

CAHIER DES CHARGES

Réf. : PSN-RES/SA2I/ 2025-00185

SENSIBLE: Non

Object: Specifications for radiation ageing tests of electric cables

Documents associés :

HISTORIQUE DES MODIFICATIONS DU DOCUMENT

Indice	Date	Nature de la modification
1	2025-09-19	Version initiale du document

Nom et visa du rédacteur :

Pascal ZAVALETA

Date:



pascal
Zavaleta
2025.09.19
18:02:42
+02'00'

Nom et visa du vérificateur :

Philippe NERISSON

Philippe BOURACHOT

Date :



Philippe
NERISSON
2025.09.19
18:03:29 +02'00'



Philippe
BOURACHOT
2025.09.19
18:03:29 +02'00'

Nom et visa de l'approbateur :

Christian MUN

Date :



Signature numérique
de C.MUN
Date : 2025.09.26
17:07:19 +02'00'

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1. **PURPOSE**

The purpose of this consultation is to establish an agreement for the performing of accelerated ageing tests of electric cables, on behalf of Fire Experiments Laboratory of ASNR, the French Authority for Nuclear Safety and Radiation Protection (PSN-RES/SA2I/LEF, Cadarache, 13115 St Paul Lez Durance, France).

2. **PRESENTATION OF ASNR AND UNITS**

2.1. **Presentation of ASNR**

The French Authority for Nuclear Safety and Radiation Protection (ASNR) oversees civil nuclear activities in France on behalf of the French State. It also carries out research, expert assessments, training, and public information in the fields of nuclear safety and radiation protection.

2.2. **Presentation of PSN and the fire experimentation laboratory (LEF)**

The ASNR Expert Assessment/Research in Nuclear Safety Unit (PSN) is responsible for expertise, research and study activities aimed at controlling the risks presented by power reactors, experimental reactors, laboratories, factories and transport.

The main mission of the fire experimentation laboratory is to conduct fire tests in large-scale facilities representative of rooms present in nuclear facilities. The objective of these tests is to assess the fire risk in such facilities in order to consolidate the means of prevention and protection implemented against this risk. In addition, the tests provide data from the measurements carried out, which will enable the validation of the digital tools used to quantify the fire risk in nuclear facilities.

3. **SPECIFICATIONS**

3.1. **General description**

To better control fire risks in a nuclear facility and assess their consequences, the ASNR is conducting experimental research within the GALAXIE Platform at Cadarache. The GALAXIE facilities are both in normally oxygenated and confined/mechanically ventilated environment, which provide data necessary for understanding the fire risk. The experimental facilities and devices of the GALAXIE Platform are detailed here : <https://www.irsn.fr/recherche/plateforme-experimentale-galaxie>.

In the frame of OECD FAIR Project (Fire risk Assessment through Innovative Research), experimental tests are planned to provide information on the effects of ageing of sheathing materials on the fire behaviour of electric cables and fire propagation

This section presents the technical specifications of the ageing test protocol of electric cables expected for this experimental campaign: cable type, required cable quantity to be artificially aged, test protocol, specific requirements...

3.2. Cable and required length to artificially age

Table 1 provides the specifications of the two electric cables that will be artificially aged. ASNR will provide the cables. The total quantity of cable to artificially age is 42 m for each of the two cables.

Table 1: specifications of the two cable types and the total cable quantity to artificially-age.

Cable ID	Supplier reference	Outer diameter (mm)	Total cable length to artificially age
ASNR1_cable	NU-SHX(ST)HX 1kV 12x1.5 mm ²	23	42 m
CERN_cable	DRAKA Li 2Y(St)H 24x2x0.75 mm ² NF	23	42 m

3.3. Specifications of the ageing protocol

Table 2 specifies the ageing test protocols that will be applied by the contractor to the cable according to the cable type. In his offer, the candidate will indicate the means (characteristics of the irradiation facility, type of climatic/thermal chambers, cable attachment during the ageing tests, specification of the control-command in terms of regulation and associated regulation range...) as it is detailed in the specific requirements section (see below). Finally, all the ageing tests should be ended at the latest by the end of June 2026.

Table 2: specifications of the ageing test protocols.

Cable ID	Ageing test protocol
ASNR1_cable	1 st step: thermal ageing during 270 h at 135°C
	2 nd step: combined thermal and radiation ageing at 70°C and a dose rate of 250 Gy/h, respectively, during 560 h (total received dose of 140 kGy)
CERN_cable	A dose rate of 1000 Gy/h during 500 h (total received dose of 500 kGy)

3.4. Specific requirements

Finally, specific requirements are described below:

- a test plan will be submitted before the test conduct,

- the total length of the cable (42 m per cable type) shall be irradiated as a total without cutting it in smaller pieces (if possible), turned around the source (source being in the centre), where the cable could be bended for and during radiation with a bending radius larger than 30 cm.
- if the total cable length cannot be irradiated as a whole, the minimum length of 1 piece is 1.2 m¹ or a multiple of 1.2 m (2.4 m, 3.6 m, 4.8 m...), and all extremities need to be sealed off with thermo-shrinkable caps (please refer to product reference in the following link: [RND 465-01003 | RND Embouts thermorétractables 2.3:1, 11 ... 25mm, Polyoléfine réticulée, 84mm | Distrelec Suisse](#)), it is recommended to use the size 25 mm before retraction to fit the cable,
- all the cable sample(s) will be exposed homogeneously to the same specified dose rate, and with a dose variation below $\pm 15\%$ for the totality of the cable length or for all the considered cable samples,
- a regular air renewal will be ensured in the irradiation facility, in order to prevent the build-up of radiation-induced reaction products. Additionally, the sample environment temperature and the sample environment humidity shall be monitored during the irradiation,
- Dosimetry for this TID test shall include measurement and reporting of:
 - The doses accumulated by the samples, expressed in Gy[water];
 - The dose rates at the sample locations;
 - The dose uncertainty (error on the measured dose) and non-uniformity/homogeneity,
- Sample handling shall be performed by the Contractor and it shall include reception and storage, preparation for irradiation and installation in suitable supports for irradiation. Scratches, as well as contamination of the cables with oils or water shall be avoided. The cables shall not be exposed to direct sunlight,
- for the thermal ageing step (ASNR1_cable, Table 2):
 - the thermal ageing step should be first conducted before the combined thermal and radiation ageing step,
 - the thermal aging step must be carried out in the same laboratory in order to limit the handling of transporting the cables between the two aging steps,
 - the relative humidity rate will be that of the ambient and measured on-line,
 - the total cable quantity will be exposed to a homogeneous ambient temperature of 135°C with a maximal deviation of $\pm 2^\circ\text{C}$,
 - the ambient temperature will be measured on-line,
 - the temperature rise at the test starting should be imposed at around 1°C/min.
- for the combined thermal and radiation ageing step (ASNR1_cable, Table 2):
 - the dose rate and the ambient temperature will be measured on-line,
 - the relative humidity rate will be that of the ambient and ideally measured on-line,
 - the ASNR1_cable will be exposed to a homogeneous ambient temperature of 70°C with a maximal deviation of $\pm 2^\circ\text{C}$,
 - the temperature rise at the test starting should be imposed at around 1°C/min.

¹ The fire tests, that will be conducted after the ageing tests, will use 1.2 m long aged cable samples.

- the cable support will be specified for all the ageing tests before the test conduct,
- after irradiation, the irradiated samples will be wrapped in protective foil and pack them in an adequate/robust shipping box such that they are shipped without damage during the transport²,
- the cables will be exposed to the ageing conditions without any mechanical constrain, except those specified above (possible radius of curvature greater than 30 cm),
- After the samples are irradiated, a detailed test report will be provided, including:
 - Sample information:
 - Photographs of the samples installed in suitable supports for their irradiation;
 - Photographs of each sample, pre-irradiation and post-irradiation (after they reach their final dose), with simple comments on their condition (grouping of samples of same type and same dose in a single photograph is allowed, provided that the photograph is clear and meaningful);
 - Irradiation conditions and information:
 - Irradiation facility (name and address) and radiation type;
 - Irradiation dates and durations (start date and end date for each dose), as well as any process interruptions (intentional or unintentional stoppage of the irradiation process);
 - Dosimetry technique;
 - Detailed dosimetry for all samples, referencing their labelling;
 - Environmental conditions;
 - Relevant documentation, including irradiation certificates;
 - Any other relevant information:
 - Additional photographs shall be added, as required for clarity of the test report.
 - Reports shall be written in English and produced in electronic format (PDF®, Microsoft Word®, Microsoft Excel®, txt files),
 - the test reports will be published no later than two months after the test has been carried out,
- The contractor shall comply with the technical requirements given in this document, following all relevant European and international professional standards including, but not limited to:
 - IEC 60544: Determination of the effects of ionising radiation on electrical insulating materials;
 - IEC 60544-1: Radiation interaction and dosimetry;
 - IEC 60544-2: Procedures for irradiation and test;
 - ISO 11137-3: Sterilization of health care products – Radiation – Guidance on dosimetric aspects.

² L'adresse pour l'envoi du câble sera fournie ultérieurement au transporteur.

4. ACCEPTANCE AND CONDITIONS

The acceptance of the verifications will be the subject of a report (model SA2I/FRM/001/05-14) signed by both parties and that will be provided by ASNR. The history of ageing parameters (dose rate, temperature and RH) will be reported as well as the whole observations/operations made before, during and after the ageing tests.

5. ORGANIZATION

5.1. ASNR organization

Contacts :

- Project manager: P. ZAVALETA, pascal.zavaleta@asnr.fr
- Head of laboratory: P. NERISSON, philippe.nerisson@asnr.fr

5.2. Supplier organization

The organization established to manage relations with the ASNR's representative must be specified in the offer.

The contractor must designate a project manager who will be the contact person for the LEF.

The project manager's role is to ensure the proper execution of the contract in accordance with the terms of the contract. He is required to report to the LEF project manager on the progress of the service and any difficulties encountered.

In the event of a change, whether temporary (absence) or permanent, of the project manager during the execution of the contract, the contractor must immediately inform the LEF project manager in writing and replace them with a person of the same level of expertise without delay.

Confidentiality: The contractor is required to respect the secrecy and confidentiality of the information they become aware of during the execution of the contract. In all cases, they must refer to the conditions of Article 5 of the decree of March 30, 2021 approving the general administrative clauses for French public works contracts.