SANDIA REPORT
SAND2013-0150
Unlimited Release
Printed January 2013

Areas for US-India Civilian Nuclear Cooperation to Prevent/Mitigate Radiological Events

Gopalan Balachandran
Consulting Analyst, Institute for Defense Studies and Analyses
New Delhi, India

Geoffrey E. Forden
Sandia National Laboratories
Albuquerque, NM

Prepared by
Cooperative Monitoring Center
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America. This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone:	(865) 576-8401
Facsimile:	(865) 576-5728
E-Mail:	reports@adonis.osti.gov
Online ordering:	http://www.osti.gov/bridge

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Rd.
Springfield, VA 22161

Telephone:	(800) 553-6847
Facsimile:	(703) 605-6900
E-Mail:	orders@ntis.fedworld.gov
Online order:	http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online

SAND2013-0150
Unlimited Release
Printed January 2013

Areas for US-India Civilian Nuclear Cooperation to Prevent/Mitigate Radiological Events

Gopalan Balachandran[1], Geoffrey E. Forden
Cooperative Monitoring Center
Sandia National Laboratories
P.O. Box 5800
Albuquerque, New Mexico 87185-MS1373

Abstract

Over the decades, India and the United States have had very little formal collaboration on nuclear issues. Partly this was because neither country needed collaboration to make progress in the nuclear field. But it was also due, in part, to the concerns both countries had about the other's intentions. Now that the U.S.-India Deal on nuclear collaboration has been signed and the Hyde Act passed in the United States, it is possible to recognize that both countries can benefit from such nuclear collaboration, especially if it starts with issues important to both countries that do not touch on strategic systems. Fortunately, there are many noncontroversial areas for collaboration. This study, funded by the U.S. State Department, has identified a number of areas in the prevention of and response to radiological incidents where such collaboration could take place.

[1] Institute for Defense Studies and Analyses

CONTENTS

TABLES

NOMENCLATURE

AERB	Atomic Energy Regulatory Board (India)
DAE	Department of Atomic Energy (India)
DOE	Department of Energy (United States)
DRDO	Defense Research and Development Organization (India)
GCNEP	Global Centre for Nuclear Energy Partnership (India)
NDMA	National Disaster Management Authority (India)
NNSA	National Nuclear Security Administration (United States)
NRC	Nuclear Regulatory Agency (United States)
SNL	Sandia National Laboratories (United States)

1. INTRODUCTION

There was very little active bilateral contact between Indian and US nuclear scientists from 1974, when India tested its Peaceful Nuclear Device, and 2008 when the US and India signed the so-called 123 Agreement.[1] A 123 Agreement is a bilateral agreement between the US and another country and is required by the United States Atomic Energy Act of 1954[2] as a prerequisite for any nuclear cooperation between the two countries. Even now, there is no overriding compulsion for any joint collaborative research in the nuclear field. The nuclear science programs in both countries are self-sufficient in fulfilling their respective national goals and needs. However, there are a number of factors encouraging such cooperation.

First, both countries are aware of, and concerned about, the developments in the international nuclear environment that may have very serious negative consequences for the global use of nuclear energy for peaceful purposes and national security. Cooperation would also strengthen India-US political and strategic efforts to manage the changing global international environment in a peaceful manner. It would also nurture the growing bilateral cooperation in other strategic areas such as defense. Finally, such cooperation would increase political awareness at all levels—governmental, commercial, and the general public—in both countries about the need to deepen and improve bilateral relations.

While these factors encouraging nuclear cooperation are real and important, there are also significant aspects that make it difficult. Foremost among those are the residual doubts and apprehensions, harbored in both countries, about the intentions of the other that inhibit greater collaboration between the two countries. For instance, the Hyde act[3], which sets out the US policy on nuclear cooperation with India, was originally viewed by many in India as placing too many restrictions on India's nuclear program.[4] Only after an open letter was sent to Parliament by a group of former military chiefs, bureaucrats, and scientists supporting the deal did it win approval in India.[5] In addition to this initial distrust, there is a lack of awareness in each country about the opportunities such cooperation can create without any adverse consequences on either country's national security goals.

In addition to such policy considerations, which tend to make cooperation difficult, there are several practical difficulties that have inhibited such interactions. Foremost among those has been the perceived lack of attention and thought among governmental offices and non-governmental circles—Think Tanks—such cooperation deserves. There has also been a lack of well-developed institutions where such collaborative research could be carried out. Fortunately, the creation of India's Global Centre for Nuclear Energy Partnership (GCNEP) now provides an appropriate center for such collaboration.

1.1 The Current Study

This study is focused on the prevention and mitigation of radiological incidents. These areas of study are noncontroversial in both countries since they concentrate on the management of emergencies; they will avoid any lingering suspicions the countries may have about cooperation that come closer to strategic systems. It also fills a noticeable void: the perceived lack of substantial interaction between agencies in the two countries that are concerned with emergency and consequence management.

Radiological incidents have been the subject of vital and increased concern, both globally and within India, after the Fukushima Daiichi nuclear accident.[6] This concern has been amplified by the planned acceleration of civil nuclear energy in India. The World Nuclear Association estimates that the power produced by nuclear plants in India will more than double in the next four years as those plants that are already under construction come on line by 2016 to more than 9.6 Gigawatts (electric).[7] The same report estimates that another 45 Gigawatts (electric)—more than ten times the current nuclear capacity in India—will be brought on line if all the planned or proposed nuclear power plants are built.

This increase in nuclear power has been accompanied by an increased public awareness of the off-site consequences of nuclear incidents. Fukushima was much more alarming to the general public than the Chernobyl nuclear power plant disaster in 1986 because so much of it was witnessed live on TV.

The objective of this study is to identify areas of possible cooperation that have a high priority in India, identify places and institutions where the cooperation could take place, and recommend strategies to enable such cooperation.

1.2 Indian Priorities

The National Disaster Management Authority, NDMA, is the cabinet level Indian organization that has been tasked with the management of nuclear and radiological emergencies. It has identified a number of areas where further development is required as a high priority.[8] They point out that rescue and relief measures will be highly demanding in terms of the availability of adequately trained personnel and advanced instruments and equipment. The nature of relief measures for radiological incidents—involving possibilities all the way from nuclear power plant accidents to orphaned radiological sources to terrorist attacks—differs in many ways from those needed in natural disasters like fire, floods, and earthquakes. In a nuclear emergency, the first responders and others who follow to carry out relief work are likely to be exposed to both high doses of direct radiation and contamination that can lead to delayed exposure. These unique aspects of radiological events not only affect the lives and health of the first emergency workers to respond, but their potential to carry out relief work.

There is also much work to be done training all the agencies involved in the management of radiological emergencies. Senior public administrators, like district or state-level officials, who would manage such emergencies, need to have an action plan worked out ahead of time and they need to practice it just as much as first responders need to practice their procedures for dealing with these unique events.

Also needed as a high priority is a mobile monitoring system available to law and order authorities which would warn them of any significant or abnormal rise in the background radiation level in the public domain. This mobile monitoring system is in addition to providing a large number of personal protective gear including personal radiation detection and monitoring instruments. Presently, any such protective gear is confined to the Department of Atomic Energy (DAE) and the Defense Research and Development Organization (DRDO) establishments. Even there, the total numbers of such devices will probably not suffice for responders off the site of nuclear power plants. This lack, and the lack of trained responders, could severely hamper the nation's ability to effectively handle any nuclear emergency scenario.

2. AREAS FOR FUTURE COLLABORATION

Under the terms of reference for this study, we confined our areas of interest to those joint projects that might either help prevent radiological events from occurring or responses that would mitigate the effects of radiological incidents. We have identified general areas for future collaboration but, again, we want to emphasize that the next step for all of these areas of cooperation would be another study to look at a specific area to plan that cooperation in detail.

2.1 Preventing Radiological Emergencies

India, like all countries, places maximum emphasis on preventing nuclear and radiological emergencies. As a consequence, India has instilled a culture of nuclear safety and security and follows the best safety and security practices in its nuclear facilities and institutions that use radioisotopes. There are, nevertheless, two types of emergencies that are of great interest: possible malfunctions in the nuclear fuel cycle and detonation of a radiological dispersal device.[9] There are a number of areas of prevention where collaboration between India and the US would be of great interest. This section lists a few of those.

2.1.1 Control of Nuclear Material across Borders

As with other countries, India is increasingly worried about terrorism of all kinds including nuclear terrorism. It views with concern the security measures its nuclear neighbor, Pakistan, is taking with both its nuclear weapons and its nuclear material.[10] Collaboration leading to an improved ability to detect nuclear material crossing its border may be of interest to India.

2.1.2 Security Measures Beyond the Boundaries of Nuclear Facilities

For the time being, it would be best if U.S. involvement in nuclear security cooperation was limited to issues outside the boundaries of India's nuclear facilities. However, there is plenty of room for cooperation between the two countries in security measures involving radiological materials outside the boundaries of these sites. A few of the possible areas for cooperation are listed below.

2.1.2.1 Security of Radiological Materials at Hospitals, Universities, Industries, etc.

India would be interested in cooperating on security measures at sites outside of its dedicated nuclear facilities. Examples include hospitals, universities, and various industries that use radioisotopes. The U.S. NNSA has started a program to improve security of nuclear material at hospitals around the United States.[11] As a first step in this process, NNSA provides hospitals with an assessment of their nuclear material and then installs security upgrades—remote monitoring systems, biometric access controls, and security cameras—as needed. India would like to study this program and understand the principles behind and guidelines for those assessments.

2.1.2.2 Recovering Orphan Sources.

India, like most countries, has been using encapsulated radioactive sources for a variety of medical, educational, and industrial purposes for years. Of these, a small fraction are so-called orphan sources; sources that possess sufficient radiological hazard to warrant regulatory control but are not so controlled because they have been abandoned, lost, misplaced, or transferred without appropriate measures having been taken. For instance, a high reactivity Cs137 source was imported into India in the 1950s, while regulatory control in the country was still in its initial stages.[12] As a consequence, the source was not placed under regulatory surveillance until a member of the corporation that owned the source discovered it. Without proper regulatory control, this source could have made it out into the community and caused substantial harm. Fortunately, this particular source was discovered and put into the regulatory system before it could escape into society. India would be interested in engaging with the U.S. on developing procedures for the recovery of such sources.

2.1.2.3 Cooperative Development of the Principles of Nuclear Transportation Security
India has plans to dramatically increase its use of nuclear power in the years ahead.[19] This will inevitably result in a huge increase in the transportation of nuclear fuel, both fresh and irradiated. The U.S. has years of experience in the safe and secure transportation of these kinds of materials and India may be interested in collaborating with the United States on designing safe and secure transportation containers and understanding the guiding principles for secure transportation.

2.1.3 Cooperation on Seismic Evaluation of Reactor Siting
India is a relatively active seismic region of the Earth with almost 54% of the land vulnerable to earthquakes.[13] Fortunately, most of the power reactors that have already been built are in relatively quiet zones either inland—and hence safe from tsunamis—or on the West coast of India. As India's fleet of nuclear power plants increases in the years ahead, that might not always be possible. India may be interested in joint research on evaluating reactor sites for seismic and tsunami suitability.

2.1.4 Cooperation on Developing Guidelines for the Preparation of Environmental Impact Statements
The U.S. Nuclear Regulatory Commission publishes detailed guidelines on how to write environmental impact statements for reactors inside the United States.[14] However, the U.S. guidelines are very US-centric and geared to responding to U.S. laws. India may be interested in understanding more about the basic principles of writing such environmental impact statements so that they can be written explicitly for the Indian experience.

2.2 Responding to Radiological Emergencies
No matter how much work is spent trying to prevent radiological emergencies most experts agree that they will eventually occur. Because of this, it is important to plan for their response, as well as their prevention. This section discusses some of the areas of joint cooperation that India and the United States might undertake to build up responses in both countries to radiological events.

2.2.1 Developing Guiding Principles for Evacuation Plans
Evacuation, and its complement, sheltering, are the principal protective actions that might be taken by the authorities to protect the public during the early phase of a radiological emergency originating in a nuclear power plant. Evacuation is the removal of the populous to avoid or reduce high-level, short-term exposure from the emitted plume. Planning for it, however, must take into account a number of different scenarios and the availability of transportation. These factors can differ considerably between the United States and India, for instance, in the US, there is a higher probability of ice storms in the vicinity of power plants and Indian authorities have to worry more about the effects of monsoons. India will need to develop its own parameters to use

in making such plans. However, India may be interested in collaborating with the United States to develop guidelines for its own evacuation plans.

2.2.2 Establishing a Nation-wide Network of Hospitals for Handling Radiation Injuries

Radiation injures are, fortunately, not frequent events, which causes most hospitals to be unfamiliar with their treatment. However, a number of specialties usually associated with other forms of care can contribute to the care of irradiated patients. For example, cancer treatment and its specialties such as those associated with the care of patients needing bone marrow transplants. Most patients, however, even those with severe doses from a radiological incident will most likely not need bone marrow transplants. But the supportive care associated with such procedures can greatly aid the expected casualties.[15] For that reason, hospitals local to the radiological incident—which most likely do not have such specialized expertise—can benefit considerably from the hospitals that do. These network hospitals can help triage the patients and determine which need more specialized supportive care and who should be moved to the network hospitals. However, setting up such a network requires considerable planning based on both the specialized medical knowledge and the results of numerous studies of large-scale simulations of radiological events. India would be interested in both collaborating with the United States on those studies and utilizing the information from past studies to develop such networks.

2.2.3 Developing Procedures for Transmitting Information to Off-Site Stakeholders

India has developed the federal-level mechanisms for dealing with large scale radiological incidents but there is considerable work to be done at the state and local levels. Of particular interest is how a nuclear facility communicates the occurrence and status of a radiological emergency to the local stakeholders: the populous as well as state and local officials.

2.2.3.1 Communicating with the Population

Communicating with the population in the region of the radiological emergency should be done by means that are available to the vast majority of the public and appropriate for their proximity to the site of the radiological emergency. Furthermore, the public must be made aware of what the appropriate response is to an issued warning and where they can learn more information about what actions to take. This necessitates continual communication with and education of the public. India may be interested in collaborating with the United States on developing the guidelines for establishing these channels of communication and education.

2.2.3.2 Communicating with State and Local Level Officials

Communication involves both technology and procedures and both need to be developed. State and local officials are in charge of the initial agencies responsible for protecting the public from the offsite consequences of a radiological incident. They are responsible for ordering such preventative measures as evacuations. However, these officials can only make their decisions based on information released by the nuclear facility so it is important that strong lines of communication be established as well as educating these officials so that they can develop written procedures for dealing with these emergencies. Cooperation between the U.S. and India on developing the guidelines for formulating these procedures—which must depend on the specific circumstances for each locale—as well as the systems for assured communication may be welcome.

2.2.4 Mobile Monitoring Systems

India recognizes the need for mobile monitoring systems for determining the levels of radiation around the site of the radiological emergency. India could either purchase such systems or license their production.

2.2.5 Develop Training Plans for Responding to Radiological Incidents

One of the most important factors in ensuring successful response to emergencies is a comprehensive training program that involves realistic exercises. Not only do such realistic exercises provide individual training, but, if the results are properly evaluated, they also improve the whole emergency management system.[16] India may wish to cooperate on planning training exercises for radiological incidents and, as preparation for that, send observers to a U.S. field exercise for a radiological incident.

3. CONCLUSIONS

In this report, we have outlined a number of new initiatives for potential cooperation between India and the United States. More joint preparatory work needs to be done on just about all of these initiatives before the actual development can take place. We recommend that follow-on studies be done between Indian and US scientists and policy makers to work out the details. However, once a work plan has been created, the joint development work will need to find a venue. We recommend that joint development work taking place in India utilize the Schools associated with the Global Centre for nuclear Energy Partnership being set up outside of New Delhi.

In September 2010, the central government approved the establishment of the Global Centre for Nuclear Energy Partnership (GCNEP).[17] The proposed center will provide facilities related to advanced education, research, and training in the fields shown in Table 1. The mission of the School of Radiological Safety Studies is "to carry out research and development in radiation monitoring including development of detectors and systems, to develop decision support systems for nuclear emergency management, to conduct radiation transport, shielding, dispersion modeling and impact assessment studies, to impart training to and certification of personnel in radiation protection principles and safety practices, and to maintain and update radiation protection standards."

Table 1. The Schools within the Global Centre for Nuclear Energy Partnership[18]

1) School of Advanced Nuclear Energy Systems Studies
2) School of Nuclear Security Studies
3) School of Radiological Safety Studies
4) School of Nuclear Material Characterization Studies
5) School for Studies on Applications of Radioisotopes

This Centre can provide the needed institutions, facilities, and personnel in India for many of the areas for joint research and cooperation outlined in this report. In particular, the School of Radiological Safety Studies' mandate aligns very well with many of the initiatives developed here. Others might well find a home in the School of Nuclear Security Studies.

4. REFERENCES

1. The Times of India, “India, US sign landmark 123 Agreement,” October 11, 2008; available at http://articles.timesofindia.indiatimes.com/2008-10-11/india/27905286_1_indian-nuclear-market-sign-landmark-civil-nuclear-field, last accessed 11/6/2012

2. The United States Atomic Energy Act of 1954, available at http://www.gpo.gov/fdsys/pkg/BILLS-112hr1320ih/pdf/BILLS-112hr1320ih.pdf, last accessed 11/6/2012

3. United States and India Nuclear Cooperation (Public Law 109-401-Dec. 18, 2006), available at http://www.gpo.gov/fdsys/pkg/PLAW-109publ401/pdf/PLAW-109publ401.pdf, last accessed 11/6/2012

4. Praful Bidwai, “POLITICS: India Split Over US Nuke Deal,” Inter Press Service News Agency, available online at http://www.ipsnews.net/2006/12/politics-india-split-over-us-nuke-deal/, last accessed 11/6/2012

5. The Indian Express, “The Question is Can We Get a Better N-Deal? No”, available online at http://www.indianexpress.com/news/-the-question-is-can-we-get-a-better-ndeal--no-/239308/0, last accessed 11/6/2012

6. Matthias Wiliams, Reuters, “Fukushima fallout seeps into India’s nuclear push”, available online at http://in.reuters.com/article/2012/09/19/india-nuclear-kudankulam-fukushima-idINDEE88H0FL20120919, last accessed 11/6/2012

7. World Nuclear Association, “Nuclear Power in India,” available online at http://www.world-nuclear.org/info/inf53.html, last accessed 11/6/2012.

8. National Disaster Management Authority (NDMA), “National Disaster Management Guidelines—Management of Nuclear and Radiological Emergencies” (February 2009), available online at http://nidm.gov.in/PDF/guidelines/nuclear_radiological_emergencies.pdf. Last accessed 11/6/2012.

9. Ibid., p. xv.

10. Parul Chandra, The Asian Age, “India worried about Pakistan’s nuclear programme, terrorism,” March 25, 2012, available online at http://www.asianage.com/india/india-worried-about-pakistan-s-nuclear-programme-terrorism-961

11. GAO, “Additional Actions Needed to Improve Security of Radiological Sources at U.S. Medical Facilities,” (GAO-12-925), September 2012, available online at http://www.gao.gov/assets/650/647931.pdf, last accessed 11/8/2012

12. The IAEA, <u>Strengthening control over radioactive sources in authorized use and regaining control over orphan sources</u>, IAEA-TECDOC-1388, February 2004, p. 25

13. Dr. B. B. Jain, “Housing Census Data and Disaster Mitigation Aspects in India,” presented at the United Nations Workshop on Census Cartography and Management for ESCAP, 15-19 October 2007, Bangkok, Thailand.

14. U.S. Nuclear Regulatory Commission, Preparation of Environmental Reports for Nuclear Power Stations, NUREG-0099, Regulatory Guide 4.2, revision 2 (1976), available online at http://www.orau.org/ptp/PTP%20Library/library/Nrc/Reguide/04-002.pdf, last accessed 11/12/2012.

15. Radiation Injury Treatment Network, Radiation Injury Treatment Network (RITN): Concept of Operations. (February 2012), available online at http://www.ritn.net/WorkArea/DownloadAsset.aspx?id=2147483905, last accessed 11/12/2012.

16. National Preparedness Directorate, FEMA, “Unite 1: Introduction to Exercise Design,” available online at http://training.fema.gov/emiweb/downloads/is139Unit1.doc, last accessed 11/15/2012

17. The Hindu, “Haryana to have global centre for nuclear energy,” available online at http://www.hindu.com/2010/12/04/stories/2010120451550400.htm, last accessed 11/6/2012

18. GCNEP List of Schools, Department of Atomic Energy, available online at http://www.gcnep.gov.in/schools.html#3, last accessed 11/6/2012

19. The Indian Department of Atomic Energy, “Meeting Demand Projection,” available on line at http://dae.nic.in/?q=node/129, last accessed 1/8/2013

APPENDIX: AUTHOR BIOGRAPHIES

Dr. Gopalan Balachandran

Dr. Balachandran is a consulting fellow at India's Institute for Defense Studies and Analysis (IDSA) where he works on projects related to Indian defense spending and civil nuclear power programs. He has advanced degrees in economics, computer science, electrical engineering, and applied physics from universities in India, England, and the United States. Previous to working at IDSA, Dr. Balachandran worked in a number of capacities ranging from correspondent (at The Hindu) and editor (at the Business Standard, New Delhi) to director for a United Nations development program. He has done a number of studies for various agencies of the Indian government.

Dr. Geoffrey E. Forden

Dr. Geoffrey Forden is a physicist by training but has been working on issues related to arms control, international security, and nonproliferation for the last 15 years. He joined Sandia in September of 2010, where he has worked on a number of projects furthering the nonproliferation goals of the Departments of State and Energy in the Middle East, North Africa, and South Asia. His work on South Asia while at Sandia has involved extensive interactions with both Indians and Pakistanis separately and together. Before coming to Sandia, he spent ten years as a principle research scientist at MIT. While there, he concentrated on understanding how developing nations acquired the world's most dangerous weapons. He took a year off from MIT to work as United Nation's Monitoring, Verification, and Inspection Commission's (UNMOVIC) first Chief of Multidiscipline Analysis and Assessment. UNMOVIC was the UN's weapon inspection agency for Iraq.

DISTRIBUTION

10 Dr. G. Balachandran
No. 1 Development Enclave
Rao Tula Ram Marg.
Delhi Cantt, New Delhi 110010
India

10	MS1373	Geoffrey Forden	6821
1	MS1373	Kent Biringer	6821
1	MS0899	Technical Library	9536 (electronic copy)