

NUCLEAR SOURCES AND ASSETS DATABASE (NUSAD) DEVELOPMENT

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ABSTRACT

The Nuclear Sources and Assets Database (NUSAD) has been developed and is being maintained by the Atmospheric Radionuclide Monitoring Program at the Center for Monitoring Research (CMR). NUSAD is an Oracle-based database that contains information regarding nuclear sources and assets throughout the world. A source is any facility that could potentially release radionuclides and an asset is any device that can detect radionuclides. The database can be accessed through the NUSAD Geographical Display Tool (GDT). The GDT is a graphical user interface that provides users not only the capability to view, enter, and modify NUSAD data but also to geographically visualize the data on configurable maps. The NUSAD GDT consists of the ArcIMS geographical information system (GIS) coupled with NUSAD and specialized Java-based software. The database and the GDT will be used to assist in identifying the source of radionuclides found in data from the International Data Centre (IDC) and other institutions. This paper describes the data contained in NUSAD and demonstrates the capabilities of the NUSAD GDT.

KEY WORDS: radionuclide monitoring, geographical information system, CMR, IDC, ArcIMS

OBJECTIVE

The objective of this work was to create and make available to authorized users a database of worldwide devices that could potentially release or potentially measure airborne radionuclides. These data could then be used to help determine the source of radionuclides found in data from the IDC or other institutions and to identify additional assets to either confirm or contradict IDC data. Anticipated users of the database are the United States (US) National Data Center (NDC) and other authorized institutions investigating the cause of a potential nuclear event. Due to the critical nature of its use, it is essential that this database maintains the utmost accuracy and integrity. In addition, it is essential that an interface be provided with the database so that users can easily and quickly interact with its data.

RESEARCH ACCOMPLISHED

NUSAD has continuously grown and evolved since its conception in 1998. It originally consisted of a few Microsoft Excel spreadsheets that contained nuclear reactors and nuclear facilities within the US and worldwide nuclear assets. In 1999, the database was converted to Oracle and worldwide nuclear reactors and facilities were added to the database. In 2000, the NUSAD Data Entering Tool (DET) was created. The DET is a Java-based graphical user interface (GUI) that allows users to easily view, edit, and insert NUSAD data. Previously NUSAD users had to use the Structured Query Language (SQL) to access NUSAD data.

Substantial development occurred in 2001. The entire database underwent a Quality Assurance and Quality Control (QA/QC) program to ensure database accuracy and integrity. The NUSAD Geographical Display Tool (GDT) was created. The GDT is a web-based ArcIMS¹ with Java-applets GUI that allows users to

¹ Commercially available geographical information system produced by Environmental Science Research Incorporation (ESRI)

interact with NUSAD data on a geographical background (maps). Finally, a list of US radioactive material (RAM) license holders was added to the database.

This section begins with a description of current content of the database and a description of the QA/QC program. Next, the NUSAD DET is discussed. The section concludes with a description of the NUSAD GDT.

NUSAD Description

The content of NUSAD has evolved continuously since 1998 and it is anticipated that the database content will continue to evolve over the next several years. The current state of NUSAD will be described here. NUSAD contains three broad classes of data: assets, sources, and geographical. Table 1 summarizes the types of data currently contained in NUSAD. Table 1 also shows the reference in which the majority of the data for each type came from. However, in most cases the data were also cross-referenced and/or supplemented with other data sources. Information on each reference is included in the database, such as the title, publication details, author's name, and how its data were used in NUSAD.

Table 1: Data Contained in NUSAD

| Class | Type | Area | Major Reference |
|---|---|--------------------------------|--|
| Asset | International Monitoring System (IMS) stations | World | CTBT Treaty and Working Group B publications |
| | Collateral monitoring stations | World | Appendix F and Prototype International Data Centre (PIDC) database |
| | Direct radiation stations | World | Miscellaneous |
| Source | Nuclear power reactors | World | International Atomic Energy Agency's (IAEA) Power Reactor Information System (PRIS) |
| | Research reactors and government facilities | US | US Department of Energy |
| | Radioactive Material (RAM) License holders | US | US Nuclear Regulatory Commission and individual states governing nuclear organizations |
| | Research reactors and other radiation handling facilities | World | IAEA |
| | Past nuclear explosions | World | PIDC database |
| | Geographical | Countries, regions, and states | World |
| Cities | | World | United Nation's (UN) Demographic Yearbook 1995 |
| Country borders and geographical features (e.g., rivers, lakes) | | World | Libraries included with ArcIMS |

An asset is any device that can detect radionuclides. The three types of assets are International Monitoring System (IMS) stations, collateral stations, and direct radiation stations. The IMS stations consist of the 79 particulate and 40 xenon radionuclide stations as defined in the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The status of each station (planned or operational) is updated as needed. Collateral monitoring stations consist of atmospheric monitoring stations not included in the IMS network in which data could be obtained to supplement the IMS station data. An example of a collateral station is a station in the Center of Slovak Radiation Monitoring Network. Direct radiation stations record the absolute magnitude of radiation

present at a site. They do not differentiate between the type of radiation, and, more importantly, the type of radionuclides present. An example of a direct radiation station is a station in the Neighborhood Environmental Watch Network (NEWNET) operated by Los Alamos National Laboratory. Pertinent information regarding each asset is recorded in the database including the station's name, location (address, latitude, longitude, and elevation), sensor type and design, point of contact information, data format, and how to obtain data from the station.

A source is any facility that could potentially release radionuclides. Table 2 lists the types of sources currently included in NUSAD. Data for nuclear power plants predominantly came from the Power Reactor Information System (PRIS) maintained by the International Atomic Energy Agency (IAEA). Data for other nuclear facilities come from a variety of references summarized in Table 1. NUSAD also contains a list of RAM license holders within the US. These data come from each state's governing nuclear organization and the US Nuclear Regulatory Commission (NRC). Pertinent information regarding each source is recorded in the database including the source's name, location, point of contact information, organization(s) responsible for maintaining the source, and the types of nuclides potentially emitted from the source. Additional information is recorded for nuclear reactors including design type, power capacity, and information pertaining to the reactor history (*e.g.*, criticality date).

Table 2: NUSAD Source Types

| Code | Source Type |
|-------------|------------------------------------|
| NPP | Nuclear power plant |
| NRF | Nuclear research facility |
| KTS | Known nuclear test site |
| PTS | Potential nuclear test site |
| FRP | Fuel reprocessing facility |
| UEF | Uranium enrichment facility |
| WFP | Weapon fabrication plant |
| FFP | Fuel fabrication plant |
| NWL | Nuclear weapons lab |
| RPF | Radioisotope production facility |
| NMF | Nuclear medical facility |
| FSF | Fuel storage facility |
| RAM | Other radioactive material license |

Because the NUSAD data is to be displayed on maps, the database must also contain geographical data. The majority of geographical features (*e.g.*, rivers) and country borders came from the geographic data provided with ArcIMS. These data are provided in shapefile² format and are not technically part of the Oracle component of NUSAD but are displayed with the NUSAD data in the GDT. Additional data were required to fill gaps in the ArcIMS libraries. These data are regions, countries, states, and cities. The city data contains location and population. The references for the geographical data are given in Table 1.

The data contained in NUSAD must be accurate and beyond reproach in order for it to be considered a reliable source of information. Hence, a QA/QC program was established to determine the reliability of a source of information (*i.e.*, a reference) and the accuracy of material entered into NUSAD. The execution of the QA/QC program follows the step process depicted in Figure 1. The material contained in NUSAD is drawn from various official and unofficial references. A reliability rating numbered five through one is assigned to each reference where a rating of five represents a very dependable reference and rating of one

² A shapefile is the format used by ESRI products to represent spatial data and is the de facto standard file format often used in geographical information systems.

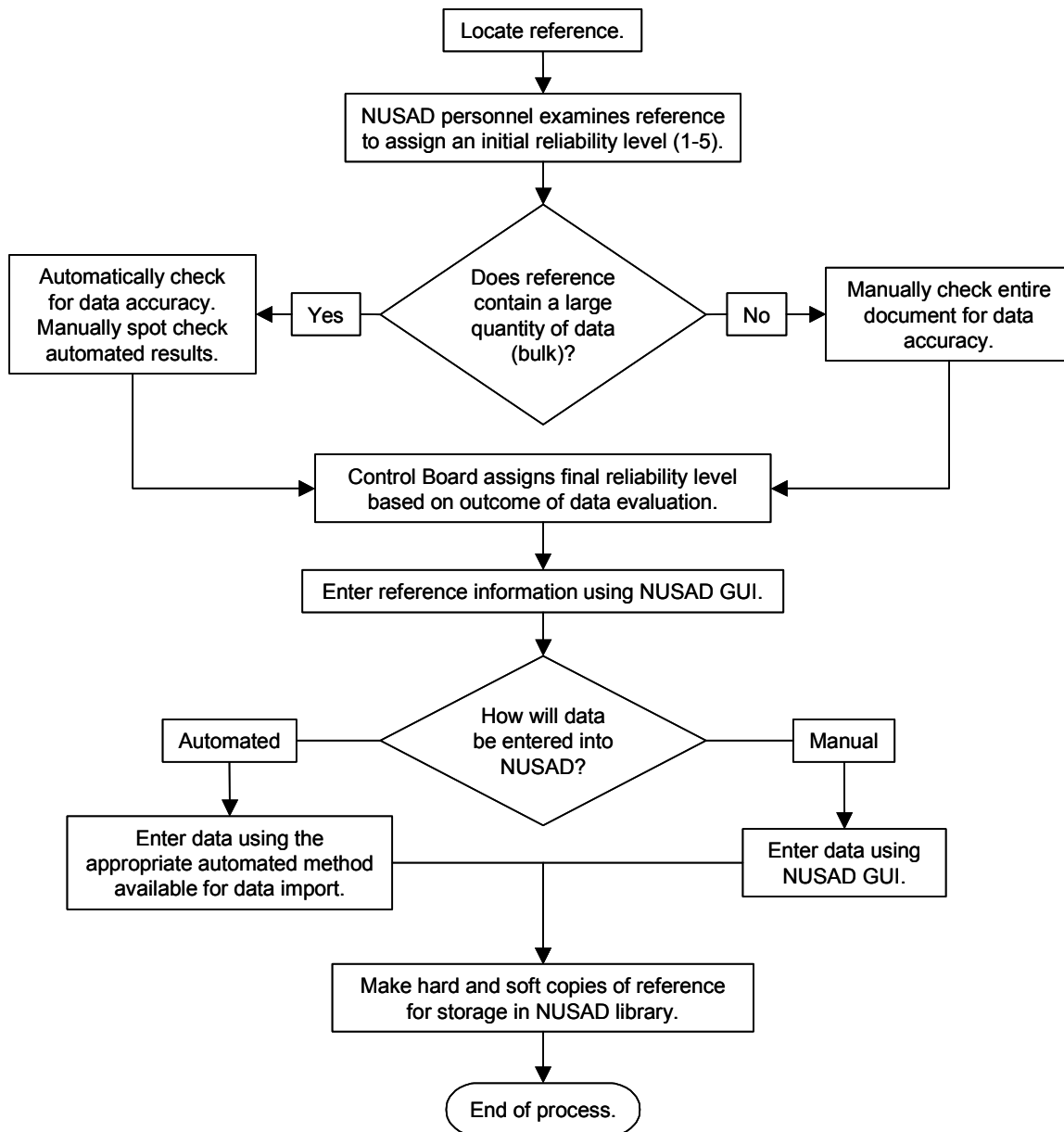


Figure 1: Flowchart of QA/QC Procedure

denotes an unreliable reference. Factors that affect the reliability rating include the consistency of their content with other works received, the date of publication, the publisher, the author, and the author's position on the topic discussed in the document. The ratings are stored in NUSAD and the NUSAD reference library.

The position (longitude and latitude) of most assets, sources, and cities are stored in NUSAD. Each position is also assigned a reliability rating that is based on reliability of its reference, the precision of the data, and how the position was obtained. Many of the source and asset references did not contain position data. In these cases the position had to be estimated from its address or nearest city. The position reliability rating informs a NUSAD user on the precision and accuracy of each position datum.

Data Entering Tool

The NUSAD data are stored in an Oracle database. When properly connected to the database all data can be viewed using SQL. However, this method requires substantial knowledge of SQL and the database schema. The DET was created to provide easier access to the data. It provides an interface to the database that allows users to easily enter, delete, modify, and view data. The DET is implemented as a Java application and thus may be run on any platform that supports the Java runtime environment. Supported platforms include Windows 2000/NT and most UNIX workstations. The NUSAD DET application may connect to the database via any workstation that has a connection to the Internet provided the user has proper authorization.

The NUSAD DET provides two main methods for viewing and editing data in the database: the browser window and the editor window. The browser window displays multiple data elements in a tabular format that provides an overview of specific database tables or table combinations. The data displayed in a browser window was determined to be the most pertinent representing that data type. The editor window is required to access all data related to a particular data element. A list of the possible browser windows is shown in Figure 2. Figure 3 shows the Source Browser Window. The editor windows can be accessed through the browser windows.

The editor windows provide a more detailed view of the data for an individual entry in the database. The editor window uses a data entry format that allows users to edit all individual fields associated with a data

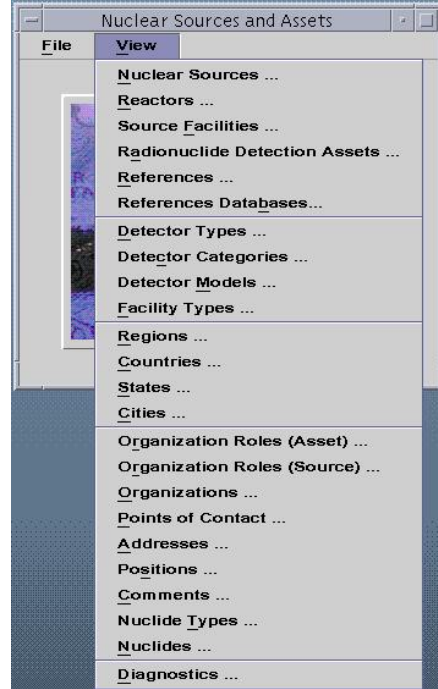


Figure 2: List of Browser Windows

| Name | Facility | Country | Latitude | Longitude | Modified |
|----------------|----------|---------------|--------------------|--------------------|-----------------|
| BONUS | NPP | United States | | | 2001-05-29 1... |
| BRAIDWOOD | NPP | United States | 41.243611111111112 | -88.2288888888889 | 2001-05-29 1... |
| BROWNS FERRY | NPP | United States | 34.704166666666667 | -87.11861111111111 | 2001-05-29 1... |
| BRUNSWICK | NPP | United States | 33.988333333333334 | -78.01055555555557 | 2001-05-29 1... |
| BYRON | NPP | United States | 42.075 | -89.28194444444445 | 2001-05-29 1... |
| CALLAWAY | NPP | United States | 38.788333333333326 | -91.78166666666668 | 2001-05-29 1... |
| CALVERT CLIFFS | NPP | United States | 38.434722222222222 | -76.44194444444446 | 2001-05-29 1... |
| CATAWBA | NPP | United States | 35.051388888888894 | -81.06944444444443 | 2001-05-29 1... |
| CLINTON | NPP | United States | 40.171944444444444 | -88.83416666666665 | 2001-05-29 1... |
| COLUMBIA | NPP | United States | 46.483333333333334 | -119.35 | 2001-05-29 1... |
| COMANCHE PEAK | NPP | United States | 32.297777777777778 | -97.785 | 2001-05-29 1... |
| COOPER | NPP | United States | 40.361944444444445 | -95.64111111111113 | 2001-05-29 1... |
| CRYSTAL RIVER | NPP | United States | 28.957222222222217 | -82.6988888888889 | 2001-05-29 1... |
| CVTR | NPP | United States | | | 2001-05-29 1... |
| DAVIS BESSE | NPP | United States | 41.597222222222214 | -83.0863888888889 | 2001-05-29 1... |
| DIABLO CANYON | NPP | United States | 35.211666666666667 | -120.8544444444444 | 2001-05-29 1... |
| DONALD COOK | NPP | United States | 41.976111111111112 | -86.66638888888887 | 2001-05-29 1... |
| DRESDEN | NPP | United States | 41.389722222222222 | -88.27111111111111 | 2001-05-29 1... |
| DUANE ARNOLD | NPP | United States | 42.100666666666666 | -91.77722222222222 | 2001-05-29 1... |
| ELK RIVER | NPP | United States | | | 2001-05-29 1... |
| ENRICO FERMI | NPP | United States | 41.963333333333334 | -83.25861111111111 | 2001-05-29 1... |
| FARLEY | NPP | United States | 31.222777777777782 | -85.1125 | 2001-05-29 1... |
| FITZPATRICK | NPP | United States | 43.52388888888889 | -76.39833333333335 | 2001-05-29 1... |
| FORT CALHOUN | NPP | United States | 41.520833333333334 | -96.07666666666668 | 2001-05-29 1... |

Figure 3: Source Browser Window

element. Using this window a user can also add new entries or delete existing entries from the database. An example of the Source Editor Window and the Reactor Editor Window is shown in Figures 4 and 5, respectively. Many of the sources, assets, and references contained in NUSAD have web pages associated with them not maintained as part of NUSAD. However, links to these web pages are stored in NUSAD. A user can open these web pages in their default browser from some editor windows.

| Name | Acronym | Role | Country | Modified |
|-----------------------------|----------|------------------|---------------|----------------|
| Constellation Nuclear Group | CONSTELL | Reactor Operator | United States | 2001-05-31 ... |
| COMBUSTION ENGINEERING CO. | CE | Reactor Supplier | United States | 2001-05-31 ... |

Figure 4: Source Editor Window

Figure 5: Reactor Editor Window

Geographical Display Tool

The GDT allows users to geographically visualize NUSAD data on configurable maps. The GDT consists of the ArcIMS geographical information system (GIS) coupled with NUSAD and specialized Java-based software. Users with Internet access and proper authorization can log onto the GDT server and download the GDT client. Using the GDT client running through Microsoft's Internet Explore (Netscape is not currently supported), the user can select the map configuration and the NUSAD data to be displayed. The user submits a request to the GDT server. The GDT server then processes this request and returns a shapefile containing the requested information. The GDT client displays the shapefile as a map. Figure 6 shows a world map with IMS stations and nuclear power plants displayed. All maps are downloaded in worldview. However, the user can manipulate the worldview by zooming in or by changing the baseline projection. Figure 7 shows map of northern Europe with IMS stations, collateral stations, nuclear power plants, and known nuclear test sites displayed.

All of the data types listed in Table 2 along with IMS stations, collateral stations, direct radiation stations, and certain geographical features can be display through the GDT. Each data type is displayed as a discrete symbol on the map. Combinations of certain data types can also be displayed as discrete symbols. Once a



Figure 6: NUSAD GDT – World View



Figure 7: NUSAD GDT – Northern Europe View

data type is downloaded it can be turned on or off without downloading a new map. However, additional data will have to be downloaded if new data types are to be displayed.

The symbols used on the map contain hot-links so that a user can easily obtain additional information concerning the data. A mouse over a particular symbol displays the name of the data element. A click on the symbol provides the user with a selection of auxiliary windows that can be opened with an additional click. The auxiliary windows are a table viewer displaying pertinent information about the data element and the NUSAD DET³ preloaded to the selected item.

CONCLUSIONS AND RECOMMENDATIONS

The Nuclear Sources and Assets Database (NUSAD) has been developed and is being maintained at the CMR. NUSAD is an Oracle-based database that contains information regarding nuclear sources and assets throughout the world. All data has undergone a QA/QC program to ensure accuracy and integrity. The NUSAD data can be accessed using the DET and the GDT. The DET is a Java-based GUI that provides an interface to the database allowing users to easily enter, delete, modify, and view all data in the database. The GDT is an ArcIMS-based GIS that allows users to geographically visualize NUSAD data on configurable maps. The DET and the GDT can be used to interact with NUSAD data from within CMR or via the Internet with proper authorization. NUSAD with the DET and the GDT can be used to assist in identifying the source of radionuclides found in data from the IDC and other institutions. It can also be used to identify additional assets to either confirm or contradict IMS station data.

Three recommendations will be made to enhance NUSAD. First, in order for the NUSAD to obtain maximum usefulness, its data must remain current. Certain data must periodically be investigated to ensure its accuracy. For example, several of the nuclear assets originally identified in 1998 have recently ceased operations; a static database would not reflect this change. Maintaining a quality database is an ongoing effort. Second, the quantity and quality of nuclear source data, excluding nuclear reactors, within the US is superior compared to data for the rest of the world. Additional work needs to be performed to identify and quantify worldwide nuclear sources other than nuclear reactors. Finally, as described in Seber (2000), databases also exist that are similar to NUSAD but orientated towards seismic events instead of radionuclide releases. It would be useful to merge these data sets (and data viewers) so that individuals or organizations researching the cause of a potential nuclear event can obtain all pertinent auxiliary information from one location and in one format.

REFERENCES

- Seber, D., E. Sandvol, C. Sandvol, C. Brindisi, and M. Barazangi (2000), Global and Regional GIS Database Development in Support of CTBT Monitoring, Proceedings of 22nd Annual DOD/DOE Seismic Research Symposium, 12-15 September, 2000.

³ Assuming the DET is installed locally on the user's computer.