report

The Development of Radiation Processing in India

September 2025

About this Document

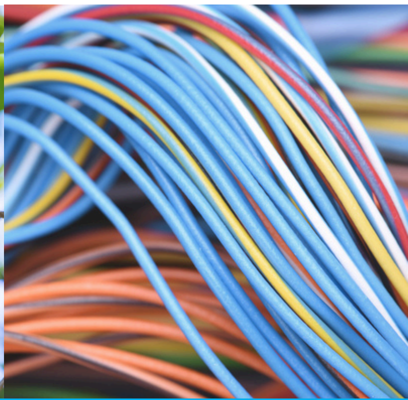
This document endeavours to provide an overview of the development and status of irradiation technologies and applications in India.

It is a result of collaboration between the International Irradiation Association (iia) and the Irradiation Industries Association of India (IIAI). The iia and IIAI would like to thank the following organisations for their contribution and/or review of the document:

Agrosurg Irradiators (India) Pvt Ltd
APAR Industries Ltd
Board of Radiation & Isotope Technology (BRIT)
Microtrol Sterilisation Services Pvt Ltd
Symec Engineers (India) Pvt Ltd

Every effort has been made to ensure the accuracy of the contents at the time of writing this document that covers a large and diversified country. Please inform the iia or the IIAI of any errors of omissions so that we can update this document periodically.



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1. The development of irradiation in India

1.1 Government of India initiatives – developing familiarization with radiation processing

The development of irradiation, or radiation processing, in India is largely the result of several initiatives undertaken by the Government of India over a long period of time. These initiatives were successful in developing a greater knowledge and familiarity with irradiation technologies and their applications.

Irradiation was first introduced into India in 1967 with the establishment of an irradiator supplied by AECL for enabling Indian scientists perform R&D on food irradiation. These efforts contributed significantly to several projects initiated by premier agencies including the Department of Atomic Energy (DAE) of India, IAEA, WHO, Codex Alimentarius Commission, FDA etc. for strengthening the application of irradiation to enhance food security and safety.

In 1974 the ISOMED gamma irradiator was established within the Department of Atomic Energy's (DAE) Bhabha Atomic Research Centre (BARC) premises in Mumbai for radiation sterilisation of medical devices. This irradiator was established under the aegis of the United Nations Development Programme (UNDP), initially for the purpose of technology-familiarisation and demonstration, and subsequently for commercial purposes.

Over the following years, the Indian scientific and technical community developed their skills in many areas of irradiation and radiation processing including: irradiator design, construction, operation and maintenance; radiation protection and safety; radiation microbiology, dosimetry and other related scientific and engineering fields. This positioned India well to train the next generation and develop its irradiation technologies and applications.

During the period of 1980-2000, the Government of India continued its initiatives to increase industry's familiarity with irradiation. Several indigenously developed gamma irradiators were established by DAE in different parts of the country to demonstrate radiation processing applications including medical device sterilization and the treatment of food and agricultural products. These irradiators were built and supplied with cobalt-60 by the Board of Radiation & Isotope Technology (BRIT). The Atomic Energy Regulatory Board (AERB) was made responsible for the implementation of regulatory aspects and irradiator safety and security.

In parallel, one imported and several indigenous industrial accelerators (electron-beams) were established by the DAE. These were used for demonstration purposes and made available to Indian industry. They were particularly used to demonstrate the advantages of radiation crosslinked wire and cable and the potential of this technology to industry.

These Government of India initiatives, along with investment in resources and infrastructure, were fundamental to the development of an irradiation industry that brings important socio-economic benefits to the country.

1.2 Transfer of Technology – the development of the Indian industry

Having successfully rolled out demonstration irradiation facilities and introduced radiation processing to industry, DAE transferred irradiation technology to the private sector. Participation by Indian industry was encouraged and, importantly, the supply of cobalt-60 to the private sector was assured. These arrangements fuelled significant growth in both the construction of new irradiators and the development of local design and manufacturing capabilities to meet the needs of this emerging industry. Local private organisations evolved to supply innovative irradiator designs and support services, including to neighbouring countries such as Bangladesh, Malaysia, Sri Lanka and Vietnam.

DAE had demonstrated the advantages of radiation crosslinking, and the wire and cable industry could see the potential demand for irradiated products from the domestic and overseas markets. Indian manufacturers soon imported and installed several low to medium energy electron beam accelerators for crosslinking of cable insulations, polymer products, tyres, etc. and started commercial scale processing. Over the years, the industry has attained technical expertise and is now less dependent on overseas vendors.

Currently, about 40 gamma irradiators and a similar number of electron beams are in operation in India.

2. Domestic factors in India

2.1 Economic and industry factors

India is a mixed economy where both public and private sectors play substantial roles. Agriculture, manufacturing and service industries are the significant sectors of the economy. Indian food, agriculture, medical device and pharmaceutical, and wire & cable industries are experiencing steady growth and are becoming increasingly important to the global market.

A large portion of the Indian population is involved in farming. With a population of ~1.45billion (2025), agricultural industries are crucial to both economic growth and food security. The Indian agricultural and food industries contribute significantly to both domestic consumption and export markets.

The Indian medical device industry is the fourth-largest market in Asia and among the top 20 globally. The market size of ~USD12 billion (2023-24) is projected to reach ~$50 billion by 2030. The industry includes both large multinational corporations and small and medium-sized enterprises (SMEs). The Government of India is supporting this industry through initiatives like the 'Make in India' programme and the National Health Policy.

These domestic factors have led Indian industry to adopt radiation processing for multiple applications including medical products sterilisation, food hygiene, shelf-life extension of agricultural products, and the crosslinking of wire and cable. It is regarded as convenient, highly effective and environmentally friendly, and is applied as either a preferred or complimentary process or an alternative to other existing methods.

2.2 Government of India support

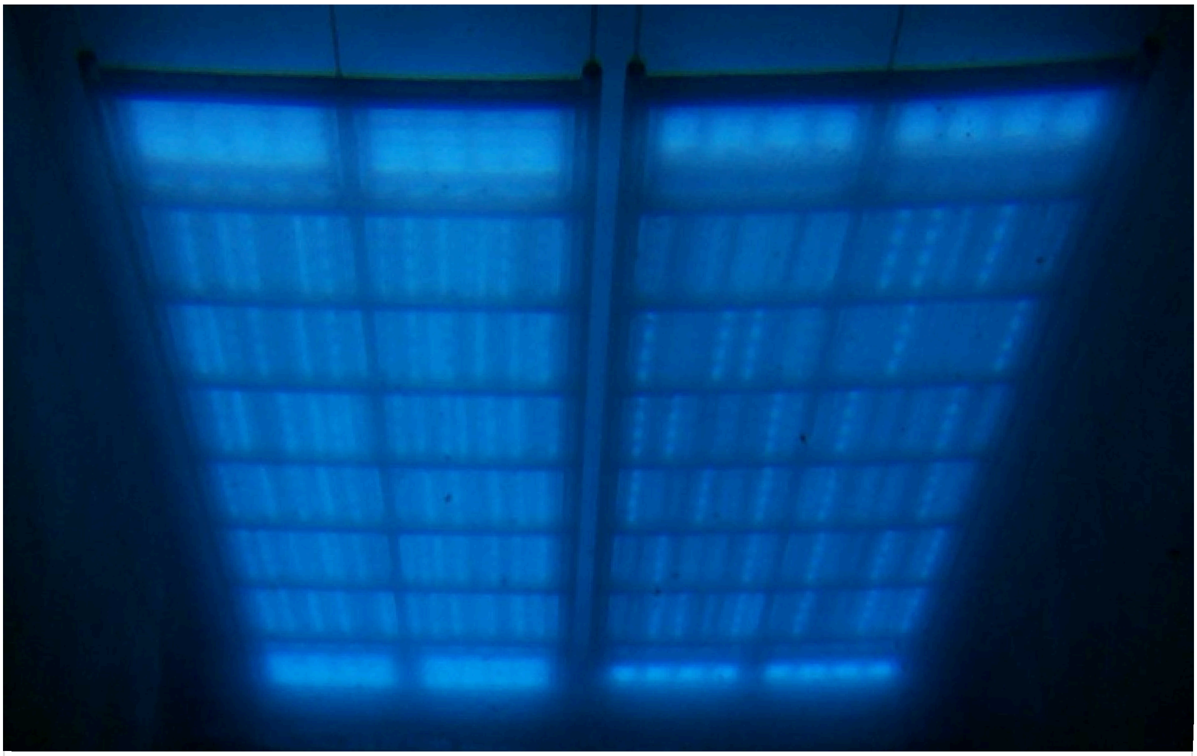
The application of irradiation to enhance the security and safety of the food supply chain is a priority in India. At the time of writing, the Ministry of Food Processing Industries, under the Scheme for Cold Chain and Value Addition Infrastructure, has announced support and financial assistance to the private sector for establishing multi-product food irradiation facilities. These facilities will have the flexibility to also cater for the non-food sector.

2.3 Cobalt-60 production

The local availability of cobalt-60 was recognized as an important factor in the development of radiation processing in India, even in the early days of developing familiarisation with irradiation technology. Investment in cobalt-60 production and the associated infrastructure, has placed Indian industry in a strong position to benefit from the applications of gamma irradiation and provides confidence in the sustainability of the industry.

Cobalt-60 is manufactured in nuclear reactors operated by the Nuclear Power Corporation of India Limited (NPCIL). It is then transferred to the Rajasthan Atomic Power Project Cobalt Facility (RAPPCOF) where sealed sources for use in gamma irradiators are manufactured. These sealed sources are supplied to industry by Board of Radiation Isotope Technology (BRIT), a unit of the DAE and commercial outlet of products and services based on radiation and isotopes.

It is reported that ~6.6 MCi of cobalt-60 was made available to stakeholders in 2023-24. This is sufficient to meet the entire demand of the domestic market and production is poised to grow as additional reactors will be utilised for producing cobalt-60. This will enable BRIT to continue meeting cobalt-60 demand as the number of gamma irradiators in India continue to grow. BRIT has the capability to export cobalt-60 in the case of surplus supply. New transport flasks have reportedly been designed and made ready to enable BRIT to distribute increasing volumes of cobalt-60.



Cobalt-60 emits gamma radiation that is used to treat a wide range of products and materials for beneficial purposes. The cobalt-60 sealed sources are tested and certified to meet international standards.

The above image shows cobalt-60 sealed sources installed in a gamma irradiator. The sources are safely stored underwater. The radiation gives off a blue glow underwater, known as the Cherenkov Effect.

Image courtesy of STERIS AST

3. Applications of irradiation in India

The following applications represent both current markets and future prospects.

3.1 Medical device sterilisation & healthcare applications

The sterilisation of medical devices is established in India with some manufacturers operating in-house gamma irradiators. Other irradiators are operated as multi-purpose service centres that treat medical products in addition to other products. The volume, however, is relatively low considering the size of the domestic and export markets. Whilst gamma irradiation finds selective applications in this sector, the use of Ethylene Oxide (EO) is still dominant for this application.

Growth is now evident in the irradiation of pharmaceutical raw materials, finished products and traditional Indian medicine (Ayurveda products). The commercial attractiveness of healthcare applications is developing and there are several opportunities for future growth in the treatment of both large scale and niche products.

A gamma irradiator used for medical devices sterilisation. This 3MCi capacity irradiator is integrated with the operator's manufacturing and packaging facilities located in India.

The image shows the conveyor that transports totes loaded with product for sterilisation into and out of the irradiation cell. The irradiation/sterilisation control room and various safety and security features are also shown.

Image courtesy of SYMEC Engineers (India) Pvt. Ltd.

3.2 Wire and cable crosslinking

Crosslinking of wires and cables is the most significant and well-established irradiation application using e-beam. The technology is used in the production of high-performance cables for critical sectors such as railways, defence, solar, automotive, nuclear, infrastructure project and export markets. Currently, it is estimated that ~1 million km of wires and cables are irradiated every month.

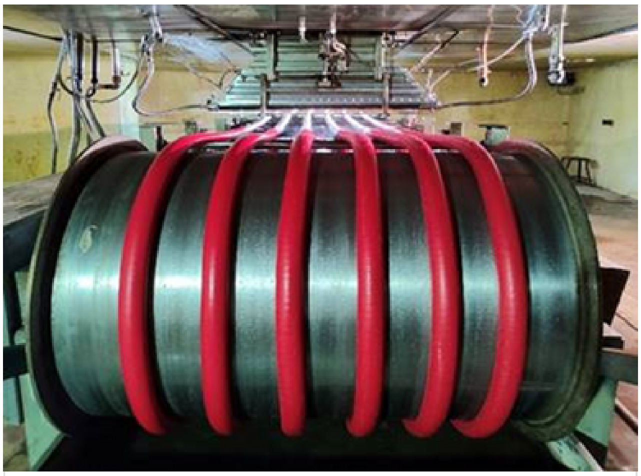
Leading manufacturers in the country operate in-house or captive e-beam systems with beam energies typically ranging from 1 MeV to 3 MeV.

Given the ongoing push for 'Make in India', the domestic demand from defence and solar projects, and the emergence of electric vehicles and smart grid infrastructures, the demand for e-beam crosslinked cables is expected to rise. Industry in India is poised to scale up e-beam processing capacity to support this growth.

Increasing demand for durable insulation and sealing components, crosslinked heat shrinkables and other polymer products, also contributes to e-beams growth potential in India.

Electron-beam operated by APAR Industries Limited.

APAR operates 5 e-beams at 1.5, 2.5 and 3 MeV, with a further machine under construction at the time of writing. APAR are currently the largest operator of e-beams in India.



Wire and cable are treated with e-beam to improve its performance characteristics such as its resistance to high temperature, abrasion and chemicals, and improved tensile strength.

Images courtesy of APAR Industries Limited

3.3 Spices, dried herbs, dried vegetables

Significant volumes of these food products are treated for microbial decontamination purposes. They are primarily treated for the export market. While spices are used widely in Indian cooking, the local method of high-temperature cooking eliminates any food safety concerns and, therefore, the need for irradiated product in the domestic market. Dried herbs and vegetables are reportedly processed selectively.

3.4 Pet feed and treats

Pet feed and dog chews, a treat for pet dogs made from rawhide, are commonly manufactured and irradiated in India for export. Irradiation achieves microbial decontamination so that owners and their pets can safely handle the products.

3.5 Onions

Onion is a staple in Indian cuisine and consumed in very large quantities with production as high as 30 million tons per year. Though low in value, huge losses are reported due to a lack of supply chain infrastructure including efficient storage and transport. Uncertain weather patterns also play a part in damaging this crop. There is thus a need to increase the shelf life of onions and gamma irradiation could offer a partial solution if combined with improved handling, packaging and storage.

As mentioned earlier, the Government of India, through the Ministry of Food Processing Industries, has notified their support for the establishment of multi-product gamma irradiation facilities to meet this need.

3.6 Food grains

India grows ~300 million tons of food grain per annum. Irradiation techniques could be deployed to reduce losses and address infestation during storage.

Considering these high volumes, there is an opportunity to use e-beam for this application to complement existing gamma irradiators.

3.7 Phytosanitary irradiation - Mangoes and Pomegranates

Mangoes, pomegranates and other fruits can benefit from phytosanitary irradiation (PI). This is the treatment of fruit and other fresh produce with irradiation to prevent the spread of insect pests during international trade.

The US is one of the largest importers of mangoes but could not import these fruits from India due to quarantine issues. Phytosanitary treatment using irradiation provides a solution to this and this sector is slowly growing. It is expected that this method of treatment will be expanded into other fresh fruits and vegetables over time.

There are currently four irradiation plants licensed by USDA-APHIS for phytosanitary treatment prior to export of fresh fruits to the USA. An additional 2-3 facilities are expected to come online for this application in the near future.

PsIP
phytosanitary
irradiation platform

To learn more about Phytosanitary Irradiation please visit the PsIP website:

psipglobal.org

3.8 Sludge hygienisation

The DAE established SHRI (Sewage Hygienisation Research Irradiator) in 1992, primarily for the hygienisation of sewage sludge in liquid form at 110m^3/h throughput for its safe disposal.

In 2019 a dry sewage sludge gamma irradiator was commissioned. This fully automated irradiator can process ~100 tons of sludge per day to eliminate its high pathogenic microbial load. The hygienised sludge is then inoculated with useful bacteria to provide a value-added bio-fertiliser.

Two gamma irradiators have now been established to demonstrate the efficacy of hygienising dry domestic sewage sludge. These plants are currently both in operation but are awaiting regulatory approval for use of the end product as a bio-fertiliser.

Images of the dry sludge gamma irradiation facility in the city of Indore, India. The irradiator has a maximum capacity of 1.5 MCi of cobalt-60.

The top images show the two loading and unloading areas where tote boxes filled with dry sludge or packed products move on the conveyor system into to the irradiator.

The left image shows the post-irradiation sludge bagging system.

Images courtesy of SYMEC Engineers (India) Pvt. Ltd.

3.9 Colour enhancement of Gems and Diamonds

The use of irradiation to enhance the colour of precious and semi-precious stones has been carried out using DAE's 2 MeV/20kW e-beam. Currently, some beam time is being devoted to this application.

4. The future of irradiation in India

In many respects, the application of irradiation in India remains 'under development' with several opportunities to grow both the domestic and export markets. Research and innovation continue with the development of new irradiation applications that are yet to be commercialised.

The Government of India initiatives since the 1970s to develop both the irradiation industry and the supporting infrastructure, now positions the country well for growth in radiation processing. India is one of the fastest growing major economies in the world and is poised to continue this path. Ongoing public investment, a growing manufacturing sector and a drive to increase global trade are all expected to have a positive impact on the country's radiation processing industry.

Traditional applications such as the treatment of spices and pet feed are expected to continue their steady growth. The range of fresh fruits and vegetables treatment for phytosanitary purposes is likely to expand over time and volumes will therefore increase. As the Indian economy and manufacturing base continues to develop, application of irradiation for the healthcare industries, both for the domestic and export market, is likely to expand more rapidly. Expansion into other applications, such as irradiation of medical and food packaging, and the treatment of ingredients for convenience food, is also anticipated to grow.

Whilst gamma irradiation is likely to remain dominant, the use of electron-beam could expand beyond the crosslinking of wire and cable in line with the growth of this technology and its applications globally. Indigenous electron-beam accelerators and support services are expected to become available in order to meet domestic and export needs.

Along with industry growth, there is an increased need for skilled personnel to carry out safe irradiator operations. These include operators, maintenance crew, safety officers and auxiliary staff. According to AERB regulations, all gamma and electron-beam facilities must have dedicated trained and certified staff. The DAE was the agency authorised to conduct the necessary training, but in 2021 the DAE assigned this responsibility to the Irradiation Industries Association of India (IIAI) who now provide the faculty and resources for this training to a prescribed syllabus. Final examinations and the issuance of training certificates remain in the hands of the DAE.

5. Further reading

(i) **Board of Radiation and Isotope Technology (BRIT) Annual Report 2023-2024**

(ii) **Bhabha Atomic Research Centre eBook '75 Years Of Bio-Science Research In Indian Atomic Energy Programme'**

(iii) **Ministry of Food Processing Industries**

6. About the Irradiation Industries Association of India (IIAI)

The IIAI provides a common platform and support to the irradiation industry with the objective of advancing the safe and beneficial use of Irradiation technology.

The aims and objectives of the association are:

- to represent the interests of members with national and international regulatory and legislative authorities and agencies
- to gather, collate and disseminate current information concerning scientific developments, legislative, regulatory and market developments that affect the ionising radiation industry, users of irradiation and irradiated products in India
- to assist in educating government agencies, other industries, professional associations and organizations, and the public
- to facilitate the commercialisation of radiation processing.

For further information please visit the IIAI website.

7. About the International Irradiation Association (iia)

The iia is a not-for-profit organisation, that supports the global irradiation industry and scientific community. A core objective of the Association is to support members in advancing the safe and beneficial use of irradiation. Communication, Education and Advocacy are key functions performed by the iia on behalf of its members and the wider irradiation community.

Membership of iia is diverse and includes corporations, research institutes, universities and governmental bodies around the world. The Association endeavours to strengthen the relationship between business and science and has forged relationships with regional, national and technology specific organisations whose aims are aligned with those of iia.

iia hosts the International Meeting on Radiation Processing (IMRP) which is the premier event for all involved in the business and science of radiation processing. It has also formed the Phytosanitary Irradiation Platform (PsIP) and is a leading partner in the Society for Sterility Assurance Professionals (SfSAP).

For further information please visit the iia website.

Tables

Table 1: DAE irradiation technology demonstration and familiarisation facilities

	Facility name	Year	Application	Design capacity (kCi/MeV)	Status
1	FIPLY, BARC, Mumbai	1967	Demonstration of food irradiation	100 kCi	Upgraded and in operation
2	Isomed, BARC, Mumbai	1974	Medical device sterilisation	1,000 kCi	Upgraded and ready for operation
3	Sludge Hygienisation Research Irradiator, Baroda, Gujarat	1992	Irradiation of liquid sewage sludge	300 kCi	In operation R&D
4	Radiation Processing Plant, Vashi Mumbai	2000	Irradiation of spices	1,000 kCi	In operation commercial
5	BRIT - EB RF Pulse Accelerator	2000	Multi product	2 MeV, 20 kW	In operation
6	Krushi Utpadan Sanrakshan Kendra (KRUSHAK), Lasalgaon, Nashik, Maharashtra	2003	Phytosanitary treatment	400 kCi	In operation commercial
7	BARC - EB LINAC	2006	Sterilisation	10 MeV, 3 kW	In operation
8	RRCAT - EB LINAC	2015	Sterilisation	10 MeV, 6 kW	In operation
9	BRIT - Low temperature Irradiator	2025	Frozen foods	400 kCi	In operation
10	BRIT - Mobile Irradiator*	n/a	See below*	100 kCi	Under development

* The BRIT mobile gamma irradiator is designed to irradiate batches of food products like fresh fruits and vegetables, cereals, pulses etc. at low and medium dose. The irradiator can be installed onto a 40-foot trailer making it possible to transport it to the location of food production. The expected typical throughput of the irradiator is approximately 9.60 MT/day for mango or 14.40 MT/day for insect disinfection of cereals.

Table 2: Summary of irradiators currently in operation in India

Gamma Irradiation Facilities

Government sector	Private sector	Designed Capacity (kCi)	Installed Capacity (kCi)	Application	
				Medical	Multi-product
10	27	68,700	23,790	9	28

Electron Beam Facilities

Government sector	Private sector	Energy / power range	Application	
			Multi-product	Wire and cable & crosslinking
3	45	0.8 to 10 MeV, 6 to 200 kW	3	45

Table 3: Irradiator equipment manufacturers in India

(i) Gamma Irradiators

Symec Engineers, Devaki Hydromatics and RadiTech Hydromatics are suppliers of gamma irradiators in India.

BRIT manufactures Ceric Cerous dosimeters and dosimetry systems and provides dosimetry validation services to the gamma irradiation industry. BRIT also manufactures and supplies compact gamma chambers (~15kCi) and low dose irradiator units for applied research studies. It is reported that seven blood irradiators and two gamma chamber units were supplied to hospitals and academic institutions during 2023-24.

(ii) EB accelerators

10 MeV linac based systems are being developed at RRCAT-ECIL and Symec Engineers, mainly to cater for the domestic market.

(A few low to medium DC accelerators have been imported from China, France, Japan and Russia.)

Table 4: Members of Irradiation Industries Association of India (IIAI)

Name	Address	Email
A V Processors Pvt. Ltd.	Ambernath, Maharashtra	info@sterico.com
Advanced Microdevices Pvt. Ltd.	Ambala, Haryana	madhur@mdimembrane.in
Agrosurg Irradiators (India) Pvt. Ltd.	Vasai, Maharashtra	pranav.parekh@agrosurg.com
Ansell Sterile Solutions Pvt. Ltd.	Erode, Tamil Nadu	gayathri.s@ansell.com
Apar Industries Ltd.	Valsad Gujarat	ritesh.baria@apar.com
Board of Radiation and Isotope Technology (BRIT)	Navi Mumbai Maharashtra	atul@britatom.gov.in
Cromwell eBeam Solutions LLP	Surat, Gujarat	cromwellebeam@gmail.com
Gamma Tech India Pvt. Ltd.	Nagercoil, Tamil Nadu	kkthomas@kanamlatex.com
Greenrad Ventures Pvt. Ltd.	Aurangabad, Maharashtra	rbgoel@greenrad.in
Lapp india Pvt. Ltd.	Bangalore, Karnataka	rakesh.choudhary@lappindia.com
Microtrol Sterilisation Services Pvt. Ltd.	Bawal, Haryana & Bangalore, Karnataka	ranjeet.kalia@microtrol-india.com
Organic Green Foods Pvt. Ltd.	Kolkata, West Bengal	organicgreenfoodslimited@rediffmail.com
R. R. Kabel Ltd.	Vadodara, Gujarat	sadashiv.patil@rrglobal.com pulakesh.maity@rrglobal.com
Shriram Institute for Industrial Research	New Delhi	rajput@shriraminstitute.org

Table 4: Members of Irradiation Industries Association of India (IIAI) (cont.)

Name	Address	Email
Solas Industries	Mathura, Uttar Pradesh	solasindustries@gmail.com
Svarn Infratel Pvt. Ltd.	Palwal, Haryana	anil@svarn.com
Symec Engineers (India) Pvt. Ltd.	Mahape, Navi Mumbai	ananthvas@symecengineers.com
Tirupati Plastomatics Pvt. Ltd.	Jaipur, Rajasthan	contact@tirupatiplastomatics.com
V-Marc India Limited	Haridwar, Uttarakhand	amit.singh@v-marc.in

Table 5: List of related organisations

Name	Website
Atomic Energy Regulatory Board	aerb.gov.in
Bhabha Atomic Research Centre	barc.gov.in
Board of Radiation and Isotope Technology	britatom.gov.in
Department of Atomic Energy	dae.gov.in
International Atomic Energy Agency	iaea.org
Irradiation Industries Association of India	iiai.org.in
International Irradiation Association	iiaglobal.com
Ministry of Food Processing Industries	mofpi.gov.in
National Association for Application of Radioisotopes and Radiation in Industry	naarri.org
Nuclear Power Corporation of India Limited	npcil.nic.in
Phytosanitary Irradiation Association	psipglobal.org
Society for Sterility Assurance Professionals	sfsap.org

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