Book Review

Mark L. Maiello, PhD
Book Review Editor

Analytical Methods for Nonproliferation

Edward C. Morse

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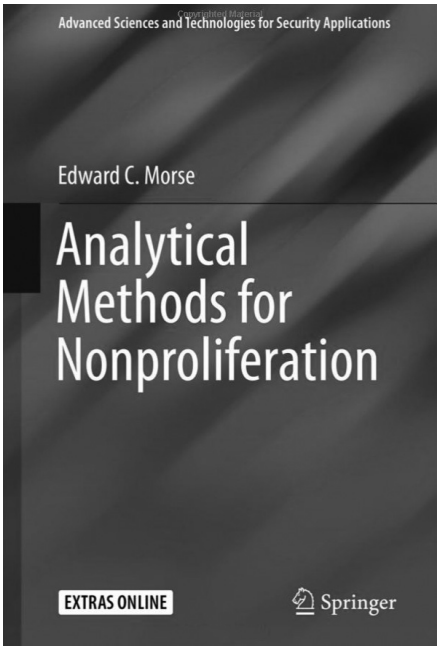

I am impressed with the breadth of knowledge that Edward Morse brings to his readers in this text, designed — according to the preface — for advanced undergraduate and graduate students of nuclear engineering. Morse's mathematical, engineering and policy prowess are evident in this concise, detailed effort. In parts, its mathematics may be beyond many readers, and in others, the deep detail about detection systems may also prove too much of an obstacle. But there is no denying the author's talent, which includes the ability to organize and communicate a well-rounded nonproliferation program of study. One assumes that the text will fulfill its classroom mission, but does it translate into a usable book for the non-student? That is the primary question here.

Analytical Methods for Nonproliferation seems more suited for the adept and aspriring nonproliferation specialist. The equations required are not derived step by step but are essentially placed in the reader's lap to absorb. It is evident that this is a text meant to accompany the author's classroom teaching, where the mathematics may be explored in more detail. As a stand-alone text for office use, be warned that the mathematical side of the book is rigorous and that derivations must be completed by the curious, ambitious and well-practiced reader. Even in the chapters covering detection instrumentation, Morse opts for mathematical discussion rather than descriptions of the electronic components. Clearly, he expects mathematical prowess in his students.

The material covered is a logical if somewhat broad mix of nonproliferation issues that nonproliferation specialists will find useful, if not totally attainable. Early chapters cover nuclear detonations, background radiation, detection statistics, forensics and detonation monitoring. The latter portion of the book covers active detection systems for interrogation, advanced detection systems (some made unusable by nuclear arms limitations inspection protocols) and public policy concerning nuclear proliferation. It is a broad palette, but it is sensible. The early chapters provide the foundational material (nuclear explosives, background radiation, detection statistics and the fuel cycle) to allow a discussion of forensics, nuclear testing detection via seismic analysis and radionuclide signatures. Arms control and treaty verification protocols also benefit from this subject-matter progression. The chapters on active interrogation and advanced technologies — areas where higher mathematics are presented — also make contextual sense here, albeit without the fuller understanding that a knowledgeable instructor could provide. The final chapter on public policy may appear a bit out of place for such a technical book, but there is no denying that it is a good, succinct survey of international and domestic nonproliferation governmental agencies and private initiatives. Certainly, these activities are part and parcel of the nonproliferation regime and partially drive the development of the analytical technologies described in the book.

Such a wide spectrum of topics also serves another purpose. It highlights the talents needed to succeed in the field (and in Professor Morse's course). Although career specialization is the norm, the book's contents are contemporary requirements for a working knowledge of the nonproliferation field — and its main objective is the technical, engineering and scientific side of the house. Policy is but an addition here. Materials management, inventory and other IAEA-type protocols are not included to any great depth.

Although the book casts a wide net, the nonproliferation endeavor is indeed wider. As Morse's students specialize, this text will morph from an excellent learning tool into a reliable reference.

A quick survey of the book reveals the following:

- The chapter on background radiation is done well. With an eye toward detection, there is an opening on the self-shielded disk, half-space and optical thickness that will require some mathematical skill to fully comprehend, but the chapter then settles nicely into an informative read that includes primordial radiation, cosmogenic radiation, Compton scatter and man-made radiation. The accompanying illustrations and tables are more than adequate, and those describing the main primordial naturally occurring decay series and gamma spectra are particularly well done.
- The detection statistics chapter is very involved. Some background in the material will be of help here to the reader (this reviewer was out of his element when the discussion of confusion matrices reared up). It was tough going through Bayesian statistics and pulse shape discrimination but, as I implied above, with the correct professor at the helm to guide students through these choppy waters, success is highly assured.
- The Nuclear Fuel Cycle chapter discusses centrifuges, along with laser isotope separation. The chapter is a brief, to-the-point overview of the cycle.
- There is good coverage of seismic, infrasonic and hydroacoustic detection of nuclear detonations. Again, though it's somewhat mathematically challenging, there is enough discussion to provide a decent understanding by a casual reader about the various physical signatures required for detection and analysis.
- The discussion of Active Interrogation measurements (highly mathematical) includes a mention of dose estimation and cancer risk, a nice touch that accounts for an issue often mentioned in connection with human exposure when vehicles are scanned.
- Advanced Detection Technologies is another nice touch, because it covers new scintillation materials and semiconductor materials, along with alternatives for neutron detection.
- A separate chapter on methods to verify arms control and treaty compliance discusses three plutonium aging methods, along with neutron imaging and neutrino counting. Of note is the author's awareness that some of these methods reveal much more than is needed for verification — for example, components or data that might be considered military secrets. Thus, the methods will not necessarily be universally applied, or will perhaps need negotiations before being accepted.
- Two appendices are included that cover the nuclear Nonproliferation Treaty and the Atomic Energy Act. A four-page glossary and an index finish the book. As a bonus, one can download text-specific material from the publisher at extras.springer.com.

This text will not appeal to everyone. Nonproliferation scientists and engineers will likely applaud its mathematical rigor. Others, such as policymakers with no interest in the physics behind nonproliferation efforts (such as verification), will no doubt steer clear. It's a classroom book first and foremost, and a reference for those skilled enough to use it. It is a well-planned, broad-scope survey of the major topics in the nonproliferation field, with an interrogation and treaty verification perspective. As I mentioned, it does not cover management and inventory of nuclear materials. It is, however, a tribute to its author, who went to great pains to create a customized text for his lecture course. His skills and knowledge are indeed worthy of the university classroom. Based on the content of the book alone, those who can attend his lectures are fortunate.