

## **Entering-Class Enrollments in Educational Programs in Radiography, Radiation Therapy, and Nuclear Medicine Technology, 1999-2006**

The paper summarizes the trends in entering-class enrollments in radiography, radiation therapy and nuclear medicine technology programs from 1999 through 2006, based primarily on the Enrollment Snapshot surveys conducted by ASRT's Research Department from 2001 through 2006. (The 2007 Snapshot is being analyzed currently.) A preprint of the manuscript as accepted by JACR is available below. The final, published article can be viewed (if you're a JACR subscriber) or purchased at [www.jacr.org](http://www.jacr.org). It can also be accessed via its DOI (digital object identifier) at <http://dx.doi.org/10.1016/j.jacr.2007.08.008>.

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**Entering-Class Enrollments in Educational Programs in Radiography,  
Radiation Therapy, and Nuclear Medicine Technology, 1999-2006**

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**Abstract**

**Purpose:** To track entering-class enrollments in primary programs in radiography, nuclear medicine technology, and radiation therapy and to anticipate trends in numbers entering those disciplines.

**Methods:** ASRT's annual *Enrollment Snapshot of Radiography, Radiation Therapy, and Nuclear Medicine Educational Programs* has surveyed program directors in these three disciplines every fall since 2001<sup>[1]-[6]</sup>, obtaining information on entering-class enrollments, retention rates, and program viability.

**Results:** These survey results, together with ARRT statistics on the number of first-time certification examinees (which they foreshadow by about two years) show that the number of radiologic technologists entering these three disciplines declined steadily from 1995 to 2000, then increased steadily from 2000 to 2005. However, since 2005 entering-class enrollments have begun to level off – especially in radiation therapy and radiography.

**Conclusions:** Entering-class enrollments provide an “early warning system” with respect to trends in the supply of radiographers, nuclear medicine technologists, and radiation therapists. Given the recent stabilization of entering-class enrollments in radiography and radiation therapy, we can anticipate a similar leveling off of number of entrants into those two disciplines over the next two years.

***Single-sentence summary:*** Entering-class enrollments in primary programs in radiography, nuclear medicine technology, and radiation therapy from 1999 – 2003 foreshadow the steady rise in number of new certificants in those disciplines by about two years, but enrollment figures for 2004 through 2006 indicate that the number of new certificants in radiography and radiation therapy will level off over the next two years.

***Key words:*** Enrollments, radiography, nuclear medicine, radiation therapy, entrants

## INTRODUCTION

The American Society of Radiologic Technologists (ASRT), with over 120,000 members, is the largest professional association for imaging technologists (including sonographers) and radiation therapists in the United States. Given the importance of anticipating the number of new entrants into the various disciplines and specialties of the radiologic sciences, the ASRT initiated in 2001 an annual “snapshot” of entering-class enrollments in primary educational programs in radiography, radiation therapy, and nuclear medicine. The resulting estimates of total nationwide enrollments are gathered in the fall of each year and published on the ASRT Web site, [www.asrt.org](http://www.asrt.org), in January of that academic year [1-6]. Data from the six enrollment surveys conducted through fall of 2006 are combined in the present paper to provide evidence of trends in entering-class enrollments from 1999 – 2006, to demonstrate that these trends are predictive of the number of new certificants in these three disciplines two years hence, and to consider the implications of enrollment figures in the past two years for rates of entry into the profession in the near future.

## METHODS

### *Samples*

In the early fall of each year from 2001 through 2006 an attempt was made to contact (postally or by email) every director of an educational program in radiography, radiation therapy, or nuclear medicine recognized by the American Registry of Radiologic Technologists (ARRT). Contact information was obtained from the ARRT online directory of program directors (<http://www.arrt.org/web/content.jsp?iframe=yes&include=http://www.arrt.org/nd/listOfSchools.ndm/listSchools>) and/or from the then current edition of the American Medical Association’s *Health Professions Career and Education Directory*. (The ARRT list is more complete since it

includes both regionally accredited programs and those accredited by disciplinary review committees, while the *HPCED* includes only programs accredited by the Joint Review Committee on Education in Radiologic Technology or by the Joint Committee on Educational Programs in Nuclear Medicine Technology.) In early years program directors (PDs) were given the choice of completing and returning to ASRT a hardcopy version of the questionnaire or instead submitting their responses by email. In later years the choice was between postal return of a hardcopy version or completing the questionnaire online.

### **Questionnaires**

The hardcopy version of each year's questionnaire occupied the front and back of a single sheet of 8.5 x 11-inch paper. Each year's questionnaire asked for the program's discipline (radiography, radiation therapy, nuclear medicine, or "Other") and the number of students entering the program that fall and each of the two previous falls. (It was explained that "A student is considered to have entered a program once he or she is admitted to the program; this may be after a year or more of general course work.") Each director was also asked to indicate the program's attrition rate ("percentage of students that do not complete the program") over "the past few years"; whether the program was at full enrollment and, if not, how many additional students could be accommodated; whether there were plans to increase or decrease enrollments; and whether there was a possibility that the program would close in the next few years.

Beginning with the 2002 enrollment survey directors were also asked to indicate the educational levels of their programs, and the 2005 and 2006 surveys asked certificate programs to indicate whether they had an articulation agreement with a community college. The 2003 and later surveys also asked in what country the program is located. (The ARRT recognizes programs based in Canada and Australia.) Some years' surveys also asked directors' opinions on

various issues in R.T. education, the most common being questions about the barriers (if any) limiting their enrollments and about the factors (if any) that made it difficult to recruit new faculty for their programs.

Directors of programs that included more than one discipline and/or more than one educational level were asked to submit separate responses for each combination of discipline and educational level.

### ***Response Rates***

Overall response rates (the percentage of all programs for which information was provided) varied from 65% (2005) to 74% (2006).

## **Results**

### ***Entering-Class Enrollments***

Beginning in 2001 each year's survey of program directors asked for their current-year entering-class enrollment as well as for retrospective reports of their entering-class enrollments for the previous two years. We thus have two separate estimates (one current, one retrospective) of year 2000 and 2005 entering-class enrollments and three estimates (one current, two retrospective) of year 2001, 2002, 2003, and 2004 entering-class enrollments. None of the differences among the different mean-enrollment figures available for a given modality's enrollment in a given year were large or statistically significant,\* so all available estimates for a given modality in a given year were averaged together in the following table:

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\* Precise significance tests for these mostly within-program but partly between-program differences are impossible, since the anonymity of responses makes it impossible to match up Program X's current report in, say, 2002 with that

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Table 1 About Here.  
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Although the focus of this report is on total entering-class enrollments, the descriptive statistics on mean program enrollment allow us to separate the consistent increase (over this period) in number of programs in each discipline from the slower growth and (for radiation therapy in recent years) drops in average number of students per program.

Multiplying the mean number of students enrolled in a given modality's educational programs by the total number of such programs in the population (supplied by ARRT) yields the estimates of total entering-class enrollment in ARRT-recognized educational programs in that modality that year that are listed in the last two lines of each section of Table 1 and are graphed as part of Charts 1 through 3 (below).

However, the descriptive statistics in Table 1 demonstrate (via the high standard deviations, the substantially higher medians than means, and the fact that maximum entering-class enrollment is often ten or more times as high as mean enrollment) that the distribution of entering-class enrollment is heavily positively skewed, leading to considerable variability in estimated total workforce-wide enrollment. It is therefore important to determine how likely it is that the year-to-year increases or decreases in estimated total enrollment reported in Table 2 reflect the direction of change in the population of all programs. The best indication of magnitude and direction of change in enrollment over the past year is provided by examining only programs whose directors reported both their current-year entering-class enrollment and their previous

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same program's retrospective reports in 2003 and 2004 of its 2002 enrollment. It seems highly likely, however, that the year-to-year correlations are all positive, so independent-means ANOVA provides conservative tests of the statistical significance of these differences.



year's enrollment, since directors are likely to be highly aware of whether and by how much their enrollment has increased or decreased over the past year.

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Table 2 About Here.  
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As Table 2's *P* values and confidence intervals indicate, we can be confident that each of these three disciplines experienced increases in total national entering-class enrollment for every pair of years from 2001-2002 through 2004-2005. The one exception to this last statement is nuclear medicine's very small and statistically nonsignificant decrease from 2004 to 2005 – and, as the footnote to Table 2 indicates, that could well have been due to an unusual sample of nuclear medicine programs in 2005, since the 2006 sample's retrospective reports of 2004 and 2005 nuclear medicine enrollments indicated a substantial increase over that period.

Neither the slight increase for radiography nor the decrease for radiation therapy estimated total enrollment from 2005 to 2006 was statistically significant, while nuclear medicine's increase *was* statistically significant. It thus seems appropriate to conclude that radiography and radiation therapy enrollments have leveled off (to within the limits of detectability against the noisy background of sampling error), while nuclear medicine enrollments continue to rise.

The 2001 *Enrollment Snapshot* didn't ask the program director to specify the educational level of her program, but subsequent surveys did.

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Table 3 About Here.  
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The percent of first-year radiography students who are enrolled in baccalaureate programs has remained steady at between 3.4% and 4.1% from fall 2000 through fall 2006. For radiation therapy, this percentage has declined from 48% in fall 2000 to 41% in fall 2001 and 36.5% in fall 2002 to 30-33% from fall 2003 through fall 2006. The corresponding percentage of nuclear medicine students rose from 31% in fall 2000 to 35% in fall 2002, then declined monotonically to 29% in fall 2006.

### ***Attrition Rates***

Each year program directors responded to the following question:

**What was the attrition rate for your program over the past few years (percentage of entering students who did not complete the program)?**

Mean reported attrition rate was significantly higher for radiography programs (20.6%) than for radiation therapy programs (15.8%), which in turn reported a significantly higher mean attrition rate than nuclear medicine programs' 9.3%,  $F_{1,3441} = 24.72$  and  $24.25$ ,  $P < .001$  in each case.

This rank order (radiography attrition rate > radiation therapy > nuclear medicine) held for every reporting year.

### ***Relationship between Entering-Class Enrollments and First-time Certification***

#### ***Exams***

The following figures display together the trends in entering-class enrollments and in the number of individuals taking the certification exam for the first time in a given year [7]:

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Charts 1 - 3 About Here.  
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Even though entering-class enrollment figures are not available for academic years before fall 1999, the first-time examinee counts for earlier years are included so as to make it clear that radiography and radiation therapy examination totals declined steadily between 1995 and 1999, showing no substantial increase until 2001. The Enrollment Snapshot data, on the other hand, showed substantial increases in entering-class enrollments from 1999 to 2000 and every year thereafter through 2003, thereby foreshadowing the trends in number of newly minted radiographers and radiation therapists by about two years – the modal number of years between entering an educational program and completing it, thereby qualifying to take the certification exam. The percentage increases in entering-class enrollments from 2004 to 2006, however, were substantially lower, with estimated radiation therapy enrollment actually declining by 3.6% from 2004 to 2006. This suggests that we can expect to see a similar leveling off of number of entrants into these two disciplines over the next few years.

The trend in nuclear medicine technology (NMT) exams is more difficult to pin down because there are two certifying examinations in this discipline -- the ARRT examination and the NMTCB examination – and many R.T.s take both exams, so one cannot simply add the exam numbers for the two certifying bodies together to get the total number attempting certification in a given year. Moreover, the percentage of the graduating class who take only the ARRT exam appears to have declined over the period under examination. Finally, graduates of NMT educational programs are *not* the only individuals who qualify to take the NMTCB examination<sup>†</sup>, as reflected in the fact that the number of individuals who have been practicing in nuclear medicine technology for a given number of years often exceeds the total number who graduated from nuclear medicine technology programs that many years ago. Nonetheless it seems likely

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<sup>†</sup> Alternative qualifying criteria include nationally certified or licensed medical technologists, nurses, radiographers and holders of a bachelor's degree in the physical or biological sciences who have four years or more of clinical experience and who have taken formal coursework or continuing education on specified subject matter.

that the total number of individuals taking one or both NMT certification exams showed essentially the same trend as did radiation therapy and radiography exam numbers from 1995 to 2003, with entering-class enrollments foreshadowing the turnaround in the trend of exam numbers for this discipline, too. However, a one-year dip from 2004 to 2005 in NMT entering-class enrollments was followed by a double-digit increase from 2005 to 2006, so there is no indication that nuclear medicine technology enrollments have begun to decelerate, and continued increase in nuclear medicine technology first-time examination numbers can be expected over the next few years.

## Conclusions

The entering-class enrollment statistics provided by ASRT's annual *Enrollment Snapshots* provide an "early warning system" for anticipating trends in the number of entrants into radiography, radiation therapy, and nuclear medicine technology. These statistics are more useful for this purpose than those provided by the American Medical Association's annual *Health Professions Career and Education Directory* [7] because there is a two-year lag between collection of enrollment data and their publication in the *HPCED* and because the *HPCED* includes only programs that are accredited by the Joint Review Committee on Education in Radiologic Technology or by the Joint Review Committee on Educational Programs in Nuclear Medicine Technology, while ASRT's *Enrollment Snapshot* includes data for regionally accredited educational programs as well.

The deceleration of entering-class enrollments in radiography and radiation therapy programs from 2004 to 2006 indicates that we can expect to see a corresponding leveling off of entry rates in those two disciplines from 2006 to 2008. Nuclear medicine technology enrollments (and,

consequently, expected number of entrants into that discipline two years hence), on the other hand, continue to increase at substantial annual rates.

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**Table 1. Mean and Estimated Total Number of Students Entering Programs**

		1999	2000	2001	2002	2003	2004	2005	2006
		entering-	entering-	entering-	entering-	entering-	entering-	entering-	entering-
Program		class	class	class	class	class	class	class	class
Type <sup>a</sup>		enrollment	enrollment	enrollment	enrollment	enrollment	enrollment	enrollment	enrollment
Radiography	Mean	17.94	18.58	20.25	21.79	22.74	23.33	23.59	23.96
	N	438	854	1292	1307	1354	1434	978	522
	Std. Deviation	18.978	19.519	21.477	17.329	13.893	15.081	16.121	16.573
	Grouped Median	14.90	15.27	16.90	18.61	20.00	20.23	20.05	20.35
	Maximum	325	375	470	410	134	176	176	176
	# of programs in population	617	602	590	631	639	684	715	723
	Estimated total enrollment	11,069	11,185	11,948	13,729	14,531	15,960	16,868	17,323
Radiation Therapy	Mean	6.47	7.94	9.64	11.6149	12.6457	12.7868	12.0284	10.9744
	N	51	101	155	161	175	197	141	78
	Std. Deviation	3.506	5.486	6.361	9.54140	8.60968	9.13868	8.49028	9.56044
	Grouped Median	5.93	6.87	8.04	9.3913	11.0000	10.7619	10.1053	9.0000
	Maximum	17	31	50	88	65	72.	65	65
	# of programs in population	83	76	86	95	101	105	113	118
	Estimated total enrollment	537	603	829	1103	1277	1,343	1,359	1,295
Nuclear Medicine	Mean	9.13	9.34	11.62	12.7956	13.5487	14.2136	14.5161	15.5217
	N	61	113	172	181	195	220	155	92
	Std. Deviation	5.533	5.770	9.150	10.16023	10.81720	12.27444	12.54569	13.66111
	Grouped Median	8.00	8.12	8.74	9.8966	10.0000	10.9000	11.5652	11.7273
	Maximum	35	35	47	50	60	83	88	91
	# of programs in population	109 <sup>b</sup>	109 <sup>b</sup>	101	104	111	117	122	131
	Estimated total enrollment	995	1018	1174	1331	1504	1,663	1,771	2,033

<sup>a</sup> Considers only programs reporting enrollments for a single modality or separately for each of the types of program offered

<sup>b</sup> Estimated from regression equation relating # of programs some of whose students took the ARRT exam to total # of NMT programs, 2001-2004. Multiple R for this relationship = .940

Table 2. Statistical Significance of Changes in Total Enrollment<sup>a</sup>

Year	Estimated total entering-class enrollment as reported that year	Retrospective report of previous year's enrollment	Percent increase	Finite- Population- corrected <sup>b</sup>  P for change	FP-corrected <sup>b</sup> confidence interval around percent increase	
					Lower Bound	Upper Bound
<b>Radiography Programs</b>						
2006	17339.49	17241.81	0.57%	0.235	-0.37%	1.50%
2005 <sup>c</sup>	16438.73	15633	5.15%	< .001	4.06%	6.24%
2004	15737.97	14533.76	8.29%	< .001	7.12%	9.45%
2003	14968.79	13762.08	8.77%	<.001	7.49%	10.04%
2002	14731.89	12120.4067	21.55%	<.001	19.66%	23.43%
<b>Radiation Therapy Programs</b>						
2006	1287.13	1342.62	-4.13%	0.073	-8.66%	0.39%
2005 <sup>c</sup>	1382.48	1268.20	9.01%	< .001	4.76%	13.26%
2004	1513.45	1389.62	8.91%	0.003	3.30%	14.52%
2003	1161.5	946.48	22.72%	<.001	13.38%	32.05%
2002	1326.35	942.69	40.70%	< .001	26.24%	55.15%
<b>Nuclear Medicine Programs</b>						
2006	2042.74	1840.73	10.97%	< .001	8.24%	13.71%
2005 <sup>c</sup>	1671.78	1672.73	-0.06%	0.977*	-4.03%	3.91%
2004	1632.84	1444.63	13.03%	< .001	7.04%	19.01%
2003	1621.33	1377.57	17.69%	< .001	12.34%	23.05%
2002	1454.14	1094.77	32.83%	< .001	25.18%	40.48%

<sup>a</sup> Only programs reporting both current and previous-year enrollment included in analyses.

<sup>b</sup> FP-corrected = Standard error corrected for having sampled high percentage of population of programs.

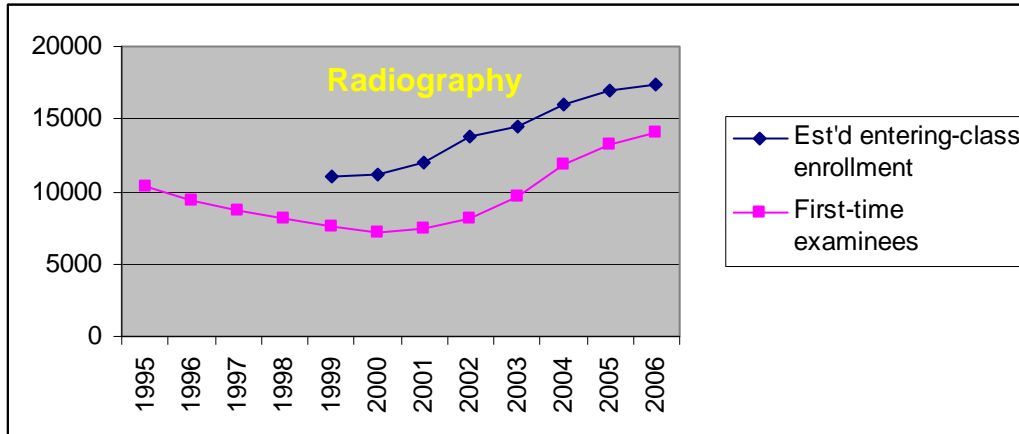
<sup>c</sup> Retrospective reports of 2004 and 2005 enrollments provided by Snapshot 2006 respondents yield estimated 2004 - 2005 percentage increases of 5.09% for radiography ( $P < .001$ ), 5.34% for radiation therapy ( $P = .002$ ) and 10.30% for nuclear medicine technology ( $P = .002$ ).



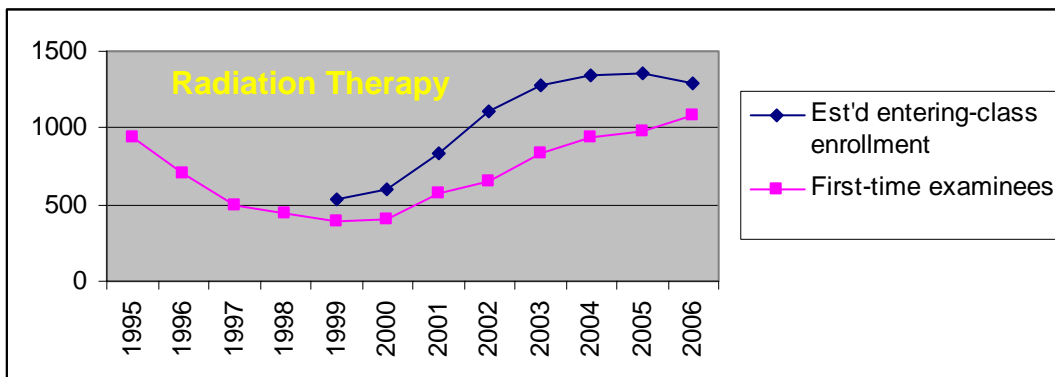
**Table 3. Percent of Students in Each Modality Entering at Each Educational Level**

Discipline	Educ'l level	Statistic	2000	2001	2002	2003	2004	2005	2006
			entering- -class enroll- ment	entering- class enroll- ment	entering- class enroll- ment	entering- class enroll- ment	entering- class enroll- ment	entering- class enroll- ment	entering- class enroll- ment
Radiography	Certificate	% of radiography entering enrollment	21.2%	21.4%	21.7%	21.2%	22.1%	21.9%	22.8%
		Sum	1173	2832	4800	5436	6439	4760	2672.5
	Associate Degree	% of radiography entering enrollment	75.1%	73.6%	73.8%	73.3%	72.8%	72.2%	71.6%
		Sum	4166	9751	16318	18795	21155	15663.5	8381.5
	Bachelor's Degree	% of radiography entering enrollment	3.4%	3.6%	3.5%	4.0%	3.7%	4.1%	3.7%
		Sum	186	471	779	1028	1085	894	438
	Other	% of radiography entering enrollment	0.4%	1.4%	1.0%	1.6%	1.4%	1.7%	1.8%
	Sum	21	189	215	399	394	372	209	
Radiation Therapy (RTT)	Certificate	% of RTT entering enrollment	19.3%	30.3%	31.0%	25.0%	25.4%	23.8%	26.6%
		Sum	50	227	420	442	498	338	178
	Associate Degree	% of RTT entering enrollment	28.6%	25.5%	30.0%	37.5%	36.3%	40.0%	37.1%
		Sum	74	191	407	663	713	568	248
	Bachelor's Degree	% of RTT entering enrollment	48.3%	40.8%	36.5%	32.8%	33.2%	30.3%	32.8%
		Sum	125	305	495	580	652	430	219
	Other	% of RTT entering enrollment	3.9%	3.3%	2.4%	4.7%	5.0%	5.8%	3.4%
	Sum	10	25	33	84	99	83	23	
Nuclear Medicine Technology (NMT)	Certificate	% of NMT entering enrollment	34.5%	29.3%	32.2%	32.7%	34.3%	29.3%	27.8%
		Sum	81	223	447	552	698	459	279
Nuclear Medicine Technology (NMT)	Associate Degree	% of NMT entering enrollment	34.9%	36.2%	30.7%	33.0%	33.1%	39.1%	40.8%
		Sum	82	275	426	557	674	613	409
	Bachelor's Degree	% of NMT entering enrollment	30.6%	31.1%	35.2%	33.1%	31.4%	30.2%	29.1%
		Sum	72	236	489	559	639	473	292
	Other	% of NMT entering enrollment	0.0%	3.4%	1.9%	1.2%	1.1%	1.5%	2.3%
	Sum		26	26	20	23	23	23	

**Chart 1. (Radiography) Entering-Class Enrollment and First-Time Examinees**



**Chart 2. (Radiation Therapy) Entering-Class Enrollment and First-Time Examinees**



**Chart 3. (Nuclear Medicine) Entering-Class Enrollment and First-Time Examinees**

