Nuclear Security Education Training Workshop
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Nuclear Nonproliferation International Safeguards Scientist and Engineer Workforce at U.S. Department of Energy National Laboratories

Prepared for:
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NA-243, International Regimes & Agreements

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Purpose

•NNSA's *Next Generation Safeguards Initiative* (NGSI) includes, as one of its five pillars, "… to recruit, train, and retain the next generation of international safeguards professionals and encourage U.S. experts to seek employment at the IAEA.

•NA-24 commissioned ORISE in 2009 to conduct a human capital requirements study to help NGSI:

oDevelop a stronger empirical data set on size, education/disciplinary base, skill sets and core capabilities in workforce at nine national laboratories supporting NA-24 sponsored international safeguards work.

oAssess impact of demographic trends and expected attrition rates that are expected to impact this workforce and its capacity to support international safeguards and NA-24 NGSI programmatic needs.

oInform NA-24 prioritization of its NGSI Human Capital Development program.

Approach

•ORISE, in cooperation with NA-243 designated contacts at the nine DOE laboratories, conducted a survey of 604 scientists and engineers involved during FY2009 in nuclear nonproliferation international safeguards work funded by four NNSA budget and reporting (B&R) codes.

•The survey respondents were asked to self-identify if they were nuclear nonproliferation international safeguards specialists.

oThose who responded in the affirmative are designated as "international safeguards specialists" in the study.

oThose who did not are designated as "supporting scientists and engineers."

Survey Results

Number of International Safeguards Specialists versus Supporting Scientists and Engineers

Figure P1. DOE Laboratory Scientists and Engineers Involved in NA-24 Funded Nuclear Nonproliferation International Safeguards Projects, FY2009
(weighted numbers)

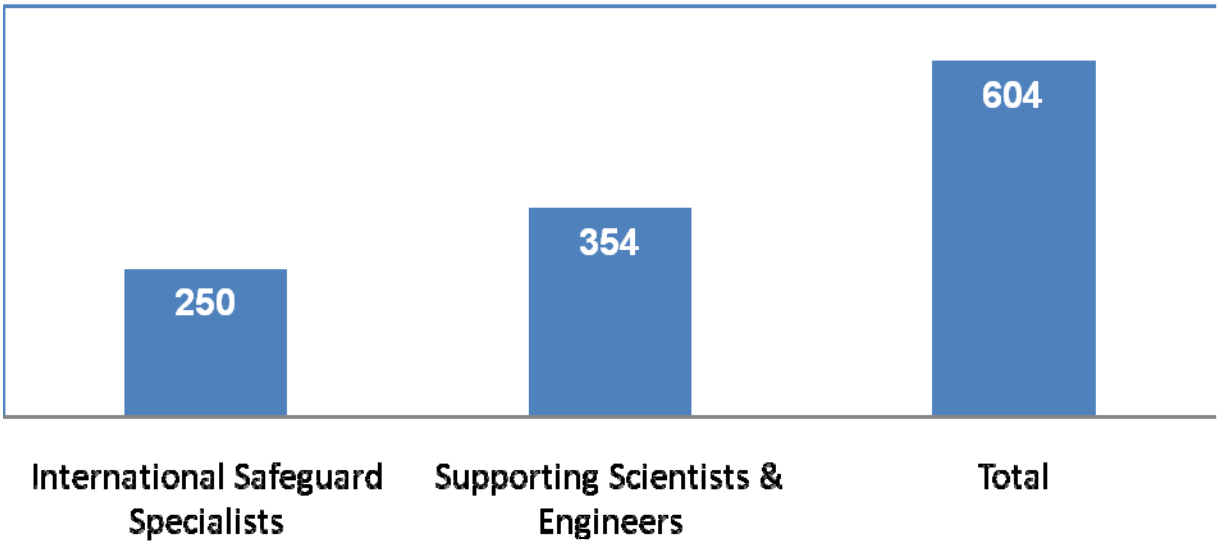
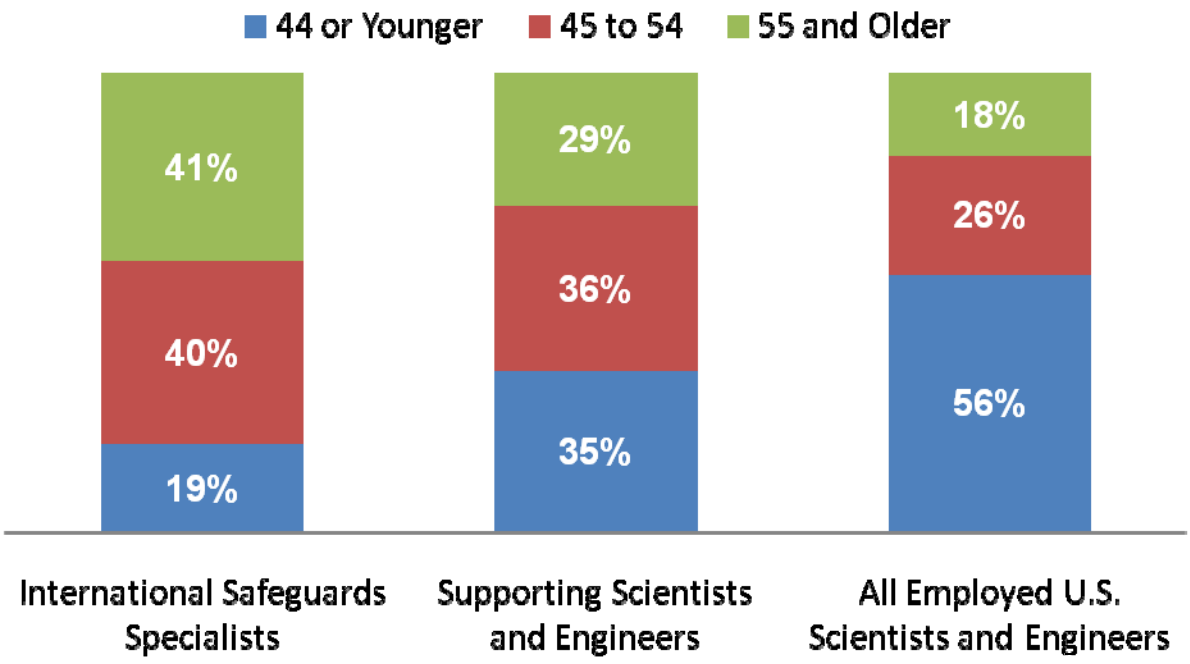


Figure P2. Age Distribution Comparisons
Nuclear Nonproliferation S&Es versus All U.S. Employed S&Es



Scientist and Engineer Occupations

Occupations	International Safeguards Specialists	Supporting Scientists & Engineers
Engineer, Chemical	3%	7%
Engineer, Electrical	4%	9%
Engineer, Mechanical	4%	6%
Engineer, Nuclear	22%	16%
Engineer, System	3%	1%
Engineer, Other	5%	6%
Chemist	14%	19%
Life & Environmental Scientist	2%	4%
Physicist	16%	6%
Social Scientist	9%	4%
Other Scientist	6%	7%
IT Specialist	5%	8%
Other	7%	7%

- In addition, the scientists and engineers in all of these occupations indicated a wide range of subfields and specialties.

Highest Degree Held	International Safeguards Specialists	Supporting Scientists & Engineers	All U.S. S&Es in R&D Work
Ph.D. or Other Doctorate	48%	38%	12%
Master's Degree	33%	28%	35%
Bachelor's Degree	16%	30%	53%
Other or Not Reported	3%	4%	0%
	100%	100%	100%

- 81% of the international safeguards specialists and 66% of the supporting scientists and engineers have a master's or doctorate degree.

Hours Worked, During FY2009, on International Safeguards Projects

	160 hrs or less	160 to 320 hrs	320 to 600 hrs	More than 600 hrs
IS Specialists	48%	15%	13%	24%
Supporting S&Es	77%	10%	7%	6%

- The international safeguards specialists working more than 600 hours (24%, or 60 of the 250) are, as a group, somewhat older than all international safeguards specialists.

  - Approximately one-half are 55 years old or older (versus 41% of all IS specialists).

  - Less than 15% are 34 years old or younger (versus 19% of all IS specialists).

Other Work Experience for International Safeguards Specialists (IS)

	Weighted Number	Percent of All IS Specialists
IAEA Work Experience	109	44%
Specific Country (non-U.S.) Work Experience	42	17%

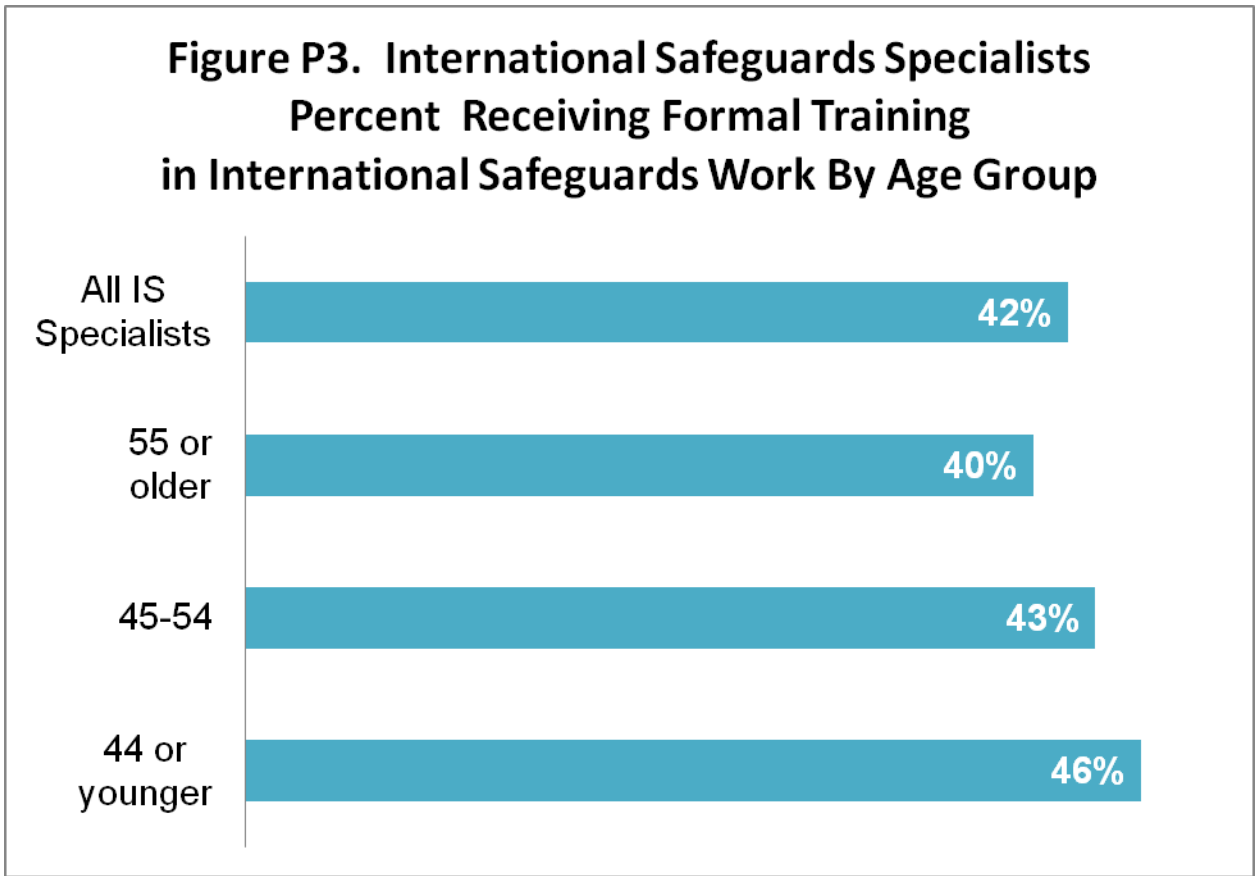
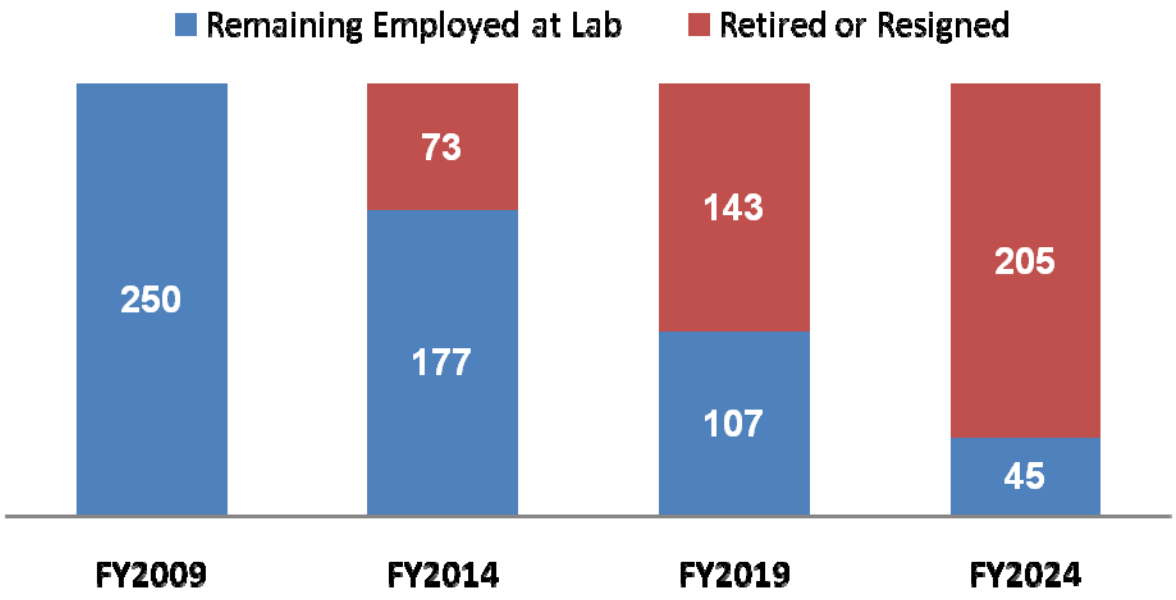


Figure P3. International Safeguards Specialists
Percent Receiving Formal Training
in International Safeguards Work By Age Group
All IS Specialists
42%
55 or older
40%
45-54
43%
44 or younger
46%

Assessment Results

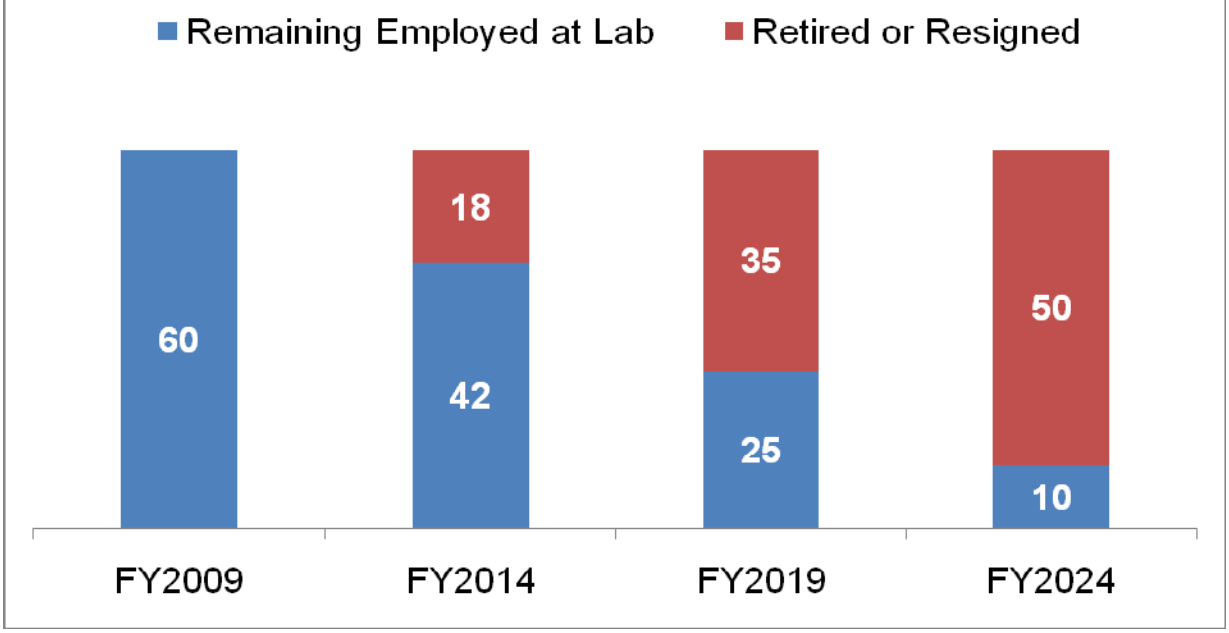
Figure P4. Estimated Future Attrition Losses of FY09 DOE Lab International Safeguards Specialists Due to Retirements and Resignations



- By FY2024, an estimated 205 (82%) of the international safeguards specialists will leave laboratory employment.

- Approximately 25% to 30% of FY2009 staff will leave during each five-year period.

Figure P5. Estimated Future Attrition Losses of DOE Lab International Safeguards Specialists Who Worked More than 600 Hours on International Safeguards Projects in FY2009



- The estimated attrition rates of international safeguards specialists working more than 600 hours are basically the same as for all international safeguards specialists.
  - By FY2024, 83% of those working 600 or more hours will leave laboratory employment.
  - During each five year period, 25% to 30% will leave laboratory employment.

Laboratory International Safeguards Specialists
Attrition by Aggregate Occupation
FY2009 – FY2024

Aggregate Occupation	FY2009 Number	Estimated Attrition by FY2024
Chemist	36	86%
Engineer, Nuclear	55	80%
Engineer, Other	47	83%
IT Specialist	13	85%
Physicist	40	83%
Social Scientist	23	78%
Other Scientist	20	80%
Other	16	81%

- The estimated attrition rates over the next 15 years for each the aggregate science and engineer occupations are very similar to that for all international safeguards specialists.

Core Capabilities Required in Nuclear Nonproliferation International Safeguards Work

- A list of 23 core capabilities was developed by NA-24 staff with input and review from laboratory subject-matter-experts.

- Based on the information provided by the respondents, subject-matter-experts identified core capabilities for each of the international safeguards specialists.

- Over 80% of the international safeguards specialists have multiple core capabilities (up to 8) with an arithmetic average of 2.6 each.

- The 18 core capabilities that have 4 or more international safeguards specialists include a range of scientist and engineer occupations.

  - Each of the 18 include at least 3 of the aggregate scientist and engineer occupations.
  - Ten (10) of the 18 include all 8 of the aggregate scientist and engineer occupations.
    - Physicists are involved in 19 core capabilities
    - Nuclear Engineers are involved in 15 core capabilities
    - Chemists are involved in 12 core capabilities
    - Social Scientists are involved in 11 core capabilities

- The estimated attrition rates over 15 years (by FY2024) for each of the 18 core capabilities with 4 or more international safeguards specialists range from 75% to 85%, similar to the estimated attrition rate for all international safeguards specialists.

Examples: Estimated Attrition of FY2009 S&Es by Five-Year Periods

	FY09-FY14	FY14-FY19	FY19-FY24
All I.S. Specialists	29%	28%	25%

Examples: Estimated Attrition by Occupation

Occupation	FY09-FY14	FY14-FY19	FY19-FY24
Chemists	31%	31%	25%
Nuclear Engineers	29%	27%	24%
Physicists	30%	28%	25%
Social Scientists	30%	26%	22%

Examples: Estimated Attrition by Core Capability

Core Capability	FY09-FY14	FY14-FY19	FY19-FY24
Nuclear Materials Accounting	27%	27%	27%
Safeguards Systems	31%	28%	23%
Nonproliferation/Safeguards Policy Analysis	29%	26%	24%

Examples: Estimated Attrition by Work Experience

Work Experience Category	FY09-FY14	FY14-FY19	FY19-FY24
IAEA	28%	28%	26%
Specific Country (non-U.S.)	28%	30%	26%

Summary of Estimated Attrition During Each Five-Year Period

- During each of the five year periods the estimated attrition for all of the FY2009 DOE laboratory international safeguards specialists was approximately 25% to 30%.

- The same pattern of approximately 25% to 30% estimated attrition during each five year period occurs for each of the core capabilities with 4 or more international safeguards specialists.

  - Thus, in ten years (by FY2019), an estimated 50% to 60% of the FY2009 international safeguards specialists in the various core capabilities will have left laboratory employment.

  - For example, the estimated losses in ten years are 54% of the scientists and engineers in nuclear materials accounting and 59% of those in safeguards systems.

- Also, the same pattern of approximately 25% to 30% estimated attrition during each five year period occurs for each of the international safeguards specialists' occupations and work experience groups examined.

International Safeguards Specialists Replacement Needs

- Based on age and estimated attrition rates, the basic replacement needs to maintain FY2009 DOE laboratory staffing levels are:
  - In round numbers, an estimated 80% of the international safeguards staff at DOE laboratories in FY2009 will have to be replaced over the next fifteen years (FY2009 – FY2024).
  - In each five-year period, in round numbers, an estimated 25 to 30% of the FY2009 staff will have to be replaced.

- Moreover, the replacements needs for each scientist and engineer occupation, core capability, and work experience category are:
  - Approximately 80% over next fifteen years
  - Generally, 25% to 30% during each five-year period

- Thus, the replacements during each time period will require scientists and engineers:
  - From many occupations/disciplines
  - Most with graduate degrees and a wide range of subfields and narrow specialties
  - Who will have to be trained and provided work experience in the broad range of international safeguards core capabilities as well as IAEA experience, and, as needed, specific country experience

Training "Supporting Scientists and Engineers" to Become International Safeguards Specialists

- The "supporting scientists and engineers" involved in the international safeguards projects are an obvious source of future international safeguards specialists. These staff have :
  - International safeguards work experience
  - Represent, in general, the same scientist and engineer occupations as the international safeguards specialists
  - Include a relatively high percentage with graduate degrees

- However, while the supporting scientists and engineers are somewhat younger than the international safeguards specialists, they still are a relatively older group of scientists and engineers, and a large majority will have to be replaced over the next 15 years.
  - Over 70% of the supporting scientists and engineers are estimated to leave laboratory employment by FY2024.
  - Among the supporting scientists and engineers, 54% (190) indicated occupations or work specialties in nuclear safeguards and security or other nuclear-related activities. Over 80% of this group are estimated to leave laboratory employment by FY2024.

Figure P6. Estimated Future Attrition of FY2009 Lab Supporting Scientist and Engineer Staff Indicating Nuclear-Specific Work Experience
N = 190