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Title: JOINT DOE-PNC RESEARCH ON THE USE OF TRANSPARENCY IN SUPPORT OF NUCLEAR NONPROLIFERATION

Author(s): Toshiro Mochiji, Makiko Tazaki, Robin Keeney, John Puckett, William Stanbro, and Charles Nakhleh

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Joint DOE-PNC Research on the Use of Transparency in Support of Nuclear Nonproliferation

Toshiro Mochiji, Makiko Tazaki and Robin Keeney, Power Reactor and Nuclear Fuel Development Corporation (PNC); John Puckett, William Stanbro and Charles Nakhleh, Los Alamos National Laboratory (LANL)

Abstract

PNC and LANL collaborated in research on the concept of transparency in nuclear nonproliferation. The research was based on the Action Sheet #21, which was signed in February 1996, "The Joint Research on 'Transparency' in Nuclear Nonproliferation" under the "Agreement between the Power Reactor and Nuclear Fuel Development Corporation of Japan (PNC) and the US Department of Energy (DOE) for Cooperation in Research and Development Concerning Nuclear Material Control and Accounting Measures for Safeguards and Nonproliferation."

The scope of the research was a fundamental study on transparency to clarify the means to improve worldwide acceptability of nuclear energy from a nuclear nonproliferation viewpoint. The research encompassed three main topics: *the policy environment of transparency, the development of transparency options,* and *technical options for transparency*. Each side performed independent research; then joint workshops were held to exchange information and views. This paper summarizes the results of these workshops.

I. First Workshop: Policy Environment of Transparency

The first workshop addressed "the policy environment of transparency." Each side presented its perspective on the following issues: 1) *a definition of transparency*, 2) *reasons for transparency*, 3) *detailed goals of transparency*, and 4) *obstacles to transparency*.

A. Determine Different Definitions of Transparency

PNC felt that the definition of transparency could change depending upon the audience, the timing requirements of the activities, changes in the international environment, and therefore a broad definition would be best. PNC submitted the following definition: "*Transparency is the effort to promote mutual trust, improve credibility and establish working relationships between countries, international agencies, other nuclear entities and citizens through the sharing of information with respect to nuclear activities, both in the areas of nuclear disarmament and the peaceful use of nuclear energy.*"

LANL also believes that each transparency effort will depend upon the situation and the target audience, but, in general, it involves documenting nuclear activities in such a way that an outside observer can form an accurate picture of those activities. In addition, LANL felt that the voluntary release of

information was the true measure of transparency and it goes beyond what are traditionally thought of as required activities. LANL defines transparency as follows: "*Transparency is the voluntary release of information for the purpose of reassuring outside parties that one is engaging only in announced activities.*"

The most important difference between the two sides seemed to be the concept of voluntary versus required transparency. LANL believed that transparency is the result of the voluntary release of information, over and above what is specified by previously existing requirements or undertakings. However, PNC felt that obligatory and voluntary documentation were both included in transparency and that, perhaps, of the two, voluntary might be inferior to obligatory activities because the voluntary information is not formally verified. This difference may be due to the fact that the US is a nuclear weapon state, where Japan is not. Nuclear weapon states and non-nuclear weapon states have different responsibilities in the international nonproliferation regime.

B. Determine Reasons for Transparency

PNC organized its reasons for transparency into three main areas: 1) the need for nuclear energy; 2) safety concerns; and 3) nonproliferation. LANL took a slightly different view and mentioned that it was desirable to give the public and other countries additional assurances that nonproliferation obligations are being met. LANL believes that extra steps beyond the requirements of IAEA promote a higher level of trust, although IAEA safeguards are completely adequate for verification of obligations under the NPT.

C. Determine the Detailed Goals of Transparency

For PNC, the goal of transparency is to become as transparent as possible to a variety of audiences; however, 100% transparency to everyone is impossible. There are always inevitable, but reasonable and acceptable, obstacles to transparency, which will be mentioned in following section. Because of the differences in target audiences, the details of transparency measures will vary. Therefore, the ultimate goal of transparency is to show satisfactory level of transparency to each target audience as much as possible. This is the same approach suggested by LANL.

D. Determine the Obstacles to Transparency

For both sides, the complications of both domestic and international (multilateral and bilateral) agreements/laws are impediments to transparency. Adhering to all the requirements of the myriad of agreements/laws is both time consuming and costly. Plus, it will also be difficult to create new transparency initiatives without reviewing how they will interact with the existing agreements. However, obstacles, such as prohibition of disseminating certain information in physical protection of nuclear materials or sensitive nuclear technology (SNT), are understandable.

In the U.S. transparency measures must take into account national security concerns. The US has the added dimension of being a nuclear weapons state. Due to the classified nature of much of the information, many additional steps are needed before the information can be released.

Both sides discussed the protection of proprietary rights and the additional burdens of environmental, safety and health regulations. For both, a major concern is the cost of transparency efforts. Transparency activities can be expensive. The challenge is to increase transparency without adding to the escalating cost of these activities.

II. Second Workshop: Development of Transparency Options

The topic of the second workshop was "Development of Transparency Options." The activities accomplished were 1) *identify type of facilities where transparency might be applied;* 2) *define criteria for applying transparency;* and 3) *delineate applicable transparency options.*

A. Identify Type of Facilities Where Transparency Might Be Applied

Both PNC and LANL agree that on the basis of the potential availability of plutonium and HEU that is easily used for nuclear weapons, the facility types of greatest proliferation concern are enrichment, reprocessing, and MOX fuel fabrication facilities. Of somewhat less concern because of the high radiation fields are storage locations for spent fuel. This conclusion is similar to the IAEA emphasis on the protection of "direct use material," which is usable for nuclear weapons purpose without further isotopic enrichment or transmutation in a reactor.

B. Define Criteria for Applying Transparency

The next step is to create some basic criteria for the evaluation of different transparency options. *Table 1* shows a summary of the criteria created by PNC and LANL.

PNC	LANL
•Confidence building	•Support for transparency objectives
•Protection of information	•Release of appropriate information
•Disruption from transparency activities	•Confidence gained
•Time	•Costs
•Cost	

Table 1: Criteria for applying transparency

PNC established five main criteria. But before evaluating those criteria, PNC would require that all information to be released undergo an initial review for quality, quantity and ownership. As for quality, information should be in a format that is easy to understand and be most beneficial to the target audience. In order to avoid releasing too much similar information, the quantity of information already available should be reviewed. Also reviewing the ownership of the information is critical because there is a case that some information cannot be released without first consulting the owner due to existing agreements with third parties.

The goal of confidence building is to release information through transparency activities that will corroborate that there are no clandestine activities taking place, bolster the validity of material accountancy, confirm that nuclear materials are adequately protected and verify that non-proliferation obligations are being met. Detailed information concerning SNT and physical protection information should not be released. The disruption category is primarily concerned with the set up and maintenance of a transparency activity. Every activity will be affected by several time constraints that will impact the effectiveness of the transparency activity. Cost is always a factor. Therefore a balance must be sought between the effectiveness of the transparency activity, the time involved and its various costs.

LANL mentioned their important themes on criteria. First, transparency activities should be undertaken as part of a rational, coordinated plan to achieve clear objectives. Second, the idea that each transparency activity should have a clearly defined target audience(s). Third, the combination of the target audience and transparency goals will help determine and constrain acceptable transparency options. And finally, each option must be reviewed in detail on a case-by-case basis to assure that the transparency objectives are being achieved. Based on these themes, LANL established four criteria. Every means of transparency should be designed to support carefully considered transparency objectives. And in considering various transparency options, it is necessary to understand what information should not be released to a given target audience to avoid damage to nonproliferation interests. It serves no purpose to release information if it does not result in increased confidence in the established transparency goals. Regarding cost, it should be realized that costs will be accrued both in terms of financial outlays and disruption of facility activities.

C. Delineate Applicable Transparency Options

In this section, PNC first identified the types of information that a variety of audiences might be interested in and not necessarily information that can be released (Table 2).

Facility Function/Design	•Facility information (design, type of operations, operations plan/schedule) •Safeguards Systems (type, inspection efforts, results, new developments) •Physical Protection Systems (type, new developments)
Operations	•Accounting information (type of material used, amount used, where stored) •Transportation (type of material, to where, how much, purpose, who is notified)
IAEA Activities	•Activities (what type of activity, schedule)

Table 2: Types of Information of Interest

Secondly PNC looked at 'transparency options that could be used to release this information (*Table 3*).

Promotional materials	Such as video tapes, brochures, tours and news releases could be used to explain both the nature of the facility and its complicated processes.
Remote Monitoring	A remote monitoring system, perhaps in a storage unit, could be used to confirm that appropriate measures are being taken to protect materials or that only declared activities are taking place in the monitored location.
Environmental Monitoring	Confirming that shipments between facilities happen as declared and demonstrating that the shipments are adequately protected.
Independent Inspectors	Allowing inspections of a facility could decrease suspicions that something other than declared activities is taking place at the facility.

Table 3: Transparency Options

LANL took a facility by facility approach towards selecting transparency measures. The facilities were organized into two categories: bulk-handling facilities and reactors and storage sites with unirradiated HEU or MOX fuels. Table 4 below lists the transparency options available in each facility categories.

The lists created by PNC and LANL are similar although both took a slightly different approach to listing potential transparency options. In conclusion, the options currently available to increase transparency are facility tours, increased information dissemination, monitoring (remote, environment and satellite), and independent inspections.

Facility	Transparency Options
Bulk-Handling Facilities	• Regular facility tours to the public, visitors • General information on facility throughputs, radiation releases, operational characteristics, material shipments • Selected environmental monitoring methods (ex. in-stack monitoring to determine burnup of spent fuel being reprocessed)
Reactors and Storage Sites with Unirradiated HEU or MOX Fuels	• Regular facility tours to the public, visitors • General information on shipments, material quantities and locations • Remote monitoring of incoming fuels, stored material • Independent inspection of tags and seals on stored or unirradiated materials

Table 4: Potential Options at Candidate Facilities

III. Third Workshop: Technical Options For Transparency

The final workshop discussed *technical options for a transparency system at enrichment, reprocessing and MOX fuel fabrication facilities.* Topics included *conceptual options for transparency system design and potential instrumentation, measurement, data processing and data display options for transparency systems.* PNC mainly focused on the latter part, while LANL introduced existing proven technology as transparency options for reprocessing, enrichment and MOX fuel fabrication facilities.

A. Identify Conceptual Options for Transparency System Design

PNC mentioned that there are four steps in transparency system design. First, target facilities should be identified on the basis of proliferation concern. On this basis, reprocessing, enrichment, and MOX fuel fabrication facilities are of critical concern. Once a facility has been identified, the second step is to review the existing material accounting, monitoring, and tracking systems at the facility to determine whether information currently being gathered could also be useful for transparency. Third, the utility for transparency of this information must be assessed using the criteria of confidence building, protection, disruption, time, and cost. Finally, the transparency system would be built. This could be accomplished by accessing the current system, building a completely new system, or by using a combination of the current system and a new system.

LANL took a facility by facility approach towards selecting transparency measures with their technical objectives for transparency shown in the *Table 5.*

Facility	Technical Objectives	Technical Measures
Reprocessing	Demonstrating the absence of material diversion and the absence of weapons-grade Pu	• Declarations • Tours • Remote monitoring • Stack sampling • Environmental sampling (ES)
Enrichment	Demonstrating the absence of HEU	same as above
MOX (or HEU) Fuel Fabrication	Demonstrate no diversion of Pu or HEU	• Declarations • Tours • Remote monitoring

Table 5: Conceptual Options for Transparency System Design (LANL)

B. Identify Instrumentation, Measurement, Data Collection and Data Display Options

It was discussed by both sides that using existing facility systems and measurement devices could be the most efficient use of resources. However, there may be several obstacles to this approach. For example, the facility systems might not collect all the information of interest or the sharing of information from these systems may be denied. An independent transparency system may be needed. Both sides concurred that sharing more existing information (reports, operations schedules, material measurements, etc.), posting information to a web site and remote monitoring are feasible data display options.

C. Technical Transparency Options

1. ***Identify Technical Transparency Options for Reprocessing Facilities***. PNC mentioned an infrared camera system at a plutonium storage area in reprocessing facilities. An infrared camera can detect the heat emitting from the material stored inside a canister, and this type of picture could be used to confirm that the container is actually in use.

LANL mentioned that on-stack stable noble gas monitoring was a particular transparency method for reprocessing facilities. The basic idea of this method is to provide a confirmation measure of the burnup of the spent fuel undergoing reprocessing. This method would provide a means of distinguishing between reactor-grade and weapons-grade Pu and is based on conducting an isotopic analysis of the xenon content of air samples taken from the plant stack. LANL added that the principle of this method has been demonstrated in experiments in the US and relies on current technology.

2. ***Identify Technical Transparency Options for Enrichment Facilities***. PNC noted that the most valuable information at an enrichment facility is the ^{235}U content to show that the facility does not make

any HEU. The discussion on data processing and data display options given with regard to reprocessing facilities also applies here. As an example, PNC discussed the use of an enrichment pipe monitor to monitor enrichment of the material, with a time series display of the data.

LANL focused on the use of environmental sampling (ES) as part of transparency. ES is concerned with the analysis of long-lived actinides in soil, water, vegetation, and other samples taken near nuclear facilities. An example signature near an enrichment plant would be the atom percent ^{235}U in the sample. LANL noted that ES is currently playing a large role in the International Atomic Energy Agency's Strengthened Safeguards.

3. ***Identify Technical Transparency Options for MOX Fuel Fabrication Facilities***. LANL mentioned the possible applications of NTvision to transparency in nonproliferation. NTvision is a LANL technology to use digital video monitoring to observe changes as they occur using Internet technologies. It is an event-driven technology that can identify changes in an image with respect to a reference image. Access to the data is given on a password basis using an Internet browser. He also discussed possible applications to remote monitoring and mentioned that the NTvision team is looking for qualified beta testers.

PNC described the Joyo Remote Monitoring System (JRMS), which is an example of a new system designed to work independently from facility systems with a goal of improving transparency.

IV. Conclusion

With PNC's and LANL's independent studies and exchange of information and views in the workshops, this fundamental research on "*Transparency in Nuclear Nonproliferation*" was completed in June 1998.

Both PNC and LANL are now working on a final paper and investigating the candidate subjects as a follow on to this transparency study. A future subject will be focused on introducing actual technical transparency measures into facilities where transparency is desired.

Remarks 1:

The views presented in this paper represent only the personal views of the authors. They do not necessarily represent the views of PNC, LANL, DOE or the University of California. All discussions were from the nuclear nonproliferation viewpoint, so information considered for release for enhancing transparency does not always mean that operators can actually release it from safeguards and physical protection of nuclear material viewpoints. In case of actual information release, more consideration and discussion are definitely needed from many viewpoints.

Remarks 2:

This paper was written as of September 1998. From October 1, PNC will change its name from PNC to JNC, Japan Nuclear Cycle Development Institute.