

# Report of the Student Delegation to the 2005 Visiting Committee

Department of Nuclear  
Science and Engineering  
**MIT**

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# 1 Introduction

A delegation of graduate and undergraduate students from the Nuclear Science and Engineering (NSE) Department had been assembled to report to the 2005 Visiting Committee on issues of importance to the entire NSE student body. This delegation is comprised of 14 students representing most academic programs and research tracks available in the Department. The specific association of each delegation member is summarized in Table 1.

**Table 1: Delegation Member Breakdown**

	<b>Graduates</b>	<b>5 Year SB/SM</b>	<b>Undergraduates</b>
<b>Fission</b>	Craig Gerardi* Chris Handwerk	David Carpenter Tyler Ellis* Mary Presley Michael Stawicki*	Ashley Finan Katherine Hohnholt David Legault
<b>Fusion</b>	Jennifer Ellsworth Alex Ince-Cushman Matt Reinke		
<b>Nuclear Science and Technology (NST)</b>	Whitney Raas	Erik Johnson*	

\* American Nuclear Society (ANS) MIT student chapter officer

In preparation for the drafting of this document, a survey was distributed to the entire NSE student body to collect opinions and gauge satisfaction with the Department. Approximately 30% of graduate and undergraduate students responded and their comments were used to develop the list of topics that are addressed here. As such, the delegation wishes to note that it believes this report represents the majority opinion of NSE students. The issues addressed are, in general, not specific to students in any particular track of the Department, though some issues clearly apply to only either graduate or undergraduate students.

This report begins with a review of progress made since the last Visiting Committee meeting in 2003. It then moves to address issues relating to the academic curriculum, general concerns and concludes with a summary of recommendations. The delegation intends, with this report, to identify areas where changes can be made to improve academic and research programs within the Department and to make recommendations which will help NSE better prepare students for futures in academia, government or industry.

What follows may appear quite critical of NSE in particular and MIT in general. The delegation does not wish to leave the Visiting Committee with the impression that students are completely unhappy. In fact, most students consider their experiences in this Department to be positive. Table 2 lists the fraction of students responding Very Good or Excellent to several general questions in the student survey designed to capture overall satisfaction.

**Table 2: Fraction of Students Responding Excellent or Very Good in the Student Survey**

	<b>Graduates / 5 Year</b>	<b>Undergraduates</b>
Overall quality of your program	79%	61%
Academic standards in your program	71%	61%
Quality of fellow students	82%	56%

## **2 Progress since 2003 Visiting Committee Meeting**

### **2.1 Changes to the Core Curriculum**

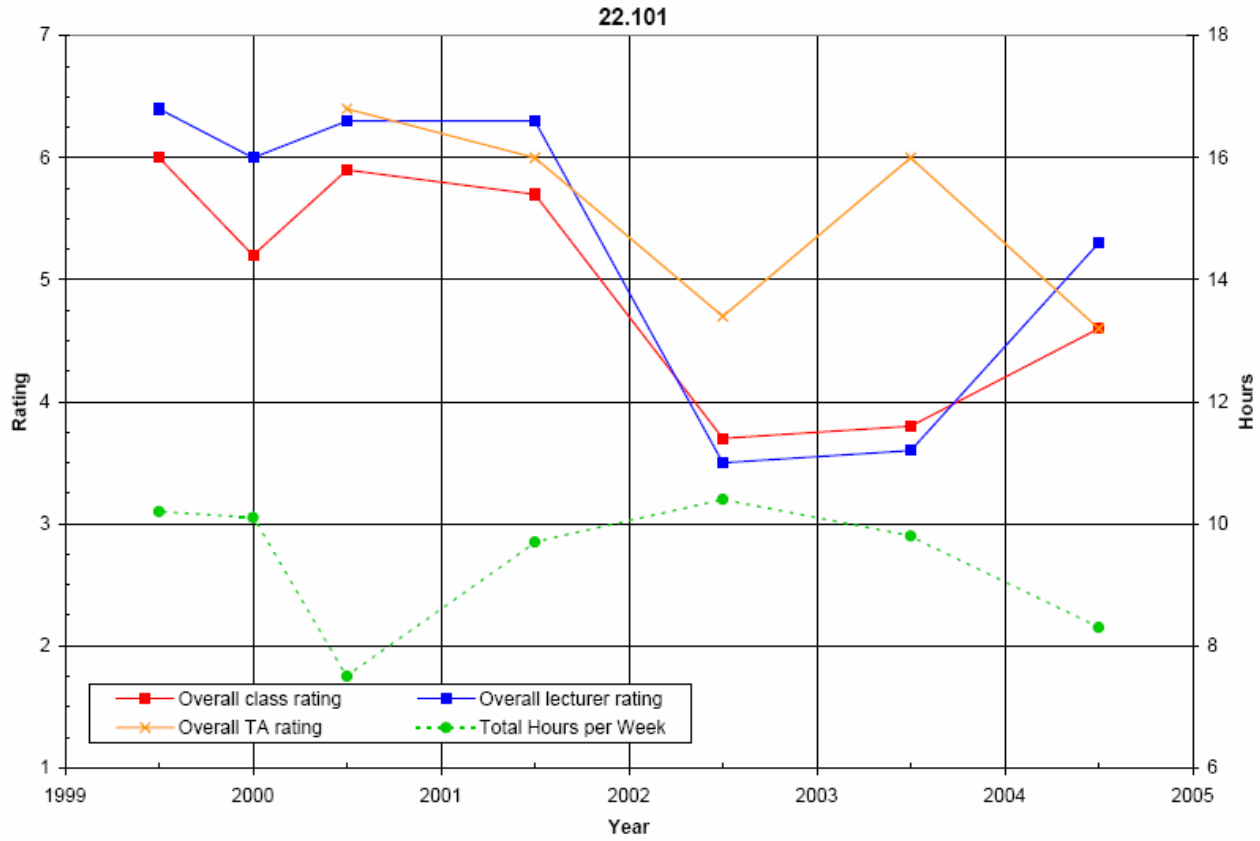
The 2003 Report of the Student Delegation discussed deficiencies in the Department's graduate core curriculum. It suggested several changes to increase the breadth of the offerings and to provide a better foundation for new graduate students lacking a nuclear science or nuclear engineering background. We address progress made on each of these recommendations below.

#### **2.1.1 22.101**

22.101 (applied nuclear physics) is a critical course for the Department because it is the only course required of all graduate students regardless of concentration, and it is a focus of the Qualifying Exam. The 2003 Report suggested several changes, including: standardizing the focus and content of the class by having the same instructor every year, broadening the content to include more information directly applicable to each concentration, and introduction of a single, comprehensive textbook to supplement lectures.

As recommended, the same professor has taught 22.101 since 2004, and it appears this will continue into the 2006 school year. This change should improve the consistency and quality of the class, and clarify the focus of the material covered on the Qualifying Exam in the future. However, the content of the class has remained unchanged, with little application to fission track students. In addition, the professor's typewritten lecture notes are still the primary source for supplementary reading and current students in 22.101 still express a desire for an applicable textbook.

Over the years the quality of instruction in 22.101 has varied greatly as reflected in student evaluations, but as shown in Figure 1, there has been a positive trend in the last year which would seem to indicate this standardization is having a positive effect on the class and is appreciated by the students.



**Figure 1: Student Evaluation of 22.101**

### 2.1.2 Fission Core Curriculum

The 2003 Report recommended revising the fission track core classes to create a broader and more fundamental start for new students. These recommendations included adding both 22.102 (introductory engineering and thermodynamics) and 22.312 (advanced thermodynamics) to the core, adding a discussion of the fuel cycle to 22.211 (introductory reactor physics), and splitting probabilistic risk assessment (PRA) into a separate track (beginning with 22.38).

The major change to the fission core curriculum since the Report is the removal of 22.102, which was discontinued in 2003 and has not been revived. In its place, 22.312 is now the only introductory thermodynamics class in the fission core curriculum. 22.211 remains focused on reactor physics, and has not been integrated with any parts of the fuel cycle analysis class, 22.251. Finally, the introductory PRA course, 22.38, remains a part of the fission core, and there is no pure PRA track for preparing for the Qualifying Exam. The delegation still feels these changes are needed to make the fission curriculum more valuable to students.

### 2.1.3 Fusion Core Curriculum

The three recommendations for updating the fusion core curriculum were replacing the thermodynamics class (22.102) with a more relevant electrodynamics class (22.105), adding

introductory plasma physics (22.611), and restoring the fundamental plasma physics laboratory course.

Two of these suggested changes have been enacted. After 22.102 was discontinued, 22.105 was added to the fusion core curriculum, as was 22.611. However, no new plasma physics laboratory course has been established or is planned even though current student continue to request one.

#### **2.1.4 NST Core Curriculum**

Suggestions for the NST core curriculum included removing an unnecessary electrodynamics component (22.105), addressing redundancy by removing either 22.51 or 22.54, which cover theoretical physics, and adding concentrations in biological applications and quantum information processing.

Since 2003, both 22.105 and 22.51 have remained a part of the core curriculum, however 22.54 has been removed. While no explicit tracks have been added for biological or quantum applications, 22.55J (biophysics) and 22.51 (quantum theory) are currently a part of the NST core curriculum.

## **2.2 TA Assignments**

A major recommendation of the 2003 Report of the Student Delegation was increasing the number of teaching assistants (TAs), especially for the core curriculum classes. Unlike graders, the TAs would be available to answer questions, hold recitations, and in general increase the availability of help when the professor may be busy or unavailable for extended periods. About half of the courses offered by the Department have a TA, however many of the introductory classes do not. Of the thirteen core classes across all three tracks, only four have TAs.

## **3 Recommendations Pursuant to Undergraduate Academic Requirements**

### **3.1 General Curriculum Issues**

Several years ago the Department made a move to homogenize the undergraduate curriculum. Instead of a three track system as exists for graduates, all undergraduates have the same core requirements regardless of interest area. This change was made for several reasons, but primarily there were not enough students to support three separate tracks. Today, however, the delegation believes that our undergraduate population is large enough to support track specific classes. While most students like the homogenized core curriculum, they also want track-specific electives; with 13 out of 17 students polled suggesting this change. This need is most strongly expressed by NST students, all of which agreed that exposure to NST concepts, particularly health physics, is lacking in NSE. In addition, 15 out of 17 students responding to the survey want more exposure to Fusion/Plasma Science.

The delegation would therefore like the Visiting Committee to explore with the faculty the option of gathering additional physical and personnel resources to offer these track specific classes. A possible solution to minimize the burden on the department is to offer classes in conjunction with the Biology, Biological Engineering or HST departments. There are several faculty in these departments that already do nuclear-related work, and having a joint offering would not only allow NSE students to draw from joint resources, but allow for larger classes. The Biological Engineering department might be a particularly good fit because they are also a small department and there already exist ties between our two departments. The delegation feels that there may be resistance among the faculty to make any changes which appear to break undergraduates back into tracks, however, we would like to emphasize that undergraduates value the homogenized core curriculum, but need the extra track-specific electives to fulfill their interests and professional goals.

### **3.2 22.06 – Engineering of Nuclear Systems**

Another specific issue regarding the undergraduate curriculum is 22.06 – Engineering of Nuclear Systems. This is a fundamental class for nuclear engineers in that it integrates knowledge from lower-level engineering classes with a systems understanding of nuclear systems. Because of the fundamentality of the subject matter, it is particularly important that this class be well taught. However, because the class addresses fission, fusion and accelerator systems, it is hard to find a professor with the necessary expertise in all three areas. It has been our experience that in 22.06 fusion and accelerator systems gets short-ended. This is particularly detrimental because 22.06 is the only class in the core undergraduate curriculum where fusion is addressed. We have no solution to this problem, but recommend at least splitting the teaching load of 22.06 between faculty from fission, fusion and NST.

As an aside, the delegation also wishes to address the very specific topic of “lecture by PowerPoint” that some members of the faculty have adopted. It is becoming more and more common for faculty to prepare a PowerPoint presentation far in advance of a lecture and then simply show and comment on each of the slides during the lecture. This teaching style is not cohesive, it is confusing and students often cannot keep up with the lectures. We ask the Visiting Committee to remind the faculty of the importance of class interaction and quality lectures in undergraduate instruction.

### **3.3 Undergraduate Engineering Capability**

The MIT administration is currently considering adding a General Institute Requirement (GIR) to the undergraduate curriculum which would develop students’ ability to engineer practical systems. The delegation asks the Visiting Committee to support this effort.

NSE undergraduates focus mostly on learning theory. It is the expectation of the faculty that an undergraduate who completes the NSE program have a firm foundation in the theory and phenomena encountered in the nuclear field but there is little expectation that the student have practical problem solving skills or knowledge. When comparing 5 year students to incoming graduate students it is often noticed that the 5 year students comparatively lack a practical understanding of how things work. This practical knowledge is supposed to be gathered in two

classes in the undergraduate curriculum. The first being the undergraduate laboratory, 22.09, and the other the senior design project, 22.033, but these have not been successful in providing this practical appreciation to date. The laboratory has been neglected in the past but a recent initiative by the faculty to update and restructure the curriculum appears promising and should be supported. The design project gives students an appreciation for the interconnectivity inherent in large engineered systems but attempts to cover too much material in too short a time without sufficient faculty instruction to allow students to develop an engineering intuition.

As such, a class which gave undergraduates experience with the actual operation and engineering of systems would be extremely valuable. Such a class could take the form of a term long project where some device was actually built or studied. Any venue which is able to connect theory to engineering reality would be appropriate. The delegation does not even feel that the project need be connected directly to a nuclear topic, though that would be beneficial, an appreciation of the limitations and applicability of theory is what is needed.

### **3.4 Undergraduate Research Experience**

One of the major items attracting undergraduates to NSE is the personal attention that faculty and other Department resources offer individual students. This contrasts sharply with other Departments which are too large to easily offer the same research and mentoring opportunities. A few years ago, it was argued that the NSE undergraduate contingent was too small and a stronger recruiting emphasis since then has resulted in a ballooning of the student population from about 20 in 2000 to about 60 today, a number that, while now large enough to contain a diverse spectrum of interests, is still sufficiently small that a proactive student should be able to find the research resources he or she desires. This is proving to be increasingly challenging and the Department has yet to comfortably adjust to this valuable influx of students. The primary deficiency seems to concern the dissemination of information regarding opportunities.

#### **3.4.1 Undergraduate Research Opportunities Program**

During recruiting, freshmen are typically enticed with the promise of participating in the Undergraduate Research Opportunities Program (UROP), a program that facilitates and encourages undergraduates to engage in current research with faculty. These UROPs are a major attraction for students and the Department's small size should give it an advantage in its ability to make these opportunities available to its students.

As such, 75% of undergraduates responding to the student survey have participated in UROPs within the Department. Due to diverse interests, half as many have also participated in UROPs outside the Department. Only 7% of individuals who have actively looked for a UROP in NSE have been unable to find one during their entire time at MIT. It is clear then that UROPs are available at one point or another to nearly all students, but it is not apparent that this availability is maintained throughout the undergraduate career, or that the experience is valuable.

Although many have participated in at least one UROP, 6 out of 14 undergraduates responded that they felt UROPs were not easy to find in their area of interest. This sentiment was especially evident among seniors and 5 year students. This lack of long term research projects in a student's area of interest calls into question the value of the program as a whole. Still, there were

some individuals from all classes who felt that it was easy to find UROPs. This difference of opinion suggests an uneven dissemination of information regarding research opportunities and maybe a result of the growing undergraduate population.

The delegation therefore recommends that a central inventory of available UROPs be maintained and that these projects' educational objectives be well defined by faculty before being offered to students. Also, fostering a broader interest among faculty for providing such opportunities would also improve the ability of students to pursue and develop new interests while simultaneously preparing them for their plans after graduation, be they continued academic study or entrance into the private sector.

### **3.4.2 External Internships**

A further consequence of student population growth is reflected in student participation in internships away from MIT. Internships present an opportunity for students to engage in experiences that will prepare them for their careers perhaps better than other opportunities on campus. Internships are emphasized as a worthwhile avenue to develop experience, particularly to upperclassmen.

Consequently, participation in internships seems to be comparable to that of UROPs. Like UROPs, 12 of out 17 responding students have participated in internships. However, at least 3 out of 15 had actively looked for an internship at one time but did not end up participating in one. Also, 9 out of 17 undergraduates felt that resources for internship and employment opportunities were not readily available from Department resources.

This attitude suggests that where word-of-mouth transmission may have been sufficient to communicate the availability of these programs in the smaller Department of the past, more systematic means are now necessary to insure that all students have access to this very useful information and do take advantage of these opportunities. Again, the delegation suggests a centralized inventory of available internship opportunities be made available to undergraduates.

### **3.5 Senior Thesis**

In their senior year, all undergraduates who do not continue into the five year program are required to complete an acceptable undergraduate thesis before graduation. In theory, a student would have a continuing UROP or other research project which would culminate naturally in a thesis. The lack of such projects however, makes finding a topic and completing a thesis difficult. All students are aware of the thesis requirement but are unsure what steps can be taken to prepare adequately for it and find that faculty expectations vary greatly. While 6 out of 10 responding seniors indicated that they felt academically prepared to complete the thesis, 8 out of 10 do not understand what is expected of them. Granted, these perspectives were obtained relatively early in the senior year (the first week of October) before seniors were expected to have begun their thesis work; however, with limited communication and understanding of the details of the requirement, seniors cannot plan and schedule in advance. This leads to unnecessary stress and confusion at a time when seniors are trying to finish up course work and find jobs.

The delegation recommends that a clear statement of objectives and requirements be prepared and approved by *all* faculty involved in undergraduate theses and that these items be provided to undergraduates upon entering NSE in their sophomore year. In addition, the delegation would ask the faculty to focus on providing research projects to undergraduates that will lead to a thesis and to encourage students working on an appropriate project to prepare a thesis even if they are not in their senior year.

## **4 Recommendations Pursuant to Graduate Academic Requirements**

### **4.1 Diagnostic Exams**

First introduced to incoming graduate students in the fall of 2003, the diagnostic exams were offered as a way of assessing doctoral candidates' proficiency with respect to math, physics, and engineering. Previously, these subject areas were explicitly tested on the Qualifying Exam. With the advent of the diagnostic exam, the Qualifying Exam now focuses on the more fundamental engineering concepts within the students' respective area of specialization. This is a win-win scenario, as students can now focus their studying efforts on this key material and the faculty can focus on assessing the students' abilities in these areas.

Overall, the diagnostic exams provide an improvement to the doctoral qualification process that is conceptually well received by all parts of the Department. However, in its implementation, the approval of the diagnostic exams is generally split. The student survey indicated that the quality of the diagnostic exams and their ability to judge the students' ability to complete their coursework was judged as equivalently good and bad by the survey population. Further, opinion of whether or not the diagnostics were a good tool for assessing preparedness for graduate work at MIT was also evenly split. Not only do these survey results express this opinion, but general sentiment among students, determined from informal conversations between members of the delegation and the graduate student population, agrees with the survey results that opinions are relatively evenly split.

Uncovered in these conversations is that these attitudes stem from several factors. What is tested in the diagnostic exam is not necessarily what is needed for success in a particular specialization in our Department (fission, fusion, NST). That is, the diagnostic exams contain math, physics and engineering concepts prevalent, yet specific, to a particular track. For example, on the fall 2004 physics exam, there were several questions about electromagnetism, a very important topic in fusion and some parts of NST, but of questionable value in most of fission engineering. As a solution, creating diagnostic exams for each of the tracks, focusing on the math, physics, and engineering that is important to that track, is proposed.

The second factor was the perceived irrelevance of the make-up course work required in the event of failing the exam. The subject matter taught in the courses offered for remedy does not reflect that which is tested in the diagnostic exam. This is best illustrated by the fact that there are 7 courses offered to satisfy the physics remediation requirement, ranging in subject matter from Quantum Mechanics to Electromagnetism to Materials Science, of which Quantum

Mechanics and Materials Science do not appear on the physics diagnostic exam. This then leads to the question of “What standard of knowledge in physics, math, and engineering is the Department trying to achieve?” If there were a clearly defined standard, the remedial work would support the accompanying exam. Consequently, a recommendation of the delegation is for the Department to more clearly and specifically define the areas and level of knowledge expected within each of these areas (math, physics, and engineering). Further, splitting each of these requirements up into the individual tracks is recommended and would support the recommendation made in the previous paragraph. Finally, closer examination of the syllabi of the remedial classes to ensure that they support the aforementioned standards would improve the quality of the diagnostic exam process and restore the faith of the half of the student population who does not believe it is working. There would be large support for this from the students as there was overwhelming support in our survey for a physics review course taught by NSE faculty that focused on material needed in NSE courses instead of the current make-up work required for failing the physics diagnostic exam. We ask the Visiting Committee to encourage closer collaboration between students and faculty in going forward to improve this process.

## **4.2 Qualifying Exams**

Several changes were made last year to the format of the departmental qualifying exams. The exam is currently given each year at the beginning of the spring semester in two parts, a six hour written exam on four subjects, and a ninety minute oral exam. A passing or failing mark is given based on both exams, so if a failing mark is given, both exams must be retaken. However, if a person performs below expectations on one exam, but exemplary on the other exam, they may still receive a passing mark for the qualifier. Previously, the written qualifier and oral qualifier were separate, and were passed or failed individually. The written exam was a nine hour exam on 3 undergraduate subjects and 3 graduate subjects. The written exam was taken in September, and the oral exam in February or June. It was necessary to pass the written exam before taking the oral exam.

It is our impression that student responses to the changes in the format of the qualifier are generally positive. In conversations with other students, negative comments center on scheduling and dissemination of information. The date of the qualifying exam was not set until early December. Until that time, it was unclear if the exam would be offered at the end of January or sometime earlier in the month. This caused some stress for nervous would be doctoral candidates. The location of the exam was not announced until 2 days before the exam. Scheduling for the oral exams was announced in late January. These concerns can easily be assuaged by the department. Other scheduling complaints concern the lack of time between the written and oral exams. The written exam was offered Friday, January 28th. Students were scheduled for oral exams as early as Wednesday, February 2nd and as late as Tuesday, February 8th.

Nine of the graduate students who returned the surveys had taken the qualifying exams. The survey did not ask if the students had taken the new format or the old format. All students said that they were usually or sometimes given adequate advice on preparation for the qualifying exams. Responses were split when students were asked if the information on what they would

be tested on was clear and available. All students agreed that the overall quality of the qualifier was high, although they were more satisfied with the quality of the oral exam than the written exam. Seven of eight respondents agreed or strongly agreed with the statement, "The ORAL qualifier did a good job assessing my knowledge of my field", while only five of eight students agreed with this statement when it was asked about the written qualifier.

Students were also asked if the "qualifying exam is a fair exam", if it "accurately assesses one's potential as a doctoral candidate", and if the "process for becoming a doctoral student is a fair process." Five of seven students agreed that the process was fair including one student who strongly agreed, while only four of the seven agreed that the qualifying exam was fair. Three of the seven students agreed that the qualifying exam accurately assesses one's potential as a doctoral candidate.

### **4.3 22.101**

One of the strengths of the graduate NSE program is the diverse background of our student population. The unfortunate consequence of this is trying to get all of the students onto the same academic path at the start of their graduate careers, which is the challenging goal of 22.101 – Applied Nuclear Physics. Every student, regardless of specialization, is required to take this class and the subject is covered on the PhD qualifying exam. Topics covered are basic quantum mechanics, nuclear models, and charged particle, neutron and gamma interactions with matter. The format of the class is two 1.5 hour lectures and one recitation per week with weekly homework assignments and three exams.

In the graduate student survey three questions addressed 22.101. Reactions were mixed regarding the utility of the course in the student's respective research as 12 of 22 responders disagreed with the statement "22.101 was a useful class for my research and/or other classes". Overwhelmingly, (21 of 22) the students felt that 22.101 did not spend too much time reviewing basic concepts, with half of the students feeling the pace was set right. This data is consistent with the theory that the course acts as a good review for former Nuclear Engineering or Physics students but may be too brief for students with Mechanical Engineering backgrounds or those who come from industry. Unfortunately, little can be done to ameliorate these concerns without splitting the class into basic and advanced versions or allowing students to earn an exemption with another diagnostic exam. Neither are very attractive options due to importance of the material and its prominence in the PhD qualifying exam. Also, because most 22.101 students are typically first year graduate students, the class is useful for developing working relationships with fellow classmates. Examining past student evaluations of 22.101, it is evident that the change of instructor to Professor Yip was an improvement and we recommend him continue to teach the course. No major changes to the curriculum are recommended.

### **4.4 22.39**

The course, 22.39, entitled "Elements of Reactor Design, Operations and Safety" is a new course being offered by the Department for the first time this fall semester. This course's purpose is to integrate the various individual elements of reactor design such as reactor physics, materials, thermal-hydraulics and probability risk assessment. These courses have, and still are taught in isolation within the Department, with very little mention of how they need be combined to

achieve successful reactor design or regulation. However, the qualifying exams expect a student to have fully pulled these topics together, which often did not happen in the past. 22.39 is the faculty's attempt to remedy this situation, and in large part seems to be working. The true test will be in how well fission students fare on this January's qualifier, but there seems to be general consensus that the course is worthwhile. Being the first iteration of the course, it is sometimes plagued with miscommunication between the faculty jointly teaching it, and a curriculum/lecture series lacking in cohesion. However, with the creation of this course, the faculty has shown the students that they are actively working on ways to better transmit the knowledge they would like us to obtain from an NSE education. The delegation applauds this effort.

#### **4.5 Doctoral Seminar**

The Department requires all doctoral candidates to enroll in a doctoral seminar course after passing the qualifying exam. This course requires all doctoral candidates to present the results of their research once per semester, thereby providing a means of gaining experience in presenting while also informing the rest of the Department of the progress of a student's research. Doctoral seminar meets once per week, with one or two students presenting each week. The doctoral seminar is separated into three sections, one for each of the Department tracks (in other words, all NST students present and listen to other NST students, fission students present to fission students, etc.). Until this year, a "joint" seminar was offered each semester in which one student from each track presented to all the doctoral students in the Department. This joint seminar was removed this year, as many felt, and the delegation concurs, that often these seminars were difficult for everyone in the Department to understand and did not achieve the "jointness" goal.

The delegation recognizes the value of doctoral seminar, as it provides a useful means of informing students and faculty of research progress. We also recognize the importance of speaking skills and doctoral seminar provides an excellent means to practice these. On the whole, we think that doctoral seminar works very well in the fission and fusion tracks. There are a relatively small number of fission students who work closely together on similar projects and doctoral seminar is a great way for fission students to stay informed. Similarly, fusion students feel that the format of doctoral seminar allows them a useful forum to discuss ideas, receive faculty input, and inform first year graduate students and students of other Departments of the scope of research performed in the fusion area.

NST seminar, however, still encounters difficulty despite Department efforts to improve it. This stems mainly from two factors. First, the number of students in NST exceeds the number of speaking opportunities, requiring three or four students to speak at every seminar meeting. This large number of speakers makes it difficult for each student to receive valuable feedback or to even get the attention of other students. Second, the variation in research topics in NST generally means that very few students understand the relevance, importance, or basic concepts of many of the presentations. While we agree that the doctoral seminar is a valuable part of the graduate education we receive at MIT, we hope that the students can work with the faculty to improve NST seminar, either by shifting some student presentations to the "fission" section to reduce the number of student presentations each week, or by splitting NST seminar into two sections, possibly a "health physics" section and a "nuclear science" section. We do not see any

need for intervention by the Visiting Committee but include this discussion in the interests of completeness and note that efforts are underway in NST to fix this problem.

## **5 General Academic Recommendations**

### **5.1 *Teaching Assistants and Graders***

The Department currently assigns graders to courses they feel require an extra person to grade homework. It is understood that these graders are to grade homework only, and not hold office hours or discuss material with students in the class. It is the experience of the delegation that this system is not working very well: many students treat the graders as TAs, expecting them to be available for additional help. In most situations, the grader is also concurrently taking the class, thus leaving no one for students to turn to for extra help, and leading to time-consuming problems for the grader who not only has to do the homework, but also understand the material well enough to grade it and explain it to other students. Roughly half of the 28 graduate students surveyed stated that the graders were unqualified for their job.

We feel the grader system as it now stands is unhelpful to the students and places an undue burden on the graders. It would be much more helpful to have TAs who have taken the class previously, understand the material, and are available for office hours and help outside of class. Especially in the case of the core curriculum, it is essential that the course have a TA who is knowledgeable about the material and available for questions. We realize that this necessitates locating additional financial resources to pay the more costly TAs, but we feel that it is vital for first year graduate courses.

Undergraduates suffer a similar problem with TAs and graders, roughly four out of 17 undergraduates surveyed stated that they could not get help with class material and homework when needed, and access to TA help and recitations was inadequate. While more TAs for undergraduate classes might not have been economically feasible for the Department in the past, with the recent increase in the undergraduate population, the delegation would like the Visiting Committee to ask the Institute for additional assistance. In the mean time, another option is undergraduate “tutors”. Several other Departments on campus (most notably the biology Department) employ upperclassmen to grade and hold recitations. This comes with the added benefit of allowing upperclassmen to strengthen their knowledge of core material and gain useful teaching experience.

### **5.2 *Mentoring and Advising***

Most graduate students within NSE are extremely satisfied with their research advisor. There is a general consensus that their advisor does a good job encouraging quality research and cares on a personal level about their success. Since the research advisor is universally considered to be a very important aspect of graduate school, this is a significant achievement, and the Department should be applauded for success in this area.

Less laudable, however, is academic advising, which is generally done by a faculty member other than the student's research advisor. Academic advising within the Department is generally substandard, with the advisor often being uninformed concerning the requirements for a certain degree and forceful in recommending courses irrelevant to a student's particular line of study. Half of the students surveyed indicated that degree requirements are not clear and most students found academic advisors unknowledgeable regarding the requirements. To alleviate this problem, the delegation recommends a compulsory information session every fall semester before the first week of school for all academic advisors and students, where degree requirements would be briefly discussed in a concise manner.

## **6 General Concerns and Considerations**

### **6.1 *NSE Recruiting and Growth***

This has been one of the most significant areas of success for the department. Even though the number of matriculating graduate students has remained roughly the same over the past several years, the undergraduate population has been booming. This year the department has enrolled about 60 undergraduates. The delegation feels there are two primary reasons for these upward trends: namely the start of a pre-orientation program and the increase in societal awareness concerning energy.

The Discover Nuclear Science and Engineering (DNSE) pre-orientation program was a huge success in 2002, its inaugural year, and continues to grow in large part due to the hard work of a NSE administrative assistant. This year, of the 22 students who participated in the program, 10 ended up declaring nuclear science and engineering at the end of their freshman year. We hope that all of the faculty, staff and students continue to support this effective program.

The second reason we identify for heightened undergraduate interest, increased societal awareness of energy policy, stems from the current political enthusiasm for nuclear generated power coupled with the recent passage of the energy bill. This has inspired several government and industrial organizations to sponsor research initiatives and create job opportunities. We feel that our department's unique ability to be a preeminent world authority on nuclear energy and nuclear science innovations will help to ensure a high quality graduate and undergraduate student body.

### **6.2 *Staffing and Resource Allocation***

There is great concern among the students that the staffing levels within the Department are not commensurate with the student population or research funding, particularly within the fission side of the Department. There are precious few research scientists within the Department, and many of them are overworked. For example, one younger research scientist reads and reviews just about every thesis from the fission portion of the Department. While he does an astounding job at this, is quite efficient, and the delegation commends him for his efforts, we feel this is an inefficient use of his capabilities and that this work needs to be spread out more. Adding capable research staff would allow students more time to interact with knowledgeable scientists and gain

additionally valuable feedback without imposing on one person in particular. This problem of overworking the few extremely proficient staff members and under working the rest is also an issue for the Department's administrative staff, where several good staff members are clearly given the majority of the work simply because the Department knows they will do a good job. This is worrisome, as the delegation feels that eventually these scientists and staff will be forced to seek employment in a more equitable environment. This problem is further troubling to the delegation as there is no indication that the appropriate persons in management rolls are aware of it. The Department should consider reevaluating the work load within the department and restructuring the staff accordingly such that there is an equitable distribution of the work. The delegation asks the Visiting Committee to lend its experience in efficient managerial technique to the department.

With the growth of the number of experimental facilities within the fission side of the Department, the delegation also believes it is appropriate to hire a full-time scientist that specializes in experimental work, specifically in thermal-hydraulics and materials. The fusion track through the Plasma Science and Fusion Center has many of these scientist positions and seem to operate effectively on this system. There is a very noticeable deficiency in experimental expertise within the fission portion of the Department, and this will need to be remedied in the near future if expansion of first-rate experimental facilities is desired. We hope that the Visiting Committee might be able to help the Department lobby MIT for additional funding to this end.

### ***6.3 Physical Plant, Space and Facilities***

The Department makes every effort to provide an office, computing facilities, and software support to each graduate student. In general, most students are happy with their office space. Even so, there is a large range of office sizes and conditions throughout NSE. Every graduate student has an office area, even if the room itself is shared with other graduate students in the department. On the whole, graduate students are happy with the support provided in terms of the availability of computers, computing assistance, software support, and similar needs. For those students who are engaged in experimental work, most are pleased with the physical support provided for experimental setup and execution.

While overall NSE and the MIT Department of Facilities maintain a good working environment wherein all students have offices and the necessary supplies for their research, there have been some problems with repairs and renovations within Buildings NW12 and NW13. Calls to the Facilities department regarding problems with heat, air conditioning and general building maintenance have routinely been ignored. In many circumstances, flooding has occurred and the hallways and labs are dotted with buckets to catch water dripping from the ceiling for days before anyone from Facilities arrives to fix the leaks. Often, a direct call to the manager of Facilities is required before any work is started. This is particularly a problem in the winter, when the heat isn't turned on and offices can cool to 50 degrees, and in the summer, when the heat isn't turned off and the office temperature rise into the 90s. While we recognize that Facilities is often overwhelmed by the call volume they receive, we hope that the Visiting Committee can bring this to the attention of MIT, as NSE has been unable to encourage Facilities to take appropriate preventative action.

#### **6.4 Reactor Utilization**

Although we recognize that the MIT Nuclear Reactor Laboratory and the MIT Department of Nuclear Science and Engineering are independent entities (both organizationally and fiscally) we feel that there should be a stronger working relationship between the two than exists today. With the exception of the 3 unit IAP course 22.921 “Nuclear Power Plant Dynamics and Control,” no other graduate courses utilize the reactor facility and it is quite feasible to graduate without having even seen the MIT research reactor. We feel that the addition of a practical hands-on knowledgebase would nicely complement the theoretical training gained through classes and research.

## 7 Selected Recommendations

The following table is a list of selected recommendations from the student report to the 2005 Visiting Committee.

### Undergraduate:

Topic	Recommendation
Research Experience	<ul style="list-style-type: none"> <li>• Central inventory of available UROPs</li> <li>• Additional UROP opportunities</li> </ul>
Senior Thesis	<ul style="list-style-type: none"> <li>• Standardized formal statement of objectives &amp; requirements</li> <li>• Better selection of topics &amp; ease of finding</li> </ul>
Lack of exposure to Health Physics & Fusion	<ul style="list-style-type: none"> <li>• Additional electives (conjunction with other depts.)</li> </ul>
22.06	<ul style="list-style-type: none"> <li>• Joint faculty Fission/Fusion/NST taught rather than 1 professor</li> </ul>
Sparse Engineering background	<ul style="list-style-type: none"> <li>• Additional Engineering design and/or theory classes</li> </ul>
External Internships	<ul style="list-style-type: none"> <li>• Centralized inventory</li> </ul>

### Graduate:

Topic	Recommendation
Diagnostic	<ul style="list-style-type: none"> <li>• Track specific</li> <li>• Properly define &amp; disseminate covered material in advance</li> <li>• Better remediation choices that cover appropriate material</li> <li>• Physics review course taught by NSE faculty</li> </ul>
Qualifier	<ul style="list-style-type: none"> <li>• Better scheduling – give times &amp; dates a month in advance</li> </ul>
22.101	<ul style="list-style-type: none"> <li>• Continue standardization</li> <li>• Formal textbook</li> </ul>
Fission Core Curriculum	<ul style="list-style-type: none"> <li>• Revival of 22.102 (introductory thermodynamics for those with little background in thermal systems)</li> <li>• Integration of 22.211 (reactor physics) with fuel cycle</li> <li>• Separate PRA track</li> </ul>
Fusion Core Curriculum	<ul style="list-style-type: none"> <li>• Establishment of a plasma physics laboratory</li> </ul>
NST Core Curriculum	<ul style="list-style-type: none"> <li>• 2 Tracks: biological applications, quantum applications with additional courses</li> <li>• Removal of electrodynamics component (22.105)</li> </ul>
Doctoral Seminar (NST)	<ul style="list-style-type: none"> <li>• Shift some presentations to fission as appropriate</li> <li>• Split in 2: 1) Health Physics, 2) Nuclear Science</li> </ul>

### **Joint Undergraduate & Graduate:**

<b>Topic</b>	<b>Recommendation</b>
Teaching Assistants	<ul style="list-style-type: none"><li>• Needed for core grad classes</li><li>• Distinction between ‘graders’ &amp; TAs</li><li>• Undergrad ‘tutors’</li></ul>
Mentoring/Advising	<ul style="list-style-type: none"><li>• Mandatory Info session for advisors &amp; students</li></ul>
Staffing	<ul style="list-style-type: none"><li>• Additional fission research scientist</li><li>• Additional fission experimental scientist</li><li>• Better staff management</li></ul>
Physical Plant	<ul style="list-style-type: none"><li>• MIT funds to fix constant leaking in NW12 &amp; NW13</li></ul>
Reactor	<ul style="list-style-type: none"><li>• More graduate curriculum involvement</li></ul>