidity resistant pigment
Type of Resin : epoxy - polyamide
Type of Solvent : aromatic hydrocarbon, alcohol and ketones
Diluter : T-12000
Mixing Ratio : 20 kg paint with 3 kg hardener
Density paint : 1.61 kg/liter
Density hardener : 0.88 kg/liter
Density component: 1.42 kg/liter
Solid content by weight paint: 69 %
Solid content by volume paint : 53 %
Solid content by weight component : 66 %
Solid content by volume component : 45 %
Coverage : 5 sq . meter / liter @ 50 microns
Drying Time : dust dry @ 25 C 1-2 hours
dry 5 hours
fully cured 3-4 days
Viscosity : thixotropy
Recommended dry film Thickness : 40 -60 microns
Minimum Overcoating Time : 6 hours after the first coat is fully dried .
Paint application : Mix paint and hardener thoroughly according to mixing ratio given above and let stand for 1 hour before application .
Directions for use : To obtain good adhesion , the surface to be coated should be dry and cleaned from oil , dust and foreign matter .
Package : in 20 and 4 liter container .
Pot life : maximum 16 hours @ 25 C after mixing the components .
Storage life : Under cool conditions away from direct sunlight , it has good stability for 1 year .

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