ENEA/2024/36127/NUC-IRAD-GAM

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TITLE	**IRRADIATION TEST CAMPAIGN AT THE CALLIOPE FACILITY (ENEA CASACCIA R. C.)**
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PREMISE

The present Technical Report (TR) describes the procedures adopted during the gamma irradiation campaign request on LED luminaires (Doc. 4irr/2024 – Prot. ENEA/2024/35063/NUC-IRAD-GAM). The irradiation campaign was carried out at the Calliope gamma irradiation Facility (FSN-FISS-SNI Laboratory), ENEA Casaccia C.R., 301, Via Anguillarese, ZIP CODE: 00123, Rome (Italy).

The campaign irradiation procedure and the dosimetric tests for the total absorbed dose measurement are described in the following Sections:

1. Introduction and preliminary considerations
2. Irradiation test campaign description
3. Dosimetricic system applied for the absorbed dose measurement
4. Results

The Irradiation and Dosimetric Certification related to the test campaign is also provided (in attachment).

1. Introduction and preliminary considerations

The present irradiation campaign was carried out at the Calliope gamma irradiation Facility (ENEA Casaccia C.R., Rome, Italy).
The Calliope Facility consists of a pool-type gamma irradiation plant (Co-60 source, mean energy of 1.25 MeV) with a maximum licensed activity of 3.7 10^15 Bq (Cat. A Clearance), of a dosimetric laboratory and of a laboratory for the characterization and treatment of the samples before and/or after irradiation.
More details are available at the following link: www.enea.it/it/seguici/pubblicazioni/pdf-opuscoli/calliope.pdf.

2. Irradiation test campaign description.

The irradiation test campaign was carried out on n. 3 LED luminaires (LN-LIN130/Gxx-45W-4000K(80)-R120-C, LN-LIN100/Gxx-45W-4000K(80)-R90-M, LN-I/REF1/Gxx-40W-4000K(80)-R120-M. Samples were irradiated in air, at room temperature and positioned at 20 cm from the Co-60 source rack placed on the steal platform that covers the Calliope water storage pool.

Pictures of the samples installed in the Calliope irradiation cell are shown in the following (Figures 1 – 2).

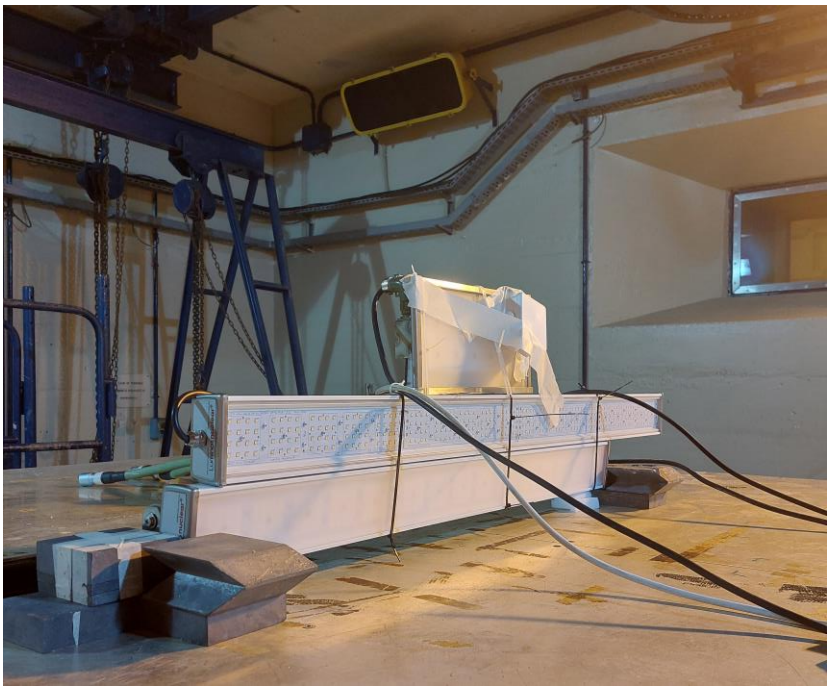

Figure 1 – Picture of NANOCUT LED luminaires samples during the irradiation test.

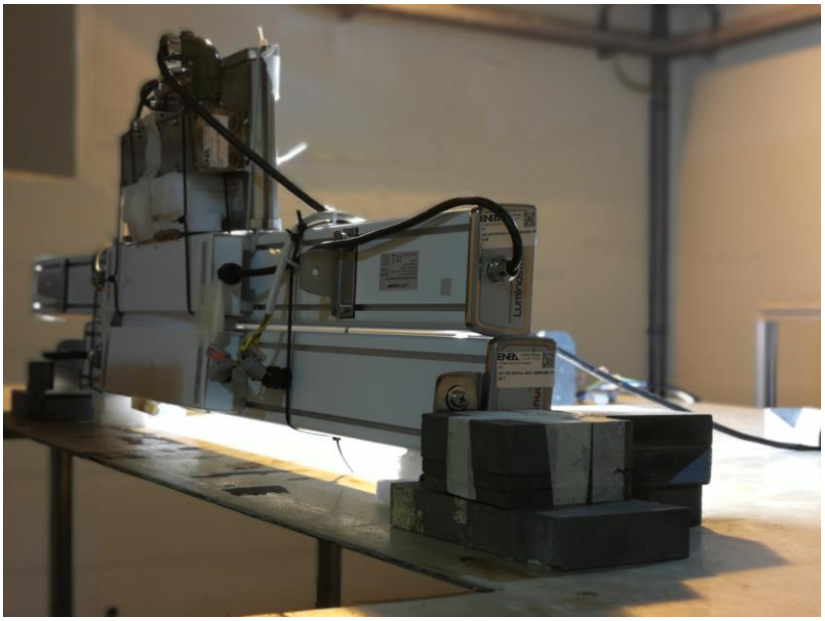

Figure 2 – Picture of NANOCUT LED luminaires samples during the irradiation test.

Due to the large size of the samples, to obtain more precise determination of the total absorbed doses, dosimetric measurements were specifically performed as reported in the Dosimetric Certification (Annex 1).

The irradiation test campaign, started on 06/05/24 at 11:00 and ended on 09/05/24 at 09:30, was performed in multiple step mode (according to Table 1) for a total irradiation time of 47h 40’ 56’’. At the end of the irradiation test, the LED luminaries result switched on.

The correspondent Irradiation and Dosimetric Certifications (with the indication of the irradiation period and of the dose rates experimental measurements) are reported in Annex 1. The natural decay of Co-60 source was daily updated and considered for the calculation of the total absorbed doses.

3. Dosimetricic system applied for the absorbed dose measurement.

Different dosimetric systems are available at the Calliope Facility for the dose rate and absorbed dose measurement (Fricke dosimeter, ESR-alanine, Red-Perspex, TLD, RADFET). For the present irradiation campaign, the Alanine dosimetry system was applied, in accordance with the specific standard regulation and procedure reported in document ENEA CAL/2003/01-0 and in the ISO/ASTM 51607:2013.

4. Results

The irradiation test campaign and the dosimetric measurement results are reported in the Irradiation and Dosimetric Certification (Annex 1).

Annex 1: Irradiation and Dosimetric Certification

ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT **Calliope Irradiation Plant** ENEA Casaccia R.C.	**Date: May 13th, 2024**	**Ref. Doc.** **04irr/2024**	**Certification number: 05/2024** **Pag. 1/5**
	Irradiation Plant Technician	**Calliope Irradiation Plant Director**	

SAMPLE DESCRIPTION:
LED Luminaires

CUSTOMER:
NANOCUT d.o.o.

REFERENCE DOCUMENT:
04irr/2024

DOSIMETRIC CERTIFICATION REFERENCES:
n. 17 – May 6th, 2024

IRRADIATION TIME:
Irradiation start: 11:00 May 6th, 2024
Irradiation stop: 09:30 May 9th, 2024

ENVIRONMENTAL CONDITIONS IN THE IRRADIATION CELL:

Temperature: Ambient
Atmosphere: air
Pressure: 1 atm

Note: The dose rate used is the average of all dosimetric values $\langle \dot{D}_{water} \rangle$ reported in the dosimetric certificate. The dose rate used in the irradiation test takes into account the natural decay of ^{60}Co radioisotopic source. The management of the irradiation test is carried out by using a Calliope plant dedicated software that allows a daily dose rate value update, the irradiation time determination and the absorbed dose calculation.

STANDARD REFERENCE REQUESTED:

ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT **Calliope Irradiation Plant** ENEA Casaccia R.C	**Date: May 13th, 2024**	**Ref. Doc.** **04irr/2024**	**Certification number: 05/2024** **Pag. 2/5**
	Irradiation Plant Technician	**Calliope Irradiation Plant Director**	

IRRADIATION CERTIFICATION

LN-LIN130/Gxx-45W-4000K(80)-R120-C

Step	Dose rate at the beginning of irradiation [kGy Air/h]	Dose rate at the end of irradiation [kGy Air/h]	Irradiation time (hh:mm:ss)	Absorbed dose [KGy Air]
1	3.310	3.310	02:00:16	5.948
2	3.310	3.310	02:53:06	8.561
3	3.309	3.309	02:58:20	9.837
4	3.309	3.309	03:59:58	13.237
5	3.309	3.308	14:56:42	49.451
6	3.308	3.308	04:51:54	16.095
7	3.308	3.307	16:00:40	52.961
TOTAL			47:40:56	**156.092**

Note:

- the dose rate value was obtained by updating, at the beginning of the irradiation test, the value reported in the dosimetric certification (n. 17 – May 6th, 2024).
- the absorbed dose relative error is 4%, and the absorbed dose value is referred to air.

ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT **Calliope Irradiation Plant** ENEA Casaccia R.C	**Date: May 13th, 2024**	**Ref. Doc. 04irr/2024**	**Certification number: 05/2024** **Pag. 3/5**
	Irradiation Plant Technician	**Calliope Irradiation Plant Director**	

IRRADIATION CERTIFICATION

LN-LIN100/Gxx-45W-4000K(80)-R90-M

Step	Dose rate at the beginning of irradiation [kGy Air/h]	Dose rate at the end of irradiation [kGy Air/h]	Irradiation time (hh:mm:ss)	Absorbed dose [KGy Air]
1	3.310	3.310	02:00:16	5.948
2	3.310	3.310	02:53:06	8.561
3	3.309	3.309	02:58:20	9.837
4	3.309	3.309	03:59:58	13.237
5	3.309	3.308	14:56:42	49.451
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TOTAL			47:40:56	**156.092**

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ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT **Calliope Irradiation Plant** ENEA Casaccia R.C	**Date: May 13th, 2024**	**Ref. Doc. 04irr/2024**	**Certification number: 05/2024** **Pag. 4/5**
	Irradiation Plant Technician	**Calliope Irradiation Plant Director**	

IRRADIATION CERTIFICATION

LN-I/REF1/Gxx-40W-4000K(80)-R120-M

Step	Dose rate at the beginning of irradiation [kGy Air/h]	Dose rate at the end of irradiation [kGy Air/h]	Irradiation time (hh:mm:ss)	Absorbed dose [KGy Air]
1	3.310	3.310	02:00:16	5.948
2	3.310	3.310	02:53:06	8.561
3	3.309	3.309	02:58:20	9.837
4	3.309	3.309	03:59:58	13.237
5	3.309	3.308	14:56:42	49.451
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7	3.308	3.307	16:00:40	52.961
TOTAL			47:40:56	**156.092**

Note:

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- the absorbed dose relative error is 4%, and the absorbed dose value is referred to air.

ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT **Calliope Irradiation Plant** ENEA Casaccia R.C	**Date: May 13th, 2024**	**Ref. Doc.** **04irr/2024**	**Certification number: 05/2024** **Pag. 5/5**
	Irradiation Plant Technician	**Calliope Irradiation Plant Director**	

DOSIMETRIC CERTIFICATION

Dosimetric measurements: n. 17 – May 6th, 2024.

Instrument used for the dosimetric measurements:

☐ UV/VIS Perkin Elmer Lambda 950 Spectrophotometer
☒ Spettrometro Bruker e-scan
☐ TLD Reader Harshaw 3500

Dosimetric system:

☒ Alanine
☐ Fricke solution
☐ Red Perspex
☐ TLD

Dosimetric measurements have been carried out according to ENEA CAL/2003/01-0. document. The relative error associated to the different dosimeters is:

Alanine:	4%
Fricke	2.5%
Red Perspex:	5%
TLD:	10%

DOSIMETRIC RESULTS

Dosimeter number	Absorbed dose/Dwater [kGy]	Irradiation time (hh:mm:ss)	Dose rate/Ḋwater [kGy/h]
1	7.359	02:00:00	3.680
2	7.772	02:00:00	3.886
3	6.847	02:00:00	3.423
4	7.552	02:00:00	3.776
5	7.298	02:00:00	3.649

Average of all dosimetric values:

$< \dot{D}_{water} > = 3.683$ kGy/h; $< \dot{D}_{Air} > = 0.899 \times < \dot{D}_{water} > = 3.311$ kGy $_{Air}$/h