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The Need for a Cooperative Ambient Radiation Monitoring System in South Asia

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1.0 Introduction

In South Asia, India and Pakistan have both recognized the need for nuclear-related Confidence Building Measures (CBMs). However, mutual distrust and a stalled dialogue hamper efforts to implement such CBMs. Fortunately, a process of engagement is again restarting between India and Pakistan. In May 2003, both countries reestablished diplomatic relations and are about to restart a composite dialogue that includes a working group on CBMs and security issues. The dialogue will begin from agreements reached at summits in Lahore in 1999, when a Memorandum of Understanding (MoU) was signed, and at Agra in 2001 when, though no formal agreement was signed, an understanding was reached prior to the summit that the CBMs proposed at Lahore would be strengthened and implemented. The time is opportune, therefore, to investigate a process of incrementally implementing nuclear-related CBMs in South Asia. One such possible CBM, a South Asia Cooperative Ambient Radiation Monitoring System (SACARMS), is discussed in this paper.

Insufficient cooperation in the sharing of nuclear monitoring information in South Asia leads to a risk that affected countries could misinterpret an accident, or unexplained incident that creates radioactive fallout in the region. This could have adverse consequences especially if the incident occurs during a crisis. The situation worsens the prospects for both: (1) stable relations between India and Pakistan, and (2) advancing nuclear nonproliferation goals in the region.

This paper explores reasons for India and Pakistan to create a project such as SACARMS for the monitoring and sharing of ambient radiation data from a network of stations. An ambient radiation-monitoring network will have intrinsic benefits related to protecting human health and the environment, as well as for the safety of nuclear installations. SACARMS will also serve as a less-sensitive step in a process of incrementally creating nuclear-related CBMs. This process helps create the infrastructure for other future projects that could involve more sensitive monitoring subjects such as those related to the reduction of nuclear weapons or their deployment status. In the paper, the existing cooperative frameworks under which a project on ambient radiation monitoring could be formulated are reviewed, and a roadmap is presented for creating and implementing the project.

2.0 Security and sensitivity issues

India's draft nuclear doctrine states very clearly in section 8.5 – "In view of the very high destructive potential of nuclear weapons, appropriate nuclear risk reduction and confidence building measures shall be sought, negotiated and instituted." Although draft, this doctrine can be interpreted as a statement of intent. There is clearly an interest within

[1] Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

India to engage in nuclear-related CBMs. Pakistan, too, is in support of nuclear-related CBMs, and at Lahore reached agreement with India on the need for such CBMs.

The Lahore MoU, among other issues that it addresses, states that – "The two sides further undertake to notify each other immediately in the event of any accidental, unauthorized or unexplained incident that could create the risk of a fallout with adverse consequences for both sides, or an outbreak of a nuclear war between the two countries, as well as to adopt measures aimed at diminishing the possibility of such actions, or such incidents being misinterpreted by the other. The two sides shall identify/establish the appropriate communication mechanism for this purpose." The agreement also stated that the two sides will undertake "immediate steps for reducing the risk of accidental or unauthorized use of nuclear weapons and discuss concepts and doctrines with a view to elaborating measures for confidence building in the nuclear and conventional field, aimed at prevention of conflict." Before the Agra summit in 2001, there was reported discussion within Indian government circles about strengthening the existing CBMs in the nuclear field signed during the Lahore summit.[1] The Lahore MoU is currently not being implemented. However, demonstrating some of the technologies that could implement the data sharing envisaged in the MoU might influence policy makers to implement some aspects of the MoU.

Based on the officially stated positions in support of nuclear-related CBMs, and the fact that a dialogue on security and CBMs is restarting, the proposed SACARMS project, would probably find support from within Indian and Pakistani security agencies as an example of the nuclear-related CBMs both sides have already reached agreement on instituting, but have made little progress in implementing.

2.1 Restricting SACARMS to non-sensitive sites and non-sensitive types of data

The key to getting Indian and Pakistani involvement in the SACARMS project, and assuaging any misgivings that might be felt by concerned security agencies, will be to restrict the project to gathering radiation data at extremely non-sensitive locations. Figure 1 graphs various types of candidate locations and their varying levels of sensitivity from a security standpoint. Within each of the major categories described in Figure 1, there are sub-categories of locations that have differing levels of sensitivity. For example, within the category of civilian nuclear facilities there are uranium mines, mills, fuel manufacturing plants, research reactors, power reactors, spent fuel storage sites, reprocessing plants, etc. Each of these locations has a varying level of sensitivity associated with it, and could be placed on a spectrum of increasing or decreasing sensitivity.

From a nonproliferation perspective, the ideal locations at which Indian and Pakistani agencies should collect and share data are located towards the right and lower side of Figure 1. From a more practical viewpoint, the likely locations at which a project could be initiated are towards the left and upper side of Figure 1. Even for locations on the left side of Figure 1, Indian and Pakistani agencies may have misgivings at getting involved in a radiation level data-sharing project. They may fear that they are getting onto a "slippery slope" designed to get them to progressively share data eventually from more sensitive sites. Therefore, it is important that the project be tied to an existing arrangement for data sharing for sites towards the left side of Figure 1 – that is, an

arrangement already agreed to by various South Asian countries which clearly limits the scope of the sites at which data will be gathered. This will allay any Indian and Pakistani fears that they are being enticed into a data-sharing framework designed solely to further nuclear nonproliferation goals, and over which they may have limited control.

The kinds of data that are gathered will also need to be considered carefully for their impact on Indian and Pakistani concerns about SACARMS.

For example, measuring concentrations of radionuclides associated with the reprocessing of plutonium, such as Krypton-85, would likely be considered off-limits. Some researchers have suggested such measurements as a part of a verification regime in South Asia for a fissile material cutoff treaty.[2] Tritium concentrations in surface water and groundwater near nuclear reactors would also be a sensitive issue as these levels could be related to leaks and accidental releases from the facilities. Data on concentrations of radionuclides associated with the separation of plutonium from spent fuel would also fall into the category of highly sensitive information that could not be readily shared.

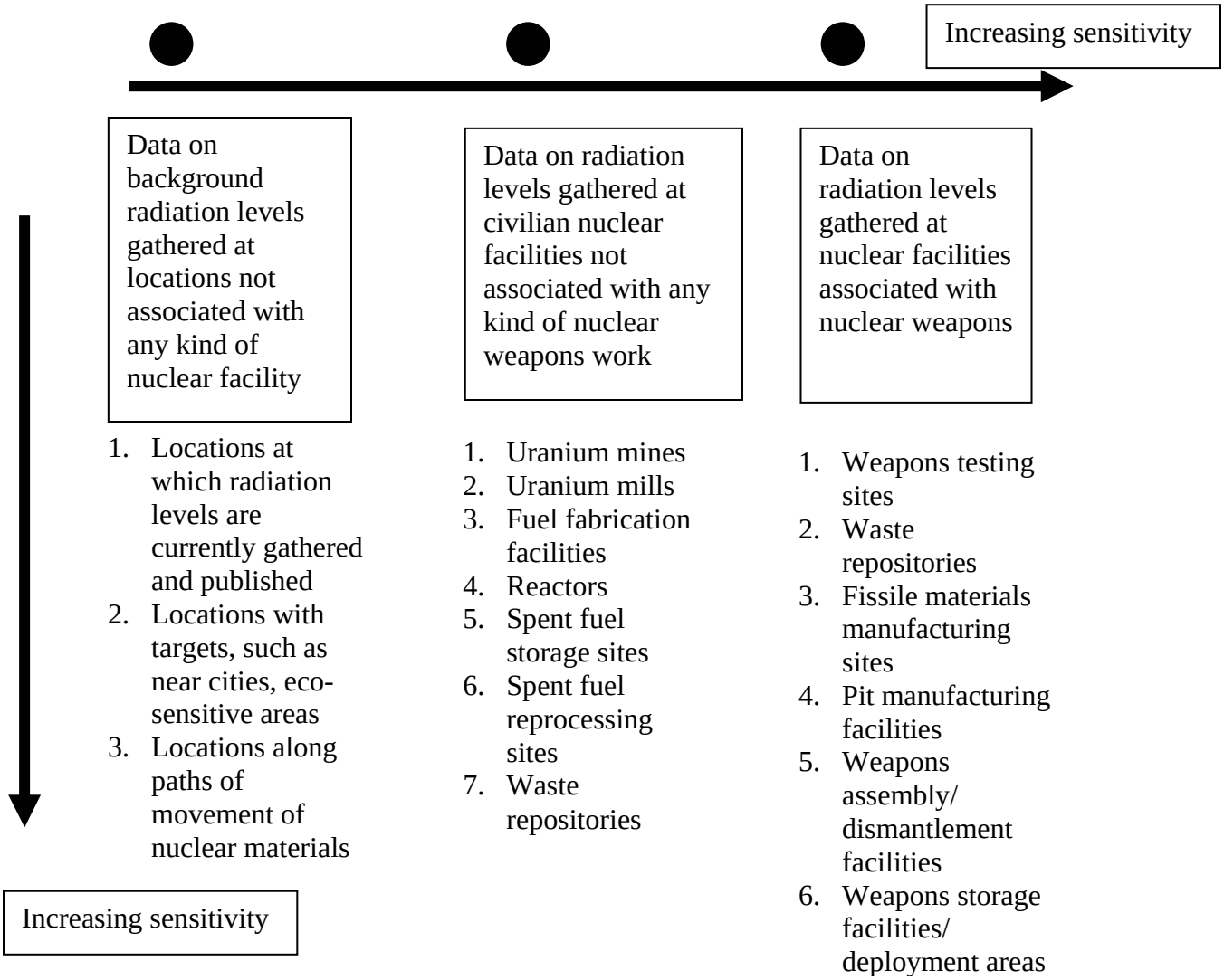

Figure 1: Degree of sensitivity of various types of locations at which data could be gathered and shared.

As in Figure 1, we can plot the increasing sensitivity of different types of data that could be gathered. As shown in Figure 2, at the low sensitivity end of the spectrum would be data on the levels of total ambient radiation. Data on concentrations of specific radionuclides would be more problematic to share, and even more so would be data on radionulicdes associated with fissile materials, weapons manufacture, and explosions.

If agreements on the sharing of certain types of data have already been reached, and if the data are already being gathered and disseminated, then the sensitivities about sharing such data in a regional context will be less.

It will be important, therefore, to find partners within India and Pakistan that are – 1) already engaged in gathering and sharing data on radiation levels; 2) able to get involved in a regional project, such as SACARMS, and to work with US organizations. In finding such partners, it will be important that the organizations are not listed as entities against which the US has imposed nuclear and missile nonproliferation sanctions.

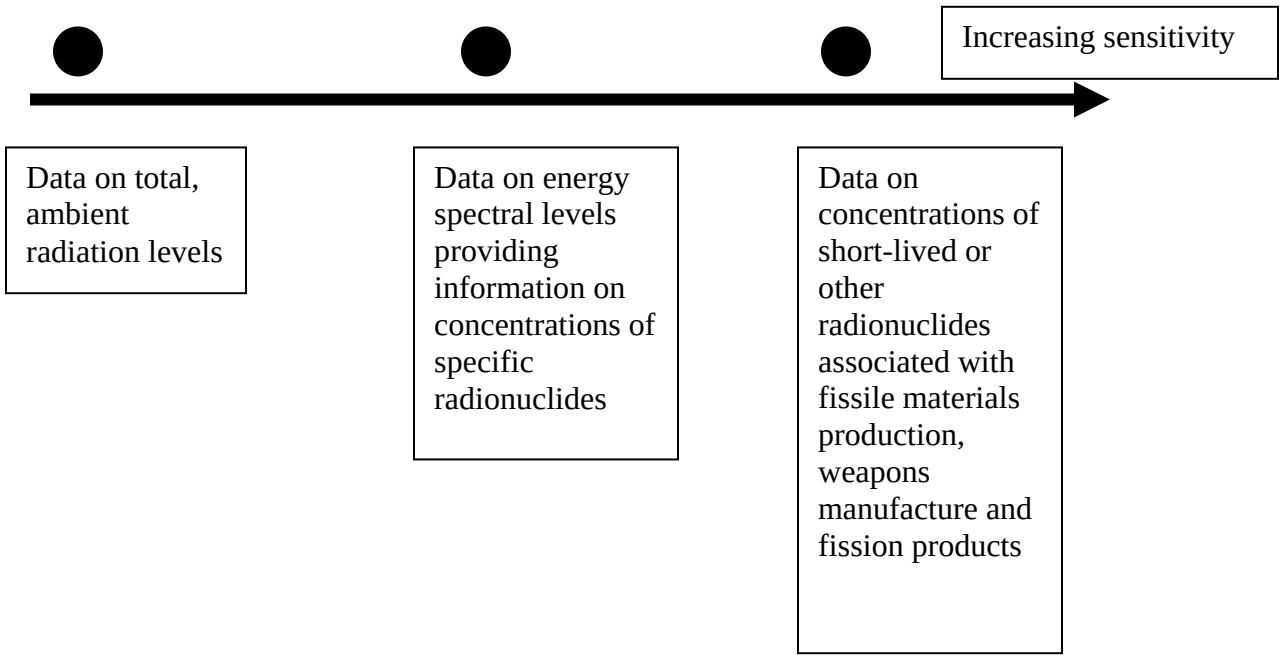

Figure 2: Degree of sensitivity of various types of data that could be gathered and shared.

2.2 Regulatory issues for Indian and Pakistani involvement

From a U.S. perspective, one of the main reasons for not initiating a project that involves the collection and sharing of data at sites located towards the right side of Figure 1 (even if Indian and Pakistani agencies were amenable to such a project) is that the agencies likely to be involved are under current US sanctions[3] that prohibit the transfer of technology to these agencies.

The two most important laws and regulations that govern US sanctions on India and Pakistan are the Export Administration Regulations and the Nuclear Proliferation

Prevention Act. In 2001, President George W. Bush waived many of the existing sanctions in the interest of waging a war on terrorism. The removal of sanctions on India and Pakistan for nuclear and missile proliferation cannot be taken to mean that the US will now engage in nuclear cooperation with these countries. Rather, the removal of sanctions allows for defense and economic assistance in select areas and there is no longer a blanket ban on such cooperation. However, the transfers of nuclear or missile related technology to a number of entities in India and Pakistan remain restricted.

Given the existence of US sanctions, SACARMS must be based on sites located towards the less sensitive end of the sensitivity spectrum to avoid interactions with agencies on the U.S. sanctions list.

2.3 Ideal sites and types of data to be gathered

The ideal sites for the proposed ambient radiation-monitoring network will be those at which data is already gathered and published. Such sites will have the least sensitivity regarding the sharing of the data. The sites should also not be associated with a nuclear facility, in order to allay any security concerns.

Total ambient gamma dose rates will be non-sensitive, easy to measure types of data that could be shared at first. The existence of the network creates the possibility for the partners to incrementally expand the sensitivity of the data. However, this expansion will have to be mutually agreeable to the partners and will be dependent on their political will and the state of their relations.

3.0 Existing Relevant Frameworks for South Asian Nuclear Cooperation

Three existing frameworks for developing SACARMS are readily available. One of these frameworks is to utilize existing bilateral US-India, US-Pakistan, and US-Bangladesh nuclear-related interactions. Another two frameworks are provided by regional and global agreements for monitoring and sharing data on radiation levels. The Regional Cooperation Agreement (RCA) involving the International Atomic Energy Agency (IAEA) and seventeen Asia-Pacific countries has a project titled "Environmental Radiation Monitoring and Regional Database". The Global Environmental Radiation Monitoring Network (GERMON) is a United Nations led program jointly run by the United Nations Environmental Program (UNEP) nand the World Health Organization (WHO). The RCA and GERMON both provide relevant frameworks for implementation of SACARMS.

3.1 US-India nuclear cooperation

US-India nuclear related interactions have recently become much more enhanced than in the past. However, the Department of Atomic Energy (DAE) and many of its key organizations remain on the US Entity List. Of most interest to this project, is the collaboration that has been initiated between the US Nuclear Regulatory Commission (NRC) and India's Atomic Energy Regulatory Board (AERB) The AERB represents an excellent choice of partner for the project under consideration.

On 24 February 2003, the Chairman of the US NRC, Richard A. Meserve, led a sixteen-member delegation to the AERB to discuss increased collaboration in nuclear safety.

During this visit, five areas of mutual interest were discussed in detail by technical teams of the NRC and the AERB.

The five areas discussed and that have been selected for collaborative work are –

- Fire safety
- Symptom-based emergency procedures
- Design modifications and retrofitting of nuclear power plants
- Risk-informed performance based regulation and procedures for license renewal
- Periodic safety reviews

A road map has been developed for future interactions.

Given this level of interaction that is now beginning between the NRC and the AERB, it should not be difficult to initiate a radiation-monitoring program with the AERB as a partner.

The AERB through its Radiation Safety Division has an active program to monitor a wide variety of radionuclides and radiation levels to assess the performance of nuclear power plants, as well as impacts on human populations from naturally occurring radiation sources. The AERB sets up radiation monitors and collects samples up to a distance of 30 km from nuclear power plants. The aim of this monitoring is to ensure that the dose received by a member of the public is within the limits prescribed by the AERB. Three types of data are gathered:

- Environmental samples, such as water and foodstuffs, to estimate human doses
- Weeds and sediments to serve as trend indicators
- Biological samples from sensitive indicator species – an example is goat thyroids for trace levels of Iodine-131, as goats usually forage over a very large area

Compilations of these data are published in annual reports of the AERB. The AERB also operates a research institute called the Safety Research Institute at Kalpakkam. Among the research interests of the AERB are –

- Population surveys on levels and effects of natural radiation environments.
- Studies on/surveys for assessment of exposure levels due to radiation and radionuclides in the environment, studies to determine transfer coefficients for radioactive iodine from pasture to cow to milk and for cesium from pasture to meat

The AERB has also funded research projects on studies of environmental radioactivity levels. For example, at Osmania Uinversity, Hyderabad, Andhra Pradesh, the AERB funded a project on “Studies on environment radioactivity levels around Lampur, Peddagatu area of Nalgonde district and along the East Coast areas between Bheemunipatanam and Kalingapatanam”. At the Indian Institute of Technology, Mumbai, the AERB has funded a project called “Integrated studies on radionuclide migration at

shallow land disposal facility". The universities conducting such research become excellent potential partners for the project.

3.2 US-Pakistan nuclear cooperation

The Pakistan Atomic Energy Commission (PAEC) and some of its subordinate organizations are on the US Entity List. Many of these same organizations conduct the most extensive environmental radiation monitoring studies.

The history of the PAEC goes back to 1956, when the Atomic Energy Research Council was established. In 1964, 1965 and 1973 the Council was reorganized and the Atomic Energy Commission was incorporated. In 1972 the commission was transferred from the Science and Technology Research Division to the President's Secretariat. The PAEC is now the largest science and technology organization in Pakistan, with programs in nuclear power, agriculture, medicine, biotechnology and other scientific disciplines, as well as in nuclear weapons.

Although the PAEC and the Karachi Nuclear Power Plant (KANUPP) facility may not become active partners in the project, data that has been gathered by these entities could be shared through the project. For example, at KANUPP, detectors have been installed around KANUPP and in the city. In addition, samples of vegetables, grass, soil, water, fish and milk are regularly analyzed to measure their radioactivity content.

A more effective project partner from within Pakistan that is not on the US Entity List could be the Pakistan Nuclear Regulatory Agency (PNRA). The PNRA is the independent authority in Pakistan responsible for controlling, regulating and supervising all matters relating to nuclear safety and radiation protection. The Pakistan Nuclear Regulatory Authority Ordinance promulgated on 22 January 2001 established the PNRA. Within the PNRA, one of the more suitable partners could be the National Radiation Emergency Coordination Center.

3.3 US-Bangladesh bilateral cooperation

A US-Bangladesh project to monitor and share nuclear data and information has been proposed and studied.

Bangladesh has signed and ratified the Nuclear Nonproliferation Treaty (NPT) and the Comprehensive Test Ban Treaty (CTBT) and is not under any nonproliferation sanctions. Bangladesh has an established nuclear technology infrastructure, operates a 3MW TRIGA II research reactor in Savar, is developing a waste processing and storage facility nearby, and eventually will ship spent nuclear fuel to the USA as part of the foreign research reactor spent nuclear fuel return program. These activities were recognized at the Cooperative Monitoring Center (CMC), at Sandia National Laboratories, as providing a number of opportunities for Bangladesh-U.S. collaborative nuclear monitoring. These opportunities include research reactor operations and maintenance and safety; fuel handling, storage, and packaging; fuel transportation; and ambient radioactivity monitoring. The U.S. Department of Energy, DOE/NN241, has provided funds to the CMC to develop the concept for a Bangladesh-U.S. nuclear monitoring project. The project is being coordinated through the U.S. Department of State, South Asia and Nonproliferation Bureaus.

A team of three staff members from the CMC traveled to Bangladesh in March 2001. and discussed prospects for a collaborative nuclear monitoring project with the Bangladesh Atomic Energy Commission (BAEC), and staff from the Savar TRIGA II facility. In March and April 2002, Dr. C. S. Karim of the BAEC worked at the CMC as a Visiting Research Scholar, and drafted specific proposals for collaboration. The initial monitoring project plan is to proceed in phases, through the sharing of existing data and information, to the eventual gathering of new data by the BAEC using equipment supplied by the CMC. The plan is being further developed in consultation with Bangladesh regulatory and facility officials.

This project in Bangladesh with CMC coordination could form the starting point of SACARMS.

3.2 The Regional Cooperation Agreement

The IAEA works in collaboration with Bangladesh, India, Pakistan and Sri Lanka on a variety of projects, providing a structure for greater South Asian nuclear transparency. The Regional Cooperative Agreement for Research, Development and Training in Nuclear Science and Technology in Asia and the Pacific (RCA) is an intergovernmental agreement under the auspices of the IAEA, in which the Government Parties undertake, in cooperation with each other and with the IAEA to promote and coordinate cooperative research, development and training projects in nuclear science and technology through their appropriate national institutions. The RCA is described in the IAEA Information Circular 167. The RCA includes the following countries along with the four South Asian countries mentioned above: Australia, Indonesia, Japan, Malaysia, Myanmar, Mongolia, New Zealand, People's Republic of China, Philippines, Republic of Korea, Singapore, Thailand and Vietnam.

Among the main areas of focus of the RCA is Radiation Protection. Within this area, the RCA has worked on the following:

- Building radiation protection infrastructure
- Waste safety
- Environmental monitoring
- Radiation protection for workers and public

Of interest to the SACARMS project is the third bullet – "environmental monitoring".

The RCA has an existing project underway titled RAS/9/024 - Environmental Radiation Monitoring and Regional Database. The objectives of this project are to "strengthen environmental radiation monitoring capability and to establish a regional environmental radiation monitoring database". The countries most involved are – Australia (through the Australian Radiation Protection and Nuclear Safety Agency), China, India (through the Department of Atomic Energy; Atomic Energy Commission; Bhabha Atomic Research Centre; Environmental Assessment Division), Myanmar, and Vietnam (through the Institute of Nuclear Sciences and Technology, Hanoi).

This project of the RCA provides a valuable framework for SACARMS. Given the involvement of India and Pakistan in the RCA, as well as that of Bangladesh and Sri Lanka, the RCA provides a structure within which a sub-regional grouping could focus on South Asian issues.

3.3 GERMON

GERMON is a United Nations monitoring and assessment program. GERMON was initiated jointly by the WHO and the UNEP and is based largely on existing national programs for monitoring environmental radiation and for dealing with major releases of radioactivity. To date, sixty countries participate in this program, including the US and India. None of the other South Asian countries of interest have yet participated in this program.

The main features of GERMON are[4] -

- "the ability to collect, compile and disseminate information on environmental radiation;
- the ability to provide an international alert in cases of unusual increases in environmental radiation;
- the ability to collect, compile, and exchange relevant information rapidly during radiation emergencies on a harmonized basis;
- the ability to improve the quality of measurements, and
- the harmonization of sampling and reporting in all participating countries."

GERMON is a part of the Global Environmental Monitoring System (GEMS) set up by the UNEP. Its organizational structure is based on: WHO Headquarters and Regional Offices, and UNEP Headquarters; a Scientific Advisory Group; a Coordinating Collaborating Center; Regional Coordinating Centers (RCC); and national Liaison Institutions.

India has been an active partner in GERMON, with twenty-five national stations. The Bhabha Atomic Research Center (BARC) coordinates Indian GERMON activities through its Environment Assessment Division. The types of data gathered in the Indian GERMON program are –

- Continuous gamma monitoring – High Presssure Ionization Chamber, GM counter
- Continuous beta-gamma air particulate monitor, with Radon/Thoron daughter products and long-lived fission products
- Large volume continuous air sampling system with weekly gamma spectrometric analysis of filters
- Collection of wet/dry deposition for analysis of long-lived radionuclides
- Periodic collection of milk samples for Cs-137 and Sr-90 (monthly)

A research center set up at Mangalore University with the assistance of the BARC and the DAE is one of the nodal centers in India for the collection of GERMON-related samples. This center is not on the Entity List, and therefore could be a viable project

partner. The BARC is on the US Entity List and subject to nonproliferation sanctions that restrict interaction between US organizations and the BARC.

The GERMON station set up at Mangalore University consists of "two GM detectors to count short-lived ^{222}Rn daughters as well as ^{220}Rn activities and long-lived radionuclides, if any. It is also fitted with a high-pressure ionization chamber to measure the gamma absorbed dose rates in air. Figure 3 presents a photograph of this station. The station was commissioned in October 1996 and has been working satisfactorily."[5]

In addition to these, the laboratory infrastructure includes a variety of radiation monitoring sensors[6], and advanced computing systems for data acquisition and analyses. A number of researchers from neighboring universities and institutions have access to the laboratory infrastructure for radionuclide analyses of environmental samples collected in their region. The facility is also utilized to train students.

The GERMON Station has collected large quantities of data on ^{222}Radon and ^{220}Radon daughters concentration, long-lived artificial radioactivity in air and gamma absorbed dose rate in air. The results show, that the ^{222} Radon daughters concentration varies from 0.5 Bq m^{-3} to 16.7 Bq m^{-3}. The highest concentration was observed in the winter season and the lowest concentration occurred in the monsoon. The gamma absorbed dose rates in air vary from 1083 nGy/ d to 1404 nGy/ d.

Figure 3: The Mangalore University GERMON station (Source: Article by K. Sidappa in Nuclear India)

The Mangalore University GERMON program researchers have also been doing systematic studies in the environs of Coastal Karnataka, Kaiga and Goa on environmental radioactivity.

4.0 Roadmap for Project Initiation

Using the existing US bilateral arrangements, monitoring systems in India, Pakistan, and Bangladesh for collecting and sharing data could quickly come on-line. Once data is

being shared with the US, the countries automatically become involved in a regional framework. The advantage of this approach is that the control of the project is shared between the US and its bilateral partner, and project implementation can proceed rapidly. The measurements from the monitoring stations established under bilateral programs will become a part of regional and global networks for sharing radiation data and information.

The specific steps to be taken are -

- Work with the US State Department to contact identified regional partners and make visits to their facilities
- Sponsor a workshop in the region to create a detailed project work plan
- Initiate project

5.0 Positive benefits of the proposed network

For the South Asian countries involved, the nuclear monitoring project provides opportunities for improving safety and facility monitoring operations. The project will enable the regional agencies involved to gain access to improved nuclear monitoring and related capabilities, experience, and technology, especially training and development for nuclear monitoring technologies. In addition, the cooperative monitoring and transparency approach complements IAEA Safeguards, and may enhance current (in the case of Bangladesh and Sri Lanka) or future (in the case of India and Pakistan) compliance with the Additional Protocol to IAEA Safeguards Agreement. As a cooperative measure, it may also help to support other agreements, such as the Early Notification of Nuclear Accidents.

SACARMS could strengthen existing bilateral, multilateral, and global nuclear cooperation agreements that have monitoring provisions. The network will establish a precedent for future South Asian nuclear-related agreements in which monitoring may be key. Starting with an ambient radiation-monitoring network, using existing frameworks, we can incrementally increase the sensitivity of the locations and the types of data involved.

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[1] "Confidence building measures likely during summit" Rediff.com, July 05, 2001. http://www.rediff.com/news/2001/jul/05inpak3.htm

[2] Z. Mian and A.H. Nayyar, An Initial Analysis of 85 Kr Production and Dispersion from Repreocessing in India and Pakistan, Science and Global Security, 10:151-179, 2002.

[3] The International Trade Administration of the US Department of Commerce maintains a web site called the "India Pakistan Sanctions Center" that provides information and links regarding existing sanctions on India and Pakistan (http://www.mac.doc.gov/sanctions/). The site provides answers to frequently asked questions, contact information for relevant US government agencies, information on dual-use export controls, sanctions legislation, Presidential determinations and other public information releases.

[4] From the GEMS/ GERMON web site - http://www.gsf.de/UNEP/germon.html

[5] From article by K. Sidappa in Nuclear India, http://www.npcil.org/docs/v14radiation1.htm

[6] These instruments include - a flat type 5"x5" NaI(T1) detector, 3"x.3" Nal(T1) detector, sensitive portable plastic scintillometer, continuous gamma logging system, ZnS(Ag) alpha counting systems, radon and SSNTD counting systems