Oregon State University

Radiological Health Physics

10-Year Graduate Program Review

April 2016

Review Team:

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Contents

1.0 Overall Recommendations

Maintain/Expand the Program in Radiological Health Physics

2.0 Summary of Recommendations

A programmatic review team was assembled in accordance with Oregon State University (OSU) policy to review the graduate program in Radiological Health Physics. The team consisted of three members, one from academia (Interim Dean of the College of Science and Engineering Idaho State University), and another from industry (The United States Nuclear Regulatory Commission) and a member internal to OSU. The team met with the Program Director, Dr. David Hamby, the Executive Associate Dean of the College of Engineering, Dr. Jim Lundy, and Program Faculty including Drs. Andy Klein, Wade Marcum, Haori Young, Dr. Alena Paulenova and Todd Palmer. The team also met with a group of students, The School Head Dr. Kathryn Higley and her office staff. The Team was provided a self-study prior to the visit, and given the opportunity to tour laboratory, teaching, and office facilities.

The team observed a high quality program, nationally important to the profession that is active in producing high quality readily employable graduates. Student numbers are characteristically small in the Radiological Health Physics Program and oscillate in a fashion anticipated from a Poisson distribution. The faculty was reported as being among the most productive in obtaining outside funding for research in the university. Faculty of the program are highly regarded in the discipline of Health Physics and the program has an excellent national and international reputation. Facilities, while starting to show their age, are in relatively good condition, clean, organized, and functional. The program could benefit from increased space allocation and it appears that this is in the works for the school. The condition of capital equipment used in teaching and research was deemed to be entirely appropriate and consistent with that found in peer programs. The program curriculum is thought to be well organized and appropriate for both emphasizing specialty areas in radioecology and instrumentation while providing the broad scope generalized education necessary to assure student employment viability in a diverse job market. Students are excited about the program and its opportunities for research and post-graduation employment. There is an evident close bond among faculty and students that implies good mentoring and nurturing of students by faculty is common.

Although faculty believe themselves as a competitive disadvantage because of the perceived small graduate stipends, this concern was not shared by students, nor did the magnitude seem out-of-line with discipline norms. The quality of students is good and their diversity reflects the demographics of applications. The program expressed a perception that inclusion of all student cohorts was unsatisfactory and that they are actively seeking institutional solutions to improve this condition. The committee suggests that the program needs to take full advantage of institutional resources available to enhance diversity and inclusion, which they may have only recently been made aware.

Faculty workloads are relatively high for the university and are at a level to restrict program growth. They limit faculty opportunity in establishing competitive research support, in sabbatical opportunities (simply because there is no one available to take their place) and these small numbers cap the graduate student mentoring possible. Questions exist to the economics of how growth might most efficiently be achieved. Perhaps a traditional model of simply increasing tenured-track faculty-lines may not provide sufficient return on investment. One proposed alternate is to diversify employment categories to include research faculty and teaching faculty. Teaching faculty would provide lower division teaching

support thus freeing tenured faculty time, and self-supported research faculty could serve to enhance graduate student mentoring and support in research. Providing this may speculatively serve to enhance productivity in multiplicative ways rather than the additive way expected from simply adding faculty using the traditional tenured track model.

A minor controversy exist within the school regarding electronic distance learning programs, the quality of students engaged in this program, the development of a bimodal population with respect to student quality, and work load equity associated with the distance learning programs. The size of the distance learning program has been relatively large and it appears to be economically important to the university and this fiscally helps justify the Radiological Health Physics Program. While it is hard to understand the implications of preliminary enrollment data, it may be that this distance learning program is starting to show declines perhaps associated with satiation of demand – but this is speculative. It is clear that the school must grapple with this question and in the best spirit of self-determination evaluate what they want to do with this distance learning program. The vision is that the program may start to decline in size and it may be moving to a scenario in which non-thesis Master of Health Physics students can be identified as an inferior sub-population. The path forward for the school is to evaluate the importance of the distance learning program to the economics, mission, and intention of the endeavor. This evaluation may lead into either accepting - as intentional- a bimodal population of students in the alumni pool, a cessation of the distance learning program, or a review of programmatic entrance thresholds and performance requirements. The review team did not discuss the best path forward and is, therefore, not in a position to make recommendations on the most productive scenario for the future. Eventually the school will need to determine what product they want to produce - following this up with definitive answers on how OSU Radiological Health Physics should procced (or not) with their distance learning program.

The OSU Radiological Health Physics Graduate program is an excellent program that should be maintained and may be expanded if economically viable models can be developed that assure long term sustainability.

3.0 Detailed Findings

3.1 Mission of the program as it relates to college and graduate school

The mission of the program is judged to be in alignment with those of the university, college, and graduate school. The Mission of the institution and its various divisions was provided in the Programmatic Self-Study and is provided below for review purposes:

The mission of the School of NSE was developed to support the missions of the College of Engineering, the Graduate School and the University. With this in mind, we continue to build our programs with the following unique characteristics:

1. OSU is one of only 5 universities in the US with an accredited, stand-alone School of Nuclear Science and Engineering, and a research reactor with a power level greater than 1 MWt;
2. Our health physics program is considered to be one of the best programs in the country;
3. Our nuclear engineering program is in the top 10 in the country;
4. Our attitude is that a cutting edge research focus is important in both our graduate and undergraduate programs;
5. Nuclear energy is paramount to our nation's electrical energy infrastructure; and
6. Work force needs in the nuclear fields are significant now and for the foreseeable future.

In an effort to provide students with a research-enriched educational experience, we focus our efforts and resources on our most reputable areas: experimental and theoretical activities in thermal hydraulics and reactor safety; scientific computing, computational methods development, and applications; and experimental & theoretical activities in health physics, including risk assessment, dosimetry, and instrumentation development.

The missions of the University, the Graduate School, the College, and the School of NSE are provided below.

University Mission: As a land grant institution committed to teaching, research and outreach and engagement, Oregon State University promotes economic, social, cultural and environmental progress for the people of Oregon, the nation and the world.

Graduate School Mission: The Graduate School contributes to OSU's goal of achieving top ten land grant status by providing leadership in all aspects of graduate education, through advocacy for the critical importance of the graduate enterprise to the university's mission, and by providing core centralized services to the graduate community. In partnership with the graduate faculty, the Graduate School plays a leadership and advocacy role to ensure that OSU attracts the best graduate students and delivers a compelling and high-quality graduate experience that prepares them to create new ideas and knowledge, to educate others, to make positive impacts on society, and to lead innovation.

College of Engineering Mission: To transform lives and enhance society through impactful education and research.

School of NSE Mission: The School of Nuclear Science and Engineering provides world-class education so students can become industry, academic, and policy leaders driving the future of nuclear science worldwide.

To ensure the mission success, the School of NSE has five major objectives:

1. To produce graduates with a high level of competency in the Nuclear Engineering and Health Physics core curricula;
2. To produce graduates with a high level of competency in engineering and science;
3. To produce graduates that can work effectively in both individual and team environments;
4. To produce graduates with effective communication skills; and
5. To produce graduates with a high regard for their profession and their responsibility to life-long learning.

3.2 Recruitment and Enrollment trends of students

The Radiological Health Physics Program is a small program but consistent with national norms for the discipline. The Oscillations observed in enrollment reflect normal trends in Poisson Distributions anticipated for programs in the size range of the Radiological Health Physics program.

3.3 Admissions Selectivity and other Indications of Selecting High Quality and Diverse Students

Recruitment and enrollment appears stable with oscillations considered to be normal for small programs. The program selects higher quality students and it appears that the diversity of the students

are consistent with the diversity of applications. Nevertheless, it is encouraged that continued ongoing diligent efforts assuring that high quality applicants with appropriate diversity are recruited. The program faculty in truthful self-evaluation identified inclusion as an area they did not believe they were accomplishing all that could be done. It is clear that the faculty within the program hold inclusion as an esteemed value. The question of inclusion is non-trivial cultural issue reflecting an amorphous set of behaviors, attitudes, practices, and actions that do not lend themselves to engineering control. Hence, this is a difficult item to asses with few tangible metrics to monitor to determine progress. There are no "silver bullets" that can be identified to institutionally assure inclusion.

A minor controversy was identified to the team with regard to distance learning admissions, recruitment, and diversity. The Radiological Health Physics Program at OSU has been able to productively develop a historically-substantial distance learning program. There are issues with workload equity associated with this effort. The existence of this program has clearly buoyed program numbers and enhanced the economic competitiveness of the school. However, some faculty expressed concerns about the quality of the non-thesis program participants relative to the resident thesis required masters level graduate students. The distance learning program numbers are slightly misleading as only considering head count inflates the initial impression of full time equivalency numbers. Moreover early numbers for next fall speculatively imply that distance learning program enrollment may be starting to decline which might be indicating satiation of a small market, these early trends are interesting but hard to understand without more data. The vision is that the program may start to decline in size and it may be moving to a scenario in which non-thesis Master of Health Physics students can be identified as an inferior sub-population. The path forward for the school is to evaluate the importance of the distance learning program to the economics, mission, and intention of the endeavor. This evaluation may lead into either accepting - as intentional- a bimodal population of students in the alumni pool, a cessation of the distance learning program, or a review of programmatic entrance thresholds and performance requirements. The review team did not discuss the best path forward and is, therefore, not in a position to make recommendations on the most productive scenario for the future. Eventually the school will need to grapple with this issue and determine what product they want to produce - following this up with definitive answers on how OSU Radiological Health Physics should procced (or not) with their distance learning program.

3.4 Level of Financial Support of Students, and as Compared to Peers

The faculty reported their perception that that the level of student financial support was insufficient to effectively compete for the best students. Health Physics and Nuclear Engineering faculty in the United States seem to have a sincere aspiration to mentor and nurture their students. This tends to exceed a level of support that exceeds that which is normally observed in other disciplines. It speaks well to the intentions of the faculty but must be part of the context of this discussion. Perhaps this arises from the universal circumstance of small programs in which faculty characteristically work closely with their students. The perspective of faculty was evaluated by considering the OSU teaching assistantships package value compared to other institutions. This seemed to be typical considering the cost of living and other parameters unique to Corvallis. While the magnitude of student support does not provide an unquestionable competitive edge in recruitment, it is not a disadvantage. Students were specifically asked about the level of funding they received and if it was adequate to meet their needs. The students had no complaints and indicated a kind of sanguine satisfaction. It is suggested that if resources are necessary to enhance the competitive edge of the program, that flexibility been given to the magnitude of externally funded graduate research assistantships. The risk of this approach is a differential salary

base within the graduate school pool, alas, in a capitalistic system not all things are intended to be equal.

3.5 Curriculum Strength

The Oregon State University Radiological Health Physics Program is among the best of its kind in the United States and for the matter globally. It represents a component of a strategically important national need uniquely offering graduate students a means to become experts in radioecology and radiation detection. The curriculum is of appropriate rigor and provides sufficient generalization to prepare students well for a great many sub-specialties in Health Physics. There are no issues associated with the quality and rigor of the curriculum. Faculty of the program did indicate a desire to engage in a periodic evaluation of the curriculum. This of course is encouraged and should be an open process involving members of the Program's industrial advisory committee. Such actions need to occur periodically and are a normal part of continuous improvement leading to a modernized set of educational objectives, enhanced streamlining , efficiency, and economizing of faculty time commitments in many cases particularly when similar courses can be joined together to create an improved version of the effort.

3.6 Quality of Personnel and Adequacy to Achieve Mission and Goals

The OSU Radiological health Physics Program enjoys the benefit of very high quality faculty who have national reputations for the rigor and importance of their research programs. There is evidence that the faculty are actively engaged in their professional societies, have strong publication records and provide rigorous teaching experiences to the classroom.

While the quality of personnel is simply not an issue the number of personnel available to complete the mission is a curious challenge. The current combination of faculty work load and productivity leads to a dilemma. While the number of faculty is capable of sustaining the program at its present size, it is too small to expand the program. The team is left in a quandary: could the program generate sufficient revenue to justify an additional tenured faculty member given the national landscape for this discipline? This frankly is not clear. The team suggest more creative approaches to staffing issues which "box" the program in with respect to growth. Perhaps instead of adding tenured faculty with the dilution of their efforts into teaching, research and service it may be better to consider bringing in research faculty who are focused on generating self-support and support of graduate students fiscally and in terms of mentoring, and also teaching faculty who have the mission of exclusively supporting lower division undergraduate courses which impact disproportionately tenured faculty workloads. This division of labor may be a more economical and fruitful way to enhance productivity by specializing. It is surprising that the use of adjunct faculty is not employed. It was expressed that they were simply not available in the region. However, it is possible to use talented individuals not located in Oregon to teach the online courses. Perhaps shared courses among other Health Physics Programs existing at other universities could be part of the workload problem solution (which incidentally is not unique to OSU). The complexity of accomplishing this among diverse state institutions - given the experience with a joint Medical Physics program with OHSU - may make this suggestion simply impractical.

3.7 Level and Adequacy of Infrastructure

A brief tour of laboratory facilities used in teaching and research, faculty offices spaces, and graduate student office space provided evidence of adequate capital infrastructure relative to the mission of the Radiological Health Physics program. While the facilities are older, they were well maintained, clean and organized. Graduate student areas might be classified by some to be perhaps cramped, however, when the team met with OSU administration, it was proactively shared that the School would be expanding into additional facilities in the immediate future.

3.8 Quality of Organizational Support

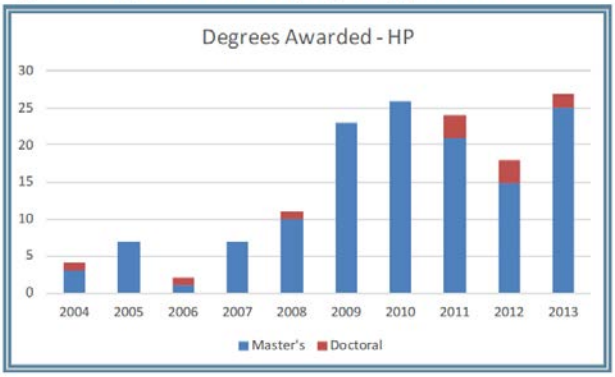
The quality of organizational Support appeared to be appropriate. No issues or short-falls were reported to the team regarding any perceived problems in this area.

4.0 Productivity

4.1 Four and Eight year graduation Rates for Master's and Doctoral Students

The School has averaged a total of about 200 students over the past 10 years (currently sitting at ~350), about 30% of whom are graduate students at various stages in their work. The graduate student population is generally 25% female and about 75% are fully funded on fellowships, scholarships, or research/teaching assistantships. The majority of the students join the American Nuclear Society (ANS) and/or the Health Physics Society (HPS) at the national, regional, and local levels. The School's graduates hold various research, management, and professional positions at national laboratories, nuclear power facilities, universities, federal agencies, research facilities, and a number of private companies.
The following information from the Program self-study summarizes graduation rates:

Figure 47. Degrees Awarded by Degree Type and Year



The data of Figure 47 show numbers of degrees awarded at the Master's and PhD levels. We see a large increase since 2008 of Master's degrees award in Health Physics; a large number of those are non-thesis MHP degrees, thus not contributing to research growth in the field. Degrees to new PhDs take on a larger fraction of the total in more recent years, consistent with our (the OSU) plan.

4.2 Publications and Evidence of Other Scholarly Work by Students and Faculty

OSU programmatic productivity is not an issue. The data justify this conclusion has been imported directly from the Programmatic Self-study reproduced in part below. Graduate faculty generated 8

patents over the evaluation period, half of which are held with graduate students as co-applicants. Publication/presentation productivity has increased by about a factor of three over the evaluation period. These facts were reported in the Self-study and were summarized in Figures 40 and 41 reproduced below. Figures 42 and 43 provide further insight into the unit's productivity.

Figure 40. Faculty Publications by Year

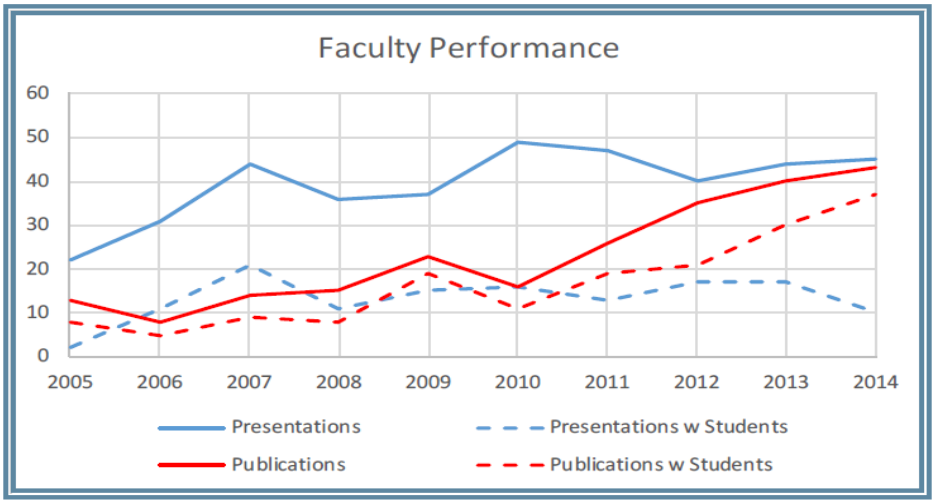
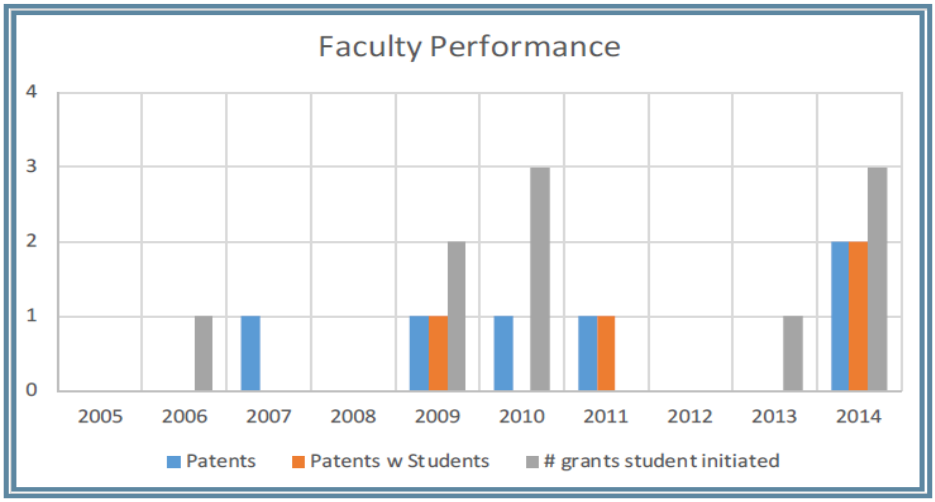
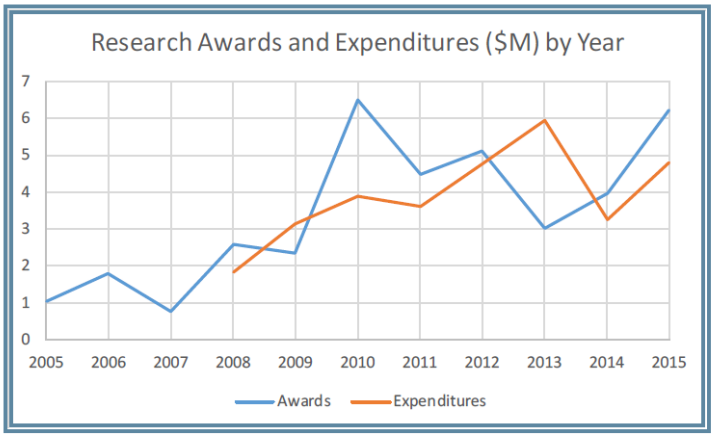


Figure 41. Patents Awarded to Faculty by Year



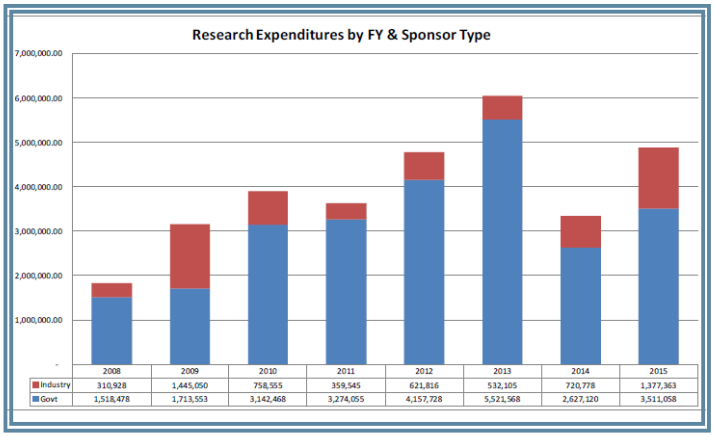
External research funding awarded to the faculty, and expended, has doubled twice over the past decade (Figure 42). Note that total awards in 2010 and 2015 exceeded $6M.

Figure 42. Research Awards and Expenditures by Year



The data of Figure 43 show research expenditures for all faculty as a function of funding source, either industry or government. The vast majority of research grants awarded to the School originate from government offerings. Over the eight-year period from 2008 to 2015, only about 19% of research funding is from industry.

Figure 43. Research Expenditures by Sponsor Type



4.3 Student Satisfaction with Their Education and Mentoring Experiences

The OSU self-study explicitly again addressed the issue of student satisfaction with education and mentoring experiences. The following information copied directly from the self-study justifies the Review Team's general opinion that student satisfaction is not an issue. This conclusion was also supported directly by discussions with students who were interviewed by members of the Review Team. We see from the OSU Radiological Health Physics Self-Study the following:

> Generally, satisfaction with the graduate program is high. There are a few instances where improvements could be made, and others that are beyond the control of the faculty. The mentoring of graduate students is one of the more important roles of university faculty and improvements in this regard appear warranted. We are always striving for improvements to our financial support system, but many of those funding opportunities are based on the flow of research dollars, primarily from government agencies. Faculty are overburdened and satisfaction with performance of the student's Major Professor is borne out by this fact; timely return of work and assistance on exam preparation appear to be desired by the students.

Results of the student exit survey are provided ……. We have listed a few of the more notable results below. The points are listed in the negative simply to give more attention to those responses of "not satisfied" or "not in agreement".

1. Major Professor mentoring: 15% not satisfied
2. Overall quality of graduate instruction: 4% not satisfied
3. Level of financial support: 17% not satisfied
4. Major Professor:
   a. knowledgeable about formal degree requirements: 6% do not agree
   b. returned work in timely manner: 8% do not agree
   c. explained survival strategies: 25% do not agree
   d. encourage my own research ideas: 2% do not agree
   e. help prepare for final oral exam: 22% do not agree

These data support a statement that in general students are satisfied with the program.

4.4 Viability of Scholarly Community within Which Students Can Interact

Yet once again the Radiological Health Physics Program's Self-study explicitly responded to the question of "Viability of Scholarly Community within which Students Can Interact" providing a direct comment to this item and by also providing data on the opinions of students generated by exit interviews.

> Every graduate student should have the opportunity to, and at times be forced to, present their research to a critical audience. We can improve our quality by providing more occasions on which students are in front of a group of peers, defending their work.
> Did you present your work in a departmental seminar? 67% No
> Did you attend professional meetings/conferences? 43% No
>
> a. of those attending, 41% reported not presenting scholarly work
> b. of those attending, 37% did not receive departmental funding
>
> Did you publish at least one scholarly article? 59% No

5.0 Outcomes and Impacts

5.1 Equity, Inclusion and Diversity Activities

The program acknowledges that they have reservations about their own performance with respect to Equity, Inclusion, and Diversity Activities. The statement in their self-study referring to this item is as follows:

> The faculty of the School of Nuclear Science and Engineering strive to offer a welcoming place that supports and encourages students from all walks of life. Our faculty roster, even though our numbers are small, shows gender and ethnic diversity and our student body is becoming more inclusive, with representation from the US, Guatemala, China, Iran, Saudi Arabia, Nigeria, Korea, and United Arab Emirates.
>
> The School hosts three major events during the school year: (1) a Fall BBQ for grad students and alumni; (2) a winter banquet; and (3) a Spring BBQ. As far as trying to include those students on the 'fringe', we don't really do anything in that regard. All materials and announcements from the Office of Equity and Inclusion are funneled down to the students through our bulletin boards, social channels, etc……. …….Specific data are lacking with regard to prejudicial targeting/witnessing, but the fact remains that prejudice does exist on campus and we as a School should do all we can to minimize that occurrence.

The Data supporting this assessment while limited is provided below. This was provided in the programmatic self-study which references information from student exit interviews.

> Answered YES to being the target of (or witnessing) –
> a. gender prejudice: 4% (6%)
> b. sexual orientation prejudice: 4% (6%)
> c. disability prejudice: 2% (2%)
> d. religious prejudice: 0% (4%)

The Program clearly values diversity, inclusion and equity. The committee suggests that the program needs to take full advantage of institutional resources available to enhance diversity and inclusion, which they man have only recently been made aware.

5.2 Placement and Success of Graduates

The placement and success of graduates was not formally elaborated to a great degree in the Programmatic Self-Study. The Self-study stated the following:

> Our HP graduates tend to migrate toward federal and state radiation protection careers, with a few heading to national laboratories. Many students also end up in the federal and state regulatory agencies. While we strongly encourage graduates to take the CHP exam after receiving their MS degree, we do not track such data.

The Health Physics job market is known to be very good with a demand unlikely to be satiated in the near future. It is well documented that there are unlikely to be sufficient graduates to replace those individuals who are currently in the retirement phase of their career. The reader is referred to the National Council of Radiation Protection and Measurement's web page where they can find documentation on the WARP (Where Are the Radiation Professionals) http://ncrponline.org/ initiative

and the outlook for jobs in the profession of Health Physics. OSU students are experiencing the same "good" market as all other students in this profession. If there are delays in finding employment they are likely to be related to individual restraints such as preferences on region of the country the student prefers or matching research interests to a specific employment need.

5.3 Satisfaction of Students and Graduates with their education and their post-graduation Employment Success

Unfortunately the program provided no information on the satisfaction of alumni. Anecdotal conversion with the School Head indicated that in general alumni are pleased with their career choices and have accomplished success in many areas of the discipline. The program is encouraged to either renew or start a data base on alumni. It is speculated that a complete data base may all exist within the universities development office. Perhaps coordination with development efforts may be a fruitful area to explore.

5.4 Professional or National Rankings/Ratings

Professional or National Rankings of small programs usually does not occur. To the extent OSU's Radiological Health Physics program is an integral part of a larger whole these rankings are interesting but other than the vanity factor have very little practical value to an assessment simply because they have a certain "popularity" contest or name recognition basis which says nothing about the true nature of the program's quality. It is clear that the winning record of the university football or basketball team has more impact on the ranking appearing in mass media then the actual viability of their particular programs.

What is noteworthy and outstanding about the OSU Radiological Health Physic Program is that it enjoys the admiration and respect of its peer Health Physics programs. The authors of this particular report can attest to the high esteem in which we in the Health Physics community hold the faculty, staff and students participating in the OSU Radiological Health Physics program.
The previous comments notwithstanding, the Programmatic Self-study provided the following information on ranking:

> The US News & World Report ranks academic "nuclear engineering" programs through surveys of "nuclear engineering" Department Heads and Deans from across the country. A Google search of "ranks of health physics academic programs" reveals that the closest ranking would be in the fields of "nuclear physics" or "physics". At any rate, a Google search of "Health Physics University" reveals the following list of programs (in this order): Oregon State University, University of Michigan, Idaho State University, Colorado State University, Georgetown University, Illinois Institute of Technology, University of Nevada Las Vegas, and the University of Texas Health Science Center. The Google search results are likely location-based, but potentially only for the first in this list. Given the data accumulated by the Oak Ridge Associated Universities, we estimate that the Health Physics programs ranks among the best in the country. The national ranking of "nuclear engineering" at OSU from 2007 to 2015 has been between 8th and 12th, with the most recent being 10th (Figure 50).
>
> Examining the ranking data by engineering discipline at Oregon State, we see that the raw score obtained by "nuclear engineering" exceeds all other Schools in the OSU College of Engineering (Figure 51), consistently about 3.2 in the US N&WR scoring system. Examining the ranking data by engineering discipline at Oregon State, we see that the raw score obtained by "nuclear engineering" exceeds all other Schools in the OSU College of

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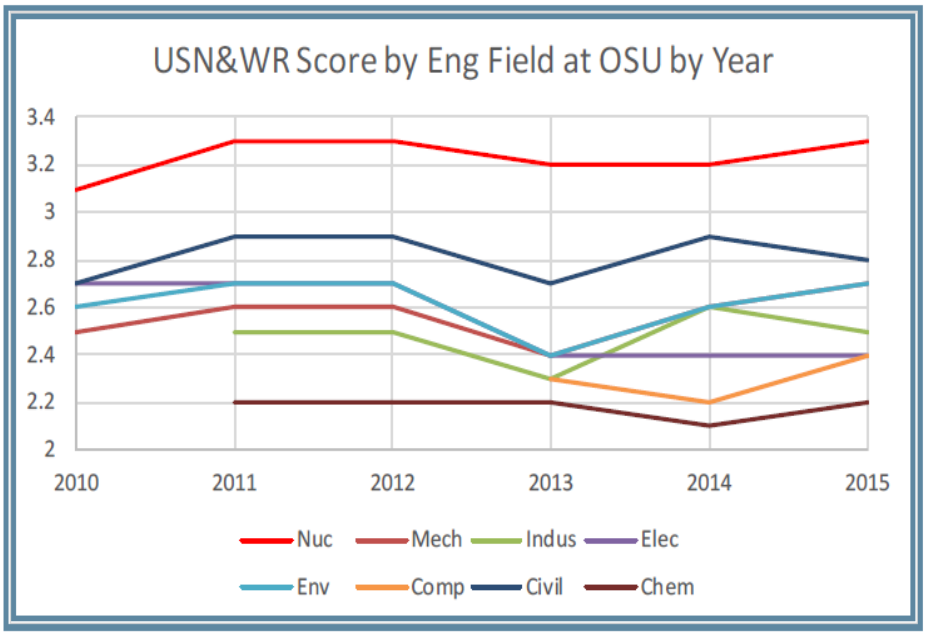
Figure 51. U.S. News and World Report Scores of Engineering Programs at OSU



5.5 Community Engagement Activities

Once Again the most succinct information on community Engagement Activities arises directly from the Programmatic Self Study. As specified in the Self-Study:

> The impact of our graduate programs can be seen in the large number of graduates employed across the country in key positions of academia, government, and industry. Locally, a vast number of our students work at NuScale, in Oregon State government, at Oregon Health Sciences University, at Oregon State University, and at several Oregon hospitals.
>
> Whenever the occasion presents itself to educate the public and various professional groups, the faculty jump at the chance. In the past we conducted departmental colloquia in the large auditorium of the OSU Alumni Center that usually attracted outside attention. Being a highly educated community, many local residents took part in these colloquia as part of life-long learning opportunities. We also participate in various annual campus events (e.g., Beaver open house, dad’s weekend) during which the TRIGA reactor and other items of interest are open (as much as possible) for guided tours.

6.0 Conclusions and Recommendations for Improvement

The Review Team for the OSU Radiological Health Physics graduate program concludes that the program should be Maintained/Expanded.

The team observed a high quality program that is nationally important to the profession and is active in producing a set of high quality readily employable graduates. Student numbers are characteristically small in the Radiological Health Physics Program and oscillate.
The program expressed a perception that inclusion of all student cohorts was unsatisfactory and that they are actively seeking institutional solutions to improve this condition. The committee suggests that the program needs to take full advantage of institutional resources available to enhance diversity and inclusion, which they may have only recently been made aware.

Faculty workloads are relatively high for the university and are at a level to restrict program growth. They limit faculty opportunity in establishing competitive research support, in sabbatical opportunities (simply because there is no one available to take their place) and these small numbers cap the graduate student mentoring possible. Questions exist to the economics of how growth might most efficiently be achieved. Perhaps a traditional model of simply increasing tenured-track faculty-lines may not provide sufficient return on investment. One proposed alternate is to diversify employment categories to include teaching faculty and research faculty. Teaching faculty would provide lower division teaching support thus freeing tenured faculty time, and self-supported research faculty could serve to enhance graduate student mentoring and support in research. Providing this may speculatively serve to enhance productivity in multiplicative ways rather than the additive way expected from simply adding faculty using the traditional tenured track model.

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