

Statistics of Ionizing Radiation Applications and Management



Atomic Energy Council
2020/07

PreFace

As technology rapidly advances and develops, applications for radiation have been widely adopted in medicine, agriculture, industry, and research. Consequently, radioactive materials and equipment capable of producing ionizing radiation, radiation personnel, and operator personnel are in great demand to lead the vital management of radiation safety. The Atomic Energy Council's (AEC) *Ionizing Radiation Protection Act (the IRP Act)* has been in place since February, 2003. Its enforcement rules and the related 21 regulations were sequentially promulgated and implemented, making the IRP Act more refined and comprehensive.

In order to provide a complete overview of ionizing radiation applications to various fields, the AEC has compiled the latest data, tables, and figures for review by radiation personnel and related stakeholders.

These statistical data are based on medical and non-medical licenses. Licenses issued in Taiwan for radioactive materials and equipment capable of producing ionizing radiation are statistically categorized according to counties/cities, facilities, types of equipment, and radioactive materials. Altogether 33,730 licenses have been issued, of which 20,911 are for medical use and 12,819 for non-medical use. Additionally, this report includes personal dose of radiation workers nationwide, as well as statistical data such as radiation protection personnel, operator personnel, and radiation safety certificate and radiation anomalies in Taiwan.

Statistics have been compiled through the end of 2019, and will be updated

annually. Should there be any missing data, please kindly advise us.

Content

1. Medical Use	1
(1) Number of Licenses for All Types of Medical Institution Installed with Medical Radiation Sources – per county/city	2
(2) Number of Licenses for All Types of Medical Institution Installed with Equipment Capable of Producing Ionizing Radiation – per county/city	3
(3) Number of Licenses for All Types of Medical Equipment Capable of Producing Ionizing Radiation – per county/city	5
(4) Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Kinds of Medical Equipment Capable of Producing Ionizing Radiation.....	8
(5) Number of Licenses for All Types of Medical Institution Installed with Medical Radioactive Materials – per county/city	10
(6) Number of Licenses for All Types of Medical Radioactive Materials – per county/city.....	12
(7) Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Types of Medical Radioactive Materials	15
(8) Number of Licenses for All Types of Equipment that should Implement Radiation Medical Exposure Quality Assurance	18
2. Non-Medical Use.....	21
(1) Number of Licenses for All Types of Facilities Installed with Non-medical Radiation Sources – per type	21
(2) Number of Licenses for All Types of Facilities Installed with Non-medical Radiation Sources – per county/city.....	23
(3) Number of Licenses for Non-medical Equipment Capable of Producing Ionizing Radiation for Various Purposes	25
(4) Number of Licenses for Non-medical Radioactive Materials for Various Purposes.....	27
3. Personnel Dose	29
(1) Statistics of the Number of Radiation Workers Nationwide	30
(2) Statistics of the Number of Radiation Workers with Dose Value and Total Number of Personnel Tested Nationwide	33
(3) Statistics of Total Collective Dose for Radiation Workers Nationwide	35
(4) Statistics of Annual Average Dose for Radiation Workers Nationwide.....	37
(5) Statistics of Gender for Radiation Workers Nationwide	39

(6) Statistics of the Number of Radiation Workers in Each Dose Interval Nationwide	41
(7) Statistics of Relative Percentage of Radiation Workers in Each Dose Interval Nationwide	42
(8) Statistics of the Number of Radiation Workers with Personal Annual Dose over 20 mSv Nationwide ..	43

4. Radiation Protection Personnel, Radiation Safety Certificates and Radiation

Protection Business..... 44

(1) Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per facility	45
(2) Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per county/city	47
(3) Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per gender	49
(4) Total Number of Radiation Protection Personnel with Certificates– per facility	50
(5) Total Number of Radiation Protection Personnel with Certificates – per county/city	51
(6) Total Number of Radiation Protection Personnel with Certificates – per gender	53
(7) Total Number of Radiation Protection Business with Certificates– per business category and county/city	54

5. Radiation Anomalies Found in the Steel Plants over the Years 56

(1) Statistics of the Number of Radiation Anomalies Found in the Steel Plants over the Years	57
(2) Statistics of Nuclides in Radiation Anomalies Found in the Steel Plants over the Years	59
(3) Statistics of the Types of Radiation Anomalies Found in the Steel Plants over the Years	61

1. Medical Use

(1) Number of Licenses for All Types of Medical Institution Installed
with Medical Radiation Sources – per county/city

Institution County/City	Permit						Registration					
	Public Medical Institutions			Private Medical Institutions			Public Medical Institutions			Private Medical Institutions		
	Equipm ent	Seale d	Unseal ed	Equipm ent	Seale d	Unseal ed	Equipm ent	Seale d	Unseal ed	Equipm ent	Seale d	Unseal ed
Keelung City	0	0	0	2	0	2	39	0	0	226	2	0
Taipei City	20	8	10	16	6	11	465	70	0	3,273	38	1
New Taipei City	0	0	1	17	7	8	97	0	0	2,794	32	0
Taoyuan City	1	1	2	13	3	7	102	4	0	1,588	29	0
Hsinchu(county and city)	1	1	1	2	1	2	82	3	0	743	7	0
Miaoli County	0	0	0	2	0	1	26	0	0	319	2	0
Taichung City	7	4	4	20	7	10	175	8	0	2,579	28	0
Changhua County	1	0	0	5	3	3	22	0	0	822	9	0
Nantou County	1	0	1	1	0	0	46	0	0	259	0	0
Yunlin County	2	1	2	2	0	1	69	7	0	314	0	0
Chiayi (county and city)	1	1	1	9	3	4	75	0	0	552	16	0
Tainan City	3	3	1	11	2	4	134	8	0	1,372	10	0
Kaohsiung City	7	2	3	19	7	7	222	3	0	2,340	25	0
Pingtung County	1	0	0	4	1	2	51	0	0	443	1	0
Yilan County	1	0	1	3	0	1	71	1	0	300	4	0
Hualien County	0	0	0	3	3	3	76	0	0	251	10	0
Taitung County	0	0	0	2	0	1	41	0	0	115	0	0
Penghu County	0	0	0	0	0	0	41	0	0	49	0	0
Kinmen County	0	0	0	0	0	0	22	0	0	42	0	0
Lienchiang County	0	0	0	0	0	0	21	0	0	0	0	0
Total	46	21	27	131	43	67	1,877	104	0	18,381	213	1

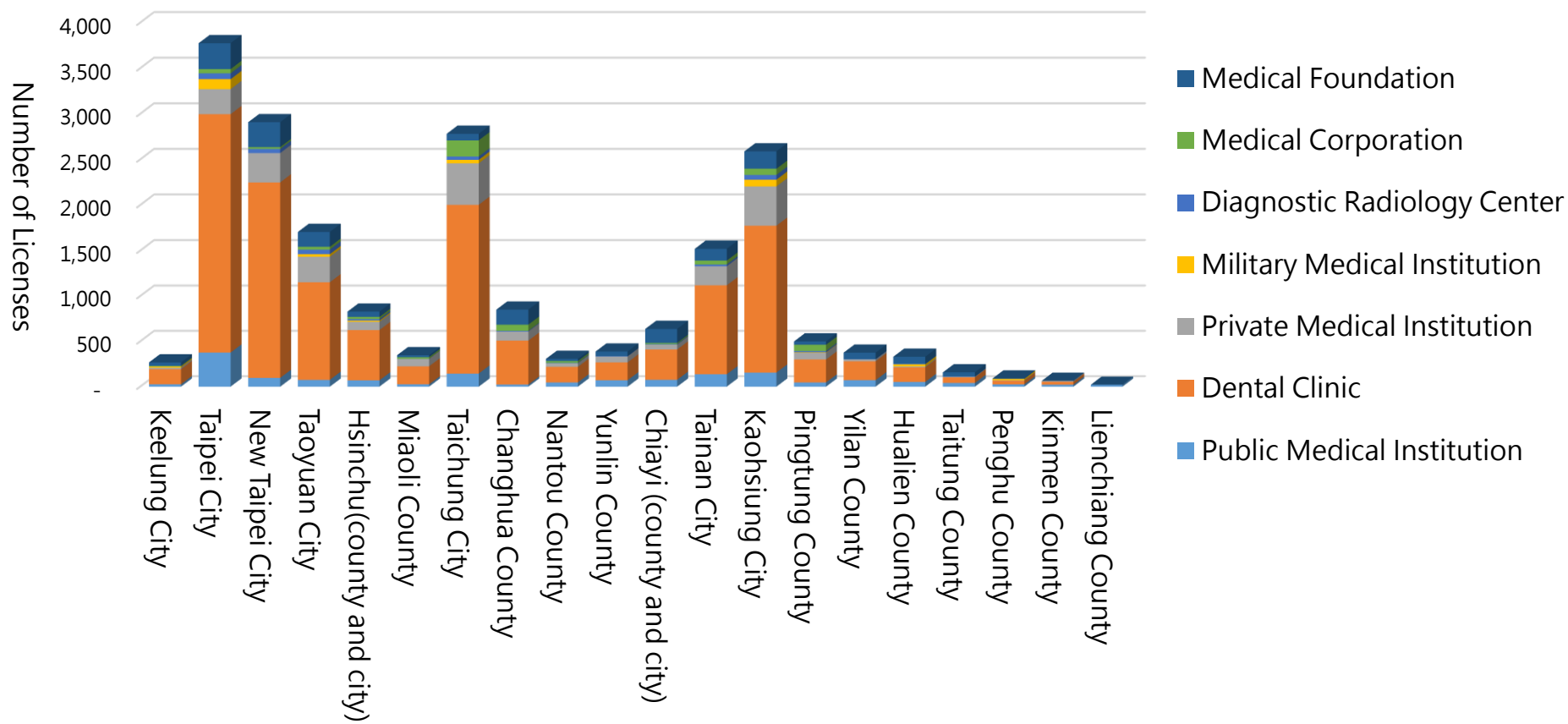
Remarks:

1. Equipment: Equipment capable of producing ionizing radiation.
2. Sealed: Sealed radioactive material.
3. Unsealed: Unsealed radioactive material.

(2) Number of Licenses for All Types of Medical Institution Installed with Equipment Capable of Producing Ionizing Radiation – per county/city

Institution County/City	Public Medical Institution	Dental Clinic	Private Medical Institution	Military Medical Institution	Diagnostic Radiology Center	Medical Corporation	Medical Foundation	Total
Keelung City	26	167	16	13	1	7	37	267
Taipei City	376	2,620	275	109	64	47	283	3,774
New Taipei City	97	2,151	322	0	45	20	273	2,908
Taoyuan City	75	1,077	281	28	50	31	162	1,704
Hsinchu(county and city)	70	555	91	13	17	24	58	828
Miaoli County	26	198	82	0	1	18	22	347
Taichung City	144	1,858	455	38	37	177	72	2,781
Changhua County	23	485	100	0	7	69	166	850
Nantou County	47	172	39	0	4	20	25	307
Yunlin County	71	197	65	0	3	0	51	387
Chiayi (county and city)	76	334	53	0	6	14	154	637
Tainan City	137	982	210	0	19	43	129	1,520
Kaohsiung City	155	1,618	431	74	52	68	190	2,588
Pingtung County	47	253	73	5	15	69	37	499
Yilan County	72	208	21	0	3	0	71	375
Hualien County	52	161	10	24	5	0	78	330
Taitung County	41	62	6	0	3	0	46	158
Penghu County	25	41	4	16	2	0	2	90
Kinmen County	22	32	10	0	0	0	0	64
Lienchiang County	21	0	0	0	0	0	0	21
Total	1,603	13,171	2,544	320	334	607	1,856	20,435

Number of Licenses for All Types of Medical Institution Installed with Equipment Capable of Producing Ionizing Radiation

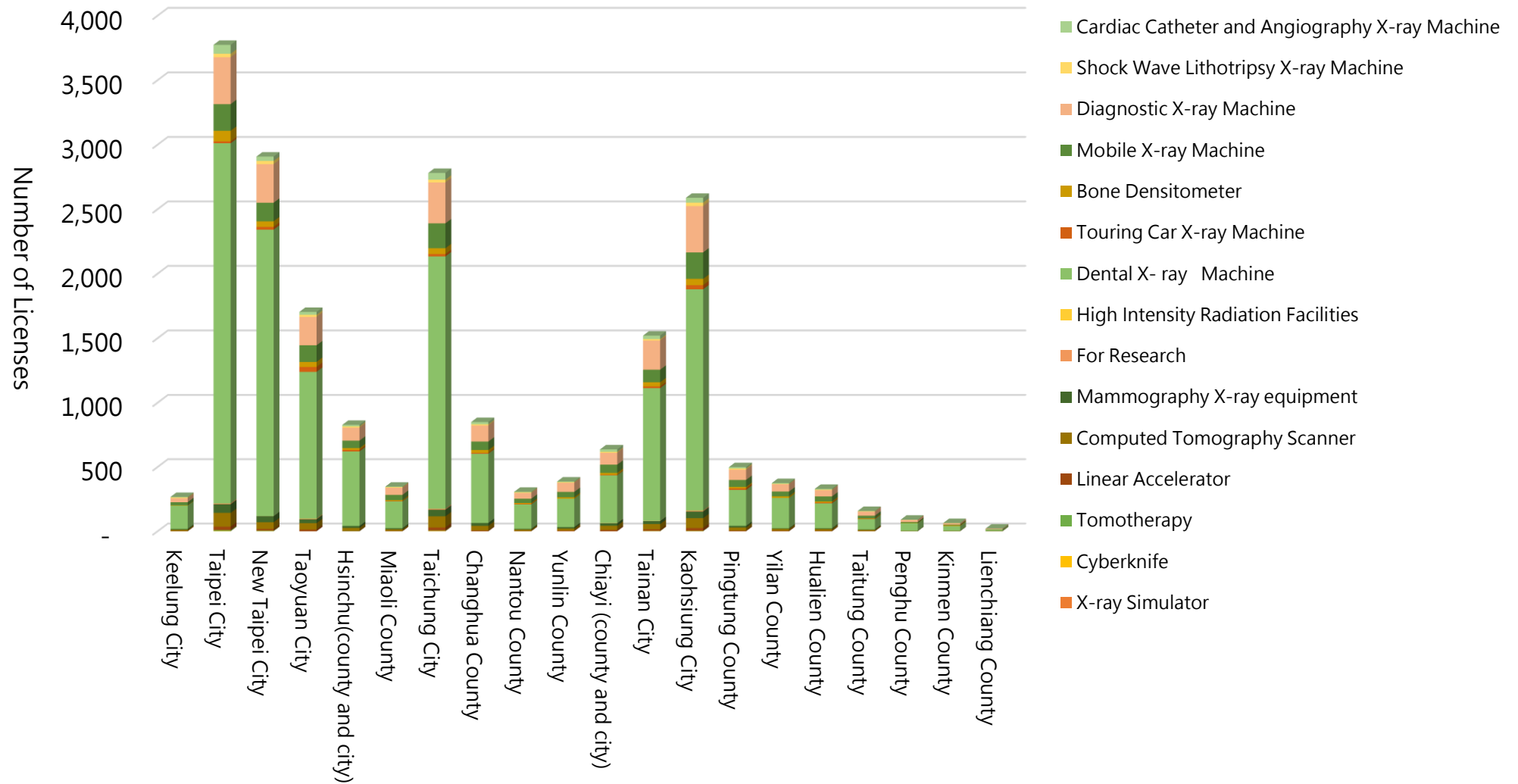


(3) Number of Licenses for All Types of Medical Equipment Capable of Producing Ionizing Radiation – per county/city

Equipment County/City	X-ray Simulator	Cyberknife	Tomotherapy	Linear Accelerator	Computed Tomography Scanner	Mammography X-ray equipment	For Research	High Intensity Radiation Facilities	Dental X-ray Machine	Touring Car X-ray Machine	Bone Densitometer	Mobile X-ray Machine	Diagnostic X-ray Machine	Shock Wave Lithotripsy X-ray Machine	Cardiac Catheter and Angiography X-ray Machine	Total
Keelung City	0	0	0	2	10	6	0	0	181	0	3	24	31	6	4	267
Taipei City	0	2	7	27	107	67	6	0	2,795	14	83	206	364	27	69	3,774
New Taipei City	1	1	4	12	52	47	1	0	2,223	22	43	144	299	25	34	2,908
Taoyuan City	0	0	0	13	50	30	4	1	1,141	38	39	129	220	16	23	1,704
Hsinchu(county and city)	0	0	1	2	23	15	0	0	580	11	15	58	101	10	12	828
Miaoli County	0	0	0	2	13	9	0	0	209	3	6	41	56	5	3	347
Taichung City	2	1	4	22	87	52	7	0	1,959	18	45	193	317	22	52	2,781
Changhua County	0	0	0	6	36	23	0	0	538	7	22	66	125	9	18	850
Nantou County	0	0	0	2	11	6	0	0	190	4	7	33	45	5	4	307
Yunlin County	1	0	0	4	16	11	0	0	221	0	11	42	71	5	5	387
Chiayi (county and city)	0	0	0	10	33	19	1	0	372	5	14	64	92	8	19	637
Tainan City	1	1	2	11	41	23	1	0	1,033	13	33	97	226	11	27	1,520
Kaohsiung	0	1	2	22	77	52	6	1	1,718	32	49	205	359	27	37	2,588

City																
Pingtung County	0	0	0	5	24	13	0	0	280	12	11	54	80	10	10	499
Yilan County	0	0	0	4	15	4	0	0	236	0	13	37	57	3	6	375
Hualien County	0	0	0	3	14	6	0	0	194	7	8	39	49	4	6	330
Taitung County	0	0	0	2	8	4	0	0	80	3	3	21	31	3	3	158
Penghu County	0	0	0	0	2	1	0	0	59	0	2	8	16	1	1	90
Kinmen County	0	0	0	0	2	1	0	0	38	1	5	5	10	1	1	64
Lienchiang County	0	0	0	0	2	1	0	0	10	0	0	2	6	0	0	21
Total	5	6	20	149	623	390	26	2	14,057	190	412	1,468	2,555	198	334	20,435

Number of Licenses for All Types of Medical Equipment Capable of Producing Ionizing Radiation

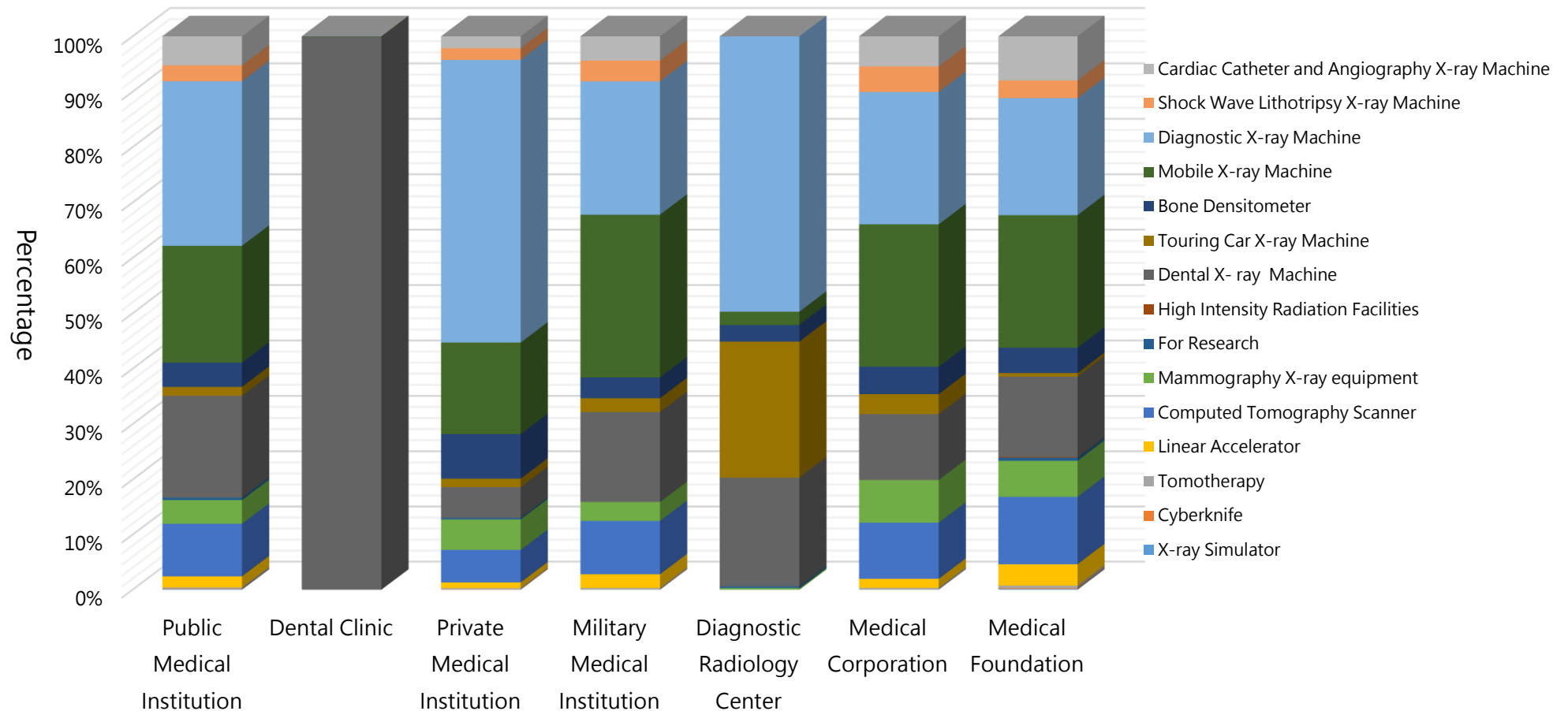


(4) Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Kinds of Medical Equipment Capable of Producing Ionizing Radiation

Equipment Institution	X-ray Simulator	Cyberknife	Tomotherapy	Linear Accelerator	Computed Tomography Scanner	Mammography X-ray equipment	For Research	High Intensity Radiation Facilities	Dental X-ray Machine	Touring Car X-ray Machine	Bone Densitometer	Mobile X-ray Machine	Diagnostic X-ray Machine	Shock Wave Lithotripsy X-ray Machine	Cardiac Catheter and Angiography X-ray Machine	Total
Public Medical Institution	2	2	3	32	153	69	7	0	295	26	70	338	476	46	84	1,603
Dental Clinic	0	0	0	0	0	0	0	0	13,161	1	0	8	1	0	0	13,171
Private Medical Institution	0	1	6	27	150	141	7	0	142	39	205	420	1,298	53	55	2,544
Military Medical Institution	0	0	1	8	31	11	0	0	52	8	12	94	77	12	14	320
Diagnostic Radiology Center	0	0	0	0	0	1	1	0	66	82	10	8	166	0	0	334
Medical Corporation	0	0	2	10	62	47	0	0	72	22	30	156	145	28	33	607
Medical Foundation	3	3	8	72	227	121	11	2	269	12	85	444	392	59	148	1,856
Total	5	6	20	149	623	390	26	2	14,057	190	412	1,468	2,555	198	334	20,435

Remarks: Equipment capable of producing ionizing radiation includes fixed type and touring type vehicle without biopsy.

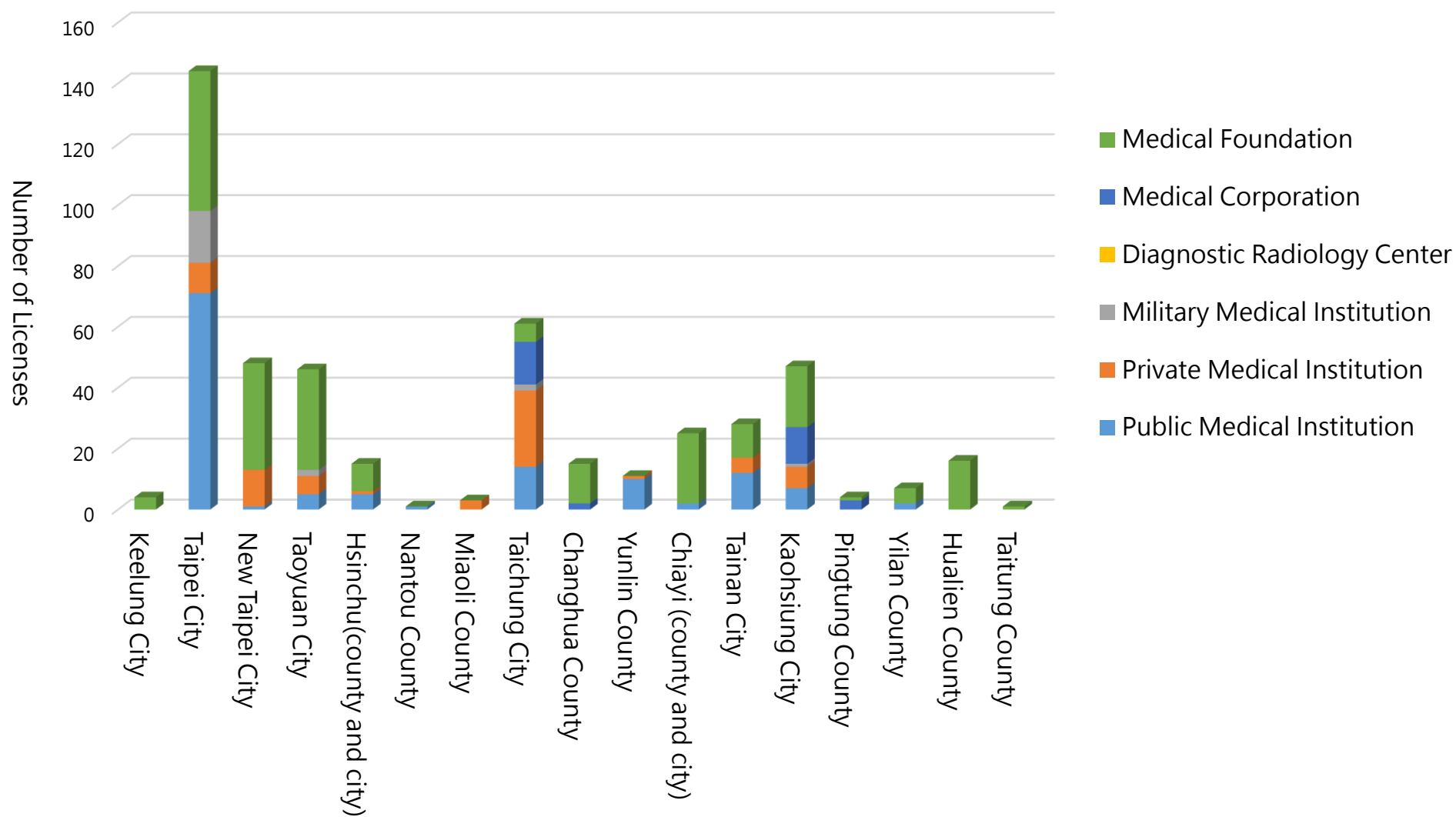
Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Kinds of Medical Equipment Capable of Producing Ionizing Radiation



(5) Number of Licenses for All Types of Medical Institution Installed with
Medical Radioactive Materials – per county/city

Institution County/City	Public Medical Institution	Private Medical Institution	Military Medical Institution	Diagnostic Radiology Center	Medical Corporation	Medical Foundation	Total
Keelung City	0	0	0	0	0	4	4
Taipei City	71	10	17	0	0	46	144
New Taipei City	1	12	0	0	0	35	48
Taoyuan City	5	6	2	0	0	33	46
Hsinchu (county and city)	5	1	0	0	0	9	15
Nantou County	1	0	0	0	0	0	1
Miaoli County	0	3	0	0	0	0	3
Taichung City	14	25	2	0	14	6	61
Changhua County	0	0	0	0	2	13	15
Yunlin County	10	1	0	0	0	0	11
Chiayi (county and city)	2	0	0	0	0	23	25
Tainan City	12	5	0	0	0	11	28
Kaohsiung City	7	7	1	0	12	20	47
Pingtung County	0	0	0	0	3	1	4
Yilan County	2	0	0	0	0	5	7
Hualien County	0	0	0	0	0	16	16
Taitung County	0	0	0	0	0	1	1
Total	130	70	22	0	31	223	476

Number of Licenses for All Types of Medical Institution Installed with Medical Radioactive Materials



(6) Number of Licenses for All Types of Medical Radioactive Materials – per county/city

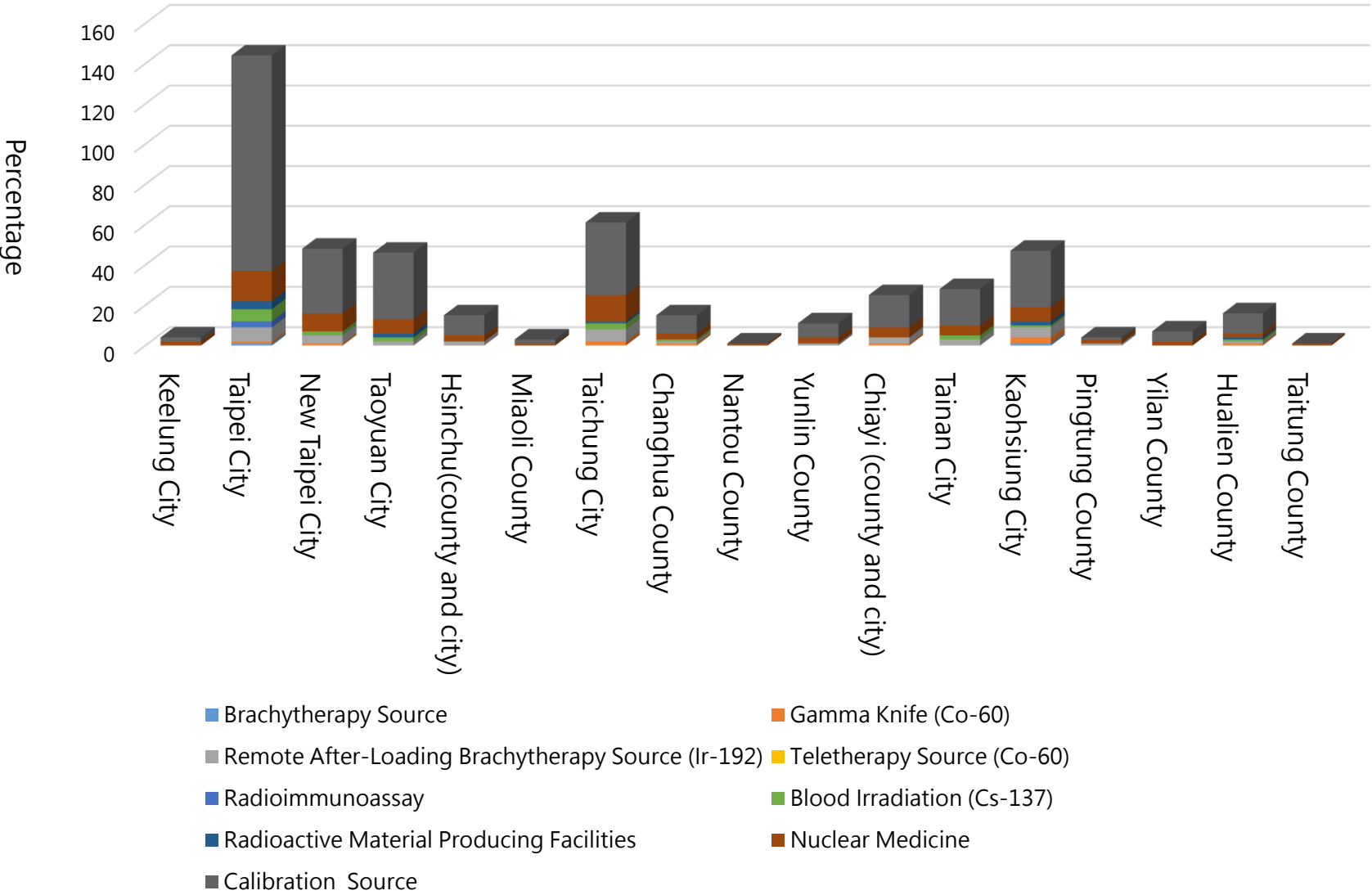
Radioactive Material County/City	Brachytherapy Source	Gamma Knife (Co-60)	Remote After- Loading Brach ytherapy Sour ce (Ir-192)	Teletherapy So urce (Co-60)	Radioimmuno assay	Blood Irradiati on (Cs-137)	Radioactive M aterial Produci ng Facilities ¹	Nuclear Medic ine ²	Calibration Source ³	Total
Keelung City	0	0	0	0	0	0	0	2	2	4
Taipei City	1	1	7	0	3	6	4	15	107	144
New Taipei City	0	1	4	0	0	2	0	9	32	48
Taoyuan City	0	0	2	0	0	2	2	7	33	46
Hsinchu(county and city)	0	0	2	0	0	0	0	3	10	15
Miaoli County	0	0	0	0	0	0	0	1	2	3
Taichung City	0	2	6	0	0	3	1	13	36	61
Changhua County	0	1	1	0	0	1	0	3	9	15
Nantou County	0	0	0	0	0	0	0	1	0	1
Yunlin County	0	0	1	0	0	0	0	3	7	11
Chiayi (county and city)	0	1	3	0	0	0	0	5	16	25
Tainan City	0	0	3	0	0	2	0	5	18	28
Kaohsiung City	1	3	5	0	0	1	2	7	28	47
Pingtung County	0	0	1	0	0	0	0	2	1	4
Yilan County	0	0	0	0	0	0	0	2	5	7
Hualien County	0	1	1	0	0	1	1	2	10	16

Taitung County	0	0	0	0	0	0	0	1	0	1
Total	2	10	36	0	3	18	10	81	316	476

Remarks:

1. Radioactive material producing facilities mainly produce F-18, C-11, N-13, O-15, etc.
2. Unsealed radioactive materials used in nuclear medicine include Tc-99m, Tl-201, Ga-67, etc.
3. Sealed radioactive materials for calibration include Co-57, Ge-68, Cs-137, etc.

Number of Licenses for All Types of Medical Radioactive Materials



(7) Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Types of Medical Radioactive Materials

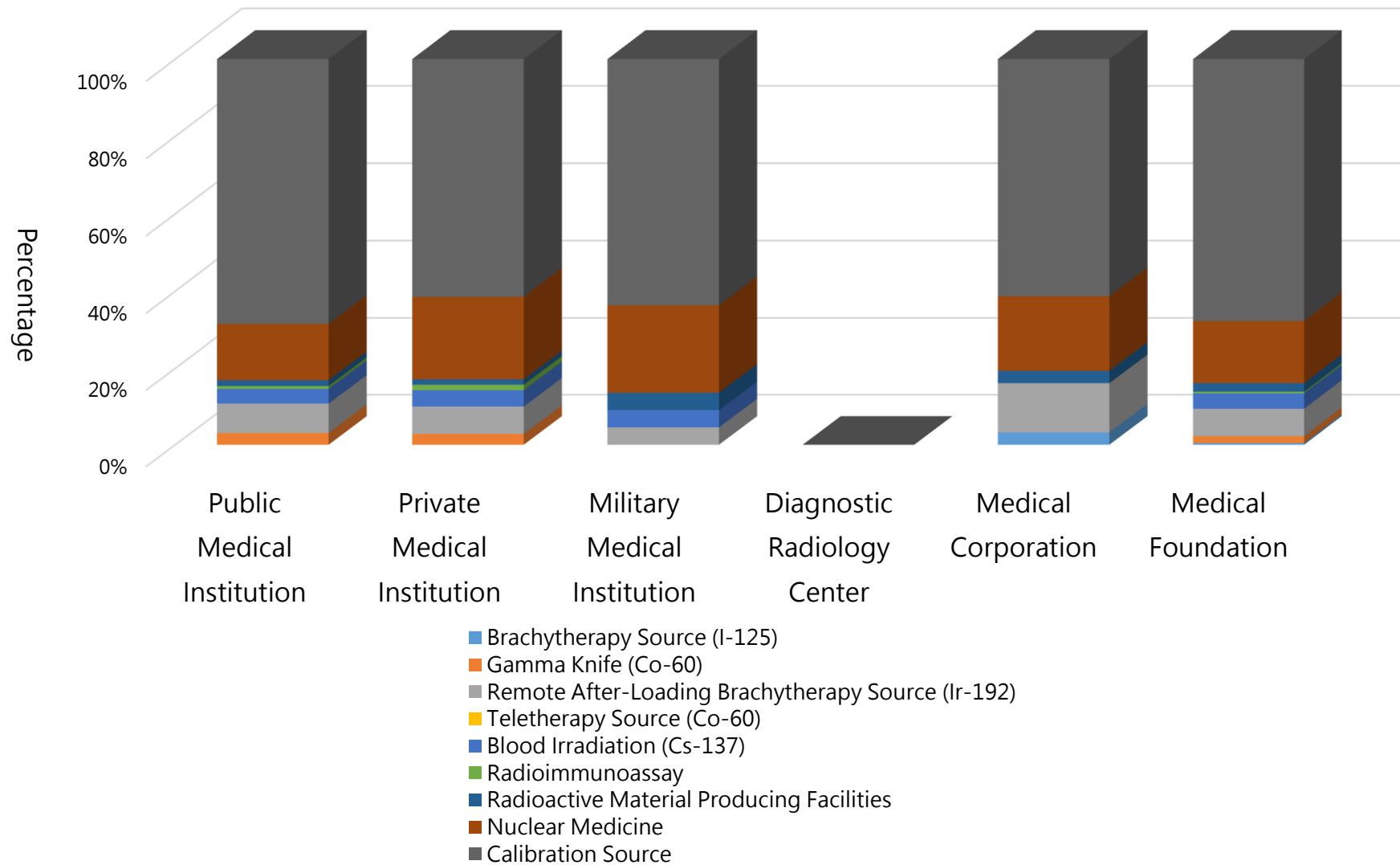
Radioactive Material Facility	Brachytherapy Source (I-125)	Gamma Knife (Co-60)	Remote After- Loading Brachytherapy Source (Ir-192)	Telethera py Source (Co-60)	Blood Irradiat ion (Cs-137)	Radioimmuno assay	Radioactive Material Prod ucing Facilitie s ¹	Nuclear Medi cine ²	Calibration S ource ³	Total
Public Medical Institution	0	4	10	0	5	1	2	19	89	130
Private Medical Institution	0	2	5	0	3	1	1	15	43	70
Military Medical Institution	0	0	1	0	1	0	1	5	14	22
Diagnostic Radiology Center	0	0	0	0	0	0	0	0	0	0
Medical Corporation	1	0	4	0	0	0	1	6	19	31
Medical Foundation	1	4	16	0	9	1	5	36	151	223
Total	2	10	36	0	18	3	10	81	316	476

Remarks:

1. Radioactive material producing facilities mainly produce F-18, C-11, N-13, O-15, etc.

2. Unsealed radioactive materials used in nuclear medicine include Tc-99m, Tl-201, Ga-67, etc.
3. Sealed radioactive materials for calibration include Co-57, Ge-68, and Cs-137, etc.

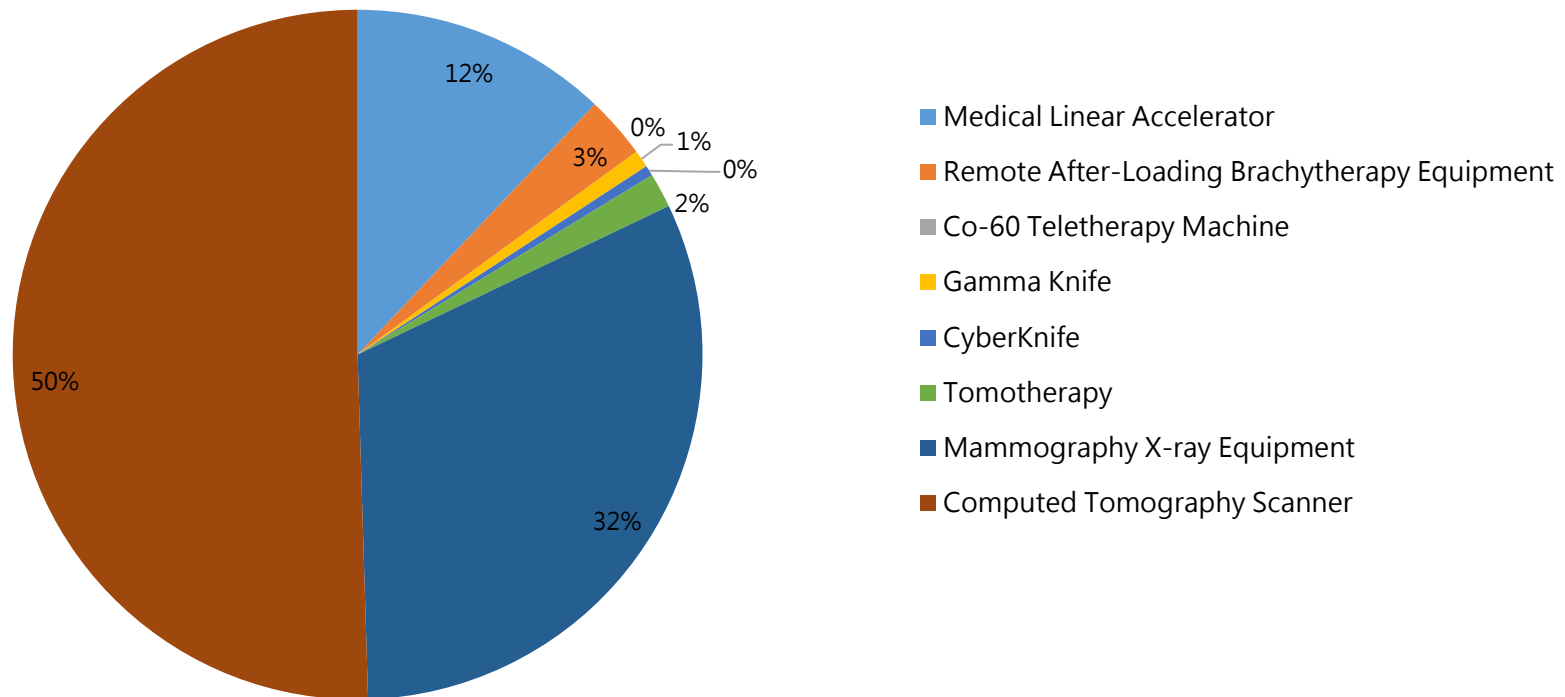
Statistics of the Number of Licenses for All Types of Medical Institution Installed with All Types of Medical Radioactive Materials



(8) Number of Licenses for All Types of Equipment that should Implement Radiation Medical Exposure Quality Assurance

Medical Equipment	Number of Licenses
Medical Linear Accelerator	149
Remote After-Loading Brachytherapy Equipment	36
Co-60 Teletherapy Machine	0
Gamma Knife	10
CyberKnife	6
Tomotherapy	20
Mammography X-ray Equipment (not include disabled equipment)	390
Computed Tomography Scanner (not include disabled equipment)	623
Total	1,234

Number of Licenses for All Types of Equipment that should Implement Radiation Medical Exposure Quality Assurance

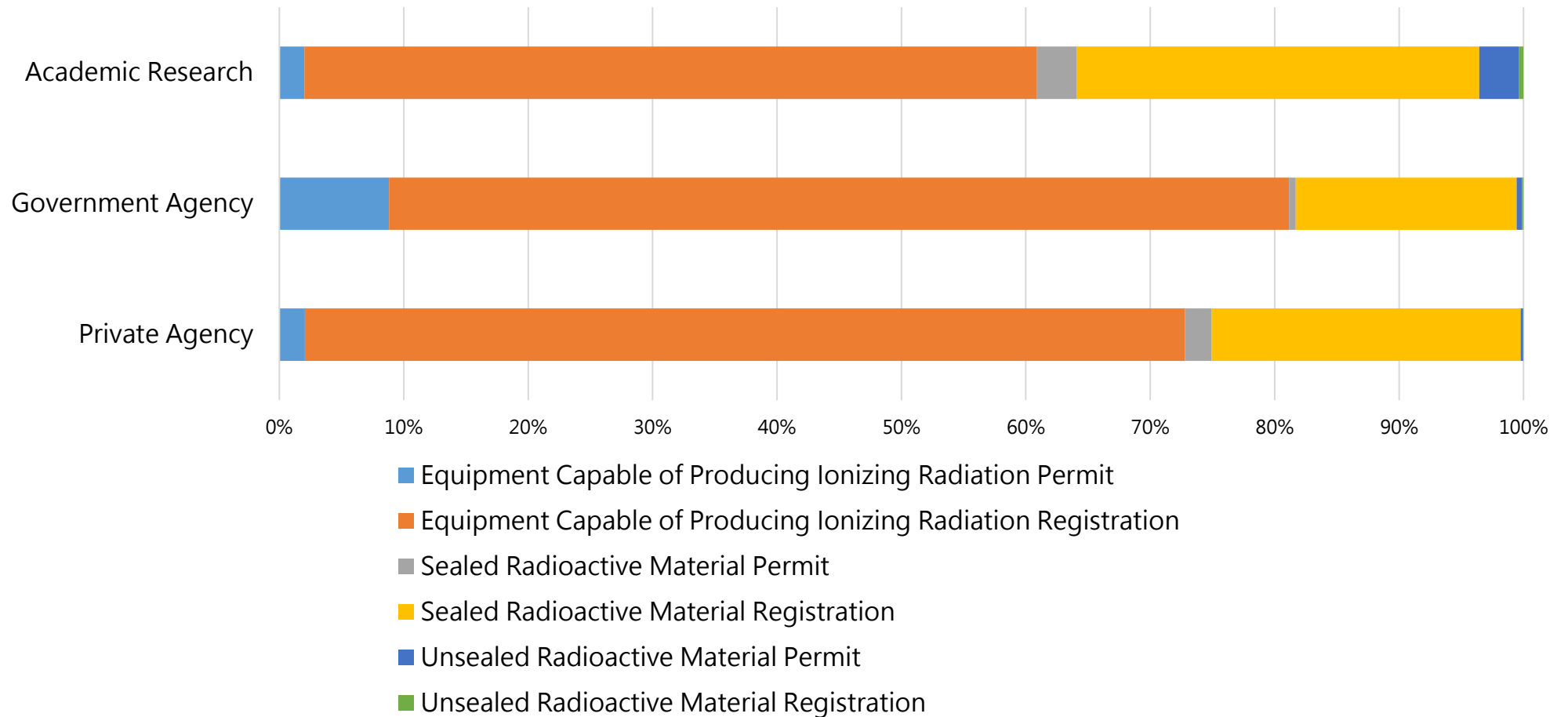


2. Non-Medical Use

(1) Number of Licenses for All Types of Facilities Installed with Non-medical Radiation Sources – per type

Type Facility	Equipment Capable of Producing Ionizing Radiation		Sealed Radioactive Material		Unsealed Radioactive Material		Total
	Permit	Registration	Permit	Registration	Permit	Registration	
Private Agency	227	7,830	238	2,747	23	3	11,068
Government Agency	80	656	5	161	4	1	907
Academic Research	17	497	27	273	27	3	844
Total	324	8,983	270	3,181	54	7	12,819

Number of Licenses for All Types of Facilities Installed with Non-medical Radiation Sources



(2) Number of Licenses for All Types of Facilities Installed with Non-medical Radiation Sources – per county/city

Facility County/City	Permit									Registration								
	Private Agency			Government Agency			Academic Research			Private Agency			Government Agency			Academic Research		
	Equip ment	Sealed	Unseal ed	Equipm ent	Sealed	Unseal ed	Equipm ent	Sealed	Unseal ed	Equipm ent	Sealed	Unseal ed	Equipm ent	Sealed	Unseal ed	Equipm ent	Sealed	Unseal ed
Keelung City	1	4	0	4	0	0	0	0	0	46	1	0	22	2	0	4	4	0
Taipei City	24	7	4	12	0	0	4	5	6	557	82	0	90	41	1	135	67	2
New Taipei City	11	7	8	7	4	1	0	0	0	1,195	212	1	20	35	0	7	1	0
Taoyuan City	40	16	2	21	0	0	5	16	9	1,688	516	1	269	23	0	54	66	0
Hsinchu(county and city)	6	6	2	1	0	1	6	5	4	833	349	0	6	2	0	105	36	0
Miaoli County	3	6	1	0	0	0	0	0	0	190	108	0	2	0	0	3	0	0
Taichung City	19	11	3	6	0	1	1	0	3	736	264	0	36	19	0	60	31	0
Changhua County	7	5	0	0	0	0	0	0	0	218	108	0	4	0	0	6	3	0
Nantou County	2	2	0	2	0	0	0	0	0	66	18	0	3	2	0	3	0	0
Yunlin County	7	31	0	0	0	0	1	0	0	159	214	0	3	1	0	6	4	0
Chiayi (county and city)	3	0	0	3	0	0	0	0	1	86	26	0	7	3	0	8	3	1
Tainan City	13	1	0	5	0	1	0	0	2	667	297	0	28	6	0	43	18	0
Kaohsiung City	80	137	2	8	1	0	0	1	1	1,218	392	0	88	17	0	34	20	0
Pingtung County	8	2	1	5	0	0	0	0	0	84	65	1	8	4	0	8	10	0
Yilan County	2	3	0	0	0	0	0	0	0	60	58	0	1	2	0	3	0	0
Hualien County	1	0	0	3	0	0	0	0	1	19	27	0	11	2	0	18	9	0

Taitung County	0	0	0	2	0	0	0	0	0	7	9	0	16	2	0	0	1	0
Penghu County	0	0	0	1	0	0	0	0	0	0	1	0	22	0	0	0	0	0
Kinmen County	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0
Lienchiang County	0	0	0	0	0	0	0	0	0	1	0	0	12	0	0	0	0	0
Total	227	238	23	80	5	4	17	27	27	7,830	2,747	3	656	161	1	497	273	3

Remarks:

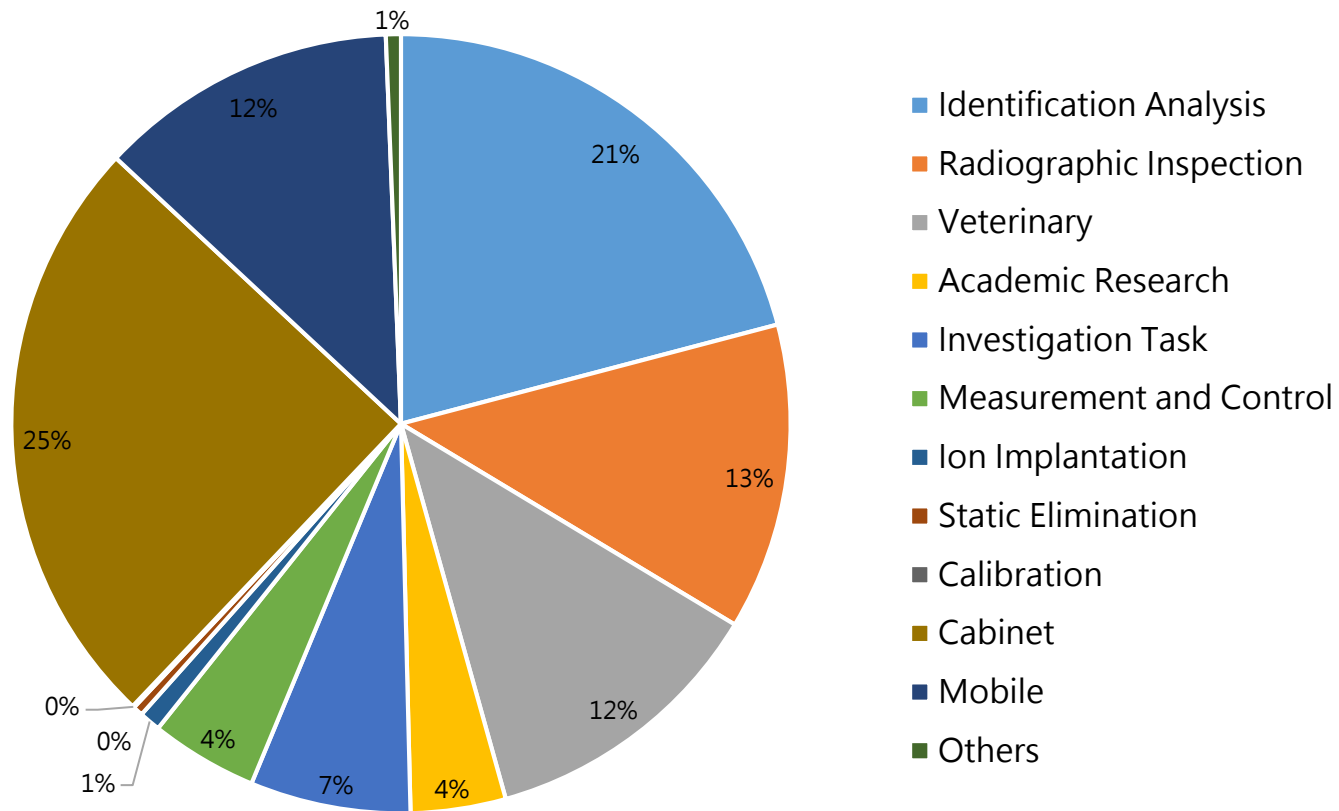
1. Equipment: Equipment capable of producing ionizing radiation.
2. Sealed: Sealed radioactive material.
3. Unsealed: Unsealed radioactive material.

(3) Number of Licenses for Non-medical Equipment Capable of Producing Ionizing Radiation for Various Purposes

Equipment Usage	Number of Licenses
Identification Analysis	1,945
Radiographic Inspection	1,184
Veterinary	1,121
Academic Research	367
Investigation Task	620
Measurement and Control	414
Ion Implantation	82
Static Elimination	39
Calibration	7
Cabinet	2,313
Mobile	1,157
Others ^{Remarks}	58
Total	9,307

Remarks: "Others" refers to the equipment held by the sales and manufacturing industry and is not classified.

Number of Licenses for Non-medical Equipment Capable of Producing Ionizing Radiation for Various Purposes



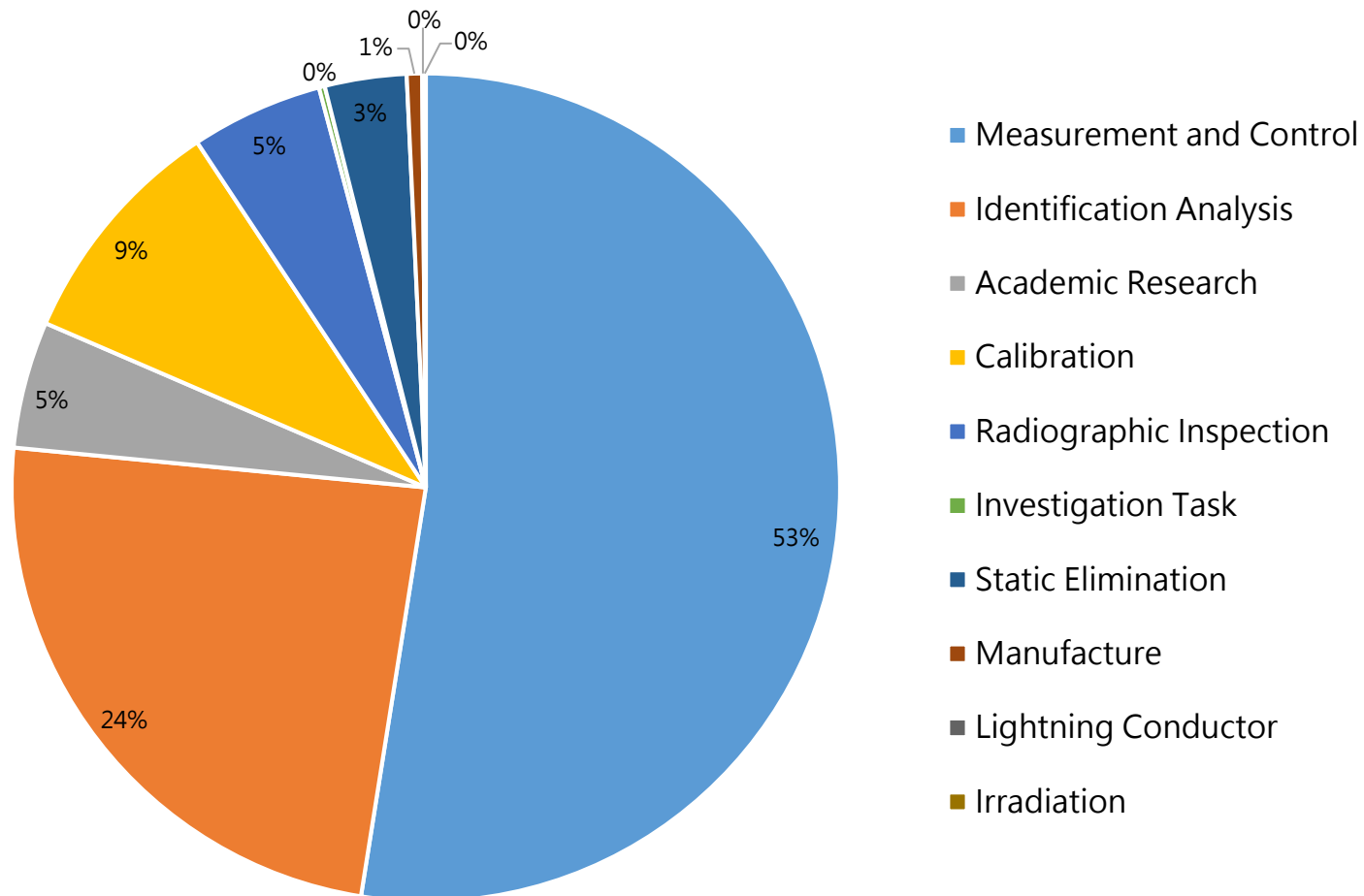
(4) Number of Licenses for Non-medical Radioactive Materials for Various Purposes

Radioactive Material Usage	Number of Licenses
Measurement and Control	1,844
Identification Analysis	844
Academic Research	174
Calibration	323
Radiographic Inspection	181
Investigation Task	8
Static Elimination	112
Manufacture ¹	21
Lightning Conductor ²	2
Irradiation ³	3
Total	3,512

Remarks:

1. Manufacture usage includes packaging and manufacturing.
2. Lightning conductors use Am-241 sources.
3. Irradiation refers to the irradiation of agricultural products, medical products, etc.

Number of Licenses for Non-medical Radioactive Materials for Various Purposes



3. Personnel Dose

(1) Statistics of the Number of Radiation Workers Nationwide

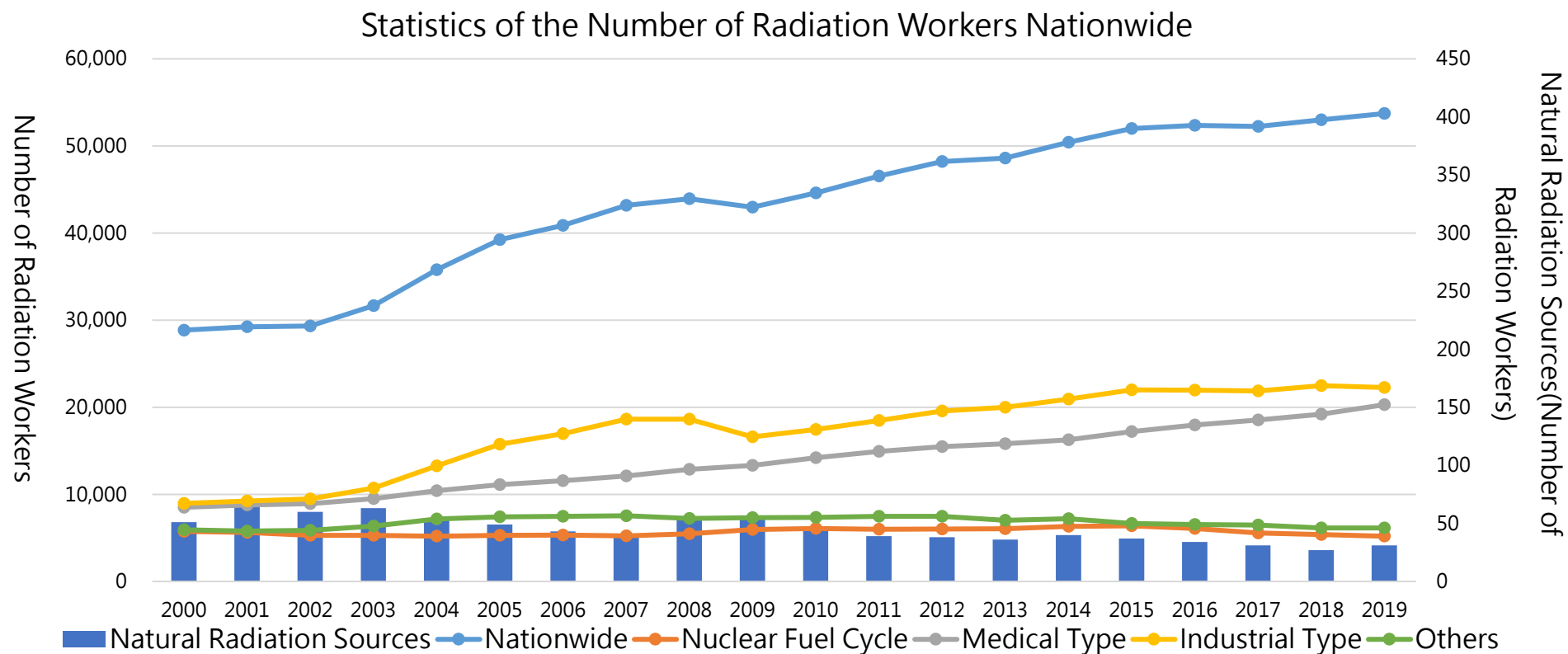
Year	Nuclear Fuel Cycle	Medical Type	Industrial Type	Natural Radiation Sources ¹	Others ²	Nationwid e ³
2000	5,731	8,510	8,960	51	5,925	28,856
2001	5,622	8,775	9,221	66	5,786	29,223
2002	5,296	8,914	9,468	60	5,857	29,325
2003	5,281	9,504	10,702	63	6,361	31,649
2004	5,189	10,425	13,272	54	7,167	35,782
2005	5,287	11,101	15,754	49	7,410	39,242
2006	5,325	11,561	16,966	43	7,472	40,881
2007	5,232	12,110	18,615	40	7,541	43,170
2008	5,473	12,873	18,639	56	7,221	43,940
2009	5,971	13,321	16,588	56	7,329	42,966
2010	6,093	14,207	17,435	46	7,360	44,607
2011	6,001	14,920	18,465	39	7,482	46,545
2012	6,026	15,482	19,576	38	7,473	48,225
2013	6,040	15,804	20,002	36	7,031	48,617
2014	6,313	16,272	20,919	40	7,199	50,437
2015	6,384	17,199	21,995	37	6,659	52,012
2016	6,084	17,958	21,951	34	6,540	52,369
2017	5,557	18,522	21,877	31	6,479	52,248
2018	5,383	19,199	22,479	27	6,137	52,995
2019	5,189	20,291	22,269	31	6,142	53,723

Remarks :

1. Natural radiation sources include civil aircraft, oil, gas, and mineral and ore processing.
2. Others category includes educational institutions, veterinarians and a few difficult to classify.
3. National dose badge usage statistics includes radiation workers and non-radiation

workers as defined by law/regulations.

4. Because some workers are engaged in more than two types of radiation works, the total number of personnel tested nationwide will be less than the total number of various types of work.

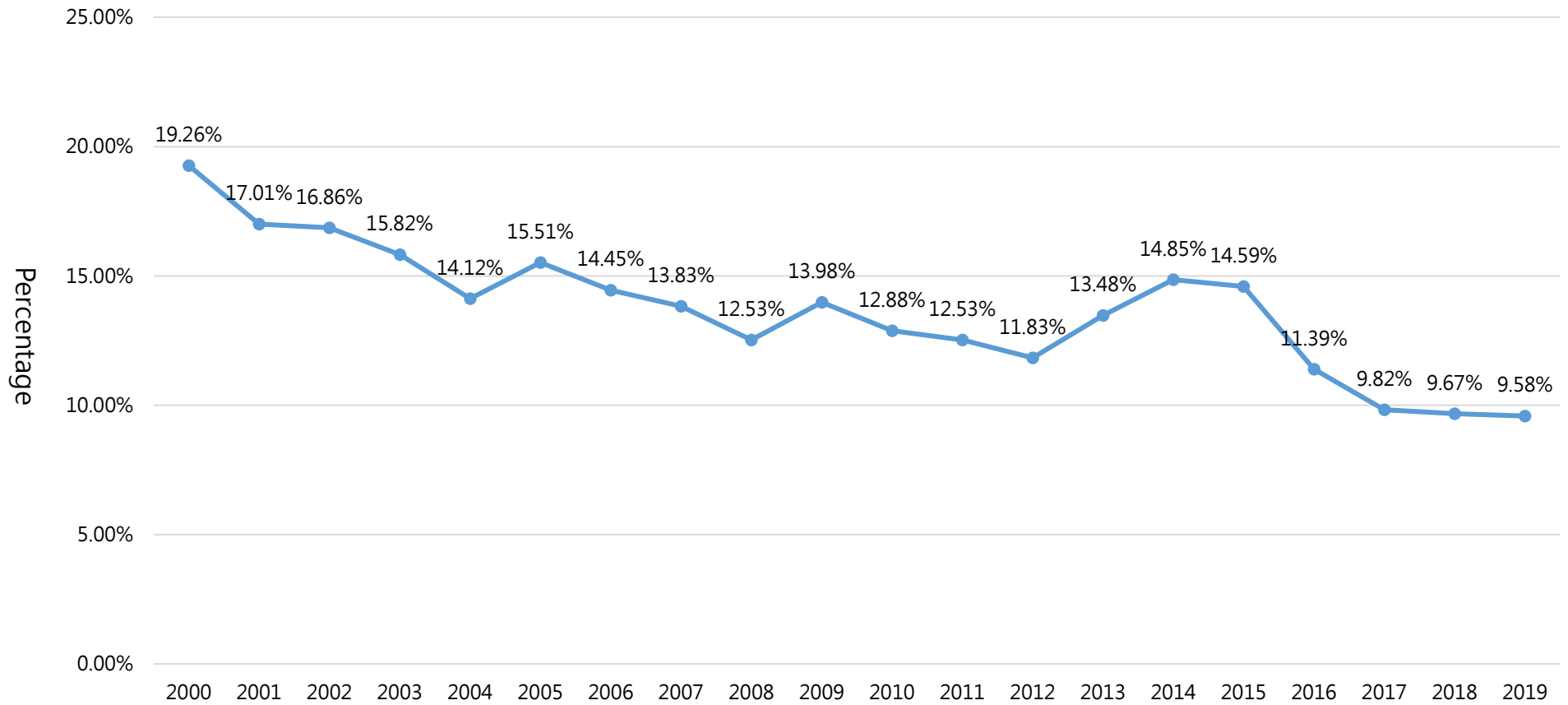


(2) Statistics of the Number of Radiation Workers with Dose Value and Total Number of Personnel Tested
Nationwide

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of People with Dose Value	5,559	4,970	4,943	5,006	5,052	6,088	5,908	5,969	5,504	6,008	5,745	,5831	5,704	6,551
Total Number of Personnel Tested	28,856	29,223	29,325	31,649	357,82	39,242	40,881	43,170	43,940	42,966	44,607	46,545	48,225	48,621
Percentage	19.26%	17.01%	16.86%	15.82%	14.12%	15.51%	14.45%	13.83%	12.53%	13.98%	12.88%	12.53%	11.83%	13.47%

Year	2014	2015	2016	2017	2018	2019
Number of People with Dose Value	7,492	7,589	5,966	5,132	5,127	5,148
Total Number of Personnel Tested	50,438	52,012	52,369	52,248	52,995	53,723
Percentage	14.85%	14.59%	11.39%	9.82%	9.67%	9.58%

Statistics of the Number of Radiation Workers with Dose Value and Total Number of Personnel Tested Nationwide



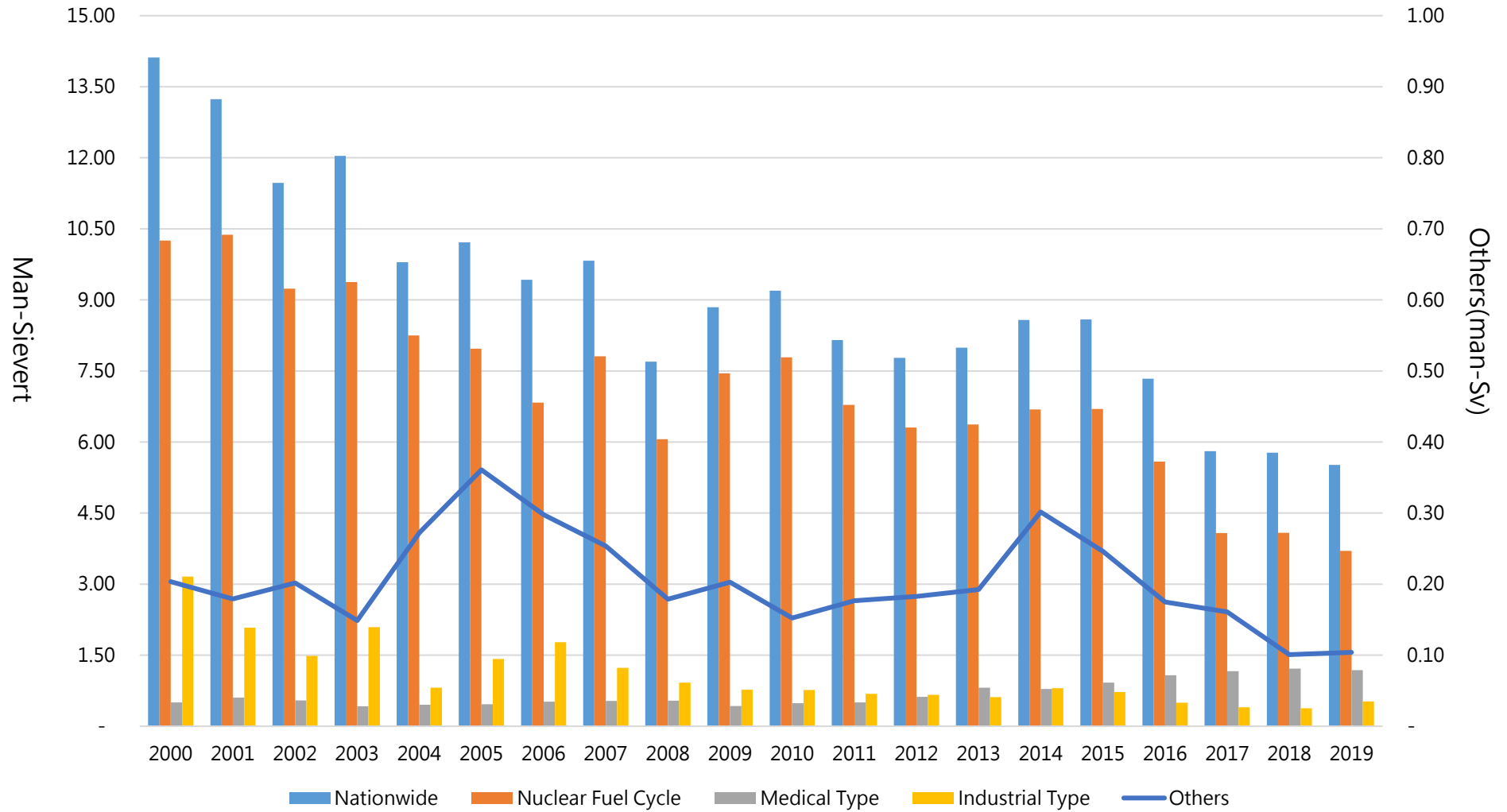
(3) Statistics of Total Collective Dose for Radiation Workers Nationwide

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Nationwide	14.12	13.24	11.47	12.04	9.79	10.22	9.43	9.83	7.70	8.85	9.19	8.15	7.78	7.99	8.58	8.59
Nuclear Fuel Cycle (Nuclear Power Plant)	10.25	10.37	9.24	9.38	8.25	7.97	6.83	7.81	6.06	7.45	7.79	6.79	6.31	6.37	6.69	6.70
Medical Type	0.50	0.61	0.55	0.42	0.45	0.46	0.52	0.53	0.54	0.43	0.49	0.50	0.62	0.81	0.79	0.92
Industrial Type (Non-Medical)	3.16	2.08	1.48	2.09	0.82	1.42	1.78	1.23	0.92	0.77	0.77	0.68	0.66	0.61	0.81	0.72
Others (Research)	0.20	0.18	0.20	0.15	0.27	0.36	0.30	0.25	0.18	0.20	0.15	0.18	0.18	0.19	0.30	0.25
Natural Radiation Sources	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Year	2016	2017	2018	2019
Nationwide	7.34	5.80	5.78	5.52
Nuclear Fuel Cycle (Nuclear Power Plant)	5.59	4.08	4.08	3.70
Medical Type	1.08	1.16	1.21	1.19
Industrial Type (Non-Medical)	0.51	0.40	0.38	0.52
Others (Research)	0.17	0.16	0.10	0.10
Natural Radiation Sources	0.00	0.00	0.00	0.00

Unit : Man-Sievert (man-Sv)

Statistics of Total Collective Dose for Radiation Workers Nationwide



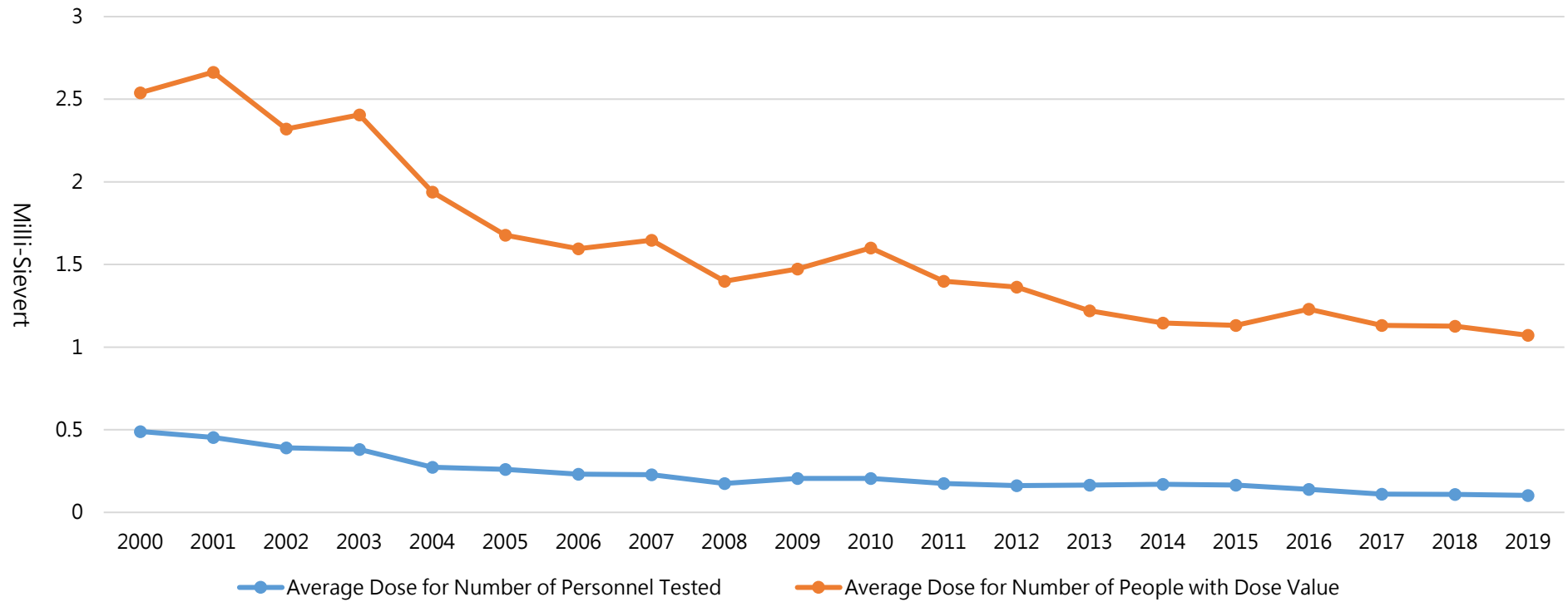
(4) Statistics of Annual Average Dose for Radiation Workers Nationwide

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Average Dose for Number of Personnel Tested	0.49	0.45	0.39	0.38	0.27	0.26	0.23	0.23	0.18	0.21	0.21	0.18	0.16	0.16	0.17	0.17
Average Dose for Number of People with Dose Value	2.54	2.66	2.32	2.40	1.94	1.68	1.60	1.65	1.40	1.47	1.60	1.40	1.36	1.22	1.15	1.13

Year	2016	2017	2018	2019
Average Dose for Number of Personnel Tested	0.14	0.11	0.11	0.10
Average Dose for Number of People with Dose Value	1.23	1.13	1.13	1.07

Unit : Milli-Sievert (mSv)

Statistics of Annual Average Dose for Radiation Workers Nationwide

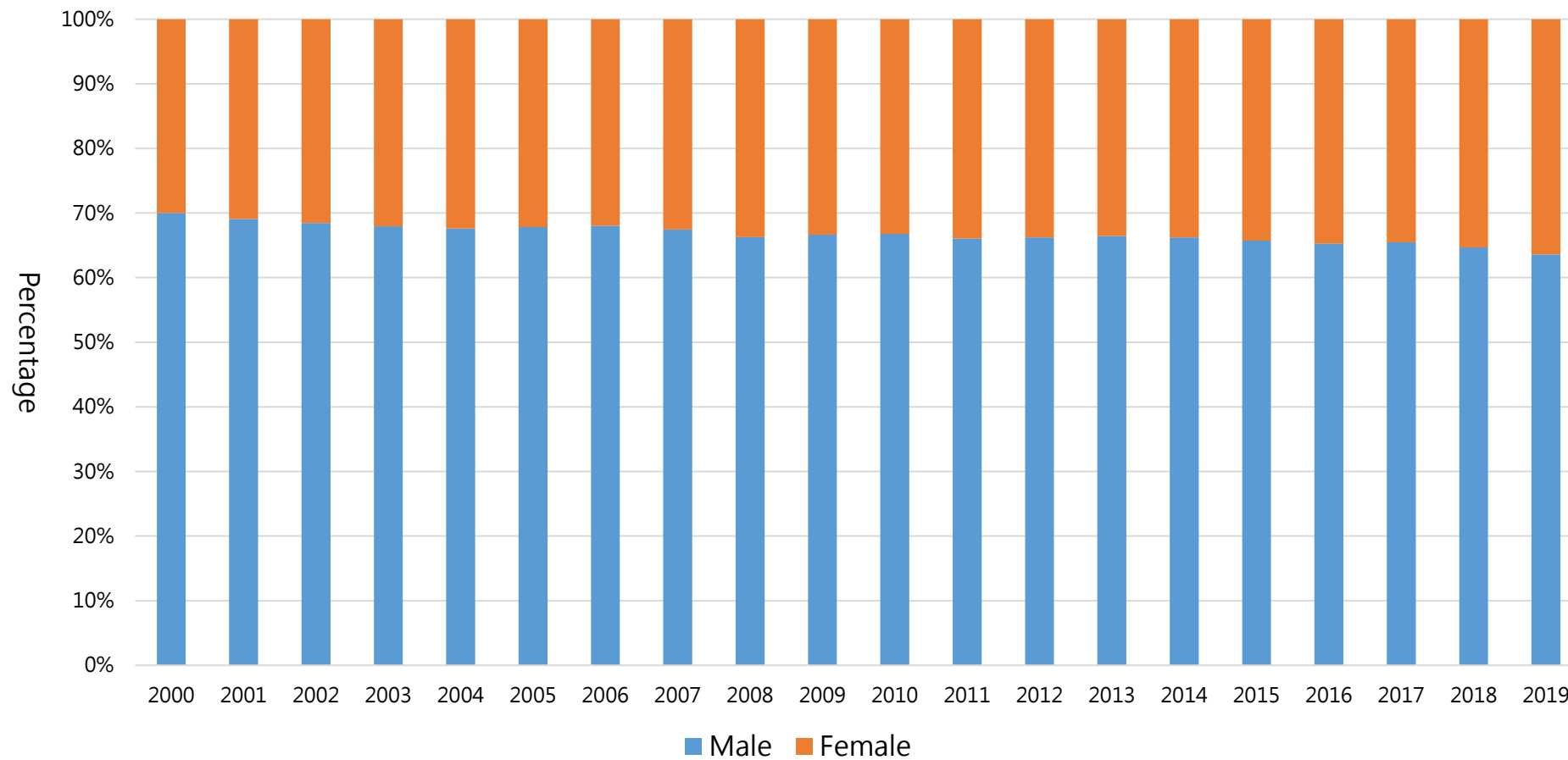


(5) Statistics of Gender for Radiation Workers Nationwide

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Male	20,201	20,194	20,069	21,507	24,194	26,620	27,816	29,122	29,112	28,639	29,778	30,740	31,950	32,298
Female	8,655	9,029	9,256	10,142	11,588	12,622	13,065	14,048	14,828	14,327	14,829	15,805	16,275	16,319
Total	28,856	29,223	29,325	31,649	35,782	39,242	40,881	43,170	43,940	42,966	44,607	46,545	48,225	48,617

Year	2014	2015	2016	2017	2018	2019
Male	33,397	34,190	34,178	34,210	34,283	34,163
Female	17,040	17,822	18,191	18,038	18,712	19,560
Total	50,437	52,012	52,369	52,248	52,995	53,723

Statistics of Gender for Radiation Workers Nationwide



(6) Statistics of the Number of Radiation Workers in Each Dose Interval Nationwide

Dose Interval (mSv)	≤LLD	≤ 1	1-2.5	2.5-5	5-7.5	7.5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-100	> 100
2000	23,297	3,296	891	549	272	191	169	90	47	26	15	8	3	0	2	0
2001	24,253	2,774	891	539	251	161	187	86	36	24	17	0	3	0	1	0
2002	24,382	2,907	857	519	225	148	155	77	40	8	5	1	0	0	1	0
2003	26,643	3,001	801	520	228	157	135	84	43	21	7	7	2	0	0	0
2004	30,730	3,152	822	512	196	126	165	75	1	1	0	2	0	0	0	0
2005	33,154	4,018	935	528	245	143	159	52	3	1	2	1	1	0	0	0
2006	34,973	3,991	854	526	214	140	132	31	13	2	5	0	0	0	0	0
2007	37,201	3,922	909	586	221	126	156	43	3	2	1	0	0	0	0	0
2008	38,436	3,644	948	503	186	118	98	6	1	0	0	0	0	0	0	0
2009	36,958	3,968	941	593	254	145	99	8	0	0	0	0	0	0	0	0
2010	38,862	3,652	961	614	238	138	121	21	0	0	0	0	0	0	0	0
2011	40,714	3,884	977	507	238	134	81	10	0	0	0	0	0	0	0	0
2012	42,519	3,758	1,030	531	201	103	68	12	1	0	0	0	0	0	0	0
2013	42,063	4,601	1,008	556	196	93	77	19	0	1	0	0	0	0	0	0
2014	42,944	5,431	1,072	542	246	101	87	11	0	0	0	0	0	0	0	0
2015	44,413	5,413	1,188	569	220	111	81	7	0	0	0	0	0	0	0	0
2016	46,403	4,200	950	477	159	87	80	13	0	0	0	0	0	0	0	0
2017	47,116	3,716	756	394	136	75	50	5	0	0	0	0	0	0	0	0
2018	47,868	3,680	840	362	117	60	52	14	2	0	0	0	0	0	0	0
2019	48,575	3,713	823	364	139	60	41	8	0	0	0	0	0	0	0	0

LLD : Lower limit of detection

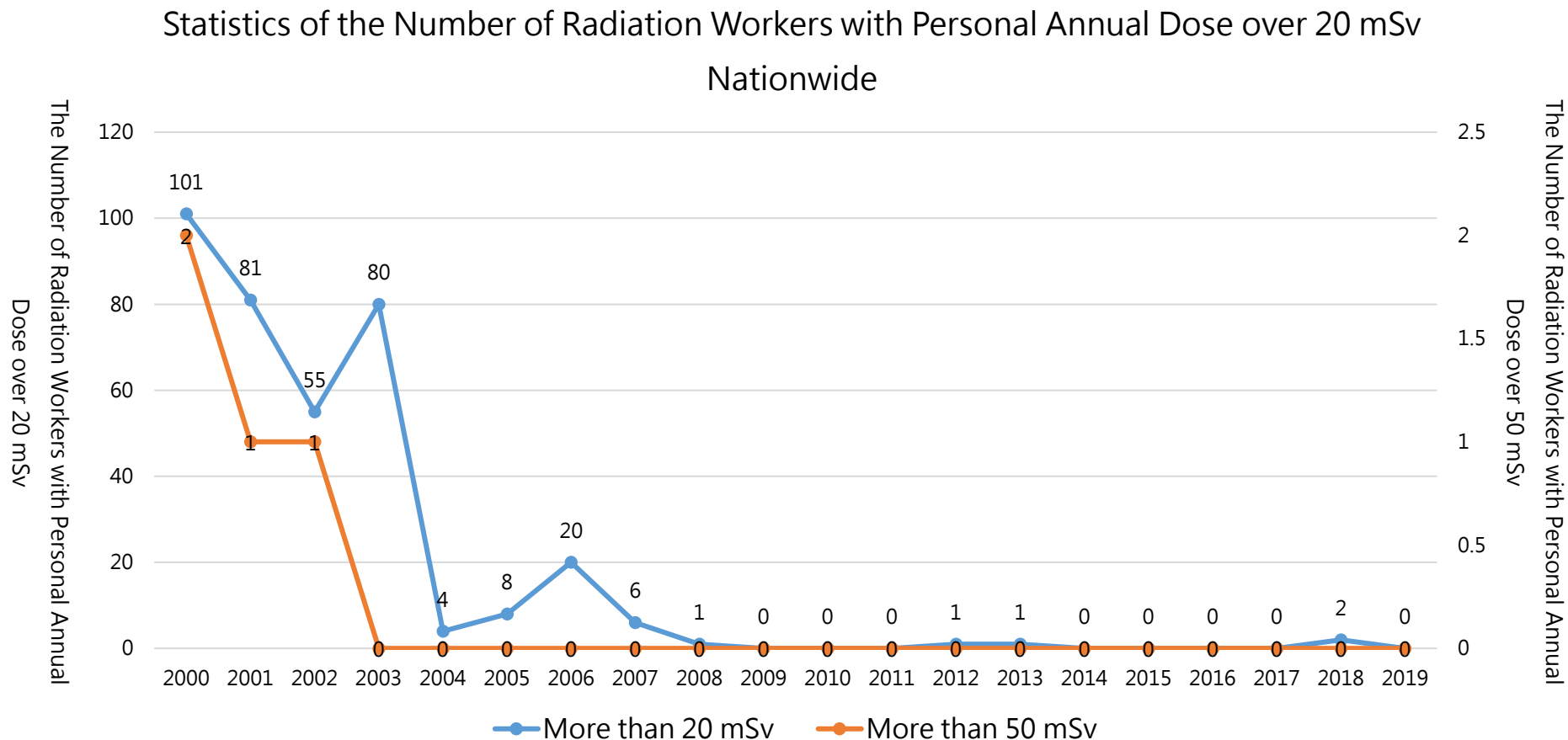
(7) Statistics of Relative Percentage of Radiation Workers in Each Dose Interval Nationwide

Dose Interval (mSv)	≤LLD	≤ 1	1-2.5	2.5-5	5-7.5	7.5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-100	> 100	Percentage of People with Dose Value
2000	80.74	11.42	3.09	1.90	0.94	0.66	0.59	0.31	0.16	0.09	0.05	0.03	0.01	0.00	0.01	0.00	19.26%
2001	82.99	9.49	3.05	1.84	0.86	0.55	0.64	0.29	0.12	0.08	0.06	0.00	0.01	0.00	0.00	0.00	17.01%
2002	83.14	9.91	2.92	1.77	0.77	0.50	0.53	0.26	0.14	0.03	0.02	0.00	0.00	0.00	0.00	0.00	16.86%
2003	84.18	9.48	2.53	1.64	0.72	0.50	0.43	0.27	0.14	0.07	0.02	0.02	0.01	0.00	0.00	0.00	15.82%
2004	85.88	8.81	2.30	1.43	0.55	0.35	0.46	0.21	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	14.12%
2005	84.49	10.24	2.38	1.35	0.62	0.36	0.41	0.13	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	15.51%
2006	85.55	9.76	2.09	1.29	0.52	0.34	0.32	0.08	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	14.45%
2007	86.17	9.09	2.11	1.36	0.51	0.29	0.36	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.83%
2008	87.47	8.29	2.16	1.14	0.42	0.27	0.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.53%
2009	86.02	9.24	2.19	1.38	0.59	0.34	0.23	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.98%
2010	87.12	8.19	2.15	1.38	0.53	0.31	0.27	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.88%
2011	87.47	8.34	2.10	1.09	0.51	0.29	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.53%
2012	88.17	7.79	2.14	1.10	0.42	0.21	0.14	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.83%
2013	86.52	9.46	2.07	1.14	0.40	0.19	0.16	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.48%
2014	85.15	10.77	2.13	1.07	0.49	0.20	0.17	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.85%
2015	85.41	10.41	2.28	1.09	0.42	0.21	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.59%
2016	88.61	8.02	1.81	0.91	0.30	0.17	0.15	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.39%
2017	90.18	7.11	1.45	0.75	0.26	0.14	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.82%
2018	90.33	6.94	1.59	0.68	0.22	0.11	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.67%
2019	90.42	6.91	1.53	0.68	0.26	0.11	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.58%

LLD : Lower limit of detection

(8) Statistics of the Number of Radiation Workers with Personal Annual Dose over 20 mSv Nationwide

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
More than 20 mSv	101	81	55	80	4	8	20	6	1	0	0	0	1	1	0	0	0	0	2	0
More than 50 mSv	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

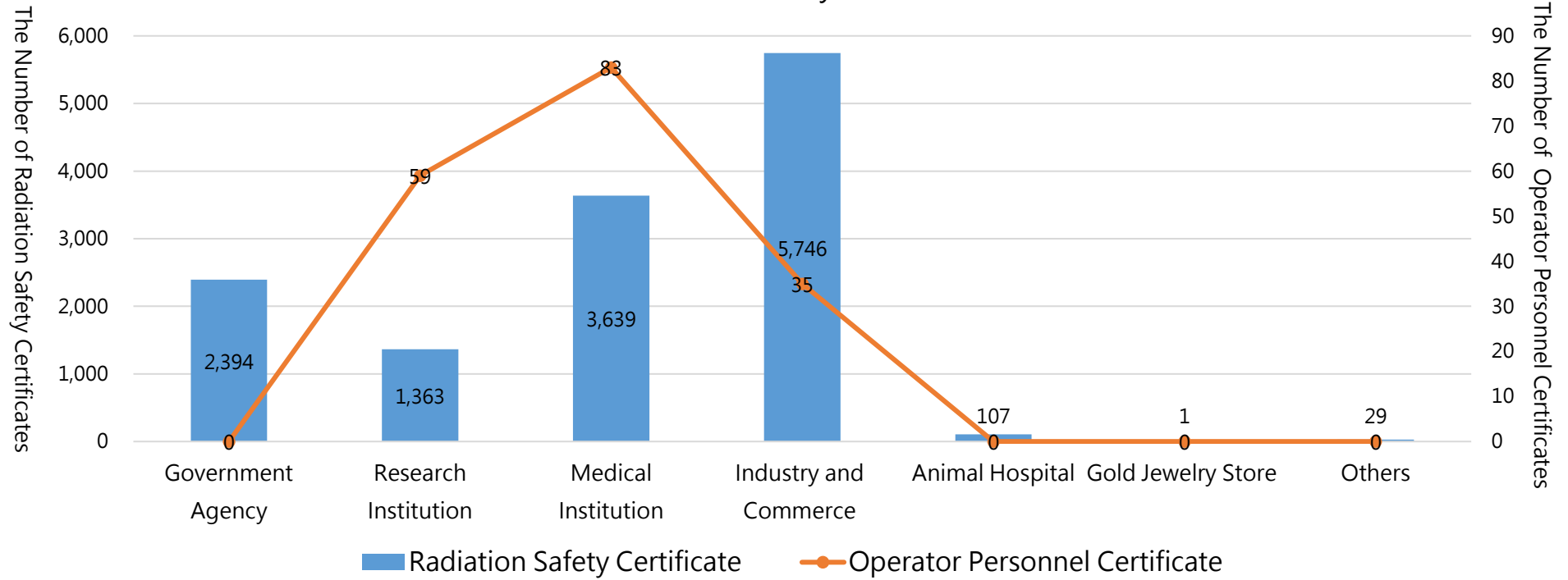


4. Radiation Protection Personnel, Radiation Safety Certificates and Radiation Protection Business

(1) Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per facility

Facility Certificate Type	Governm ent Agency	Research Institution	Medical Institution	Industry and Commerce	Animal Hospital	Gold Jewelry Store	Others (Including unemployed people)	Total
Radiation Safety Certificate	2,394	1,363	3,639	5,746	107	1	29	13,279
Operator Personnel Certificate	0	59	83	35	0	0	0	177
Total	2,394	1,422	3,722	5,781	107	1	29	13,456

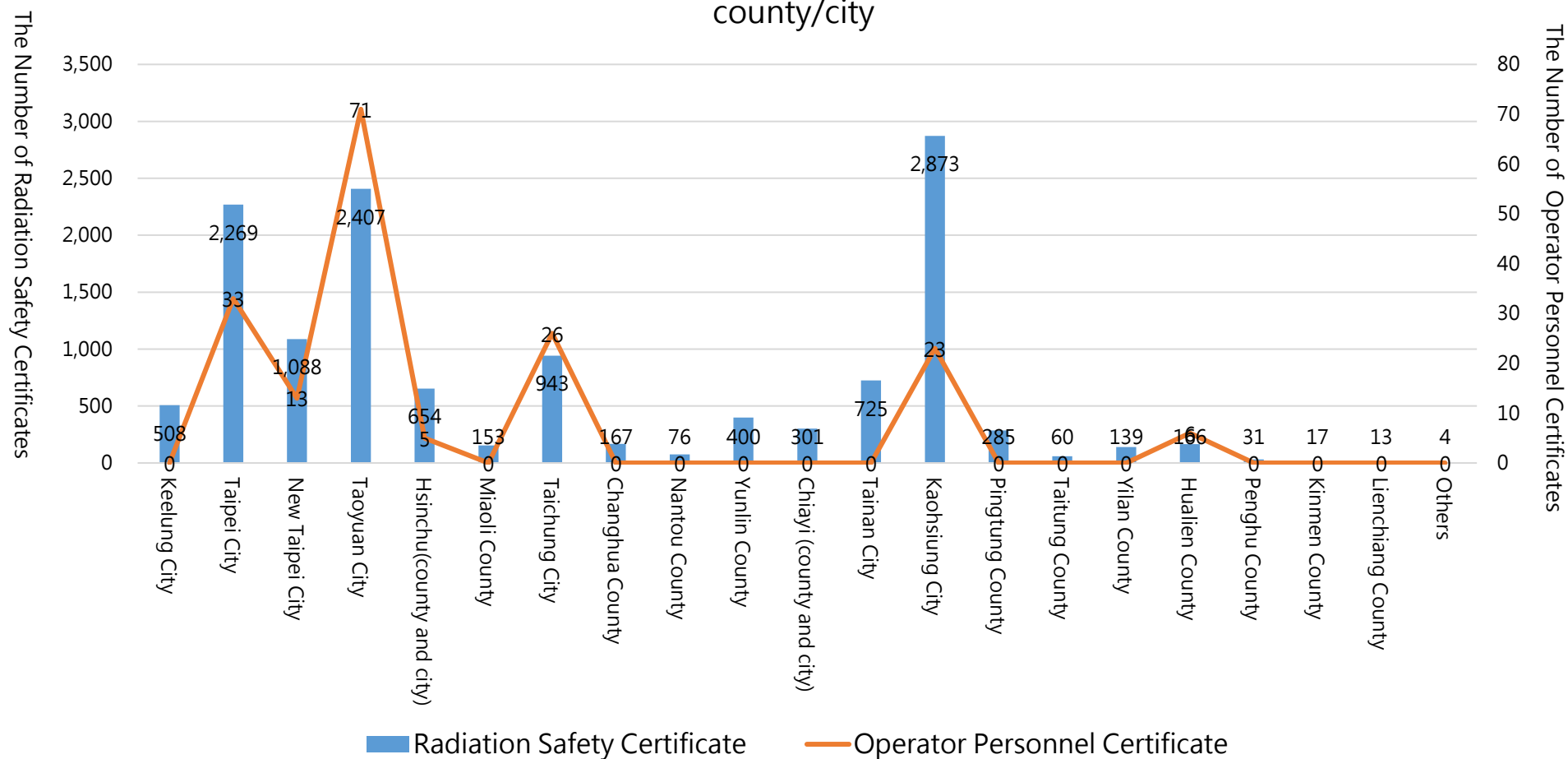
Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per facility



(2) Total Number of Radiation Safety Certificates and Operator Personnel
Certificates – per county/city

Certificate type County/City	Radiation Safety Certificate	Operator Personnel Certificate	Total
Keelung City	508	0	508
Taipei City	2,269	33	2,302
New Taipei City	1,088	13	1,101
Taoyuan City	2,407	71	2,478
Hsinchu(county and city)	654	5	659
Miaoli County	153	0	153
Taichung City	943	26	969
Changhua County	167	0	167
Nantou County	76	0	76
Yunlin County	400	0	400
Chiayi (county and city)	301	0	301
Tainan City	725	0	725
Kaohsiung City	2,873	23	2,896
Pingtung County	285	0	285
Taitung County	60	0	60
Yilan County	139	0	139
Hualien County	166	6	172
Penghu County	31	0	31
Kinmen County	17	0	17
Lienchiang County	13	0	13
Others	4	0	4
Total	13,279	177	13,456

Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per county/city

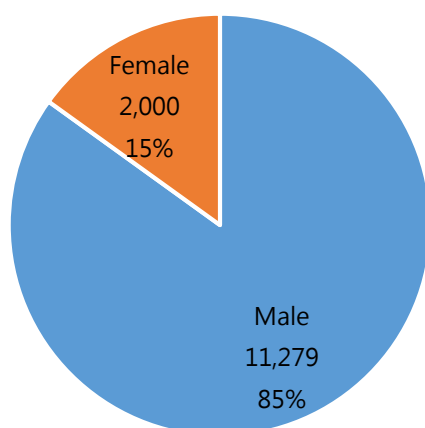


(3) Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per gender

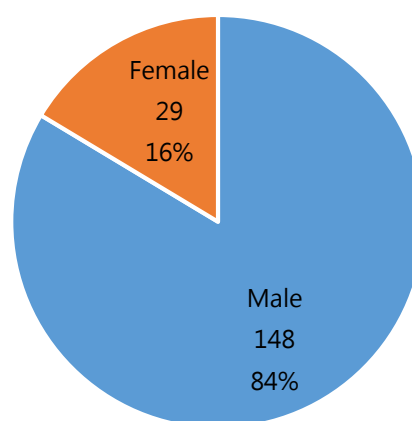
Certificate Type \ Gender	Male	Female	Total
Radiation Safety Certificate	11,279	2,000	13,279
Operator Personnel Certificate	148	29	177
Total	11,427	2,029	13,456

Total Number of Radiation Safety Certificates and Operator Personnel Certificates – per gender

Radiation Safety Certificate

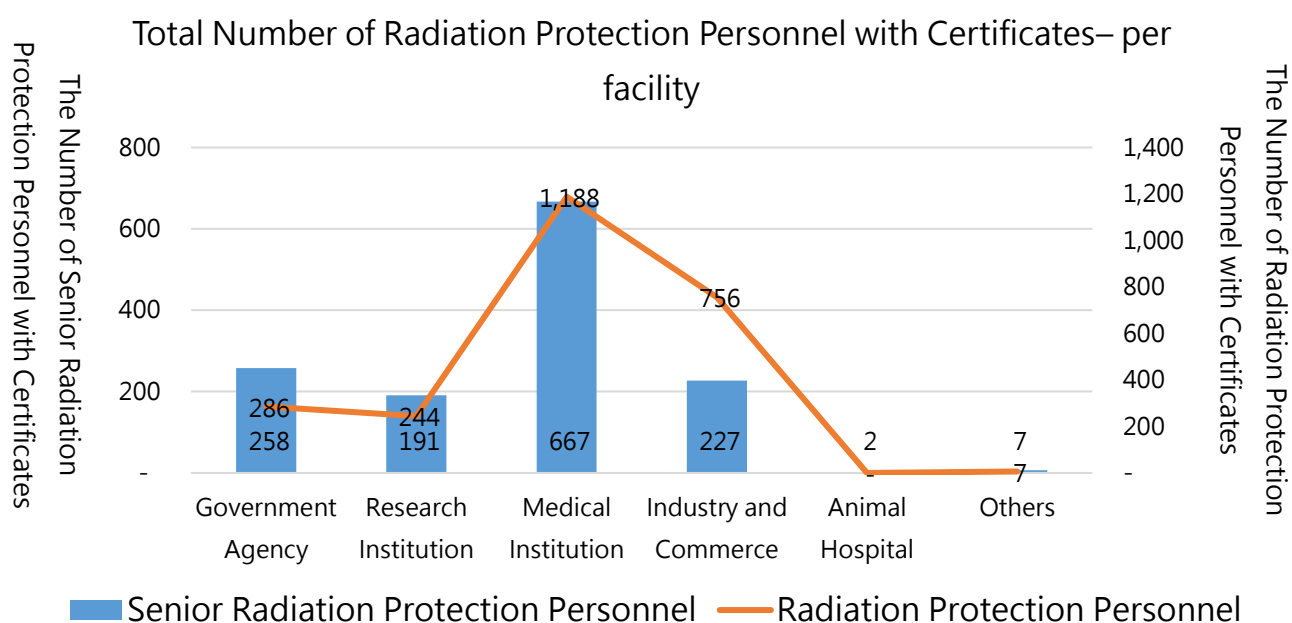


Operator Personnel Certificate



(4) Total Number of Radiation Protection Personnel with Certificates– per facility

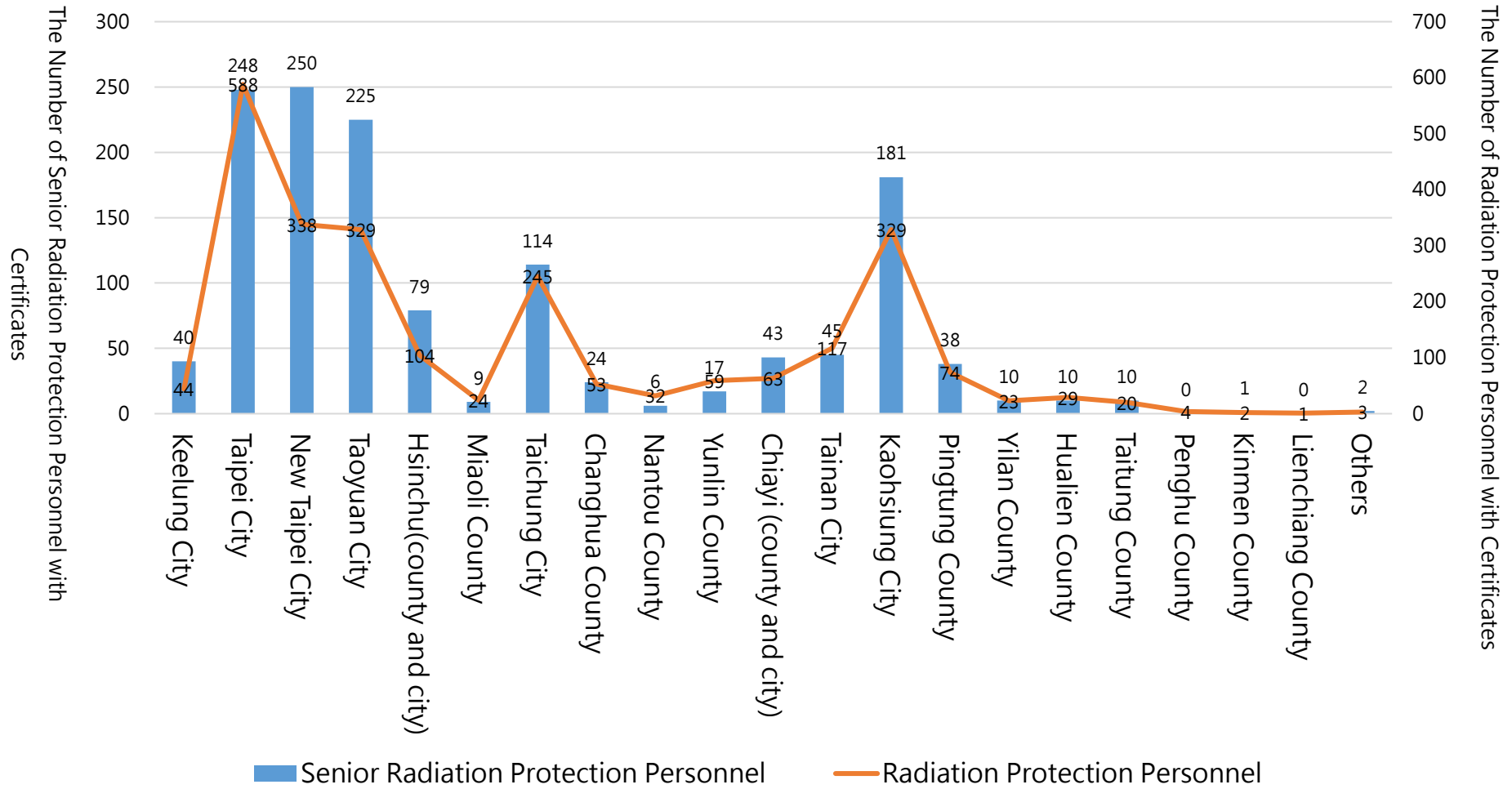
Certificate Type \ Facility	Government Agency	Research Institution	Medical Institution	Industry and Commerce	Animal Hospital	Others (Including unemployed people)	Total
Senior Radiation Protection Personnel	258	191	667	227	2	7	1,352
Radiation Protection Personnel	286	244	1,188	756	0	7	2,481
Total	544	435	1,855	983	2	14	3,833



(5) Total Number of Radiation Protection Personnel with Certificates – per county/city

Certificate Type County/City	Senior Radiation Protection Personnel	Radiation Protection Personnel	Total
Keelung City	40	44	84
Taipei City	248	588	836
New Taipei City	250	338	588
Taoyuan City	225	329	554
Hsinchu(county and city)	79	104	183
Miaoli County	9	24	33
Taichung City	114	245	359
Changhua County	24	53	77
Nantou County	6	32	38
Yunlin County	17	59	76
Chiayi (county and city)	43	63	106
Tainan City	45	117	162
Kaohsiung City	181	329	510
Pingtung County	38	74	112
Yilan County	10	23	33
Hualien County	10	29	39
Taitung County	10	20	30
Penghu County	0	4	4
Kinmen County	1	2	3
Lienchiang County	0	1	1
Others	2	3	5
Total	1,352	2,481	3,833

Total Number of Radiation Protection Personnel with Certificates – per county/city

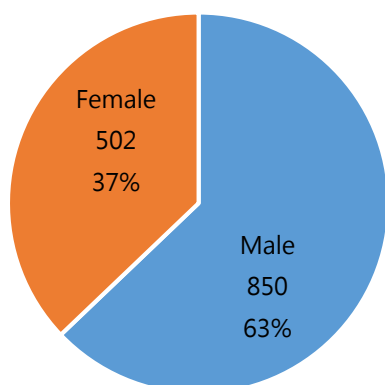


(6) Total Number of Radiation Protection Personnel with Certificates – per gender

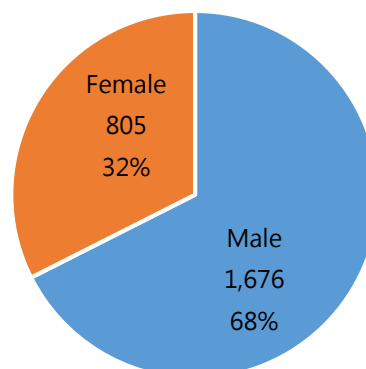
Certificate Type \ Gender	Gender		
	Male	Female	Total
Senior Radiation Protection Personnel	850	502	1,352
Radiation Protection Personnel	1,676	805	2,481
Total	2,526	1,307	3,833

Total Number of Radiation Protection Personnel with Certificates – per gender

Senior Radiation Protection Personnel



Radiation Protection Personnel

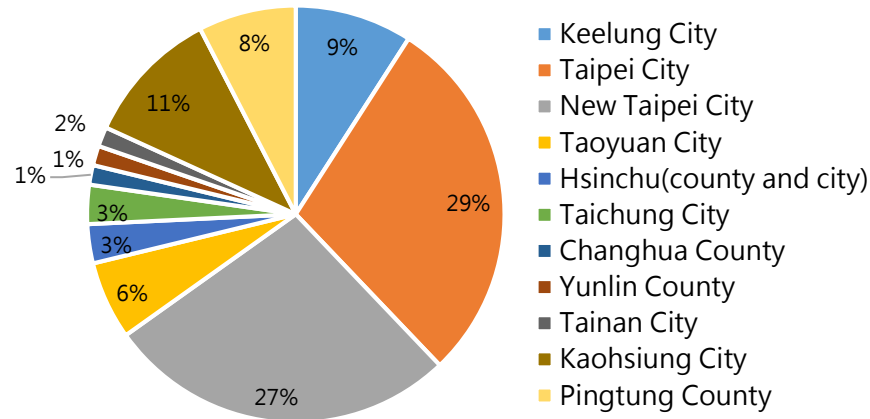


(7) Total Number of Radiation Protection Business with Certificates– per business category and county/city

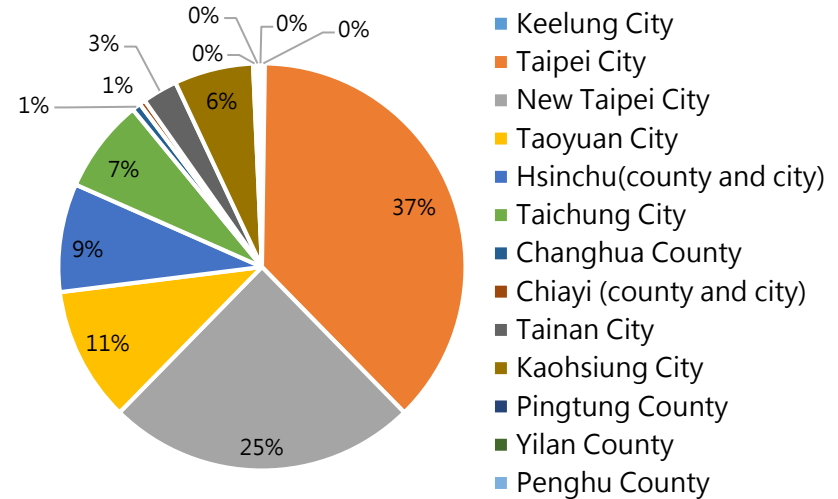
Business category County/City	Radiation Protection Detection Businesses	Radiation Protection Service Businesses	Institutions of Radiation Protection Training Affairs	Total
Keelung City	6	1	0	7
Taipei City	19	161	1	181
New Taipei City	18	106	5	129
Taoyuan City	4	46	3	53
Hsinchu(county and city)	2	37	5	44
Miaoli County	0	0	0	0
Taichung City	2	32	2	36
Changhua County	1	3	1	5
Nantou County	0	0	0	0
Yunlin County	1	0	0	1
Chiayi (county and city)	0	2	0	2
Tainan City	1	12	2	15
Kaohsiung City	7	27	2	36
Pingtung County	5	1	0	6
Yilan County	0	1	1	2
Hualien County	0	1	0	1
Taitung County	0	0	0	0
Penghu County	0	0	0	0
Kinmen County	0	0	0	0
Lienchiang County	0	0	0	0
Total	66	430	22	518

Total Number of Radiation Protection Business with Certificates– per business category and county/city

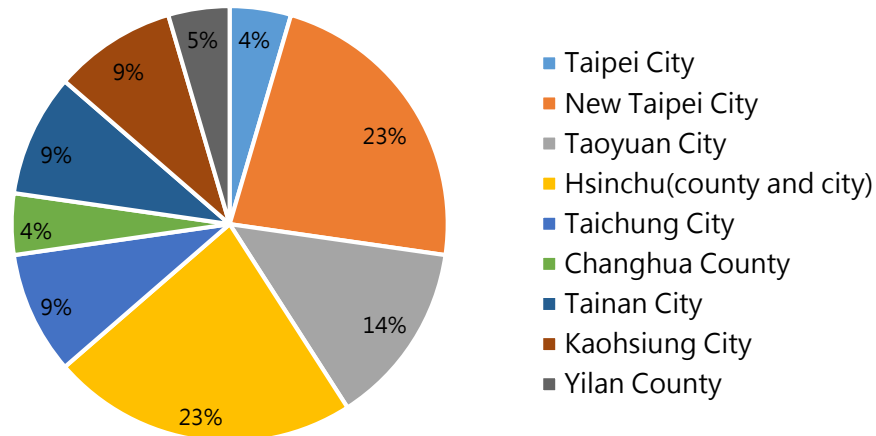
Radiation Protection Detection Businesses



Radiation Protection Service Businesses



Institutions of Radiation Protection Training Affairs



5. Radiation Anomalies Found in the Steel Plants over the Years

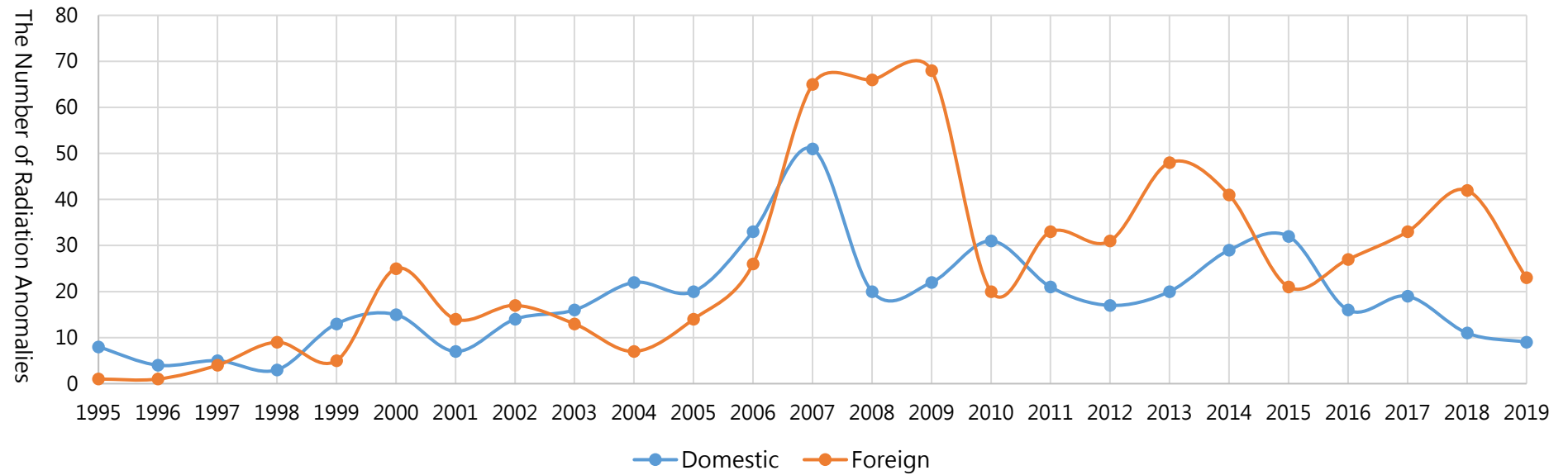
(1) Statistics of the Number of Radiation Anomalies Found in the Steel Plants over the Years

Source \ Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Domestic	8	4	5	3	13	15	7	14	16	22	20
Foreign	1	1	4	9	5	25	14	17	13	7	14
Total	9	5	9	12	18	40	21	31	29	29	34

Source \ Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Domestic	33	51	20	22	31	21	17	20	29	32	16
Foreign	26	65	66	68	20	33	31	48	41	21	27
Total	59	116	86	90	51	54	48	68	70	53	43

Source \ Year	2017	2018	2019	Total
Domestic	19	11	9	458
Foreign	33	42	23	654
Total	52	53	32	1,112

Statistics of the Number of Radiation Anomalies Found in the Steel Plants over the Years



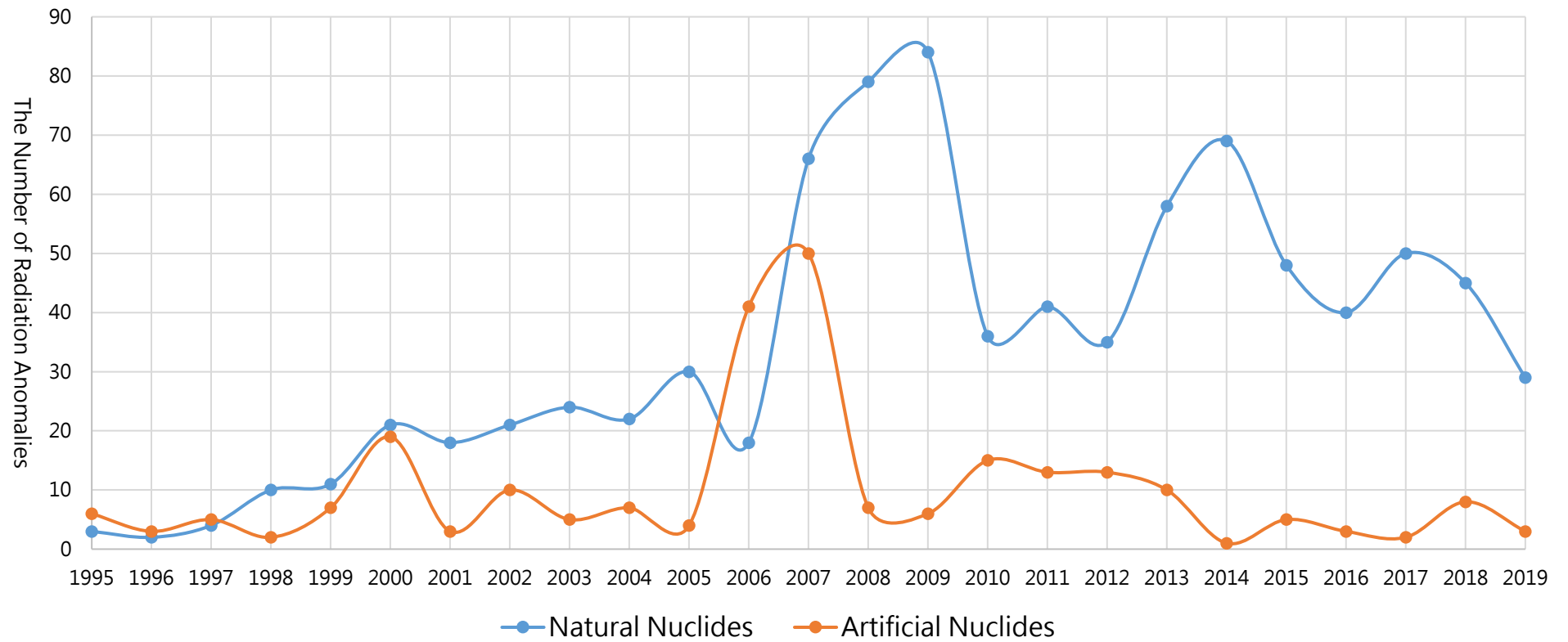
(2) Statistics of Nuclides in Radiation Anomalies Found in the Steel Plants over the Years

Nuclides \ Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Natural Nuclides	3	2	4	10	11	21	18	21	24	22	30
Artificial Nuclides	6	3	5	2	7	19	3	10	5	7	4
Total	9	5	9	12	18	40	21	31	29	29	34

Nuclides \ Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Natural Nuclides	18	66	79	84	36	41	35	58	69	48	40
Artificial Nuclides	41	50	7	6	15	13	13	10	1	5	3
Total	59	116	86	90	51	54	48	68	70	53	43

Nuclides \ Year	2017	2018	2019	Total
Natural Nuclides	50	45	29	864
Artificial Nuclides	2	8	3	248
Total	52	53	32	1,112

Statistics of Nuclides in Radiation Anomalies Found in the Steel Plants over the Years



(3) Statistics of the Types of Radiation Anomalies Found in the Steel Plants over the Years

Types of Radiation Anomalies \ Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Radiation-Contaminated Steel Bars	5	2	4	1	3	8	1	4	2	2	3
Radiation Sources	1	1	1	1	2	4	0	4	3	2	2
Others ^{Remarks}	3	2	4	10	13	28	20	23	24	25	29
Total	9	5	9	12	18	40	21	31	29	29	34

Types of Radiation Anomalies \ Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Radiation-Contaminated Steel Bars	5	32	2	2	9	5	2	2	0	2	0
Radiation Sources	4	7	2	3	5	5	6	6	1	2	2
Others ^{Remarks}	50	77	82	85	37	44	40	60	69	49	41
Total	59	116	86	90	51	54	48	68	70	53	43

Types of Radiation Anomalies \ Year	2017	2018	2019	Total
Radiation-Contaminated Steel Bars	2	1	0	100
Radiation Sources	0	4	6	73
Others ^{Remarks}	50	48	26	939
Total	52	53	32	1,112

Remarks: "Others" refers to those that are difficult to classify, and most are naturally occurring radioactive materials.

Statistics of the Types of Radiation Anomalies Found in the Steel Plants over the Years

