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Technical Inspection
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ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

COMPILATION OF RADIATION DAMAGE TEST DATA

PART I, 2nd EDITION: Halogen-free cable-insulating materials

INDEX DES RÉSULTATS D'ESSAIS DE RADIORÉSISTANCE

I^re PARTIE, 2^e ÉDITION: Matériaux d'isolation de câbles exempts d'halogène

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Abstract

This report summarizes radiation damage test data on commercially available organic cable insulation and jacket materials: ethylene-propylene rubbers, polyethylenes, polyurethanes, silicone rubbers, and copolymers based on polyethylene. The materials have been irradiated either in a nuclear reactor, or with a cobalt-60 source, or in the CERN accelerators, at different dose rates. The absorbed doses were between 10^3 and 5×10^6 Gy. Mechanical properties, e.g. tensile strength, elongation at break, and hardness, have been tested on irradiated and non-irradiated samples, according to the recommendations of the International Electrotechnical Commission. The results are presented in the form of tables and graphs to show the effect of the absorbed dose on the measured properties.

Résumé

Ce rapport donne les résultats d'essais sur la résistance aux rayonnements ionisants de matériaux utilisés comme isolations et gaines de câbles électriques, tels que les caoutchoucs éthylène-propylène, les polyéthylènes, les polyuréthanes, les caoutchoucs silicones et les copolymères à base de polyéthylène. Les matériaux ont été irradiés soit dans un réacteur nucléaire, soit par une source de cobalt-60, soit dans les accélérateurs du CERN, à différents débits de dose. La dose absorbée était comprise entre 10^3 et 5×10^6 Gy. La résistance à la traction, l'allongement à la rupture et la dureté ont été testés sur des échantillons irradiés et non irradiés, conformément aux recommandations de la Commission Electrotechnique Internationale. Les résultats sont présentés sous forme de tableaux et de graphiques qui montrent l'effet de la dose absorbée sur ces propriétés mécaniques.

CONTENTS

The English text is a translation from the French

TABLE DES MATIÈRES

1. Introduction

Investigations into the degradation of materials and components which are exposed to ionizing radiation have been carried out in the past in many different fields of applications, such as for nuclear reactors, fusion reactors, high-energy accelerators, medical and industrial irradiation facilities, space projects, etc. At the European Organization for Nuclear Research (CERN), radiation damage test studies have been concentrated on organic and inorganic materials, electronic and optical components and devices, and other materials that are used in the construction and operation of high-energy accelerators.

Apart from electronic and optical devices, the organic materials are the ones most sensitive to radiation. As a consequence of this, a large number of radiation tests have been made on these materials and the results are extensively documented [1-15]. Design engineers are, however, often faced with the problem of finding the desired information quickly within the available literature. We therefore decided to publish our radiation damage test results on organic materials in the form of catalogues.

The first volume, published ten years ago, concerned organic materials used as insulation and sheathing for electric cables [16].

The second volume dealt with thermosetting and thermoplastic resins, the majority being epoxies used for magnet coil insulations [17].

The third volume contained information on miscellaneous materials and components used around high-energy accelerators [18].

The present volume complements the first one: it concerns halogen-free cable-insulating materials. As in previous parts, the materials are presented in alphabetical order following the English name.

We first present some characteristic properties of the materials represented here, and define our end-point criteria for selection of radiation-resistant materials. We then list the tests and test methods, and give the irradiation conditions. In Section 5 we explain the presentation of the data. It must be noted that most of the data have been obtained from tests after accelerated irradiations, and that all tests were made at ambient temperature. After long-time exposures and ageing in other environments, a variation in the presented data may be expected [15].

2. Materials, characteristic properties, and end-point criteria

With a few exceptions, which are marked in the catalogue, all test data given here have been obtained, over the past ten years, from commercially available materials. In the meantime, some

1. Introduction

Des essais sur la dégradation des matériaux due aux rayonnements ionisants ont été effectués dans plusieurs domaines d'application, par exemple autour des réacteurs nucléaires et de fusion, des accélérateurs à haute énergie, dans les installations industrielles ou médicales, dans les centres d'études spatiales, etc. A l'Organisation européenne pour la recherche nucléaire (CERN), les essais de radiorésistance ont été concentrés sur des matériaux organiques et inorganiques, des composants électroniques et optiques, et d'autres matériaux qui sont utilisés pour la construction et l'opération des accélérateurs à haute énergie.

A part les composants électroniques et optiques, les matériaux organiques sont parmi les plus sensibles aux rayonnements ionisants. Par conséquent, une grande quantité de ces matériaux ont été soumis à des essais d'irradiation, et les résultats peuvent être trouvés dans de nombreuses publications [1-15]. Toutefois, les ingénieurs rencontrent souvent des difficultés pour trouver, dans la littérature, l'information voulue. C'est pour cette raison que nous avons décidé de publier nos résultats d'essais de radiorésistance des matériaux organiques sous forme de catalogues.

Le premier volume, paru il y a dix ans, concernait les matériaux utilisés comme isolants et pour les gaines de câbles électriques [16].

Le deuxième volume comprenait des résines thermodurcissables et thermoplastiques dont la plupart sont des époxydes utilisées dans l'isolation de bobines d'aimants [17].

Le troisième volume comprenait divers matériaux et composants utilisés autour des accélérateurs de particules [18].

Le présent volume est un complément du premier: il comprend les matériaux pour isolations et gaines de câbles exempts d'halogène. Comme dans chaque volume, les matériaux sont présentés dans l'ordre alphabétique suivant leur nom anglais.

Nous commençons par exposer quelques propriétés caractéristiques des matériaux présentés dans ce catalogue; nous définissons les critères de dégradation de ces propriétés, qui servent à sélectionner les matériaux radiorésistants. Nous décrivons ensuite les méthodes d'essais, ainsi que les conditions d'irradiation. Dans la section 5 nous expliquons la présentation des données. Il faut noter que les résultats ont généralement été obtenus par des irradiations accélérées, et que tous les essais ont été faits à température ambiante. Après une longue période d'irradiation et un vieillissement sous d'autres conditions, on peut s'attendre à un changement dans les résultats que nous avons obtenus [15].

of them may no longer be on the market; this is indicated in the tables of the catalogue, whenever known. The most common materials that are dealt with here are:

- ethylene-propylene rubbers,
- EVA copolymers,
- linear or cross-linked polyethylenes,
- polyolefins,
- polyurethanes.

The materials were usually supplied in connection with offers from European cable manufacturers, and according to CERN specifications for control and power cables that have to operate in radiation environments. A list of firms supplying such materials is given in Appendix 3.

In Table 1 we summarize the mechanical, electrical, and physical properties of the materials, and give some indications of their behaviour in the event of combustion.

All the materials presented here are halogen-free and contain little or no sulfur and phosphorus. They have passed the DIN 57.472/813, which defines the maximum acidity and the maximum conductivity of combustion gases.

It is evident that for selection and classification of materials according to their radiation resistance, not all of the properties listed in Table 1 can be tested, and we have to restrict ourselves to a few characteristic and representative ones. In our case the mechanical properties were chosen. We justify this by our own experience and that of others [8], which shows that, in general, the mechanical degradation of plastic insulating materials due to ionizing radiation occurs before the degradation of the electrical and physical properties. Also, no important change in flammability has been observed with radiation [9].

Among the mechanical properties, elongation at break is the most sensitive, i.e. it decreases sharply above a threshold dose. According to the recommendations of the International Electrotechnical Commission (IEC), the elongation at break is the reference critical property and the end-point criterion is 50% of its initial value [19].

The Radiation Index (RI) is defined in IEC 544-4 as the logarithm, base 10, of the absorbed dose in grays (rounded down to two significant digits) at which the elongation at break is reduced to 50% of its initial value, under specified conditions of irradiation and tests. (Note that 1 Gy = 1 gray = 1 J/kg = 100 rad.)

3. Tests and test methods

Whenever possible, tests have been carried out according to international norms [19]. Sometimes, for practical or technical reasons, exceptions had to be made.

The samples were usually given to us in the form of moulded plates 1 to 3 mm thick. Some were supplied in the form of an extruded ribbon or

2. Les matériaux, leurs propriétés caractéristiques et les critères de dégradation de ces propriétés

A part quelques exceptions, qui sont indiquées dans le catalogue, tous les résultats donnés ont été obtenus, au cours des dix dernières années, sur des matériaux disponibles dans le commerce. Il est possible que quelques-uns ne soient plus sur le marché, et nous l'avons noté dans les tableaux, pour les cas où nous l'avons su. Les plus courants de ces matériaux sont:

- Caoutchoucs éthylène-propylène,
- Copolymères EVA,
- Polyéthylènes réticulés ou non,
- Polyoléfines,
- Polyuréthanes.

En général, les matériaux ont été fournis par des fabricants de câbles européens, suivant des spécifications du CERN pour des câbles de contrôle ou de puissance qui doivent être utilisés en présence de rayonnements ionisants. L'appendice 3 est une liste des fabricants qui ont fourni les échantillons.

Le tableau 1 donne un résumé des propriétés mécaniques, électriques et physiques des matériaux, ainsi que quelques indications sur leur comportement en cas de combustion.

Soulignons que tous les matériaux présentés dans ce catalogue sont exempts d'halogène et ne contiennent que peu ou pas de soufre ou de phosphore. Ils passent tous le test DIN 57.472/813 qui définit une acidité et une conductivité maximales des gaz de combustion.

Il est évident que, pour la sélection et la classification des matériaux selon leur résistance aux rayonnements, on ne peut pas tester toutes les propriétés citées dans le tableau 1, et qu'il faut se limiter à quelques-unes des plus représentatives. Dans le cas présent, nous avons choisi les propriétés mécaniques. Ce choix se justifie par notre propre expérience, et celle d'autres auteurs [8], qui nous a appris que la dégradation, due à l'irradiation, des propriétés mécaniques des isolants plastiques intervient généralement avant celle de leurs propriétés électriques et physiques. Nous avons aussi trouvé que les rayonnements n'ont que peu d'effet sur l'inflammabilité de ces matériaux [9].

Parmi les propriétés mécaniques, on trouve que l'allongement à la rupture est la plus notable: il diminue sensiblement en dessus d'une dose seuil. Conformément aux recommandations de la Commission électrotechnique internationale (CEI) l'allongement à la rupture est donc choisi comme propriété critique de référence, et le critère de fin de vie est 50% de sa valeur initiale [19].

La publication CEI 544-4 définit un indice de rayonnement (RI) déterminé par le logarithme, en base 10, de la dose absorbée en grays (arrondie à deux chiffres significatifs) au-dessus de laquelle la valeur de l'allongement à la rupture a atteint a sheath. Others were cut from prototype or production cables [the latter are marked (C) in the 'Remarks' line of the results tables]. In all cases, from five to eight samples were cut for each tested dose.

The following tests have been carried out:

i) Tensile tests, according to ISO recommendation R37, on dumb-bell samples mainly of type S1 or S2 with an overall length of 115 mm or 75 mm. The tests were carried out on an Instron machine and allowed the following parameters to be determined:
   - tensile strength,
   - elongation at break.
ii) Hardness Shore A, C, or D, according to ISO recommendations R868, carried out with a Wolpert apparatus.
iii) Oxygen Index (OI) test, according to ISO 4589. This value gives an indication of the flammability of the plastic materials. Test results are reported for non-irradiated materials only. Some results of the change of this parameter with radiation are given in Ref. [9]. The test apparatus was made by Stanton Redcroft.

More details about test methods are given in Ref. [22].

4. Irradiation conditions and dosimetry

Most of the samples were irradiated either in the ASTRA reactor at Seibersdorf (Austria), at doses of 5×10^5 Gy, 10^6 Gy, and 5×10^6 Gy, at a dose rate of about 2×10^5 Gy/h, or with a cobalt-60 source, at Conservatome in Dagneux (France), at doses of 2×10^5 Gy, 5×10^5 Gy, and 10^6 Gy, at a dose rate of about 4000 Gy/h.

Samples were also taken from cables that needed to be replaced in high-radiation areas of the CERN accelerators; they were irradiated at doses between 10^3 and 10^6 Gy [10, 11, 14].

In the 7 MW pool reactor, the irradiation position 'Ebene 1' is in the pool about 26 cm away from the reactor core. The neutron dose is less than 5% of the total dose to the samples. The irradiation medium is air, and the temperature is kept below 60 °C. More details about irradiation conditions and dosimetry are given in Ref. [20].

5. Presentation of the data

The list of the materials (with the relevant suppliers) that are presented in this catalogue and in the preceding volumes is given in Appendix 1.

Appendix 2 gives the popular names and trade names of the materials, together with the corresponding chemical names.

Appendix 3 is the alphabetical compilation of data. Under each letter, the following information can be found:

50% de sa valeur initiale, dans les conditions spécifiques d'irradiation et de test. (Pour mémoire, 1 Gy = 1 gray = 1 J/kg = 100 rad.)

3. Essais et méthodes d'essais

Nous avons exécuté nos essais selon les normes internationales [19] dans tous les cas où cela était possible. Pour des raisons pratiques ou techniques, quelques exceptions étaient inévitables.

Les matériaux nous ont en général été fournis sous forme de plaques, de 1 à 3 mm d'épaisseur. Certains nous ont été fournis sous forme de ruban ou de gaine extrudés. D'autres encore ont été prélevés sur des câbles prototypes ou de production [ces derniers sont en général marqués (C) sur la ligne 'Remarks' du tableau de résultats]. Dans tous les cas, de cinq à huit échantillons ont été coupés pour chaque essai.

Nous avons effectué les tests suivants:

i) Traction, selon la recommandation ISO R37, sur des échantillons S1 ou S2, de longueur 115 mm ou 75 mm. Les essais ont été faits sur une machine Instron et ont permis de déterminer les paramètres suivants:
   - Résistance à la traction,
   - Allongement à la rupture.
ii) Dureté Shore A, C ou D, selon la recommandation ISO R868, mesurée sur un appareil Wolpert.
iii) L'indice d'oxygène, selon la norme ISO 4589. Cette valeur permet de classer les matériaux plastiques selon leur inflammabilité. La valeur de l'indice d'oxygène (OI) est donnée, dans ce catalogue, pour les matériaux non irradiés seulement. Quelques résultats du changement de ce paramètre avec la radiation peuvent être trouvés dans la référence [9]. L'appareil de mesure était fabriqué par Stanton Redcroft.

4. Conditions d'irradiation et dosimétrie

La plupart des échantillons ont été irradiés soit au réacteur ASTRA, à Seibersdorf (Autriche), à des doses de 5×10^5 Gy, 10^6 Gy et 5×10^6 Gy, où le débit de dose est de l'ordre de 2×10^5 Gy/h, soit par une source de cobalt-60, à la société Conservatome, à Dagneux, France, à des doses de 2×10^5 Gy, 5×10^5 Gy et 10^6 Gy, à un débit de dose de l'ordre de 4000 Gy/h.

Dans les accélérateurs du CERN, des échantillons ont été pris des câbles qui ont été remplacés après service dans des zones de radiations élevées à des doses comprises entre 10^3 et 10^6 Gy [10, 11, 14].

Dans le réacteur-piscine de 7 MW, la position «Ebene 1» se trouve à 26 cm du cœur; la dose en neutrons intégrée par les échantillons est inférieure à 5% de la dose totale. Le milieu d'ir-

- Names of the materials (trade name and/or chemical names) and their chemical composition or structure, whenever known.
- Some general information on the material properties and radiation resistance, if no detailed data are included in this catalogue.
- The radiation test results in the form of tables for every material of the same type. In these tables are given the TIS identification number of each material, its type or trade name or commercial reference, the name of the supplier, the exposition doses and dose rates; then come the values of the tensile strength and elongation at break for tensile tests, the hardness Shore D, the limit of oxygen index (before irradiation) and the value of the radiation index for the corresponding dose rate.
- For each material, the individual data sheet in the form of table and graph, according to IEC 544 standard [21].

Appendix 4 is a list of the suppliers of materials and cables which collaborated to the catalogue.

Appendix 5 gives the main abbreviations used in the tables of results.

6. Classification of materials

In Table 2 we give a classification of the materials in decreasing order of radiation resistance. This classification corresponds to accelerated irradiations: it gives only an order of magnitude of the limit-dose of usability of the materials. From the table it appears that for a large number of materials the 'limit for application' is around 5×10^5 Gy. Under long-term irradiations at low dose rate, this limit may be as low as 2×10^5 Gy, or even 10^5 Gy for some polyolefins, which are rather sensitive to degradation in the presence of oxygen [15].

radiation est l'air, et la température maximale est de 60°C. Plus de détails sur les conditions d'irradiation et de dosimétrie peuvent être trouvés dans la référence [20].

5. Présentation des résultats

Les listes des matériaux (avec leurs fournisseurs respectifs) pour lesquels nous donnons des résultats et ceux présentés dans les volumes précédents constituent l'appendice 1. Pour y retrouver facilement un matériau dont on ne connaît le nom qu'en français, nous avons préparé une liste de traductions (voir tableau 3).

L'appendice 2 donne les noms déposés des matériaux, avec leur nom chimique.

L'appendice 3 est la compilation des résultats. Sous chaque lettre de l'alphabet on peut y trouver les informations suivantes:

- Noms des matériaux (nom du commerce et/ou nom chimique) et leur formule chimique, si connue.
- Quelques informations sur la radiorésistance des matériaux pour le cas où les données détaillées manquent.
- Les résultats, sous forme de tableaux, des essais de radiorésistance de tous les matériaux d'un même type. Dans ces tableaux, on trouve le numéro TIS d'identification, le type de matériau ou sa désignation commerciale, le nom du fournisseur, les doses d'exposition, les débits de dose; viennent ensuite les valeurs de la force et de l'élongation à la rupture en essais de traction, les valeurs de la dureté Shore D, la valeur de l'indice d'oxygène mesuré avant irradiation, et enfin la valeur de l'indice de rayonnement au débit de dose considéré.
- Les résultats individuels des essais, pour chaque matériau, sous forme de graphique et tableau, conformément à la norme CEI 544 [21].

L'appendice 4 donne les noms des fournisseurs de matériaux et de câbles qui ont collaboré à ce catalogue.

L'appendice 5 présente les principales abréviations utilisées dans les tableaux de résultats.

6. Classification des matériaux

Dans le tableau 2, nous classons les matériaux dans l'ordre décroissant de leur tenue aux radiations. Ce classement correspond à des irradiations accélérées; il ne donne donc qu'un ordre de grandeur de la dose jusqu'à laquelle les produits peuvent être utilisés. Il ressort de ce tableau que, même en irradiation accélérée, la plupart des matériaux ont une utilisation limitée à une dose se situant autour de 5×10^5 Gy. Lors d'irradiations à long terme, cette dose limite peut être abaissée à 2×10^5 Gy, ou même 10^5 Gy, pour certaines polyoléfines particulièrement sensibles à la dégradation en présence d'oxygène [15].

Acknowledgements

This data compilation was carried within the framework of an IAEA Research coordination programme on radiation degradation of polymers (Contract No. 4319, 1985 to 1989).

Our particular thanks are due to K. Goebel and K. Potter at CERN for their interest in this work and for their constant support of radiation-damage studies.

Most of the tested materials were used or proposed for LEP and the SPS at CERN. We thank MM. K. Badke, J. Thorlund and F. Vriens for their collaboration.

We would also like to thank the European manufacturers who have supplied the test samples, both for their interest in the subject and for the useful discussions that we had with representatives of many of them.

The irradiations were carried out in the ASTRA reactor of the Forschungszentrum Seibersdorf in Austria, where we appreciated the collaboration with A. Burtscher and J. Casta, and at Conservatome in Dagneux, France, with Mrs C. Saunier and Mrs M.-O. Bachelier.

Some mechanical tests and oxygen-index measurements were carried out at CERN by P. Beynel. The data processing and the presentation of results were realized from programmes written by G. Tartaglia and R. Tartaglia.

Finally, we thank the CERN Scientific Reports Editing and Text Processing Sections for the effort and attention they have given to this work.

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Nous remercions particulièrement K. Goebel et K. Potter, du CERN, pour l'intérêt qu'ils ont montré pour ce travail et leur soutien continu des études de dégradation des matériaux due aux rayonnements.

La plus grande partie des matériaux testés ont été utilisés ou proposés pour le LEP et au SPS (CERN). Nous remercions MM. K. Badke, J. Thorlund et F. Vriens pour leur bonne collaboration.

Nous tenons aussi à remercier les fabricants de câbles européens qui ont fourni des échantillons d'essais; nous avons eu des discussions utiles avec les représentants de nombreuses firmes.

Les irradiations ont été effectuées au réacteur ASTRA du Forschungszentrum Seibersdorf en Autriche, où nous avons apprécié la collaboration que nous ont offerte A. Burtscher et J. Casta, et à Conservatome, à Dagneux, France, où nous remercions Mmes C. Saunier et M.-O. Bachelier.

Certains des essais mécaniques et des mesures de l'indice d'oxygène ont été effectués au CERN par P. Beynel. Le traitement des données et la présentation des résultats sont réalisés à partir de programmes écrits par G. Tartaglia et R. Tartaglia.

Nous voudrions enfin exprimer notre appréciation de l'effort et de l'attention que le Service de dactylographie de rapports scientifiques a apportés à la présentation de ce document.

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Table 1

Main characteristics of some materials

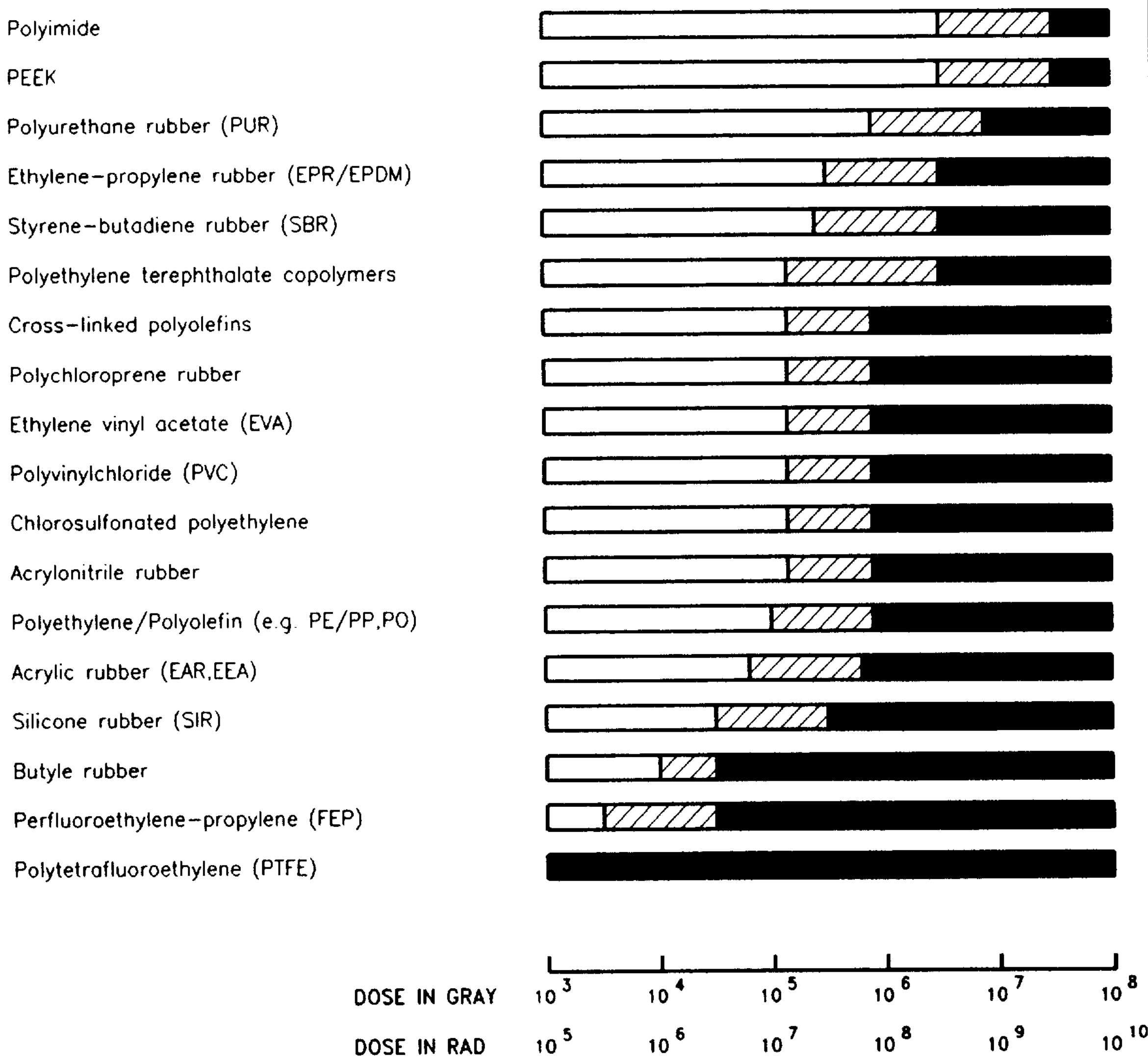
Properties	EAR EEA	EPR std	EPDM f	EVA	Kapton	PUR	PE	XLPE	Silicone rubber	Butyl rubber	PEEK
Physical											
Specific gravity (g/cm^3)	1.09	0.86		0.94	1.42	1.1-1.3	0.91-0.96		1.2-1.5	1.3	1.3-1.5
Water absorption (%)				< 0.01	1.3	0.6-0.8	< 0.01		0.5-2.4		0.5
Thermal conductivity (kcal/m · h · °C)							0.28				0.25-0.9
Thermal coefficient of expansion (10^{-5}/°C)							16-30		15-16		2-5
Electrical											
Dielectric constant at 1 kHz		2.5-4.0	3.2-4.5	4.2-5.3	3.5	6.0	2.2-4.5		3.0	7-10	3.2
Loss factor at 1 kHz		0.02-0.004		0.05	0.003	0.005	0.05-0.0003		0.004		0.003
Resistivity (Ω · m)		10^{11}-10^{15}		10^{14}-10^{15}	10^{14}	10^{11}-10^{13}	10^{15}-10^{16}		10^{13}	10^{12}-10^{14}	10^{12}-10^{15}
Dielectric strength (kV/mm)		15-30		20	160-280	15	15-25		16-28	6-20	15-20
Mechanical											
Ultimate tensile strength (MPa)	11.7-22	3.9-8.8		10-15	118-168	24.5-34.3	12.3-17.7		5.9-8.8	17-21	120-200
Ultimate elongation (%)	270-500	250-550		320-600	50-70	400-600	600-650	200-350	400-600	400-900	2-50
Hardness Shore D		15-36		32-40		30-40	32-55			10-35	
Abrasion resistance compared to PVC		worse		same to worse	better	better	same to worse		worse	good	
Combustion											
Toxic gases[a)]											
CO_2		m				m	m		l		
SO_2		l				o	o		o		
HF		o				o	o		o		
HCN		o				l	o		o		
Hydrocarbon		h				m	m		l		
Max. temperature (°C)											
permanently	140-150	85-90			200	70	70	85-90	150		250
$t < 4$ h		160-180				100	90-180		320		
$t < 4$ s		250					150				
Oxygen index	20-25	18-21	23-31	18-22	50-90	19-22	18-20		24-35		24-35
Fume production[a)]		h			l	m	h		l		

a) For toxic gas content and fume production: l = low; m = medium; h = high; o = nothing; all gases contain CO.

std = standard material, f = special flame-retardant material.

Table 2

Classification of materials according to their radiation resistance



Appreciation of Damage	Elongation	Utility	
Incipient to mild	75–100 % OF IN. VALUE	Nearly always usable	(white)
Radiation index area	25–75 % OF IN. VALUE	Often satisfactory	(hatched)
Moderate to severe	< 25 % OF IN. VALUE	Not recommended	(black)

Tableau 3

Noms, en ordre alphabétique, de tous les matériaux cités dans ce volume, avec le titre en anglais sous lequel on peut les trouver dans le catalogue.

Les noms *en italiques* sont des marques de fabrique, ou des noms déposés, pour lequels nous ne donnons pas de traduction.

En français	En anglais
Acorad	
Afumex	
Caoutchouc butyle	Butyl rubber
Caoutchouc acrylique d'éthylène	EAR, EEA
Caoutchouc éthylène-propylène	EPR
Caoutchouc éthylène-propylène diène monomère	EPDM
Caoutchouc silicone	SIR
Caoutchouc thermoplastique	Thermoplastic rubber (TPR)
Chlorostop	
Chlorure de polyvinyle	PVC
Cogegum	
Desmopan	
Elastollan	
Éthylène-acétate de vinyle	EVA
Flamtrol	
Halar	
Hypalon	
Hytrel	
Kapton	
Lupolen	
Megolon	
Neoprene	
Nordel	
Polyéthylène	PE
Polyéthylène réticulé (PRC)	XLPE
Polyéthylène semiconducteur	Semiconducting PE
Polyoléfines	Polyolefins
Polyuréthane	PUR
Pyrofil	
Radox	
Rheyhalon	
Silanpex	
Silythene	
Sioplas	
Teflon	
Tefzel	
Toxfree	
VAC	
Vamac	
Viton	

Appendix 1a:

LIST OF MATERIALS AND RELEVANT SUPPLIERS*)
(FOR THIS EDITION ONLY)

Material (Trade names are in italics)	Supplier
Acorad	Acome
Afumex	Pirelli SPA
Cogegum (blend of EVA and EPDM)	Norsk Kabel EB Padanaplast
Elastollan	Elastogran-EPE
Ethyl acrylate rubber (EAR)	Dätwyler Du Pont de Nemours Norsk Kabel EB
Ethylene ethyl acrylate (EEA)	BP Chemicals Fulgor Cavi
Ethylene-propylene diene monomer rubber (EPDM)	Bical – BICC Cables Câbles de Lyon Dätwyler Gorse Huber & Suhner NKT Telecom Cables Studer Kabel
Ethylene-propylene rubber (EPR)	AEG Kabel Cablexport Câbles de Lyon CEAT Cavi Cossonay Câbleries Dätwyler Fulgor Cavi Gorse kabelmetal electro Lynenwerk Metallurgica Bresciana Pirelli SPA Roque Silec Studer Kabel

*) Addresses may be found in Appendix 4

Ethylene vinyl acetate copolymer (EVA)	BASF Bical - BICC Cables BP Chemicals Cabeltel-Filotex Câbles de Lyon Dätwyler Fulgor Cavi Gorse Lynenwerk NKT Telecom Cables Norsk Kabel EB Pirelli SPA Roque STC Telecommunications
Lupolen (polyolefin)	BASF Cabeltel-Filotex Kabelmetal electro Pirelli SPA
Megolon (polyolefin)	Lindsay & Williams
Polyethylene (PE)	BP Chemicals Câbles de Lyon Huber & Suhner kabelmetal electro Neste (ex-Unifos) NKT Telecom Cables Norsk Kabel EB Silec Studer Kabel
Polyolefin	Acome AEG Kabel AEI Compounds Bical - BICC Cables BP Chemicals Cabeltel-Filotex Cablexport Dätwyler Lindsay & Williams Metallurgica Bresciana Neste (ex-Unifos) NKT Telecom Cables Norsk Kabel EB Padanaplast Pirelli SPA Silec
Polyurethane (PUR)	Elastogran - EPE Huber & Suhner Metallurgica Bresciana
Radox (Polyolefin base)	Huber & Suhner
Rheyhalon (polyolefin or rubber)	AEG Kabel
Semiconducting polyethylene	Gorse Silec
Silanpex (EVA base)	NKT Telecom Cables

Silicone rubber (SIR)	Gorse
Silythene (PE)	Silec
Sioplas (polyolefin)	AEI Compounds NKT Telecom Cables STC Telecommunications
Thermoplastic rubber (TPR)	BP Chemicals
Toxfree (polyolefin or rubber)	Cablexport CEAT Cavi
VAC (vinyl acetate copolymer)	kabelmetal electro
Vamac (EAR)	Du Pont de Nemours Norsk Kabel EB
XLPE (cross-linked polyethylene)	AEG Kabel Fulgor Cavi Gorse Metallurgica Bresciana Padanaplast Pirelli SPA Silec

Appendix 1b:

LIST OF MATERIALS PRESENTED IN THE PREVIOUS VOLUMES
(Trade names in italics)

Volume I: Cable insulating materials (Ref. 16)

Butyl rubber
Chlorostop
Chlorosulfonated polyethylene (CSP)
Cross-linked polyethylene (XLPE)
Desmopan
Ethyl-acrylate rubber (EAR)
Ethylene-propylene diene rubber (EPDM)
Ethylene-propylene rubber (EPR)
Ethylene vinyl acetate (EVA)
Flamtrol
Fluoropolymer
Halar
Hypalon
Hytrel
Kapton
Lupolen
Neoprene
Nordel
Polychloroprene
Polyethylene (PE)
Polyurethane (PUR)
Polyvinyl chloride (PVC)
Pyrofil
Radox
Semiconducting polyethylene
Silicone rubber
Silythene
Stilan
Teflon
Tefzel
Viton
XLPE

Volume II: Thermoplastic and thermosetting resins (Ref. 17)

Araldite B
Araldite D
Araldite F and other *Araldite* resins
Araldite F + epoxy *Novolac*
Birakrit
Cevolit
Crystic
Dobeckan IF
Dobeckot
Epikote
Epoxy resins
Epoxy resins + epoxy *Novolac*
Etronax
Isoval
Kerimid
Kinel
Makrolon
Novolac
Orlitherm
Phenolic resins
Polycarbonate resins
Polyester resins
Polyimide resins
Polylite
Polyurethane resins
Resofil
Ryton
Samicanit
Samicatherm
Silicone resins
Veridur
Vetresit
Vetronit

Volume III: Accelerator engineering materials and components (Ref. 18)

Adhesive tape
Aluminium oxide
Araldite
Asbestos cement
Askarel
Buna
Cable insulation
Cable tie
Ceramic
Cerium-doped glass
Connector
Copper wire
Diala C
Diester oil
Electronic components
Epoxy resin
Ethylene-propylene rubber (EPR) and (EPDM)
Ethylene-tetrafluoroethylene copolymer (ETFE)
Fluorinated oil

Fluorinated polymer
Foam
Glass
Glass fibre
Heating element
HF absorber
Hoses
Hostalen
Hypermalloy
Hytrel
Insulated wire
Insulating oil
Insulating sleeve
Insulating tape
Iron
Joint
Kapton
Kevlar
Kynar
Lighting
Lithium polysilicate
Lubricating oil
Luminous paint
Lupolen
Magnet coil insulation
Magnetic material
Makrolon
Micatherm
Microswitch
Mineral oil
Motor, electric
Mylar
Neoprene
Nitrile-butadiene rubber
Nomex
Noryl
Novolac
Nylon
Oil
Optical fibre
O-ring
Paint
Paper
Particle detector
Pertinax
Plexiglas
Polyacrylate
Polyamide
Polybutylene terephthalate (PBTP)
Polycarbonate
Polychloroprene *(Neoprene)*
Polyester resin
Polyethylene (PE) and (XLPE)
Polyethylene terephthalate (PETP)
Polyhydantoin
Polyimide
Polyolefin
Polyphenylene oxide (PPO)
Polyphenylene sulfide (PPS)
Polypropylene (PP)
Polysiloxane
Polytetrafluoroethylene (*Teflon* PTFE)
Polyurethane resin (PUR)
Polyurethane rubber (PUR)
Polyvinyl chloride (PVC)
Polyvinyl toluene
Quartz
Relay
Resin
Resistofol
Rubber
Ryton
Scintillator
Scotchcal
Seal (O-ring)
Silica
Silicon detector
Silicone oil
Silicone rubber
Sleeve
Styrene-butadiene rubber (SBR)
Switch
Tape
Teflon (PTFE)
Tefzel
Terminal board
Textile
Thermoplastic resin
Thermosetting resin
Thermoshrinking sheath
Vacuum chamber tube
Vacuum gasket
Vacuum pump accessory
Vacuum seal
Vacuum valve
Valvata
Valve
Vestolene
Viton
Wire
Wood

Appendix 2:

TRADE AND POPULAR NAMES AND CORRESPONDING CHEMICAL NAMES OF MATERIALS PRESENTED IN THIS EDITION

Acorad	Polyolefin
Afumex	Polyolefin
Cogegum	Blend of polyolefin and rubber
Elastollan	Polyurethane
Lupolen	Polyolefin (PE or EVA)
Megolon	Polyolefin
Radox	Polyolefin
Rheyhalon	Polyolefin or rubber
Silanpex	EVA base
Silythene	Polyethylene
Sioplas	EVA base
Toxfree	Polyolefin or rubber
Vamac	Ethyl acrylate rubber

Appendix 3:

ALPHABETIC COMPILATION OF THE DATA

ACORAD, trade name of Acome
see polyolefins

ACRYLIC RUBBERS
see EAR and EEA

AFUMEX, trade name of Pirelli
see polyolefins (see also in 1st edition (Ref. [16])

B

BUTYL RUBBER, see first edition (Ref. [16])
for general characteristics, see Tables 1 and 2.

C

CHLOROSTOP, trade name of kabelmetal electro,
see PVC in 1st edition (Ref. [16])

CHLOROSULFONATED POLYETHYLENE (CSP)
see HYPALON (trade name of Du Pont de Nemours) in 1st edition (Ref. [16])

COGEGUM, trade name of Padanaplast
see polyolefins

CROSS-LINKED POLYETHYLENE
see XLPE

CROSS-LINKED POLYOLEFINS
see polyolefins

D

DESMOPAN, trade name of Bayer
see polyurethane in 1st edition (Ref. [16])

E

EAR
ethyl acrylate rubber

EEA
ethylene ethyl acrylate rubber

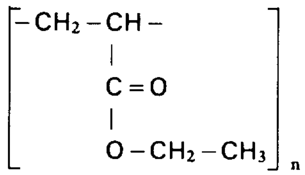
ELASTOLLAN, trade name of Elastogran-EPE
see PUR

EPDM
ethylene-propylene diene monomer rubber

EPR
ethylene-propylene rubber

EVA
ethylene vinyl acetate

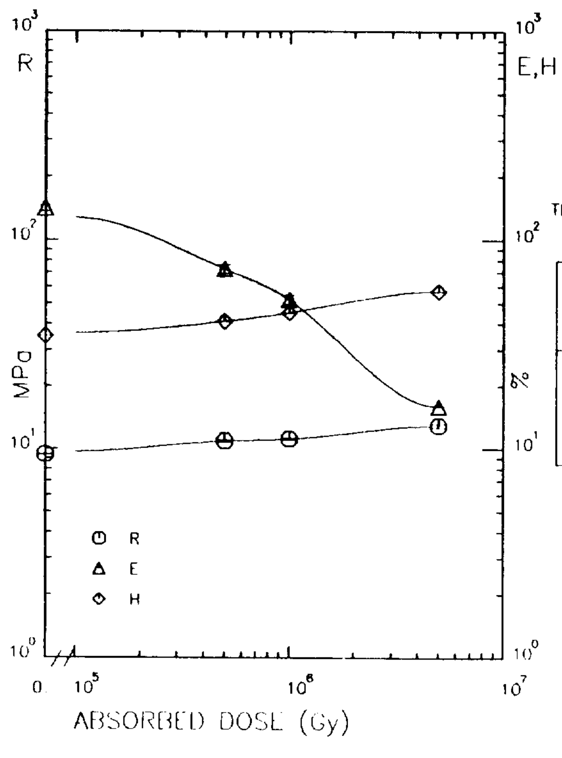
ETHYL-ACRYLATE RUBBER



For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
840	4-20122 09 Sheath	Dätwyler	0.0	–	9.4	142	35	48	
			0.5	3×10^5	10.9	73	41		5.7
			1.0	3×10^5	11.1	52	45		
			5.0	3×10^5	13.0	16	57		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 840

MATERIAL : Acryl rubber
TYPE : 4-20122 09
SUPPLIER : Dätwyler
REMARKS : Sheath (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.4 ± 0.1	141.6 ± 4.6	35.0 ± 0.0
0.500	2.7×10^5	10.9 ± 0.1	72.8 ± 3.3	41.0 ± 0.0
1.000	2.7×10^5	11.1 ± 0.1	52.0 ± 2.8	45.0 ± 0.0
5.000	2.7×10^5	13.0 ± 0.3	16.0 ± 0.0	57.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) : 5.7

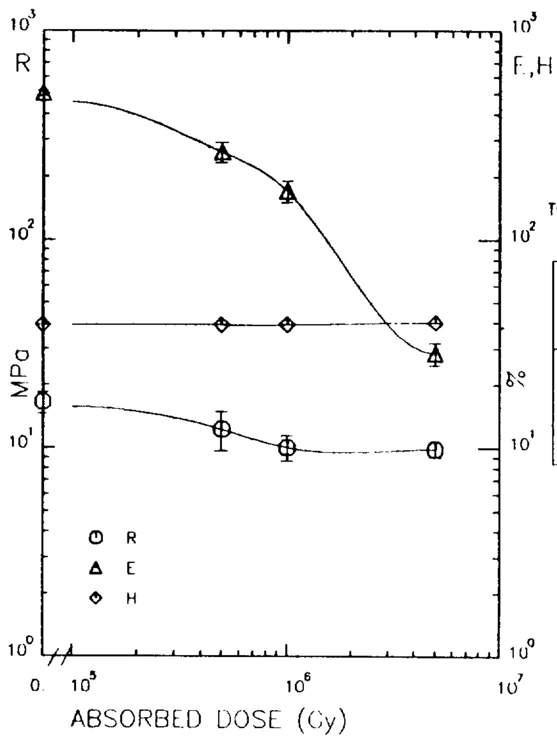
RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 48.0 %
CORROSIVITY (DIN 57472) : PASS

ETHYLENE ETHYL ACRYLATE RUBBER

Copolymer of ethylene and ethyl acrylate, cross-linked.
For general characteristics, see Tables 1 and 2.

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
557	MCA 280	Fulgor Cavi (BP)	0.0	–	16.6	501	39	24	
			0.5	2×10^5	12.3	263	39		5.7
			1.0	2×10^5	10.0	171	39		
			5.0	2×10^5	9.9	28	40		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 557

MATERIAL : EEA copolymer
TYPE : BP MCA 280
SUPPLIER : Fulgor Cavi
REMARKS : (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	16.6 ± 2.0	500.8 ± 14.3	39.0 ± 0.0
0.500	2.0×10^5	12.3 ± 2.6	263.2 ± 29.3	39.0 ± 0.0
1.000	2.0×10^5	10.0 ± 1.4	171.2 ± 20.1	39.0 ± 0.0
5.000	2.0×10^5	9.9 ± 0.8	28.4 ± 3.6	40.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

ETHYLENE-PROPYLENE DIENE MONOMER RUBBER

Ethylene-propylene containing 1–2% of radical of diene.
Properties almost identical to those of EPR.
For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
410	LD 3734 Sheath	Câbles de Lyon	0.0	-	9.8	261	19	-	
			0.5	2×10^5	9.0	150	17		5.9
			1.0	2×10^5	8.8	125	20		
			5.0	2×10^5	9.1	44	25		
420	Insulation	Huber & Suhner	0.0	-	7.2	220	19	28	
			0.5	2×10^5	7.5	133	20		5.8
			1.0	2×10^5	7.7	95	24		
			5.0	2×10^5	7.5	34	31		
421	Insulation	Huber & Suhner	0.0	-	7.0	233	18	29	
			0.5	2×10^5	7.4	131	22		5.7
			1.0	2×10^5	6.5	72	23		
			5.0	2×10^5	7.7	33	28		
550	IS 20	Studer Kabel (BICC)	0.0	-	5.2	384	23	19	
			0.5	2×10^5	9.3	121	20		
			1.0	2×10^5	8.6	63	26		
			5.0	2×10^5	9.3	25	17		
578	IE 452 Sheath	Gorse	0.0	-	4.0	562	21	26	
			0.5	2×10^5	2.7	218	24		
			1.0	2×10^5	3.3	104	24		
			5.0	2×10^5	5.2	37	33		
580	Insulation	Gorse	0.0	-	4.5	332	19	22	
			0.5	2×10^5	3.9	170	18		5.7
			1.0	2×10^5	3.5	113	19		
			5.0	2×10^5	3.8	42	22		
585	IE 606 Insulation	Gorse	0.0	-	4.9	202	18	23	
			0.5	2×10^5	4.5	118	17		5.8
			1.0	2×10^5	4.1	71	18		
			5.0	2×10^5	4.3	34	20		
620	MAF 34 B	Studer Kabel (Dolder - Dupont)	0.0	-	6.8	170	39	30	
			0.5	2×10^5	16.5	57	48		
			1.0	2×10^5	20.4	17	51		
			5.0	2×10^5	12.1	6	57		
631	PM 177 Sheath	BICC	0.0	-	2.6	382	25	31	
			0.5	2×10^5	3.4	115	29		
			1.0	2×10^5	4.3	70	34		
			5.0	2×10^5	8.8	21	51		
677	EPDM/PE 83-34	NKT	0.0	-	5.7	50	39	29	
			0.5	2×10^5	6.8	15	41		
			1.0	2×10^5	6.9	16	44		
			5.0	2×10^5	10.3	10	54		
897	4-97150 05 EPDM/EVA	Dätwyler	0.0	-	9.5	127	35	-	
			0.5	2×10^5	8.3	58	38		5.6
			1.0	2×10^5	10.6	48	40		
			5.0	2×10^5	14.3	7	65		
899	4-57280 06 Insulation	Dätwyler	0.0	-	12.0	104	25	-	
			0.5	2×10^5	13.8	64	30		5.9
			1.0	2×10^5	14.1	49	31		
			5.0	2×10^5	15.1	20	48		
			0.2	100	10.9	85	26		

EPDM

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
900	4-56963 12 Sheath	Dätwyler	0.0	-	12.2	128	30	-	
			0.5	2×10^5	13.0	75	35		5.9
			1.0	2×10^5	13.4	60	39		
			5.0	2×10^5	15.1	18	51		
			0.2	100	12.2	93	33		

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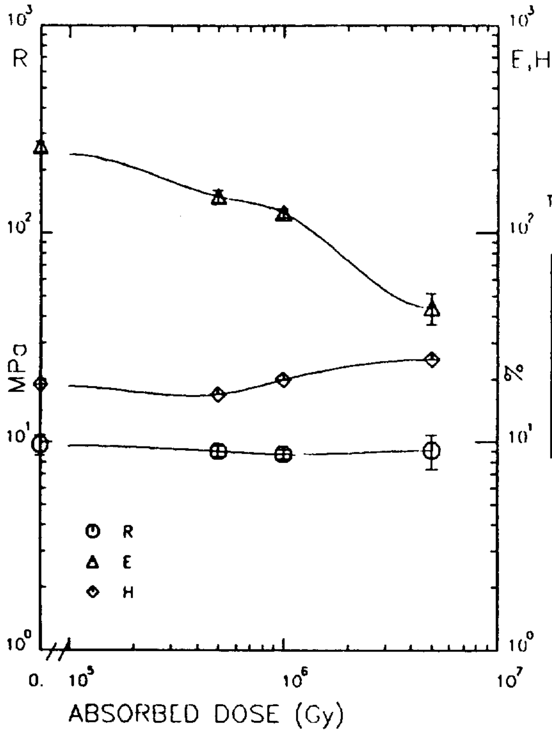


CERN MATERIAL No. : 410

MATERIAL : EPDM
TYPE : LD 3734
SUPPLIER : Cables de Lyon
REMARKS : Sheath

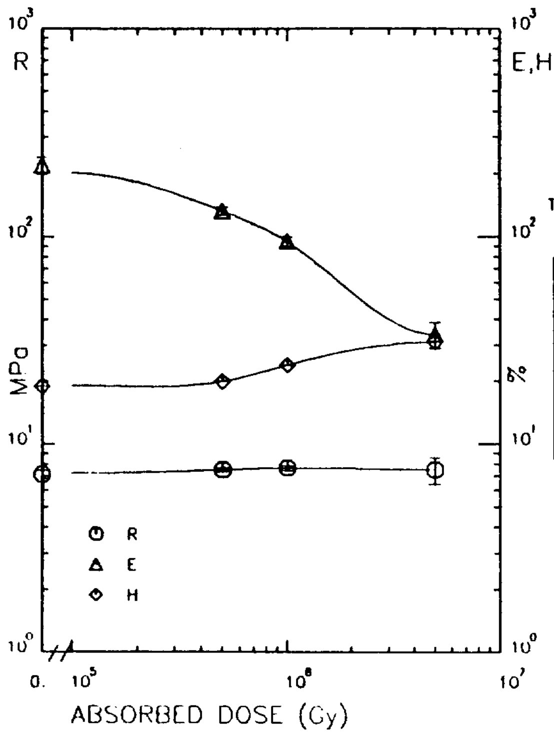
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.8 ± 1.1	261.0 ± 15.2	19.0 ± 0.0
0.500	1.7×10^5	9.0 ± 0.6	150.0 ± 10.6	17.0 ± 0.0
1.000	1.7×10^5	8.8 ± 0.4	125.0 ± 6.1	20.0 ± 0.0
5.000	1.7×10^5	9.1 ± 1.7	44.0 ± 7.4	25.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 420

MATERIAL : EPDM
TYPE : Insulation
SUPPLIER : Huber & Suhner
REMARKS : Blue plates

TEST RESULTS :

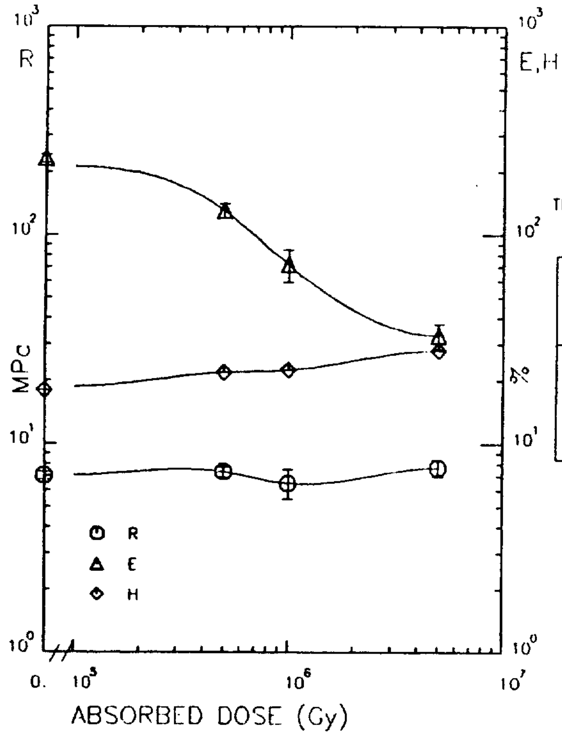
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.2 ± 0.3	220.0 ± 20.3	19.0 ± 0.0
0.500	2.5×10^5	7.5 ± 0.2	133.0 ± 5.7	20.0 ± 0.0
1.000	2.5×10^5	7.7 ± 0.2	95.0 ± 5.0	24.0 ± 0.0
5.000	2.5×10^5	7.5 ± 1.1	33.8 ± 4.8	31.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.0 %
CORROSIVITY (DIN 57472) : PASS

EPDM

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 421

MATERIAL : EPDM
TYPE : Insulation
SUPPLIER : Huber & Suhner
REMARKS : Yellow plates

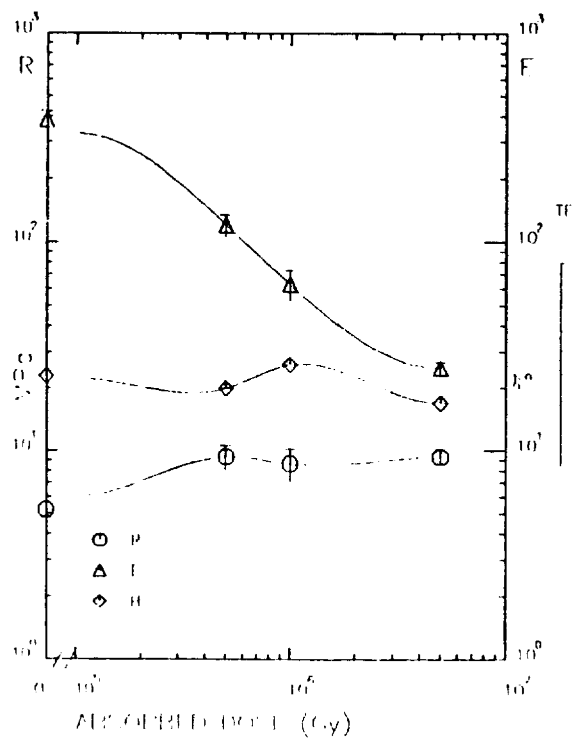
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.0 ± 0.3	233.0 ± 10.4	18.0 ± 0.0
0.500	2.5×10^5	7.4 ± 0.4	131.0 ± 10.8	22.0 ± 0.0
1.000	2.5×10^5	6.5 ± 1.0	72.0 ± 13.0	22.5 ± 0.0
5.000	2.5×10^5	7.7 ± 0.7	33.0 ± 4.5	28.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 550

MATERIAL : EPDM
TYPE : IS 20 by BICC
SUPPLIER : Studer-Kabel
REMARKS : Insulation (P)

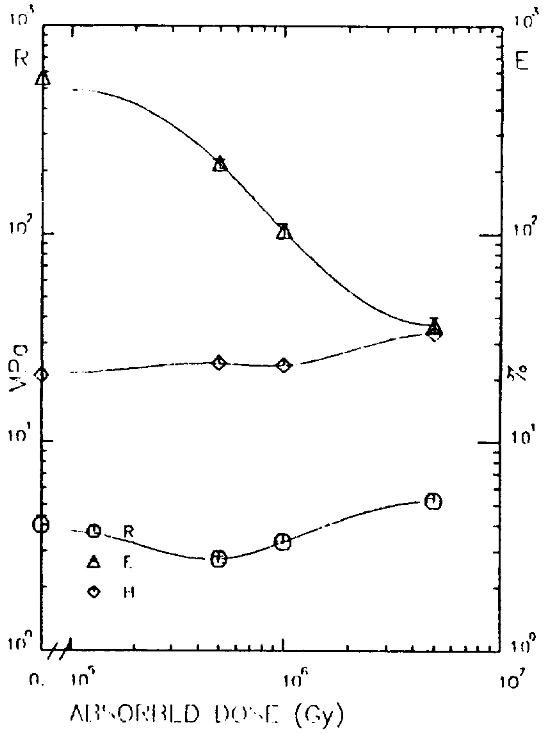
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000		5.2 ± 0.3	383.5 ± 39.3	23.0 ± 0.0
0.500	1.7×10^5	9.3 ± 1.3	121.0 ± 14.0	20.0 ± 0.0
1.000	1.7×10^5	8.6 ± 1.6	63.1 ± 10.3	26.0 ± 0.0
5.000	1.7×10^5	9.3 ± 0.6	25.0 ± 1.8	17.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 578

MATERIAL : EPDM
TYPE : Sheath IE 452
SUPPLIER : Gorse
REMARKS : (P)

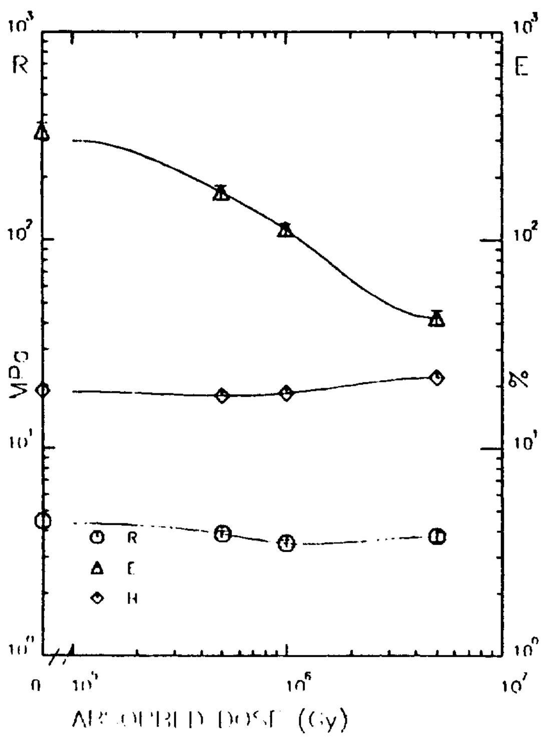
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.0 ± 0.4	562.4 ± 8.3	21.0 ± 0.0
0.500	2.5×10^5	7.7 ± 0.1	218.0 ± 10.6	24.0 ± 0.0
1.000	2.5×10^5	3.3 ± 0.0	104.0 ± 8.5	23.5 ± 0.0
5.000	2.5×10^5	5.2 ± 0.2	36.8 ± 3.3	33.5 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 26.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 580

MATERIAL : EPDM
TYPE : Insulation
SUPPLIER : Gorse
REMARKS : (P)

TEST RESULTS :

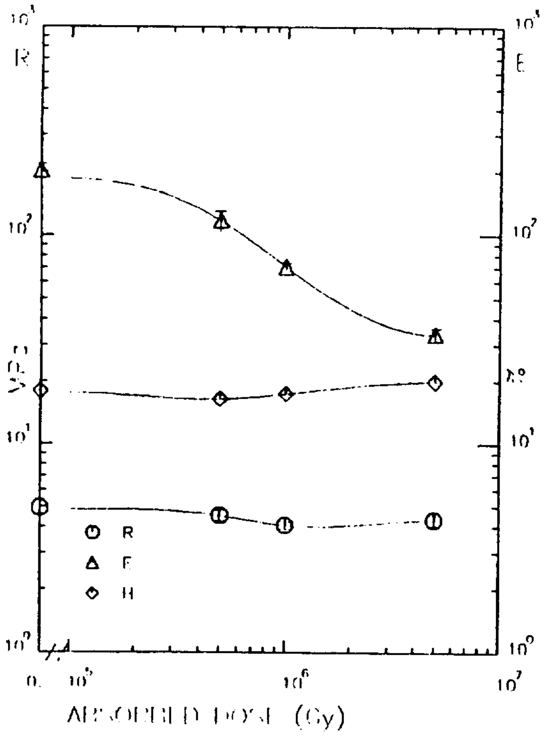
Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.5 ± 0.2	332.0 ± 33.8	19.0 ± 0.0
0.500	2.5×10^5	3.9 ± 0.1	169.6 ± 12.8	18.0 ± 0.0
1.000	2.5×10^5	3.5 ± 0.1	112.8 ± 7.2	18.5 ± 0.0
5.000	2.5×10^5	3.8 ± 0.2	42.4 ± 3.6	22.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 22.0 %
CORROSIVITY (DIN 57472) : PASS

EPDM

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 585

MATERIAL : EPDM
TYPE : Insulation IE 606 grey
SUPPLIER : Gorse
REMARKS : (P)

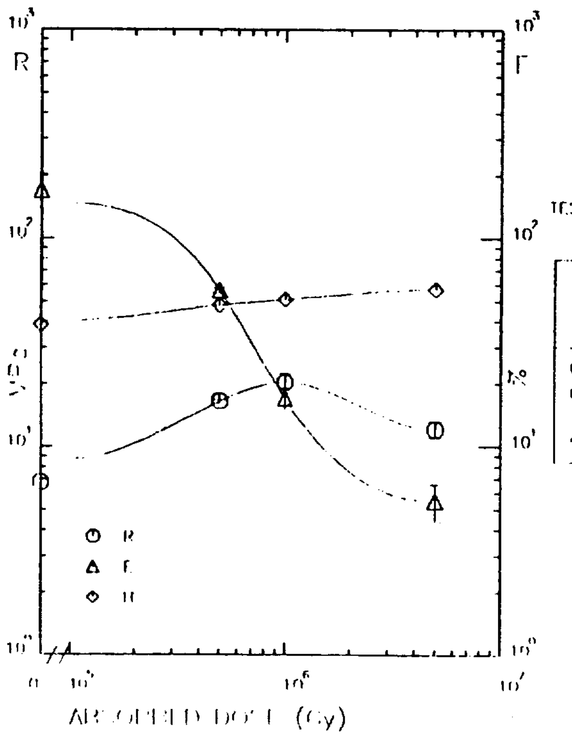
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.9 ± 0.3	202.0 ± 15.7	18.0 ± 0.0
0.500	2.5×10^5	4.5 ± 0.3	117.5 ± 13.2	16.5 ± 0.0
1.000	2.5×10^5	4.1 ± 0.2	70.6 ± 3.1	17.5 ± 0.0
5.000	2.5×10^5	4.3 ± 0.3	33.8 ± 2.5	20.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 23.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 620

MATERIAL : EPDM
TYPE : MAF 34 B by Dolder-Dupont
SUPPLIER : Studer-Kabel
REMARKS : Insulation (P)

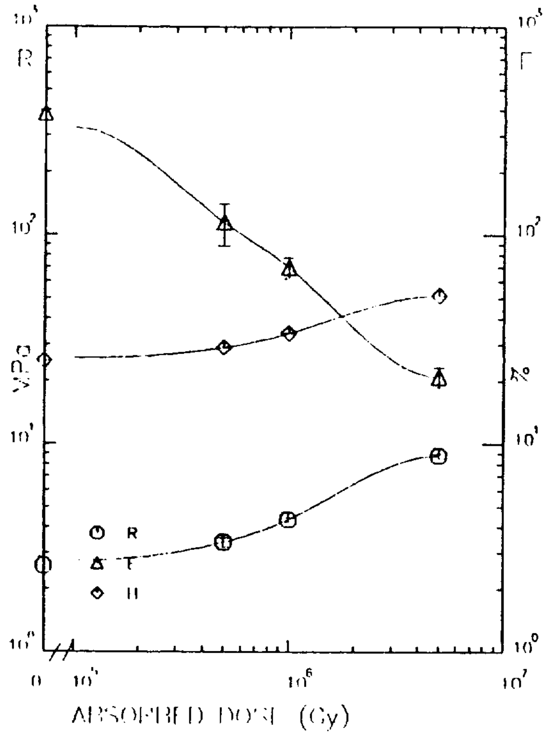
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	--	6.8 ± 0.2	170.0 ± 34.2	38.5 ± 0.0
0.500	1.4×10^5	16.5 ± 0.3	56.5 ± 1.4	48.0 ± 0.0
1.000	1.4×10^5	20.4 ± 2.0	17.0 ± 2.1	51.0 ± 0.0
5.000	1.4×10^5	12.1 ± 1.1	5.5 ± 1.1	57.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 631

MATERIAL : EPDM
TYPE : PM 177
SUPPLIER : BICC
REMARKS : Sheathing compound

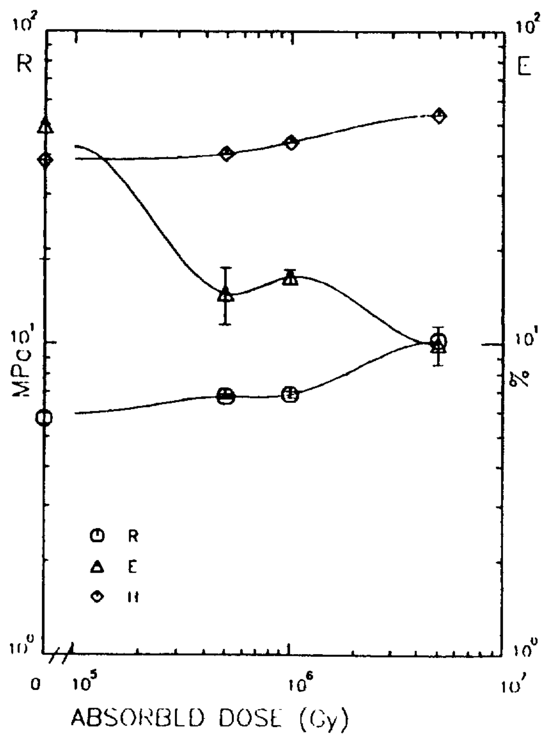
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	2.6 ± 0.1	382.0 ± 16.4	25.0 ± 0.0
0.500	1.7×10^5	3.4 ± 0.2	115.0 ± 26.5	29.0 ± 0.0
1.000	1.7×10^5	4.3 ± 0.1	70.0 ± 7.9	34.0 ± 0.0
5.000	1.7×10^5	8.8 ± 0.2	21.0 ± 2.2	51.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 677

MATERIAL : EPDM/PE Compound
TYPE : (Ref.83-34)
SUPPLIER : NKT
REMARKS : (P)

TEST RESULTS :

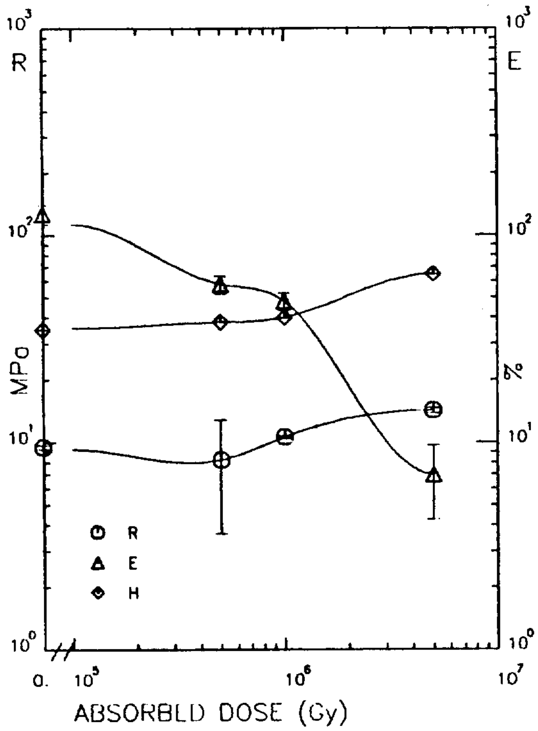
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.7 ± 0.2	49.6 ± 31.0	38.5 ± 0.0
0.500	1.7×10^5	6.8 ± 0.1	14.5 ± 3.0	40.5 ± 0.0
1.000	1.7×10^5	6.9 ± 0.2	16.4 ± 0.9	44.0 ± 0.0
5.000	1.7×10^5	10.3 ± 0.5	10.0 ± 1.4	54.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.5 %
CORROSIVITY (DIN 57472) : PASS

EPDM

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 897

MATERIAL : EPDM/EVA
TYPE : 4-97150-05
SUPPLIER : Dälwyler
REMARKS : Sheath (Extruded S2 samples)

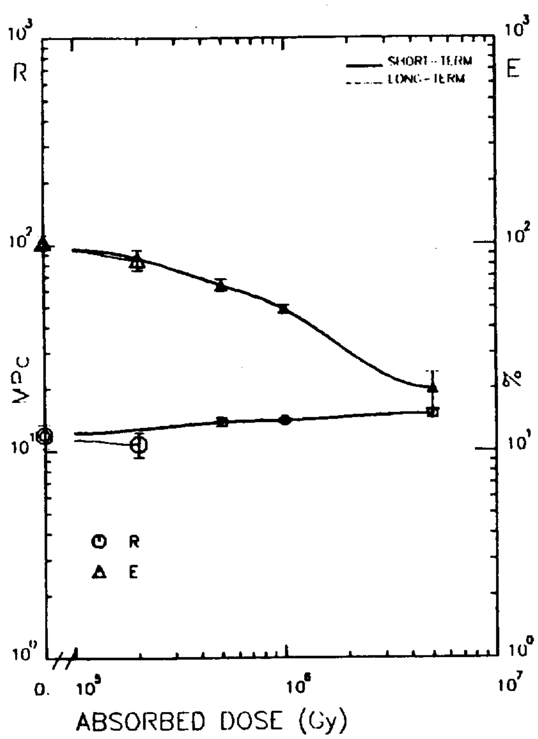
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.5 ± 0.2	127.0 ± 14.0	35.0 ± 0.0
0.500	2.5×10^5	8.3 ± 4.6	58.0 ± 5.7	38.0 ± 0.0
1.000	2.5×10^5	10.6 ± 0.1	48.0 ± 4.5	40.0 ± 0.0
5.000	2.5×10^5	14.3 ± 0.4	7.0 ± 2.7	65.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 899

MATERIAL : EPDM
TYPE : 4-57280-06
SUPPLIER : Dalwyler
REMARKS : Insulation (Extruded S2 samples)

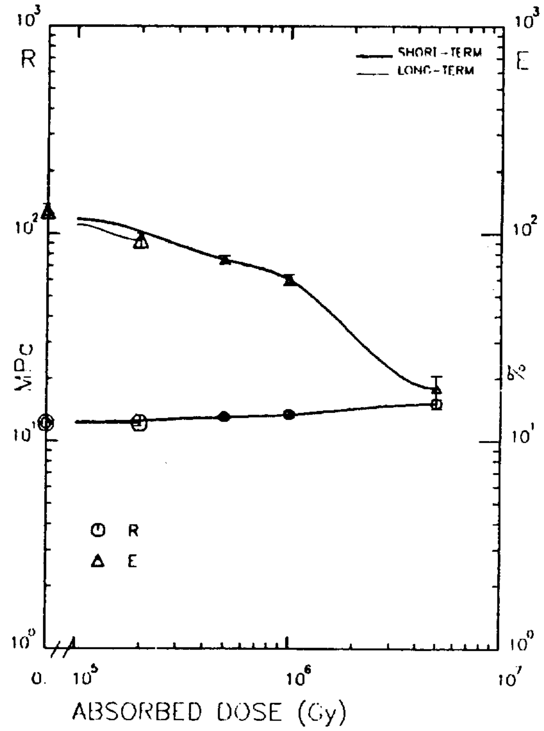
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.0 ± 1.6	104.0 ± 8.2	25.0 ± 0.0
0.500	2.5×10^5	13.8 ± 0.7	64.0 ± 4.2	30.0 ± 0.0
1.000	2.5×10^5	14.1 ± 0.4	49.0 ± 2.2	31.0 ± 0.0
5.000	2.5×10^5	15.1 ± 0.6	20.0 ± 4.1	48.0 ± 0.0
0.000	–	12.0 ± 1.6	104.0 ± 8.2	25.0 ± 0.0
0.200	100.0	10.9 ± 1.5	85.0 ± 9.8	26.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 900

MATERIAL : EPDM
TYPE : 4-56963-12
SUPPLIER : Datwyler
REMARKS : Sheath (Extruded S2 samples)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.2 ± 0.2	128.0 ± 10.4	30.0 ± 0.0
0.500	2.5×10^5	13.0 ± 0.2	75.0 ± 3.5	35.0 ± 0.0
1.000	2.5×10^5	13.4 ± 0.5	60.0 ± 3.5	39.0 ± 0.0
5.000	2.5×10^5	15.1 ± 0.8	18.0 ± 2.7	51.0 ± 0.0
0.000	–	12.2 ± 0.2	128.0 ± 10.4	30.0 ± 0.0
0.200	100.0	12.2 ± 0.3	93.0 ± 7.6	33.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) : > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

ETHYLENE-PROPYLENE RUBBER

$$\left[-CH_2-CH_2-CH_2-\underset{\displaystyle |}{\overset{\displaystyle CH_3}{CH}}\!\!-CH_2-CH_2-CH_2-\overset{\displaystyle CH_3}{\underset{}{CH}}- \right]_n$$

For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

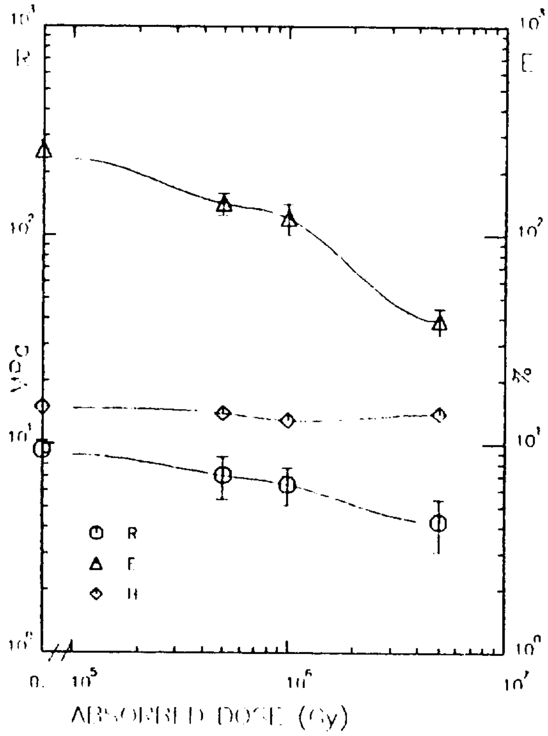
Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
409	LD 3792 Insulation	Câbles de Lyon	0.0	-	9.4	255	15	-	
			0.5	2×10^5	7.1	142	14		5.9
			1.0	2×10^5	6.4	121	13		
			5.0	2×10^5	4.2	39	14		
411	Rheyhalon Insulation	AEG-Kabel	0.0	-	6.1	433	22	-	
			0.5	2×10^5	6.2	180	26		5.6
			1.0	2×10^5	7.3	108	30		
			5.0	2×10^5	10.7	35	45		
412	Rheyhalon Sheath	AEG-Kabel	0.0	-	8.3	132	27	-	
			0.5	2×10^5	9.8	93	35		6.0
			1.0	2×10^5	10.6	75	36		
			5.0	2×10^5	11.7	25	53		
433	840 Insulation	Silec	0.0	-	7.2	490	22	21	
			0.5	2×10^5	6.3	246	24		5.7
			1.0	2×10^5	5.1	211	22		
			5.0	2×10^5	6.4	34	30		
442	Sheath 772	Cablexport CEAT	0.0	-	7.5	253	19	-	
			0.5	2×10^5	7.4	150	21		5.8
			1.0	2×10^5	6.0	108	19		
			5.0	2×10^5	6.9	49	22		
443	Insulation 773	Cablexport CEAT	0.0	-	6.2	217	17	-	
			0.5	2×10^5	6.1	126	17		5.8
			1.0	2×10^5	5.9	99	16		
			5.0	2×10^5	7.6	54	20		
464	NI 909 Insulation	Cossonay	0.0	-	9.2	293	15	32	
			0.5	2×10^5	7.5	150	16		5.7
			1.0	2×10^5	7.3	123	16		
			5.0	2×10^5	7.7	38	25		
465	NI 913 Sheath	Cossonay	0.0	-	7.9	220	19	42	
			0.5	2×10^5	7.2	136	20		5.9
			1.0	2×10^5	6.9	101	21		
			5.0	2×10^5	8.5	36	33		
466	NI 1058 Sheath	Cossonay	0.0	-	10.0	275	18	32	
			0.5	2×10^5	8.5	150	19		5.7
			1.0	2×10^5	8.1	107	19		
			5.0	2×10^5	8.5	40	24		
468	Insulation ISR cables	Cablexport Pirelli	0.0	-	3.9	360	20	27	
			0.5	2×10^5	4.2	134	21		
			1.0	2×10^5	5.5	76	25		
			5.0	2×10^5	10.4	21	50		
474	Insulation 4 SPS cables	Gorse	0.0	-	4.4	308	13	27	
			1.0	2×10^5	5.6	98	22		
475	Sheath 501 SPS cables	Gorse	0.0	-	5.7	113	23	27	
			1.0	2×10^5	5.8	63	24		6.0
511	1053 ISR cables	Pirelli	0.0	-	7.7	253	15	20	
			0.5	2×10^5	7.0	150	15		5.8
			1.0	2×10^5	6.4	108	16		
			5.0	2×10^5	4.5	26	21		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
555	Insulation G 5	Fulgor Cavi	0.0	-	3.6	407	14	24	
			0.5	2×10^5	3.2	198	15		5.6
			1.0	2×10^5	3.4	109	15		
			5.0	2×10^5	7.1	27	28		
556	Sheath of SPS power cables	Fulgor Cavi	0.0	-	5.9	290	17	32	
			0.5	2×10^5	6.1	124	19		
			1.0	2×10^5	6.3	86	22		
			5.0	2×10^5	9.0	29	42		
559	ZID 33 OF/1 Sheath	Pirelli	0.0	-	4.0	357	20	31	
			0.5	2×10^5	3.0	111	21		
			1.0	2×10^5	3.5	62	22		
			5.0	2×10^5	8.4	17	43		
561	Sheath of aluminium cable 1982	CEAT Cavi	0.0	-	3.2	280	18	28	
			0.5	2×10^5	3.4	172	16		5.8
			1.0	2×10^5	3.8	117	18		
			5.0	2×10^5	5.5	40	25		
565	Sheath of copper cable 4 × 50 mm²	Gorse	0.0	-	17.3	315	30	-	
			0.5	2×10^5	13.0	178	32		5.7
			1.0	2×10^5	14.0	84	30		
			5.0	2×10^5	18.2	16	62		
624	AT/2	Cablexport CEAT	0.0	-	6.7	242	14	-	
			0.5	2×10^5	9.0	77	17		
			1.0	2×10^5	10.9	28	22		
			5.0	2×10^5	5.0	8	24		
625	AT/3	Cablexport CEAT	0.0	-	7.3	325	14	18	
			0.5	2×10^5	5.9	92	14		
			1.0	2×10^5	5.0	28	17		
			5.0	2×10^5	3.6	13	17		
626	Sheath 4/957	Cablexport CEAT	0.0	-	8.9	160	21	30	
			0.5	2×10^5	11.0	61	35		
			1.0	2×10^5	14.2	22	50		
			5.0	2×10^5	12.3	10	57		
682	Rheyhalon power cable Insulation	AEG-Kabel	0.0	-	9.1	110	30	25	
			0.5	2×10^5	9.7	56	34		5.7
			1.0	2×10^5	9.8	34	36		
			5.0	2×10^5	14.0	14	53		
683	Rheyhalon Sheath for power cable	AEG-Kabel	0.0	-	9.7	162	29	35	
			0.5	2×10^5	12.5	80	37		5.6
			1.0	2×10^5	13.5	65	38		
			5.0	2×10^5	19.2	17	57		
730	Rheyhalon Sheath for power cable	AEG-Kabel	0.0	-	6.3	184	25	32	
			0.5	2×10^5	8.2	79	36		
			1.0	2×10^5	8.7	59	40		
			0.5	100	6.1	86	40		
736	Sheath of power cable	Pirelli	0.0	-	3.4	265	31	33	
			0.5	2×10^5	4.3	52	49		
			1.0	2×10^5	5.5	32	55		
			0.5	100	4.7	28	50		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
737	Insulation power cable	Pirelli	0.0	-	2.9	352	23		
			0.5	2×10^5	3.2	130	39		
			1.0	2×10^5	3.9	82	42		
			0.5	100	3.1	165	38		
760	Insulation LEP 20 kV cables	Fulgor Cavi	0.0	-	4.8	520	19	19	
			0.2	2×10^5	4.7	360	16		5.5
			0.5	2×10^5	3.4	191	17		
			1.0	2×10^5	3.3	125	16		
			5.0	2×10^5	5.0	33	23		
			0.2	100	5.1	423	16		5.5
			0.5	100	2.7	183	14		
767	Insulation 3 G	Lynenwerk	0.0	-	5.9	276	24	26	
			0.2	2×10^5	5.4	173	26		5.5
			0.5	2×10^5	5.6	115	27		
			2.5	2×10^5	6.2	68	30		
			0.2	100	3.8	90	32		
			0.5	100	4.9	47	37		
806	Rheyhalon Insulation	AEG-Kabel	0.0	-	6.5	375	21	29	
			0.2	2×10^5	7.0	244	23		5.4
			0.5	2×10^5	7.2	95	24		
			1.0	2×10^5	7.6	63	26		
			5.0	2×10^5	11.7	22	42		
			0.2	100	6.1	152	26		5.2
			0.5	100	9.1	43	29		
807	Rheyhalon Sheath for power cable	AEG-Kabel	0.0	-	8.7	160	29	43	
			0.2	2×10^5	6.9	95	34		5.8
			0.5	2×10^5	11.2	90	37		
			1.0	2×10^5	13.2	60	41		
			5.0	2×10^5	20.3	16	60		
			0.2	100	10.0	102	36		5.6
			0.5	100	10.4	70	40		
808	Rheyhalon Insulation	AEG-Kabel	0.0	-	7.7	416	15	24	
			0.2	2×10^5	5.2	222	18		5.4
			0.5	2×10^5	6.5	182	19		
			1.0	2×10^5	5.9	111	20		
			5.0	2×10^5	6.7	28	30		
			0.2	100	7.8	91	27		
			0.5	100	7.5	45	30		
809	Rheyhalon Insulation	AEG-Kabel	0.0	-	14.4	294	25	19	
			0.2	2×10^5	9.6	148	25		5.3
			0.5	2×10^5	12.1	124	25		
			1.0	2×10^5	10.4	79	25		
			5.0	2×10^5	8.6	20	33		
			0.2	100	12.9	202	25		5.7
			0.5	100	12.4	162	26		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
818	154	Roque	0.0	-	6.7	155	17	33	
	Insulation		0.5	2×10^5	6.4	103	17		6.0
			1.0	2×10^5	6.9	78	18		
			5.0	2×10^5	8.4	26	25		
			0.2	100	6.4	117	19		5.6
			0.5	100	6.8	73	22		
836	4-56680 04	Dätwyler	0.0	-	7.4	138	24	40	
	Insulation		0.5	3×10^5	7.0	89	24		6.0
			1.0	3×10^5	7.5	70	25		
			5.0	3×10^5	8.6	26	35		
884	154	Roque	0.0	-	6.4	126	17	-	
	Insulation		0.5	2×10^5	7.3	71	20		5.8
	of ACOL		1.0	2×10^5	7.4	52	21		
	cable		5.0	2×10^5	7.8	21	32		
925	3 GI 340	kabelmetal	0.0	-	7.5	483	21	22	
	Insulation	electro	0.2	2×10^5	7.4	351	22		5.8
			0.5	2×10^5	6.9	259	23		
			1.0	2×10^5	6.3	176	24		
			5.0	2×10^5	5.2	34	27		
			0.2	100	6.2	200	23		
			0.5	100	5.4	53	28		
926	DM 021	kabelmetal	0.0	-	10.3	588	18	22	
	Sheath	electro	0.2	2×10^5	10.5	468	18		5.8
			0.5	2×10^5	9.5	335	18		
			1.0	2×10^5	8.6	220	18		
			5.0	2×10^5	7.0	63	20		
			0.2	100	8.6	440	16		5.5
			0.5	100	6.6	194	20		
929	G 10	Fulgor Cavi	0.0	-	6.1	405	32	33	
	Insulation		0.2	3000	6.3	244	38		5.6
			0.5	3000	6.9	161	43		
			1.0	3000	8.9	42	48		
			0.2	100	5.3	265	32		5.4
			0.5	100	6.4	52	39		
952	G 5	Fulgor Cavi	0.0	-	9.7	110	34	47	
	Sheath of		0.2	2×10^5	11.1	77	38		5.9
	LEP cable		0.5	2×10^5	11.8	63	41		
			1.0	2×10^5	12.7	48	43		
			5.0	2×10^5	18.5	15	59		
			0.2	100	8.2	96	29		5.8
			0.5	100	8.1	56	33		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 409

MATERIAL : EPR
TYPE : LD 3792
SUPPLIER : Câbles de Lyon
REMARKS : Insulation

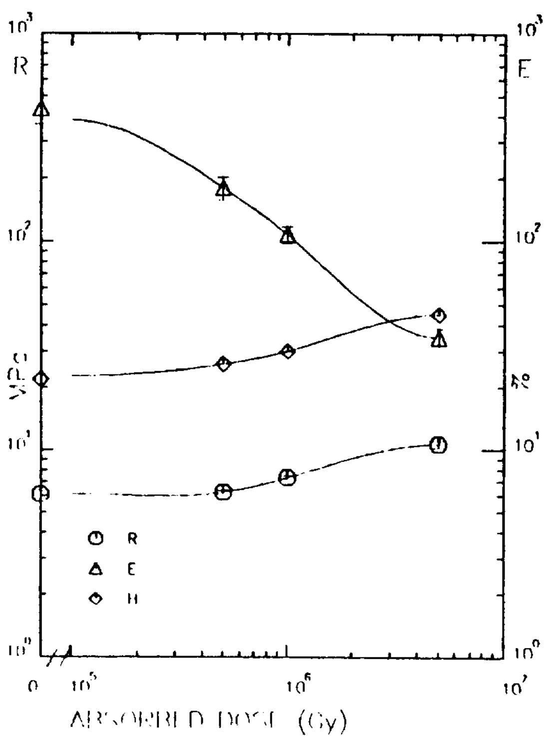
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	-	9.4 ± 1.0	255.0 ± 28.6	15.0 ± 0.0
0.500	1.7×10^5	7.1 ± 1.6	142.0 ± 17.2	14.0 ± 0.0
1.000	1.7×10^5	6.4 ± 1.3	121.0 ± 20.4	13.0 ± 0.0
5.000	1.7×10^5	4.2 ± 1.2	39.0 ± 5.5	14.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 411

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Insulation

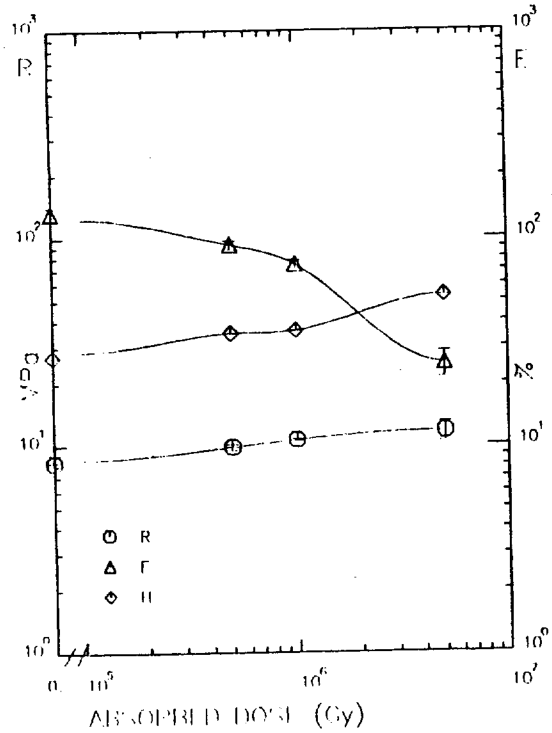
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.1 ± 0.3	432.8 ± 66.9	22.0 ± 0.0
0.500	2.5×10^5	6.2 ± 0.1	180.0 ± 22.6	26.0 ± 0.0
1.000	2.5×10^5	7.3 ± 0.2	108.0 ± 9.7	30.0 ± 0.0
5.000	2.5×10^5	10.7 ± 0.4	35.0 ± 3.5	45.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 412

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Sheath

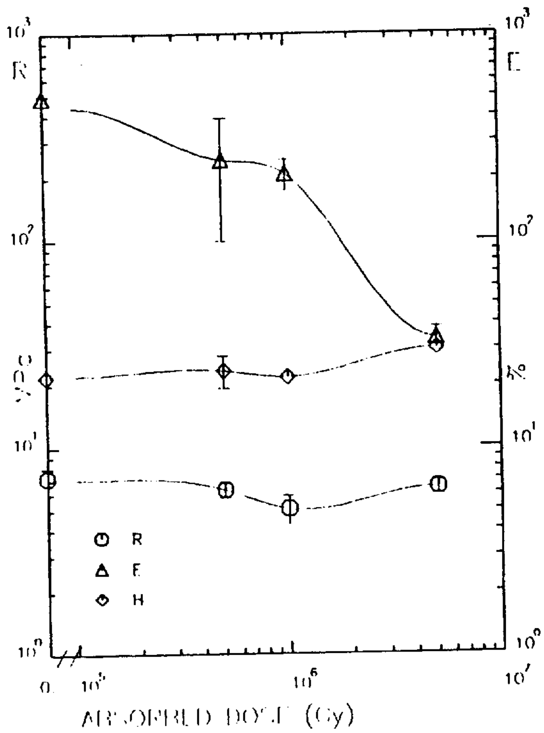
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.3 ± 0.1	132.0 ± 9.1	27.0 ± 0.0
0.500	2.5×10^5	9.8 ± 0.3	93.0 ± 4.5	35.0 ± 0.0
1.000	2.5×10^5	10.6 ± 0.1	75.0 ± 3.5	36.0 ± 0.0
5.000	2.5×10^5	11.7 ± 1.3	25.0 ± 3.5	53.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 433

MATERIAL : EPR
TYPE : 840 – Insulation
SUPPLIER : SILEC
REMARKS : (P)

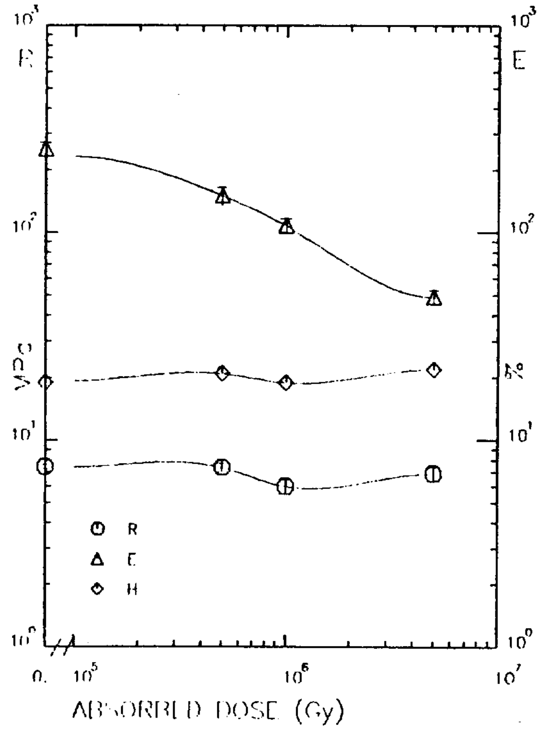
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.2 ± 0.8	489.6 ± 16.2	22.0 ± 0.0
0.500	1.7×10^5	6.3 ± 0.5	246.0 ±146.3	23.6 ± 4.3
1.000	1.7×10^5	5.1 ± 0.8	211.2 ± 35.3	22.0 ± 0.0
5.000	1.7×10^5	6.4 ± 0.5	33.6 ± 4.6	30.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 21.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 442

MATERIAL : EPR
TYPE : Sheath 772
SUPPLIER : Cablexport / CEAT
REMARKS : SPS cables (P)

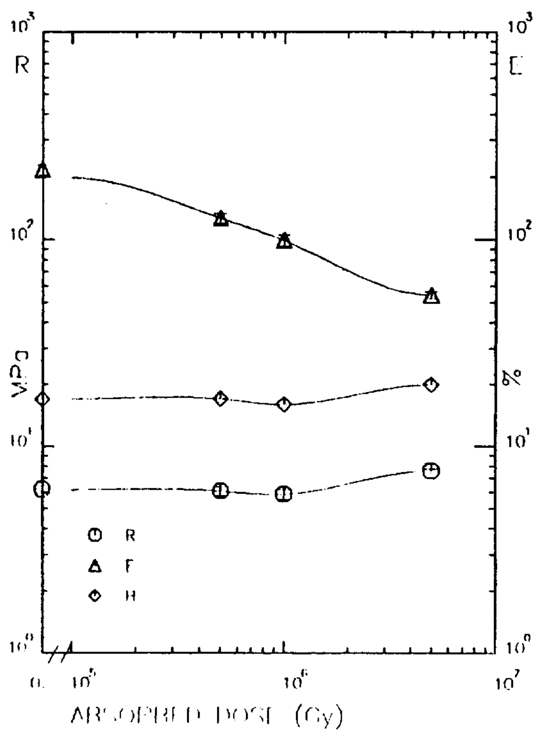
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.5 ± 0.2	252.8 ± 20.1	19.0 ± 0.0
0.500	1.7×10^5	7.4 ± 0.3	150.4 ± 15.4	21.0 ± 0.0
1.000	1.7×10^5	6.0 ± 0.5	108.0 ± 9.4	19.0 ± 0.0
5.000	1.7×10^5	6.9 ± 0.5	49.0 ± 3.8	22.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 443

MATERIAL : EPR
TYPE : Insulation 773
SUPPLIER : Cablexport / CEAT
REMARKS : SPS cables (P)

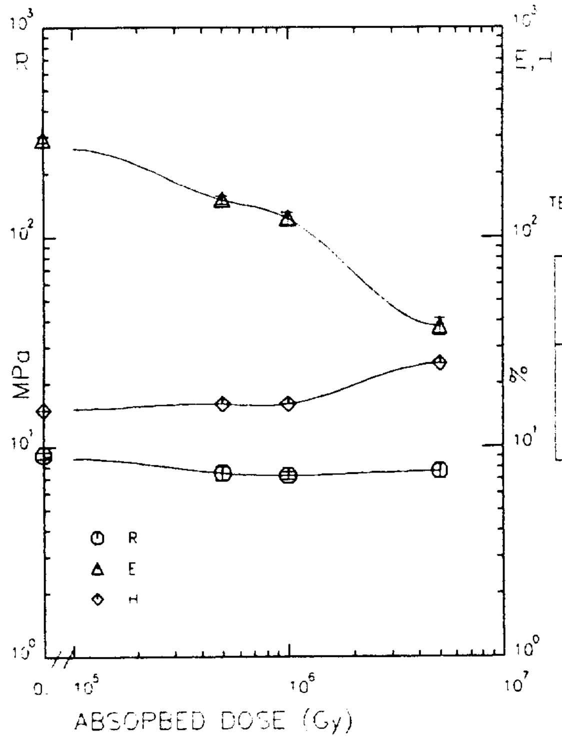
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.2 ± 0.3	216.8 ± 12.1	17.0 ± 0.0
0.500	1.7×10^5	6.1 ± 0.3	126.4 ± 6.7	17.0 ± 0.0
1.000	1.7×10^5	5.9 ± 0.3	99.2 ± 5.9	16.0 ± 0.0
5.000	1.7×10^5	7.6 ± 0.2	54.4 ± 2.2	20.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. 464

MATERIAL : EPR
TYPE : NI 909
SUPPLIER : Cableries de COSSONAY
REMARKS : Insulation (P)

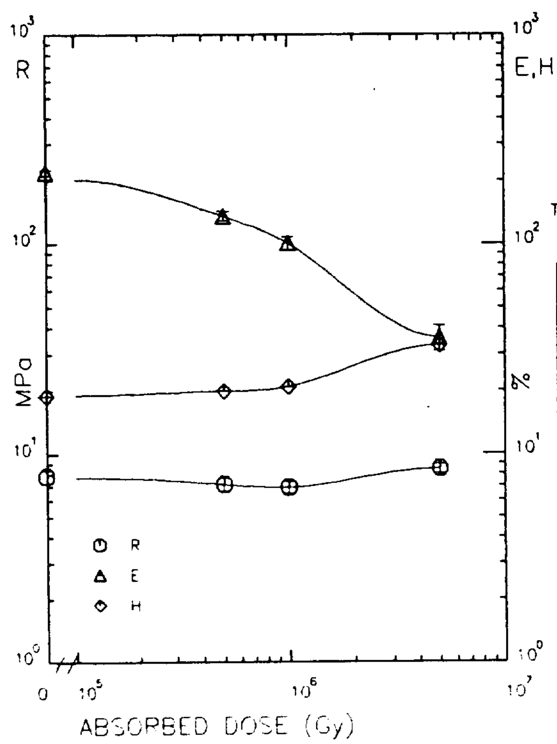
TEST RESULTS

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.2 ± 0.3	292.8 ± 10.0	15.0 ± 0.0
0.500	1.7×10^5	7.5 ± 0.6	150.4 ± 7.3	16.0 ± 0.0
1.000	1.7×10^5	7.3 ± 0.3	123.2 ± 8.7	16.0 ± 0.0
5.000	1.7×10^5	7.7 ± 0.6	37.6 ± 3.6	25.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 465

MATERIAL : EPR
TYPE : NI 913
SUPPLIER . Cableries de COSSONAY
REMARKS : Sheath (P)

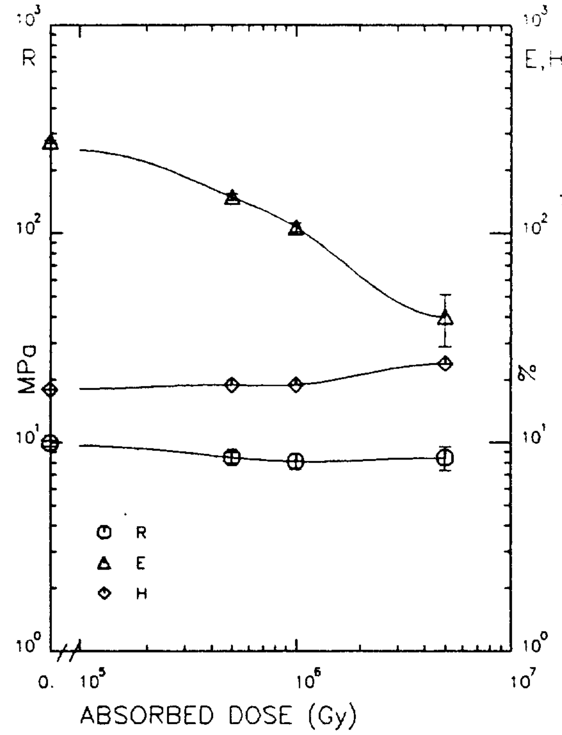
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.9 ± 0.6	220.0 ± 7.5	19.0 ± 0.0
0.500	1.7×10^5	7.2 ± 0.5	136.0 ± 6.9	20.0 ± 0.0
1.000	1.7×10^5	6.9 ± 0.5	100.8 ± 7.7	21.0 ± 0.0
5.000	1.7×10^5	8.5 ± 0.4	36.0 ± 4.9	33.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS .
OXYGEN INDEX(ISO 4589) : 42.0 %
CORROSIVITY (DIN 57472) PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. 466

MATERIAL : EPR
TYPE : NI 1058
SUPPLIER : Cableries de COSSONAY
REMARKS : Sheath (P)

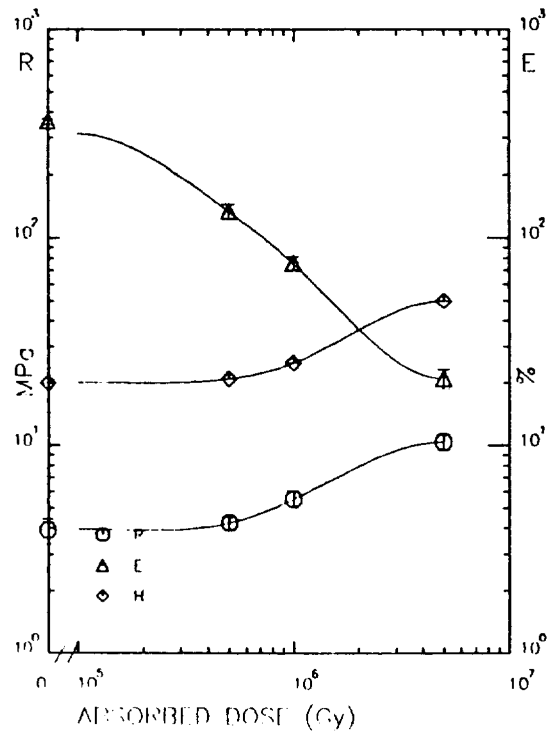
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness Shore D H (Degree)
		Strength R (MPa)	Elongation E (%)	
0.000	–	10.0 ± 0.3	275.2 ± 5.2	18.0 ± 0.0
0.500	1.7×10^5	8.5 ± 0.5	149.6 ± 5.4	19.0 ± 0.0
1.000	1.7×10^5	8.1 ± 0.7	107.2 ± 5.2	19.0 ± 0.0
5.000	1.7×10^5	8.5 ± 1.1	40.0 ± 11.3	24.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 468

MATERIAL : EPR
TYPE : Insulation
SUPPLIER : Cablexport / Pirelli
REMARKS : ISR LV DC magnet cables (P)

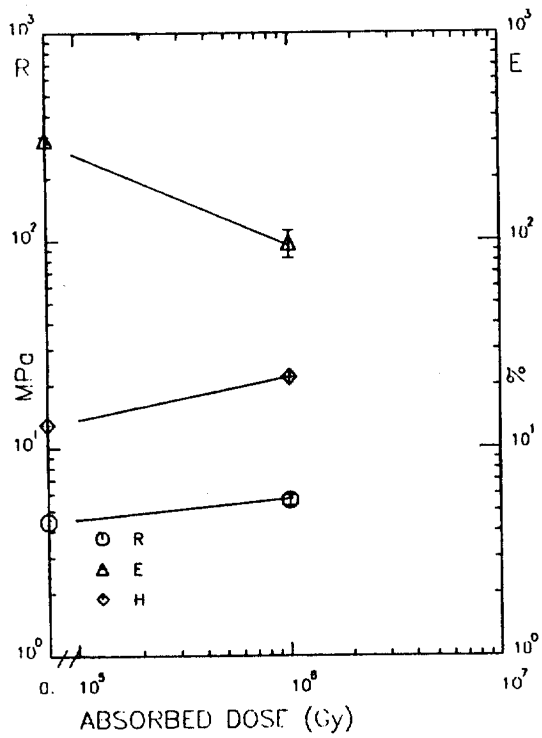
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness Shore D H (Degree)
		Strength R (MPa)	Elongation E (%)	
0.000	–	3.9 ± 0.5	360.0 ± 10.6	20.0 ± 0.0
0.500	1.7×10^5	4.2 ± 0.3	134.0 ± 10.8	21.0 ± 0.0
1.000	1.7×10^5	5.5 ± 0.5	76.0 ± 5.5	25.0 ± 0.0
5.000	1.7×10^5	10.4 ± 0.9	21.0 ± 2.2	50.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 474

MATERIAL : EPR
TYPE : Insulation 4
SUPPLIER : GORSE
REMARKS : used as SPS power cables

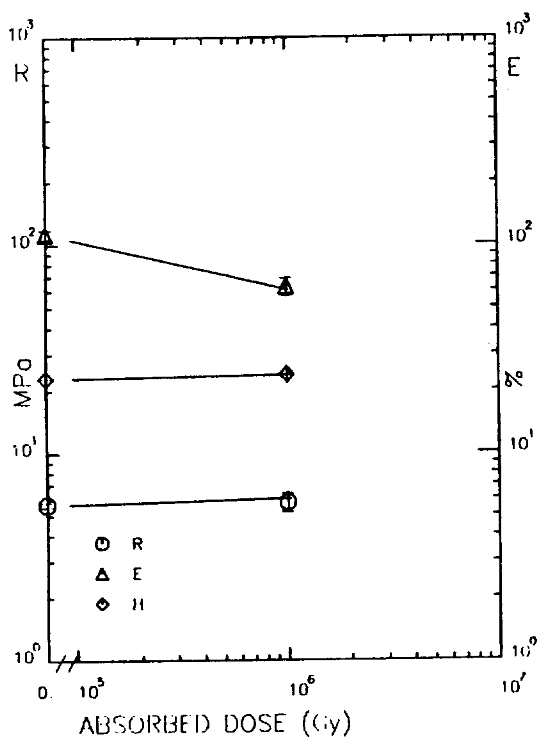
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.4 ± 0.1	308.0 ± 11.7	13.0 ± 0.0
1.000	1.7×10^5	5.6 ± 0.3	97.6 ± 14.9	22.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 475

MATERIAL : EPR
TYPE : Sheath 501
SUPPLIER : GORSE
REMARKS : used as SPS power cables

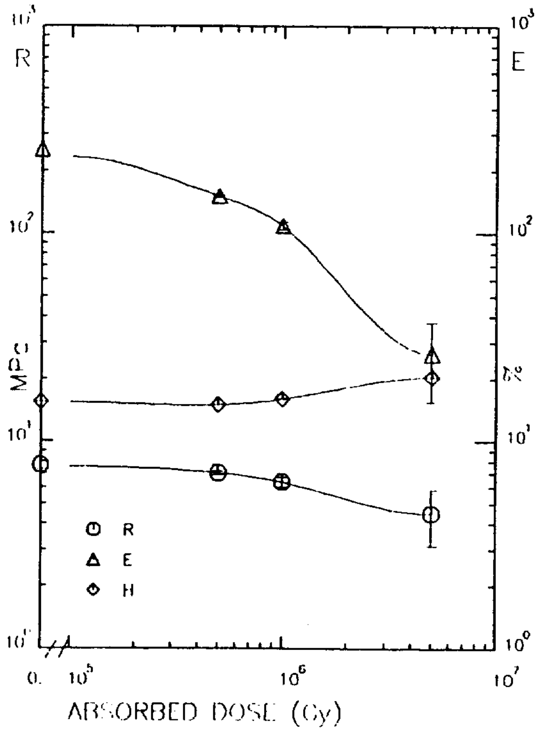
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.7 ± 0.2	112.8 ± 5.9	23.0 ± 0.0
1.000	1.7×10^5	5.8 ± 0.6	63.2 ± 5.9	24.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 511

MATERIAL : EPR
TYPE : 1053
SUPPLIER : Pirelli
REMARKS : ISR cables 12/80

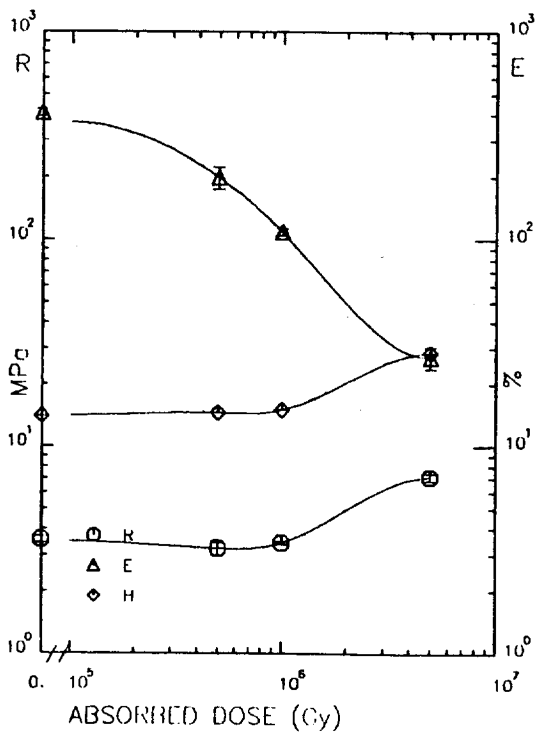
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	--	7.7 ± 0.3	253.3 ± 22.0	15.5 ± 0.0
0.500	1.7×10^5	7.0 ± 0.2	150.4 ± 2.2	15.0 ± 0.0
1.000	1.7×10^5	6.4 ± 0.4	108.4 ± 4.8	16.0 ± 0.0
5.000	1.7×10^5	4.5 ± 1.4	26.4 ± 10.9	20.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 20.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 555

MATERIAL : EPR
TYPE : G 5 Insulation
SUPPLIER : Fulgor Cavi
REMARKS : (P)

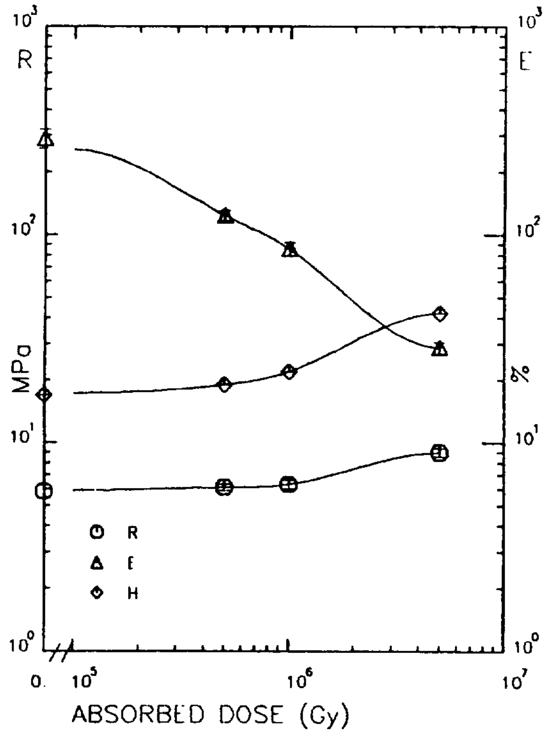
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	3.6 ± 0.1	407.2 ± 17.3	14.0 ± 0.0
0.500	2.0×10^5	3.2 ± 0.2	198.4 ± 24.3	14.5 ± 0.0
1.000	2.0×10^5	3.4 ± 0.1	108.8 ± 4.4	15.0 ± 0.0
5.000	2.0×10^5	7.1 ± 0.3	27.2 ± 3.3	28.5 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 556

MATERIAL : EPR
TYPE : G 5 Sheath
SUPPLIER : Fulgor Cavi
REMARKS : Used for SPS Al power cable

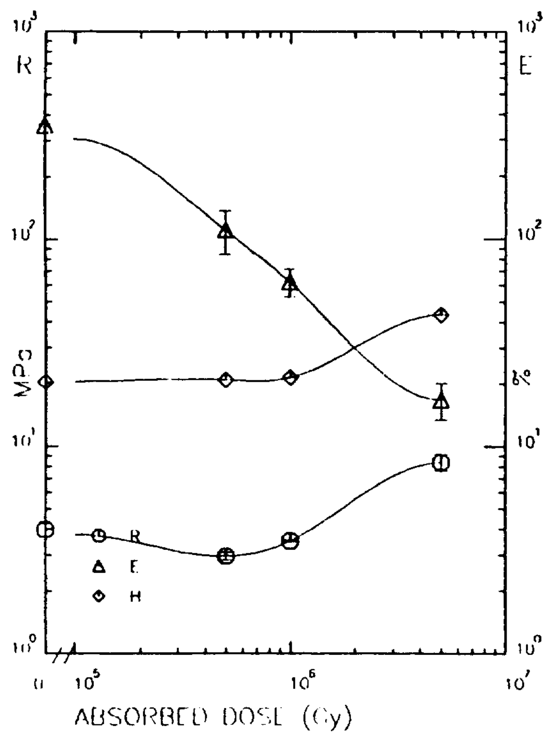
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.9 ± 0.4	290.4 ± 30.3	17.0 ± 0.0
0.500	2.0×10^5	6.1 ± 0.2	124.0 ± 6.9	19.0 ± 0.0
1.000	2.0×10^5	6.3 ± 0.3	85.6 ± 6.1	22.0 ± 0.0
5.000	2.0×10^5	9.0 ± 0.4	28.8 ± 1.8	42.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 559

MATERIAL : EPR
TYPE : ZID 33 OF/1
SUPPLIER : Pirelli
REMARKS : Sheath (P)

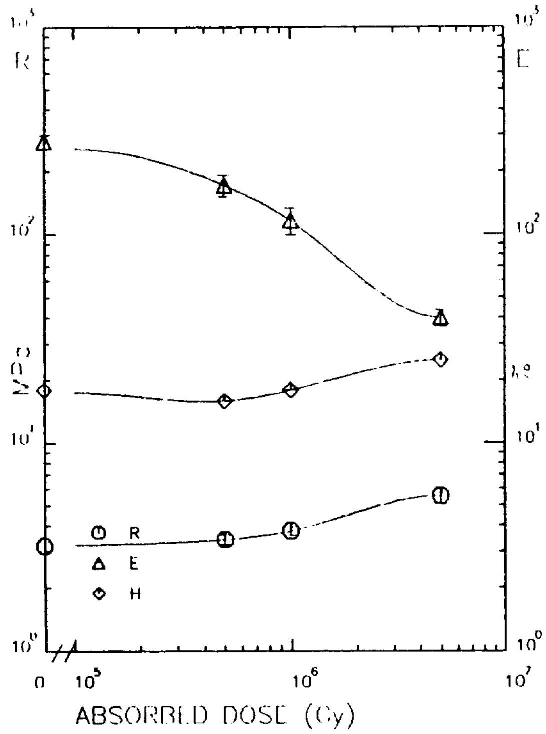
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.0 ± 0.3	357.0 ± 6.0	20.5 ± 0.0
0.500	2.0×10^5	3.0 ± 0.1	111.2 ± 26.6	21.0 ± 0.0
1.000	2.0×10^5	3.5 ± 0.0	62.4 ± 9.6	21.5 ± 0.0
5.000	2.0×10^5	8.4 ± 0.8	16.8 ± 3.3	43.5 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 561

MATERIAL : EPR
TYPE :
SUPPLIER : CEAT Cavi
REMARKS : from aluminium cable 150 mm2

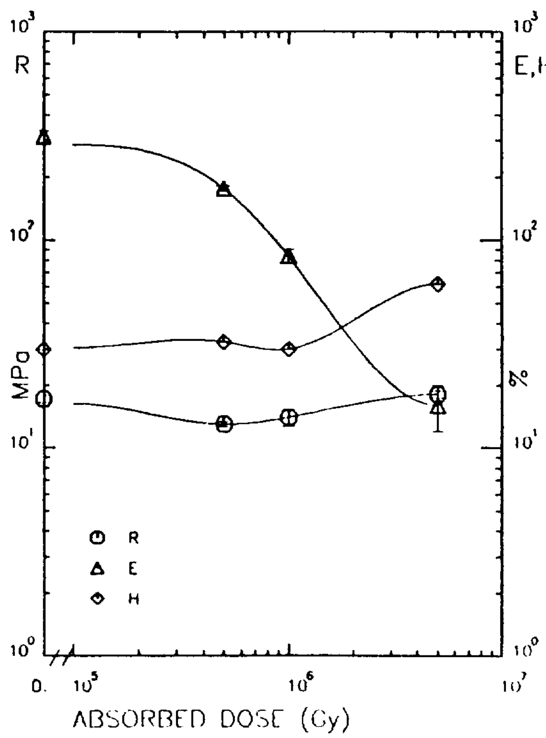
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	3.2 ± 0.2	280.0 ± 20.9	18.0 ± 0.0
0.500	2.0×10^5	3.4 ± 0.2	172.0 ± 20.2	16.0 ± 0.0
1.000	2.0×10^5	3.8 ± 0.2	117.0 ± 17.2	18.0 ± 0.0
5.000	2.0×10^5	5.5 ± 0.5	40.0 ± 3.5	25.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 565

MATERIAL : EPR
TYPE :
SUPPLIER : Gorse
REMARKS : from Cu cable 4x50 mm2

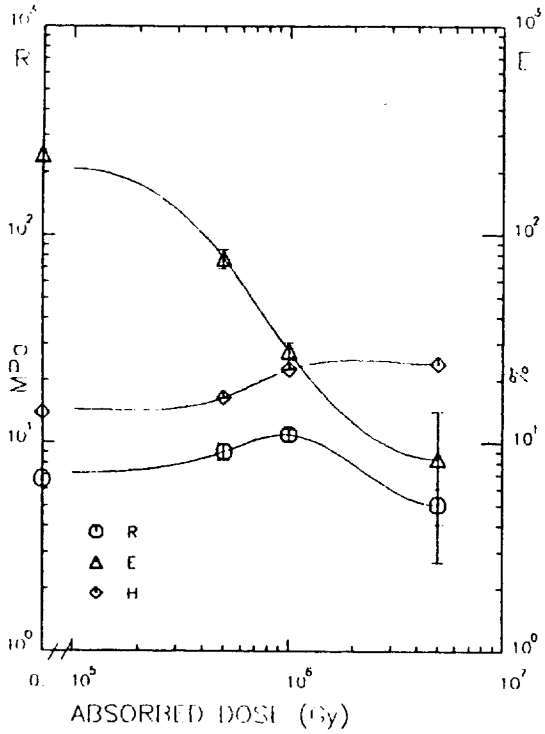
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	17.3 ± 0.7	315.2 ± 22.2	30.0 ± 0.0
0.500	2.0×10^5	13.0 ± 0.3	177.6 ± 4.6	32.5 ± 0.0
1.000	2.0×10^5	14.0 ± 1.3	84.0 ± 6.5	30.0 ± 0.0
5.000	2.0×10^5	18.2 ± 0.7	16.0 ± 4.0	62.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 624

MATERIAL : EPR perpolymer
TYPE : AT/2
SUPPLIER : Cablexport (CEAT Cavi)
REMARKS : for high- and mid-voltage cables

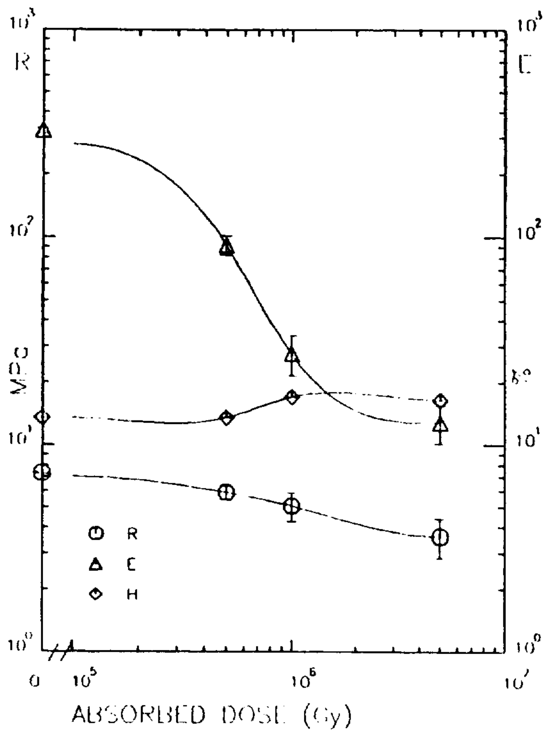
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.7 ± 0.1	242.0 ± 15.7	14.0 ± 0.0
0.500	1.4×10^5	9.0 ± 0.8	76.8 ± 8.1	16.5 ± 0.0
1.000	1.4×10^5	10.9 ± 0.7	27.6 ± 2.6	22.5 ± 0.0
5.000	1.4×10^5	5.0 ± 1.0	8.4 ± 5.7	24.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 625

MATERIAL : EPR copolymer
TYPE : AT/3
SUPPLIER : Cablexport (CEAT Cavi)
REMARKS : (P)

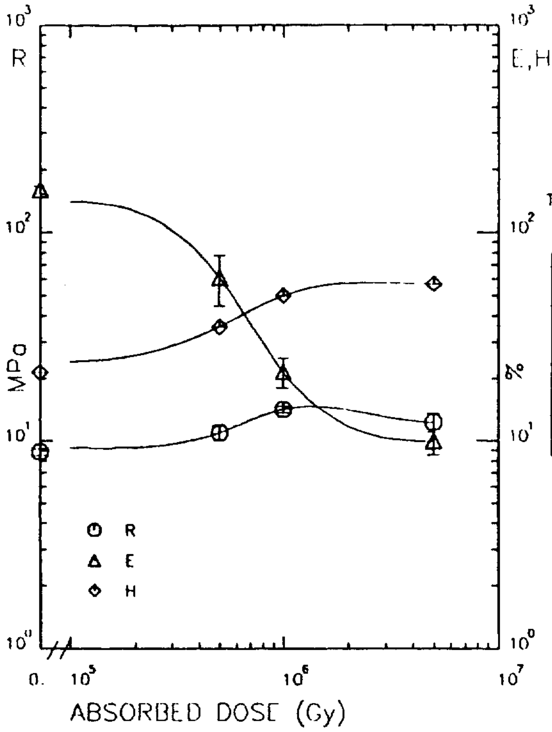
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.3 ± 0.1	325.0 ± 9.9	13.5 ± 0.0
0.500	1.4×10^5	5.9 ± 0.4	91.6 ± 9.5	13.5 ± 0.0
1.000	1.4×10^5	5.0 ± 0.8	27.6 ± 6.1	17.0 ± 0.0
5.000	1.4×10^5	3.6 ± 0.8	12.8 ± 2.7	16.5 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 626

MATERIAL : EPR
TYPE : 4/957 Sheath
SUPPLIER : Cablexport (CEAT Cavi)
REMARKS : (P)

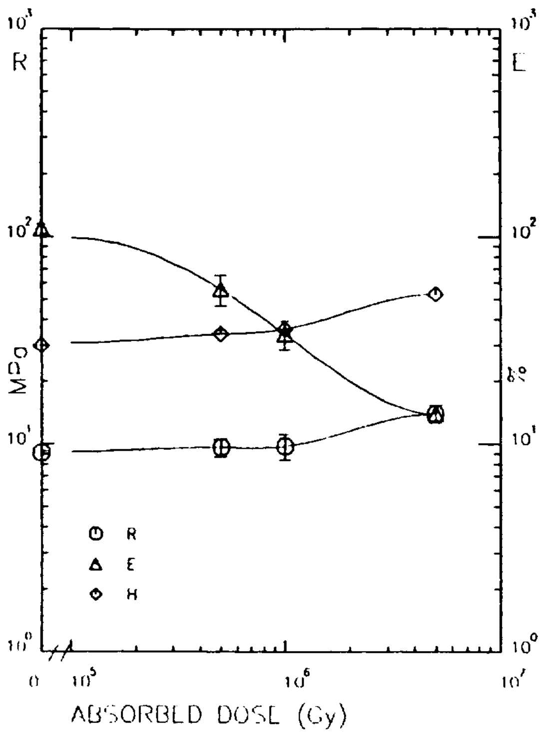
TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness Shore D
		Strength R (MPa)	Elongation E (%)	
(MGy)	(Gy/H)			H (Degree)
0.000	–	8.9 ± 0.3	160.4 ± 7.1	21.5 ± 0.0
0.500	1.4×10^5	11.0 ± 0.9	61.2 ± 16.6	35.5 ± 0.0
1.000	1.4×10^5	14.2 ± 0.5	21.6 ± 3.6	50.0 ± 0.0
5.000	1.4×10^5	12.3 ± 1.3	10.0 ± 1.4	57.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 682

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG–Kabel
REMARKS : Power cable insulation (P)

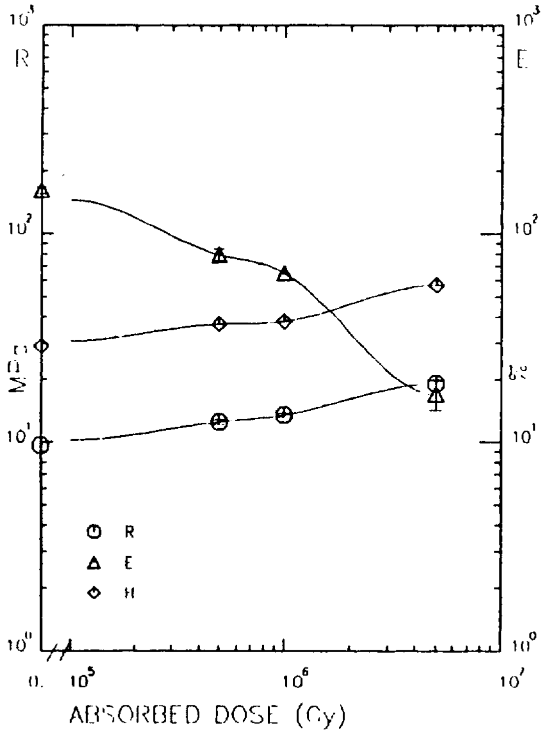
TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness Shore D
		Strength R (MPa)	Elongation E (%)	
(MGy)	(Gy/H)			H (Degree)
0.000	–	9.1 ± 0.2	110.0 ± 6.1	30.0 ± 0.0
0.500	1.9×10^5	9.7 ± 1.0	56.0 ± 9.5	34.0 ± 0.0
1.000	1.9×10^5	9.8 ± 1.4	34.0 ± 5.5	36.0 ± 0.0
5.000	1.9×10^5	14.0 ± 1.3	14.0 ± 1.4	53.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 683

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Power cable sheath (P)

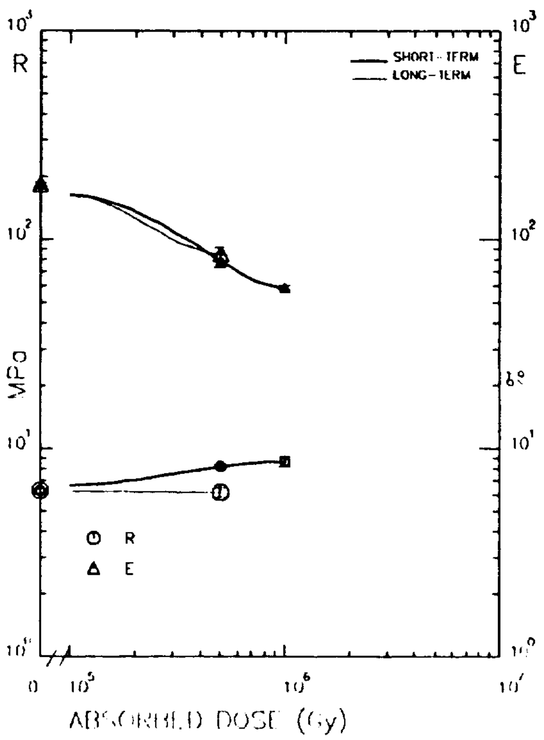
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.7 ± 0.1	162.0 ± 5.7	29.0 ± 0.0
0.500	1.9×10^5	12.5 ± 0.4	79.5 ± 5.1	37.0 ± 0.0
1.000	1.9×10^5	13.5 ± 0.3	65.0 ± 0.0	38.0 ± 0.0
5.000	1.9×10^5	19.2 ± 0.9	17.0 ± 2.7	57.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 35.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 730

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Power cable sheath (C)

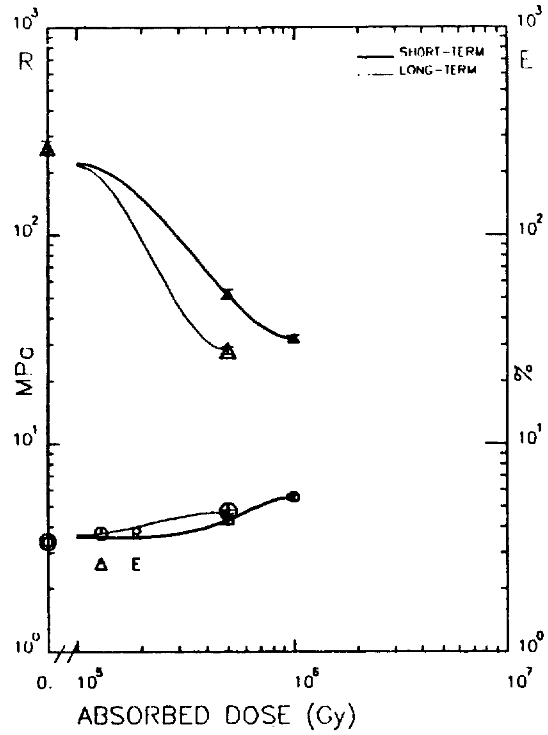
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.3 ± 0.2	184.0 ± 3.8	25.0 ± 0.0
0.500	1.8×10^5	8.2 ± 0.2	79.0 ± 5.8	36.0 ± 0.0
1.000	1.8×10^5	8.7 ± 0.5	59.0 ± 1.4	40.0 ± 0.0
0.000	–	6.3 ± 0.2	184.0 ± 3.8	25.0 ± 0.0
0.500	100.0	6.1 ± 0.3	85.5 ± 6.2	40.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 736

MATERIAL : EPR
TYPE : sheath of power cable
SUPPLIER : Pirelli
REMARKS : CERN store (C)

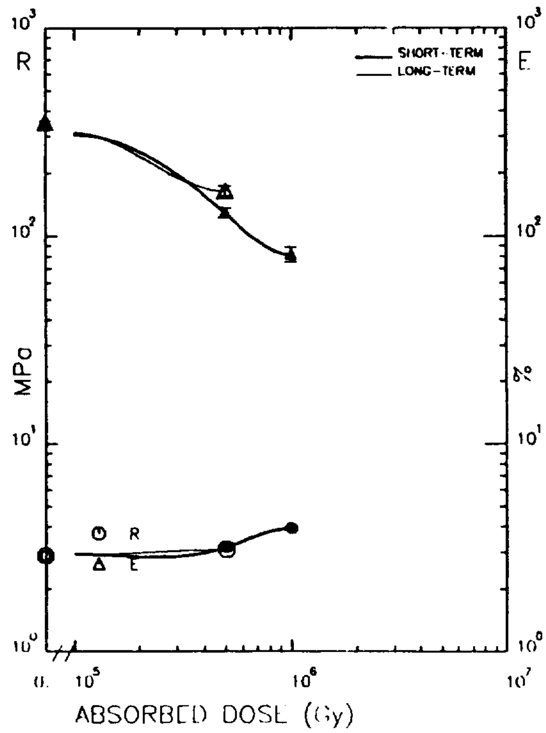
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	3.4 ± 0.2	265.0 ± 20.9	31.0 ± 0.0
0.500	1.8×10^5	4.3 ± 0.2	52.0 ± 2.7	49.0 ± 0.0
1.000	1.8×10^5	5.5 ± 0.2	32.0 ± 1.1	55.0 ± 0.0
0.000	–	3.4 ± 0.2	265.0 ± 20.9	31.0 ± 0.0
0.500	100.0	4.7 ± 0.1	28.0 ± 1.1	50.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 737

MATERIAL : EPR
TYPE : inner sheath for power cable
SUPPLIER : Pirelli
REMARKS : CERN store (C)

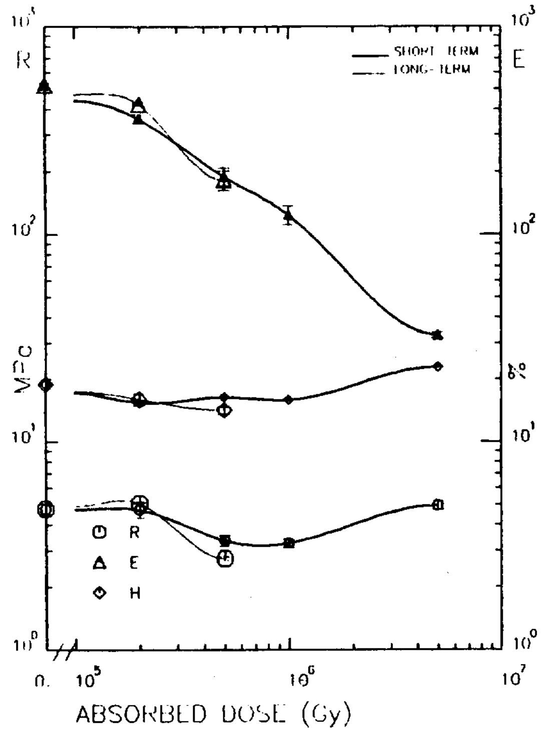
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	2.9 ± 0.1	352.0 ± 6.7	23.0 ± 0.0
0.500	1.8×10^5	3.2 ± 0.0	130.0 ± 7.1	39.0 ± 0.0
1.000	1.8×10^5	3.9 ± 0.1	82.0 ± 6.7	42.0 ± 0.0
0.000	–	2.9 ± 0.1	352.0 ± 6.7	23.0 ± 0.0
0.500	100.0	3.1 ± 0.1	165.0 ± 9.4	38.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 760

MATERIAL : EPR
TYPE :
SUPPLIER : Nuova Fulgor Cavi
REMARKS : Insulation for 20 kV cable (LFP) (P)

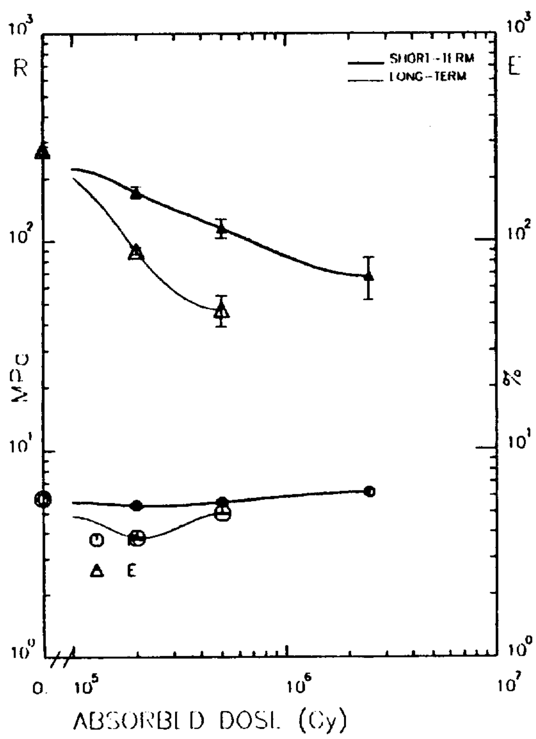
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.8 ± 0.3	520.0 ± 16.2	19.0 ± 0.0
0.200	1.7×10^5	4.7 ± 0.4	360.0 ± 17.7	15.5 ± 0.5
0.500	1.7×10^5	3.4 ± 0.2	190.8 ± 18.5	16.5 ± 0.0
1.000	1.7×10^5	3.3 ± 0.1	124.8 ± 13.1	16.0 ± 0.0
5.000	1.7×10^5	5.0 ± 0.2	32.8 ± 1.1	23.0 ± 0.0
0.000	–	4.8 ± 0.3	520.0 ± 16.2	19.0 ± 0.0
0.200	100.0	5.1 ± 0.1	422.8 ± 6.4	16.1 ± 1.0
0.500	100.0	2.7 ± 0.0	183.2 ± 19.5	14.3 ± 0.6

RADIATION INDEX (1.7×10^5 Gy/h) : 5.5
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 19.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 767

MATERIAL : EPR
TYPE : 3 G
SUPPLIER : Lynenwerk
REMARKS : Insulation for 1–3 kV cable LFP (P)

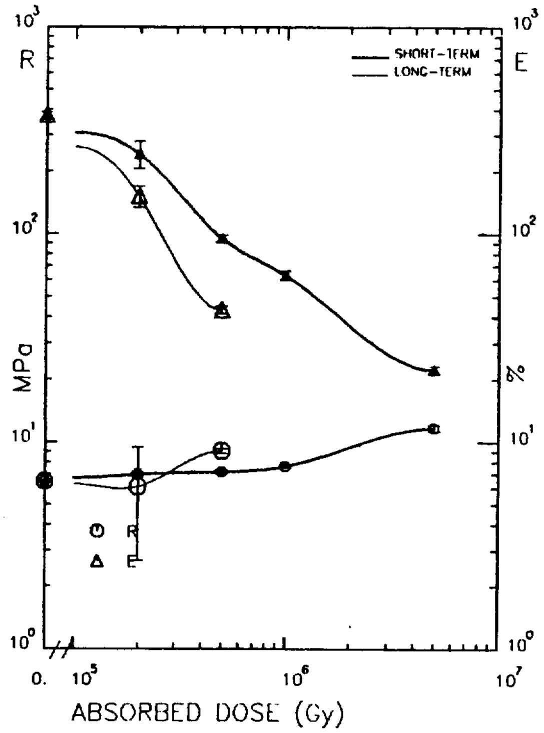
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.9 ± 0.4	276.0 ± 11.7	24.0 ± 0.0
0.200	1.9×10^5	5.4 ± 0.1	172.5 ± 11.5	26.4 ± 0.5
0.500	1.9×10^5	5.6 ± 0.1	115.2 ± 12.1	27.0 ± 0.0
2.500	1.9×10^5	6.2 ± 0.2	67.6 ± 15.5	30.0 ± 0.0
0.000	–	5.9 ± 0.4	276.0 ± 11.7	24.0 ± 0.0
0.200	100.0	3.8 ± 0.1	90.0 ± 3.7	32.1 ± 0.7
0.500	100.0	4.9 ± 0.0	46.8 ± 7.8	36.5 ± 0.5

RADIATION INDEX (1.9×10^5 Gy/h) : 5.5
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.9 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 806

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Insulation (P)

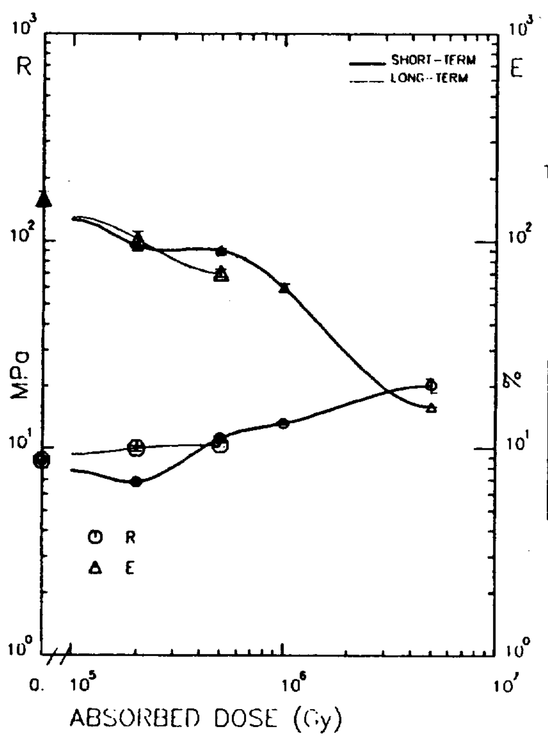
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.5 ± 0.1	375.0 ± 13.6	21.0 ± 0.0
0.200	1.7×10^5	7.0 ± 0.1	244.0 ± 37.4	23.2 ± 0.6
0.500	1.7×10^5	7.2 ± 0.1	95.0 ± 3.8	24.0 ± 0.0
1.000	1.7×10^5	7.6 ± 0.1	63.2 ± 3.3	26.0 ± 0.0
5.000	1.7×10^5	11.7 ± 0.4	22.4 ± 0.9	42.0 ± 0.0
0.000	–	6.5 ± 0.1	375.0 ± 13.6	21.0 ± 0.0
0.200	100.0	6.1 ± 3.4	152.0 ± 17.7	25.5 ± 0.6
0.500	100.0	9.1 ± 0.2	43.2 ± 1.8	29.3 ± 0.8

RADIATION INDEX (1.7×10^5 Gy/h) : 5.4
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 807

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Power cable sheath (P)

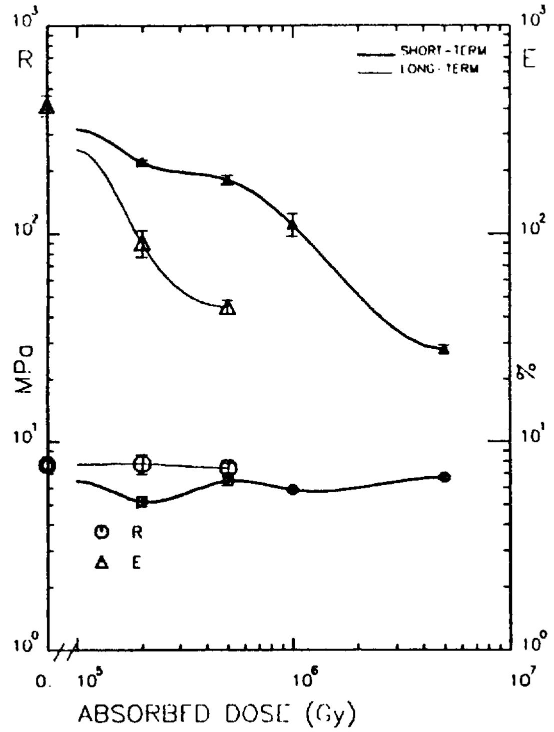
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.7 ± 0.1	160.0 ± 13.6	29.0 ± 0.0
0.200	1.7×10^5	6.9 ± 0.1	94.8 ± 4.4	33.5 ± 0.5
0.500	1.7×10^5	11.2 ± 0.2	90.4 ± 2.2	37.0 ± 0.0
1.000	1.7×10^5	13.2 ± 0.2	60.0 ± 2.8	41.0 ± 0.0
5.000	1.7×10^5	20.3 ± 1.6	16.0 ± 0.0	60.0 ± 0.0
0.000	–	8.7 ± 0.1	160.0 ± 13.6	29.0 ± 0.0
0.200	100.0	10.0 ± 0.3	102.4 ± 9.6	36.0 ± 0.6
0.500	100.0	10.4 ± 0.2	70.4 ± 3.0	39.5 ± 0.6

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 43.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 808

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Insulation (P)

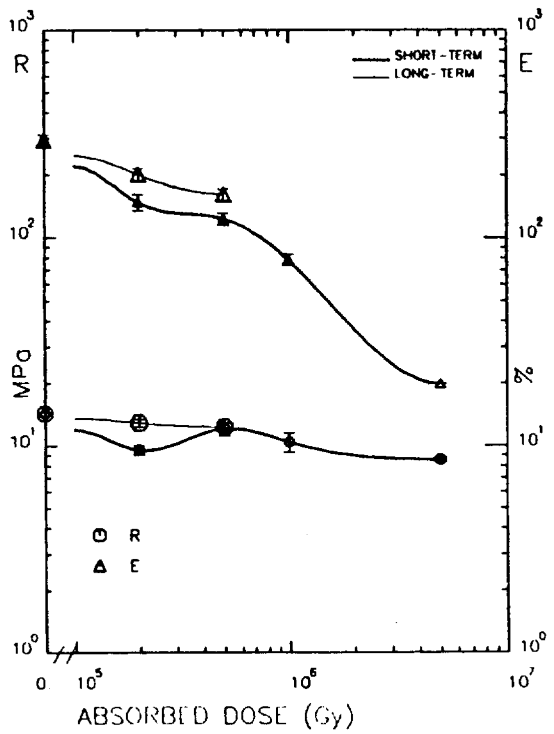
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.7 ± 0.4	416.0 ± 46.3	15.0 ± 0.0
0.200	1.7×10^5	5.2 ± 0.3	221.5 ± 3.4	17.5 ± 0.4
0.500	1.7×10^5	6.5 ± 0.3	181.6 ± 9.2	19.0 ± 0.0
1.000	1.7×10^5	5.9 ± 0.1	111.2 ± 13.7	20.0 ± 0.0
5.000	1.7×10^5	6.7 ± 0.1	28.0 ± 1.4	30.0 ± 0.0
0.000	–	7.7 ± 0.4	416.0 ± 46.3	15.0 ± 0.0
0.200	100.0	7.8 ± 0.8	90.8 ± 13.2	26.6 ± 0.4
0.500	100.0	7.5 ± 0.4	44.8 ± 3.3	29.9 ± 0.7

RADIATION INDEX (1.7×10^5 Gy/h) : 5.3
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 809

MATERIAL : EPR
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Insulation (> 6kV) (P)

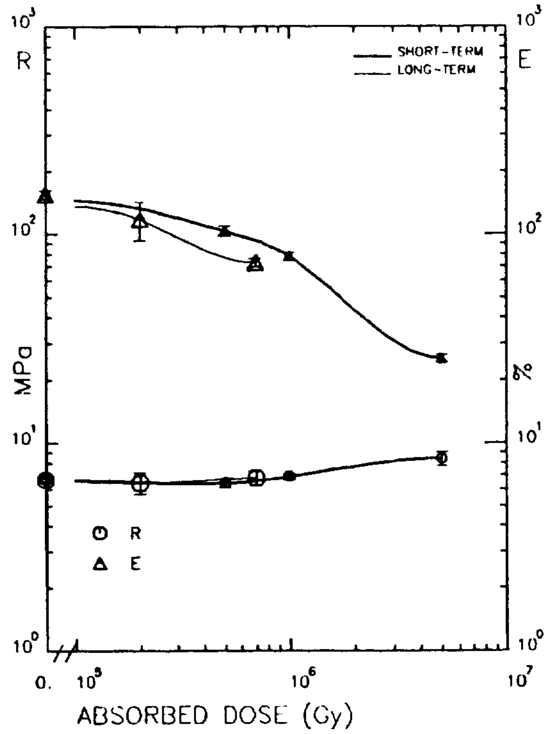
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.4 ± 0.3	293.6 ± 18.9	25.0 ± 0.0
0.200	1.7×10^5	9.6 ± 0.5	148.4 ± 13.2	25.0 ± 0.6
0.500	1.7×10^5	12.1 ± 0.9	123.6 ± 8.1	25.0 ± 0.0
1.000	1.7×10^5	10.4 ± 1.1	78.8 ± 4.8	25.0 ± 0.0
5.000	1.7×10^5	8.6 ± 0.2	20.0 ± 0.0	33.0 ± 0.0
0.000	–	14.4 ± 0.3	293.6 ± 18.9	25.0 ± 0.0
0.200	100.0	12.9 ± 0.5	202.4 ± 13.0	25.4 ± 0.4
0.500	100.0	12.4 ± 0.6	162.0 ± 9.8	26.3 ± 0.7

RADIATION INDEX (1.7×10^5 Gy/h) : 5.3
RADIATION INDEX (100.0 Gy/h) > 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 818

MATERIAL : EPR
TYPE : Insulation 154
SUPPLIER : Roque
REMARKS : (P)

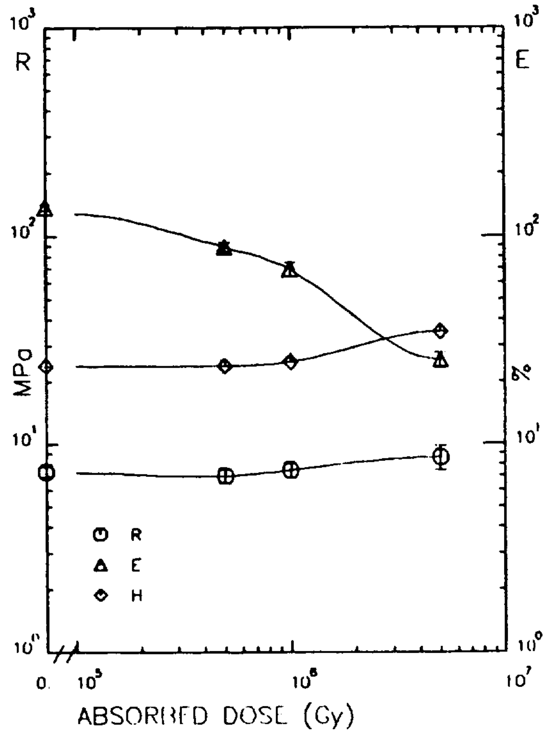
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.7 ± 0.1	155.2 ± 7.7	17.0 ± 0.0
0.500	1.7×10^5	6.4 ± 0.3	103.2 ± 5.9	17.0 ± 0.0
1.000	1.7×10^5	6.9 ± 0.2	78.4 ± 3.3	18.0 ± 0.0
5.000	1.7×10^5	8.4 ± 0.6	25.5 ± 1.0	25.0 ± 0.0
0.000	–	6.7 ± 0.1	155.2 ± 7.7	17.0 ± 0.0
0.200	100.0	6.4 ± 0.8	117.5 ± 24.7	19.0 ± 0.0
0.700	100.0	6.8 ± 0.5	72.9 ± 3.4	22.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.0
RADIATION INDEX (100.0 Gy/h) : 5.6

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.9 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 836

MATERIAL : EPR Copolymer
TYPE : 4-56680 04
SUPPLIER : Dätwyler
REMARKS : Insulation (P)

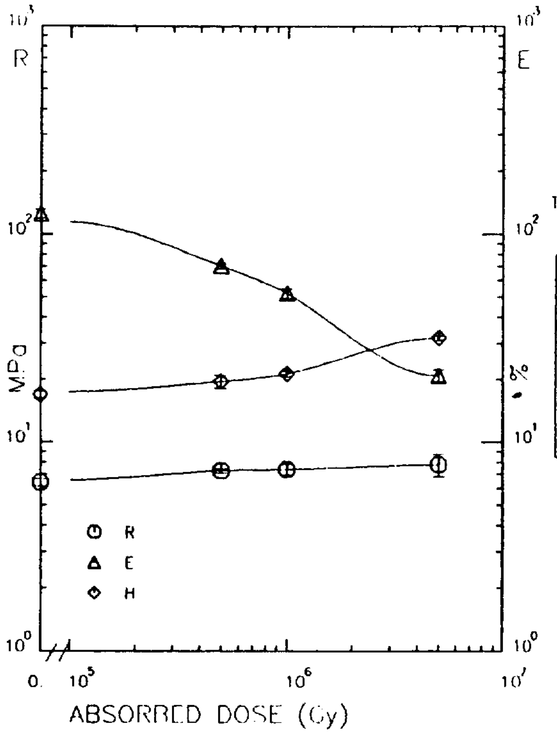
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.4 ± 0.4	138.0 ± 4.9	24.0 ± 0.0
0.500	2.7×10^5	7.0 ± 0.5	89.2 ± 4.4	24.0 ± 0.0
1.000	2.7×10^5	7.5 ± 0.6	69.6 ± 5.4	25.0 ± 0.0
5.000	2.7×10^5	8.6 ± 1.2	25.6 ± 2.2	35.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 40.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 884

MATERIAL : EPR
TYPE : Internal sheath 154
SUPPLIER : Roque
REMARKS : Taken from ACOI cable (C)

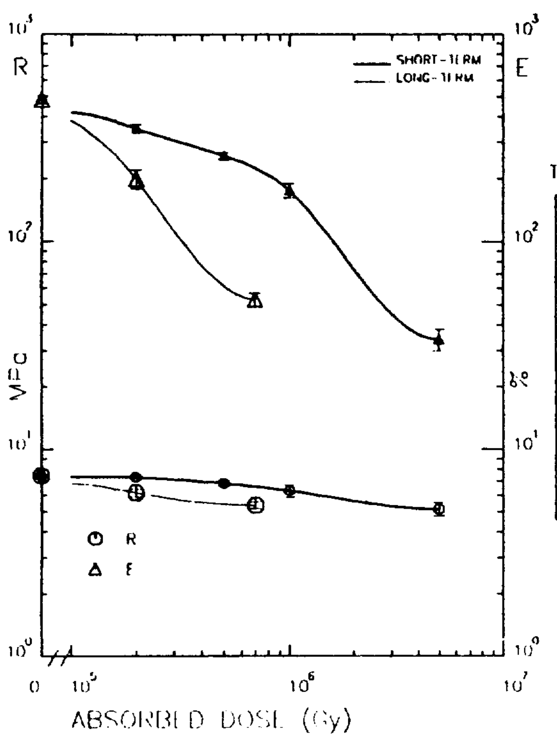
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 0.3	125.5 ± 6.2	17.0 ± 0.7
0.500	1.7×10^5	7.3 ± 0.1	70.5 ± 2.1	19.6 ± 1.4
1.000	1.7×10^5	7.4 ± 0.4	52.0 ± 2.7	21.4 ± 0.7
5.000	1.7×10^5	7.8 ± 1.0	21.0 ± 1.4	31.9 ± 0.7

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 925

MATERIAL : EPR
TYPE : 3 GI 340, crosslinked
SUPPLIER : kabelmetal electro
REMARKS : Insulation (S2)

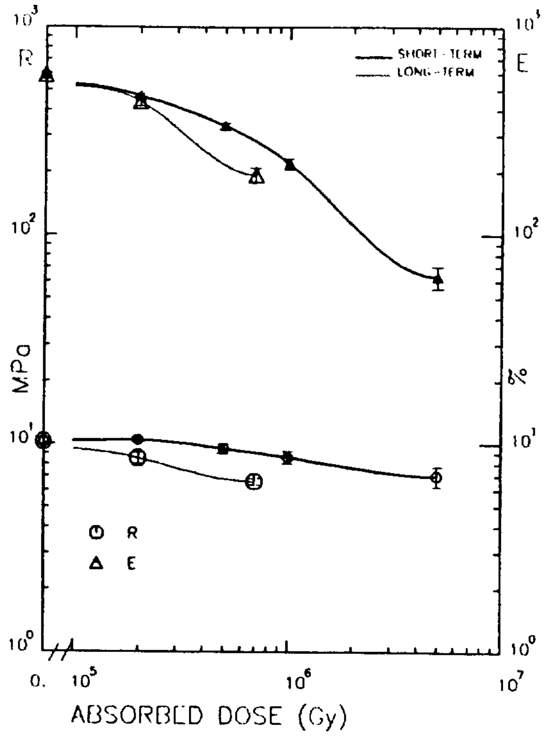
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.5 ± 0.1	483.0 ± 22.8	21.0 ± 0.0
0.200	2.5×10^5	7.4 ± 0.1	351.0 ± 15.6	22.0 ± 0.0
0.500	2.5×10^5	6.9 ± 0.2	259.0 ± 10.8	23.0 ± 0.0
1.000	2.5×10^5	6.3 ± 0.4	176.0 ± 13.9	24.0 ± 0.0
5.000	2.5×10^5	5.2 ± 0.4	34.0 ± 4.2	27.0 ± 0.0
0.000	–	7.5 ± 0.1	483.0 ± 22.8	21.0 ± 0.0
0.200	100.0	6.2 ± 0.3	200.0 ± 20.4	23.0 ± 0.0
0.700	100.0	5.4 ± 0.2	53.1 ± 3.8	28.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) 22.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 926

MATERIAL : EPR
TYPE : DM 021, crosslinked
SUPPLIER : kabelmetal electro
REMARKS : Sheath (S2)

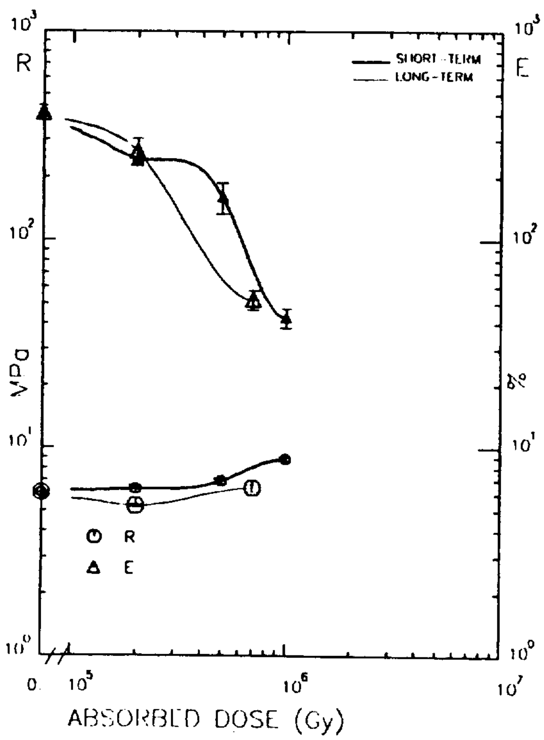
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.3 ± 0.3	588.0 ± 15.2	18.0 ± 0.0
0.200	2.5×10^{5}	10.5 ± 0.3	468.0 ± 10.4	18.0 ± 0.0
0.500	2.5×10^{5}	9.5 ± 0.5	335.0 ± 11.2	18.0 ± 0.0
1.000	2.5×10^{5}	8.6 ± 0.6	220.0 ± 13.7	18.0 ± 0.0
5.000	2.5×10^{5}	7.0 ± 0.8	63.0 ± 7.6	20.0 ± 0.0
0.000	–	10.3 ± 0.3	588.0 ± 15.2	18.0 ± 0.0
0.200	100.0	8.6 ± 0.6	440.0 ± 23.5	16.0 ± 0.0
0.700	100.0	6.6 ± 0.2	194.0 ± 15.6	20.0 ± 0.0

RADIATION INDEX (2.5×10^{5} Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 22.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 929

MATERIAL : EPR
TYPE : G 10
SUPPLIER : Nuova Fulgor Cavi
REMARKS : Insulation (P)

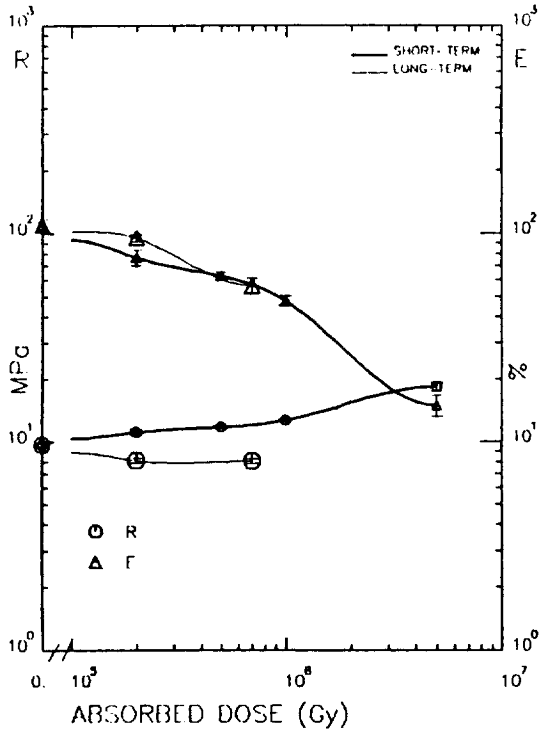
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.1 ± 0.1	404.8 ± 34.5	32.0 ± 0.0
0.200	3000.0	6.3 ± 0.3	244.0 ± 15.0	38.0 ± 0.0
0.500	3000.0	6.9 ± 0.2	160.8 ± 27.3	43.0 ± 0.0
1.000	3000.0	8.9 ± 0.2	42.4 ± 4.6	48.0 ± 0.0
0.000	–	6.1 ± 0.1	404.8 ± 34.5	32.0 ± 0.0
0.200	100.0	5.3 ± 0.1	265.0 ± 39.0	32.3 ± 1.4
0.700	100.0	6.4 ± 0.2	52.0 ± 5.7	39.0 ± 0.0

RADIATION INDEX (3000.0 Gy/h) : 5.6
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 33.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 952

MATERIAL : EPR
TYPE : Black G 5
SUPPLIER : Fulgor Cavi
REMARKS : Taken from sheath of 3.3 kV/LEP

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.7 ± 0.2	110.0 ± 7.6	34.0 ± 0.0
0.200	2.4×10^5	11.1 ± 0.4	77.1 ± 6.4	38.0 ± 0.0
0.500	2.4×10^5	11.8 ± 0.2	62.9 ± 2.7	41.0 ± 0.0
1.000	2.4×10^5	12.7 ± 0.2	47.9 ± 2.7	43.0 ± 0.0
5.000	2.2×10^5	18.5 ± 0.9	15.0 ± 1.8	59.0 ± 0.0
0.000	–	9.7 ± 0.2	110.0 ± 7.6	34.0 ± 0.0
0.200	100.0	8.2 ± 0.2	95.7 ± 3.7	29.0 ± 0.0
0.700	100.0	8.1 ± 0.2	56.4 ± 5.0	33.0 ± 0.0

RADIATION INDEX (2.4×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 47.5 %
CORROSIVITY (DIN 57472) : PASS

ETHYLENE VINYL ACETATE

Copolymer of ethylene ($CH_2=CH_2$) and vinyl acetate ($CH_3-COOCH=CH_2$)
For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

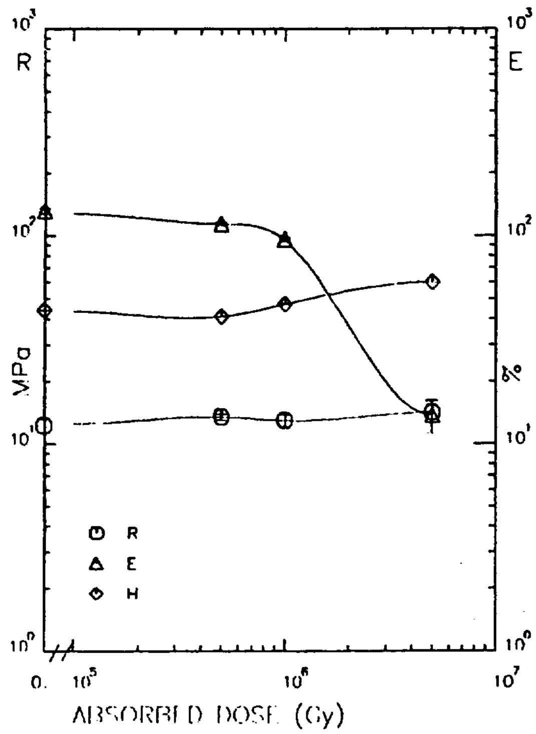
Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
473	Sioplas 17407	AEI via NKT	0.0	-	12.3	132	44	25	
			0.5	2×10^5	13.5	114	41		6.1
			1.0	2×10^5	13.0	96	47		
			5.0	2×10^5	14.2	14	60		
507	Silanpex	NKT	0.0	-	10.4	163	41	25	
			0.5	2×10^5	12.7	133	39		5.9
			1.0	2×10^5	13.5	64	46		
			5.0	2×10^5	10.0	11	55		
514	Lupolen V 3900 DX SA	BASF via A. Pasta (Pirelli)	0.0	-	8.3	432	48	25	
			0.7	2×10^5	12.7	87	53		
			1.0	2×10^5	13.3	38	56		
			5.0	2×10^5	13.9	10	65		
545	Sioplas 4/7 Sheath	STC Telecommun.	0.0	-	5.3	212	42	31	
			0.5	2×10^5	13.4	134	44		5.9
			1.0	2×10^5	14.5	102	45		
			5.0	2×10^5	14.9	18	53		
			0.2	100	9.2	140	43		>5.7
			0.5	100	9.7	143	43		
546	Sioplas 4/7L Sheath	STC Telecommun.	0.0	-	9.8	761	34	25	
			0.5	2×10^5	12.9	237	36		5.4
			1.0	2×10^5	12.3	130	36		
			5.0	2×10^5	7.1	18	30		
			0.2	100	9.1	507	36		5.4
			0.5	100	8.3	277	37		
575	Sheath 4 G (1982)	Lynenwerk	0.0	-	7.1	264	23	29	
			0.5	2×10^5	7.4	176	26		5.9
			1.0	2×10^5	7.5	110	28		
			5.0	2×10^5	10.8	21	49		
581	G.EVA 1 Sheath	Gorse	0.0	-	7.4	165	23	32	
			0.5	2×10^5	7.7	76	25		5.6
			1.0	2×10^5	8.2	51	33		
			5.0	2×10^5	10.5	13	46		
583	G.EVA 605 Sheath	Gorse	0.0	-	7.6	191	25	33	
			0.5	2×10^5	8.6	99	32		5.7
			1.0	2×10^5	9.2	78	35		
			5.0	2×10^5	10.6	23	50		
630	HFI/20/KX659 Sheath	BICC	0.0	-	8.5	716	41	27	
			0.5	2×10^5	11.1	418	43		5.8
			1.0	2×10^5	8.3	271	45		
			5.0	2×10^5	8.5	15	48		
652	D 2983 FR 1982 plates no longer in production	BP Chemicals	0.0	-	8.0	610	42	32	
			0.5	2×10^5	10.6	378	42		5.8
			1.0	2×10^5	8.2	160	43		
			5.0	2×10^5	10.3	19	47		
			0.2	100	6.6	527	41		5.4
			0.5	100	5.3	59	36		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
659	Sioplas 4/7 Thermoplast.	STC/STL	0.0	-	6.9	152	41	34	
			0.5	2×10^5	17.1	88	48		5.7
			1.0	2×10^5	12.8	21	48		
			5.0	2×10^5	16.8	12	52		
660	Sioplas 4/7 Radiation cross-linked	STC/STL	0.0	-	11.4	181	45	30	
			0.5	2×10^5	19.0	82	49		5.6
			1.0	2×10^5	11.1	23	48		
			5.0	2×10^5	18.8	15	57		
661	5/2 compound Radiation cross-linked	STC/STL	0.0	-	11.5	284	40	31	
			0.5	2×10^5	16.5	134	46		5.6
			1.0	2×10^5	15.0	43	45		
			5.0	2×10^5	12.7	15	48		
663	HFI/36 Sheath	BICC	0.0	-	8.5	720	34	24	
			0.5	2×10^5	12.3	440	41		5.9
			1.0	2×10^5	8.5	314	42		
			5.0	2×10^5	7.5	29	45		
664	HFI/38 Sheath	BICC	0.0	-	6.9	712	36	25	
			0.5	2×10^5	7.8	416	43		5.7
			1.0	2×10^5	6.0	157	43		
			5.0	2×10^5	6.9	20	48		
672	5/2 compound XL peroxide	STC/STL	0.0	-	6.4	682	36	26	
			0.5	2×10^5	14.2	167	46		
			1.0	2×10^5	15.7	103	47		
			5.0	2×10^5	14.7	13	49		
686	HFI/36 (2) Sheath	BICC	0.0	-	8.8	658	37	29	
			0.5	2×10^5	6.5	343	41		5.7
			1.0	2×10^5	5.4	137	39		
			5.0	2×10^5	9.3	24	47		
687	HFI/38 (2) Sheath	BICC	0.0	-	8.4	666	40	34	
			0.5	2×10^5	6.6	353	43		5.7
			1.0	2×10^5	5.9	57	41		
			5.0	2×10^5	10.2	19	51		
696	G.EVA 810 Sheath	Gorse	0.0	-	10.3	148	32	33	
			0.5	2×10^5	11.0	87	34		5.8
			1.0	2×10^5	12.3	59	37		
			5.0	2×10^5	16.1	19	58		
699	HFI/50/KX706 Sheath	Bical	0.0	-	10.5	748	38	24	
			0.5	2×10^5	13.9	140	44		
			1.0	2×10^5	15.7	84	45		
			5.0	2×10^5	7.9	9	53		
700	HFI/50/KX707 Sheath	Bical	0.0	-	9.3	696	40	28	
			0.5	2×10^5	14.0	154	46		
			1.0	2×10^5	16.1	96	48		
			5.0	2×10^5	10.8	10	55		
701	KX 712 Sheath	Bical	0.0	-	11.7	158	45	24	
			0.5	2×10^5	14.3	98	48		5.8
			1.0	2×10^5	14.2	72	47		
			5.0	2×10^5	14.7	18	55		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
752	3917 DQ 226	Cabeltel	0.0	–	11.0	516	43	33	
	Lupolen	(BASF)	0.5	2×10^5	11.2	410	43		6.1
	No longer in		1.0	2×10^5	9.4	325	42		
	production		5.0	2×10^5	9.1	27	47		
766	D 2983 FR	Norsk-Kabel	0.0	–	6.2	583	25	32	
	Taken from	EB	0.5	2×10^5	6.7	397	36		5.8
	prototype	(BP)	2.5	2×10^5	4.9	37	39		
	cable sheath								
			0.1	1000	7.1	526	28		
			0.2	100	4.1	60	29		5.0
			0.5	100	3.1	6	31		
812	Sheath 4 G	Lynenwerk	0.0	–	9.7	185	29	41	
	(1986)		0.5	2×10^5	10.7	96	34		5.7
			1.0	2×10^5	11.2	58	36		
			0.2	100	11.1	130	33		
819	159	Roque	0.0	–	10.3	255	25	37	
	Sheath		0.5	2×10^5	11.2	142	29		5.9
			1.0	2×10^5	11.6	111	30		
			5.0	2×10^5	13.5	36	38		
			0.2	100	11.2	140	29		5.4
			0.7	100	9.7	60	30		
841	X-2502 19	Dätwyler	0.0	–	13.1	218	46	34	
	Insulation		0.5	3×10^5	13.9	131	44		5.8
			1.0	3×10^5	14.1	82	50		
			5.0	3×10^5	9.8	8	56		
860	D 2983 FR	Norsk-Kabel	0.0	–	5.0	465	25	34	
	Taken from	EB	0.2	2×10^5	5.7	229	29		5.2
	LEP cable	(BP)	0.5	2×10^5	5.8	37	30		
			1.0	2×10^5	6.0	21	35		
			0.1	7000	4.2	287	25		5.1
			0.2	7000	4.5	62	27		
			0.5	7000	4.9	30	32		
			0.1	1000	4.9	99	25		
			0.2	100	5.2	35	27		
			0.5	100	4.3	6	31		
885	D 2983 FR	BP Chemicals	0.0	–	8.9	670	36	34	
	1987 plates		0.5	3×10^5	9.5	393	36		5.7
	no longer in		1.0	3×10^5	4.9	63	36		
	production		5.0	3×10^5	8.1	13	44		
			0.2	100	5.0	169	37		
			0.7	100	4.9	6	36		
912	D 2983 FR	Norsk-Kabel	0.0	–	6.4	614	28	–	
	Taken from	(BP)	0.5	2×10^5	7.2	316	29		5.7
	LEP control								
	cable		0.2	4000	7.1	490	36		5.4
			0.5	4000	6.2	57	34		
			1.0	4000	7.3	25	36		

Mat. No.	Type	Supplier	Dose	Dose rate	Tensile properties R	Tensile properties E	H	OI	RI
			(MGy)	(Gy/h)	(MPa)	(%)	(°D)	(%)	
928	M 2 Sheath	Fulgor Cavi	0.0	–	10.7	182	30	39	5.7
			0.2	3000	11.5	132	33		
			0.5	3000	11.7	91	36		
			1.0	3000	12.2	65	41		
			0.2	100	9.6	161	29		5.9
			0.7	100	8.8	96	32		
951	Sioplas 407/424 Sheath – LEP	Fulgor Cavi	0.0	–	10.0	118	41	–	5.8
			0.2	2×10^5	11.1	100	44		
			0.5	2×10^5	11.0	63	45		
			1.0	2×10^5	10.3	52	45		
			5.0	2×10^5	10.8	13	52		
			0.2	100	7.9	118	40		5.6
			0.7	100	6.0	32	43		
1000	E 4112 Sheath	Câbles de Lyon	0.0	–	10.7	139	44	42	5.7
			0.2	6000	11.0	118	45		
			0.5	6000	11.1	76	46		
			1.0	6000	10.1	32	48		
			5.0	2×10^5	14.8	15	54		
1001	E 4152 Sheath	Câbles de Lyon	0.0	–	5.9	267	18	39	5.8
			0.2	6000	6.7	198	26		
			0.5	6000	8.4	148	33		
			1.0	6000	9.0	105	38		
			5.0	2×10^5	13.7	17	53		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 473

MATERIAL : Silylated EVA
TYPE : Sioplas 17407
SUPPLIER : AEI via NKT
REMARKS : (P)

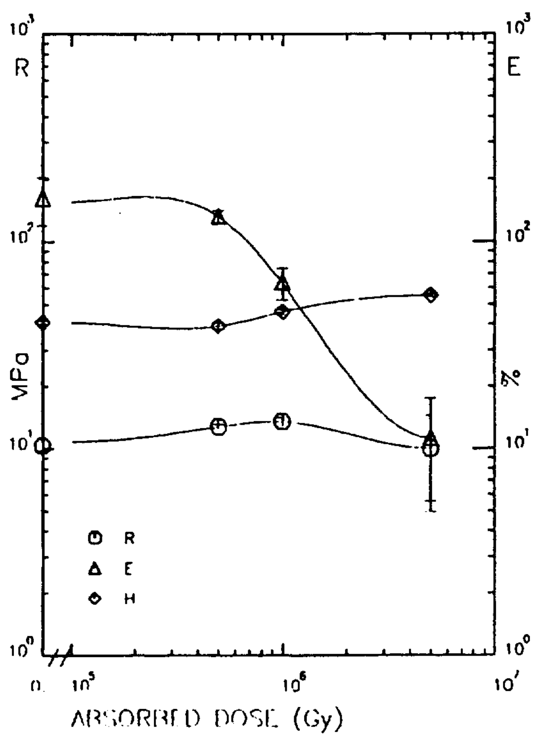
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.3 ± 1.0	132.0 ± 4.1	44.0 ± 0.0
0.500	1.7×10^5	13.5 ± 0.4	114.0 ± 2.2	41.0 ± 0.0
1.000	1.7×10^5	13.0 ± 0.9	96.0 ± 2.2	47.0 ± 0.0
5.000	1.7×10^5	14.2 ± 2.0	13.8 ± 2.5	60.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.1

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 507

MATERIAL : Silylated EVA
TYPE : Silanpex
SUPPLIER : NKT
REMARKS : Used for SPS multicore cables

TEST RESULTS :

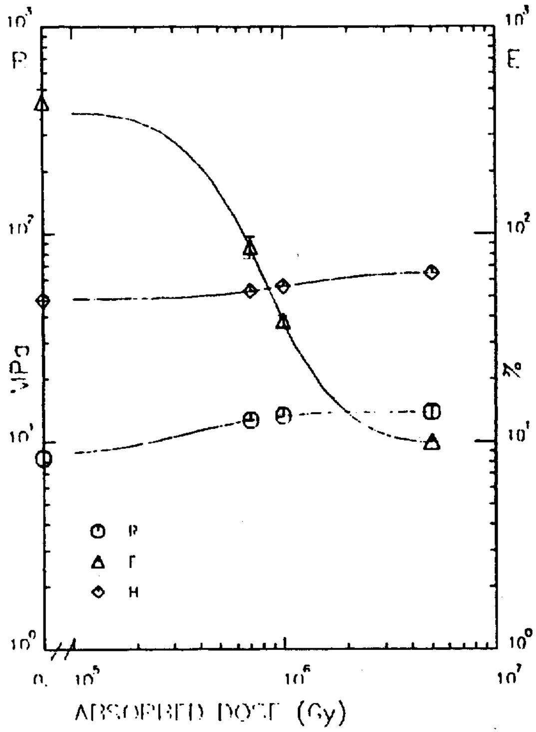
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.4 ± 0.6	162.5 ± 42.1	41.0 ± 0.8
0.500	1.7×10^5	12.7 ± 0.4	132.5 ± 8.7	39.3 ± 1.5
1.000	1.7×10^5	13.5 ± 0.7	63.8 ± 11.1	46.0 ± 1.4
5.000	1.7×10^5	10.0 ± 4.4	11.3 ± 6.3	55.3 ± 1.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.2 %
CORROSIVITY (DIN 57472) : PASS

EVA

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 514

MATERIAL : EVA
TYPE : Lupolen V3900 DX SA 0009
SUPPLIER : BASF via A.Pasta (Pirelli)
REMARKS : Used for SPS multicore cables

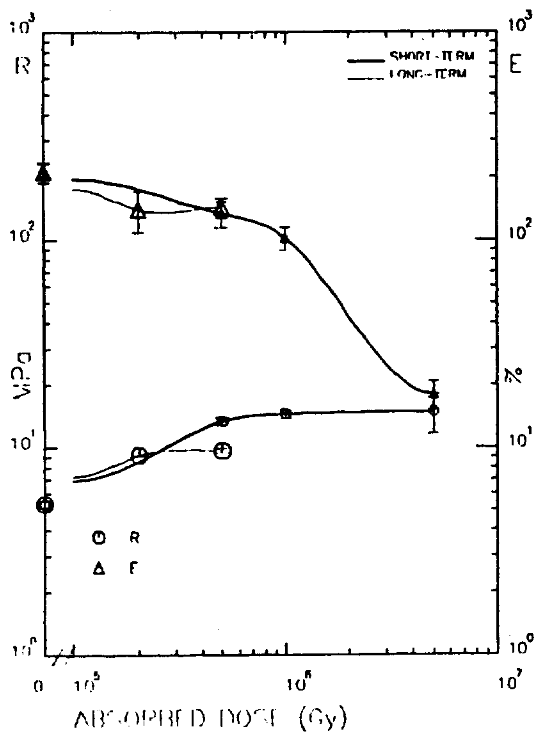
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	–	8.3 ± 0.7	432.5 ± 70.1	48.0 ± 0.0
0.700	1.7×10^5	12.7 ± 0.1	86.7 ± 10.4	53.0 ± 0.0
1.000	1.7×10^5	13.3 ± 0.2	38.1 ± 2.4	56.0 ± 0.0
5.000	1.7×10^5	13.9 ± 1.0	10.0 ± 0.0	65.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 545

MATERIAL : EVA
TYPE : Sloplas 4/7
SUPPLIER : STC / STL
REMARKS : Sheath compound

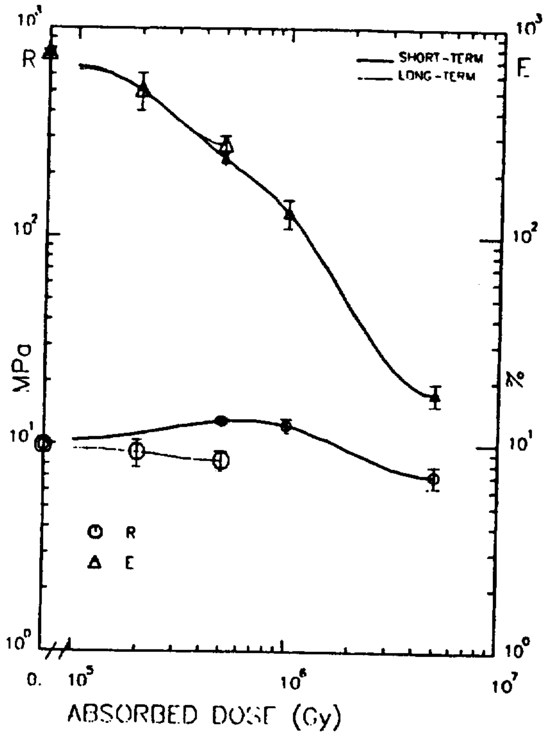
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	–	5.3 ± 0.2	212.0 ± 24.0	41.5 ± 0.0
0.500	1.7×10^5	13.4 ± 0.6	134.0 ± 19.5	44.0 ± 0.0
1.000	1.7×10^5	14.5 ± 0.7	102.4 ± 12.8	44.5 ± 0.0
5.000	1.7×10^5	14.9 ± 3.2	18.0 ± 2.8	53.0 ± 0.0
0.000	–	5.3 ± 0.2	212.0 ± 21.4	41.5 ± 0.0
0.200	100.0	9.2 ± 0.0	140.4 ± 31.2	42.5 ± 0.0
0.500	100.0	9.7 ± 0.2	143.2 ± 15.3	43.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) > 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 546

MATERIAL : EVA
TYPE : Sioplas 4/7 L
SUPPLIER : STC / STL
REMARKS : Sheath compound

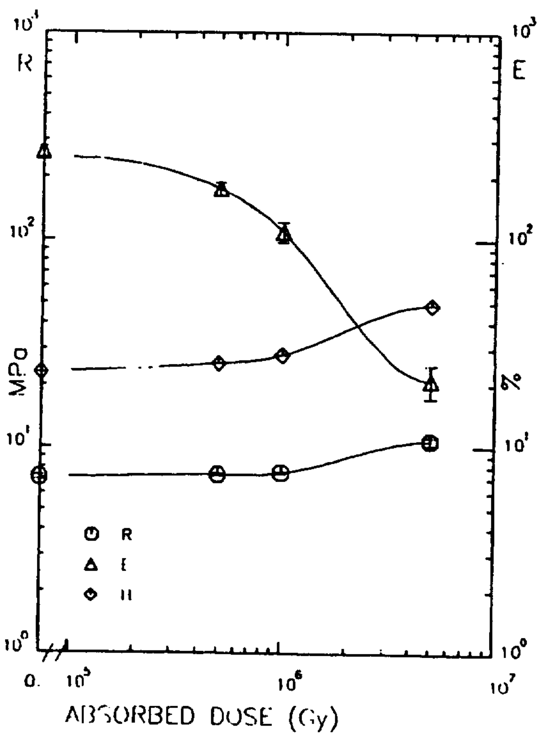
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.8 ± 0.7	760.8 ± 22.2	34.0 ± 0.0
0.500	1.7×10^5	12.9 ± 0.4	236.5 ± 17.6	36.0 ± 0.0
1.000	1.7×10^5	12.3 ± 0.9	130.0 ± 20.2	36.0 ± 0.0
5.000	1.7×10^5	7.1 ± 0.8	17.6 ± 2.2	30.0 ± 0.0
0.000	–	9.8 ± 0.7	760.8 ± 22.2	34.0 ± 0.0
0.200	100.0	9.1 ± 1.4	506.8 ± 103.4	36.0 ± 0.0
0.500	100.0	8.3 ± 0.9	276.8 ± 28.6	37.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 575

MATERIAL : EVA
TYPE : 4 G
SUPPLIER : Lynenwerk
REMARKS : Black sheath (P)

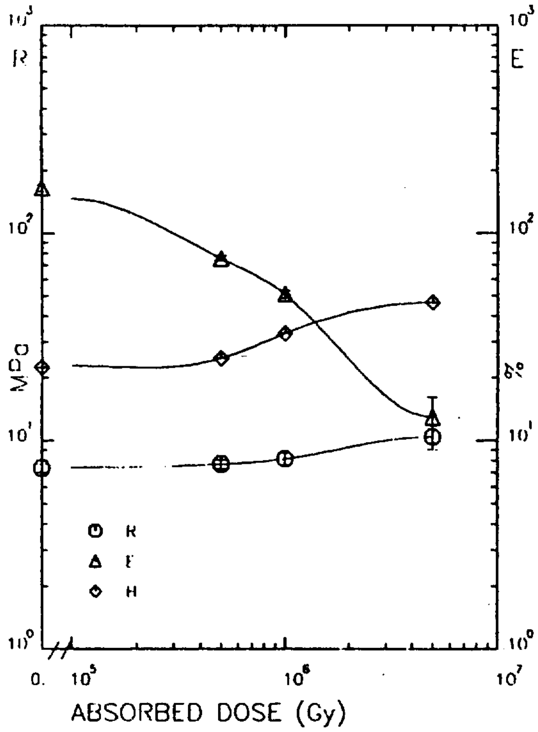
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.1 ± 0.2	264.0 ± 16.2	23.0 ± 0.0
0.500	2.5×10^5	7.3 ± 0.1	176.0 ± 13.3	25.5 ± 0.0
1.000	2.5×10^5	7.5 ± 0.1	109.6 ± 12.2	28.0 ± 0.0
5.000	2.5×10^5	10.8 ± 0.5	21.2 ± 3.9	49.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 581

MATERIAL : EVA
TYPE : Sheath G.EVA 1
SUPPLIER : Gorse
REMARKS : (P)

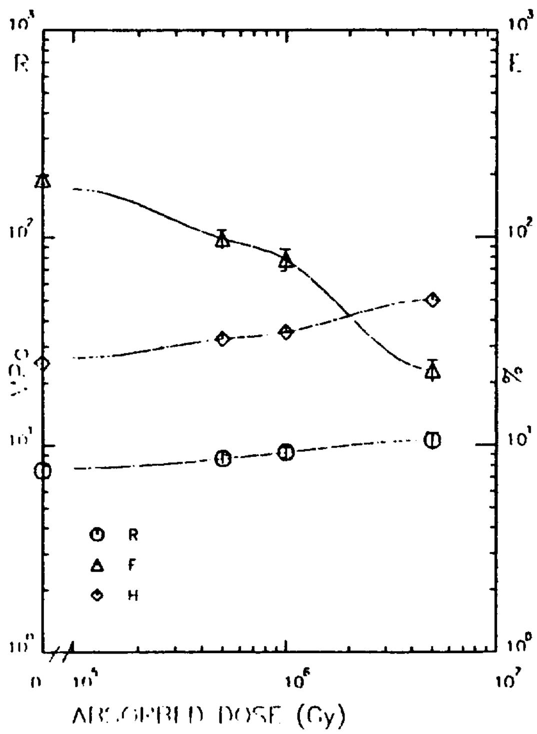
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.4 ± 0.3	165.0 ± 6.1	22.5 ± 0.0
0.500	2.5×10^5	7.7 ± 0.4	76.0 ± 2.2	25.0 ± 0.0
1.000	2.5×10^5	8.2 ± 0.6	51.0 ± 2.2	33.0 ± 0.0
5.000	2.5×10^5	10.5 ± 1.4	13.0 ± 3.3	46.5 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.9 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 583

MATERIAL : EVA
TYPE : Sheath G.EVA 605 green
SUPPLIER : Gorse
REMARKS : (P)

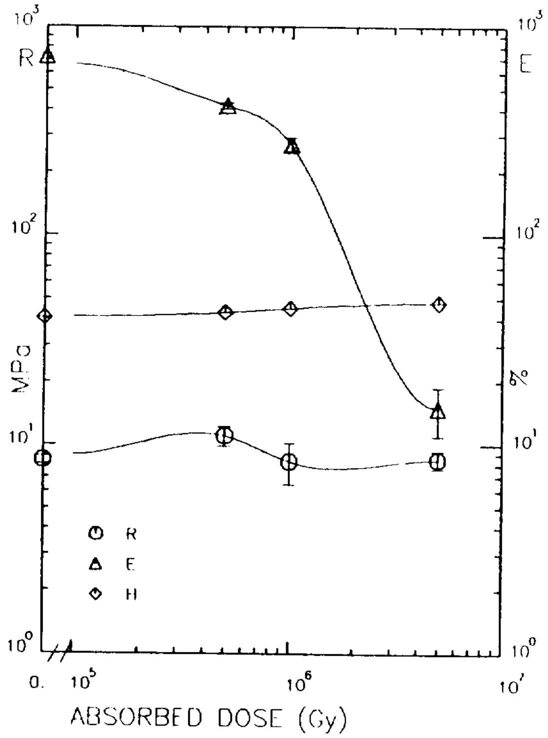
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.6 ± 0.6	191.0 ± 8.2	25.0 ± 0.0
0.500	2.5×10^5	8.6 ± 0.4	98.8 ± 10.3	32.5 ± 0.0
1.000	2.5×10^5	9.2 ± 0.5	78.1 ± 9.4	35.0 ± 0.0
5.000	2.5×10^5	10.6 ± 1.0	23.0 ± 2.7	50.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 33.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 630

MATERIAL : EVA copolymer
TYPE : HFI/20/KX 659
SUPPLIER : BICC
REMARKS : Sheathing compound

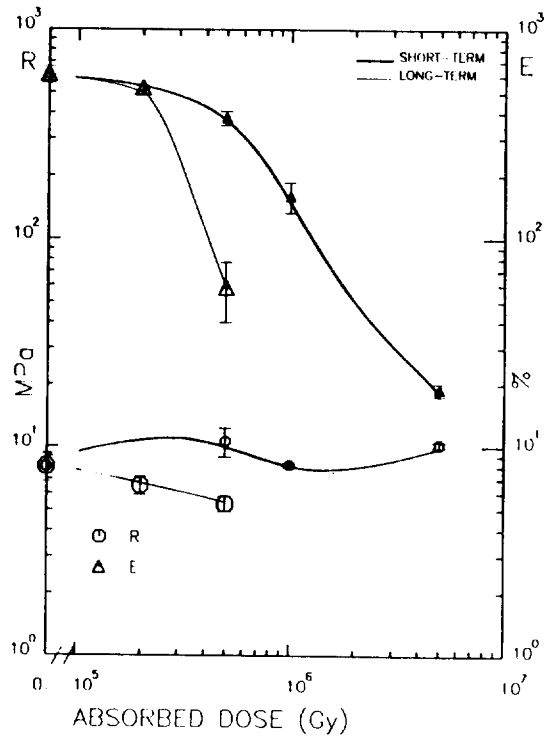
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.5 ± 0.4	715.5 ± 24.9	40.5 ± 0.0
0.500	1.7×10^5	11.1 ± 1.2	417.5 ± 14.6	43.0 ± 0.0
1.000	1.7×10^5	8.3 ± 1.9	271.5 ± 22.3	45.0 ± 0.0
5.000	1.7×10^5	8.5 ± 0.8	15.0 ± 4.0	48.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 652

MATERIAL : Thermoplastic EVA
TYPE : MCA 319 (D 2983 FR)
SUPPLIER : BP Chemicals
REMARKS : Plates 1982

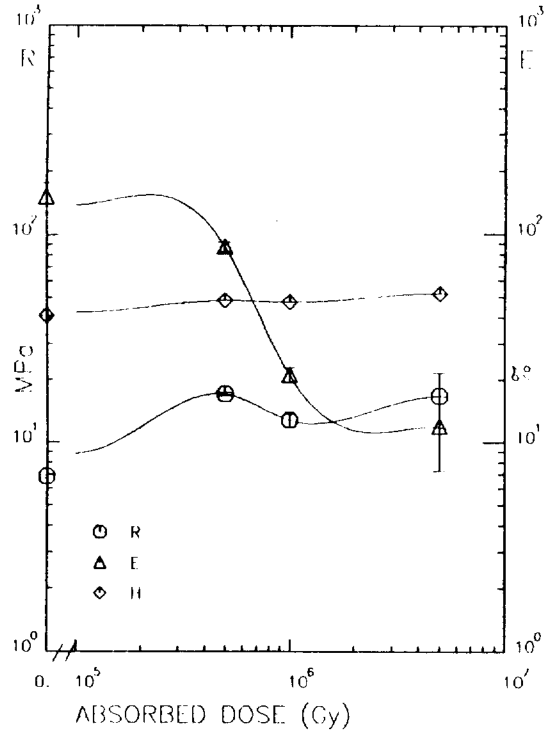
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.0 ± 1.2	610.0 ± 55.6	42.0 ± 0.0
0.500	1.7×10^5	10.6 ± 1.7	377.5 ± 30.5	41.5 ± 0.0
1.000	1.7×10^5	8.2 ± 0.2	160.0 ± 26.2	43.0 ± 0.0
5.000	1.7×10^5	10.3 ± 0.3	19.0 ± 1.4	47.0 ± 0.0
0.000	–	8.0 ± 1.2	610.0 ± 55.6	42.0 ± 0.0
0.200	100.0	6.6 ± 0.6	526.5 ± 13.6	41.0 ± 0.0
0.500	100.0	5.3 ± 0.4	58.5 ± 18.7	35.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 659

MATERIAL : EVA
TYPE : Sioplas 4/7
SUPPLIER : STC / STL
REMARKS : Thermoplastic sheath

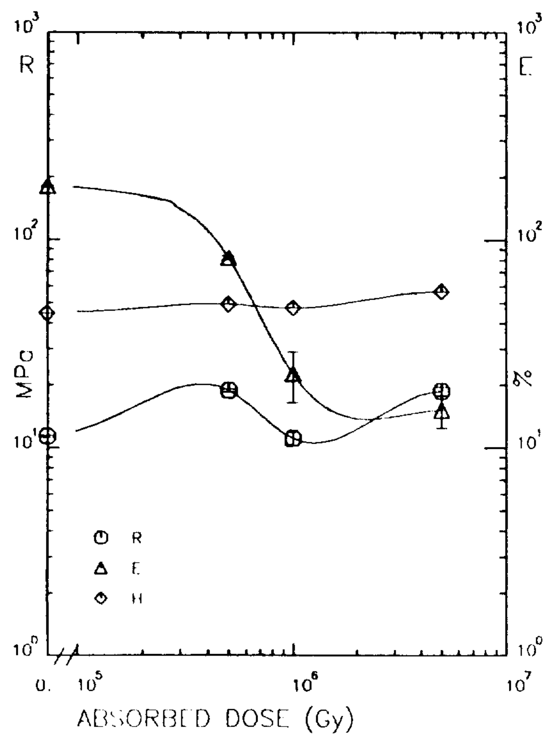
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.9 ± 0.1	152.0 ± 24.3	41.0 ± 0.0
0.500	1.7×10^5	17.1 ± 0.3	88.0 ± 4.7	48.5 ± 0.0
1.000	1.7×10^5	12.8 ± 0.9	21.2 ± 1.8	47.5 ± 0.0
5.000	1.7×10^5	16.8 ± 5.0	12.0 ± 4.7	52.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 33.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 660

MATERIAL : EVA
TYPE : Sioplas 4/7 X-L
SUPPLIER : STC / STL
REMARKS : Radiation crosslinked

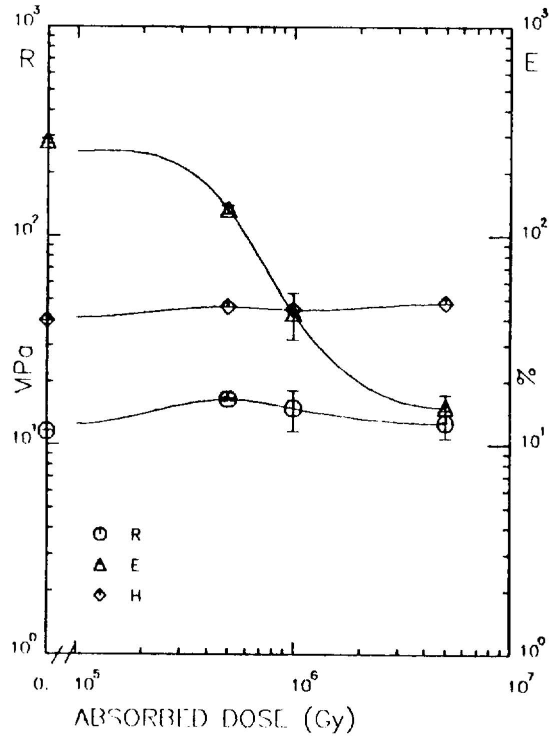
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.4 ± 0.1	180.8 ± 1.8	44.5 ± 0.0
0.500	1.7×10^5	19.0 ± 0.3	82.4 ± 1.7	49.5 ± 0.0
1.000	1.7×10^5	11.1 ± 0.9	22.8 ± 6.3	47.5 ± 0.0
5.000	1.7×10^5	18.8 ± 0.9	15.2 ± 2.7	57.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 661

MATERIAL : EVA
TYPE : 5/2 compound
SUPPLIER : STC / STL
REMARKS : Radiation crosslinked

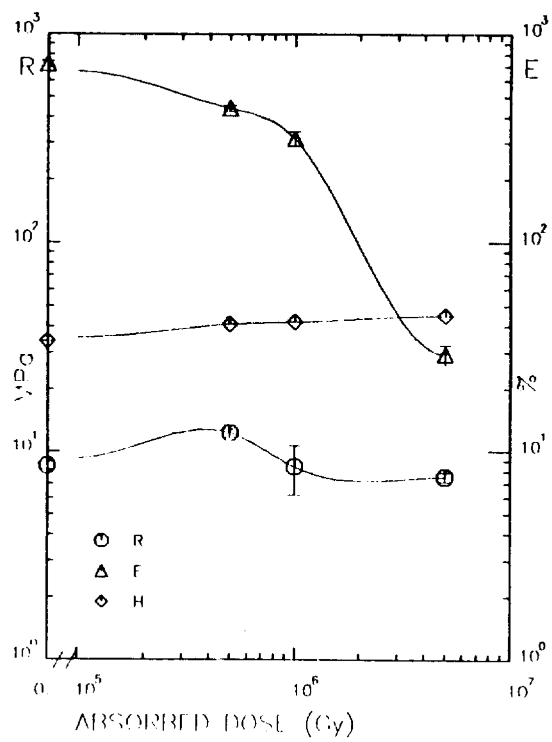
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.5 ± 0.1	284.0 ± 6.9	39.5 ± 0.0
0.500	1.7×10^5	16.5 ± 0.3	134.4 ± 6.1	46.0 ± 0.0
1.000	1.7×10^5	15.0 ± 3.3	42.8 ± 10.9	44.5 ± 0.0
5.000	1.7×10^5	12.7 ± 2.0	15.2 ± 2.3	48.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 663

MATERIAL : EVA copolymer
TYPE : HFI/36
SUPPLIER : BICC
REMARKS : = HFI/20 + antioxidant

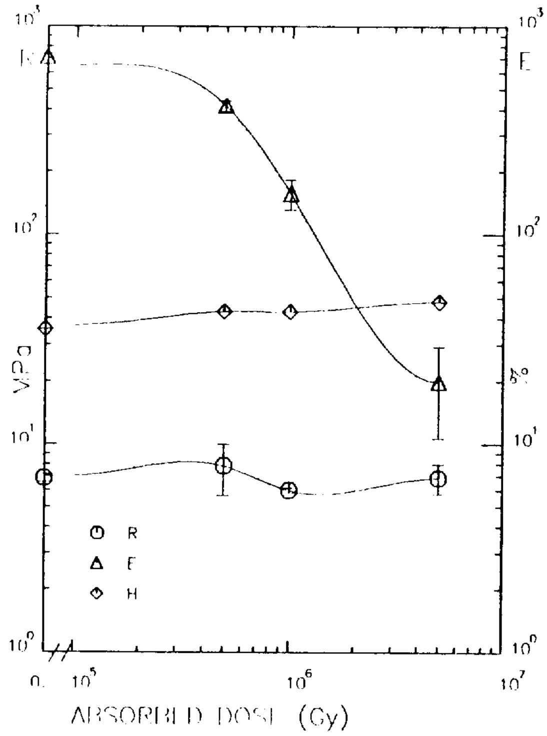
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.5 ± 0.3	720.0 ± 23.5	34.0 ± 0.0
0.500	1.9×10^5	12.3 ± 0.6	440.0 ± 13.5	41.0 ± 0.0
1.000	1.9×10^5	8.5 ± 2.2	314.4 ± 26.0	42.0 ± 0.0
5.000	1.7×10^5	7.5 ± 0.4	29.4 ± 3.1	45.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 664

MATERIAL : EVA copolymer
TYPE : HFI/38
SUPPLIER : BICC
REMARKS : = HFI/20 + antioxidant

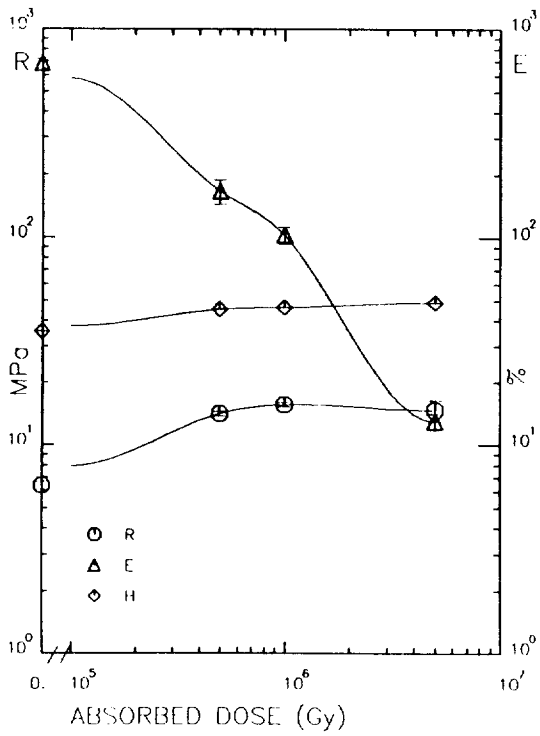
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.9 ± 0.3	712.0 ± 27.7	35.5 ± 0.0
0.500	1.9 x 10^5	7.8 ± 2.2	416.0 ± 25.1	43.0 ± 0.0
1.000	1.9 x 10^5	6.0 ± 0.1	157.0 ± 25.4	43.0 ± 0.0
5.000	1.9 x 10^5	6.9 ± 1.1	20.0 ± 9.4	48.0 ± 0.0

RADIATION INDEX (1.9 x 10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 672

MATERIAL : EVA
TYPE : 5/2 compound
SUPPLIER : STC / STL
REMARKS : Peroxide XL

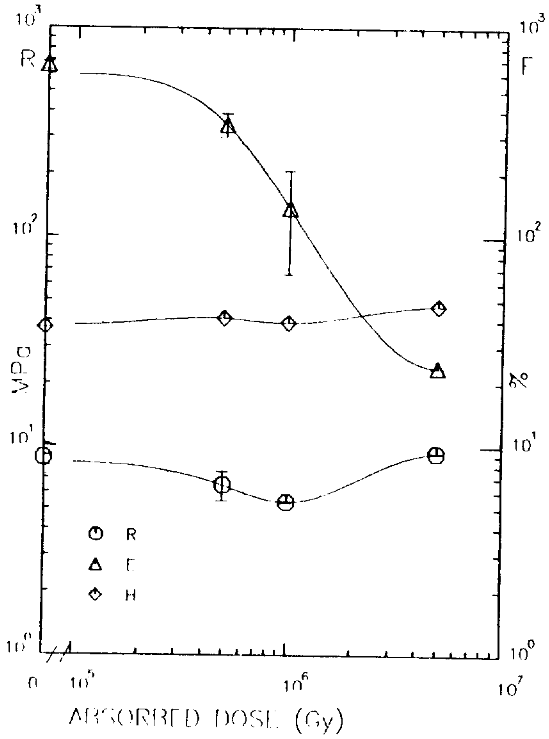
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 0.3	682.4 ± 36.7	35.5 ± 0.0
0.500	1.7 x 10^5	14.2 ± 0.4	166.8 ± 22.3	45.5 ± 0.0
1.000	1.7 x 10^5	15.7 ± 0.3	103.2 ± 9.4	46.5 ± 0.0
5.000	1.7 x 10^5	14.7 ± 1.8	13.0 ± 1.2	49.0 ± 0.0

RADIATION INDEX (1.7 x 10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.7 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 686

MATERIAL : EVA Copolymer
TYPE : HFI/36
SUPPLIER : BICC
REMARKS : (P)

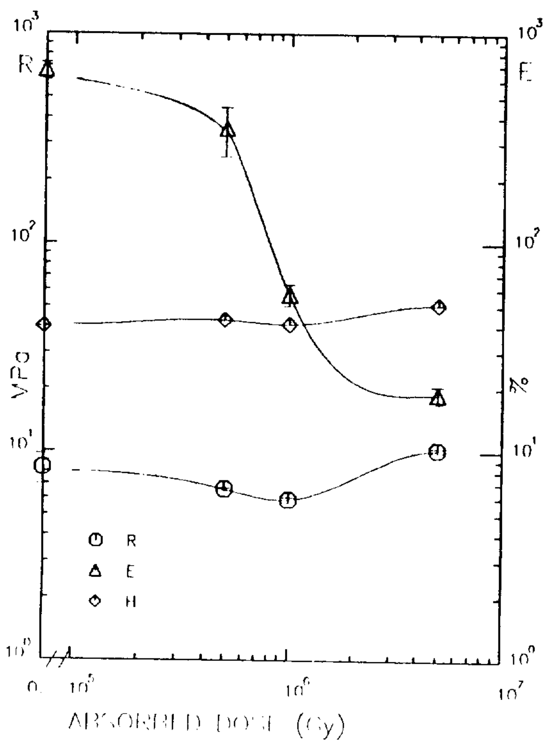
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.8 ± 1.5	658.0 ± 29.3	37.0 ± 0.0
0.500	1.9×10^5	6.5 ± 1.1	343.2 ± 45.2	41.0 ± 0.0
1.000	1.9×10^5	5.4 ± 0.0	136.8 ± 70.1	39.0 ± 0.0
5.000	1.9×10^5	9.3 ± 0.1	24.0 ± 0.0	47.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 687

MATERIAL : EVA Copolymer
TYPE : HFI/38
SUPPLIER : BICC
REMARKS : (P)

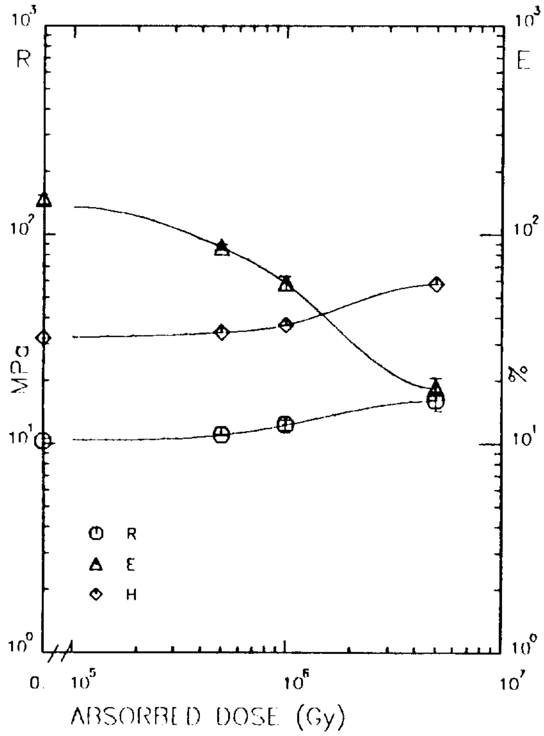
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	-	8.4 ± 1.4	666.4 ± 59.7	40.0 ± 0.0
0.500	1.9×10^5	6.6 ± 0.1	353.0 ± 94.1	43.0 ± 0.0
1.000	1.9×10^5	5.9 ± 0.2	56.8 ± 6.6	41.0 ± 0.0
5.000	1.9×10^5	10.2 ± 0.2	18.8 ± 1.8	51.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 696

MATERIAL : EVA
TYPE : Sheath G 810
SUPPLIER : Gorse
REMARKS : Halogen- and Sulphur-free

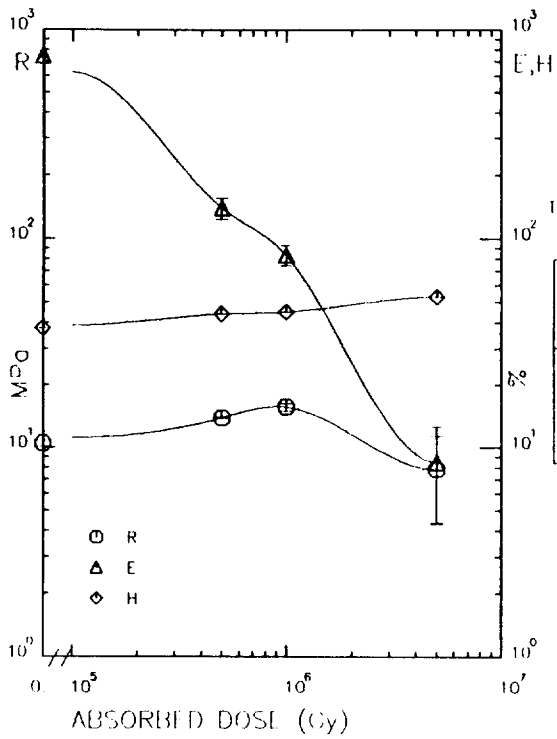
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.3 ± 0.3	147.5 ± 7.9	32.0 ± 0.0
0.500	1.7×10^5	11.0 ± 0.1	87.0 ± 2.7	34.0 ± 0.0
1.000	1.7×10^5	12.3 ± 0.7	58.5 ± 4.5	37.0 ± 0.0
5.000	1.7×10^5	16.1 ± 1.7	18.5 ± 2.2	58.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 699

MATERIAL : EVA Copolymer
TYPE : HFI/50 (KX 706)
SUPPLIER : Bicai
REMARKS : Sheath (P)

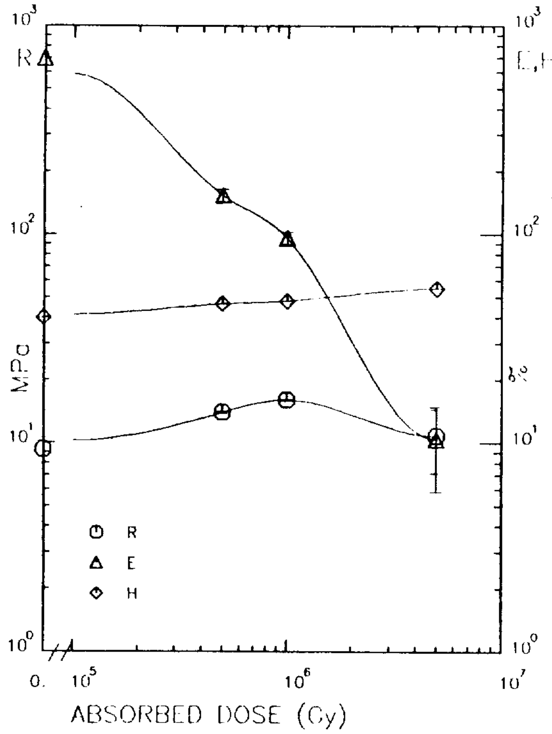
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.5 ± 0.3	747.6 ± 12.8	37.5 ± 0.0
0.500	1.9×10^5	13.9 ± 0.1	140.0 ± 16.0	44.0 ± 0.0
1.000	1.9×10^5	15.7 ± 0.7	83.6 ± 9.2	45.0 ± 0.0
5.000	1.9×10^5	7.9 ± 3.6	8.5 ± 4.1	53.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 700

MATERIAL : EVA Copolymer
TYPE : HFI/50 (KX 707)
SUPPLIER : Bicol
REMARKS : Sheath (P)

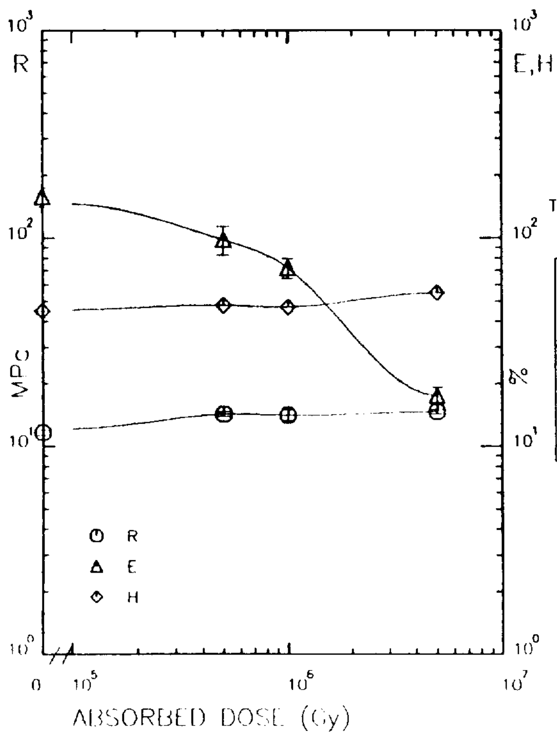
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.3 ± 1.3	696.0 ± 51.3	40.0 ± 0.0
0.500	1.9×10^5	14.0 ± 0.1	153.6 ± 10.4	46.5 ± 0.0
1.000	1.9×10^5	16.1 ± 0.1	96.0 ± 6.3	48.0 ± 0.0
5.000	1.9×10^5	10.8 ± 3.7	10.4 ± 4.6	55.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 701

MATERIAL : EVA Copolymer
TYPE : KX 712
SUPPLIER : Bicol
REMARKS : Sheath (P)

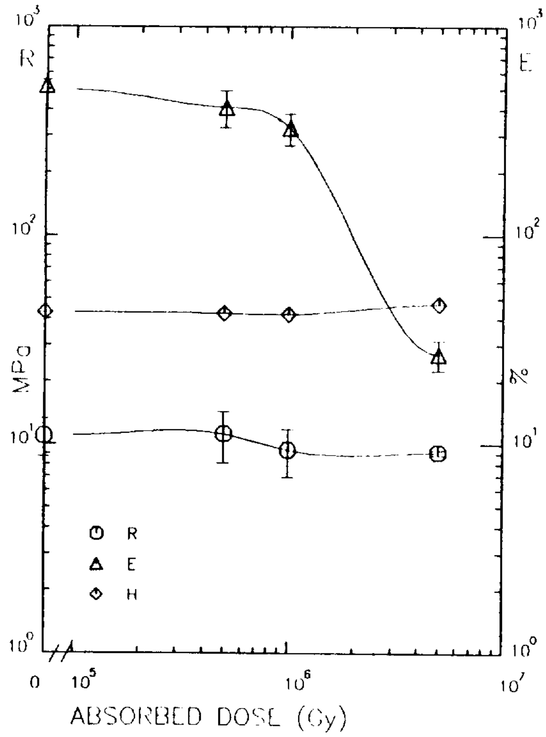
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.7 ± 0.3	158.0 ± 16.2	45.0 ± 0.0
0.500	1.9×10^5	14.3 ± 0.4	98.4 ± 15.2	48.0 ± 0.0
1.000	1.9×10^5	14.2 ± 0.8	72.4 ± 7.8	47.0 ± 0.0
5.000	1.9×10^5	14.7 ± 0.4	17.6 ± 1.7	55.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.4 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 752

MATERIAL : EVA copolymer
TYPE : Lupolen 3917 DQ 226
SUPPLIER : Cabeltel
REMARKS : (BASF) (P)

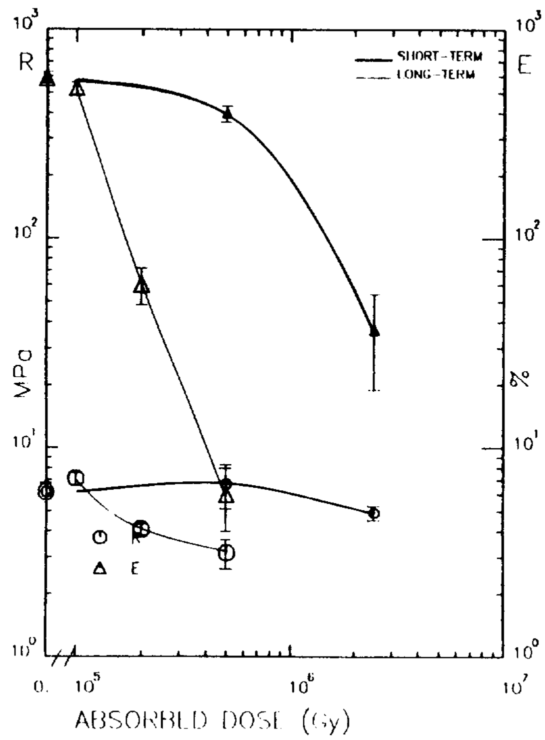
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness Shore D H (Degree)
		Strength R (MPa)	Elongation E (%)	
0.000	–	11.0 ± 2.3	516.0 ± 36.3	43.0 ± 0.0
0.500	1.8×10^5	11.2 ± 3.1	410.0 ± 83.4	42.5 ± 0.0
1.000	1.8×10^5	9.4 ± 2.4	325.0 ± 55.2	42.0 ± 0.0
5.000	1.8×10^5	9.1 ± 0.2	27.0 ± 4.5	47.0 ± 0.0

RADIATION INDEX (9.0×10^4 Gy/h) : 6.1

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 33.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 766

MATERIAL : Polyolefin thermoplastic
TYPE : BP D 2983 FR (black)
SUPPLIER : Norsk Kabelfabrik EB
REMARKS : Taken from LEP prototype cable

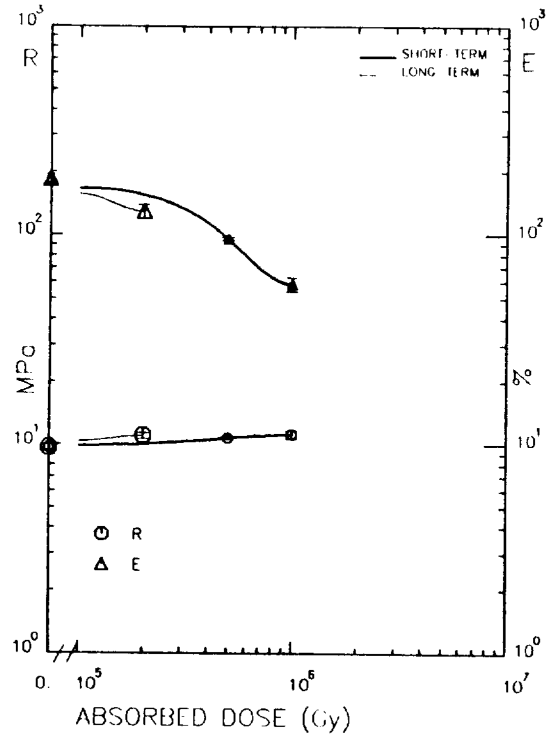
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness Shore D H (Degree)
		Strength R (MPa)	Elongation E (%)	
0.000	–	6.2 ± 0.7	583.3 ± 45.5	25.0 ± 0.0
0.500	1.7×10^5	6.7 ± 1.6	397.0 ± 35.1	36.0 ± 0.0
2.500	1.7×10^5	4.9 ± 0.4	36.7 ± 17.6	39.0 ± 0.0
0.000	–	6.2 ± 0.7	583.3 ± 45.5	25.0 ± 0.0
0.100	1000.0	7.1 ± 0.5	526.0 ± 36.1	28.0 ± 0.0
0.200	100.0	4.1 ± 0.2	60.0 ± 11.8	29.0 ± 0.0
0.500	100.0	3.1 ± 0.5	6.0 ± 2.0	31.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8
RADIATION INDEX (550.0 Gy/h) : 5.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 812

MATERIAL : EVA
TYPE : 4 G coloured
SUPPLIER : Lynenwerk
REMARKS : Sheath for 1-3 kV LEP cables (P)

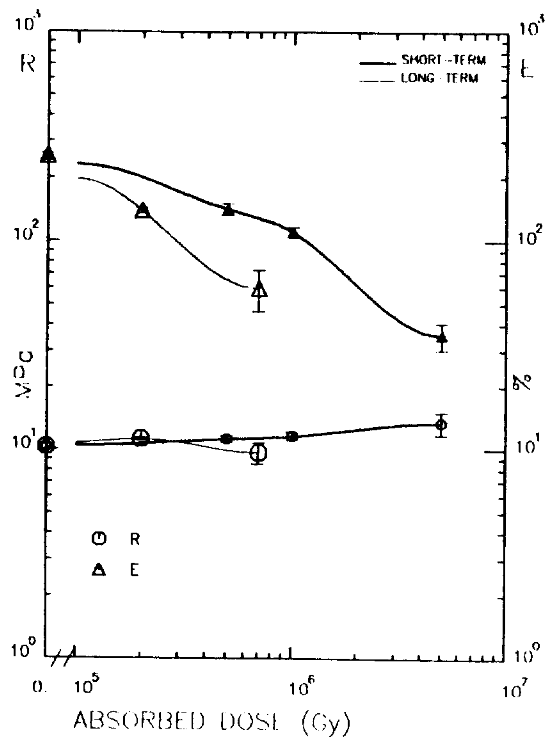
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	-	9.7 ± 0.3	184.8 ± 10.4	29.0 ± 0.0
0.500	1.8x10^5	10.7 ± 0.2	95.6 ± 1.7	34.0 ± 0.0
1.000	1.8x10^5	11.2 ± 0.5	58.4 ± 4.3	36.0 ± 0.0
0.000	–	9.7 ± 0.3	184.8 ± 10.4	29.0 ± 0.0
0.200	100.0	11.1 ± 0.4	129.6 ± 10.4	33.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.7
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 40.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 819

MATERIAL : EVA
TYPE : Sheath 159
SUPPLIER : Roque
REMARKS : (P)

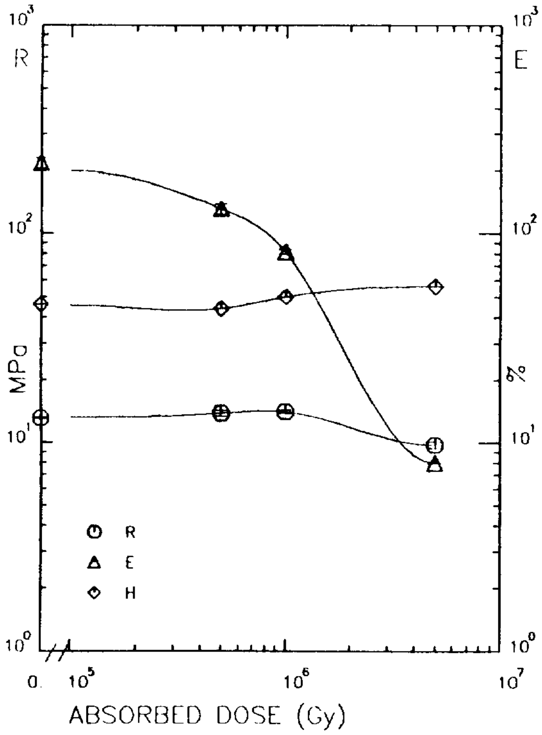
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.3 ± 0.3	255.2 ± 7.2	25.0 ± 0.0
0.500	1.7x10^5	11.2 ± 0.4	142.0 ± 8.7	29.0 ± 0.0
1.000	1.7x10^5	11.6 ± 0.5	110.8 ± 5.9	30.0 ± 0.0
5.000	1.7x10^5	13.5 ± 1.6	35.5 ± 5.3	38.0 ± 0.0
0.000	–	10.3 ± 0.3	255.2 ± 7.2	25.0 ± 0.0
0.200	100.0	11.2 ± 0.1	140.0 ± 4.0	28.5 ± 1.3
0.700	100.0	9.7 ± 1.1	59.5 ± 13.3	30.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) : 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 36.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 841

MATERIAL : EVA
TYPE : X-2502 19
SUPPLIER : Dätwyler
REMARKS : Insulation (P)

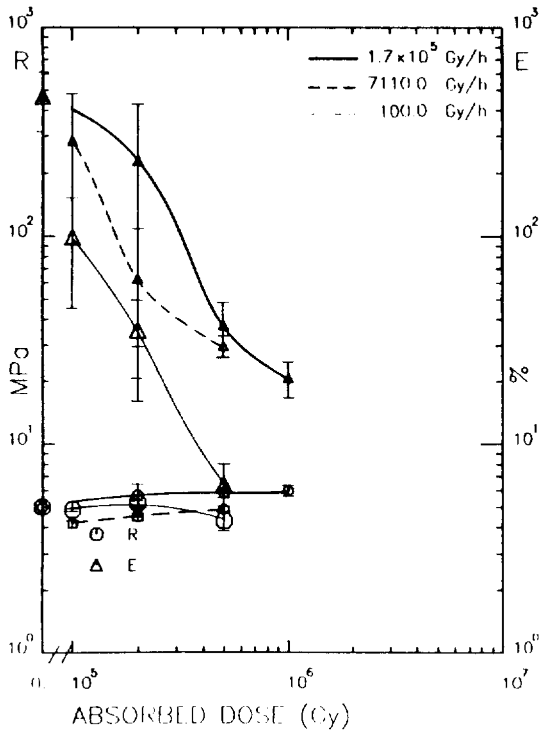
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.1 ± 0.1	218.4 ± 12.8	46.0 ± 0.0
0.500	2.7×10^5	13.9 ± 0.5	131.2 ± 7.7	44.0 ± 0.0
1.000	2.7×10^5	14.1 ± 0.3	81.6 ± 2.2	50.0 ± 0.0
5.000	2.7×10^5	9.8 ± 0.4	8.0 ± 0.0	56.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 860

MATERIAL : Polyolefin
TYPE : BP D 2983 FR (white)
SUPPLIER : Norsk Kabelfabrik EB
REMARKS : Taken from NF-48 LEP cable (C)

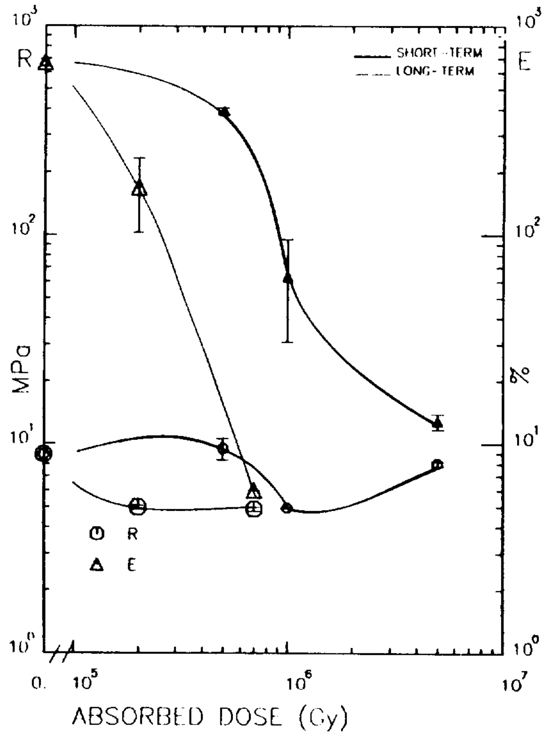
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.0 ± 0.3	464.8 ±147.8	25.0 ± 0.0
0.200	1.7×10^5	5.7 ± 0.8	229.3 ±199.9	29.0 ± 0.0
0.500	1.7×10^5	5.8 ± 0.3	37.2 ± 10.9	30.0 ± 0.0
1.000	1.7×10^5	6.0 ± 0.3	20.8 ± 4.1	35.0 ± 0.0
0.000	–	5.0 ± 0.3	464.8 ±147.8	25.0 ± 0.0
0.100	7110.0	4.2 ± 0.2	287.2 ±194.8	25.0 ± 0.0
0.200	7110.0	4.5 ± 0.2	62.4 ± 46.4	27.0 ± 0.0
0.500	7110.0	4.9 ± 0.2	29.6 ± 3.6	32.0 ± 0.0
0.000	–	5.0 ± 0.3	464.8 ±147.8	25.0 ± 0.0
0.100	1000.0	4.9 ± 0.1	99.2 ± 53.9	25.0 ± 0.0
0.200	108.0	5.2 ± 0.2	35.2 ± 14.5	27.0 ± 0.0
0.500	100.0	4.3 ± 0.5	6.4 ± 1.7	31.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.2
RADIATION INDEX (7110.0 Gy/h) : 5.1
RADIATION INDEX (100.0 Gy/h) < 5.0

OXYGEN INDEX(ISO 4589) : 34.3 %

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 885

MATERIAL : Thermoplastic EVA
TYPE : D 2983 FR
SUPPLIER : BP Chemicals
REMARKS : 1987 plates

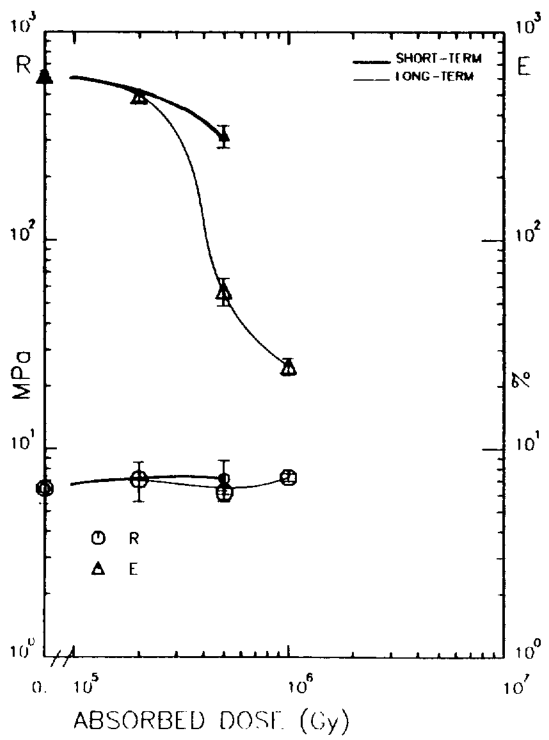
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.9 ± 0.5	670.4 ± 27.2	35.8 ± 0.4
0.500	2.7×10^5	9.5 ± 1.1	392.8 ± 14.3	36.0 ± 0.6
1.000	2.7×10^5	4.9 ± 0.0	63.2 ± 32.5	36.0 ± 0.0
5.000	2.7×10^5	8.1 ± 0.2	12.8 ± 1.1	44.0 ± 0.0
0.000	–	8.9 ± 0.5	670.4 ± 27.2	35.8 ± 0.4
0.200	100.0	5.0 ± 0.1	168.8 ± 65.8	36.7 ± 0.4
0.700	100.0	4.9 ± 0.1	6.0 ± 0.0	36.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) : 5.7
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 912

MATERIAL : Polyolefin (EVA)
TYPE : BP D 2983 FR
SUPPLIER : Norsk Kabel EB
REMARKS : from NE 18 LEP control cable

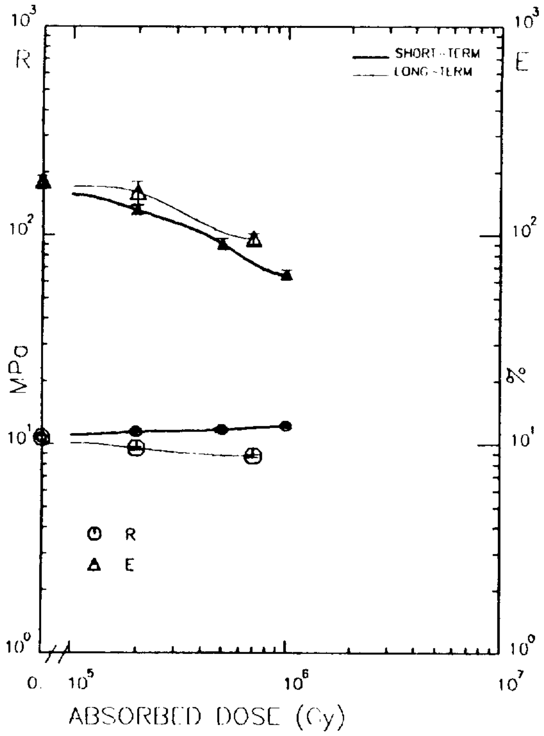
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 1.0	614.3 ± 33.5	27.7 ± 0.8
0.500	2.5×10^5	7.2 ± 1.6	316.2 ± 38.5	29.0 ± 0.0
0.000	--	6.4 ± 1.0	614.3 ± 33.5	27.7 ± 0.8
0.200	3700.0	7.1 ± 1.5	490.4 ± 27.8	35.7 ± 0.8
0.500	3600.0	6.2 ± 0.1	57.1 ± 8.4	33.7 ± 1.0
1.000	3600.0	7.3 ± 0.3	25.0 ± 2.2	36.2 ± 1.9

RADIATION INDEX (2.5×10^5 Gy/h) : 5.7
RADIATION INDEX (3650.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 928

MATERIAL : EVA
TYPE : M2 (vulcanized)
SUPPLIER : Nuova Fulgor Cavi
REMARKS : Sheath (P)

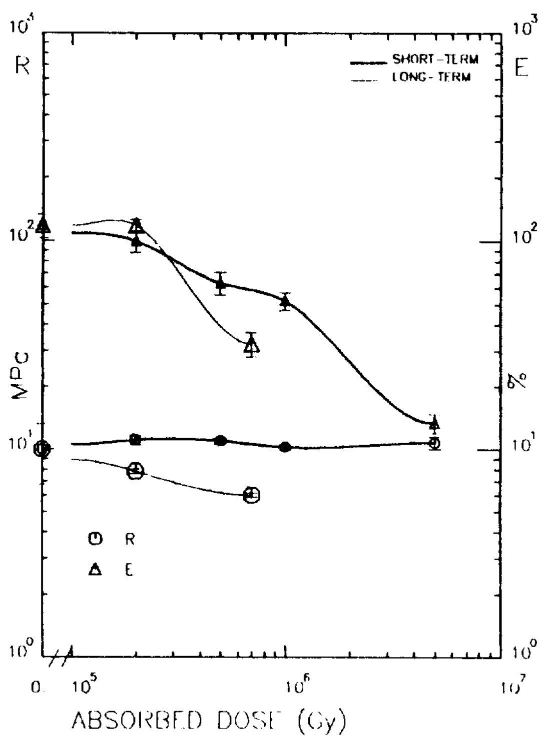
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.7 ± 0.2	181.6 ± 11.5	30.0 ± 0.0
0.200	3000.0	11.5 ± 0.4	132.0 ± 6.3	33.0 ± 0.0
0.500	3000.0	11.7 ± 0.3	91.2 ± 5.2	36.0 ± 0.0
1.000	3000.0	12.2 ± 0.2	64.8 ± 3.3	41.0 ± 0.0
0.000	–	10.7 ± 0.2	181.6 ± 11.5	30.0 ± 0.0
0.200	100.0	9.6 ± 0.2	161.0 ± 20.8	28.9 ± 0.8
0.700	100.0	8.8 ± 0.1	96.0 ± 5.7	32.0 ± 0.0

RADIATION INDEX (3000.0 Gy/h) : 5.7
RADIATION INDEX (100.0 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 39.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 951

MATERIAL : Sioplas 407/424
TYPE : Red and white (2 layers)
SUPPLIER : Fulgor Cavi
REMARKS : Taken from sheath of LEP 12/20 kV cable

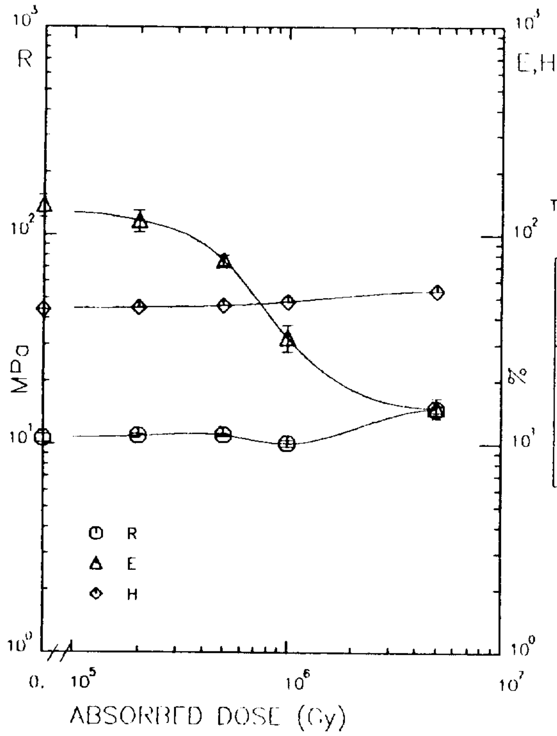
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.0 ± 3.2	118.4 ± 15.4	41.0 ± 0.0
0.200	2.4×10^5	11.1 ± 0.5	100.0 ± 12.0	44.0 ± 0.0
0.500	2.4×10^5	11.0 ± 0.3	63.2 ± 7.7	45.0 ± 0.0
1.000	2.4×10^5	10.3 ± 0.3	52.0 ± 4.9	45.0 ± 0.0
5.000	2.2×10^5	10.8 ± 0.8	13.4 ± 1.4	52.0 ± 0.0
0.000	–	10.0 ± 3.2	118.4 ± 15.4	41.0 ± 0.0
0.200	100.0	7.9 ± 0.2	118.4 ± 8.3	40.1 ± 1.4
0.700	100.0	6.0 ± 0.1	32.4 ± 4.3	43.0 ± 0.0

RADIATION INDEX (2.4×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.6

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 1000

MATERIAL : EVA
TYPE : E 4112
SUPPLIER : Câbles de Lyon
REMARKS : Sheath (P)

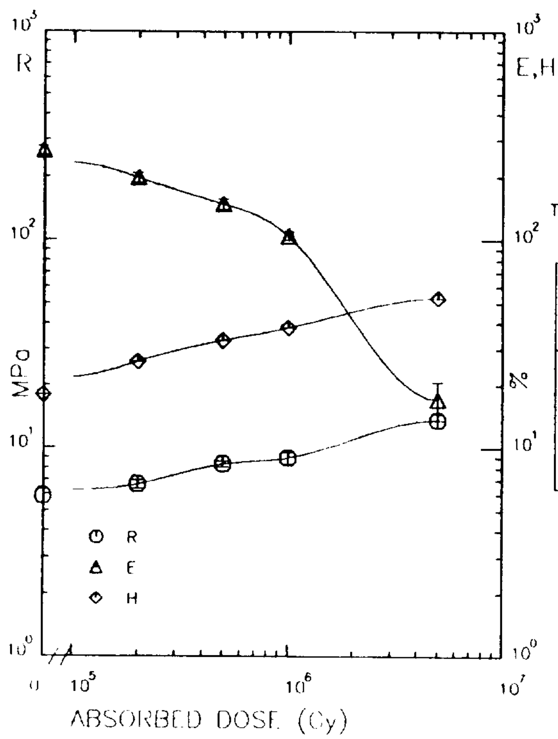
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.7 ± 0.5	139.2 ± 17.4	44.0 ± 0.0
0.200	5898.0	11.0 ± 0.2	117.5 ± 14.5	45.0 ± 0.0
0.500	6007.0	11.1 ± 0.2	75.6 ± 4.6	46.0 ± 0.0
1.000	6685.0	10.1 ± 0.4	32.4 ± 4.8	48.0 ± 0.0
5.000	2.2×10^5	14.8 ± 0.6	15.0 ± 1.7	54.0 ± 0.0

RADIATION INDEX (6346.0 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 42.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 1001

MATERIAL : EVA
TYPE : E 4152
SUPPLIER : Câbles de Lyon
REMARKS : Sheath (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.9 ± 0.4	266.8 ± 12.7	18.0 ± 0.0
0.200	5898.0	6.7 ± 0.3	198.4 ± 11.1	26.0 ± 0.0
0.500	6007.0	8.4 ± 0.3	148.4 ± 8.5	33.0 ± 0.0
1.000	6685.0	9.0 ± 0.6	104.8 ± 5.0	38.0 ± 0.0
5.000	2.2×10^5	13.7 ± 1.0	17.2 ± 3.6	53.0 ± 0.0

RADIATION INDEX (6346.0 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 39.0 %
CORROSIVITY (DIN 57472) : PASS

FLAMTROL, trade name of Raychen
see polyolefins in 1st edition (Ref. [16])

FLUOROPOLYMERS
see HALAR
see TEFLON
see TEFZEL
see VITON
in 1st edition (Ref. [16])

H

HALAR, fluoropolymer trade name of Allied Chemical
see in 1st edition (Ref. [16])

HYPALON, chlorosulfonated polyethylene (CSP) trade name of Du Pont de Nemours
see in 1st edition (Ref. [16])

HYTREL, polyester elastomer trade name of Du Pont de Nemours
see in 1st edition (Ref. [16])

K

KAPTON, polyimide film trade name of Du Pont de Nemours
see in 1st edition (Ref. [16]).
For general characteristic, see Tables 1 and 2.

LUPOLEN, trade name of BASF
see EVA-based materials and polyethylene
See also in 1st edition (Ref. [16])

MEGOLON, trade name of Lindsay & Williams Ltd.
see polyolefins

N

NEOPRENE, chloroprene rubber trade name of Du Pont de Nemours
see in 1st edition (Ref. [16])

NORDEL, trade name of Du Pont de Nemours
see EPDM in 1st edition (Ref. [16])

P

POLYCHLOROPRENE
see NEOPRENE in 1st edition (Ref. [16])

PE
polyethylene

PEEK
polyether ether ketone, see 1st edition (Ref. [16]).
For general characteristics, see Tables 1 and 2.

POLYIMIDE
see KAPTON in 1st edition (Ref. [16])

POLYOLEFINS

PUR
polyurethane

PVC
see polyvinyl chloride in 1st edition (Ref. [16])
PVC standard
PVC flame-retardant

PYROFIL, trade name of Dätwyler for material based on EPDM;
see EPDM in 1st edition (Ref. [16])

POLYETHYLENE

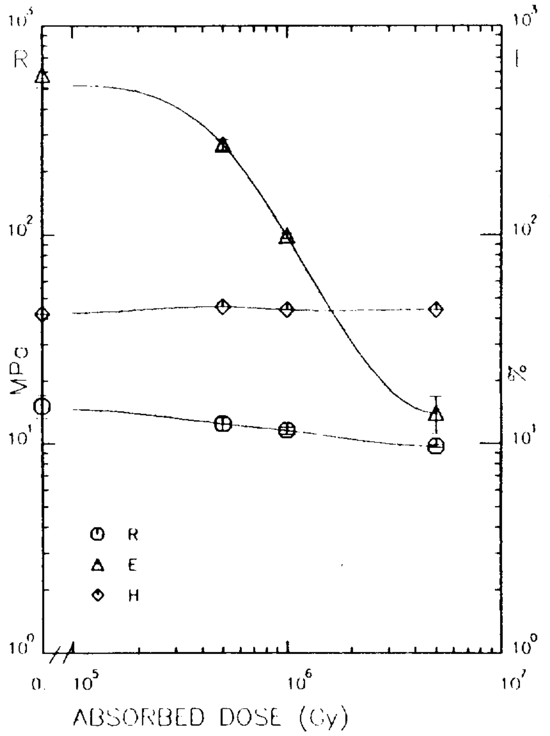
$[-CH_2-CH_2-]_n$

For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
549	LDPE	Studer Kabel	0.0	-	15.2	581	42	19	
	DFDM 6005	(BP)	0.5	2×10^5	12.5	270	45		5.6
			1.0	2×10^5	11.6	99	44		
			5.0	2×10^5	9.7	14	44		
678	DFDS 6032	NKT	0.0	-	17.1	681	53	19	
			0.5	2×10^5	15.5	126	55		
			1.0	2×10^5	15.2	116	56		
			5.0	2×10^5	18.4	23	59		
726	DFDK 4906	Huber &	0.0	-	3.0	28	38	17	
		Suhner	0.5	2×10^5	2.6	22	36		5.9
			1.0	2×10^5	2.8	12	41		
			5.0	2×10^5	1.6	6	41		
750	Insulation of	Câbles	0.0	-	12.1	435	48	-	
	ISR (FKID)	de Lyon	0.01	0.13	13.5	527	48		4.4
	cables		0.05	0.65	9.9	124	48		
757	Black sheath	kabelmetal	0.0	-	12.3	464	47	-	
	of ISR power	electro	0.001	0.002	12.4	472	47		
	cables		0.004	0.01	11.5	469	46		
	(life tests)		0.015	0.10	13.2	490	47		
			0.040	0.14	13.2	436	46		
758	White insul.	kabelmetal	0.0	-	12.4	471	46	-	
	of ISR power	electro	0.004	0.01	11.4	457	47		
	cables		0.015	0.10	13.2	475	47		
	(life tests)		0.040	0.14	11.1	396	47		
783	972	Silec	0.0	-	18.9	610	49	17	
	HT sheath		0.5	2×10^5	21.0	358	49		5.8
			1.0	2×10^5	16.5	190	52		
			5.0	2×10^5	13.7	20	53		
790	NCPE 1386	Neste	0.0	-	14.0	121	51	39	
		(Unifos)	0.5	2×10^5	18.0	92	54		5.9
			1.0	2×10^5	17.6	51	56		
			5.0	2×10^5	16.2	7	68		
			0.2	7000	14.6	121	51		5.7
			0.5	7000	14.6	72	53		
			1.0	7000	13.2	24	57		
			0.2	100	11.8	76	50		5.3
			0.5	100	7.2	7	51		
866	Lupolen	kabelmetal	0.0	-	11.7	414	50	-	
	1817 HX	electro	0.001	0.04	11.4	468	48		
	SPS HT sheath		0.002	0.09	14.3	475	53		
	(life tests)		0.010	0.43	11.6	464	48		
867	Lupolen	kabelmetal	0.0	-	13.6	474	51	-	
	1812 DSK	electro	0.001	0.04	11.7	391	50		
	SPS HT insul.		0.002	0.09	12.7	439	50		
	(life tests)		0.010	0.43	11.2	379	50		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
908	News 1386	Neste via NK EB	0.0	–	14.3	127	44	–	
			0.5	2×10^5	17.4	95	47		5.9
			1.0	2×10^5	17.6	47	48		
			5.0	2×10^5	11.2	6	54		
			0.2	100	12.4	127	42		5.5
			0.7	100	5.2	4	29		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 549

MATERIAL : PE Low Density
TYPE : DFDM 6005 by BP
SUPPLIER : Studer-Kabel
REMARKS : Insulation (P)

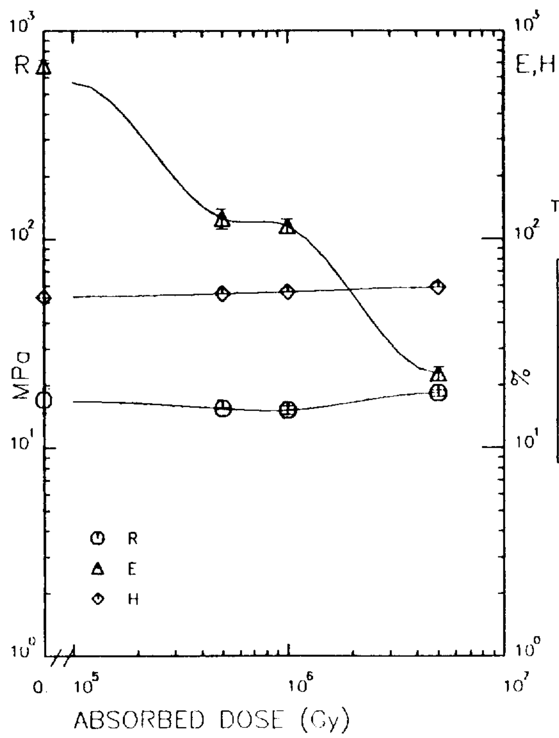
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	15.2 ± 1.9	581.0 ± 74.0	42.0 ± 0.0
0.500	1.7x10^5	12.5 ± 0.9	270.0 ± 15.7	45.5 ± 0.0
1.000	1.7x10^5	11.6 ± 0.5	99.0 ± 2.9	44.0 ± 0.0
5.000	1.7x10^5	9.7 ± 0.1	14.0 ± 2.9	44.0 ± 0.0

RADIATION INDEX (1.7x10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 678

MATERIAL : Polyethylene
TYPE : DFDS 6032
SUPPLIER : NKT
REMARKS : Insulation

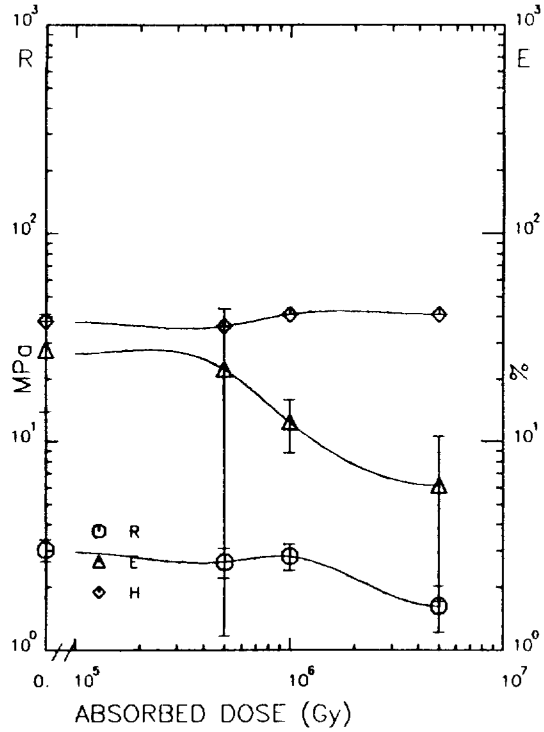
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	17.1 ± 2.3	680.8 ± 47.3	53.0 ± 0.0
0.500	1.7x10^5	15.5 ± 0.1	125.6 ± 14.0	55.0 ± 0.0
1.000	1.7x10^5	15.2 ± 0.7	115.6 ± 9.6	56.0 ± 0.0
5.000	1.7x10^5	18.4 ± 0.6	22.8 ± 1.8	59.0 ± 0.0

RADIATION INDEX (1.7x10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 19.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 726

MATERIAL : Polyethylene
TYPE : DFDK 4960
SUPPLIER : Huber & Suhner
REMARKS : (P)

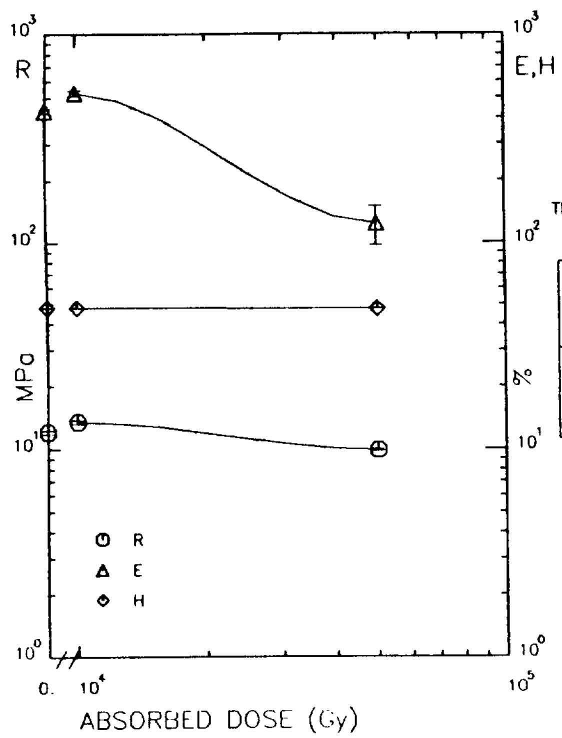
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	3.0 ± 0.4	27.6 ± 13.6	38.0 ± 0.0
0.500	1.8×10^5	2.6 ± 0.4	22.4 ± 21.2	36.0 ± 0.0
1.000	1.8×10^5	2.8 ± 0.4	12.4 ± 3.6	41.0 ± 0.0
5.000	1.8×10^5	1.6 ± 0.4	6.2 ± 4.4	41.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 17.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 750

MATERIAL : Polyethylene
TYPE : white insulation
SUPPLIER : Câbles de Lyon
REMARKS : ISR cables for FKID (C)

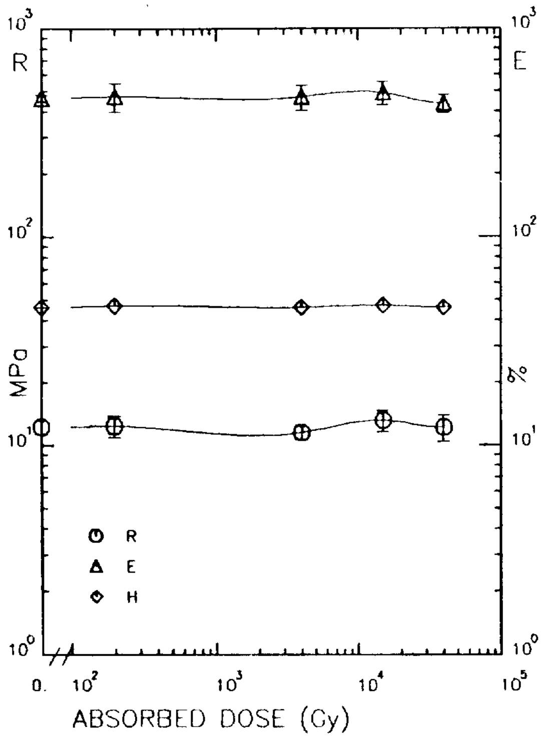
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.1 ± 0.2	435.0 ± 11.7	48.0 ± 0.0
0.010	0.1	13.5 ± 0.3	527.5 ± 16.6	48.0 ± 0.0
0.050	0.6	9.9 ± 0.1	124.0 ± 26.3	47.5 ± 0.0

RADIATION INDEX (0.4 Gy/h) : 4.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 757

MATERIAL : **Polyethylene**
TYPE : **black sheath**
SUPPLIER : **kabelmetal electro**
REMARKS : **taken from ISR power cables**

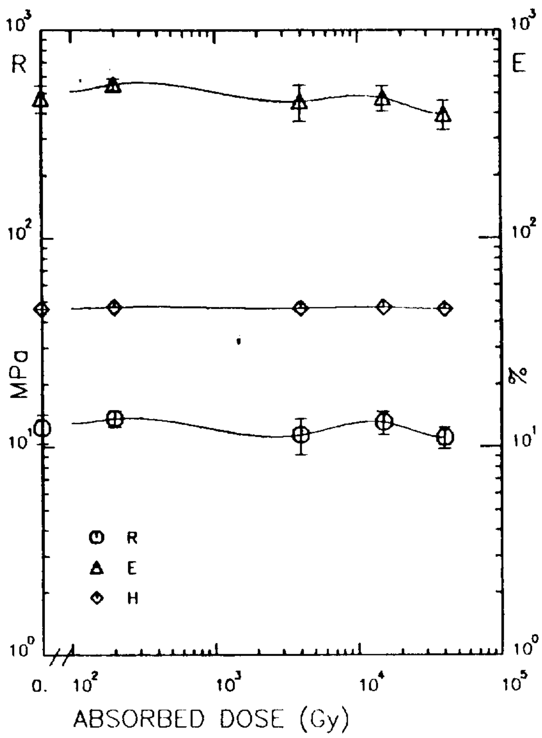
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.3 ± 0.9	464.0 ± 16.7	46.0 ± 0.0
0.000	0.0	12.4 ± 1.5	472.0 ± 73.5	47.0 ± 0.0
0.004	0.0	11.5 ± 0.8	469.0 ± 64.0	46.0 ± 0.0
0.015	0.1	13.2 ± 1.6	490.0 ± 61.9	47.0 ± 0.0
0.040	0.1	12.2 ± 1.8	436.0 ± 42.6	46.0 ± 0.0

RADIATION INDEX (0.1 Gy/h) > 4.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 758

MATERIAL : **Polyethylene**
TYPE : **white insulation**
SUPPLIER : **kabelmetal electro**
REMARKS : **taken from ISR power cables**

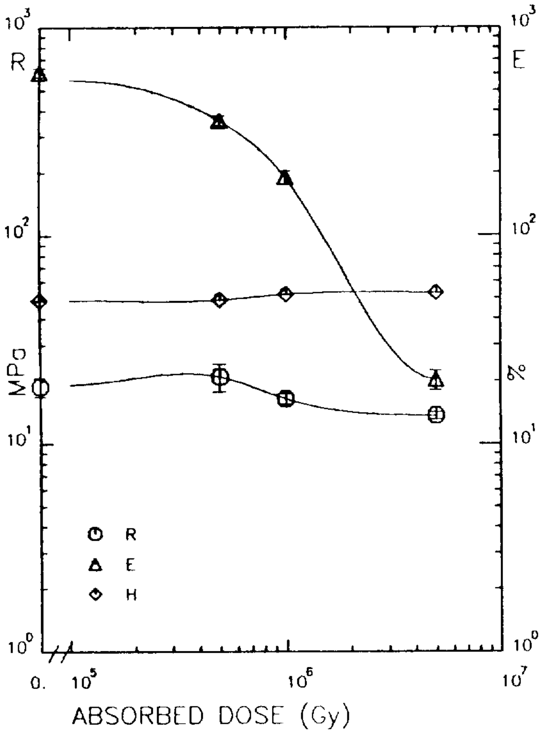
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.4 ± 2.0	471.3 ± 70.4	46.0 ± 0.0
0.000	0.0	13.7 ± 1.2	551.0 ± 35.8	47.0 ± 0.0
0.004	0.0	11.4 ± 2.2	457.0 ± 90.4	46.5 ± 0.0
0.015	0.1	13.2 ± 1.7	475.0 ± 66.6	47.0 ± 0.0
0.040	0.1	11.1 ± 1.3	396.0 ± 64.3	46.0 ± 0.0

RADIATION INDEX (0.1 Gy/h) > 4.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 783

MATERIAL : Polyethylene
TYPE : HT sheath 972
SUPPLIER : SILEC
REMARKS : (P)

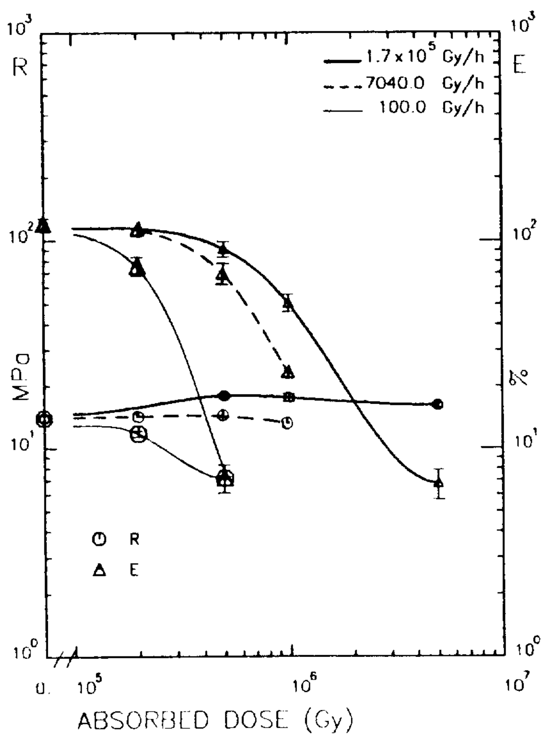
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	18.9 ± 2.0	609.6 ± 29.2	49.0 ± 0.0
0.500	1.8×10^5	21.0 ± 3.2	358.4 ± 19.9	49.0 ± 0.0
1.000	1.8×10^5	16.5 ± 1.0	190.4 ± 13.4	52.0 ± 0.0
5.000	1.8×10^5	13.7 ± 0.6	20.4 ± 2.2	53.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 17.1 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 790

MATERIAL : Polyethylene
TYPE : NCPE 1386
SUPPLIER : Neste Chemicals (Unifos)
REMARKS : (P)

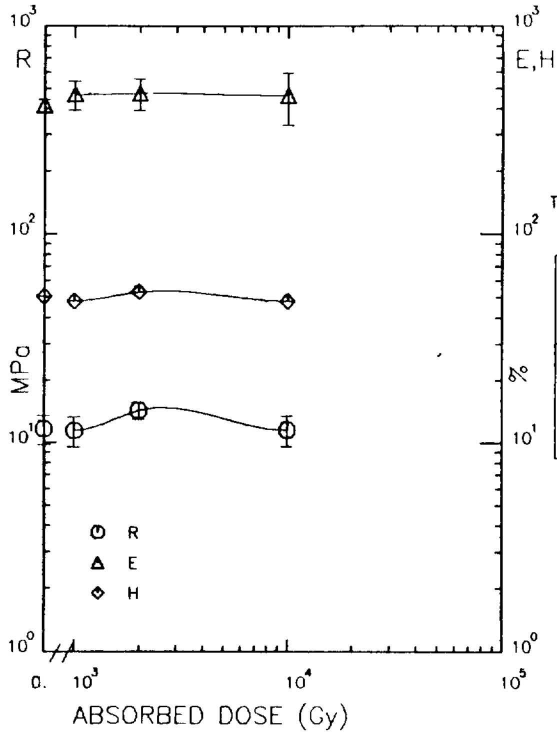
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.0 ± 0.5	121.0 ± 7.3	51.0 ± 0.0
0.500	1.7×10^5	18.0 ± 0.3	91.6 ± 7.9	54.0 ± 0.0
1.000	1.7×10^5	17.6 ± 0.7	50.8 ± 4.8	56.0 ± 0.0
5.000	1.7×10^5	16.2 ± 0.4	6.8 ± 1.1	68.0 ± 0.0
0.000	–	14.0 ± 0.5	121.0 ± 7.3	51.0 ± 0.0
0.200	6960.0	14.6 ± 0.4	120.8 ± 7.2	51.0 ± 0.0
0.500	7160.0	14.6 ± 0.5	72.0 ± 8.0	53.0 ± 0.0
1.000	6870.0	13.2 ± 0.2	24.0 ± 0.0	57.0 ± 0.0
0.000	–	14.0 ± 0.5	121.0 ± 7.3	51.0 ± 0.0
0.200	100.0	11.8 ± 0.4	76.0 ± 7.6	50.0 ± 0.0
0.500	100.0	7.2 ± 0.1	7.2 ± 1.1	51.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9
RADIATION INDEX (7015.0 Gy/h) : 5.7
RADIATION INDEX (100.0 Gy/h) : 5.3

OXYGEN INDEX(ISO 4589) : 38.8 %

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 866

MATERIAL : Polyethylene
TYPE : Lupolen 1817 HX
SUPPLIER : kabelmetal electro
REMARKS : Sheath of 2 kV cable 2YC2Y

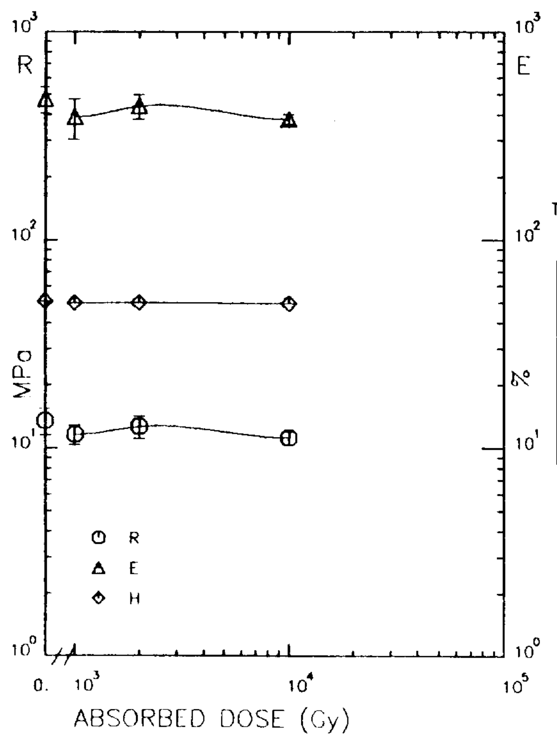
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.7 ± 1.8	414.4 ± 29.3	50.5 ± 0.0
0.001	0.0	11.4 ± 1.9	468.0 ± 73.2	48.0 ± 0.0
0.002	0.1	14.3 ± 1.3	475.0 ± 82.6	53.0 ± 0.0
0.010	0.4	11.6 ± 1.9	463.7 ±130.2	48.0 ± 0.0

RADIATION INDEX (0.4 Gy/h) > 4.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 867

MATERIAL : Polyethylene
TYPE : Lupolen 1812 DSK
SUPPLIER : kabelmetal electro
REMARKS : Insulation of 2kV cable 2YC2Y

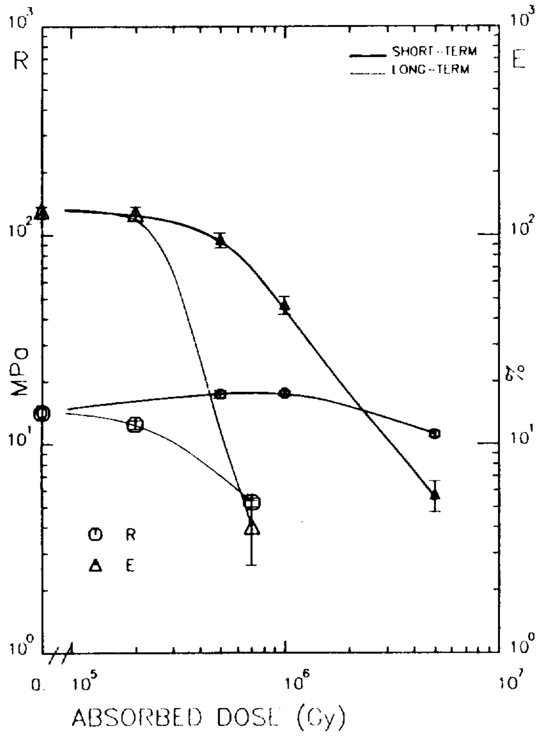
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.6 ± 2.0	474.4 ± 68.3	51.0 ± 0.0
0.001	0.0	11.7 ± 1.3	390.6 ± 86.6	50.0 ± 0.0
0.002	0.1	12.7 ± 1.5	438.6 ± 58.5	50.0 ± 0.0
0.010	0.1	11.2 ± 0.8	379.4 ± 21.0	49.5 ± 0.0

RADIATION INDEX (0.1 Gy/h) > 4.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 908

MATERIAL : Polyethylene
TYPE : NCPE 1386
SUPPLIER : Neste via Norsk Kabel EB
REMARKS : Taken from prototype cable

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.3 ± 0.9	126.5 ± 10.2	44.0 ± 0.0
0.500	2.5×10^5	17.4 ± 0.7	95.0 ± 7.9	47.0 ± 0.0
1.000	2.5×10^5	17.6 ± 0.4	46.5 ± 4.5	48.0 ± 0.0
5.000	2.5×10^5	11.2 ± 0.4	5.7 ± 1.0	54.0 ± 0.0
0.000	–	14.2 ± 1.0	131.5 ± 6.0	38.0 ± 0.0
0.200	100.0	12.4 ± 0.5	127.1 ± 9.4	41.5 ± 2.2
0.700	100.0	5.2 ± 0.3	4.0 ± 1.4	29.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 36.0 %
CORROSIVITY (DIN 57472) : PASS

POLYOLEFINS

POLYOLEFINS

Polyolefins are thermoplastic (or sometimes cross-linked) compounds, mainly based on copolymers obtained from polyethylene and other aliphatic monomers.

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
414	Acorad Insulation	Acome	0.0	–	18.3	443	42	32	
			0.5	2×10^5	16.9	194	44		
			1.0	2×10^5	13.1	112	40		
			5.0	2×10^5	9.9	20	43		
415	Acorad Sheath	Acome	0.0	–	17.6	442	51	27	
			0.5	2×10^5	16.4	120	58		
			1.0	2×10^5	16.5	50	55		
			5.0	2×10^5	19.2	20	60		
434	801 internal sheathing	Silec	0.0	–	3.7	621	27	42	
			0.5	2×10^5	9.6	40	43		
			1.0	2×10^5	10.6	32	47		
			5.0	2×10^5	15.2	16	62		
469	Sheath ISR cables	Cablexport/ Pirelli	0.0	–	11.5	205	25	29	
			0.5	2×10^5	12.8	120	31		5.9
			1.0	2×10^5	12.5	93	35		
			5.0	2×10^5	13.7	23	51		
472	Afumex Sheath	Pirelli	0.0	–	2.9	130	29	35	
			0.5	2×10^5	3.8	23	32		
			1.0	2×10^5	4.0	17	33		
			5.0	2×10^5	4.6	12	41		
519	BP/MCA 236 cured	BICC	0.0	–	16.7	527	42	27	
			0.5	2×10^5	16.7	302	45		5.8
			1.0	2×10^5	13.8	223	49		
			5.0	2×10^5	11.4	26	51		
520	BP/MCA 245 unirradiated	BICC	0.0	–	11.2	634	46	25	
			0.5	2×10^5	13.2	349	48		5.7
			1.0	2×10^5	9.0	160	52		
			5.0	2×10^5	12.3	22	53		
521	BP/MCA 245 irradiated	BICC	0.0	–	14.2	482	47	24	
			0.5	2×10^5	11.9	256	48		5.7
			1.0	2×10^5	9.7	146	50		
			5.0	2×10^5	11.9	24	39		
560	2 GV 38 AF/4 Sheath	Pirelli	0.0	–	10.8	325	34	28	
			0.5	2×10^5	10.3	197	35		5.9
			1.0	2×10^5	10.1	148	34		
			5.0	2×10^5	14.1	26	36		
684	Rheyhalon Sheath No longer in production	AEG-Kabel	0.0	–	6.2	202	41	46	
			0.5	2×10^5	8.0	78	42		
			1.0	2×10^5	7.0	54	39		
			5.0	2×10^5	12.9	17	55		
			0.2	94	7.7	89	45		
			0.5	94	8.3	46	48		
712	Cogegum AFR	Metallurgica Bresciana	0.0	–	8.3	505	42	24	
			0.5	2×10^5	9.5	152	44		
			1.0	2×10^5	9.5	57	45		
			5.0	2×10^5	10.7	12	55		

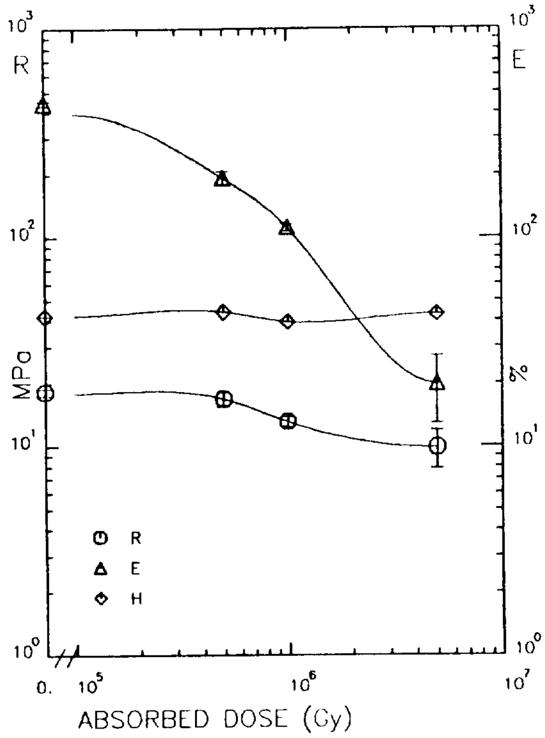
POLYOLEFINS

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
716	NCPE 5040	Neste (Unifos)	0.0	–	5.7	131	40	31	
			0.5	2×10^5	10.4	81	43		5.8
			1.0	2×10^5	9.9	51	40		
			5.0	2×10^5	16.4	8	64		
			0.2	100	7.9	93	45		5.4
			0.5	100	6.7	20	46		
746	Megolon S 2 Sheath	Lindsay & Williams	0.0	–	6.9	223	44	50	
			0.5	2×10^5	9.8	49	47		
			1.0	2×10^5	11.8	32	51		
			5.0	2×10^5	15.9	6	67		
747	Megolon I LV Insulation	Lindsay & Williams	0.0	–	6.1	444	32	26	
			0.5	2×10^5	6.1	161	34		
			1.0	2×10^5	7.5	66	37		
			5.0	2×10^5	11.7	16	52		
751	802 external sheathing	Silec	0.0	–	6.7	550	41	39	
			0.5	2×10^5	13.4	18	57		
			1.0	2×10^5	15.1	12	58		
			5.0	2×10^5	20.1	6	68		
754	BP D 2983 FR + LFHS 5040	Cabeltel	0.0	–	6.9	239	40	–	
			0.5	2×10^5	8.9	140	44		5.7
			1.0	2×10^5	10.0	76	46		
			5.0	2×10^5	13.0	14	58		
784	244 X-L Sheath	Silec	0.0	–	10.2	94	38	52	
			0.5	2×10^5	12.2	57	43		6.0
			1.0	2×10^5	11.6	47	46		
			5.0	2×10^5	15.7	12	53		
785	251 X-L Insulation	Silec	0.0	–	14.4	216	48	30	
			0.5	2×10^5	14.7	110	51		5.7
			1.0	2×10^5	13.3	40	50		
			5.0	2×10^5	13.6	12	58		
786	270 Thermopl. Sheath	Silec	0.0	–	11.6	161	48	35	
			0.5	2×10^5	13.2	130	50		5.9
			1.0	2×10^5	11.5	66	48		
			5.0	2×10^5	13.1	12	57		
788	ZH 33 Cross-linked	Acome	0.0	–	11.1	109	37	49	
			0.5	2×10^5	15.1	66	46		5.8
			1.0	2×10^5	15.0	43	49		
791	Cogegum AFR/1 Sheath	Padanaplast	0.0	–	12.0	551	42	35	
			0.2	7000	14.4	236	47		
			0.5	2×10^5	18.3	177	47		
			1.0	2×10^5	18.9	112	49		
			5.0	2×10^5	14.4	11	62		
			0.2	100	9.1	176	44		
			0.5	100	7.1	17	49		
			0.7	100	6.1	20	44		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
813	Rheyhalon	AEG-Kabel	0.0	-	15.8	174	48	32	
	Cross-linked		0.5	2×10^5	15.2	118	50		5.9
	Copolymer		1.0	2×10^5	14.9	80	51		
			5.0	2×10^5	15.1	15	59		
			0.2	100	16.9	147	51		
814	Rheyhalon	AEG-Kabel	0.0	-	13.2	172	46	37	
	Cross-linked		0.5	2×10^5	13.7	106	47		5.9
	Copolymer		1.0	2×10^5	13.7	74	48		
			5.0	2×10^5	16.6	16	59		
			0.2	100	14.6	187	49		
862	NCPE 5040	Dätwyler	0.0	-	8.8	141	44	38	
	Sheath of		0.2	2×10^5	13.8	117	46		5.9
	LEP cable		0.5	2×10^5	14.5	91	47		
			1.0	2×10^5	15.2	65	53		
			0.2	7000	11.8	121	42		5.7
			0.5	7000	12.4	79	45		
			1.0	7000	12.5	38	51		
			0.2	100	9.3	124	44		5.4
			0.5	100	7.1	30	46		
886	D 2979 FR	BP Chemicals	0.0	-	9.0	535	42	25	
	1987 plates		0.5	3×10^5	13.3	374	44		5.9
			1.0	3×10^5	10.0	190	45		
			5.0	3×10^5	10.8	12	52		
			0.2	100	7.4	464	40		5.4
			0.7	100	8.4	52	43		
891	Megolon S 1	Lindsay &	0.0	-	7.0	194	41	54	
	Sheath	Williams	0.5	2×10^5	8.7	57	43		
			1.0	2×10^5	9.9	33	46		
			5.0	2×10^5	12.4	7	61		
892	Megolon S 1	Lindsay &	0.0	-	7.8	97	44	53	
	Sheath	Williams	0.5	2×10^5	9.2	50	46		5.7
	annealed		1.0	2×10^5	9.7	33	47		
			5.0	2×10^5	11.9	7	66		
893	Megolon S300	Lindsay &	0.0	-	10.9	125	32	36	
	Sheath	Williams	0.5	2×10^5	12.5	62	35		5.6
			1.0	2×10^5	12.7	32	37		
			5.0	2×10^5	11.1	6	40		
			0.2	100	11.4	70	34		
914	Cogegum	Padanaplast	0.0	-	12.9	273	39	-	
	AFR/2	via NK EB	0.2	3600	15.6	168	47		5.5
	Sheath		0.5	2×10^5	14.6	96	42		
			1.0	2×10^5	15.3	60	47		
			5.0	2×10^5	8.0	10	51		
			0.2	100	10.1	117	43		
			0.7	100	5.3	9	45		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
937	ZH 33 (XL)	Acome	0.0	–	8.6	121	27	–	
	Sheath of		0.2	1100	9.6	87	29		5.6
	LEP cable		0.5	2200	10.0	54	39		
			1.0	2700	10.7	28	49		
			0.2	100	8.0	94	20		5.6
			0.7	100	4.9	50	22		
953	Megolon S300	Lindsay &	0.0	–	16.5	171	31	–	
	Sheath	Williams	0.2	2×10^5	16.7	147	42		6.1
	15 parts of		0.5	2×10^5	15.1	122	42		
	stabilizer		1.0	2×10^5	14.2	102	42		
			5.0	2×10^5	10.7	22	46		
			0.2	100	13.0	121	34		
954	Megolon S300	Lindsay &	0.0	–	14.8	154	32	–	
	Sheath	Williams	0.2	2×10^5	13.8	129	35		6.0
	10 parts of		0.5	2×10^5	13.6	112	39		
	stabilizer		1.0	2×10^5	13.1	87	42		
			5.0	2×10^5	10.5	14	46		
955	Megolon S2-1	Lindsay &	0.0	–	7.0	415	36	–	
	Sheath	Williams	0.2	2×10^5	6.8	301	37		5.5
			0.5	2×10^5	5.8	169	35		
			1.0	2×10^5	7.3	118	36		
			5.0	2×10^5	13.2	18	49		
			0.2	100	8.9	219	40		
956	Megolon S2-5	Lindsay &	0.0	–	5.6	486	35	–	
	Sheath	Williams	0.2	2×10^5	5.4	354	35		5.6
			0.5	2×10^5	5.9	226	35		
			1.0	2×10^5	7.0	164	35		
			5.0	2×10^5	11.7	25	47		
961	Cogegum	Padanaplast	0.0	–	6.4	560	34	36	
	AFR/11		0.2	2×10^5	7.7	553	34		5.8
	Sheath		0.5	2×10^5	6.5	418	35		
			1.0	2×10^5	5.2	37	36		
			5.0	2×10^5	6.6	5	50		
			0.2	3000	7.4	490	37		5.7
			0.5	3000	6.7	383	38		
			1.0	3000	6.3	24	41		
980	Rheyhalon	AEG-Kabel	0.0	–	13.7	237	45	37	
	Sheath		0.2	3000	13.1	207	46		5.8
	Radiation-		0.5	3000	12.8	169	48		
	resistant		1.0	3000	12.8	102	50		
981	Rheyhalon	AEG-Kabel	0.0	–	13.7	237	46	37	
	Sheath		0.2	3000	13.5	155	47		5.4
			0.5	3000	13.2	65	49		
			1.0	3000	9.2	9	51		
994	Rheyhalon	AEG-Kabel	0.0	–	6.4	216	40	–	
	Sheath of		0.2	7000	9.3	146	47		5.6
	production		0.5	7000	11.4	94	51		
	1 kV cable		1.0	7000	13.9	58	60		
			5.0	2×10^5	16.3	6	67		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 414

MATERIAL : Polyolefin
TYPE : Acorad
SUPPLIER : Acome
REMARKS : Insulation (P)

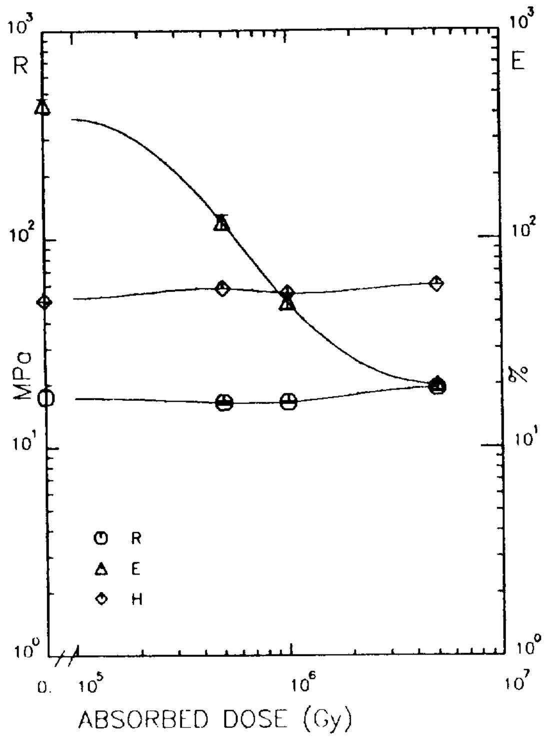
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	18.3 ± 0.7	443.0 ± 11.5	42.0 ± 0.0
0.500	1.7×10^5	16.9 ± 1.4	194.0 ± 13.9	44.0 ± 0.0
1.000	1.7×10^5	13.1 ± 0.7	112.0 ± 4.5	39.5 ± 0.0
5.000	1.7×10^5	9.9 ± 2.0	20.0 ± 7.1	43.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 415

MATERIAL : Polyolefin
TYPE : Acorad
SUPPLIER : Acome
REMARKS : Sheath (P)

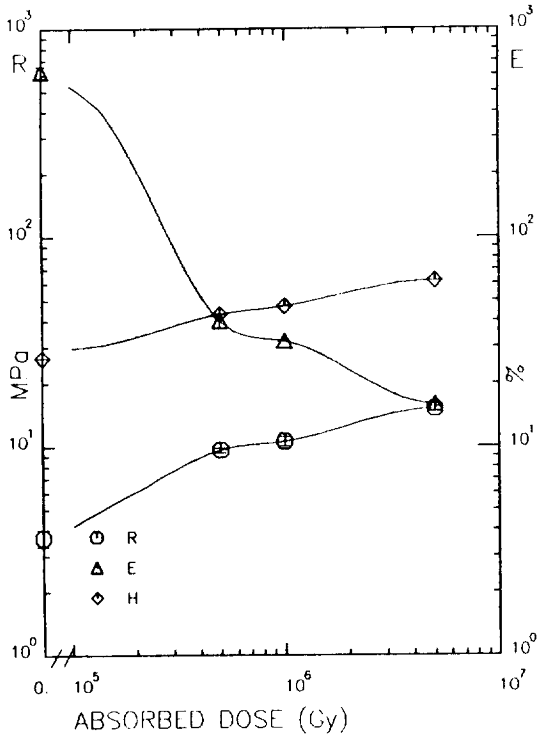
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	17.6 ± 1.3	442.0 ± 32.1	51.0 ± 0.0
0.500	1.7×10^5	16.4 ± 0.4	120.0 ± 10.0	58.0 ± 0.0
1.000	1.7×10^5	16.5 ± 0.2	50.0 ± 4.1	55.0 ± 0.0
5.000	1.7×10^5	19.2 ± 0.5	20.0 ± 0.0	60.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 434

MATERIAL : Polyolefin
TYPE : 801 – Internal sheath
SUPPLIER : SILEC
REMARKS : Flame retardant (P)

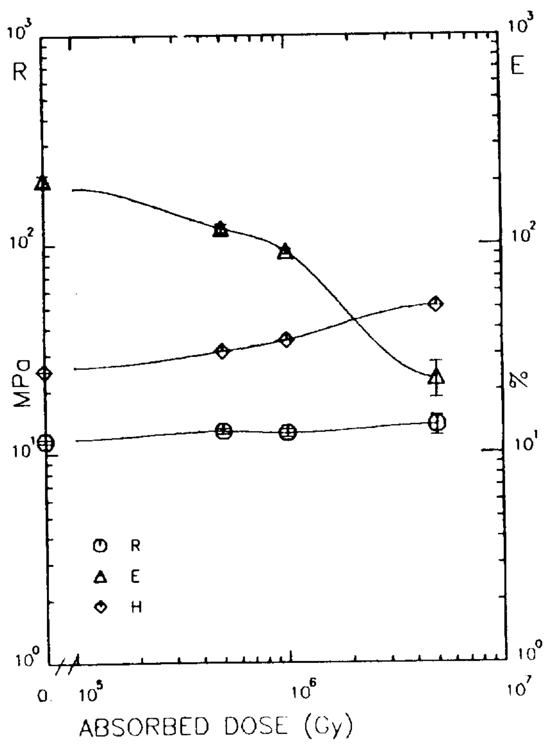
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	3.7 ± 0.3	621.0 ± 39.0	26.5 ± 0.0
0.500	1.7×10^5	9.6 ± 0.3	40.0 ± 3.3	43.0 ± 0.0
1.000	1.7×10^5	10.6 ± 0.6	32.0 ± 0.0	47.0 ± 0.0
5.000	1.7×10^5	15.2 ± 0.4	16.0 ± 0.0	62.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 42.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 469

MATERIAL : Polyolefin
TYPE : Sheath
SUPPLIER : Cablexport / Pirelli
REMARKS : ISR magnet cables (P)

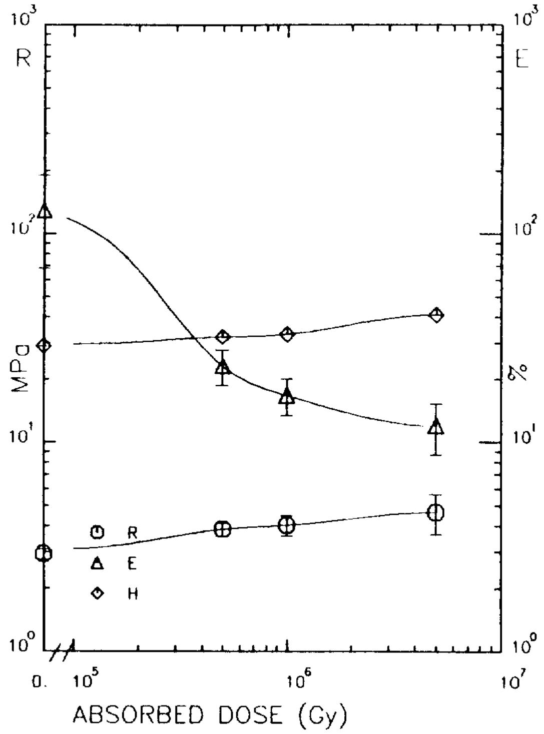
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.5 ± 0.2	205.0 ± 11.7	25.0 ± 0.0
0.500	1.7×10^5	12.8 ± 0.4	120.0 ± 6.1	31.0 ± 0.0
1.000	1.7×10^5	12.5 ± 0.6	93.0 ± 2.7	35.0 ± 0.0
5.000	1.7×10^5	13.7 ± 1.5	23.0 ± 4.5	51.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 472

MATERIAL : Polyolefin
TYPE : Afumex
SUPPLIER : Pirelli – A.Pasta
REMARKS : Surface deformations after irradiation

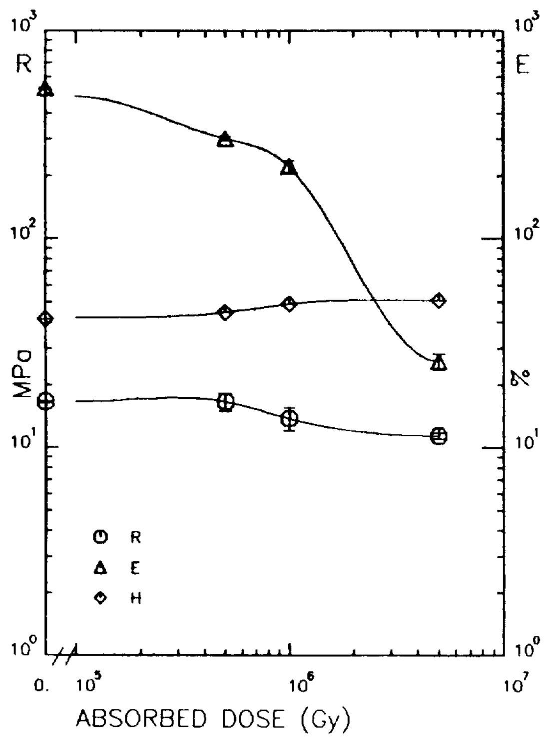
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	2.9 ± 0.2	129.6 ± 61.5	29.0 ± 0.0
0.500	1.7×10^5	3.8 ± 0.3	23.2 ± 4.4	32.0 ± 0.0
1.000	1.7×10^5	4.0 ± 0.4	16.8 ± 3.3	33.0 ± 0.0
5.000	1.7×10^5	4.6 ± 1.0	12.0 ± 3.3	41.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 35.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 519

MATERIAL : Polyolefin
TYPE : BP/MCA 236 – Cured
SUPPLIER : BICC
REMARKS : (P)

TEST RESULTS :

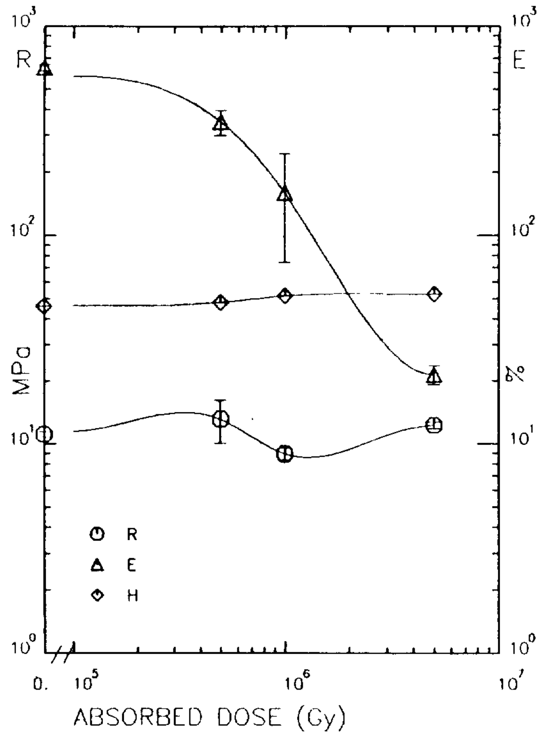
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	16.7 ± 0.2	527.0 ± 5.7	41.5 ± 0.0
0.500	1.7×10^5	16.7 ± 1.6	302.0 ± 6.7	44.5 ± 0.0
1.000	1.7×10^5	13.8 ± 1.7	222.5 ± 14.3	49.0 ± 0.0
5.000	1.7×10^5	11.4 ± 0.4	26.0 ± 2.2	51.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

POLYOLEFINS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 520

MATERIAL : Polyolefin
TYPE : BP/MCA 245 unirradiated
SUPPLIER : BICC
REMARKS : (P)

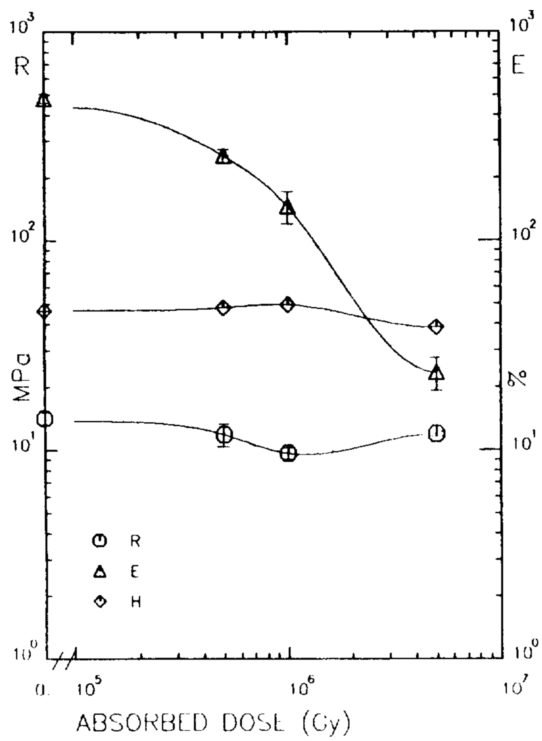
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.2 ± 0.3	634.0 ± 22.2	46.0 ± 0.0
0.500	1.7×10^5	13.2 ± 3.1	349.0 ± 47.4	48.0 ± 0.0
1.000	1.7×10^5	9.0 ± 0.6	160.0 ± 85.7	51.5 ± 0.0
5.000	1.7×10^5	12.3 ± 0.4	21.5 ± 2.2	52.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 521

MATERIAL : Polyolefin
TYPE : BP/MCA 245 Irradiated
SUPPLIER : BICC
REMARKS : (P)

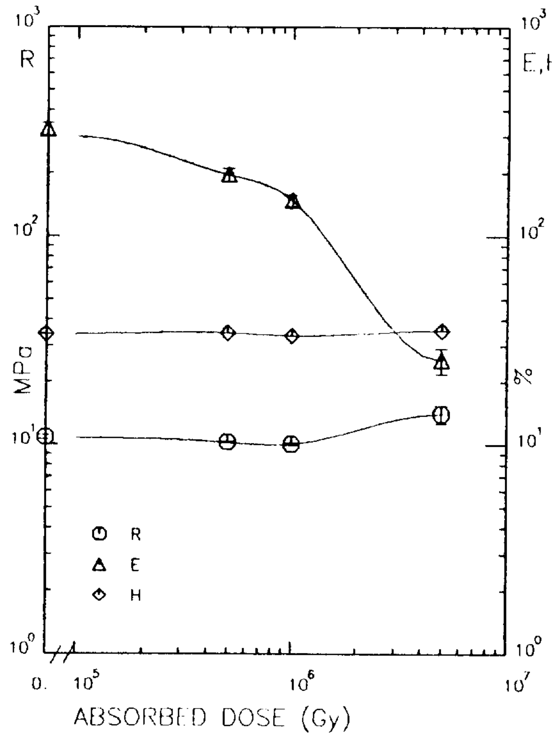
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.2 ± 1.0	481.5 ± 23.6	46.5 ± 0.0
0.500	1.7×10^5	11.9 ± 1.5	256.0 ± 19.2	48.0 ± 0.0
1.000	1.7×10^5	9.7 ± 0.6	146.0 ± 26.1	49.5 ± 0.0
5.000	1.7×10^5	11.9 ± 0.3	23.5 ± 4.2	38.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 560

MATERIAL : Polyolefin
TYPE : 2GV 38 AF/4
SUPPLIER : Pirelli
REMARKS : Sheath (P)

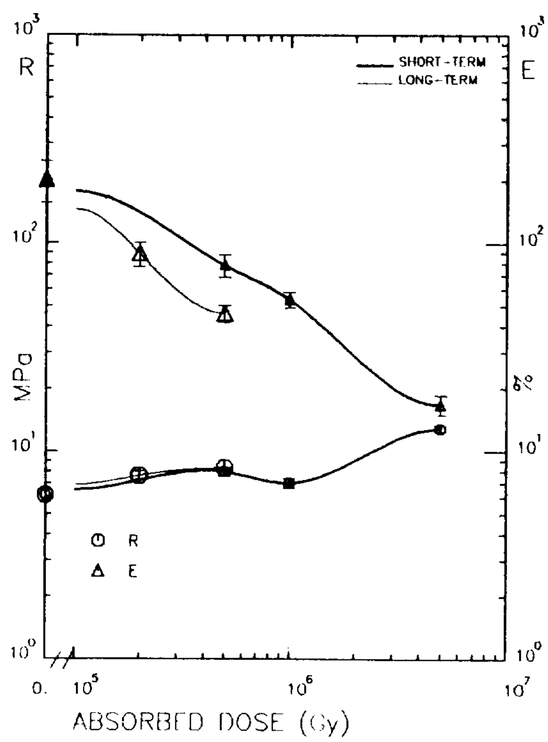
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.8 ± 0.2	324.8 ± 21.8	34.0 ± 0.0
0.500	2.0×10^5	10.3 ± 0.1	196.8 ± 14.3	34.5 ± 0.0
1.000	2.0×10^5	10.1 ± 0.1	148.0 ± 9.4	33.5 ± 0.0
5.000	2.0×10^5	14.1 ± 1.4	25.6 ± 3.6	35.5 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 684

MATERIAL : Polyolefin
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Cable sheath (P)

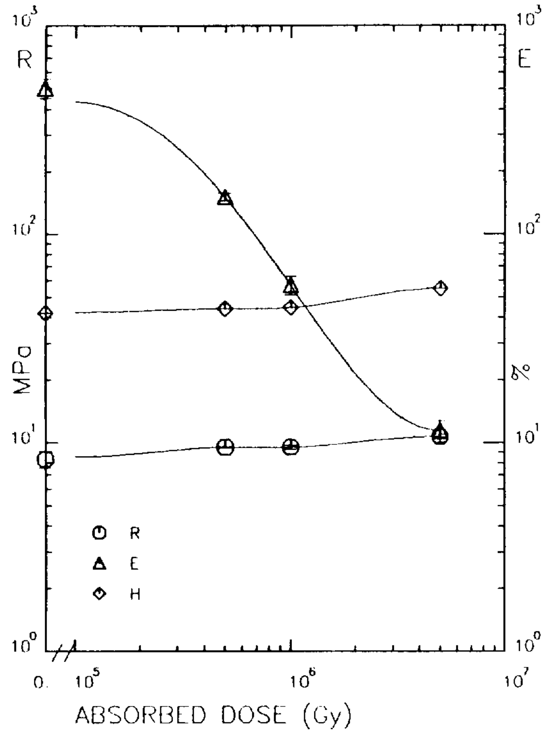
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.2 ± 0.4	201.6 ± 45.1	41.0 ± 0.0
0.500	1.7×10^5	8.0 ± 0.4	78.0 ± 9.8	42.0 ± 0.0
1.000	1.8×10^5	7.0 ± 0.4	53.6 ± 4.6	39.0 ± 0.0
5.000	1.9×10^5	12.9 ± 0.4	16.8 ± 1.8	55.0 ± 0.0
0.000	–	6.2 ± 0.4	201.6 ± 45.1	41.0 ± 0.0
0.200	94.0	7.7 ± 0.4	89.0 ± 11.9	45.0 ± 0.0
0.500	94.0	8.3 ± 0.1	46.0 ± 4.2	48.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7
RADIATION INDEX (94.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 46.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 712

MATERIAL : Polyolefin
TYPE : Cogegum AFR
SUPPLIER : Metallurgica Bresciana
REMARKS : (P)

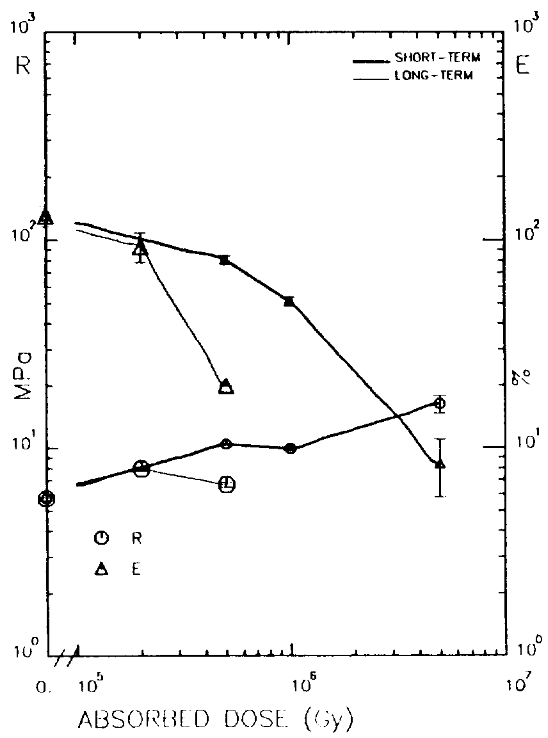
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	--	8.3 ± 0.8	505.0 ± 52.4	42.0 ± 0.0
0.500	1.7×10^5	9.5 ± 0.1	151.5 ± 6.5	44.0 ± 0.0
1.000	1.7×10^5	9.5 ± 0.2	57.0 ± 5.7	44.5 ± 0.0
5.000	1.7×10^5	10.7 ± 0.3	11.5 ± 1.4	55.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 23.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 716

MATERIAL : Polyolefin
TYPE : NCPE 5040
SUPPLIER : Neste Chemicals (Unifos)
REMARKS : Basis EVA (P)

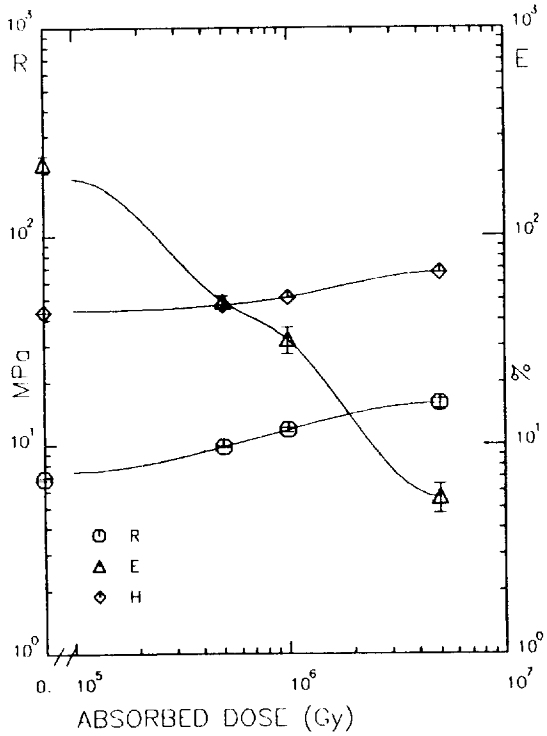
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	–	5.7 ± 0.1	130.8 ± 14.7	40.5 ± 0.0
0.500	1.7×10^5	10.4 ± 0.1	80.8 ± 3.3	43.5 ± 0.0
1.000	1.7×10^5	9.9 ± 0.2	51.2 ± 2.3	40.0 ± 0.0
5.000	1.7×10^5	16.4 ± 1.6	8.4 ± 2.6	64.5 ± 0.0
0.000	–	5.7 ± 0.1	130.8 ± 14.7	40.5 ± 0.0
0.200	100.0	7.9 ± 0.1	93.0 ± 14.8	45.0 ± 0.0
0.500	100.0	6.7 ± 0.2	20.0 ± 0.0	46.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 746

MATERIAL : Polyolefin
TYPE : Megolon S2
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : Halogen-free cable jacket (P)

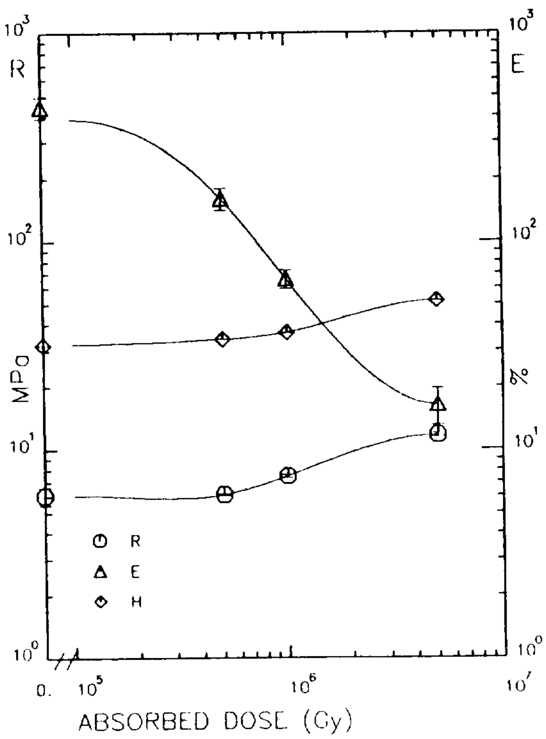
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.9 ± 0.1	223.2 ± 18.4	43.5 ± 0.0
0.500	1.8×10^5	9.8 ± 0.1	48.8 ± 3.0	47.0 ± 0.0
1.000	1.8×10^5	11.8 ± 0.3	32.0 ± 4.7	51.0 ± 0.0
5.000	1.8×10^5	15.9 ± 0.8	5.6 ± 0.9	67.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 49.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 747

MATERIAL : Polyolefin
TYPE : Megolon I
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : Low-voltage insulation (P)

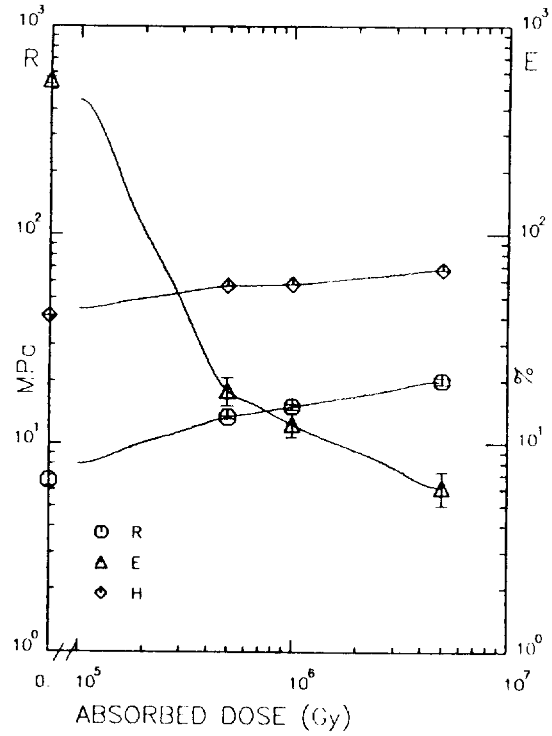
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.1 ± 0.6	444.0 ± 52.2	32.0 ± 0.0
0.500	1.8×10^5	6.1 ± 0.0	160.8 ± 19.5	34.0 ± 0.0
1.000	1.8×10^5	7.5 ± 0.1	66.4 ± 6.7	36.5 ± 0.0
5.000	1.8×10^5	11.7 ± 0.2	16.4 ± 3.3	52.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 751

MATERIAL : Polyolefin
TYPE : 802 – External sheath
SUPPLIER : SILEC
REMARKS : Flame retardant (P)

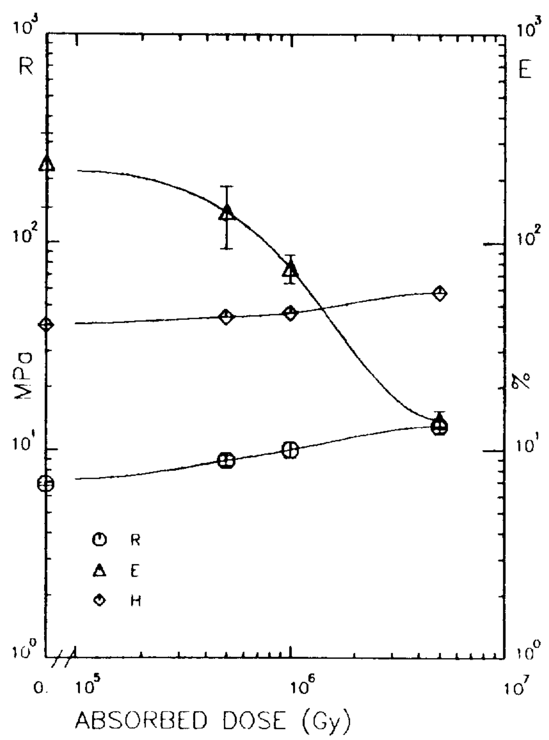
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.7 ± 0.4	550.0 ± 22.2	41.0 ± 0.0
0.500	1.8×10^5	13.4 ± 0.2	18.0 ± 2.8	57.0 ± 0.0
1.000	1.8×10^5	15.1 ± 0.4	12.4 ± 1.7	58.0 ± 0.0
5.000	1.8×10^5	20.1 ± 0.7	6.2 ± 1.2	68.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 38.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 754

MATERIAL : Polyolefins compound
TYPE : 50% D 2983 + 50% LFHS 5040
SUPPLIER : Cabeltel
REMARKS : (BP + Neste) (P)

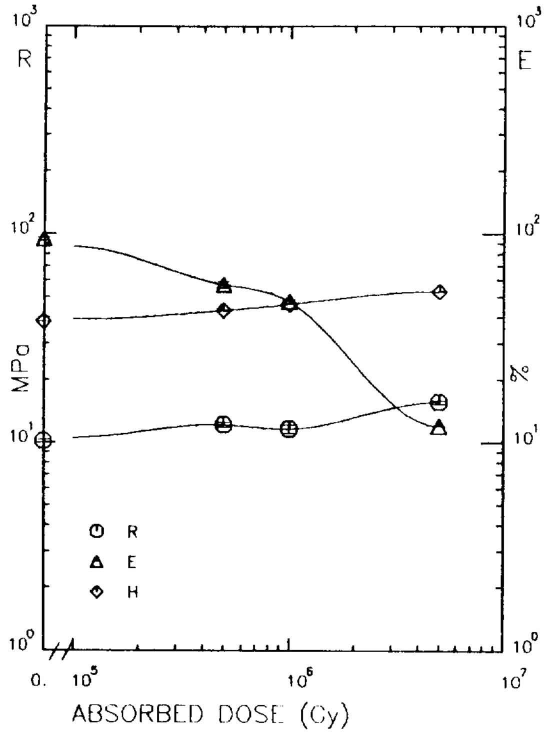
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.9 ± 0.1	239.0 ± 93.2	40.0 ± 0.0
0.500	1.8×10^5	8.9 ± 0.5	140.0 ± 46.5	44.0 ± 0.0
1.000	1.8×10^5	10.0 ± 0.8	76.0 ± 11.8	46.0 ± 0.0
5.000	1.8×10^5	13.0 ± 0.8	14.0 ± 1.4	58.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 784

MATERIAL : Crosslinked polyolefin
TYPE : Sheath 244
SUPPLIER : SILEC
REMARKS : Flame retardant (P)

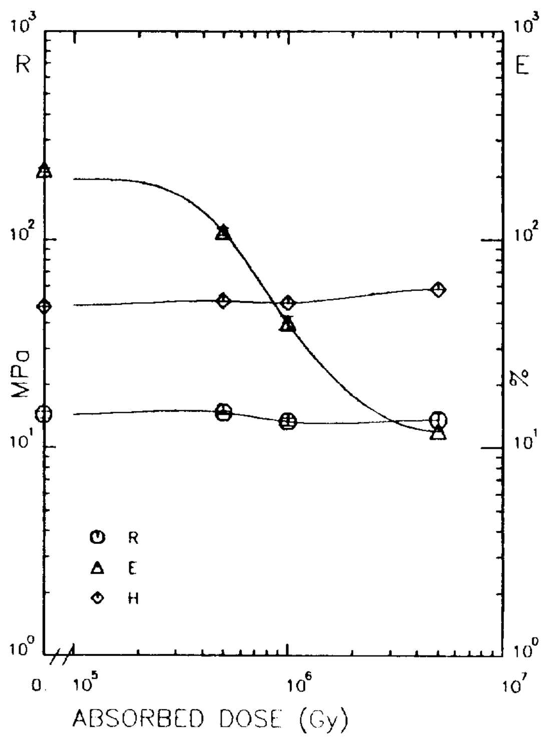
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.2 ± 0.2	94.4 ± 1.7	38.0 ± 0.0
0.500	1.8×10^5	12.2 ± 0.3	57.0 ± 2.0	43.0 ± 0.0
1.000	1.8×10^5	11.6 ± 0.5	47.5 ± 1.0	46.0 ± 0.0
5.000	1.8×10^5	15.7 ± 0.3	12.0 ± 0.0	53.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 51.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 785

MATERIAL : Crosslinked polyolefin
TYPE : Insulation 251
SUPPLIER : SILEC
REMARKS : Flame retardant (P)

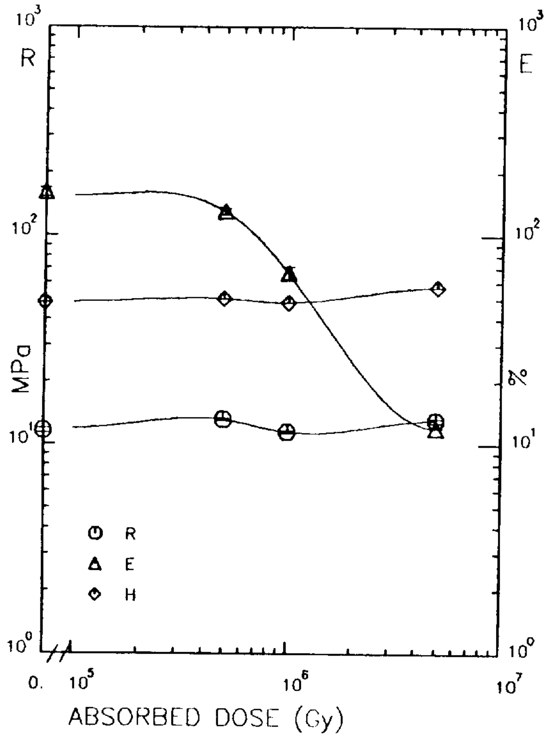
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.4 ± 0.5	216.4 ± 5.4	48.0 ± 0.0
0.500	1.8×10^5	14.7 ± 0.3	109.6 ± 4.6	51.0 ± 0.0
1.000	1.8×10^5	13.3 ± 0.6	40.0 ± 3.3	50.0 ± 0.0
5.000	1.8×10^5	13.6 ± 1.1	12.0 ± 0.0	58.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 786

MATERIAL : Thermoplastic polyolefin
TYPE : Sheath 270
SUPPLIER : SILEC
REMARKS : Flame retardant (P)

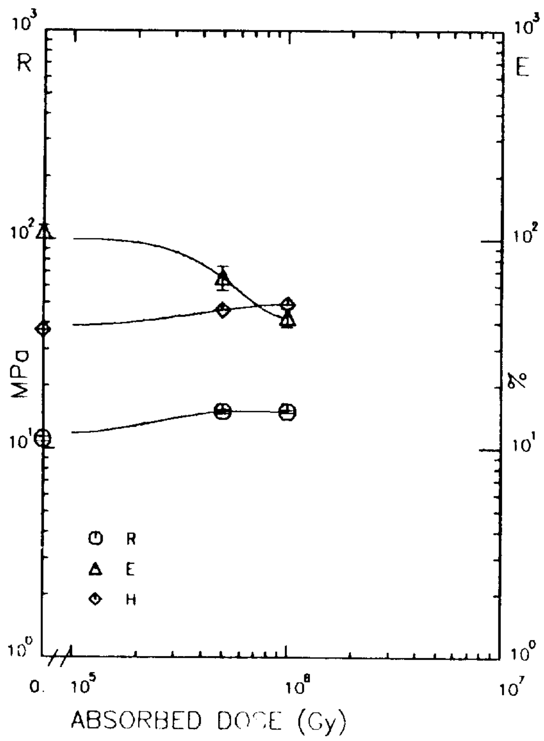
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.6 ± 0.3	160.8 ± 8.2	48.0 ± 0.0
0.500	1.8×10^5	13.2 ± 0.2	130.4 ± 4.6	50.0 ± 0.0
1.000	1.8×10^5	11.5 ± 0.2	66.4 ± 4.6	48.0 ± 0.0
5.000	1.8×10^5	13.1 ± 0.3	12.0 ± 0.0	57.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 788

MATERIAL : X-L. Polyolefin
TYPE : ZH 33
SUPPLIER : Acome
REMARKS : Sheath (Ribbon)

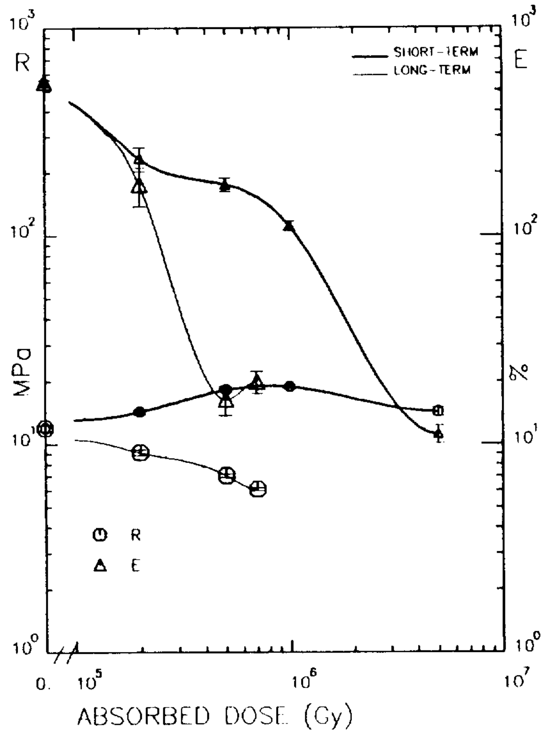
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.1 ± 0.3	108.5 ± 8.2	37.0 ± 0.0
0.500	1.7×10^5	15.1 ± 0.4	65.8 ± 8.8	46.0 ± 0.0
1.000	1.7×10^5	15.0 ± 0.3	42.5 ± 4.3	49.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 49.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 791

MATERIAL : EPDM + EVA
TYPE : Cogegum AFR/1
SUPPLIER : Padanaplast
REMARKS : sheath (P)

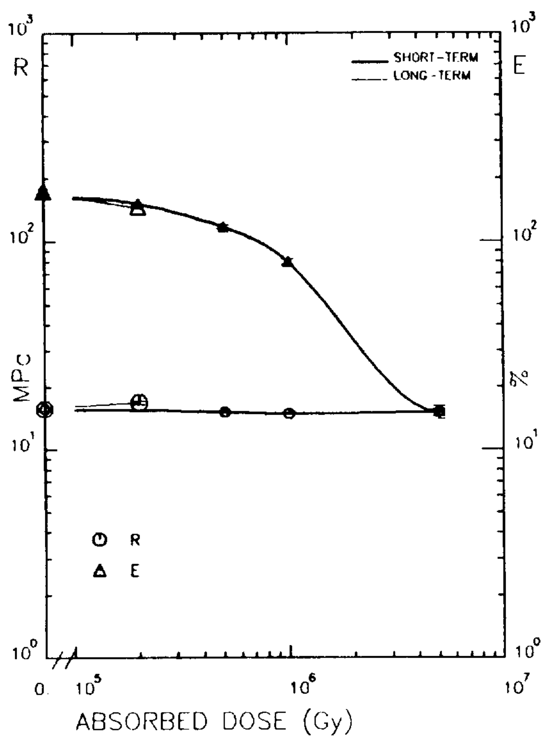
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.0 ± 0.4	551.2 ± 11.8	42.0 ± 0.0
0.200	6960.0	14.4 ± 0.3	236.0 ± 31.5	47.0 ± 0.0
0.500	1.8×10^5	18.3 ± 0.3	176.8 ± 13.6	47.0 ± 0.0
1.000	1.8×10^5	18.9 ± 0.3	112.0 ± 5.7	49.0 ± 0.0
5.000	1.8×10^5	14.4 ± 0.7	11.2 ± 1.1	62.0 ± 0.0
0.000	–	12.0 ± 0.4	551.2 ± 11.8	42.0 ± 0.0
0.200	100.0	9.1 ± 0.3	176.0 ± 37.0	44.3 ± 1.1
0.500	100.0	7.1 ± 0.2	16.4 ± 2.6	49.0 ± 0.0
0.700	100.0	6.1 ± 0.1	20.0 ± 2.4	44.0 ± 0.0

RADIATION INDEX (6960.0 Gy/h) < 5.3
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 813

MATERIAL : PE Copolymer cross-linked
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Flame retardant insulation (P)

TEST RESULTS :

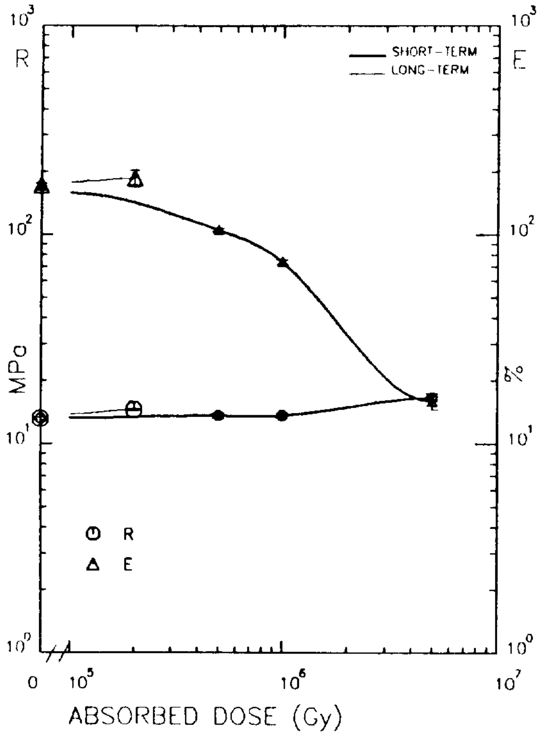
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	15.8 ± 0.2	174.4 ± 4.6	48.0 ± 0.0
0.500	1.9×10^5	15.2 ± 0.1	117.6 ± 2.2	50.0 ± 0.0
1.000	1.7×10^5	14.9 ± 0.1	80.0 ± 2.8	51.0 ± 0.0
5.000	1.7×10^5	15.1 ± 0.6	15.2 ± 1.1	59.0 ± 0.0
0.000	–	15.8 ± 0.2	174.4 ± 4.6	48.0 ± 0.0
0.200	100.0	16.9 ± 0.3	147.2 ± 3.3	51.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.6 %
CORROSIVITY (DIN 57472) : PASS

POLYOLEFINS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 814

MATERIAL : PE Copolymer cross-linked
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Flame retardant insulation (P)

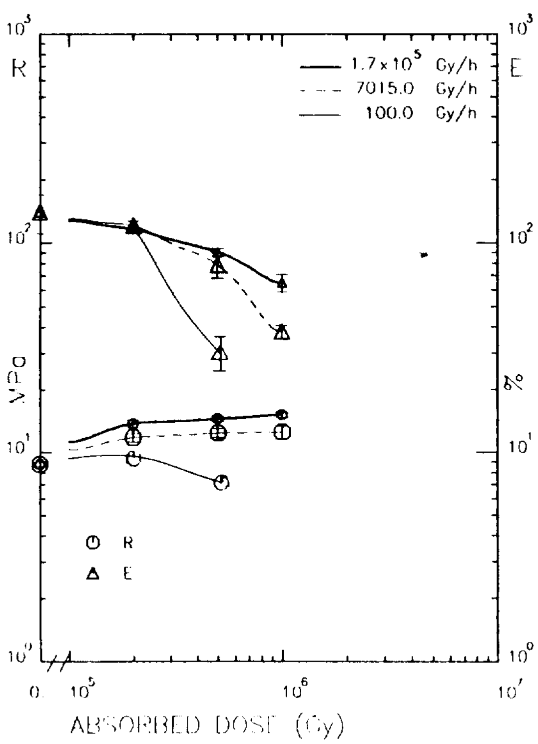
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.2 ± 0.2	172.0 ± 4.9	46.0 ± 0.0
0.500	1.9×10^5	13.7 ± 0.4	105.6 ± 1.7	46.5 ± 0.0
1.000	1.7×10^5	13.7 ± 0.3	74.0 ± 2.0	48.0 ± 0.0
5.000	1.7×10^5	16.6 ± 0.3	16.0 ± 1.4	59.0 ± 0.0
0.000	–	13.2 ± 0.2	172.0 ± 4.9	46.0 ± 0.0
0.200	100.0	14.6 ± 0.1	187.0 ± 16.8	49.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.1 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 862

MATERIAL : Polyolefin
TYPE : red NCPE 5040 by Neste
SUPPLIER : Dätwyler
REMARKS : Taken from LEP SVA-11 cable sheath

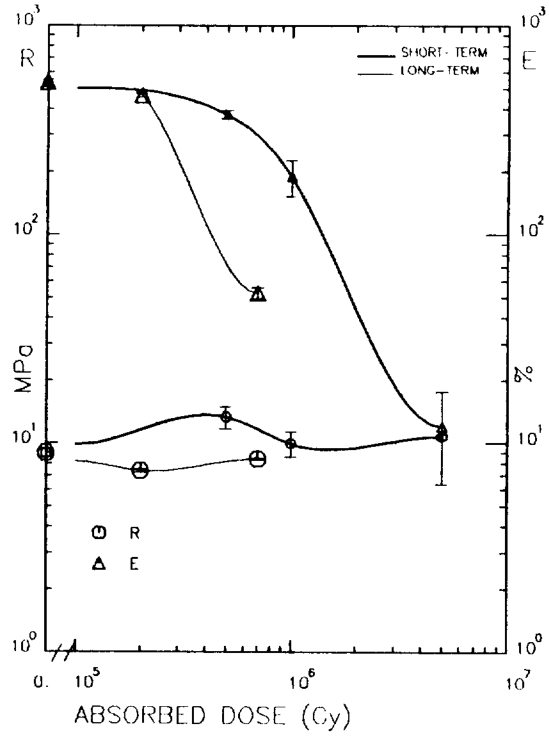
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.8 ± 0.2	140.5 ± 29.5	44.0 ± 0.0
0.200	1.7×10^5	13.8 ± 0.6	116.5 ± 2.2	46.0 ± 0.0
0.500	1.7×10^5	14.5 ± 0.4	90.5 ± 3.7	47.0 ± 0.0
1.000	1.7×10^5	15.2 ± 0.4	65.0 ± 6.1	53.0 ± 0.0
0.000	–	8.8 ± 0.2	140.5 ± 29.5	44.0 ± 0.0
0.200	6960.0	11.8 ± 0.5	121.0 ± 6.5	42.0 ± 0.0
0.500	7160.0	12.4 ± 0.6	79.0 ± 10.8	45.0 ± 0.0
1.000	6870.0	12.5 ± 0.9	38.0 ± 2.7	51.0 ± 0.0
0.000	–	8.8 ± 0.2	140.5 ± 29.5	44.0 ± 0.0
0.200	100.0	9.3 ± 0.6	124.0 ± 7.4	44.0 ± 0.0
0.500	100.0	7.1 ± 0.4	30.0 ± 5.6	45.9 ± 2.9

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9
RADIATION INDEX (7015.0 Gy/h) : 5.7
RADIATION INDEX (100.0 Gy/h) : 5.4

OXYGEN INDEX(ISO 4589) : 38.2 %

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 886

MATERIAL : Polyolefin thermoplastic
TYPE : D 2979 FR
SUPPLIER : BP Chemicals
REMARKS : 1987 plates

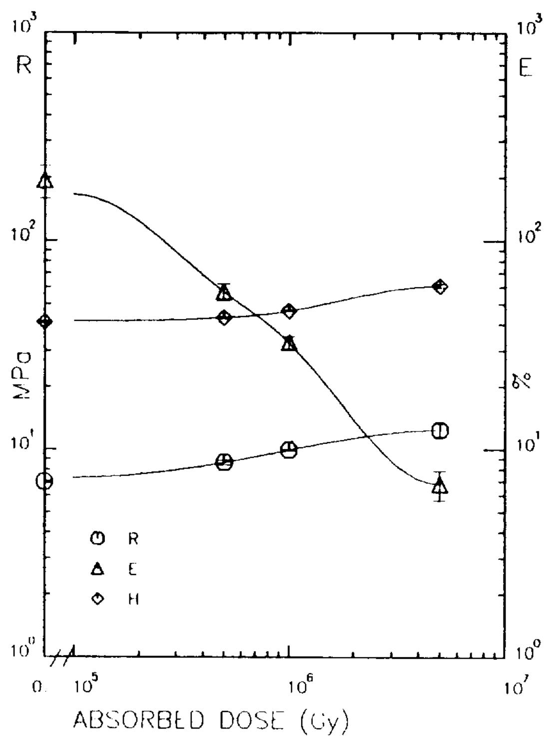
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.0 ± 0.4	535.2 ± 16.8	42.0 ± 0.0
0.500	2.7×10^5	13.3 ± 1.6	374.4 ± 18.0	44.5 ± 0.0
1.000	2.7×10^5	10.0 ± 1.3	189.6 ± 37.2	45.0 ± 0.0
5.000	2.7×10^5	10.8 ± 0.3	12.0 ± 5.7	52.0 ± 0.0
0.000	–	9.0 ± 0.4	535.2 ± 16.8	42.0 ± 0.0
0.200	100.0	7.4 ± 0.2	464.0 ± 8.5	39.8 ± 0.4
0.700	100.0	8.4 ± 0.1	52.4 ± 3.3	43.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) : 5.9
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 891

MATERIAL : Polyolefin
TYPE : Megolon S1
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : (P)

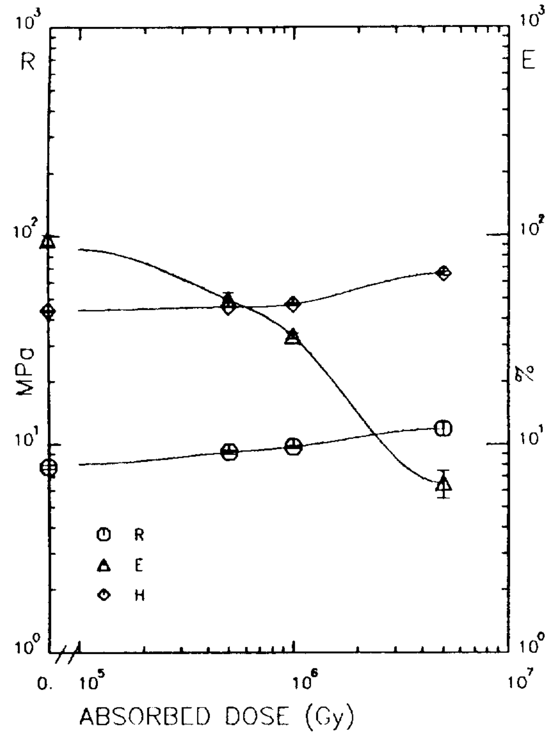
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.0 ± 0.1	193.6 ± 34.5	41.1 ± 0.4
0.500	2.5×10^5	8.7 ± 0.2	57.2 ± 5.2	43.1 ± 0.4
1.000	2.5×10^5	9.9 ± 0.1	32.8 ± 2.3	46.3 ± 0.3
5.000	2.5×10^5	12.4 ± 0.9	6.8 ± 1.1	61.0 ± 1.2

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 53.5 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 892

MATERIAL : Polyolefin
TYPE : Megolon S1
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : Annealed (P)

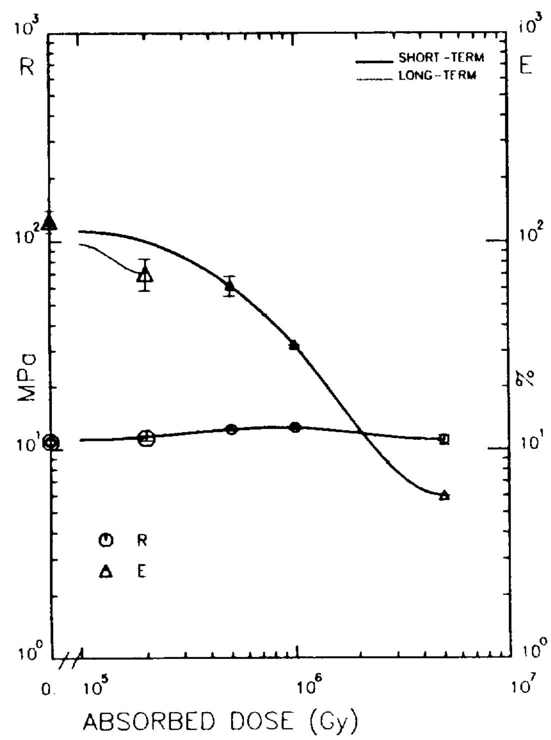
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.8 ± 0.2	96.5 ± 5.3	44.0 ± 0.4
0.500	2.5×10^5	9.2 ± 0.2	49.6 ± 3.8	45.7 ± 0.3
1.000	2.5×10^5	9.7 ± 0.1	33.2 ± 1.1	47.0 ± 0.5
5.000	2.5×10^5	11.9 ± 0.9	6.5 ± 1.0	65.8 ± 1.3

RADIATION INDEX (2.5×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 53.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 893

MATERIAL : Polyolefin
TYPE : Megolon S 300
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : Extruded (S1)

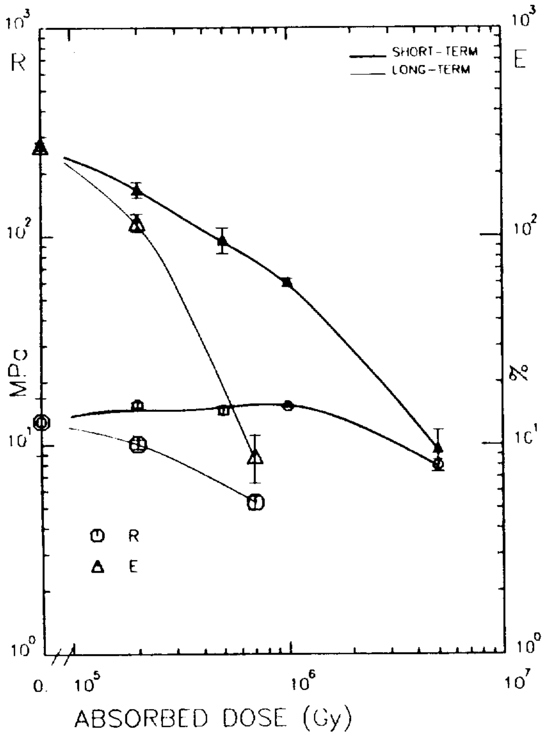
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.9 ± 0.2	125.2 ± 15.1	31.8 ± 4.0
0.500	2.5×10^5	12.5 ± 0.1	61.6 ± 6.7	35.0 ± 0.0
1.000	2.5×10^5	12.7 ± 0.2	32.0 ± 0.0	36.6 ± 0.5
5.000	2.5×10^5	11.1 ± 0.6	6.0 ± 0.0	40.0 ± 0.0
0.000	–	10.9 ± 0.2	125.2 ± 15.1	31.8 ± 4.0
0.200	100.0	11.4 ± 0.3	70.4 ± 12.2	34.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 36.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 914

MATERIAL : Polyolefin EVA + PE
TYPE : Cogegum AFR 2
SUPPLIER : Padanaplast via Norsk-Kabel EB
REMARKS : from prototype cable sheath

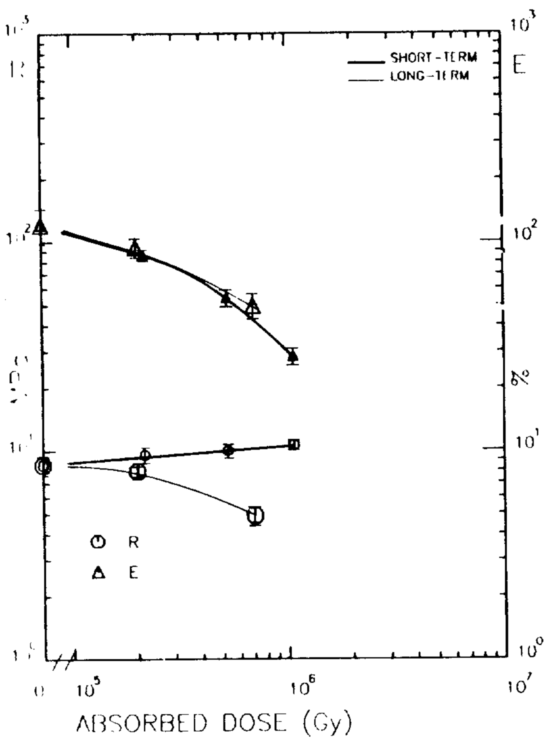
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.9 ± 4.0	272.7 ± 11.7	39.0 ± 1.5
0.200	3600.0	15.6 ± 0.4	167.6 ± 14.2	47.0 ± 1.2
0.500	2.5×10^5	14.6 ± 0.7	96.0 ± 13.6	42.0 ± 0.0
1.000	2.5×10^5	15.3 ± 0.2	60.0 ± 2.8	47.0 ± 0.0
5.000	2.5×10^5	8.0 ± 0.5	9.6 ± 2.2	51.0 ± 0.0
0.000	–	12.9 ± 4.0	272.7 ± 11.7	39.0 ± 1.5
0.200	100.0	10.1 ± 0.5	116.8 ± 11.8	42.8 ± 1.0
0.700	100.0	5.3 ± 0.4	8.8 ± 2.3	45.0 ± 0.0

RADIATION INDEX (1.3×10^5 Gy/h) : 5.5
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 937

MATERIAL : Cross-linked polyolefin
TYPE : ZH 33
SUPPLIER : Acome
REMARKS : Taken from sheath of VBA 4 /LEP

TEST RESULTS :

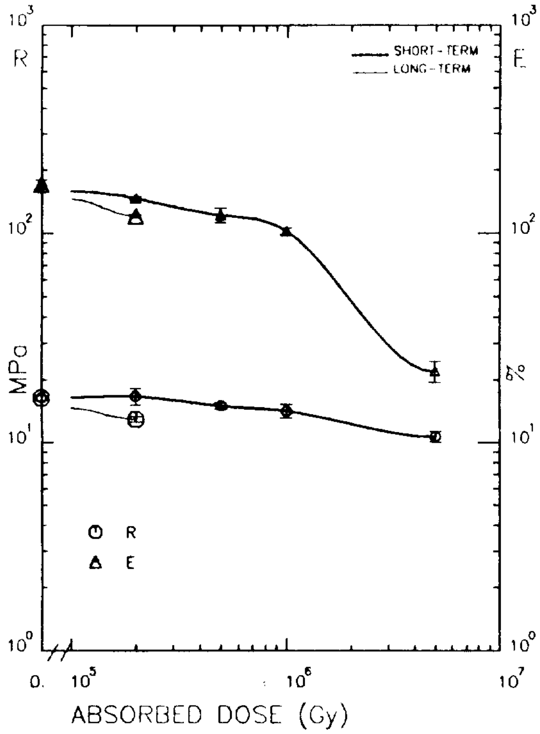
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.6 ± 0.9	120.8 ± 23.1	27.0 ± 0.0
0.217	1[illegible]20.0	9.6 ± 0.8	86.7 ± 5.2	29.0 ± 0.0
0.523	2[illegible]20.0	10.0 ± 0.8	54.2 ± 4.9	39.0 ± 0.0
1.070	2[illegible]10.0	10.7 ± 0.6	28.3 ± 2.6	49.0 ± 0.0
0.000	–	8.6 ± 0.9	120.8 ± 23.1	27.0 ± 0.0
0.200	100.0	8.0 ± 0.4	94.2 ± 9.7	20.0 ± 0.0
0.700	100.0	4.9 ± 0.5	49.6 ± 6.8	22.0 ± 0.0

RADIATION INDEX (1670.0 Gy/h) : 5.6
RADIATION INDEX (100.0 Gy/h) : 5.6

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

POLYOLEFINS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 953

MATERIAL : Polyolefin
TYPE : Megolon S300-15
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : 15 parts of stabiliser (P)

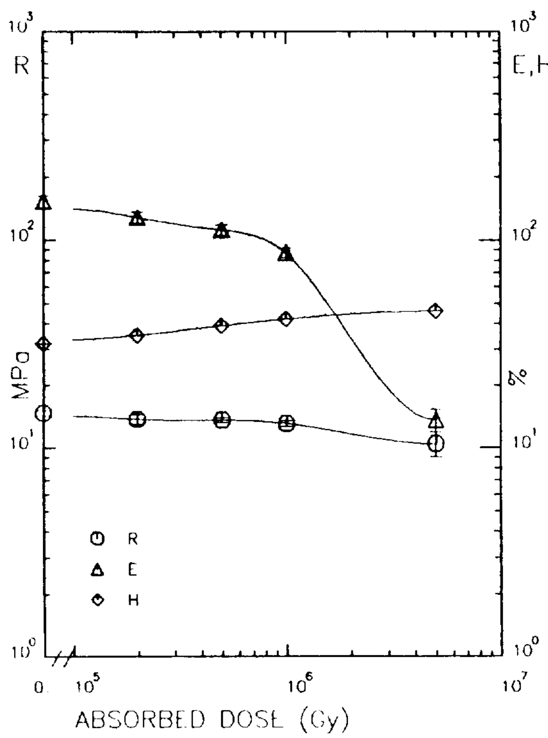
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	16.5 ± 0.4	171.2 ± 8.7	31.0 ± 0.0
0.200	2.4×10^5	16.7 ± 1.5	147.2 ± 3.3	42.0 ± 0.0
0.500	2.4×10^5	15.1 ± 0.5	122.4 ± 10.0	42.0 ± 0.0
1.000	2.4×10^5	14.2 ± 1.0	102.4 ± 3.6	42.0 ± 0.0
5.000	2.2×10^5	10.7 ± 0.6	22.0 ± 2.5	46.0 ± 0.0
0.000	–	16.5 ± 0.4	171.2 ± 8.7	31.0 ± 0.0
0.200	100.0	13.0 ± 0.4	120.8 ± 2.3	34.0 ± 0.0

RADIATION INDEX (2.3×10^5 Gy/h) : 6.1
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 954

MATERIAL : Polyolefin
TYPE : Megolon S300-10
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : 10 parts of stabiliser (P)

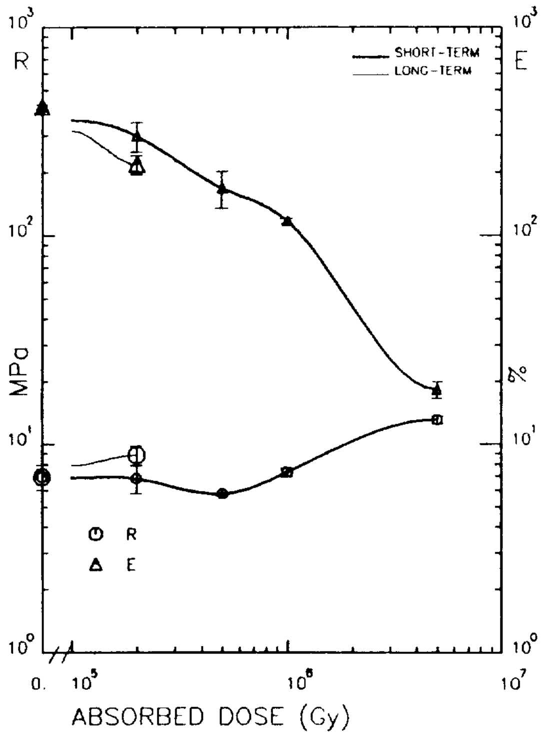
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.8 ± 0.4	153.6 ± 10.0	32.0 ± 0.0
0.200	2.4×10^5	13.8 ± 0.8	128.8 ± 7.7	35.0 ± 0.0
0.500	2.4×10^5	13.6 ± 0.3	112.0 ± 6.9	39.0 ± 0.0
1.000	2.4×10^5	13.1 ± 0.4	87.2 ± 4.4	42.0 ± 0.0
5.000	2.2×10^5	10.5 ± 1.4	13.6 ± 1.7	46.0 ± 0.0

RADIATION INDEX (2.3×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 955

MATERIAL : Polyolefin
TYPE : Megolon S2-1
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : (P)

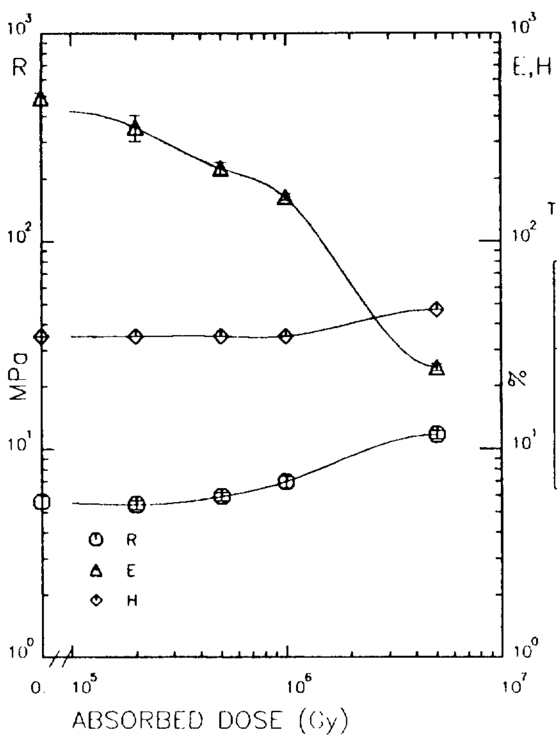
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.0 ± 0.9	415.2 ± 11.8	36.0 ± 0.0
0.200	2.4×10^5	6.8 ± 1.0	300.8 ± 48.2	37.0 ± 0.0
0.500	2.4×10^5	5.8 ± 0.1	168.8 ± 33.9	35.0 ± 0.0
1.000	2.4×10^5	7.3 ± 0.4	117.6 ± 3.6	36.0 ± 0.0
5.000	2.2×10^5	13.2 ± 0.5	18.4 ± 1.7	49.0 ± 0.0
0.000	–	7.0 ± 0.9	415.2 ± 11.8	36.0 ± 0.0
0.200	100.0	8.9 ± 0.9	219.3 ± 23.5	40.0 ± 0.0

RADIATION INDEX (2.4×10^5 Gy/h) : 5.5
RADIATION INDEX (100.0 Gy/h) > 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 956

MATERIAL : Polyolefin
TYPE : Megolon S2-5
SUPPLIER : Lindsay & Williams, Ltd.
REMARKS : More stabiliser than in S2-1

TEST RESULTS :

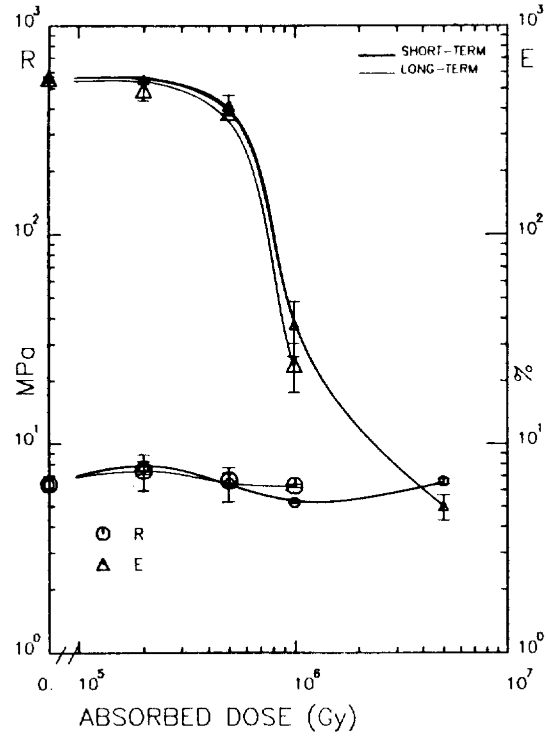
Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.6 ± 0.4	486.4 ± 31.7	35.0 ± 0.0
0.200	2.4×10^5	5.4 ± 0.3	353.6 ± 50.1	35.0 ± 0.0
0.500	2.4×10^5	5.9 ± 0.3	225.6 ± 15.1	35.0 ± 0.0
1.000	2.4×10^5	7.0 ± 0.5	164.0 ± 6.3	35.0 ± 0.0
5.000	2.2×10^5	11.7 ± 0.5	24.7 ± 0.9	47.0 ± 0.0

RADIATION INDEX (2.4×10^5 Gy/h) : 5.6

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

POLYOLEFINS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 961

MATERIAL : EPDM + EVA
TYPE : Cogegum AFR 11
SUPPLIER : Padanaplast
REMARKS : Grey sheath (P)

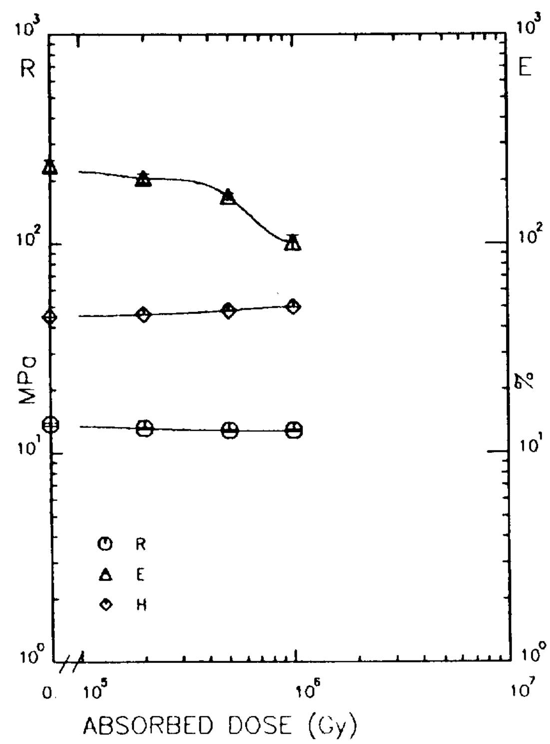
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 0.4	560.0 ± 12.2	34.0 ± 0.0
0.200	2.0×10^5	7.7 ± 0.6	553.0 ± 16.0	34.0 ± 0.0
0.500	2.0×10^5	6.5 ± 1.2	418.0 ± 46.4	34.5 ± 0.6
1.000	2.0×10^5	5.2 ± 0.0	37.0 ± 10.8	36.3 ± 0.7
5.000	2.0×10^5	6.6 ± 0.2	5.0 ± 0.7	50.0 ± 0.0
0.000	–	6.4 ± 0.4	560.0 ± 12.2	34.0 ± 0.0
0.200	3113.0	7.4 ± 1.5	490.0 ± 52.7	37.0 ± 0.0
0.500	3215.0	6.7 ± 0.5	383.0 ± 7.6	38.0 ± 0.0
1.000	3210.0	6.3 ± 0.1	24.0 ± 6.3	41.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.8
RADIATION INDEX (3212.5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 36.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 980

MATERIAL : Polyolefin
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : 'Radiation Resistant' sheath compound

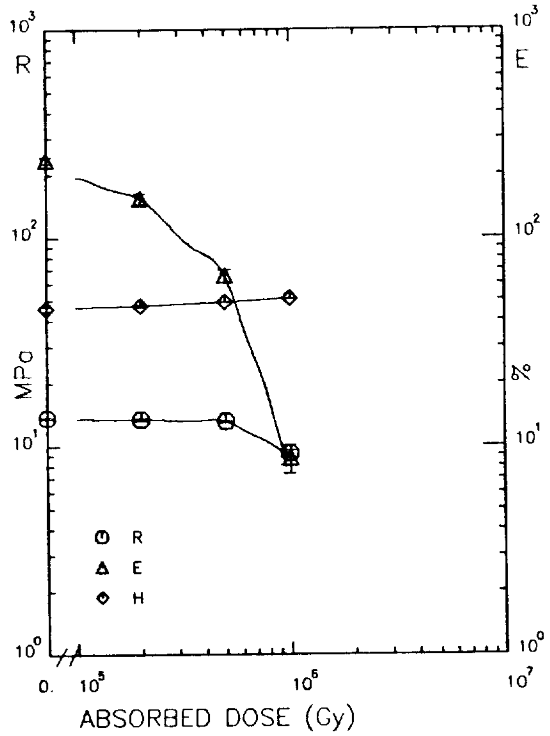
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.7 ± 0.2	237.1 ± 15.0	45.0 ± 0.0
0.200	3176.0	13.1 ± 0.1	206.7 ± 9.8	46.0 ± 0.0
0.500	3176.0	12.8 ± 0.2	168.7 ± 6.3	48.0 ± 0.0
1.000	3176.0	12.8 ± 0.1	102.1 ± 8.1	50.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 981

MATERIAL : Polyolefin
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Sheath compound (P)

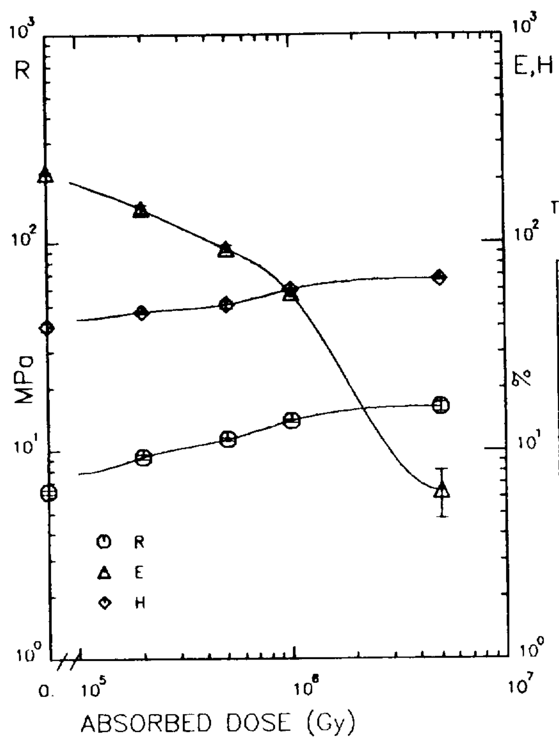
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.7 ± 0.1	237.0 ± 9.1	45.7 ± 1.0
0.200	3176.0	13.5 ± 0.2	154.5 ± 9.4	47.1 ± 0.7
0.500	3176.0	13.2 ± 0.1	65.4 ± 4.9	49.0 ± 0.0
1.000	3176.0	9.2 ± 0.3	8.8 ± 1.4	51.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 994

MATERIAL : Polyolefin
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Taken from sheath of 1kV cable

TEST RESULTS :

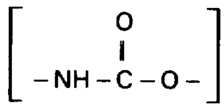
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 0.1	216.0 ± 2.8	40.0 ± 1.9
0.200	7090.0	9.3 ± 0.2	145.6 ± 6.7	46.8 ± 0.8
0.500	7750.0	11.4 ± 0.2	93.6 ± 3.6	50.8 ± 2.2
1.000	7950.0	13.9 ± 0.2	57.5 ± 1.9	59.8 ± 0.5
5.000	2.2×10^5	16.3 ± 0.9	6.4 ± 1.7	67.0 ± 1.0

RADIATION INDEX (7420.0 Gy/h) : 5.6

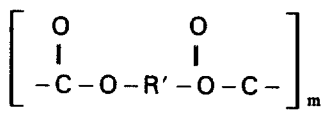
RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

POLYURETHANE*)

Characteristic group

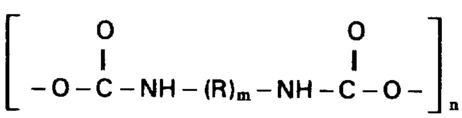

urethane group

Chemically, the commercial PUR elastomers are copolymers containing polyurethane and polyester or polyether units:

polyester: 

polyether: $O - [R'' - O -]_m$

They are linked together in the polymer formation to give the following urethane polymer linkage:



where n ranges from 50 to 100**).

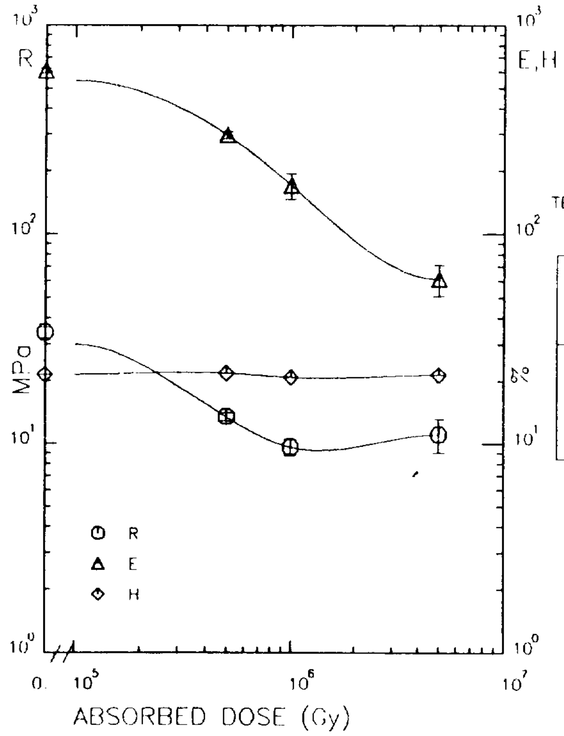
For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

*) J.H. Saunders and K.C. Frisch, High polymers, Vol. XVI: Polyurethanes. Part I - Chemistry; Part 2 - Technology (Interscience Publ., New York, 1964).

**) F.M. Clark, Insulating materials for design and engineering practice (John Wiley and Sons, Inc., New York, 1962).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
430	PUR- Polyether X 7043/12	Huber & Suhner	0.0	-	34.1	606	21	22	
			0.5	2×10^5	13.6	299	22		5.6
			1.0	2×10^5	9.7	171	21		
			5.0	2×10^5	11.1	63	22		
431	PUR- Polyester X 7043/11	Huber & Suhner	0.0	-	50.9	566	29	24	
			0.5	2×10^5	30.0	677	24		6.3
			1.0	2×10^5	27.2	619	19		
			5.0	2×10^5	13.2	143	27		
432	PUR- Polyester X 7043/10	Huber & Suhner	0.0	-	35.5	593	28	22	
			0.5	2×10^5	21.3	578	22		6.2
			1.0	2×10^5	17.1	508	21		
			5.0	2×10^5	9.1	143	23		
689	AF 30 Sheath	Metallurgica Bresciana	0.0	-	35.3	622	26	29	
			0.5	2×10^5	6.9	242	26		5.6
			5.0	2×10^5	6.6	97	19		
706	PUR-Polyester Elastollan C 85 A	Elastogran	0.0	-	59.8	548	34	27	
			0.5	2×10^5	39.8	557	34		6.2
			1.0	2×10^5	38.5	463	33		
			5.0	2×10^5	16.2	119	30		
			0.2	100	28.5	614	32		
			0.5	100	9.7	458	24		>5.7
707	PUR-Polyether Elastollan 1185 A	Elastogran	0.0	-	53.9	555	34	25	
			0.5	2×10^5	44.9	568	33		6.2
			1.0	2×10^5	35.3	466	33		
			5.0	2×10^5	12.4	90	32		
			0.2	100	35.0	582	35		
			0.5	100	15.2	478	28		>5.7

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 430

MATERIAL : PUR Polyether
TYPE : X 7043/12
SUPPLIER : Huber & Suhner
REMARKS : (P)

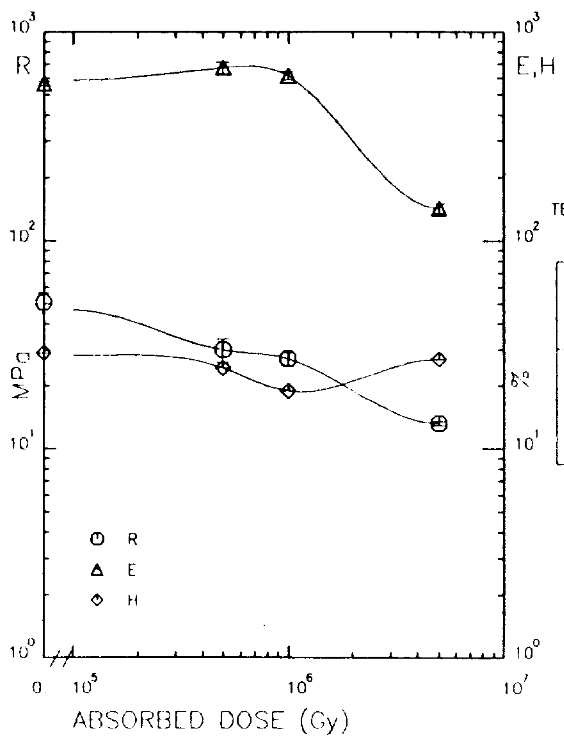
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	34.1 ± 2.1	606.0 ± 16.4	21.5 ± 0.0
0.500	2.0×10^5	13.6 ± 0.6	299.0 ± 12.4	22.0 ± 0.0
1.000	2.0×10^5	9.7 ± 0.8	171.0 ± 24.1	21.0 ± 0.0
5.000	2.0×10^5	11.1 ± 2.0	61.3 ± 10.3	21.5 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 22.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 431

MATERIAL : PUR Polyester
TYPE : X 7043/11
SUPPLIER : Huber & Suhner
REMARKS : (P)

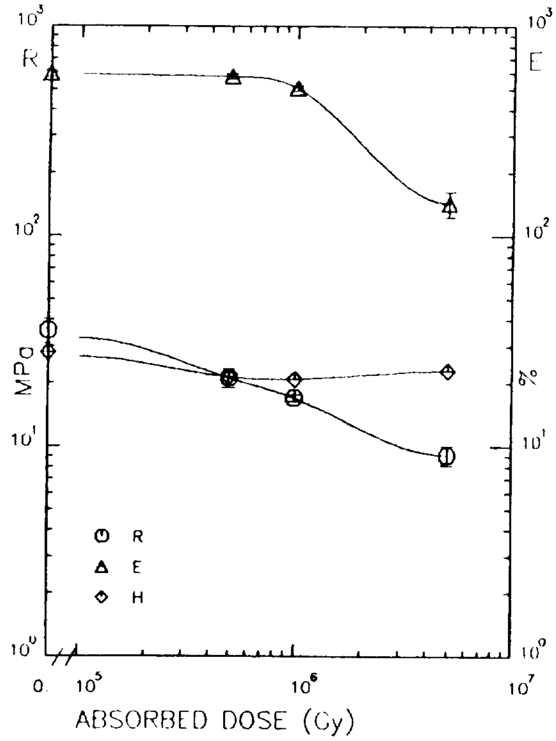
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	50.9 ± 5.7	566.2 ± 13.2	29.0 ± 0.0
0.500	2.0×10^5	30.0 ± 3.9	677.0 ± 44.2	24.5 ± 0.0
1.000	2.0×10^5	27.2 ± 2.0	618.7 ± 29.3	19.0 ± 0.0
5.000	2.0×10^5	13.2 ± 0.3	143.0 ± 7.6	27.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 6.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 432

MATERIAL : PUR Polyester
TYPE : X 7043/10
SUPPLIER : Huber & Suhner
REMARKS : (P)

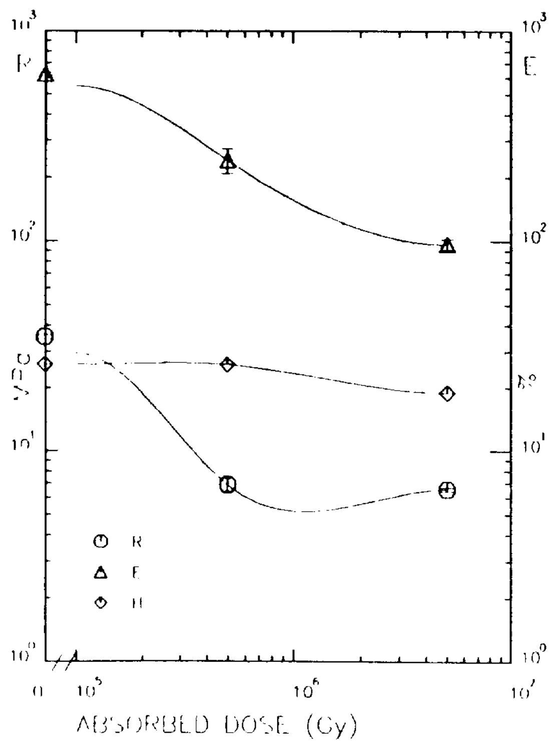
TEST RESULTS

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	35.5 ± 4.5	592.5 ± 21.0	28.0 ± 0.0
0.500	2.0×10^5	21.3 ± 2.2	578.0 ± 17.9	21.5 ± 0.0
1.000	2.0×10^5	17.1 ± 0.6	508.0 ± 15.2	21.0 ± 0.0
5.000	2.0×10^5	9.1 ± 0.9	143.0 ± 19.6	23.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 6.2

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 22.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 689

MATERIAL : Polyurethane
TYPE : AF-30
SUPPLIER : Metallurgica Bresciana
REMARKS : Cable sheath (P)

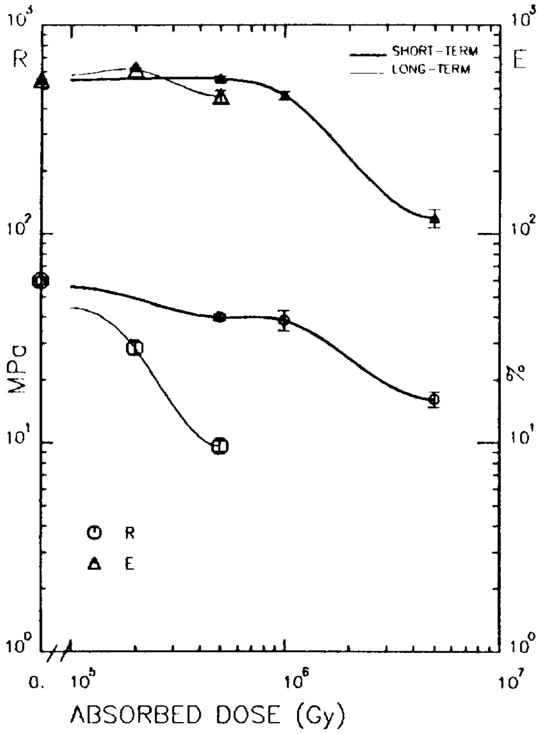
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000		35.3 ± 0.9	622.0 ± 9.1	26.0 ± 0.0
0.500	1.7×10^5	6.9 ± 0.5	242.0 ± 31.7	26.0 ± 0.0
5.000	1.7×10^5	6.6 ± 0.1	97.0 ± 5.7	19.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.2 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 706

MATERIAL : Polyester-Polyurethan
TYPE : Elastollan C 85 A
SUPPLIER : Elastogran - EPE
REMARKS : (P)

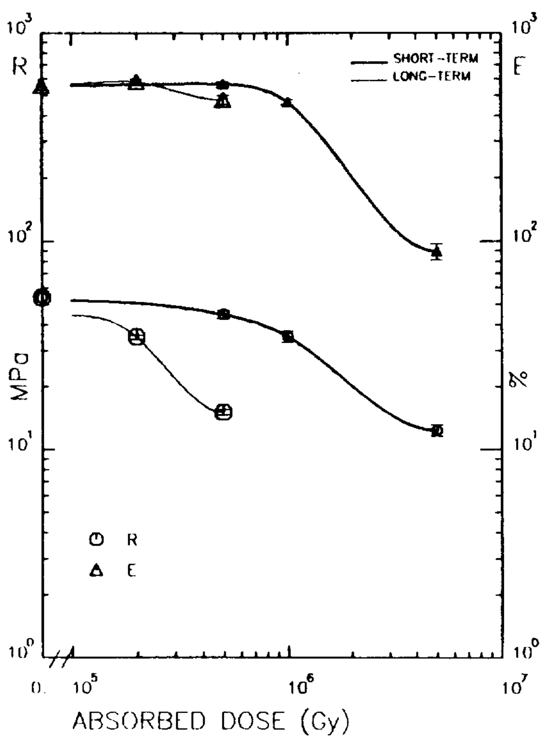
TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness
		Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	-	59.8 ± 2.4	548.0 ± 7.6	34.0 ± 0.0
0.500	1.7×10^5	39.8 ± 1.4	557.0 ± 14.5	34.0 ± 0.0
1.000	1.7×10^5	38.5 ± 4.3	463.0 ± 20.8	33.0 ± 0.0
5.000	1.7×10^5	16.2 ± 1.4	119.0 ± 11.4	29.5 ± 0.0
0.000	-	59.8 ± 2.4	548.0 ± 7.6	34.0 ± 0.0
0.200	100.0	28.5 ± 1.8	614.2 ± 12.0	32.0 ± 0.0
0.500	100.0	9.7 ± 0.5	458.0 ± 30.1	24.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.2
RADIATION INDEX (100.0 Gy/h) > 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 26.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 707

MATERIAL : Polyether-Polyurethan
TYPE : Elastollan 1185 A
SUPPLIER : Elastogran - EPE
REMARKS : (P)

TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness
		Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	-	53.9 ± 4.0	555.0 ± 42.3	34.0 ± 0.0
0.500	1.7×10^5	44.9 ± 2.1	568.0 ± 17.2	33.0 ± 0.0
1.000	1.7×10^5	35.3 ± 2.2	466.0 ± 14.3	33.0 ± 0.0
5.000	1.7×10^5	12.4 ± 0.8	89.5 ± 8.0	32.0 ± 0.0
0.000	-	53.9 ± 4.0	555.0 ± 42.3	34.0 ± 0.0
0.200	100.0	35.0 ± 0.8	581.7 ± 18.9	35.0 ± 0.0
0.500	100.0	15.2 ± 0.4	478.3 ± 22.3	28.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 6.2
RADIATION INDEX (100.0 Gy/h) > 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 25.2 %
CORROSIVITY (DIN 57472) : PASS

POLYVINYL CHLORIDE

$[-CH_2-CHCl-]_n$

Note: Installations using PVC and other materials containing halogen have been forbidden at CERN for safety reasons since 1982. For this reason, no tests have been carried out on these materials. Data can, however, be found in the 1st edition ((Ref. [16]).

R

RADOX, trade name of Huber & Suhner
radiation cross-linked polyolefin copolymer

RHEYHALON, trade name of AEG Kabel
see polyolefins, EPDM, and EPR

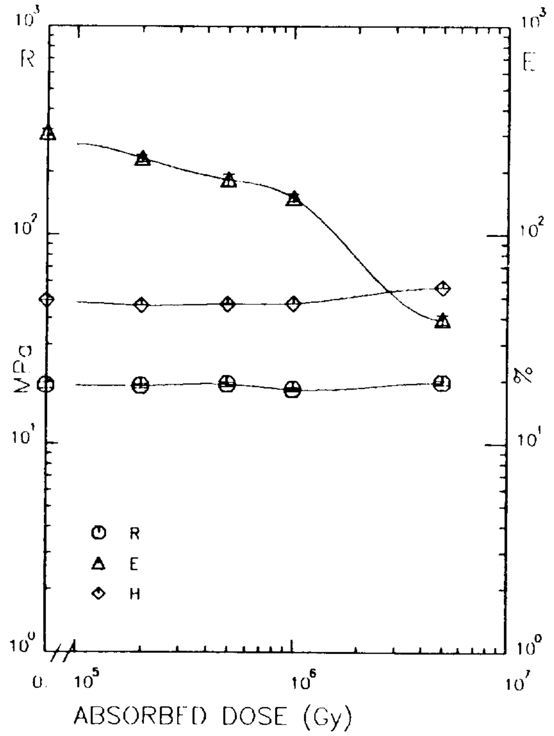
RUBBERS
Rubbers are long chain cross-linked polymers or copolymers. Cross-linking may be realized by a mineral reactant, as Sulphur in natural rubber.
see butyl rubber
see EAR and EEA for acrylic rubber
see EPDM and EPR
see polychloroprene
see silicone rubber
see also in 1st edition (Ref. [16])

RADOX

trade name of Huber & Suhner
radiation cross-linked polyolefin copolymer
see also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
617	Radox 110 28/26/52 Cross-linked	Huber & Suhner	0.0	-	19.1	309	48	28	
			0.2	2×10^5	19.0	234	46		5.9
			0.5	2×10^5	19.4	184	47		
			1.0	2×10^5	18.3	151	47		
			5.0	2×10^5	19.7	40	56		
618	Radox 110 A M 2336/56 Cross-linked	Huber & Suhner	0.0	-	16.1	178	51	32	
			0.2	2×10^5	16.0	160	52		6.0
			0.5	2×10^5	16.4	123	54		
			1.0	2×10^5	15.9	95	54		
			5.0	2×10^5	19.5	21	59		
619	Radox 110 M 2371/55 Cross-linked Sheath	Huber & Suhner	0.0	-	5.9	179	37	37	
			0.2	2×10^5	7.9	113	41		5.8
			0.5	2×10^5	9.4	98	43		
			1.0	2×10^5	10.5	75	46		
			5.0	2×10^5	14.0	21	50		
739	Radox Sheath of power cable	Huber & Suhner	0.0	-	10.6	123	38	37	
			0.5	2×10^5	10.8	59	42		5.6
			1.0	2×10^5	11.9	32	44		
			0.5	100	9.7	54	40		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 617

MATERIAL : Radox 110
TYPE : 28-2652
SUPPLIER : Huber & Suhner
REMARKS : Radiation cross-linked (P)

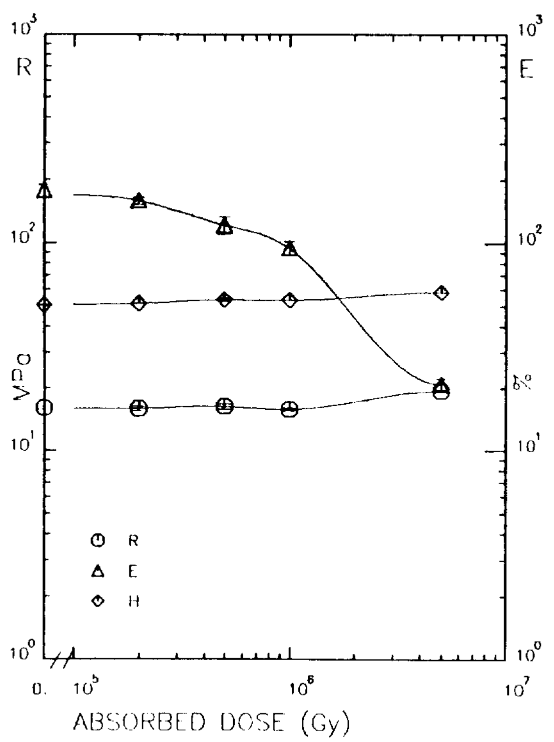
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	19.1 ± 0.6	309.0 ± 12.9	48.5 ± 0.0
0.200	1.4×10^5	19.0 ± 0.4	233.5 ± 8.9	46.0 ± 0.0
0.500	1.4×10^5	19.4 ± 0.4	184.4 ± 12.1	46.8 ± 0.3
1.000	1.4×10^5	18.3 ± 0.4	150.5 ± 6.5	47.0 ± 0.0
5.000	1.4×10^5	19.7 ± 0.4	39.5 ± 2.1	56.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 618

MATERIAL : Radox 110 A
TYPE : M 2336/56
SUPPLIER : Huber & Suhner
REMARKS : Radiation cross-linked (P)

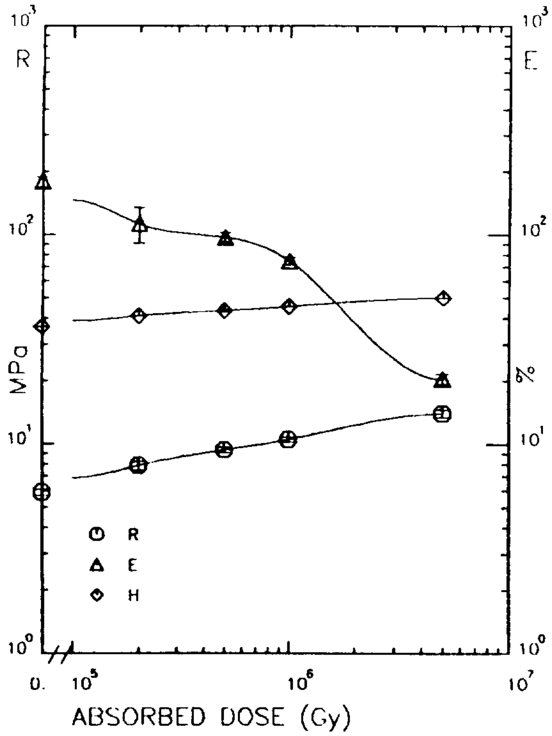
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	16.1 ± 0.3	178.0 ± 12.4	50.5 ± 0.0
0.200	1.4×10^5	16.0 ± 0.4	159.5 ± 6.5	51.5 ± 0.0
0.500	1.4×10^5	16.4 ± 0.4	122.5 ± 11.7	53.8 ± 0.8
1.000	1.4×10^5	15.9 ± 0.3	95.0 ± 7.3	53.5 ± 0.0
5.000	1.4×10^5	19.5 ± 0.2	21.0 ± 1.4	58.5 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) : 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 619

MATERIAL : Radox 110 sheath
TYPE : M 2371/55
SUPPLIER : Huber & Suhner
REMARKS : Radiation cross-linked (P)

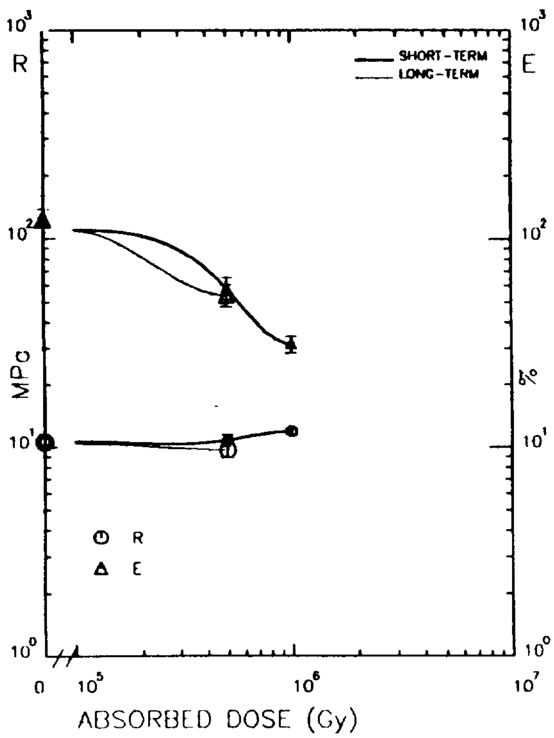
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.9 ± 0.2	179.0 ± 10.2	36.5 ± 0.0
0.200	1.4×10^5	7.9 ± 0.4	113.0 ± 22.0	41.0 ± 0.0
0.500	1.4×10^5	9.4 ± 0.3	97.5 ± 5.0	43.4 ± 0.5
1.000	1.4×10^5	10.5 ± 0.3	75.0 ± 3.1	45.5 ± 0.0
5.000	1.4×10^5	14.0 ± 0.5	20.5 ± 1.1	50.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 739

MATERIAL : Polyolefin
TYPE : Radox
SUPPLIER : Huber & Suhner
REMARKS : taken from power cable sheath

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.6 ± 0.5	123.1 ± 16.0	38.0 ± 0.0
0.500	1.8×10^5	10.8 ± 0.7	58.5 ± 7.0	42.0 ± 0.0
1.000	1.8×10^5	11.9 ± 0.4	31.5 ± 2.9	44.0 ± 0.0
0.000	–	10.6 ± 0.5	123.1 ± 16.0	38.0 ± 0.0
0.500	100.0	9.7 ± 0.8	54.0 ± 6.5	40.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) < 5.7

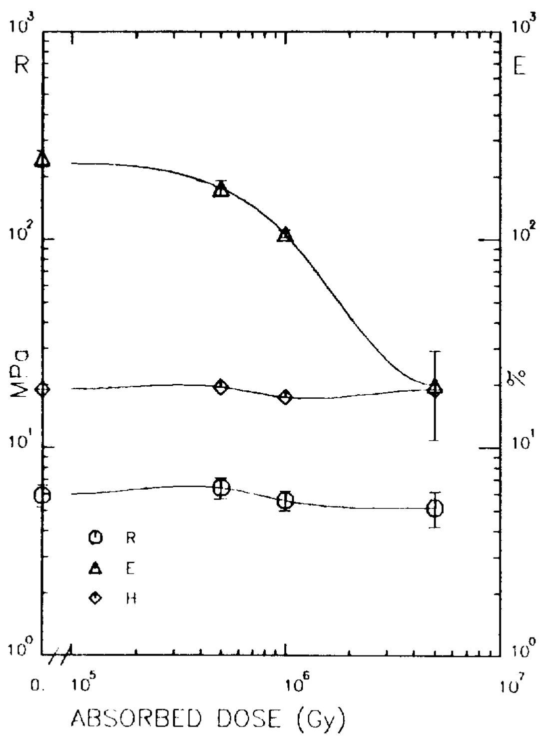
RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.0 %
CORROSIVITY (DIN 57472) : PASS

RUBBER

long chain cross-linked polymers or copolymers

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
713	G-102	Metallurgica Bresciana	0.0	-	5.9	246	19	18	
			0.5	2×10^5	6.4	177	19		5.9
			1.0	2×10^5	5.6	107	18		
			5.0	2×10^5	5.2	20	19		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 713

MATERIAL : Rubber
TYPE : G-102
SUPPLIER : Metallurgica Bresciana
REMARKS : (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.9 ± 0.7	246.0 ± 22.2	19.0 ± 0.0
0.500	1.7×10^5	6.4 ± 0.7	177.0 ± 15.2	19.5 ± 0.0
1.000	1.7×10^5	5.6 ± 0.6	107.0 ± 4.5	17.5 ± 0.0
5.000	1.7×10^5	5.2 ± 1.0	20.0 ± 9.1	19.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 17.8 %
CORROSIVITY (DIN 57472) : PASS

S

SEMICONDUCTING PE
see polyethylene and XLPE

SILANPEX, trade name of AEI Compounds
see EVA

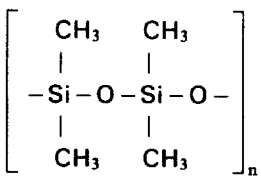
SILYTHENE, trade name of Silec
see polyethylene

SIOPLAS, trade name of AEI Compounds
polyolefin compound based on EVA
see EVA

SIR
Silicone rubber
see also in 1st edition (Ref. [16])

SILICONE RUBBER

The silicone rubbers are polysiloxanes. The most widely used type is polydimethylsiloxane.

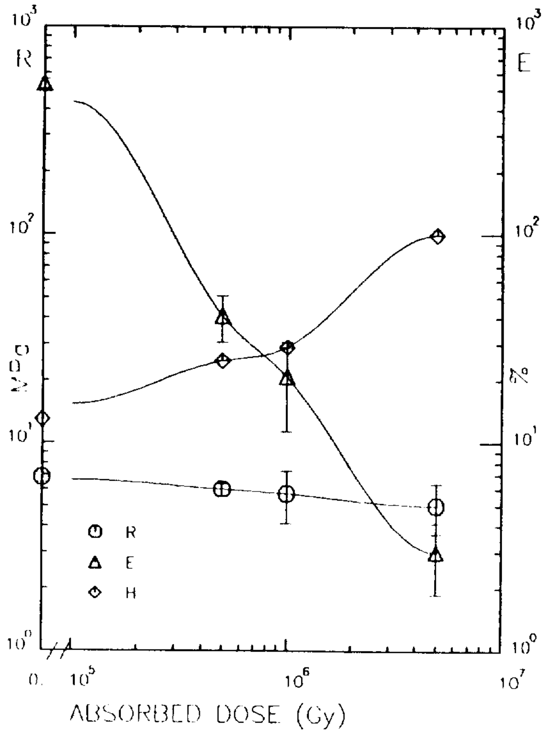


For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
582	349 V Insulation	Gorse	0.0	-	6.8	531	13	32	
			0.5	2×10^5	6.0	41	25		
			1.0	2×10^5	5.7	21	29		
			5.0	2×10^5	5.0	3	100		

Remark: Materials 550 and 624 are respectively indexed under EPDM and EPR. Their silicon content is high and their radiation resistance is bad.

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 582

MATERIAL : Silicon Rubber
TYPE : Insulation 349 V
SUPPLIER : Gorse
REMARKS : (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.8 ± 0.4	531.0 ± 28.8	13.0 ± 0.0
0.500	2.5×10^5	6.0 ± 0.4	41.0 ± 10.2	25.0 ± 0.0
1.000	2.5×10^5	5.7 ± 1.6	21.0 ± 9.6	29.0 ± 0.0
5.000	2.5×10^5	5.0 ± 1.4	3.0 ± 1.1	100.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.7 %
CORROSIVITY (DIN 57472) : PASS

TEFLON, fluoropolymers trade name of Du Pont de Nemours
see in 1st edition (Ref. [16])

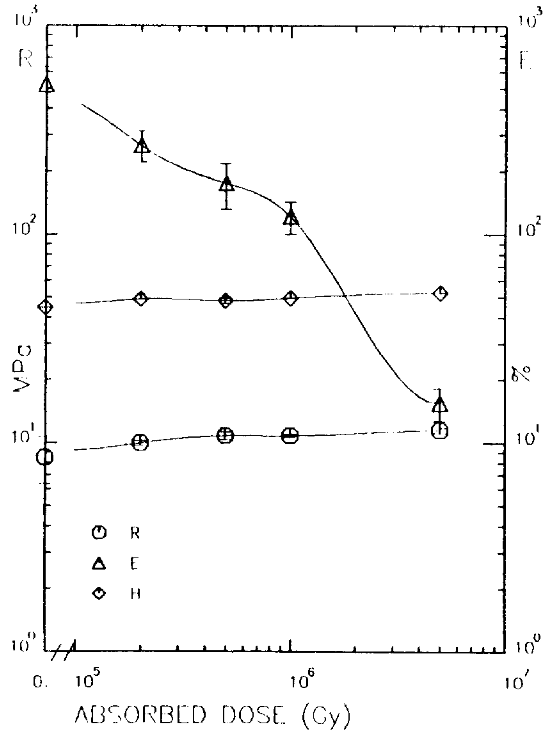
TEFZEL, fluoropolymers trade name of Du Pont de Nemours
see in 1st edition (Ref. [16])

THERMOPLASTICS
Thermoplastics are (for us) undefined polymers, not cross-linked. Thermoplastic rubbers (TPR) are copolymers with a low degree of cross-linking.

TOXFREE, trade name of CEAT Cavi
Polyolefin or rubber

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
615	M-7059-11	Huber & Suhner	0.0	-	8.5	522	45	28	
			0.2	2×10^5	10.0	268	49		5.3
			0.5	2×10^5	10.8	176	48		
			1.0	2×10^5	10.8	122	50		
			5.0	2×10^5	11.5	16	53		
616	M-7059-204	Huber & Suhner	0.0	-	7.9	294	51	29	
			0.2	3×10^5	10.7	90	54		
			0.5	3×10^5	11.2	72	55		
			1.0	3×10^5	11.4	56	54		
			5.0	3×10^5	12.8	13	59		
888	TPR 799 nat. 1987 plates	BP Chemicals	0.0	-	5.7	138	34	37	
			0.5	2×10^5	10.5	34	41		
			1.0	2×10^5	12.3	15	51		
			5.0	2×10^5	15.9	7	60		
			0.2	100	7.3	43	41		
			0.7	100	10.2	21	45		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 615

MATERIAL : Thermoplastic
TYPE : M 7059/11
SUPPLIER : Huber & Suhner
REMARKS : (P)

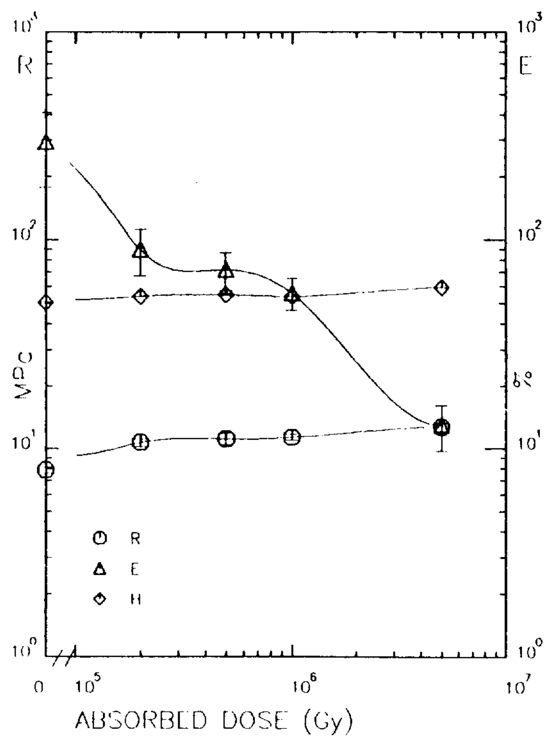
TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness Shore D
(MGy)	(Gy/H)	Strength R (MPa)	Elongation E (%)	H (Degree)
0.000	–	8.5 ± 2.2	522.0 ±113.9	44.5 ± 0.0
0.200	1.4×10^5	10.0 ± 0.2	268.0 ± 46.0	49.0 ± 0.0
0.500	1.4×10^5	10.8 ± 0.5	176.4 ± 43.8	48.1 ± 1.3
1.000	1.4×10^5	10.8 ± 0.2	122.0 ± 21.7	49.5 ± 0.0
5.000	1.4×10^5	11.5 ± 0.3	15.5 ± 2.7	52.5 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) : 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 616

MATERIAL : Thermoplastic
TYPE : M 7059/204
SUPPLIER : Huber & Suhner
REMARKS : (P)

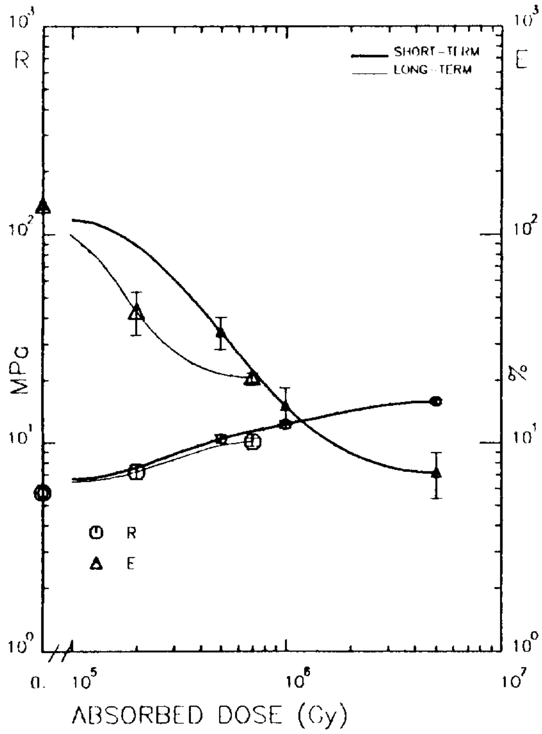
TEST RESULTS :

Dose	Dose rate	Tensile properties		Hardness Shore D
(MGy)	(Gy/H)	Strength R (MPa)	Elongation E (%)	H (Degree)
0.000	–	7.9 ± 0.3	294.0 ±116.5	50.5 ± 0.0
0.200	1.4×10^5	10.7 ± 0.5	90.0 ± 22.6	54.0 ± 0.0
0.500	1.4×10^5	11.2 ± 0.7	72.2 ± 14.6	55.1 ± 0.5
1.000	1.4×10^5	11.4 ± 0.4	56.0 ± 9.6	54.0 ± 0.0
5.000	1.4×10^5	12.8 ± 0.6	13.0 ± 3.3	59.5 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 29.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 888

MATERIAL : Thermoplastic Rubber
TYPE : TPR 799 NAT
SUPPLIER : BP Chemicals
REMARKS : 1987 plates

TEST RESULTS :

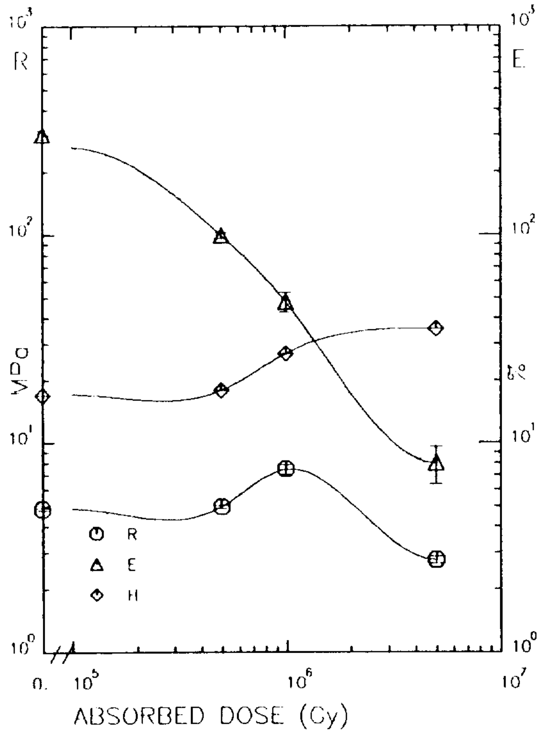
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	5.7 ± 0.4	138.4 ± 4.6	34.0 ± 0.0
0.500	2.7×10^5	10.5 ± 0.5	34.4 ± 6.1	41.0 ± 0.0
1.000	2.7×10^5	12.3 ± 0.4	15.2 ± 3.3	51.0 ± 0.0
5.000	2.7×10^5	15.9 ± 0.4	7.2 ± 1.8	60.0 ± 0.0
0.000	–	5.7 ± 0.4	138.4 ± 4.6	34.0 ± 0.0
0.200	100.0	7.3 ± 0.6	43.2 ± 10.0	41.4 ± 0.4
0.700	100.0	10.2 ± 0.5	20.8 ± 1.1	45.0 ± 0.0

RADIATION INDEX (2.7×10^5 Gy/h) < 5.7
RADIATION INDEX (100.0 Gy/h) < 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.2 %
CORROSIVITY (DIN 57472) : PASS

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
627	773 G 5 FR	Cablexport CEAT	0.0	-	4.9	304	17	27	
			0.5	2×10^5	5.0	100	18		
			1.0	2×10^5	7.5	48	27		
			5.0	2×10^5	2.8	8	35		
628	4/846-b ric 772	Cablexport CEAT	0.0	-	8.8	277	21	27	
			0.5	2×10^5	6.9	89	20		
			1.0	2×10^5	7.0	39	23		
			5.0	2×10^5	4.5	16	32		
629	4/40 G5 ric 739	Cablexport CEAT	0.0	-	8.2	156	17	21	
			0.5	2×10^5	9.1	69	20		
			1.0	2×10^5	10.1	32	22		
			5.0	2×10^5	3.0	5	27		
799	M 2 (809) Sheath	CEAT Cavi	0.0	-	8.5	126	32	50	
			0.5	2×10^5	11.6	61	42		5.6
			1.0	2×10^5	11.7	37	46		
			5.0	2×10^5	17.1	11	65		
800	M 2 (782) Sheath	CEAT Cavi	0.0	-	7.3	163	25	42	
			0.5	2×10^5	8.0	94	27		5.8
			1.0	2×10^5	8.2	66	30		
			5.0	2×10^5	12.4	12	55		
801	G 10 (04022) HT insul.	CEAT Cavi	0.0	-	8.0	179	29	42	
			0.5	2×10^5	8.3	74	31		
			1.0	2×10^5	8.3	54	31		
			5.0	2×10^5	10.6	20	46		
802	G 5 (773) Insulation	CEAT Cavi	0.0	-	6.3	222	19	31	
			0.5	2×10^5	6.3	133	20		5.8
			1.0	2×10^5	5.5	78	20		
			5.0	2×10^5	7.4	38	28		
803	G 9 (819)	CEAT Cavi	0.0	-	14.7	136	42	40	
			0.5	2×10^5	14.0	93	49		5.9
			1.0	2×10^5	13.9	57	50		
			5.0	2×10^5	14.5	14	61		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 627

MATERIAL : **Toxfree**
TYPE : **773 G5 F.R.**
SUPPLIER : **Cablexport (CEAT Cavi)**
REMARKS : **(P)**

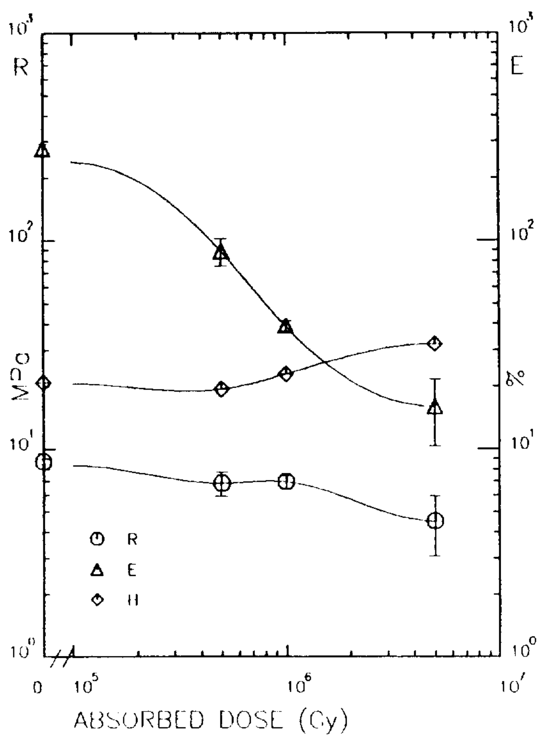
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	4.9 ± 0.1	304.0 ± 15.2	17.0 ± 0.0
0.500	1.4×10^5	5.0 ± 0.1	100.0 ± 3.2	18.0 ± 0.0
1.000	1.4×10^5	7.5 ± 0.4	48.0 ± 5.1	27.0 ± 0.0
5.000	1.4×10^5	2.8 ± 0.1	8.0 ± 1.6	35.5 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 628

MATERIAL : **Toxfree**
TYPE : **4/846-b ric 772**
SUPPLIER : **Cablexport (CEAT Cavi)**
REMARKS : **(P)**

TEST RESULTS :

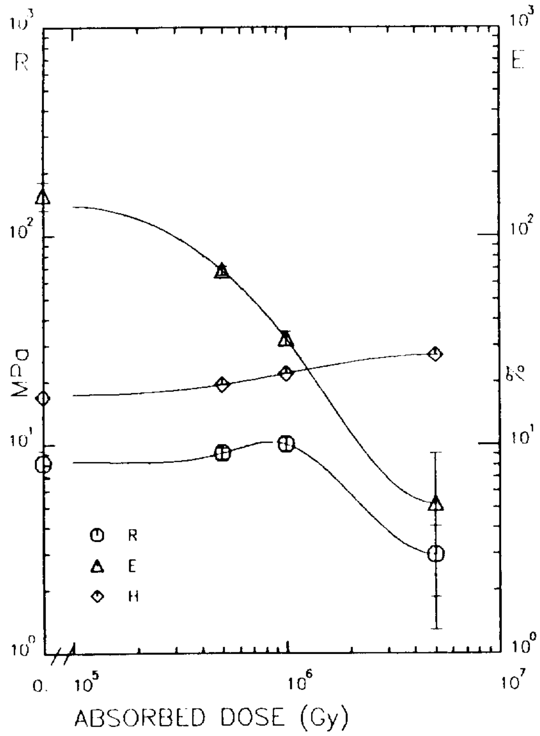
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.8 ± 0.3	276.8 ± 15.5	21.0 ± 0.0
0.500	1.4×10^5	6.9 ± 0.9	89.2 ± 13.5	19.5 ± 0.0
1.000	1.4×10^5	7.0 ± 0.5	39.2 ± 2.3	23.0 ± 0.0
5.000	1.4×10^5	4.5 ± 1.4	16.0 ± 5.7	32.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

TOXFREE

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 629

MATERIAL : Toxfree
TYPE : 4/40 ric 739 G5
SUPPLIER : Cablexport (CEAT Cavi)
REMARKS : (P)

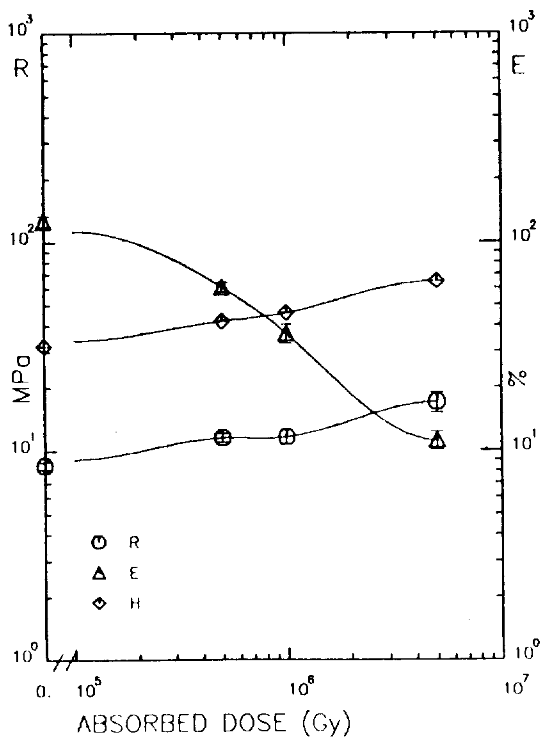
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	–	8.2 ± 1.2	156.4 ± 23.6	17.0 ± 0.0
0.500	1.4×10^5	9.1 ± 0.6	68.8 ± 3.3	19.5 ± 0.0
1.000	1.4×10^5	10.1 ± 0.7	32.4 ± 2.6	22.0 ± 0.0
5.000	1.4×10^5	3.0 ± 1.1	5.2 ± 3.9	27.0 ± 0.0

RADIATION INDEX (1.4×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 21.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 799

MATERIAL : Toxfree
TYPE : M 2 (809) compound
SUPPLIER : CEAT Cavi
REMARKS : External sheath (P)

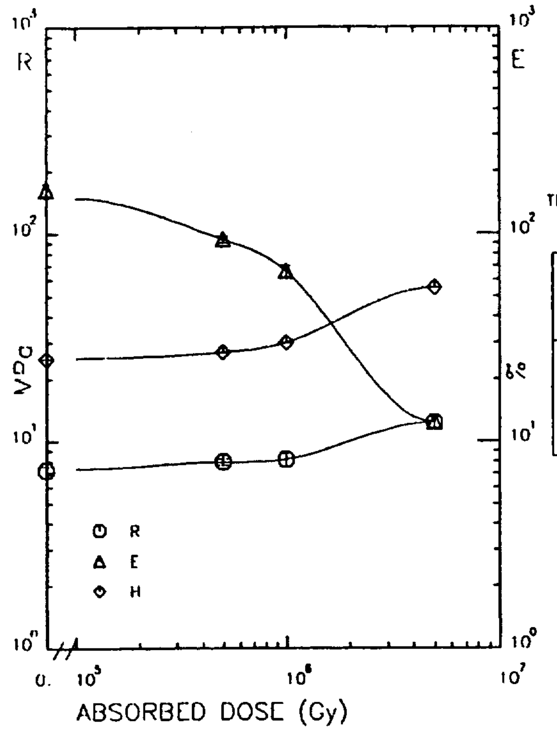
TEST RESULTS :

Dose	Dose	Tensile properties		Hardness
	rate	Strength	Elongation	Shore D
(MGy)	(Gy/H)	R (MPa)	E (%)	H (Degree)
0.000	–	8.5 ± 0.4	126.5 ± 7.5	32.0 ± 0.0
0.500	1.8×10^5	11.6 ± 0.6	61.2 ± 3.0	42.0 ± 0.0
1.000	1.8×10^5	11.7 ± 0.9	36.8 ± 3.9	46.0 ± 0.0
5.000	1.8×10^5	17.1 ± 1.9	11.2 ± 1.1	65.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 49.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. · 800

MATERIAL : Toxfree
TYPE : M 2 (782) compound
SUPPLIER : CEAT Cavi
REMARKS : External sheath (P)

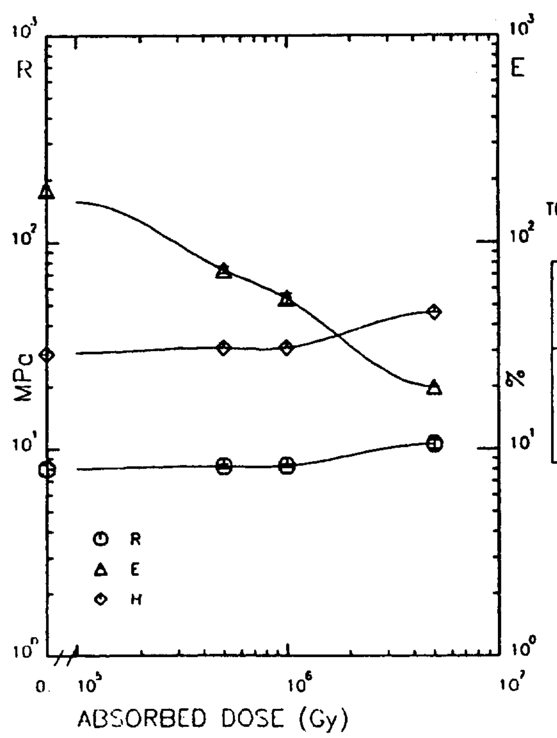
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	7.3 ± 0.3	163.2 ± 11.1	25.0 ± 0.0
0.500	1.8×10^5	8.0 ± 0.3	94.4 ± 3.6	27.0 ± 0.0
1.000	1.8×10^5	8.2 ± 0.6	66.4 ± 4.3	30.0 ± 0.0
5.000	1.8×10^5	12.4 ± 0.8	12.4 ± 0.9	55.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 42.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 801

MATERIAL : Toxfree
TYPE : G 10 (04022) compound
SUPPLIER : CEAT Cavi
REMARKS : HT insulation (P)

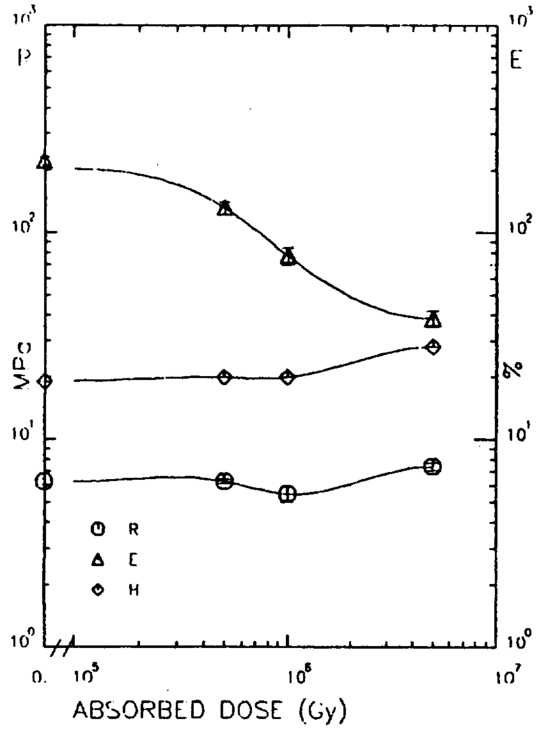
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.0 ± 0.4	178.5 ± 10.0	29.0 ± 0.0
0.500	1.8×10^5	8.3 ± 0.2	74.0 ± 2.8	31.0 ± 0.0
1.000	1.8×10^5	8.3 ± 0.2	54.0 ± 3.2	31.0 ± 0.0
5.000	1.8×10^5	10.6 ± 0.5	20.0 ± 0.0	46.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 41.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 802

MATERIAL : Toxfree
TYPE : G 5 (773) compound
SUPPLIER : CEAT Cavi
REMARKS : Insulation (P)

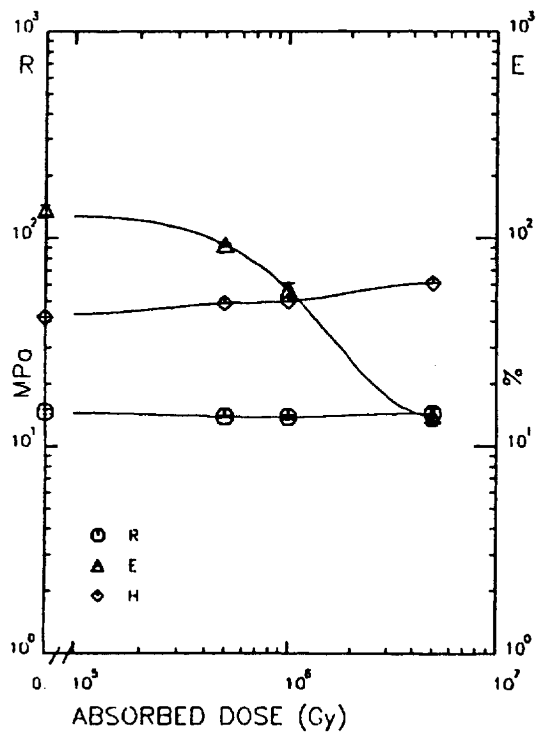
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.3 ± 0.2	221.6 ± 10.8	19.0 + 0.0
0.500	1.8×10^5	6.3 ± 0.2	132.8 ± 9.1	20.0 ± 0.0
1.000	1.8×10^5	5.5 ± 0.5	77.6 ± 7.3	20.0 ± 0.0
5.000	1.8×10^5	7.4 ± 0.3	38.4 ± 3.3	28.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.8 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 803

MATERIAL : Toxfree
TYPE : G 9 (819) compound
SUPPLIER : CEAT Cavi
REMARKS : (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.7 ± 0.4	136.4 ± 7.5	42.0 ± 0.0
0.500	1.8×10^5	14.0 ± 0.2	93.2 ± 1.8	49.0 ± 0.0
1.000	1.8×10^5	13.9 ± 0.4	56.8 ± 4.1	50.0 ± 0.0
5.000	1.8×10^5	14.5 ± 0.7	14.0 ± 1.4	61.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.9

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 40.3 %
CORROSIVITY (DIN 57472) : PASS

V

VAC
abbreviation used by kabelmetal electro for vinyl acetate copolymers

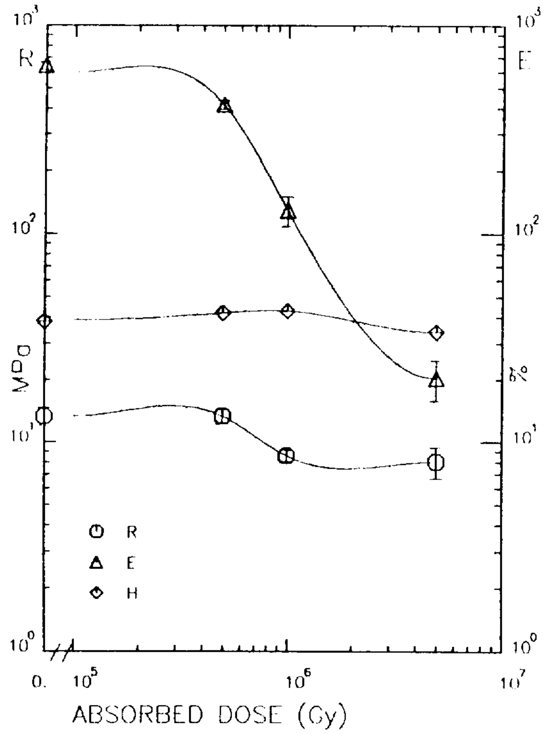
VAMAC, trade name of Du Pont de Nemours
ethyl acrylate rubber

VITON, trade name of Du Pont de Nemours
see 1st edition (Ref. [16])

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
483	VAC/EPR T1 Thermoplastic sheath	kabelmetal electro	0.0	–	13.3	643	38	27	
			0.5	2×10^5	13.4	418	42		5.8
			1.0	2×10^5	8.6	130	43		
			5.0	2×10^5	8.1	20	34		
484	VAC/EPR T2 Thermoplastic sheath	kabelmetal electro	0.0	–	11.5	620	42	32	
			0.5	2×10^5	11.4	375	43		5.8
			1.0	2×10^5	8.5	128	44		
			5.0	2×10^5	6.4	12	43		
			0.2	200	9.4	491	42		5.5
			0.5	200	7.2	180	44		
485	VAC/EPR T3 Thermoplastic sheath	kabelmetal electro	0.0	–	8.5	574	43	37	
			0.5	2×10^5	8.5	312	46		5.7
			1.0	2×10^5	8.4	71	46		
			5.0	2×10^5	7.2	13	47		
486	VAC/EPR T4 Thermoplastic sheath	kabelmetal electro	0.0	–	6.3	342	45	42	
			0.5	2×10^5	6.8	142	47		5.6
			1.0	2×10^5	8.6	64	48		
			5.0	2×10^5	9.0	16	47		
763	3 GI 190 Cross-linked Insulation	kabelmetal electro	0.0	–	11.6	352	29	24	
			0.5	2×10^5	11.5	210	29		6.0
			2.5	2×10^5	10.8	145	29		
			5.0	2×10^5	7.7	33	31		
			0.2	100	11.7	303	30		
			0.5	100	9.9	215	31		>5.7
764	2 YM 011-011 Thermoplastic sheath	kabelmetal electro	0.0	–	10.2	569	40	30	
			0.5	2×10^5	11.9	403	42		6.3
			2.5	2×10^5	12.3	280	45		
			5.0	2×10^5	8.9	10	50		
			0.2	100	8.4	444	43		5.5
			0.5	100	7.9	42	45		
871	VAC + EPR T 2 External sheath of LEP cables	kabelmetal electro	0.0	–	10.2	663	36	32	
			0.2	2×10^5	11.6	426	38		5.4
			0.5	2×10^5	7.7	186	41		
			1.0	2×10^5	8.6	86	43		
			0.2	100	8.4	450	41		5.3
			0.5	100	4.7	32	38		
872	VAC + EPR T 2 Inner sheath of LEP cables	kabelmetal electro	0.0	–	8.9	653	30	33	
			0.2	2×10^5	12.1	454	35		5.5
			0.5	2×10^5	8.1	250	36		
			1.0	2×10^5	7.0	91	38		
			0.2	100	6.2	438	38		5.3
			0.5	100	4.7	40	36		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
915	2 YM 010–011 Thermoplastic Sheath	kabelmetal electro	0.0	–	10.9	657	36	33	
			0.2	2×10^5	13.1	526	38		5.8
			0.5	2×10^5	13.0	391	39		
			1.0	2×10^5	8.0	231	41		
			5.0	2×10^5	8.5	29	46		
			0.2	100	8.1	726	37		5.5
			0.7	100	5.4	136	30		
922	2 YM 010 RR Thermoplastic Sheath	kabelmetal electro	0.0	–	11.6	608	39	32	
			0.2	2×10^5	13.2	594	40		6.0
			0.5	2×10^5	13.1	527	40		
			1.0	2×10^5	10.0	340	40		
			5.0	2×10^5	9.1	25	45		
			0.2	100	7.8	709	38		5.4
			0.7	100	5.0	33	33		
982	2 YM 011 RR Thermoplastic Sheath	kabelmetal electro	0.0	–	9.2	628	32	30	
			0.2	3200	9.7	577	34		5.7
			0.5	3200	9.0	487	36		
			1.0	3200	6.1	28	38		
			5.0	2×10^5	8.0	13	43		
983	2 YM 012 RR Thermoplastic Sheath	kabelmetal electro	0.0	–	14.2	607	34	34	
			0.2	3200	8.6	558	37		5.5
			0.5	3200	5.4	96	40		
			1.0	3200	6.5	12	42		
			5.0	2×10^5	7.3	12	47		
988	2 YI 066 RR Thermoplastic Insulation	kabelmetal electro	0.0	–	11.8	668	36	31	
			0.2	3200	11.6	597	38		5.7
			0.5	3200	9.3	371	40		
			1.0	3200	10.1	134	41		
			5.0	2×10^5	13.7	24	39		
989	2 XI 076 Cross-linked Insulation	kabelmetal electro	0.0	–	10.3	458	37	36	
			0.2	3200	10.2	402	41		5.5
			0.5	3200	6.9	92	42		
			1.0	3200	7.5	57	45		
			5.0	2×10^5	7.0	7	44		
990	HM 180 RR Cross-linked Sheath	kabelmetal electro	0.0	–	7.2	483	28	35	
			0.2	3200	6.6	340	30		5.7
			0.5	3200	5.4	263	31		
			1.0	3200	5.6	62	33		
			5.0	2×10^5	11.4	14	53		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. 483

MATERIAL : Copolymer VAC/EPR
TYPE : T1, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : Sheath, 50 % filler

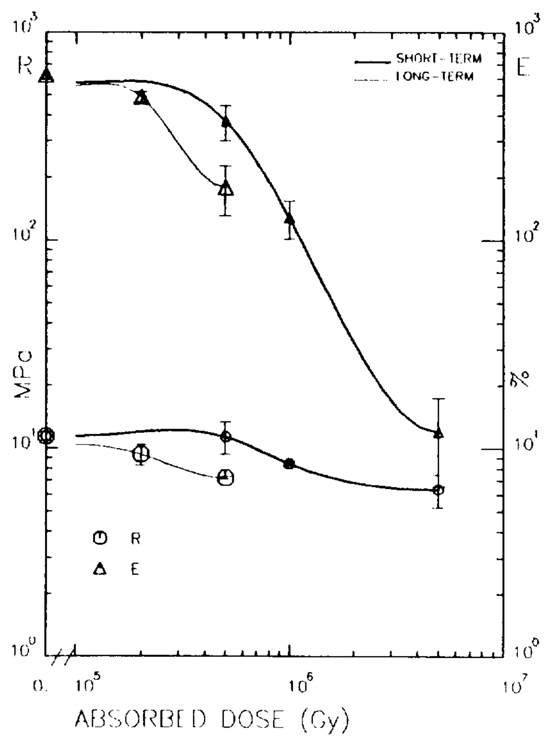
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	-	13.3 ± 1.3	643.2 ± 27.8	38.0 ± 0.0
0.500	1.7×10^5	13.4 ± 1.1	417.6 ± 20.3	42.0 ± 0.0
1.000	1.7×10^5	8.6 ± 0.5	130.0 ± 21.3	43.0 ± 0.0
5.000	1.7×10^5	8.1 ± 1.4	20.4 ± 4.6	34.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 484

MATERIAL : Copolymer VAC/EPR
TYPE : T2, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : Sheath, 55 % filler

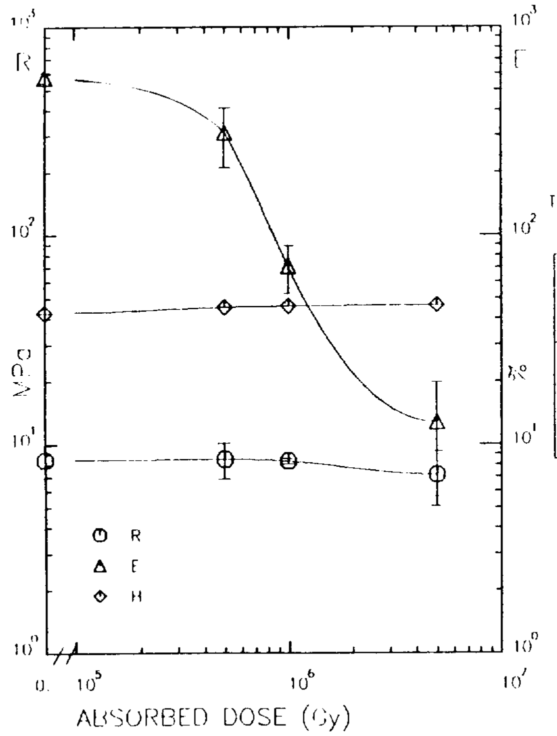
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.5 ± 0.5	620.0 ± 24.0	41.5 ± 0.0
0.500	1.7×10^5	11.4 ± 2.0	375.2 ± 72.1	43.5 ± 0.0
1.000	1.7×10^5	8.5 ± 0.2	128.4 ± 26.3	44.0 ± 0.0
5.000	1.7×10^5	6.4 ± 1.1	12.0 ± 5.4	42.5 ± 0.0
0.000	–	11.5 ± 0.5	620.0 ± 24.0	41.5 ± 0.0
0.200	200.0	9.4 ± 1.1	490.5 ± 27.2	42.0 ± 0.0
0.500	200.0	7.2 ± 0.1	180.0 ± 48.3	43.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8
RADIATION INDEX (200.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 485

MATERIAL : Copolymer VAC/EPR
TYPE : T3, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : Sheath, 58 % filler

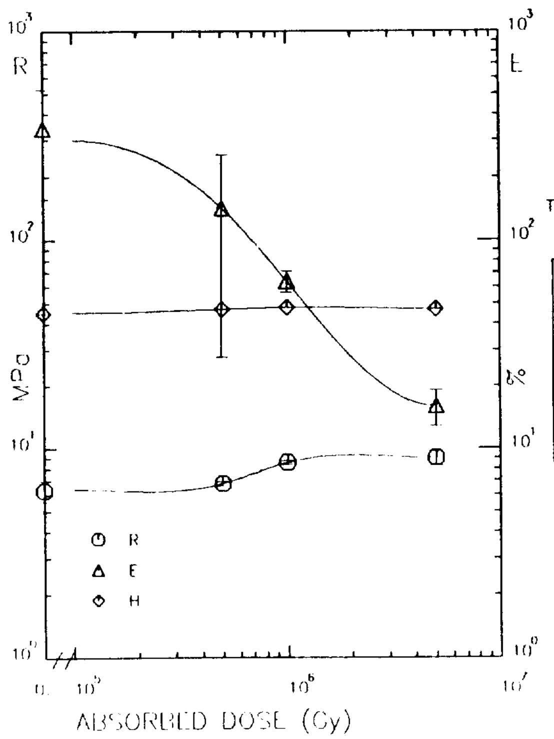
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.5 ± 1.5	574.4 ± 30.5	42.5 ± 0.0
0.500	1.7×10^5	8.5 ± 1.7	312.0 ± 99.0	45.5 ± 0.0
1.000	1.7×10^5	8.4 ± 0.3	71.2 ± 18.2	46.0 ± 0.0
5.000	1.7×10^5	7.2 ± 2.1	12.8 ± 7.2	46.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 37.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 486

MATERIAL : Copolymer VAC/EPR
TYPE : T4, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : Sheath, 62 % filler

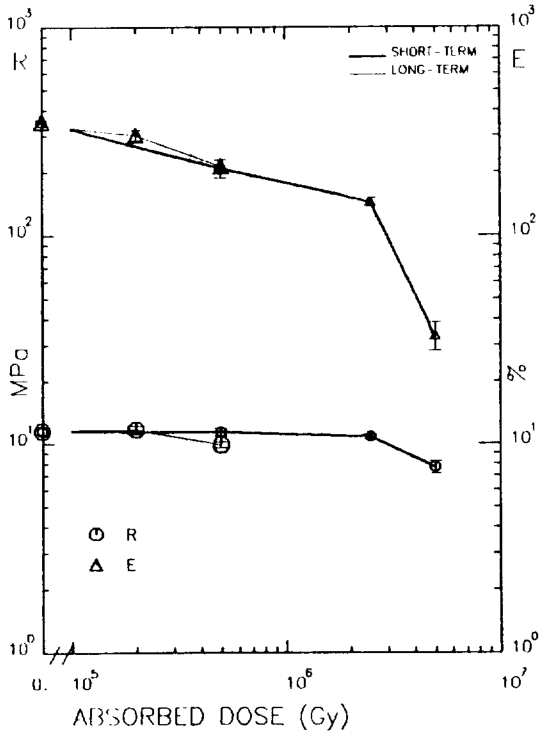
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.3 ± 0.7	341.6 ±184.6	45.0 ± 0.0
0.500	1.7×10^5	6.8 ± 0.2	142.4 ±114.6	47.0 ± 0.0
1.000	1.7×10^5	8.6 ± 0.2	64.0 ± 7.6	48.0 ± 0.0
5.000	1.7×10^5	9.0 ± 0.7	16.0 ± 3.2	47.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 42.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 763

MATERIAL : EPR / VAC copolymer
TYPE : 3 GI 190, XL (85-2/19)
SUPPLIER : kabelmetal electro
REMARKS : Insulation for magnet cables (S3)

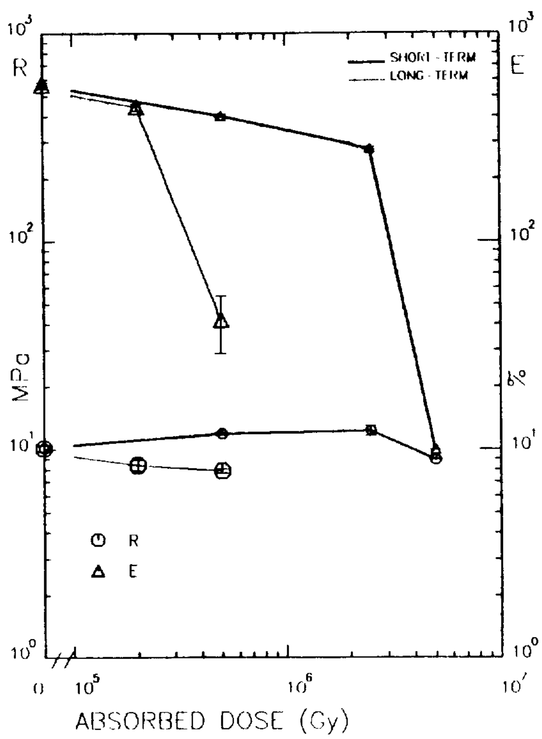
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.6 ± 0.3	351.7 ± 6.8	29.0 ± 0.0
0.500	1.7×10^5	11.5 ± 0.5	210.0 ± 21.7	29.0 ± 0.0
2.500	1.7×10^5	10.8 ± 0.2	145.0 ± 6.3	29.0 ± 0.0
5.000	1.7×10^5	7.7 ± 0.5	33.3 ± 5.2	31.0 ± 0.0
0.000	–	11.6 ± 0.3	351.7 ± 6.8	29.0 ± 0.0
0.200	100.0	11.7 ± 0.5	303.3 ± 18.3	30.3 ± 0.5
0.500	100.0	9.9 ± 0.3	215.0 ± 16.6	30.9 ± 0.9

RADIATION INDEX (1.7×10^5 Gy/h) : 6.0
RADIATION INDEX (100.0 Gy/h) > 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 24.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 764

MATERIAL : VAC-copolymer
TYPE : 2 YM 011, therm. (85-4/20)
SUPPLIER : kabelmetal electro
REMARKS : Black sheath for magnet cables (S3)

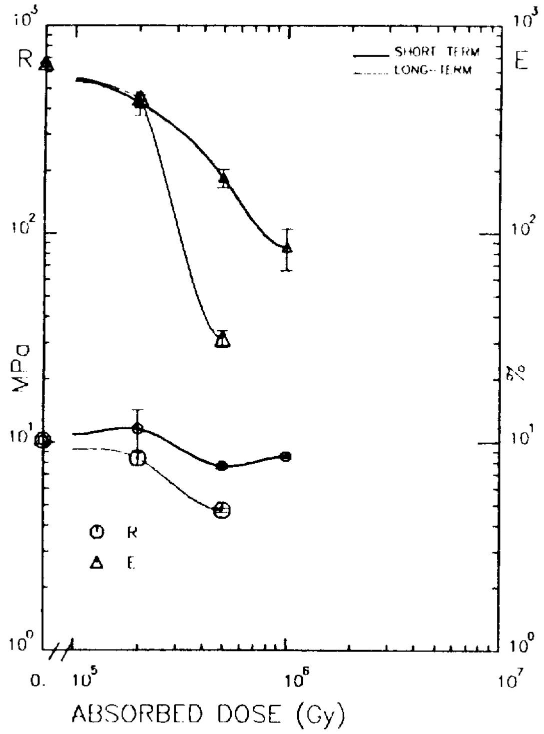
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.2 ± 0.4	569.2 ± 12.8	40.0 ± 0.0
0.500	1.7×10^5	11.9 ± 0.2	403.3 ± 5.2	42.0 ± 0.0
2.500	1.7×10^5	12.3 ± 0.7	280.0 ± 3.2	45.0 ± 0.0
5.000	1.7×10^5	8.9 ± 0.0	10.0 ± 0.0	50.0 ± 0.0
0.000	–	10.2 ± 0.4	569.2 ± 12.8	40.0 ± 0.0
0.200	100.0	8.4 ± 0.5	444.2 ± 17.2	42.7 ± 1.1
0.500	100.0	7.9 ± 0.2	42.0 ± 13.0	45.4 ± 1.4

RADIATION INDEX (1.7×10^5 Gy/h) : 6.3
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 871

MATERIAL : VAC Copolymer /EPR
TYPE : Black T 2
SUPPLIER : kabelmetal electro
REMARKS : from external sheath of LEP cable

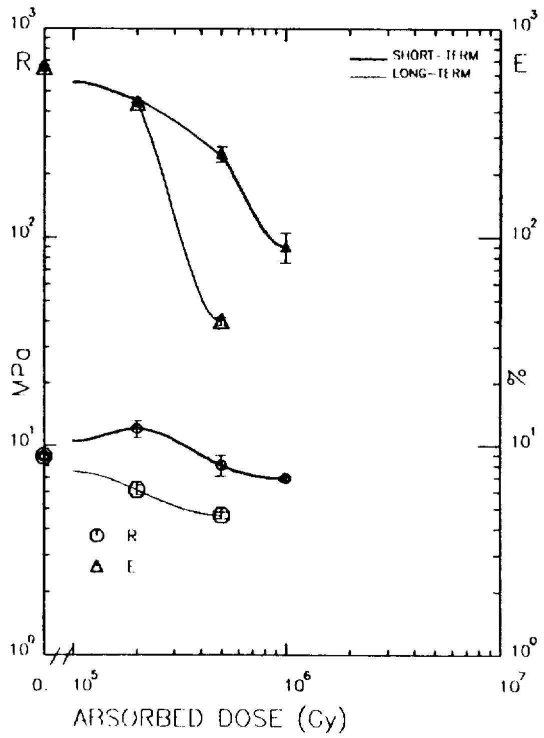
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.2 ± 0.4	663.0 ± 7.6	36.4 ± 0.5
0.200	1.7×10^5	11.6 ± 2.7	426.0 ± 54.5	38.1 ± 1.6
0.500	1.7×10^5	7.7 ± 0.2	185.5 ± 19.2	40.6 ± 0.5
1.000	1.7×10^5	8.6 ± 0.1	86.0 ± 19.5	42.6 ± 0.5
0.000	--	10.2 ± 0.4	663.0 ± 7.6	36.4 ± 0.5
0.200	100.0	8.4 ± 0.7	450.0 ± 16.6	41.0 ± 0.0
0.500	100.0	4.7 ± 0.1	31.5 ± 2.9	38.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.4
RADIATION INDEX (100.0 Gy/h) : 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 872

MATERIAL : VAC Copolymer /EPR
TYPE : Black T 2
SUPPLIER : kabelmetal electro
REMARKS : from inner sheath of LEP cable

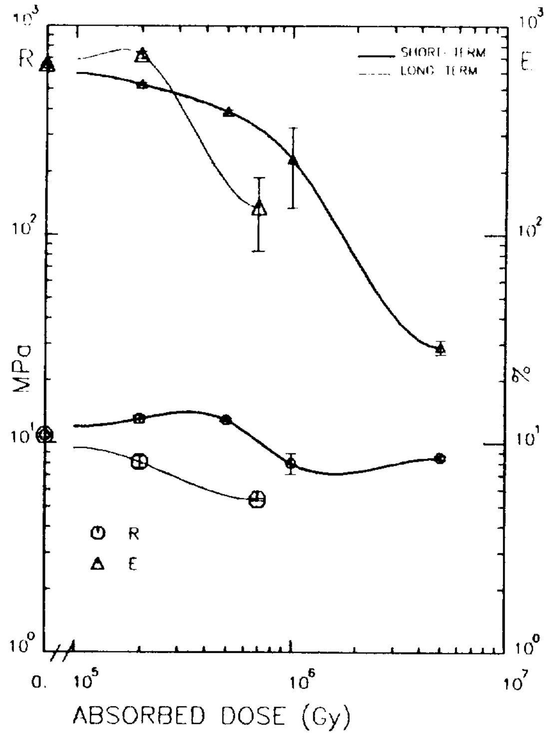
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	8.9 ± 0.3	653.0 ± 10.4	30.0 ± 0.0
0.200	1.7×10^5	12.1 ± 1.2	454.0 ± 12.9	34.8 ± 1.2
0.500	1.7×10^5	8.1 ± 0.9	250.0 ± 20.9	36.0 ± 0.0
1.000	1.7×10^5	7.0 ± 0.1	90.5 ± 14.6	38.0 ± 0.0
0.000	–	8.9 ± 0.3	653.0 ± 10.4	30.0 ± 0.0
0.200	100.0	6.2 ± 0.3	438.0 ± 18.9	38.0 ± 0.0
0.500	100.0	4.7 ± 0.2	40.0 ± 1.8	36.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.5
RADIATION INDEX (100.0 Gy/h) : 5.3

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.9 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 915

MATERIAL : VAC-copolymer
TYPE : 2 YM 010-011, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : black sheath (S2)

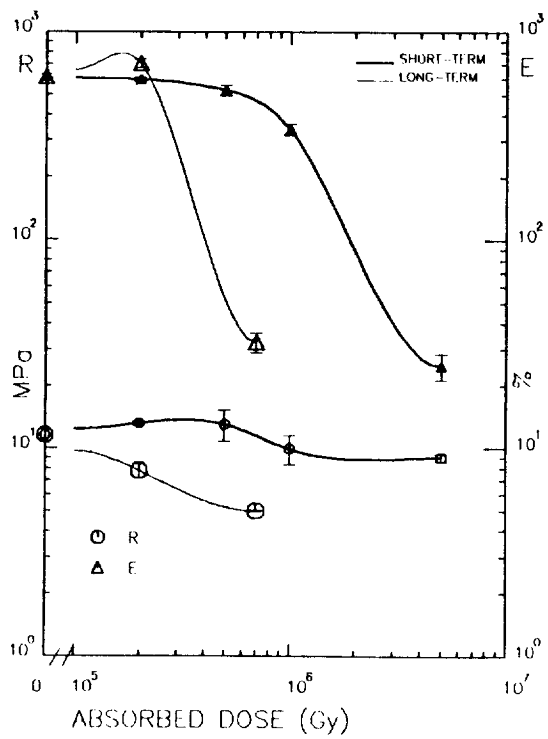
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.9 ± 0.2	657.0 ± 10.4	36.0 ± 0.0
0.200	2.5×10^5	13.1 ± 0.6	526.0 ± 8.9	38.0 ± 0.0
0.500	2.5×10^5	13.0 ± 0.2	391.0 ± 8.2	39.0 ± 0.0
1.000	2.5×10^5	8.0 ± 0.9	231.0 ± 96.1	41.0 ± 0.0
5.000	2.5×10^5	8.5 ± 0.2	29.0 ± 2.2	46.0 ± 0.0
0.000	–	10.9 ± 0.2	657.0 ± 10.4	36.0 ± 0.0
0.200	100.0	8.1 ± 0.5	726.0 ± 29.9	36.5 ± 0.0
0.700	100.0	5.4 ± 0.1	136.0 ± 52.4	30.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.8
RADIATION INDEX (100.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 33.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 922

MATERIAL : VAC-copolymer
TYPE : 2 YM 010 RR, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : sheath, colourable (S2)

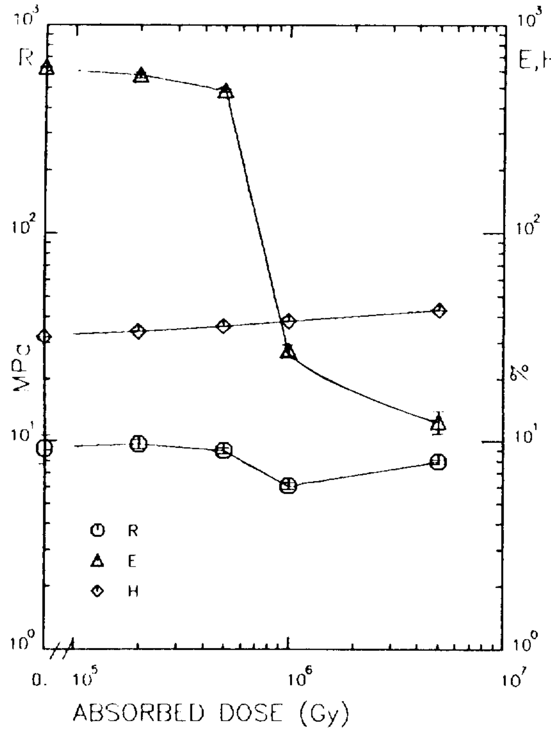
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Tensile properties Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	11.6 ± 0.8	608.0 ± 20.8	39.0 ± 0.0
0.200	2.5×10^5	13.2 ± 0.3	594.0 ± 12.9	40.0 ± 0.0
0.500	2.5×10^5	13.1 ± 2.3	527.0 ± 31.5	40.0 ± 0.0
1.000	2.5×10^5	10.0 ± 1.6	340.0 ± 21.5	40.0 ± 0.0
5.000	2.5×10^5	9.1 ± 0.4	25.0 ± 3.5	45.0 ± 0.0
0.000	–	11.6 ± 0.8	608.0 ± 20.8	39.0 ± 0.0
0.200	100.0	7.8 ± 0.6	709.0 ± 36.0	37.5 ± 0.0
0.700	100.0	5.0 ± 0.0	32.5 ± 3.5	33.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 6.0
RADIATION INDEX (100.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 32.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 982

MATERIAL : VAC–copolymer
TYPE : 2 YM 011 RR, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : sheath colourable

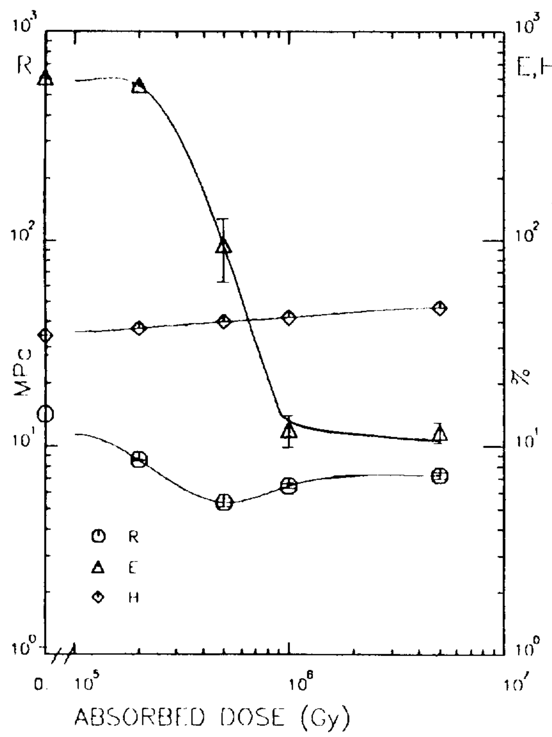
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.2 ± 1.5	628.0 ± 4.5	32.0 ± 0.0
0.200	3176.0	9.7 ± 0.5	577.0 ± 18.2	34.0 ± 0.0
0.500	3176.0	9.0 ± 0.3	487.0 ± 8.4	36.0 ± 0.0
1.000	3176.0	6.1 ± 0.2	27.5 ± 1.8	38.0 ± 0.0
5.000	2.2×10^5	8.0 ± 0.2	12.5 ± 1.6	43.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 30.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 983

MATERIAL : VAC–copolymer
TYPE : 2 YM 012 RR, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : sheath, colourable

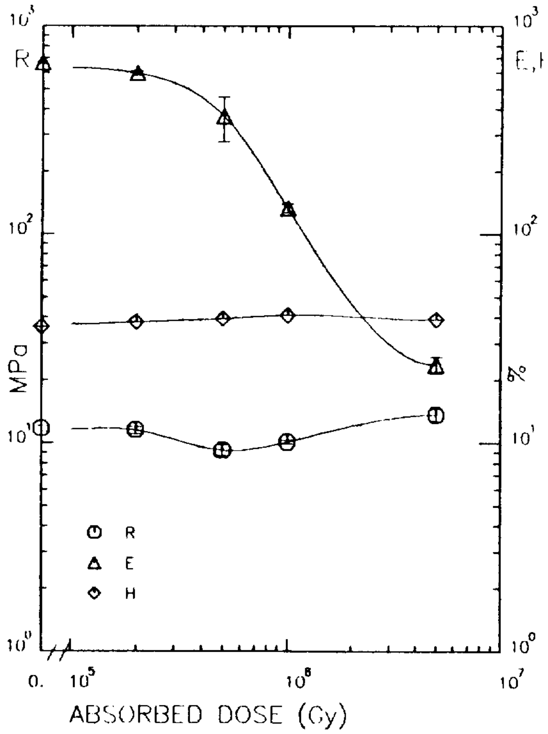
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.2 ± 13.2	607.0 ± 6.7	34.0 ± 0.0
0.200	3176.0	8.6 ± 0.1	557.5 ± 6.5	37.0 ± 0.0
0.500	3176.0	5.4 ± 0.2	95.5 ± 32.8	40.0 ± 0.0
1.000	3176.0	6.5 ± 0.2	12.0 ± 2.1	42.0 ± 0.0
5.000	2.2×10^5	7.3 ± 0.3	11.7 ± 1.3	47.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 34.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 988

MATERIAL : VAC-copolymer
TYPE : 2 YI 066 RR, thermoplastic
SUPPLIER : kabelmetal electro
REMARKS : insul. flat ribbon cable

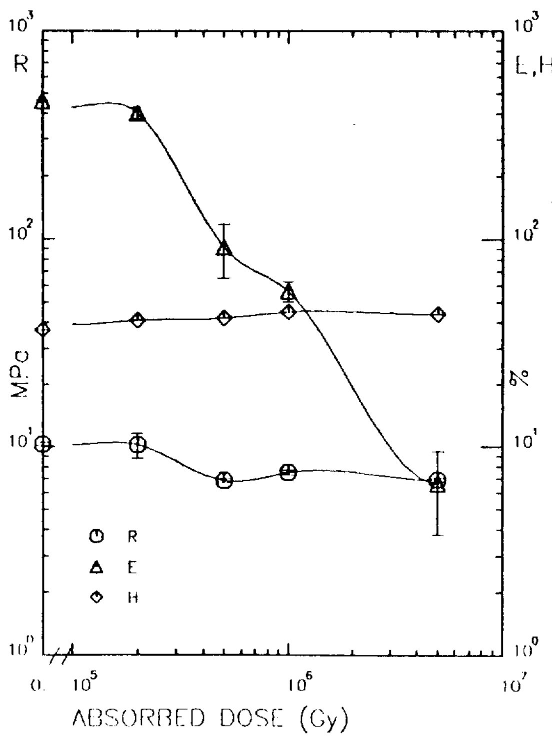
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	—	11.8 ± 0.3	668.0 ± 7.6	36.0 ± 0.0
0.200	3176.0	11.6 ± 0.5	597.0 ± 12.5	38.0 ± 0.0
0.500	3176.0	9.3 ± 0.6	371.0 ± 90.4	39.5 ± 0.0
1.000	3176.0	10.1 ± 0.2	134.0 ± 6.5	41.0 ± 0.0
5.000	2.2×10^5	13.7 ± 0.9	23.8 ± 2.1	39.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 31.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 989

MATERIAL : VAC-copolymer
TYPE : 2 XI 076, crosslinked
SUPPLIER : kabelmetal electro
REMARKS : insul. high temperature appl.

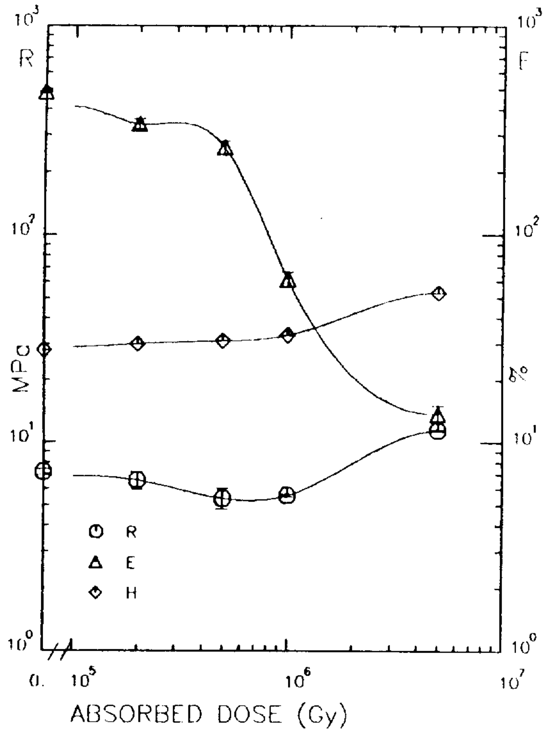
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	—	10.3 ± 0.2	458.0 ± 5.7	37.0 ± 0.0
0.200	3176.0	10.2 ± 1.4	402.0 ± 26.4	41.0 ± 0.0
0.500	3176.0	6.9 ± 0.1	91.5 ± 26.4	42.0 ± 0.0
1.000	3176.0	7.5 ± 0.2	56.5 ± 6.3	45.0 ± 0.0
5.000	2.2×10^5	7.0 ± 0.1	6.7 ± 2.9	44.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 36.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 990

MATERIAL : VAC-copolymer
TYPE : HM 180 RR, crosslinked
SUPPLIER : kabelmetal electro
REMARKS : sheath

TEST RESULTS :

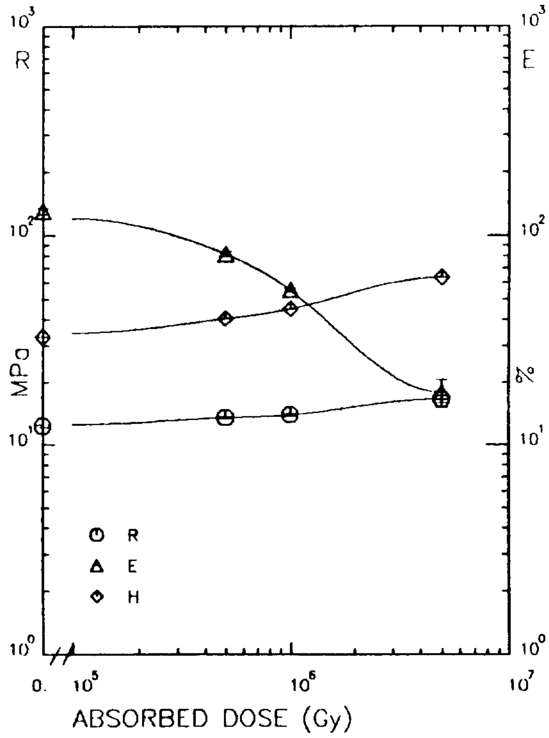
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	-	7.2 ± 0.2	483.0 ± 4.5	28.0 ± 0.0
0.200	3176.0	6.6 ± 0.6	340.0 ± 18.7	30.0 ± 0.0
0.500	3176.0	5.4 ± 0.6	263.0 ± 18.6	31.0 ± 0.0
1.000	3176.0	5.6 ± 0.1	61.5 ± 4.9	33.0 ± 0.0
5.000	2.2×10^5	11.4 ± 0.1	13.8 ± 1.4	53.0 ± 0.0

RADIATION INDEX (3176.0 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 35.0 %
CORROSIVITY (DIN 57472) : PASS

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
674	1983	Du Pont de Nemours via NK EB	0.0	-	12.3	131	33	27	
			0.5	2×10^5	13.6	82	41		5.8
			1.0	2×10^5	14.0	56	45		
			5.0	2×10^5	16.7	18	64		
805	ZFI 3H 1p	Du Pont de Nemours via NK EB	0.0	-	6.4	278	27	43	
			0.5	2×10^5	7.8	116	33		
			1.0	2×10^5	8.9	66	38		
			5.0	2×10^5	12.4	16	59		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 674

MATERIAL : Vamac
TYPE :
SUPPLIER : Norsk Kabelfabrik EB
REMARKS : (duPont de Nemours) (P)

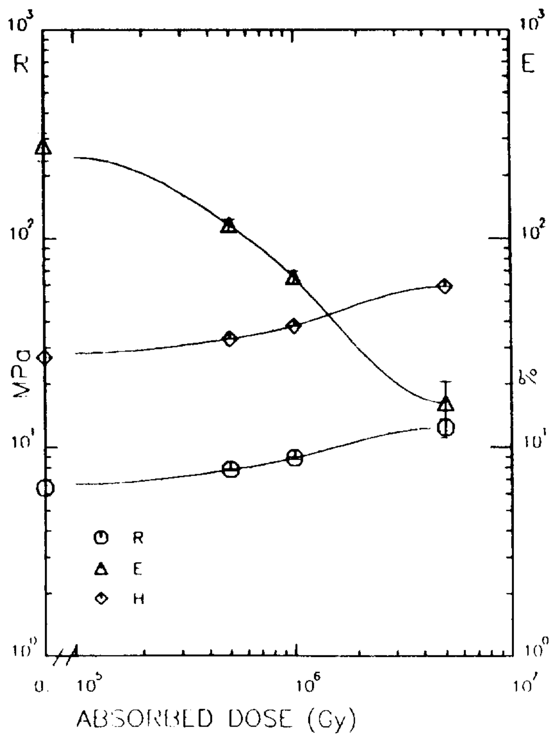
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	12.3 ± 0.1	131.0 ± 4.5	33.0 ± 0.0
0.500	1.7×10^5	13.6 ± 0.1	82.0 ± 2.1	40.5 ± 0.0
1.000	1.7×10^5	14.0 ± 0.2	55.5 ± 1.1	45.0 ± 0.0
5.000	1.7×10^5	16.7 ± 0.7	18.0 ± 2.7	63.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 27.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 805

MATERIAL : Vamac
TYPE : ZFI 3H 1p (grey)
SUPPLIER : Norsk Kabelfabrik EB
REMARKS : (duPont de Nemours) (P)

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	6.4 ± 0.2	278.0 ± 42.2	27.0 ± 0.0
0.500	1.7×10^5	7.8 ± 0.1	116.0 ± 7.6	33.0 ± 0.0
1.000	1.7×10^5	8.9 ± 0.1	65.5 ± 4.5	38.0 ± 0.0
5.000	1.7×10^5	12.4 ± 1.2	16.3 ± 4.3	59.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) < 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 42.7 %
CORROSIVITY (DIN 57472) : PASS

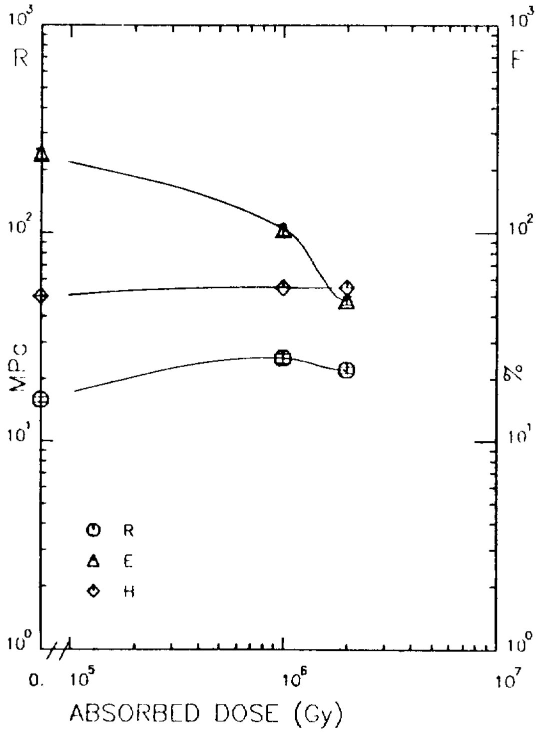
XLPE

chemically or radiation cross-linked polyethylene.
For general characteristics, see Tables 1 and 2.
See also in 1st edition (Ref. [16]).

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	Tensile properties E (%)	H (°D)	OI (%)	RI
455	909 Insulation	Silec	0.0	-	15.9	239	50	-	
			1.0	2×10^5	25.3	104	55		
			2.0	2×10^5	22.2	48	55		
558	HFDS 4201 Insulation	Pirelli	0.0	-	22.0	547	40	19	
			0.5	2×10^5	15.2	296	42		5.7
			1.0	2×10^5	11.5	171	43		
			5.0	2×10^5	10.9	30	44		
576	Insulation	Gorse	0.0	-	16.0	461	44	21	
			0.5	2×10^5	15.0	310	46		5.8
			1.0	2×10^5	11.1	139	44		
			5.0	2×10^5	11.6	127	50		
577	Semi-conducting	Gorse	0.0	-	18.5	214	50	20	
			0.5	2×10^5	20.3	118	53		5.8
			1.0	2×10^5	18.2	85	51		
			5.0	2×10^5	15.0	20	57		
714	LD EC-41	Metallurgica Bresciana	0.0	-	10.7	219	45	18	
			0.5	2×10^5	11.4	136	45		5.8
			1.0	2×10^5	12.2	71	46		
			5.0	2×10^5	11.0	11	48		
715	MD EC-MD	Metallurgica Bresciana	0.0	-	14.1	243	52	19	
			0.5	2×10^5	15.3	150	52		5.8
			1.0	2×10^5	15.7	78	53		
			5.0	2×10^5	17.3	15	56		
759	Sheath for LEP 20 kV cables	Fulgor Cavi	0.0	-	9.6	142	42	28	
			0.5	2×10^5	11.8	104	43		6.0
			1.0	2×10^5	11.1	84	42		
			5.0	2×10^5	11.7	13	55		
			0.2	100	11.0	114	42		5.5
			0.5	100	9.0	53	43		
769	Rheyhalon Insulation	AEG-Kabel	0.0	-	13.9	307	40	-	
			0.5	2×10^5	15.7	239	41		5.9
			1.0	2×10^5	11.8	101	42		
			0.2	100	13.5	260	46		5.4
			0.5	100	10.6	30	50		
780	4201 Insulation HT	Silec	0.0	-	23.3	530	43	17	
			0.5	2×10^5	20.9	363	45		5.8
			1.0	2×10^5	13.7	194	44		
			5.0	2×10^5	9.2	12	47		
781	951 Semi-conducting	Silec	0.0	-	9.3	294	33	24	
			0.5	2×10^5	10.0	177	34		5.8
			1.0	2×10^5	10.0	126	34		
			5.0	2×10^5	10.1	34	40		
782	931 Insulation	Silec	0.0	-	15.5	341	50	17	
			0.5	2×10^5	16.3	236	53		5.8
			1.0	2×10^5	15.3	95	54		
			5.0	2×10^5	15.9	10	57		

Mat. No.	Type	Supplier	Dose (MGy)	Dose rate (Gy/h)	Tensile properties R (MPa)	E (%)	H (°D)	OI (%)	RI
798	Silythene Insulation SPS HT cable	Silec	0.0	–	13.6	540	46	–	
			0.01	1×10^5	13.4	527	47		5.6
			0.1	1×10^5	14.2	497	48		
			0.5	1×10^5	11.5	237	48		
			1.0	1×10^5	12.3	85	49		
			0.01	1000	12.6	489	49	–	5.2
			0.1	1000	14.0	486	50		
			0.5	4000	12.7	63	50		
			1.0	4000	11.6	40	51		
	life tests		0.01	0.4	12.8	549	47	–	>5
			0.1	3.6	12.5	372	47		
856	Polydan G2 EC-MD Insulation	Padanaplast	0.0	–	18.4	342	54	19	
			0.5	2×10^5	19.6	174	55		5.7
			1.0	2×10^5	18.8	64	58		
			5.0	2×10^5	18.2	7	59		
906	Rheyhalon Insulation	AEG-Kabel	0.0	–	17.1	302	44	–	
			0.2	2×10^5	19.5	271	45		5.9
			0.5	2×10^5	18.1	198	48		
			1.0	2×10^5	15.3	111	50		
			0.2	4000	16.9	261	47		5.8
			0.5	4000	13.8	159	48		
			1.0	4000	11.1	55	50		

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 455

MATERIAL : XLPE
TYPE : 909 – Insulation
SUPPLIER : SILEC
REMARKS : (P)

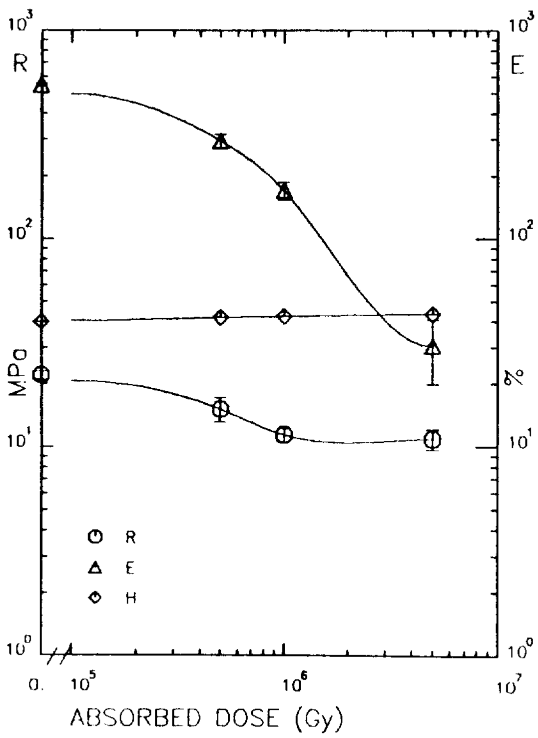
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	15.9 ± 0.5	239.2 ± 14.3	50.0 ± 0.0
1.000	2.0×10^5	25.3 ± 1.3	103.6 ± 6.5	55.0 ± 0.0
2.000	2.0×10^5	22.2 ± 0.8	47.6 ± 2.2	55.0 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) < 6.0

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 558

MATERIAL : XLPE
TYPE : HFDS 4201
SUPPLIER : Pirelli
REMARKS : Insulation (P)

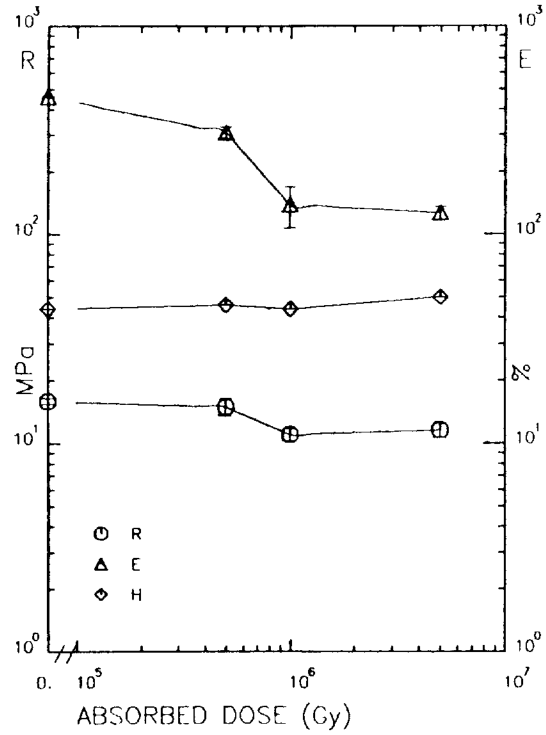
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	22.0 ± 1.0	547.0 ± 9.5	40.0 ± 0.0
0.500	2.0×10^5	15.2 ± 2.0	296.0 ± 22.4	42.0 ± 0.0
1.000	2.0×10^5	11.5 ± 0.9	171.0 ± 16.8	42.5 ± 0.0
5.000	2.0×10^5	10.9 ± 1.2	30.4 ± 10.4	43.5 ± 0.0

RADIATION INDEX (2.0×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 19.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 576

MATERIAL : XLPE
TYPE : Insulation
SUPPLIER : Gorse
REMARKS : (P)

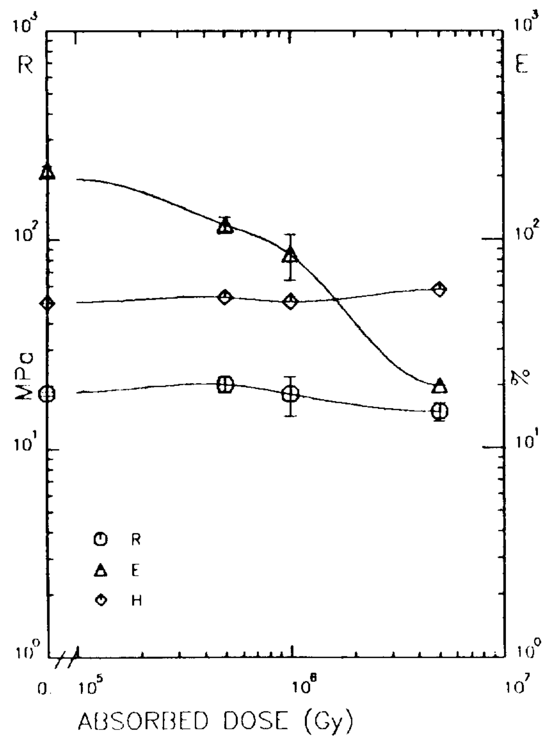
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness
		Strength R (MPa)	Elongation E (%)	Shore D H (Degree)
0.000	–	16.0 ± 0.5	461.0 ± 2.2	44.0 ± 0.0
0.500	2.5×10^5	15.0 ± 1.4	310.0 ± 18.7	46.0 ± 0.0
1.000	2.5×10^5	11.1 ± 0.8	139.0 ± 31.5	44.0 ± 0.0
5.000	2.5×10^5	11.6 ± 0.9	127.0 ± 9.1	50.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 21.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 577

MATERIAL : XLPE
TYPE : Semiconductor
SUPPLIER : Gorse
REMARKS : (P)

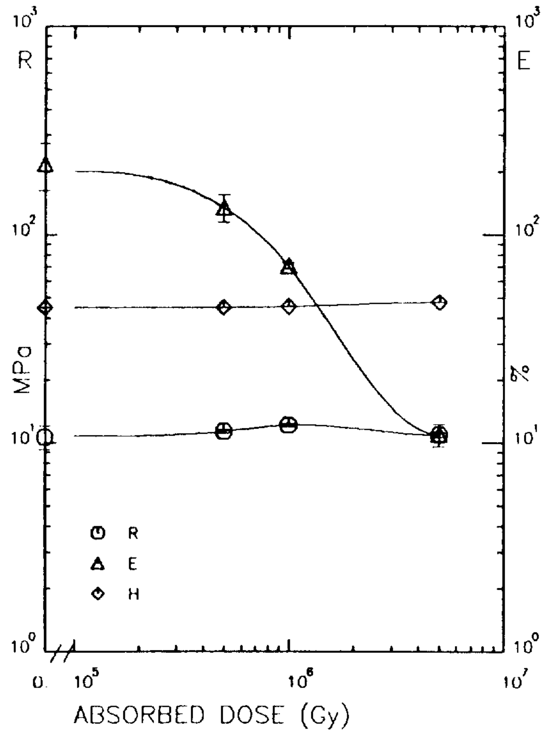
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties		Hardness
		Strength R (MPa)	Elongation E (%)	Shore D H (Degree)
0.000	–	18.5 ± 0.5	214.0 ± 11.9	50.0 ± 0.0
0.500	2.5×10^5	20.3 ± 1.8	118.0 ± 10.4	53.0 ± 0.0
1.000	2.5×10^5	18.2 ± 4.0	85.0 ± 21.2	50.5 ± 0.0
5.000	2.5×10^5	15.0 ± 1.5	20.0 ± 0.0	57.5 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 20.4 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 714

MATERIAL : XLPE
TYPE : Low Density EC-41
SUPPLIER : Metallurgica Bresciana
REMARKS : (P)

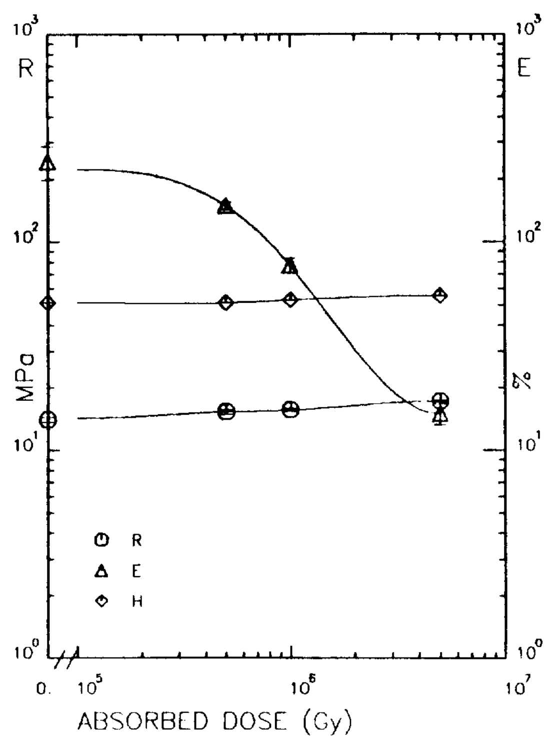
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	10.7 ± 1.4	219.0 ± 55.9	45.0 ± 0.0
0.500	1.7×10^5	11.4 ± 0.3	135.5 ± 20.2	45.0 ± 0.0
1.000	1.7×10^5	12.2 ± 0.2	71.0 ± 2.2	45.5 ± 0.0
5.000	1.7×10^5	11.0 ± 0.3	11.0 ± 1.4	47.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 715

MATERIAL : XLPE
TYPE : Mid Density EC-MD
SUPPLIER : Metallurgica Bresciana
REMARKS : (P)

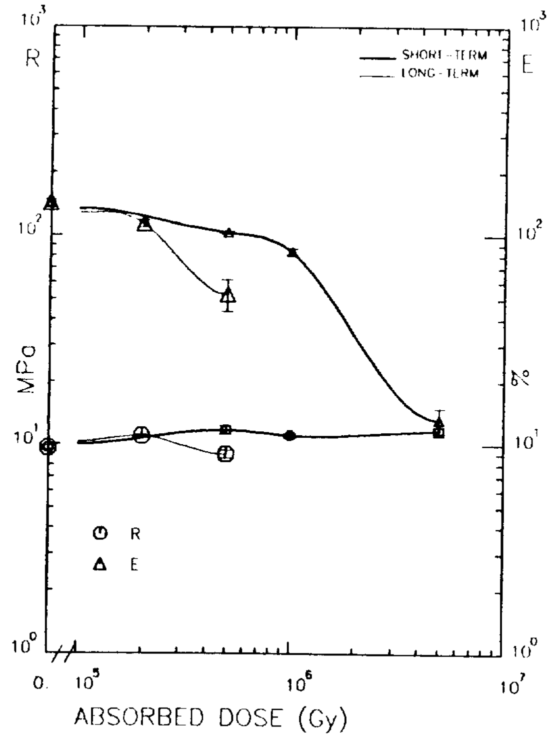
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	14.1 ± 0.4	243.0 ± 43.4	51.5 ± 0.0
0.500	1.7×10^5	15.3 ± 0.4	150.0 ± 6.4	51.5 ± 0.0
1.000	1.7×10^5	15.7 ± 0.3	77.5 ± 6.1	53.0 ± 0.0
5.000	1.7×10^5	17.3 ± 0.2	15.0 ± 1.8	55.5 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 18.6 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 759

MATERIAL : XLPE
TYPE : charged (black)
SUPPLIER : Nuova Fulgor Cavi
REMARKS : Sheath for 20 kV cable (LEP) (P)

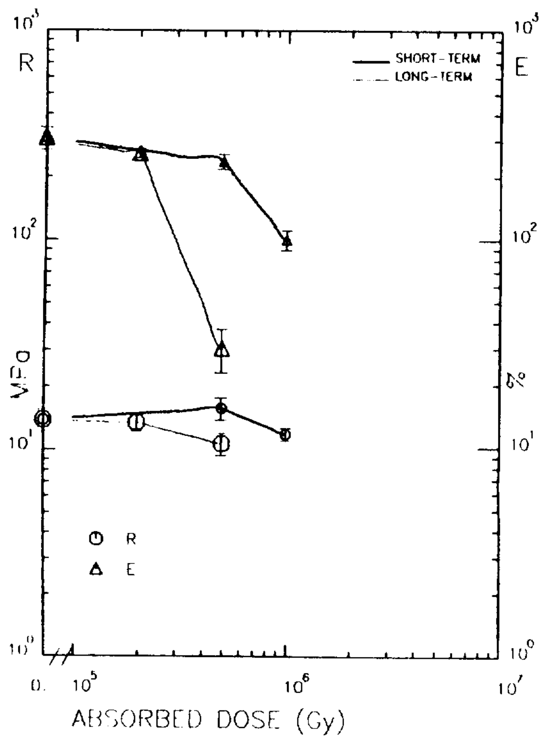
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.6 ± 0.2	142.4 ± 5.4	42.0 ± 0.0
0.500	1.7×10^5	11.9 ± 0.5	103.6 ± 1.7	43.0 ± 0.0
1.000	1.7×10^5	11.1 ± 0.3	84.0 ± 2.8	42.0 ± 0.0
5.000	1.7×10^5	11.7 ± 0.6	13.2 ± 1.8	55.0 ± 0.0
0.000	–	9.6 ± 0.2	142.4 ± 5.4	42.0 ± 0.0
0.200	100.0	11.0 ± 0.2	114.0 ± 4.5	41.6 ± 0.4
0.500	100.0	9.0 ± 0.4	52.8 ± 9.0	42.6 ± 0.7

RADIATION INDEX (1.7×10^5 Gy/h) : 6.0
RADIATION INDEX (100.0 Gy/h) : 5.5

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 28.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 769

MATERIAL : XLPE
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Coloured cable insulations (C)

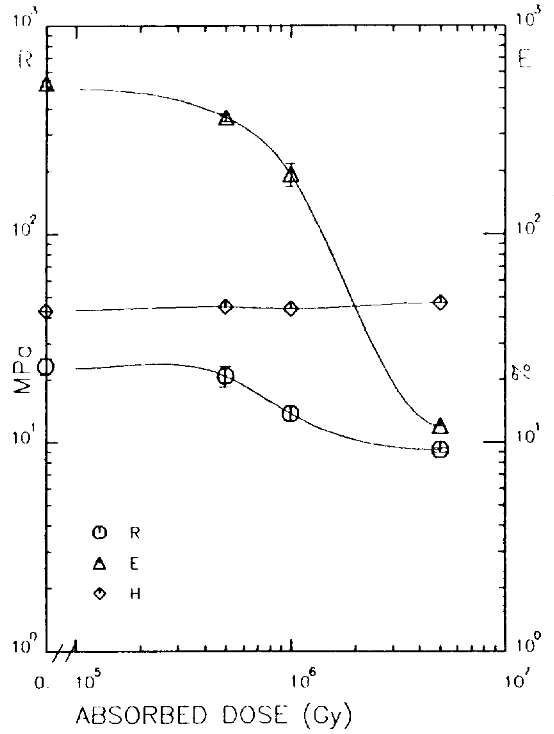
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.9 ± 1.6	306.9 ± 37.1	40.0 ± 0.0
0.500	1.9×10^5	15.7 ± 2.0	239.3 ± 19.0	41.1 ± 1.5
1.000	1.9×10^5	11.8 ± 0.8	100.9 ± 10.9	41.5 ± 0.9
0.000	–	13.9 ± 1.6	306.9 ± 37.1	40.0 ± 0.0
0.200	70.0	13.5 ± 1.2	260.0 ± 12.6	46.0 ± 0.0
0.500	70.0	10.6 ± 1.3	30.4 ± 7.1	50.0 ± 0.0

RADIATION INDEX (1.9×10^5 Gy/h) : 5.9
RADIATION INDEX (70.0 Gy/h) : 5.4

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 780

MATERIAL : XLPE
TYPE : 4201 – HT insulation
SUPPLIER : SILEC
REMARKS : (P)

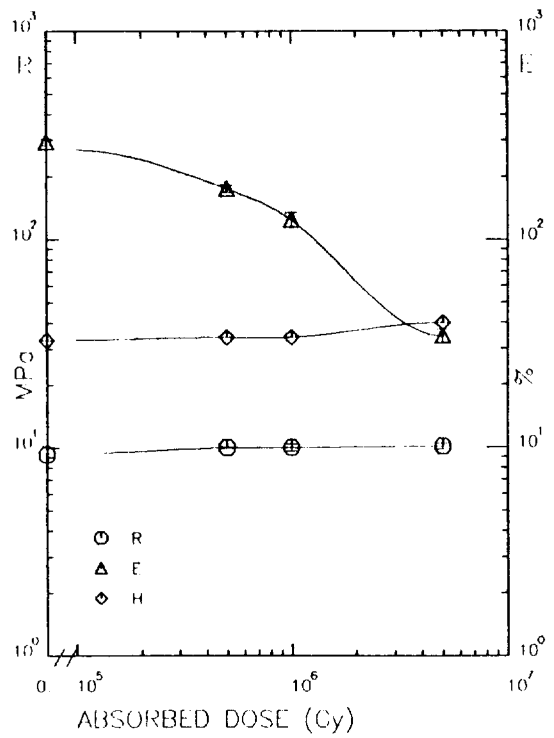
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	23.3 ± 2.0	530.4 ± 20.1	43.0 ± 0.0
0.500	1.8×10^5	20.9 ± 2.4	363.0 ± 16.1	45.0 ± 0.0
1.000	1.8×10^5	13.7 ± 1.0	193.6 ± 25.1	44.0 ± 0.0
5.000	1.8×10^5	9.2 ± 0.2	12.0 ± 0.0	47.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 17.3 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 781

MATERIAL : Semi-conductor compound
TYPE : 951
SUPPLIER : SILEC
REMARKS : (P)

TEST RESULTS :

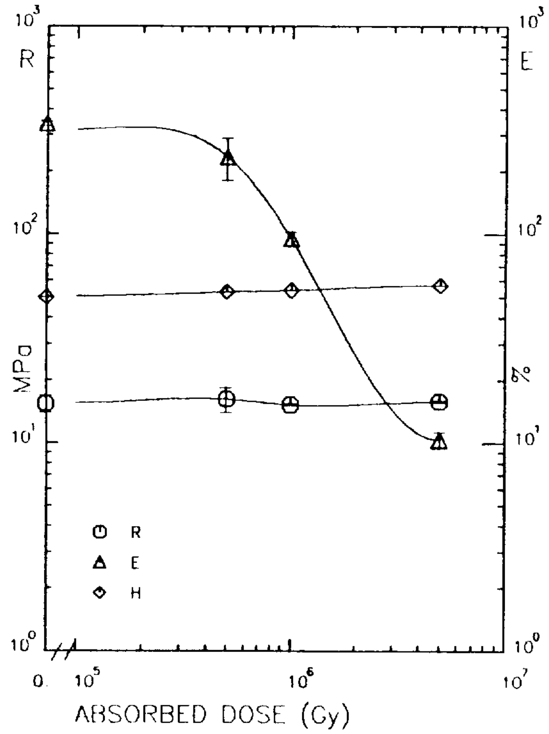
Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	9.3 ± 0.2	294.0 ± 10.6	33.0 ± 0.0
0.500	1.8×10^5	10.0 ± 0.1	176.8 ± 6.6	34.0 ± 0.0
1.000	1.8×10^5	10.0 ± 0.4	125.6 ± 10.0	34.0 ± 0.0
5.000	1.8×10^5	10.1 ± 0.3	34.4 ± 2.6	40.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 23.5 %
CORROSIVITY (DIN 57472) : PASS

XLPE

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 782

MATERIAL : XLPE
TYPE : 931 – Insulation
SUPPLIER : SILEC
REMARKS : XL with Silane (P)

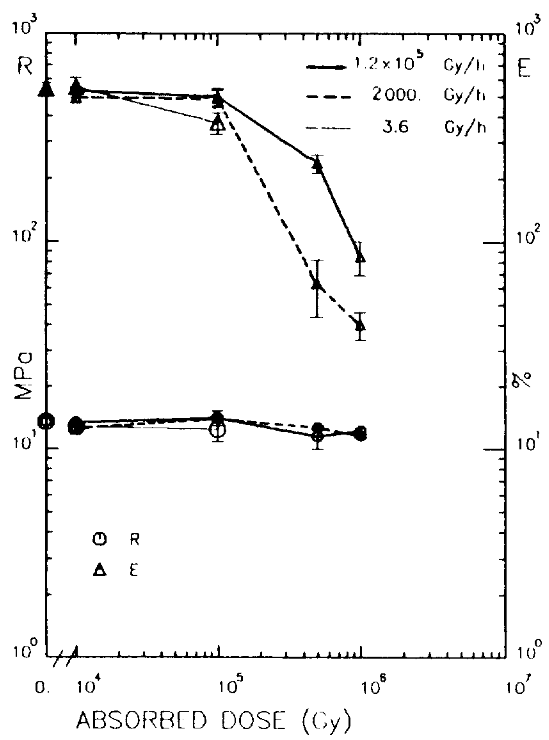
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	15.5 ± 1.4	341.0 ± 8.9	50.0 ± 0.0
0.500	1.8×10^5	16.3 ± 2.2	236.0 ± 54.8	53.0 ± 0.0
1.000	1.8×10^5	15.3 ± 0.2	95.2 ± 7.2	54.0 ± 0.0
5.000	1.8×10^5	15.9 ± 0.1	10.4 ± 0.9	57.0 ± 0.0

RADIATION INDEX (1.8×10^5 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 17.4 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 798

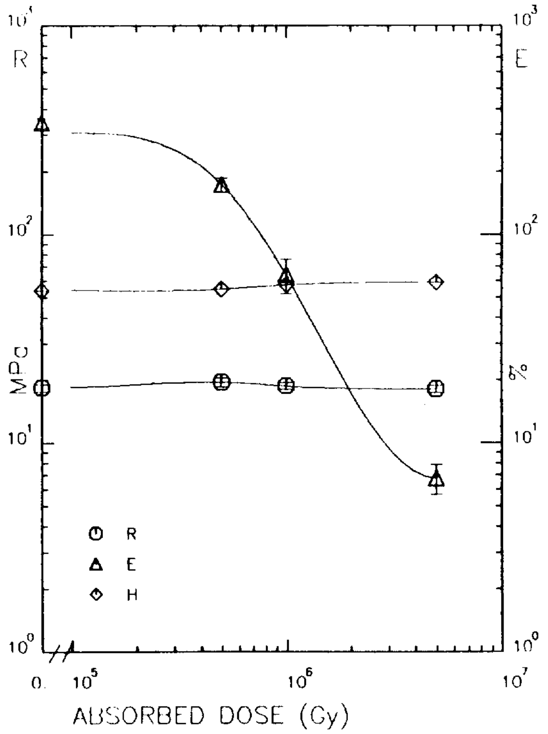
MATERIAL : XLPE Silythene
TYPE : Internal Insulation
SUPPLIER : SILEC
REMARKS : from HT 1x240 Alu/PE cable

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties Strength R (MPa)	Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	13.6 ± 0.5	540.0 ± 35.4	46.2 ± 1.0
0.010	1.2×10^5	13.4 ± 0.3	527.0 ± 22.2	47.5 ± 0.0
0.100	1.2×10^5	14.2 ± 1.2	497.0 ± 47.6	47.5 ± 0.0
0.500	1.2×10^5	11.5 ± 1.5	237.0 ± 23.9	48.0 ± 0.0
1.000	1.2×10^5	12.3 ± 0.3	85.0 ± 15.8	49.0 ± 0.0
0.000	–	13.6 ± 0.5	540.0 ± 35.4	46.2 ± 1.0
0.010	1000.0	12.6 ± 0.3	489.0 ± 29.2	49.5 ± 0.0
0.100	1000.0	14.0 ± 0.5	486.0 ± 46.7	50.0 ± 0.0
0.500	3970.0	12.7 ± 0.2	63.0 ± 19.2	50.0 ± 0.0
1.000	4250.0	11.6 ± 0.2	40.0 ± 6.1	50.5 ± 0.0
0.000	–	13.6 ± 0.5	540.0 ± 35.4	46.2 ± 1.0
0.010	0.4	12.8 ± 1.0	549.2 ± 60.2	46.9 ± 0.7
0.100	3.6	12.5 ± 1.6	372.2 ± 43.8	47.4 ± 0.8

RADIATION INDEX (1.2×10^6 Gy/h) : 5.6
RADIATION INDEX (2485.0 Gy/h) : 5.2
RADIATION INDEX (3.6 Gy/h) > 5.0

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 856

MATERIAL : XLPE
TYPE : Polydan PE/G2 natural EC-MD
SUPPLIER : Padunaplast
REMARKS : Insulation (P)

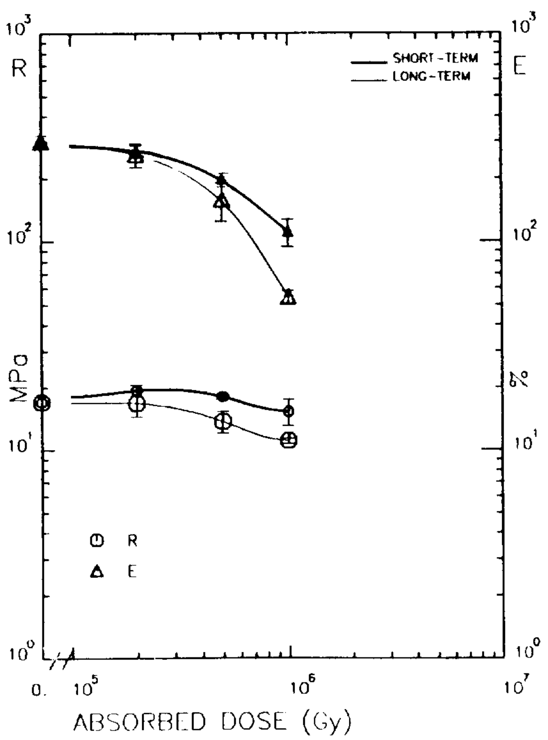
TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	18.4 ± 0.7	342.0 ± 18.6	54.0 ± 0.0
0.500	1.7×10^5	19.6 ± 0.9	174.4 ± 13.4	55.0 ± 0.0
1.000	1.7×10^5	18.8 ± 0.7	64.4 ± 12.0	57.5 ± 0.0
5.000	1.7×10^5	18.2 ± 0.7	6.8 ± 1.1	59.0 ± 0.0

RADIATION INDEX (1.7×10^5 Gy/h) : 5.7

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : 19.0 %
CORROSIVITY (DIN 57472) : PASS

DETERMINATION OF EFFECTS OF IONIZING RADIATION ON INSULATING MATERIALS, IEC 544



CERN MATERIAL No. : 906

MATERIAL : XLPE
TYPE : Rheyhalon
SUPPLIER : AEG-Kabel
REMARKS : Cable insulation

TEST RESULTS :

Dose (MGy)	Dose rate (Gy/H)	Tensile properties: Strength R (MPa)	Tensile properties: Elongation E (%)	Hardness Shore D H (Degree)
0.000	–	17.1 ± 1.2	302.0 ± 20.8	44.0 ± 0.0
0.200	2.5×10^5	19.5 ± 1.2	271.0 ± 18.8	45.0 ± 0.0
0.500	2.5×10^5	18.1 ± 0.4	198.0 ± 14.8	48.0 ± 0.0
1.000	2.5×10^5	15.3 ± 2.3	111.0 ± 16.7	50.0 ± 0.0
0.000	–	17.1 ± 1.2	302.0 ± 20.8	44.0 ± 0.0
0.200	4000.0	16.9 ± 2.4	261.0 ± 33.8	47.0 ± 0.0
0.500	4000.0	13.8 ± 1.7	158.5 ± 33.3	48.0 ± 0.0
1.000	4000.0	11.1 ± 0.3	54.5 ± 3.7	50.0 ± 0.0

RADIATION INDEX (2.5×10^5 Gy/h) : 5.9
RADIATION INDEX (4000.0 Gy/h) : 5.8

RESULTS OF OTHER TESTS :
OXYGEN INDEX(ISO 4589) : NOT MEASURED
CORROSIVITY (DIN 57472) : PASS

Appendix 4:

LIST OF SUPPLIERS OF BASE MATERIALS (M) AND CABLES (C)
(Trade names are in italics)

Suppliers	(M/C)	Materials
Acome 14, rue de Marignan F-75008 Paris	C	*Acorad*, polyolefins
AEG Kabel Postfach 200141 D-4050 Mönchengladbach	C	Polyolefins, *Rheyhalon*, rubbers, XLPE
Bical 69, bd de la Wolume B-1200 Bruxelles	C	EVA
BICC Cables GB-Helsby-Warrington WA60DJ	C	EPDM, EVA, polyolefins
BP Chemicals 11, rue de Veyrot BP 149 CH-1217 Meyrin 2	M	EEA, EVA, PE, polyolefins, thermoplastics
Cabeltel-Filotex BP 1 F-91211 Draveil CEDEX	C	EVA, polyolefins
Câbles de Lyon BP 7153 F-69344 Lyon CEDEX 07	C	EPDM, EPR, EVA, PE
Cablexport P.O. Box 10096 I-20100 Milano	C	EPR, polyolefins, *Toxfree*
CEAT Cavi CP 498 I-10100 Torino	C	EPR, polyolefins, *Toxfree*
Cossonay Câbleries CH-1305 Cossonay-Gare	C	EPR
Dätwyler CH-6460 Altdorf	C	EAR, EPDM, EPR, EVA, polyolefins
Elastogran - EPE Postfach 1107 D-2844 Lemforde	M	*Elastollan*, PUR
Fulgor Cavi 18, via del Crocefisso I-04100 Latina	C	EEA, EPR, EVA, XLPE

Gorse 96 bd Général Leclerc BP 704 F-92007 Nanterre CEDEX	C	EPDM, EPR, EVA, semiconducting PE, SIR, XLPE
Huber & Suhner CH-8330 Pfäffikon	C	EPDM, PE, polyolefins, PUR, *Radox*
kabelmetal electro Postfach 260 D-3000 Hannover 1	M+C	EPR, PE, VAC
Lindsay & Williams Columbine Street GB-Manchester M11 2LH	M	*Megolon*
Lynenwerk Postfach 1240 D-5180 Eschweiler	C	EPR, EVA
Metallurgica Bresciana 3, via Brognolo I-25050 Passirano	C	EPR, polyolefins, PUR, XLPE
Neste Chemicals S-444 86 Stenungsund	M	PE, polyolefins
NKT Telecom Cables 95, Broendbystervej DK-2605 Broendby	C	EPDM, EVA, PE, *Silanpex*, *Sioplas*
Norsk Kabel EB Postbocks 369 N-3001 Drammen	C	*Cogegum*, EVA, PE, polyolefins, *Vamac*
Padanaplast Via Paganina I-43010 Roccabianca	M	*Cogegum*, XLPE
Pirelli SPA Viale Sacra 202 I-20100 Milano	C	Afumex, EPR, EVA, polyolefins, XLPE
Roque Carretera Rusinol 63 E-08560 Manlieu	C	EPR, EVA
Silec BP 6 F-77871 Montereau CEDEX	C	EPR, PE, polyolefins, semiconducting PE, *Silythene*, XLPE
STC Telecommunications Wednesbury Street Newport UK-Gwent NP9 OWS	C	EVA, *Sioplas*
Studer Kabel CH-4658 Däniken	C	EPDM, EPR, PE

Appendix 5:

ABBREVIATIONS USED IN THE TABLES OF RESULTS

C	indicates that the tested material was taken from real cable
E	elongation at break
Gy	gray (dose unit)
Gy/h	gray per hour (dose rate)
H	hardness
OI	oxygen index
P	indicates that the tested material was taken from moulded plaques
Pa	pascal
R	tensile strength
RI	radiation index
S3	indicates that the tested material was received in the form of S3 dumb-bell samples

DIN	Deutsche Industrie Normen
IEC	International Electrotechnical Commission
ISO	International Standards Organization