Current status of irradiation service using ARTI's low-level irradiation facility in 22nd year

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1. Introduction

The Advanced Radiation Technology Institute of the Korea Atomic Energy Research Institute operates various types of irradiation facilities. The most representative facility is a device for irradiating radiation using a cobalt source. Irradiation devices are divided into high level and low level for convenience according to the loading amount of the radioactive meterial. High-level irradiation equipment can be loaded up to 14.8 PBq (400,000 Ci, and low-level rradiation equipment is allowed to load up to 111 TBq(3000 Ci). High-level irradiation facilities are currently capable of irradiating up to 10 kGy per hour. A low-level irradiation facility can irradiate a maximum of 600 Gy per hour and a minimum of 1 Gy. Irradiation services have been widely used in pasteurization, sterilization, and mutant breeding. [1]

Recently, as the Naro (KSLV-I; Korea Space Launch Vehicle-I) succeeded in launching as a Korean-style space launch vehicle, research in the field of space aviation has been more actively conducted, and many experiments are being conducted to test the radiation durability of devices mounted on spacecraft. [2][3]

To examine the change in the use of mutant breeding from the biological field to other fields Analysis of the operation performance by field in the first half of 21st and 22nd year, I would like to find out the current status of the irradiation service.

2. Methods and Results

2.1 Irradiation Facilities

The low-level irradiation facility is an irradiation device (Model. IR-222) imported from Nordion Canada. [4] In January 2006, it obtained permission to use radioactive isotopes and has been operating until now. The internal dimensions of the facility are 8 meters long and 4.4 meters, and the furthest distance from the radioactive source is 5.2 meters. The main structure of the facility is a concrete structure. The licensed radioactive source is a Co60 source, and the maximum loaded radioactivity of this nuclide is 111 TBq(3,000 Ci), and the use of radioactive isotopes has been permitted. The Co^{60} source is a model C-198 in the form of a long stick, with a total of 6 sources built-in. Unlike high-level irradiation facilities, this source is placed in a lead shielding container and installed on the floor of the facility.

Fig. 1 Inside of the low-level irradiation facility - To the central chimney, six radiation sources are climbed from the storage box under the shelf.

2.2 Classification of materials

Institutional classification was divided into internal users and external users according to the characteristics of the applicant institution. External users were classified into educational institutions, commercial enterprises, and public research institutes according to the type of business. According to the purpose of irradiating the applied sample, statistics were aggregated by dividing it into waste, parts (materials), living things, and the environment. Data on the number of requests were also compiled by distinguishing between irradiating samples with various radiation doses. Information on the classification of institutional characteristics, irradiation time, and regional distribution of the applicant institution was aggregated.

2.3 Radiation Hardness Assurance (RHA)

For RHA, the level of radiation is specified in the ESCC Basic Specification specified by the European Space Agency. [5]

The ESCC classifies the dose levels as shown in Table 1 and provides that there should be at least three exposures for the dose per dose specified.

Table 1 specifying radiation levels for radiation hardness assurance in ESCC

Letter	RHA Level (TID)		Corresponding Exposure Levels	
	rad(Si)	Gy(Si)	rad(Si)	Gy(Si)
M	3k	30	1.5k /3k /4.5k	15 / 30 / 45
D	10k	100	5k / 10k / 15k	50/ 100/ 150
E	20k	200	10k / 20k / 30k	100/ 200/ 300
P	30k	300	15k / 30k / 45k	150/ 300/ 450
F	50k	500	25k / 50k / 75k	250/ 500/ 750
R	100k	1000	50k / 100k / 150k	500/ 1000/ 1500
A	300k	3000	150k / 300k / 450k	1500/ 3000/ 4500
G	500k	5000	250k / 500k / 750k	2500/ 5000/ 7500
H	1000k	10000	500k / 1000k / 1500k	5k / 10k / 15k

3. Results

Internal users used 20% and external users used 80%. A total of 49 organizations visited 95 times and received services. It was counted that 2.87 radiation irradiations were requested for each visit.

Table 2 Number of internal user and external companies, number of applications, and number of doses requested

Category		Number of institutions	ratio(%)	Number of visiting	ratio(%)	number of requests	ratio(%)
Internal users		10	20%	35	27	98	36%
External users	Education	4	8%	8	8	22	8%
	Enterprise	18	37%	24	25	42	16%
	Research	17	35%	28	29	108	40%
	Totals	**49**		**95**		**270**	

Table 2 shows the classification of individual institutions for each project by radiation service purpose. Most of the 24 material parts were experiments to test RHA for parts in the aerospace field.

Table 3 Classification status according to the purpose of the irradiation in each field

Category		Spare parts.	Biology	Measurement	Waste	Environment	Totals
Internal users		2	22	10		1	35
External users	Education	2	2		4		8
	Enterprise	15	9				24
	Research	5	23				28
	Totals	24	56	11	4		95

As shown in Figure 2, compared to the same period, the number of applications for use in the biological field decreased from 74 to 56. The number of dose requests also decreased from 279 to 205.

In comparison, parts and materials are showing a slight increase, but what is noteworthy is that most nuclear power plant parts were tested in the material parts field last year, but all of them were tested in space radiation-related parts in 2022.

Table 4 Consumption time of radiation irradiation service by sector in 22 years

Category		Spare parts.	Biology	Waste	Environment	Totals
Internal users		32	176		5	213
External users	Education	46	19	108		173
	Enterprise	130	65			195
	Research	172	412			584
	Totals	380	672	108	5	1,165

4. Conclusions

In the past, radiation irradiation services of less than 1kGy were mostly focused on mutation breeding of organisms. As the years passed, the irradiation service was also used a lot for sterilization. Since then, many tests have been conducted to determine the aging of parts for long-term safety verification of nuclear facilities. Recently, as research on Korean space launch vehicles has increased, irradiation experiments in related fields are increasing.

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