Evaluation of ARGOS for use in Australia

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- AFP – Australian Federal Police
- ANSTO – Australian Nuclear Science and Technology Organisation
- BOM – Bureau of Meteorology
- DSTO – Defence, Science and Technology Organisation
- CSIRO – Commonwealth Scientific and Industrial Research Organisation
- Department of Health and Ageing
- NT Counter Terrorism Division
- ACT Emergency Services
- Qld Fire and Rescue Services
- NSW Fire Brigade
- Chemistry Centre WA
- Victorian Fire Brigade

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NSW Fire Brigade:  
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Dept Prime Minister & Cabinet:  
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* = Apologies given
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Executive Summary

ARGOS (Accident Reporting and Guidance Operational System) is a decision support system for Chemical, Biological, Radiological and Nuclear incidents. In 2007, ARPANSA with financial support from the Department of Defence (Navy) and Emergency Management Australia (EMA) acquired an Australian ARGOS licence, in order to co-ordinate a national working group to evaluate its suitability for Australian CBRN emergency management.

The primary feature of ARGOS is the ability to collect and store measurement information relating to a CBRN incident. ARGOS has the capability to run prognoses and to interpret and visualise results from a range of models, including atmospheric dispersion models. This means that given some meteorological data and information about a CBRN accident, ARGOS can show a prognosis of which areas are likely to be contaminated, when and how much. The result is shown on a digital map and can be exported as a GIS product for incorporation into other systems.

ARPANSA developed a virtual machine ware (VM-Ware) installation of the ARGOS software for distribution to the Working Group. During the rollout of ARGOS, several scenarios were distributed to stakeholders for training providing a walk-through of the basic controls of ARGOS. This distribution included numerical weather prediction data provided by the Australian Bureau of Meteorology (BOM). A sharepoint discussion web site was established to allow for exchange of data and to facilitate group discussions.

A questionnaire was sent to stakeholders to assess their initial requirements and their formal evaluation. Questions were designed to help prompt stakeholder appraisal and their comments about applicability and problems encountered. Questions covered the technical and functionality attributes of ARGOS with regards to its effectiveness and useability as an emergency management support tool from each Agency’s perspective. Issues such as how ARGOS manages the import and export of maps and the display of database information were also captured.

From an analysis of the questionnaire responses, ARGOS satisfied nearly all requirements of Stakeholder needs related to the questions posed, with a 91% positive assessment. The particular area that ARGOS did not do as well (with the majority of negative responses) was with regard to its performance as a GIS tool.

A workshop on the evaluation of ARGOS was held at Melbourne Australia, on 13 August, 2008 hosted by ARPANSA. The objective of the workshop was to discuss the results of the evaluation and to achieve a consensus on further Australian work on possible implementation of the ARGOS system. The scope of the workshop was to summarise the findings of the evaluation and to agree on a set of recommendations.

Assessment

ARGOS is an advanced and mature tool for the assessment of protective measures during nuclear emergencies. ARGOS was successfully applied to provide advice for the February 2008 US military satellite re-entry incident and the July 2008 international IAEA ConvEx-3 exercise involving a nuclear power plant release exercise in Mexico. ARGOS was shown to be consistent with Australian protective measures in Radiation Protection Series No. 7.
The evaluation outcomes identified that, notwithstanding the effectiveness of the RIMPUFF atmospheric dispersion model, further work is required on the chemical and biological capabilities of ARGOS. The Chemical component was considered to have performed well, however certain functions were not available. These included ‘heavypuff’ and the calculation of alternate source-term geometries. The Biological databases needed significant addition and revision due to the lack of agents available for use. ICT (Incapacitating Concentration over Time) isolines should also be included for the Biological simulations to be applied regularly.

The GIS capability of the system was adequate for entry of source terms but was identified as an area that could be improved. In its current form ARGOS provides outputs that are consistent with open GIS framework for spatial data, but further work needs to be done to ensure the process is more transparent and is in accord with the National spatial information strategies.

During the Australian evaluation the developers of the software provided timely advice and guidance on issues related to training and trouble shooting. The developers were able to supply effective add-on tools for meteorological data import – a demonstration of their capability to customise. Specific customisation was identified by the evaluators as a critical support capability in the development of ARGOS for Australian needs. The ARGOS manual was identified as an area of weakness for software support.
Recommendations

The participants of the ARGOS workshop agreed that:

1. ARGOS is an advanced tool for the assessment of protective measures for emergencies. ARPANSA should continue the ongoing implementation of ARGOS as a tool to support Australian arrangements for nuclear and radiological emergency response.

2. While ARGOS shows maturity for assessment of nuclear and radiological releases, it has potential for dealing with Chemical and Biological releases for both HAZMAT and CBRN incidents. Further development is required to extend databases and source terms or to adopt existing software capabilities to link into ARGOS’ architecture. Specific training for Australian users would be beneficial.

3. The optimum process for Australian implementation of ARGOS and other decision support tools needs further assessment. A Working Group should be established to assess the elements and core requirements of implementation. This group should work closely with similar evaluation initiatives, such as those being considered by DSTO and NSW Fire Brigade HAZMAT.

4. ARPANSA, as National coordinator, should submit to the ARGOS Consortium the following key areas where the software can be improved;
   - Enhancement of chemical and biological databases and source terms (through further development or links into existing software used in Australia).
   - Streamlining and completion of supporting documentation, particularly for chemical and biological sections as these are incomplete.
   - Strengthening of ARGOS’ GIS capabilities.
   - The inclusion of Urban Dispersion Modelling (currently under development for ARGOS Version 8.4).
   Funding may be required to support these changes.

5. The full implementation and integration of Decision Support Tools for emergency management across Australia would require implementation of new policy and appropriate funding.
1. Introduction

Project Background

The software system, ARGOS\(^1\) (*Accident Reporting and Guidance Operational System*) is a Decision Support System for CBRN Emergencies. ARGOS is primarily an SQL database with GIS and atmospheric dispersion modelling capability. ARGOS was originally developed to aid the Danish Emergency Management in dealing with accidents in nuclear power plants, but has been extended to deal with chemical, biological and radiological emergencies, including Radioactive Dispersion Devices (RDDs), and primitive nuclear weapons, so-called improvised nuclear devices (IND).

The tools within ARGOS provide a means to:

- Get an overview of the situation.
- Create a prognosis of how the situation will evolve.
- Analyse and visualise measurements.
- Calculate the consequences of the accident.
- Decide on appropriate counter measurements.
- Disseminate information to responders and/or the public.

ARGOS is administered as a partnership between the Danish Emergency Management Agency (DEMA) and Prolog Development Centre A/S (PDC). The ARGOS Consortium consists of central organizations responsible for Emergency Management in a country. The current nine member countries by November 2006 are: Canada, Ireland, Denmark, Sweden, Norway, Poland, Estonia, Latvia, and Lithuania. ARPANSA, with financial support from the Department of Defence (Navy) and Emergency Management Australia (EMA) acquired an Australian licence for 2007 and 2008, in order to evaluate its suitability for Australian CBRN emergency management.

Project Overview

ARPANSA has coordinated a national project to evaluate ARGOS for its suitability for Australian CBRN emergency planning. The ARGOS software has been installed and tested on ARPANSA servers and distributed to other stakeholders in a VM-Ware environment. A cross-Agency Working Group has been established to evaluate the usefulness and implementation requirements of ARGOS, in support of Australian CBRN emergency arrangements.

Purpose

The objective of the ARGOS evaluation is to assess the potential for ARGOS to support the emergency organizations to make the best possible decisions in case of a CBRN incident.

General Description

ARGOS is primarily an SQL database with GIS and modelling capability. The structure of the database is shown in the flow chart below, which should be read from top-to-bottom. Inputs of data (Box 1) are stored in the ARGOS database (Box 2). The main power of ARGOS is related to the storage in databases T, N, C and B. Data can be incorporated into modelling tools or GIS/visualisation (Box 3), and finally presented as products to aid decision makers (Box 4).

ARGOS Structure and Data Flow

Input Data (Box 1)
- Meteorology
  - Prediction Data
  - Radar (rain)
  - MET towers
  - Manual Entry
- Field Monitoring
  - Serial Mapping
  - Fixed Stations
  - Environmental
  - Teams
- Source Terms
  - Nuclear
  - Radionuclide
  - Chemical
  - Biological

Data Storage (Box 2)
- MET Data (T)
- Nuclear (N)
- Chemical (C)
- Biological (B)

Tools (Box 3)
- Visualisation
  - GIS
  - 72 hour wind
  - Radar (rain)
  - Source locations
  - Monitoring Sites
- ARGOS Models
  - RIMPUFF
  - Food Dose
  - Monitoring Syst.
  - Urban Dispersion
  - Long Range

Outputs and Products (Box 4)
- Outputs (eg):
  - Airborne Levels
  - Contamination
  - Trajectory
  - Alarms
- Calculation of (eg):
  - Protective Meas.
  - Concentrations
  - Radiation Dose
  - Deposition
- Products (eg):
  - Web Animations
  - Shape files
  - Map Products


**Scope**

This project aims to evaluate the usefulness and implementation requirements of ARGOS in support of Australian CBRN emergency arrangements.

**Objectives**

The objectives of the ARGOS Evaluation are:

- To assess the applicability of ARGOS for Australian CBRN emergency management.
- To assess the inter operability and consistency with Australian consequence management and modelling systems.
- To assess the customisation requirements for the use of ARGOS in Australia.
- To assess the implementation requirements and costs.
- To assess any shortfalls with ARGOS for its use in Australia, including a comparison with other CBRN decision support systems.
- To assess and advise on the potential science and technology research and development activities that would support the effective implementation of decision support systems such as ARGOS.
2. ARGOS’ Australian History

ARGOS has been administered as a partnership between the Danish Emergency Management Agency (DEMA) and Prolog Development Centre A/S (PDC). The ARGOS Consortium consists of central organizations responsible for Emergency Management in a particular country. To enter the consortium a new member organisation (country) must enter a contract, which is also signed by PDC and DEMA. ARGOS and the related systems can be installed on as many computers as required in the organisation and organisations related to the emergency preparedness. The fees for the countries are set relative to the GDP of the country so larger countries pay more than smaller countries. According to the GDP, and the consortium fee formula, the fee for Australia for 2007 was 263,000DKK (approx. 60,000AUD).

2.1 Funding and Timetable

It was proposed and agreed that ARPANSA, Department of Defence (Navy) and Emergency Management Australia (EMA) jointly support the acquisition of a one year Australian licence for 2007, in order to evaluate its suitability for Australian radiation emergency planning. EMA agreed to provide funding of $30K from funding for Research and Development for CBR emergency management and the Chair of the Navy VSP(N) agreed to provide $15K towards the ARGOS evaluation. ARPANSA provided the remaining $15K. The one year licence was subsequently extended (with additional funds) to include 2008.

The timetable of milestones that was undertaken during the project includes;

<table>
<thead>
<tr>
<th>Month</th>
<th>Milestone Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2007</td>
<td>With financial support from EMA ($30K), Navy ($15K) and ARPANSA ($15K), Australia joins ARGOS Consortium.</td>
</tr>
<tr>
<td>April 2007</td>
<td>ARPANSA established a Cross-Agency Working Group.</td>
</tr>
<tr>
<td>June 2007</td>
<td>ARPANSA IT acquired Server to host ARGOS software image.</td>
</tr>
<tr>
<td>July 2007</td>
<td>PDC established Sharepoint WEB portal for Australian ARGOS evaluation.</td>
</tr>
<tr>
<td>August 2007</td>
<td>Conversion of 250k topographical maps for ARGOS.</td>
</tr>
<tr>
<td>Sept 2007</td>
<td>ARGOS Consortium releases Final version 8.2 of software.</td>
</tr>
<tr>
<td>Oct 2007</td>
<td>ARPANSA IT builds first VM-Ware Installation of ARGOS.</td>
</tr>
<tr>
<td>Dec 2007</td>
<td>Software deployment to WG members begins (AFP, ACT Emergency Services, ARPANSA Steering Group).</td>
</tr>
<tr>
<td>Feb 2008</td>
<td>Additional ARPANSA staff recruited and Reference Scenarios and training material prepared for deployment.</td>
</tr>
<tr>
<td>Feb- March 2008</td>
<td>ARGOS software and training rolled out to stakeholders.</td>
</tr>
<tr>
<td>June 2008</td>
<td>Questionnaires distributed and returned.</td>
</tr>
<tr>
<td>June 2008</td>
<td>Jan Pehrsson of PDC visited ARPANSA for 5 days – installation of ARGOS V8.3 and a server-client setup was successfully undertaken.</td>
</tr>
<tr>
<td>Early-August 2008</td>
<td>Draft evaluation report distributed.</td>
</tr>
<tr>
<td>Mid-August 2008</td>
<td>Workshop to discuss evaluation report (see Appendix F).</td>
</tr>
<tr>
<td>Late-August 2008</td>
<td>Evaluation report Finalised.</td>
</tr>
<tr>
<td>September 2008</td>
<td>Results of Evaluation to be presented at ARGOS consortium meeting, Denmark.</td>
</tr>
</tbody>
</table>
2.2 Stakeholder Profiles and ARGOS Training

A variety of Federal and State Government Agencies (listed below) have been involved in the evaluation procedure. Each was contacted after discussions with the national CBRN working group and agreed to be involved with the evaluation. These have received and installed the ARGOS software and contributed directly to the evaluation by responding to questionnaires based on Version 8.2 of ARGOS (deployed as a stand-alone system in a virtualised environment).

Federal Government Agencies
ARPANSA – Australian Radiation Protection and Nuclear Safety Agency
- The coordination of the ARGOS project has been undertaken by ARPANSA.
- The main interest of this agency is in the protection of the public from sources of radiation. This includes accidental and intentional releases. ARPANSA regulates radioactive sources within Australia.
- ARGOS can be used for the simulation of radioactive/nuclear releases (through RIMPUFF), and also in the integration of field information (from permanent monitoring stations and mobile gamma mapping) into databases which may be presented in a GIS format.
- Training has been undertaken directly from developers of the ARGOS system (PDC) and through use of the software prior to ‘rollout’. There are currently four users of ARGOS at ARPANSA, and demonstrations have also been provided to ARPANSA staff in Sydney (on 7th May 2008).

AFP – Australian Federal Police
- AFP has committed resources to the evaluation of ARGOS’ CBRN (Chemical, Biological, Radiological/Nuclear) and GIS capabilities.
- ARGOS would be used as a radiological, chemical and biological graphical database, with an interest in 3D urban modelling and backtracking functionality.
- Software and training were provided by ARPANSA to a group of 5 users on 12th February 2008.

ANSTO – Australian Nuclear Science and Technology Organisation
- ANSTO’s main focus is on the safe operation of the Lucas Heights OPAL reactor.
- The RIMPUFF model has been applied in the area surrounding Lucas Heights and the monitoring stations that exist in the area. There is some interest in using the additional features of ARGOS for these applications.
- Software and training were provided by ARPANSA to two users on 8th May 2008.

BOM – Bureau of Meteorology
- As a major holder and developer of atmospheric models, BOM has an interest in the use of atmospheric dispersion modelling in Australia.
- BOM’s specific input to the project is in the provision of numerical weather prediction data. LAPS (Limited Area Prediction System; 72 hours) and MesolAPS (finer grid, 54 hours) data have been made available for download via FTP. These are updated 12-hourly.
- Software and training were provided by ARPANSA to two users on 18th March 2008.
DSTO – Defence, Science and Technology Organisation
- DSTO (Human Protection and Performance Division) has significant modelling resources and capabilities in relation to defence capabilities. This includes an interest in the modelling of plume hazards in the atmosphere.
- A preference for Chemical/Biological/Radiological/Nuclear dispersion simulation has been expressed, as has the use of mapping tools in an office-based setting.
- Software and training were provided by ARPANSA to three users on 12th March 2008.

CSIRO – Commonwealth Scientific and Industrial Research Organisation
- CSIRO have an interest in modelling and scientific research, and have been kept abreast of the ARGOS evaluation project.
- Software and training were provided by ARPANSA to a single user on 12th March 2008.

Department of Health and Ageing
- The department has an interest in the health effects due to Chemical and Biological dispersion, and the atmospheric distribution of iodine.
- Software and training materials were provided remotely in February 2008.

State Government Agencies/Bodies
Of paramount importance to the success of the ARGOS project was the involvement of first responders in the evaluation of the software. The following first responders based all around Australia agreed to be involved in the ARGOS evaluation project;
- NT Government,
- ACT Emergency Services,
- Qld Fire and Rescue Services,
- NSW Fire Brigade – Specific training provided 7th May 2008,
- Chemistry Centre WA,
- Victorian Fire Brigade.
These organisations received the software and training materials between February and May 2008.

2.3 ARGOS Structure – Database Server and Version Control
Argos Version 8.2 (Final Release) was distributed to stakeholders under a VM-Ware environment. This ensured that a consistency of images could be kept and that individual machine setups would not become an issue during software rollout.

An installation of the ARGOS database structure was independently undertaken at ARPANSA. This involved the installation of Version 8.3 (Release Candidate 4 – later updated to FINAL release candidate) on client machines, and the setup of a server for database information. The client machines (individual desktops) undertake RIMPUFF and dose assessment calculations. Mapping and GIS applications could be stored on the database server or on individual clients.

Features installed onto the server-client database at ARPANSA that are not available in VM-Ware versions include;
- Ability to export output data to a website.
- Inclusion of PMS (Permanent Monitoring Station) software.
- FDM (Food Dose Model) installation.
• Automation of current BOM downloads.
• Extensive database storage (as opposed to the limits of VM-Ware).

Enhancements of Version 8.3 (over 8.2) include;
• Comprehensive manual (this still requires work – see Section 7).
• Absolute source term capability.
• ‘Release Type’ specification, e.g. explosion, reactor, Radiation Dispersion Device, etc.
• “Zoom to AOI” button to pick up Area of Interest for an archived run.
• Use of the “Map...” button in the Prognosis window enables the user to drag and drop the position of the source.
• Functionality to move source terms and create new sources (reactors and absolute sources) from map positions.
• 3D Mapping of plume using 3D button. This feature requires building shapefiles, which can be obtained for Sydney and Melbourne. Some work needs to be undertaken to fully realise this capability for Australian installations.
• Google maps integration (See V8.4 features below).

ARGOS Version 8.4 is currently under development. This includes features such as;
• An explosive release term (including nuclear weapon scenarios and RDD).
• Ability to define a radius from the release point when defining map area.
• Inclusion of an event mode where the location/time are specified and combined with a generic scenario. The prognosis will then be populated automatically, saving time in emergency situations.
• Use of Google Maps with a direct internet link is to be supported by V8.4. At this stage it is implemented in V8.3 but there is a zooming issue.

2.4 Relevant RIMPUFF Studies

The RIMPUFF (Risø Mesoscale PUFF model) system is a Lagrangian mesoscale atmospheric dispersion puff model, designed for calculating the concentration and doses resulting from the dispersion of airborne materials. The model manages changing and inhomogeneous meteorological situations, used for short term (accidental) release of airborne materials into the atmosphere. The model applies both to homogeneous and inhomogeneous terrain with moderate topography on a horizontal scale of typically up to 100 km, and responds to changing meteorological conditions. It can simulate the time changing releases (emission) of airborne materials by sequentially releasing a series of Gaussian shaped puffs at a fixed rate on a specified grid. The amount of airborne materials allocated to individual puffs equals the release rate multiplied by the time elapsed between puff releases.

Subroutines for calculation of radiation doses from puffs and deposited radionuclides have been added to the model. The present version of the code is suitable for real-time calculation of concentrations, time integrated concentrations, deposition and doses of gamma radiation both from radioactive cloud and deposited radionuclides released into the atmosphere.
A full technical description of the Model can be found in Thykier-Nielsen et al. (2005)².

3. Application of ARGOS to Specific Australian Chemical, Biological, Nuclear and Radiological Scenarios

Various CBRN (chemical, biological, radiological and nuclear) scenarios have been investigated in order to evaluate ARGOS in a range of situations. These have included the use of ARGOS during emergency exercises and incident planning, both within Australia and abroad. A summary of each situation is provided in this section, with details of ARGOS given in the Appendices following the evaluation report.

ARPANSA’s evaluation has focussed mainly on nuclear/radiological scenarios, however some simple chemical and biological dispersions have also been considered. Additional evaluation of chemical/biological scenarios has been considered during the stakeholder questionnaire assessments.

3.1 Basic Training Scenarios

During the rollout of ARGOS, several scenarios were distributed to stakeholders for training. These involved chemical (ERH-HP-SOP-0001), biological (ERH-HP-SOP-0002) and radiological (ERH-HP-SOP-0003) release situations, and walked new users through the basic controls of ARGOS. Each of the scenario papers is attached in Appendix A.

Basic running of ARGOS has been described and tested in each of the training scenarios, including:
- Opening/saving maps,
- Navigating to regions of interest,
- Opening Rimpuff,
- Displaying BOM wind fields and creating simple wind files,
- Performing a prognosis and the options involved with this,
- Display of outputs.

The chemical scenario involved the stepped release of a chlorine source in Brisbane. A user-defined wind field was applied. Simple testing of the source release calculator (for alternative release geometries) was unsuccessful in the version of ARGOS distributed to stakeholders (Version 8.2 Final).

The radiological scenario involved the release of a Radioactive Dispersion Device (RDD or Dirty Bomb) from the Sydney Opera House. A release of 80TBq of CsCl powder was simulated using the BOM Meso-LAPS wind field in the Sydney/Canberra area (initially available during the interval 0:00 22/10/2007 to 22:00 24/10/2007 (UTC)). This simulation was successfully performed, however it has been noted that ARGOS does not currently include an adequate explosive term for use in RDD simulations. Additionally, new versions of ARGOS have incorporated the ability to quickly and easily choose a single radionuclide release term, which is ideal for RDD simulations.

The biological scenario simulates the simple release of Bacillus anthracis from Parliament House, Canberra. This simulation also makes use of the Meso-LAPS wind field, which has coverage in the Canberra region. As with the chemical release, the biological agent can be defined with a stepped source term and a prognosis was
considered over 6 hours. It was noted that the biological database was the most limited of the three types of release considered. Only *Bacillus anthracis* has been included in the V8.2 Final release candidate. It is expected that more complete libraries of biological agents will be made available in the future.

Basic running of ARGOS has been described and tested in the training scenario, including:
- Opening maps,
- Navigating to region of interest,
- Opening Rimpuff,
- Displaying wind fields,
- Performing a prognosis – including prescribing wind fields, gridpoint sizes, etc.,
- Display of outputs.

### 3.2 USA-193 Satellite

On February 21st 2008 an out-of-radio-range US military satellite (USA-193) was intentionally fired upon at a height of approximately 250km above the Pacific Ocean. The satellite was destroyed, and nearly all of the debris was expected to burn up on re-entry.

Various scenarios for crash-landing of the in-tact satellite were considered using ARGOS Version 8.2 Final, which was housed on a virtual machine. This was equivalent to that distributed to stakeholders in the evaluation project. ARGOS' results were qualitatively compared to NOAA's Hy-Split model (as used by the BOM). The satellite contained a confirmed fuel load of approximately 500kg Hydrazine (N₂H₄) and potentially some radioactive sources (unconfirmed). Incorporation of a coarse-grid LAPS (Limited Area Prediction System) wind field for Australia (obtained from BOM) into ARGOS was undertaken, and the system was applied to chemical dispersal and radionuclide trajectory calculation.

During the exercise a number of issues were raised with the running of ARGOS in various situations. These included the nature of the ‘heat’ term in chemical dispersal and insufficient disk space on the VM-Ware virtual machine (a problem overcome with the installation of a server-client setup and ARGOS V8.3 at ARPANSA). Of the most concern was an apparent singularity at various release points which seemed to be related to the LAPS data. This error is currently undergoing investigation and will be rectified in future releases.

Taking into account differing sources for wind data, ARGOS (NWP wind field) and Hy-split (observed wind field) trajectories are generally comparable in direction, with Hy-split trajectories showing greater displacement from the point of origin. A quantitative analysis of this data was considered to be outside the overall scope of the simulation, however some quantitative data for trajectories has been provided (see Appendix B).

Overall recommendations from the simulation of Satellite USA-193 suggested that further work and clarification is undertaken during (and after) the evaluation of ARGOS to ensure that:
- ARGOS is suitable for larger-scale advection of pollutants in Australian Desert Areas.
The use of BOM data in ARGOS is robust, with no restriction on source positions.
Disk space for ‘virtual machines’ does not become a restrictive issue.
Guidelines are given to succinctly specify which situations ARGOS should and should not be applied in.

During the evaluation it has been found that upgrades to ARGOS have solved most of the problems experienced in this project. Specific issues will be discussed in the sections that follow.

### 3.3 Emergency Exercise ConvEx-3

An IAEA international radiological release exercise from a nuclear reactor in Laguna Verde, Mexico, was conducted on July 8th and 9th. ARGOS was one of the tools applied by ARPANSA in order to provide radiological protection advice. Other consortium members also took part in this exercise, and in the future it may be beneficial for Australia to coordinate with consortium members. This is particularly useful for the sharing of meteorological data and source term information.

Step-by-step descriptions of the use of ARGOS in the exercise are included in Appendix C. The server-client Version 8.3 (Release Candidate 4) in use at ARPANSA was originally applied at Laguna Verde and the wind field was manually defined according to local conditions published on the IAEA ENAC website. During the exercise, ARGOS was used for successful import of geotiff imagery, simulation of the specified release using RIMPUFF, specification of Australian Operation Intervention Level (OIL) isolines, and final production of web-based outputs and ESRI Shape files. All work on this exercise was conducted using the Event Mode of ARGOS, with all products stamped ‘Exercise’. Overall it was found that ARGOS successfully simulated and delivered a range of release scenarios from the Laguna Verde reactor.

Some teething problems with the server-client setup were observed during the exercise. It was found that the location for the reactor specified in ARGOS did not match precisely with that observed in Google Earth. This change was easily made, however it is worth noting. The source terms for Laguna Verde were not included in the database by default, however these were easily created with the knowledge that the reactor was a 682.44MW Boiling Water Reactor (BWR). Saving and loading of incidents and maps did not appear to work at all times. This aspect needs to be investigated further, and could be an artefact of the use of a number of client machines. It may be useful to develop a protocol for saving files in future ARGOS training.

### 3.4 Nuclear Release from Southern Sydney

One of the sites for consideration of Australian radionuclide dispersion in the case of an accident is a hypothetical reactor located in Southern Sydney. As well as being considered by ARPANSA (see Appendix D), the ARGOS system has been applied to the planning of releases and response in this region by ANSTO modellers (see Questionnaire response, Appendix H).

ARPANSA’s consideration of the reactor created in ARGOS has involved;
• Definition of source inventory for 20MW open pool research reactor (Frikken, 19973),
• Entry of source inventory into ARGOS database thus creating a new reactor type,
• Prognoses to investigate various release scenarios.

Initial running of an accidental release scenario was considered using the virtualised version of ARGOS 8.2, as released to stakeholders. When the server-client system was incorporated at ARPANSA, V8.3 Release Candidate 4 was applied. Most recently, ARGOS Version 8.3 (Final) was applied, as shown in the appendix. Accident scenarios can use specifically defined releases (based on reference accidents), or percentages of the total radionuclide inventory as defined by release categories in ARGOS (based on WASH-1400, 19754). In an emergency situation field measurements could be used to refine the release category and ensure the most realistic simulation.

Releases were considered using both LAPS and MesoLAPS Numerical Weather Prediction (NWP) data obtained from BOM. This enabled the investigation of isolines for intervention purposes, and the export of animations to web-based products. This also enables the testing of the coarse-grid (LAPS) against the finer grid (MesoLAPS) NWP data. Initial investigation of the Food Dose Model was also considered.

Overall it was found that ARGOS successfully simulated emergency releases from the hypothetical reactor in Southern Sydney. As mentioned in Section 3, it may be useful in the future to consider batch jobs for emergency planning and situation management for differing conditions (e.g. varying winds) at similar sites around Australia.

3.5 Planning for Nuclear Powered Warship (NPW) Visits to Australia

ARGOS has been applied to Nuclear Powered Warship (NPW) emergency planning and arrangements throughout Australia (see Appendix E). Through the use of reference accidents (Frikken, 1997), ARGOS source terms have been defined for both NIMITZ aircraft carriers and nuclear powered submarines. Removal times in the case of an incident/accident are 24 hours for a submarine, 2 hours for an aircraft carrier.

Locations for approved berths and anchorages (with GPS coordinates) are given in OPSMAN15, and include;

- Western Australia
  - HMAS STIRLING/Cockburn Sound,
  - Gage Roads (near Fremantle),
  - Albany.
- Tasmania
  - Hobart.

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- Queensland
  - Brisbane,
  - Gladstone.
- Northern Territory
  - Darwin.
- New South Wales
  - Jervis Bay.
- Victoria
  - Melbourne.

Each of the 9 sites listed is incorporated into the coarse-grid LAPS wind field supplied by BOM. Currently, MesoLAPS (fine-grid) wind data is also available at Victorian, New South Wales and Tasmanian ports.

Various release scenarios and times were considered at these locations, and ARGOS has shown that it is a very useful tool for this type of situation. In the future, ARGOS can be used to:

a) Contribute to emergency planning for each of the Ports by providing scenario-based simulations,

b) Provide predictions of radionuclide dispersal 48 hours prior to NPW docking,

c) Provide fast, up-to-date real-time simulations using current meteorological predictions,

d) Produce information for possible countermeasures, including evacuation and iodine prophylaxis, in the case of a nuclear emergency.
4. Stakeholder Replies to Questionnaires

A questionnaire was sent to stakeholders in two parts;

1. **Initial Requirements** – These were intended to obtain the projected uses and requirements for the software. Initial impressions of ARGOS were evaluated, however in-depth assessment was not required at this stage. It was requested that this first part of the questionnaire could be returned to ARPANSA by Friday 30th May.

2. **Formal Evaluation** – These questions were intended to help prompt stakeholder appraisal of the ARGOS software. Comment from users who are familiar with the software and its application to stakeholder problems were required in order to ensure an in-depth assessment. A cut-off date of Friday 4th July was set as the last date to return formal evaluation forms.

Copies of the questionnaire forms and responses from stakeholders are shown in Appendices G and H.

4.1 Summary of Initial Questionnaire Responses

Responses to the initial questionnaire have been received by AFP, ANSTO, DSTO, NSW Fire Brigade, Qld Fire & Rescue Service, Dept. Health & Ageing. The overall initial requirements have been summarised below.

**Summary of Responses**

1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)

There was interest in each of the capabilities a), b) and c). Other features of interest included use of rain-radar images and food dose modelling.

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?

All situations are of interest, with individual stakeholders having specific preferences driven by their 'sphere of interest'.

3) Is it your intention to use ARGOS in the field ('front-line') or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

Most respondents preferred to apply ARGOS as an office-based system that would be used in support of field operatives. Capability as an incident planning tool and stand-alone use on laptops in the field was suggested for specific needs. Generally, it was preferred that ARGOS was kept as an in-house tool, but it was suggested that the capability to interact with a cross-Governmental system during operational or incident management work may be useful.

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google,
Most respondents are using a mixture of Mapinfo, ESRI and Google Earth. Other tools, such as vertical mapper, streetpro (within Mapinfo), UBD maps, FME, ArcGIS and Leica Geosystems Ermapper are also in use.

b. Which GIS tools would you prefer ARGOS to interact with?

Google Earth, Mapinfo and ESRI are the preferred tools.

c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

Map layers (including satellite photos or aerial maps, roads, rivers, contour lines, 3D features), isolines (horizontal and vertical), numerical output are required by all users. Other suggestions include;

- Movies of plume evolution with times marked, instantaneous concentrations and time integrated doses,
- Surface deposition maps,
- Combinations of plume doses with population maps to give affected populations,
- Ability to import/export maps in various image and GIS formats,
- The ability to import data via spreadsheets for map creation,
- Ability to link source information with GPS and graphical locations (e.g. a graphical database of relevant facilities across Australia).

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?

The current improvements mentioned here were well received. Further specific improvements suggested include;

- 2D output map layer to specify height so that 3D visualisations can be made,
- WMS (Web Mapping Service), WFS (Web Feature Service) and WCS (Web Content Service) capability,
- Improvements to the chemical and biological source terms and their effects,
- Accommodation of a variety of datums/projections to suit northern and southern hemispheres,
- Improved functionality for GIS aspects (e.g. pan, layer control, zoom, querying, etc.),
- Improvements in the user-friendliness of the graphical user interface,
- Incorporation of back-tracking function,
- Functionality similar to the nuclear scenarios for entering new sites for chemical/biological scenarios,
- A 3D view for the Urban Dispersion Model,
- More descriptive explanation of outputs via a detailed manual (including RIMPUFF outputs),
- RIMPUFF dispersion output is preferred in specific intervention levels/colours (this does not specifically work using the palette and isocurve combination),
- Movement of the colour legend to an alternative position (due to clashes with
map layers),
- Use of meteorological data and NWP during the same run as well as automatic input of 15-minute meteorological data from several stations,
- Ability to input field data and subsequently update the plume model particularly when an accurate source term is not known. The capability to interpolate such field data to establish the unknown source term (where source position is known) would be particularly useful.

4.2 Summary of Final Questionnaire Responses

Responses to the Final questionnaire were received from AFP, ANSTO, DSTO, Chemistry Centre WA, NSW Fire Brigade and Queensland Fire and Rescue Service. Some stakeholders were unable to return completed questionnaires due to installation issues and specific requirements. Significant work was undertaken to assess ARGOS for the needs of each organisation. The completed questionnaires are included in Appendix H, and are summarised below for each question considered. The percentage of users that indicated their satisfaction with various aspects of ARGOS via tick-boxes has also been indicated. Where an assessment was not available the percentage was calculated according to the number of respondents. Where relevant, the current progress of ARGOS development has been included in italics and square brackets.

**Question 1:** After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

<table>
<thead>
<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied 0%</th>
<th>Partially Satisfied 100% (6)</th>
<th>Not Satisfied 0%</th>
</tr>
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</table>

Most users thought that the GUI was not particularly intuitive to initially use. Once a user became familiar with the program (through training or general use) ARGOS could be easily run and results could be examined effectively. This is reflected with all users being ‘Partially Satisfied’ with the performance of the GUI. Some suggestions for improvements included;

- Ability to move a source with the cursor [This feature has been added in current versions of ARGOS 8.3].
- White borders for the legend and number labels due to difficulty in reading these against some maps – a number of users had difficulty reading these indicators. Another suggestion was the ability to move the legend.
- Automatic download of wind information [This feature is available in the current server-client version of ARGOS at ARPANSA].
- More complete source terms – this is particularly relevant for chemical (e.g. liquid/gas) and biological agents. Generation of sources such as ‘chlorine tanker ruptured by explosion’ was also suggested.
- Australian Acute Exposure Guide Line isolines (AEGL’s) are needed for chemical incidents. Infectious Concentration by Time isolines for biological releases would also be useful (e.g. ICT50 refers to infections dose for 50% of those exposed).
- A local time to UTC converter.
- Default fields for locations coordinates (WGS84) through Map-Find-Point should be 0°0′0″ to remind users of formatting.
- A zoom-in button would be useful.
- Australian street address information as well as population density information [*This should be possible with the server-client setup at ARPANSA – the database needs to be populated*].
- Maps with street level detail for small scale releases [*A link to Google Maps is included in ARGOS V8.3 Final*].
- Ability to control minimum concentrations/doses tracked in plots, so irrelevant concentrations are not plotted [*This is possible within ARGOS*].
- The option to do batch jobs for planning purposes would enable users to re-run the same scenario many times whilst varying wind conditions.
- More complete documentation on the details of how source inputs are incorporated into the plume would increase user confidence.
- User guides and procedures for the PMS database, NucSpec, FDM and countermeasures modules were requested [*These will be provided in the future*].
- The reactor inventory input function was found to be useful, and similar function for chemical and biological sources would be desirable.
- Graphical reporting of outputs was considered to be good (particularly for nuclear releases), however a more comprehensive description of the output terms is required.
- Improved documentation would help to ensure that all functions could be effectively used.
- Units could be included next to output names.

Stakeholders evaluated the software based on demonstrations by ARPANSA staff members and also by hands on application to various scenarios.

**Question 2:** Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

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<thead>
<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
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<tr>
<td>33% (2)</td>
<td>67% (4)</td>
<td>0%</td>
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All responders were, to differing extents, satisfied with ARGOS’ speed. Some users thought that ARGOS might be too slow for real-time decision making, particularly when high resolution runs were being considered, however ARGOS was still seen as a useful additional tool for Emergency Response. Start up within the virtual environment was thought to be slow, however this improves using a server-client system. Once a user was experienced in the use of the programme, the setup time was considered to be satisfactory. The setup of prior saved scenarios can also significantly reduce startup times. Mapping speeds were found to be directly related to the size of the data being mapped.

**Question 3:** ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?
Users were happy with the outputs from RIMPUFF, however some users would like further access to validation studies including direct comparison with experimental data. Particular users would like to have the flexibility to determine turbulence conditions directly rather than having the use of the algorithm within ARGOS/RIMPUFF as the only option. Outputs from detailed chemical release models were generally unable to be assessed.

DSTO would like to see probabilistic outputs incorporated into the plume modelling (e.g. the probability of exceeding a given concentration or dosage value at a given distance downwind of the source). This helps to quantify uncertainties that should be taken into account in decision making. This would require significant implementation in RIMPUFF (transport of concentration variance or modelling of concentration probability distribution at all points of the plume), however there are other models that have this feature that may be used within ARGOS.

**Question 4:** Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

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<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
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<tr>
<td></td>
<td>33% (1)</td>
<td>67% (2)</td>
<td>0%</td>
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Some users did not fully evaluate this feature, however those that did were satisfied with the outcomes. It was thought that it was reasonably simple and user-friendly to input these source terms, however more detail could be provided as to how the internal model uses the data to generate a release. It was noted that when creating a new reactor entry data input into the release category did not always save – this meant that the data had to be re-entered. [Perhaps a standard procedure could help to reduce occurrences of this problem.] A similar input function would be an essential addition to chemical and biological prognoses in order to create catalogues (with source terms) of relevant facilities.

The input of data from monitoring stations (e.g. meteorological and radiological) was desired in the future.

Logging of field measurements and import of datasets was difficult to undertake using the version of ARGOS distributed to stakeholders. ARPANSA is currently undertaking work to make use of this feature, and feels that it will be an extremely important tool.

**Question 5:** Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

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<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
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<tr>
<td></td>
<td>0%</td>
<td>0%</td>
<td>100% (2)</td>
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</table>
Most users did not evaluate this aspect of ARGOS’ performance or considered minor import/export of data (such as png files).

Both assessors felt that ARGOS performed poorly in all tested sections as a GIS tool. Included maps were not considered adequate for use in first response situations. Importing geotiffs proved to be difficult due to difficulties with southern hemisphere coordinates, and the process was quite labour-intensive. ARGOS seemed to have some issues with reprojected files, with one particular geotiff only displaying after a modification of the raster image itself. There was some difficulty with loading shapefiles into ARGOS, and formal training for this procedure was recommended.

ARPANSA has found that the newer versions of ARGOS are improved as a GIS tool. The inclusion of online Google Maps (V8.3) has reduced the need to import images and has improved the speed of output provision.

**Question 6:** Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

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<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied 25% (1)</th>
<th>Partially Satisfied 75% (3)</th>
<th>Not Satisfied 0%</th>
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</table>

Upon initial impressions as a novice, most users felt that ARGOS was not particularly flexible – particularly due to initial assessments requiring significant trial and error. It was suggested that a formal training program may be beneficial in the future.

Most users found that re-running and refinement of modelling runs was relatively simple, and ARGOS is well set up for this. It was noted, however, that altering some options can significantly increase computation time (which may not be desirable for operational situations). It was suggested that ARGOS benefit from the ability to perform batch jobs, and that error messages were sometimes poorly defined.

Flexibility of detailed release models was unable to be assessed as this feature was not functioning in the evaluation version.

**Question 7:** ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

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<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied 25% (1)</th>
<th>Partially Satisfied 75% (3)</th>
<th>Not Satisfied 0%</th>
</tr>
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</table>

A variety of Chemical, Biological and Radiological/Nuclear scenarios were investigated by users. General improvements suggested include:
- The ability to export data in a tabular format,
- Improvements in the GUI to make more user-friendly (as previously mentioned),
- Significant upgrades of biological databases and agents,
- Function similar to the ‘reactor’ input in Nuclear database to be applied to other database types to enable production of a graphical database of source terms around Australia,
• Clearer definition of outputs and some functions, as well as an understanding of how input data is utilised in the Rimpuff model.

Overall, stakeholders felt that Radiological/Nuclear incidents were simulated easily, however it was noted that some functions were not available in the test version due to errors in database connections or lack of specific data. Users were happy adding reactors into the database. It was suggested that the inclusion of intervention level colours onto isolines would be desirable.

It was thought that the Biological databases needed significant addition and revision due to the lack of agents available for use and lack of outputs generated. ICT isolines should also be included for the Biological simulations to be applied regularly. Assessors also noted that much of the data currently held in the biological database is not being incorporated into the model, and therefore could not be appropriately evaluated. This may also apply to chemical databases.

The Chemical section was considered to have performed well for simple releases, and results were consistent with other software available and field measurements. Certain functions were not available in the evaluation version. These included ‘heavypuff’ and the calculation of alternate source-term geometries (templates section). There is some interest in chemical warfare agent source models, which are currently unavailable in ARGOS.

**Question 8:** Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

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<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
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<td></td>
<td>0%</td>
<td>100% (1)</td>
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Most users were unable to apply this functionality through the virtualised evaluation version of ARGOS, however it was thought that this feature would be very useful.

At ARPANSA the export of outputs to an internal web server has been completed successfully. In the longer term it would be useful to be able to provide this product externally to field personnel and decision makers.

**Question 9:** As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?

<table>
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<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
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<tbody>
<tr>
<td></td>
<td>50% (1)</td>
<td>0%</td>
<td>50 (1)%</td>
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</table>

It was suggested that if ARGOS were incorporated into various Government organisations more stringent testing into security would be considered. Each department felt that they had relevant processes in place to ensure security, and there was also the possibility that ARGOS would be placed on ‘stand-alone’ machines or a restricted network if deemed necessary.
Dissatisfaction was displayed with having ARGOS as a system exclusively driven from a server or web-based product as this would limit its use in the field. This is particularly relevant in remote areas, where internet services may not be available.

**Question 10:** Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

| Satisfaction with this aspect of ARGOS’ performance | Totally Satisfied 0% | Partially Satisfied 80% (4) | Not Satisfied 20% (1) |

Some evaluators felt that they were unable to comment on ARGOS’ reliability until they had used the system more extensively. Use at ARPANSA has found that certain modules were not fully functioning on the version distributed for evaluation (V8.2, in virtual machine environment). As in Question 5, dissatisfaction with ARGOS was mainly focussed on weaknesses with regards to GIS aspects.

Reviews on reliability during prognoses made the following suggestions;
- Certain utilities/modules did not function, such as “Calculate” and “Heavypuff” within C, and the trajectory module within C and B.
- In general, C and B lack important outputs when compared with N (e.g. ground contamination).
- For N, when creating a new reactor entry, data input into the release category did not always save. The data needed to be entered a number of times before it remained.
- Within the B section, some of the database entity information is inaccurate.
- To fully utilise the Tanker/truck templates within the C prognosis further information on how the database information is incorporated into modelling is required. This would include a general understanding of what information is used to create the output.

GIS comments indicate that ARGOS has not been reliable from a GIS perspective, and it is well below the standard expected. It may be worth assessing other GIS applications to attain a desired look and feel. The following aspects should be addressed;
- Import and export functions should be easy to use and easily accessible.
- Shapefile import needs to be a lot simpler.
- The basic GIS tools offered such as pan and zoom need to be refined and made more user-friendly.
- The table of contents pane is redundant unless it offers the ability to re-organise order of layers or change symbology.
- ARGOS needs to have the ability to work with a range of projections and datums.
- ARGOS needs to have the ability to export in a wide variety of formats.

It should be noted that the VM-Ware implementation of ARGOS was problematic for some networks. There have been some cases of computers ‘freezing’ due to the software. This should be overcome with direct installation.

Extensive use by ARPANSA has uncovered various errors and issues specific to use of ARGOS in Australia. These have been referred directly to the developers, and it is
expected that many of these have been addressed in Version 8.3 Final. These limitations and issues are included in the sections that follow.

**Question 11:** Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?

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<thead>
<tr>
<th>Satisfaction with this aspect of ARGOS’ performance</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
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<td></td>
<td>20% (1)</td>
<td>80% (4)</td>
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Overall stakeholders were satisfied with the use of ARGOS as a decision support tool in Australia. It was felt that ARGOS has various strengths and weaknesses, and has potential to be a very useful tool if certain improvements are made. Other tools that are currently used within Australia for decision support include;

- ALOHA,
- HPAC,
- British urban dispersion modelling packages,
- In-house Emergency Response systems.

In general, it was felt that ARGOS could be used as an additional tool to current systems. In some cases it was felt that if certain aspects (as outlined above) were addressed, that ARGOS could replace certain tools for use within Australia.

**Question 12:** Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Further improvements arranged in the area of interest (in addition to those stated above) include;

**Graphical User Interface**

- A ‘wizard’ style interface aimed at the casual user [Note that simple scenarios can be developed to enable quick loading in the case of an emergency].
- More user-friendly Graphical User Interface

**Source Terms**

- A function similar to N scenarios to enter new “reactor” sites for C and B scenarios or a setup wizard.
- Implementation of ARGOS for more conventional chemical weapon agents, such as Mustard Gas, and G and V nerve agents.
- An easier and more intuitive interface with the database for data entry and amendment of CBR materials and agents.

**Intervention Level Indicators/Decision Support**

- If ARGOS could generate isolines based on the probability (due to plume/wind fluctuations) of local time integrated concentration exceeding a particular threshold (for example AEGL-2), it would make ARGOS a more powerful decision tool. For example, a local commander would know there is a 5% probability that people within the 5% AEGL-2 isoline have in excess of a 5% chance of getting in harms way. Is RIMPUFF capable of probability calculations of this nature?
The radiation simulation has some good effects based metrics, such as preventative effects of taking iodine and staying indoors. It would be good if this theme could be extended to C and B as well, such as the effect of wearing gas masks, and wearing other protective equipment, staying indoors, etc.

If the above effects based metrics could be combined with AEGL and ICT isolines to give adjusted regions where protected people would feel effects, this would also be a powerful decision tool.

- Intervention levels within contours for plume outputs.

Import/Export and GIS

- Tabulated numerical output.
- More descriptive map layers including roads, 3D features, horizontal and vertical isolines.
- The ability to import and export maps in various image and GIS formats.
- The ability to import data via spreadsheets for map creation.
- Generally, basic GIS-like functionality (pan, layer control, zoom, querying, etc.) should be included and is a must for any software of this nature.
- It would be useful if ARGOS could generate plots of 2D cross section concentration (instantaneous, time integrated, etc) at user defined points.
- Ability to export numerical output/data for graphing.

Further Functionality

- Inclusion of an Urban dispersion and explosive models (BLEVE, TNT and fireballs).
- Incorporation of the “back tracking” function (previously demonstrated with ARGOS) to determine the origin of release using reverse wind field.
- A 3D view for the Urban Dispersion Model [Note that this currently exists but 3D building information is required for implementation].
- Building infiltration and exfiltration.
- Concentration of chemical contaminant by height.

Miscellaneous

- More descriptive explanation of outputs via a manual.
- Inclusion of units next to RIMPUFF output names.
- Ability to move the colour legend or for this to be more legible (e.g. white bordering).

Users would like the opportunity to test the detailed chemical models, as this was non-functional in the distributed evaluation version of ARGOS.

Additional suggestions for the development of Chemical and Biological aspects of ARGOS were given after the ARGOS Evaluation workshop (see below). These focus on database, source terms and outputs.

Biological Prognosis Development

Database

- Easy creation, entry and amendment of data. There would be an interest in:
  - The ability to easily incorporate a greater number of biological agents and amending some of the data already entered.
The ability to easily incorporate additional categories/fields for data storage in the databases.

- Including the 22 biological agents which are on the COAG list of Biological Agents of Security Concern, as well as a provision for the inclusion of other biological agents of concern.

- Ability to input facility locations at specific coordinates and create an inventory of biological agents stored at each location and their source terms, similar to the reactor inventory input function in the Nuclear Prognosis.

- Ability to query/search the above facilities/inventories for specific descriptors.

- Database Categories
  - Biological Agent
  - Active component of agent
  - Disease name
  - Aerobiological properties of agents such as:
    - Particle size
    - Weight
    - Structure
    - Gaussian distribution of particle sizes in a release
    - Dynamic changes over time i.e. loss/gain of particle size due to changes in weather conditions etc
  - Infectious dose (minimum/maximum)
  - Mortality and Morbidity
    - Untreated, treated, vaccine (if available)
  - Potency
  - Stability/Degradation of agent due to:
    - UV (for day vs. night release)
    - Humidity
    - Temperature
    - pH
    - Others e.g. mechanical stress caused by dispersion device
  - Incubation Time (minimum/maximum)
  - Time to death
  - Spread
  - Isolation or quarantine required

- Data to be entered and stored in database (to include shaded fields in database to denote what parameters are not utilised by the model)
  - Communicable/non-communicable ratio
  - Diagnosis
    - Tests available
- Presumptive
- Clinical/confirmatory
- Environmental
  - Differential (common mistaken diagnosis)
  - Treatment regime (e.g. vaccine/other prophylaxis, antibiotics)
  - Duration (minimum/maximum)
    - Disease progression
    - Infectious period
    - Illness
  - Personal Protective Equipment requirements (Category A, B, C suits etc.)
  - Animal reservoir (e.g. equine, bovine etc.)

**Source Terms**
- Delivery/Dispersion methods
  - Spray devices – foggers or crop dusters
    - nozzle diameter, flow rate and droplet size
  - Manual release
  - Unassisted dispersion
  - Explosive dispersion (only for certain explosives)
- Form of agent
  - Liquid, powder

**Outputs**
- Clear description of the output terms
- Additional output terms
  - Time integrated inhalation dose, maximum inhalation dose, ground contamination, wet and dry deposition, UMD parameters
  - Isolines for Lethal Dose (LD_{50}, LD_{90}, LD_{10}) and minimum infectious dose
  - Time integrated cumulative dose functions (i.e. from multiple agent release)

**Additional proposals**
- Point, line, area and volume sources.
- Stationary and moving releases.
- The ability to incorporate measurements from the field to confirm agent and influence model outputs in a real-time event.
- Places of special interest inside the plume to be identified e.g. hospitals, schools, government buildings.
- Backtracking to source of release.
Population for day and night times.

**Chemical Prognosis Development**

*Database*

- Easy creation, entry and amendment of data. There would be interest in:
  - The ability to easily incorporate a greater number of chemicals and amending data already entered.
  - The ability to easily incorporate additional categories/fields for data storage.
  - The inclusion of a number of chemicals currently on the COAG list of Chemicals of Security Concern, as well as others that could pose a serious threat if used in conjunction with an improvised explosive device.
  - The inclusion of a number of Chemical Warfare Agents.

- Ability to input facility locations at specific coordinates and create an inventory of chemicals stored at each location and their source terms, similar to the reactor inventory input function in the Nuclear Prognosis.

- Ability to query/search the above facilities/inventories for specific descriptors.

- Database Categories
  - Chemical formula
  - Name (alternate names)
  - CAS
  - Melting and boiling point
  - Melting and evaporation heat
  - Heat capacity (gas, liquid, solid)
  - Density (gas, liquid, solid)
  - Liquid viscosity
  - Flammability
  - Lower explosive limits, higher explosive limits
  - Vapour pressure
  - Atmospheric half-life
    - UV
    - Humidity
    - Temperature
  - Acute Exposure Guideline Limits

- Data to be entered and stored in database
  - Corrosive properties (gas, liquid)
  - Distinctive characteristics (e.g. smell)
  - Toxicological properties
Symptoms/effects of agent (e.g. choking)
- Personal Protective Equipment requirements (Category A, B, C suits etc.)

**Source Terms**
- Delivery/Dispersion methods
  - Further development of tanker, tank and cylinder templates
    - valve diameter and flow rate
    - pool calculations: percentage of chemical in liquid pool, vapour and aerosol droplets
    - Tanker/tank/cylinder disruption
      - Catastrophic
      - Mechanical puncture (hole diameter, flow rate)
  - Spray devices – foggers or crop dusters
    - nozzle diameter, flow rate and droplet size
  - Manual release (e.g. release valve)
  - Explosive dispersion

- Form of agent
  - Liquid, gas (pressurised)

**Outputs**
- Clear description of output terms
- Additional output terms
  - Acute Exposure Guideline Level isolines
  - Lower and higher explosive limit isolines
  - Time integrated cumulative dose functions (i.e. from multiple agent release)

**Additional proposals**
- Main transportation routes through urban areas, such as Sydney, Melbourne or other CBDs.
- Point, line, area and volume source.
- Stationary and moving releases.
- The ability to incorporate measurements from the field to confirm agent and influence model outputs in a real-time event.
- Places of special interest inside the plume to be identified e.g. hospitals, schools, government buildings.
- Backtracking to source of release.
- Population for day and night times.
4.3 Analysis of Questionnaire Responses

With such wide-ranging requirements and backgrounds the responses to the questionnaires from each of the stakeholders are (understandably) difficult to collate and analyse.

In general, when considering the responses to the ‘tickbox’ questionnaire, ARGOS satisfied nearly all requirements of Stakeholders. This is shown graphically in the figure below.

The particular area that ARGOS did not do well was with regard to its performance as a GIS tool. Two negative (Not Satisfied) responses were received, and both referred to ARGOS’ GIS capability. Improvements to ARGOS’ GIS aspects are possible, and various suggestions have been made (see Section 3.2). It is worth noting, however, that ARGOS is not first and foremost a GIS tool. The information stored within the ARGOS databases and calculations using RIMPUFF can be exported to other GIS tools as ESRI shapefiles. Users have suggested that it would be beneficial to be able to generate tabular output and extract data from the database relatively simply. These options should be investigated further, as they will allow that user to incorporate ARGOS outputs into GIS tools that are already being used by Australian first responders.

The responses to each question have been tabulated below. A scoring system has also been applied, where;
- Totally Satisfied scores 3 points,
- Partially Satisfied scores 2 points,
- Not Satisfied scores 1 point.

<table>
<thead>
<tr>
<th>Overall Outcome</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>No Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>19.6%</td>
<td>71.7%</td>
<td>8.7%</td>
</tr>
</tbody>
</table>

The overall score for all responses was 2.04, which indicates users were mostly satisfied with ARGOS’ performance, however some aspects needed improvement to reach total satisfaction. A graphical representation of scores for each question is also shown below.
### Questionnaire Results

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>6</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
<td>2.33</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>6</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
<td>2.33</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>3</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>3</td>
<td></td>
<td>2.25</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td></td>
<td>4</td>
<td>1.8</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td></td>
<td>4</td>
<td>2.2</td>
</tr>
</tbody>
</table>

As previously discussed, the lowest scoring questions (5 and 10) were related to GIS aspects. The relatively small number of responses for certain questions has meant that their calculated assessment score is particularly sensitive to fluctuations. For example, the highest and lowest scoring questions both had a single response. This makes it very difficult to quantitatively analyse the questionnaire returns.

In general, the overall average of 2.16 reflects the comments received in the questionnaires – that is, users feel that ARGOS is a very useful tool and complements current capabilities. Improvements need to be made for the package to be used as the primary decision support tool in operational environments in Australia, particularly when considering atmospheric dispersion of biological and chemical hazards.

### 4.4 Major Issues Raised in Questionnaires

Various issues and suggestions for improvement were suggested within both parts of the questionnaire. The main issues were related to the GIS tools, Graphical User Interface and definition of source terms (particularly biological and chemical). Stakeholders would like to see intervention level indicators tailored to Australia’s needs – these should cover chemical and biological situations, as well as radiological.
Other suggestions include the addition of more complete mapping data (which should be overcome with the inclusion of Google Maps in ARGOS Version 8.3) and the provision of an improved manual. The manual is further assessed with other support in Section 6. Further specific training in the use of ARGOS from an expert user/developer would also be extremely useful.

Some users were doubtful if ARGOS was fit for purpose as a first response tool, however most would like to use ARGOS for decision support. The need for users to be experienced with the software was seen as the main negative aspect for applying ARGOS operationally in a field situation.

Overall, the majority of issues put forward during the questionnaire and evaluation can be addressed in upcoming versions of ARGOS. Many of the suggestions have (independently) been incorporated into Version 8.3 Final, which was released on 1st August 2008. Additional testing and documentation of this version will be carried out in the near future.
5. **Assessment of Suitability for ARGOS in Australia**

Each aspect of ARGOS has been investigated to evaluate for use of the decision support tool in Australia. Some complementary add-ons to ARGOS have not been fully incorporated at this stage, however the plans for these are discussed. ARPANSA’s main focus has been on radiological/nuclear aspects of ARGOS, however biological/chemical situations have been considered where relevant.

### 5.1 Databases

Databases for the ARGOS Evaluation Project have been considered in two forms. The first of these was as a ‘stand alone’ system through VM-Ware, as distributed to stakeholders (using V8.2 Final). This database structure had the disadvantage that it was restricted by the size of the virtual machine and inputs could only be received from the single ‘client’ interface. Disk space became a significant issue when testing of LAPS data over Australia was considered.

The second (preferred) database type was the purchase and installation of a stand-alone SQL server at ARPANSA. This has been linked to four ‘client’ machines where data can be added to the database and prognoses can be run based on the contents of the database (using ARGOS V8.3, various release candidates including FINAL release August 2008). Significant storage space (up to a Terabyte) is available, and can be extended further if required in the future.

It has been found that the database is relatively easy to set up and maintain, and data can be added easily. Prognoses were easily run using the processing power of the client machines, however extraction of data from the databases using the tools provided should be investigated further.

Some information that should be considered for incorporation into the database (both manually and automatically) in the future includes;

- Address details around Australia,
- Population density details,
- Meteorological data (see Section 4.3),
- Data from Permanent Monitoring Stations (development is currently in progress for development of a PMS array),
- Field data from mobile teams.

### 5.2 Source Terms

A large number of nuclear/radiological source terms and positions are provided within the initial setup of the ARGOS database. The definition of new source terms has been simplified in ARGOS Version 8.3, and reactors (or radionuclide releases) can be created and relocated directly onto the mapping display. As in Version 8.2, a user can calculate inventories based on the reactor type and the power output. Various release fraction scenarios are provided, and specific releases can be defined if required.

Chemical source terms (and types) are provided and various geometries for containers can be defined. These calculation algorithms were not functional for ARGOS Version 8.2 as distributed to stakeholders. This hampered efforts to
completely test the chemical part of the ARGOS system. The chemical source term definition is less complete than that provided for nuclear/radiological sources.

The biological source terms provided within the database are the least complete. Significant population of these databases is required to consider the simulation of biological agents, as at this time only one biological agent type is included.

Stakeholders have suggested (in Section 2) that it would be advantageous for biological and chemical source term inputs to offer the same format for inclusion into the database as provided for radiological/nuclear dispersion scenarios. This would enable the storage of information at specific sites for fast prognoses when required.

Overall, ARPANSA is satisfied with the radiological/nuclear source terms provided, as well as the methodology incorporated in ARGOS for defining new sources. Chemical and biological source term provision requires further work, including the population of the relevant databases.

5.3 Meteorological Data

Meteorological data from a number of sources can be incorporated for storage within ARGOS databases and subsequently utilised within RIMPUFF. The datatypes include:

- User-defined wind fields – These were easily input during initial testing of ARGOS, as described in the training documents.
- HIRLAM (Numerical Weather Prediction, NWP) fields – The main focus of resources due to direct relevance to emergency response predictions.
- Weather station (Met. Tower) observations – For inclusion in the future.
- Wet deposition from Radar – For inclusion in the future.

With particular thanks to the Bureau of Meteorology, various stages have been undertaken in order to input detailed meteorological predictions into ARGOS on a regular basis. The importance of this data cannot be underestimated. Quality meteorological data is a major factor in accurate calculation of atmospheric dispersion. Two resolutions were available (LAPS and MesoLAPS), as well as single-level (incorporating a number of parameters) and multi-level data. Work completed to incorporate BOM NWP data into ARGOS includes:

1) Initial provision of 72 hours MesoLAPS fine-grid wind data over Sydney/Canberra for rollout with virtualised ARGOS to stakeholders.
2) ARGOS V8.2 was modified by PDC in order to input multi-level BOM data. Some parameters included in single-level fields were estimated at this stage.
3) Discussions between ARPANSA and BOM led to the regular provision of NWP files on the BOM ftp site in an ARGOS-friendly format (combined single- and multi-level fields). Coarse-grid coverage Australia-wide (72 hour predictions) and fine-grid coverage (54 hours) over Sydney/Canberra and Melbourne/Tasmania. Files are updated every 12 hours.
4) Further modification of ARGOS was undertaken by PDC to incorporate the new files made available by BOM. The update is available in ARGOS Version 8.3 Final, as released 1st August 2008.
5) Once-daily automatic downloads of (1.5GB) meteorological data are planned at ARPANSA, to provide 24-hour coverage in case of incidents in the Australasian region. During an incident a further download will be conducted to ensure the most up-to-date data is available.
5.4 Prognoses
Numerous tests of the RIMPUFF model within ARGOS have been undertaken during the evaluation. These have been described in Section 4, and have investigated the dispersion of radionuclides, chemical and biological agents in various locations. Event modes have also been investigated. ARGOS has performed well in all of these prognoses, with the ease-of-use increasing as the user becomes more experienced. More details are provided in the attached appendices.

Other modules of the ARGOS software include the Food Dose Model (FDM), Permanent Monitoring Station (PMS) and Urban Dispersion Model (UDM, to be incorporated in future releases). These have undergone minor testing only, and it is expected that these applications will be incorporated into the Australian ARGOS system in the future.

5.5 Delivery of Product
The creation of various products by ARGOS has been successfully undertaken. Outputs that have been produced have been described in Section 4 and the attached appendices. These include:
- Output plumes for viewing within ARGOS,
- Trajectories (and corresponding text files) for comparison with other modelling packages,
- Geotiff import/export and multipublish,
- ESRI Shape files indicating Operational Intervention Levels (OILs) for incorporation in external GIS packages,
- Animations of radionuclide concentration and dose to thyroid were exported to internal ARPANSA websites.

The underlying map in ARGOS versions distributed to stakeholders does not include a great deal of detail, particularly at street level. Because of this, geotiff inputs of maps and pictures were performed and attached to the basic mapping data. The newest version of ARGOS (Version 3 Final) incorporates a live link to Google Map data, and this will help to reduce the need for importing raster images into ARGOS, thus increasing efficiency when fast output of detailed product is required.
6. Support

The ARGOS system has a significant associated network of support. The structure of the Consortium for contributing countries ensures that all payments for membership are used for development of the system. The program of work for each year is agreed at a Consortium Meeting, enabling each member country to raise issues and suggest potential improvements for the software.

During the Australian evaluation, the developers of the software (PDC) have been particularly helpful. They have responded promptly to queries both personally and via a more formal helpdesk system.

ARGOS includes a comprehensive manual, which has been upgraded for ARGOS Version 8.3. This manual includes details of many of the features of ARGOS and associated programs, however it is extremely difficult to read and requires a great deal of improvement. Some issues associated with the manual are:

- **Size** – At close to 1000 pages in total with no contents pages the document is extremely intimidating.
- **Structure** – The manual is difficult to break into bite-sized sections, particularly for the novice user of ARGOS. A ‘quick-start’ section (such as provided with the training materials in the attached appendices) would be useful for the first time user.
- **Completeness** – Many of the descriptions within the manual are incomplete or unhelpful. In many cases a screen ‘grab’ of a particular feature has been given with no further details.
- **Readability** – The manual is generally written in a dot-point format (which is relatively simple to absorb), however there are numerous spelling and grammatical errors. This is most probably due to issues in translation and should be rectified in the Final version.

During the ARGOS Evaluation Workshop it was suggested that further specific training from one of PDC’s programmers or expert users would be extremely useful for all stakeholders. ARPANSA will endeavour to organise this training in the near future.

Overall the support for ARGOS is very reasonable. With a number of worldwide users the potential for scientific collaboration is great, and the development support provided by PDC is significant. The Australian ARGOS system certainly requires a new (or considerably upgraded) manual. This will be considered as a part of the support and development plan for ARGOS in the future.
7. Improvements Suggested for the Next Generation of ARGOS Software

Various suggestions for improving the software have been suggested by stakeholders through the questionnaires (see Section 3). Some of these coincide with ARPANSA’s findings, but will not be re-stated here.

Discussion at the ARGOS Evaluation Workshop centred on priorities for improvement of the software specific to the needs of stakeholders. The following key areas were identified for the improvement of the software;

- The enhancement of chemical and biological databases and source terms – these were extremely limited in the evaluation versions, and it was thought that these could either be further built upon, or ARGOS could be modified to incorporate other software that already includes these terms.
- Streamlining and completion of supporting documentation – This was particularly relevant to incomplete Biological and Chemical sections. Additionally, a specific training course for Australian users was suggested.
- Strengthening of ARGOS’ GIS capabilities – as discussed in questionnaires.
- Inclusion of Urban Dispersion Modelling capability – as currently underway in ARGOS’ development program.

During the ARPANSA evaluation a number of bugs were uncovered and forwarded to the developers at PDC. It is expected that specific errors have been addressed in ARGOS Version 8.3 Final, which was released on 1st September 2008.

A catalogue of ARPANSA’s specific suggestions/recommendations and observed errors during the evaluation includes;

- ARGOS has shown limited capability to perform calculations from moving sources (e.g. satellite, truck, and aeroplane). This could be estimated by specifying multiple sources at different times and calculating position according to speed and acceleration/deceleration. This is a major negative for uses in emergency situations because of the time taken to get a prognosis running.
- Complex chemical source term calculation tools were not operational in evaluation version of the software.
- It would be useful to have a ‘play’ button to cycle through views after running a prognosis. The export of product to the web does incorporate a ‘play’ feature, however.
- The use of the map can be incredibly frustrating when a ‘click’ is interpreted as a ‘drag’, and a new zoomed area is created. A dedicated ‘zoom’ button would be useful. The button to return to the previous zoom level is very useful in this situation.
- There are some problems with the specification of certain units in various sub-menus. This is also the case with prognosis outputs. Units should always be provided to ensure that errors are not made.
- An import of LAPS data from BOM caused an error in RIMPUFF – this seemed to be location-specific, and occurs in some places but not others. The error given is ATANH: X<0.95. A fix was requested, and ARGOS V8.3 Final will be tested for this error with a variety of BOM data.
- In the chemical scenario, the RIMPUFF Prognosis window is labelled as ‘untitled’ even though the file has been saved with a specific name. The
RIMPUFF output file is also labelled ‘untitled’. Similar errors have occurred with other RIMPUFF output naming conventions – this will need to be tested further on the newest version.

- .shp file import/export procedures need clarification. This should be included in an updated manual.

Due to the time taken in evaluating the software, many of the suggestions put forward by ARPANSA and other stakeholders may have already been addressed in the newest version of ARGOS. Further testing will be undertaken to ensure that the final suggestions put forward to the ARGOS consortium for future development are relevant to ARGOS 8.3 Final.
Appendix A – Procedure Documents for Using ARGOS

ARPANSA QUALITY SYSTEM
ENVIRONMENTAL AND RADIATION HEALTH BRANCH
HEALTH PHYSICS SECTION

STANDARD OPERATING PROCEDURE

ERH-HP-MS-SOP-0001

Running a Chemical Release Scenario in ARGOS

Version: 1
Issue Date: 6th May 2008

Prepared by: Marcus Grzechnik and Milly Cox
PURPOSE

This document explains how to run a Chemical release scenario in ARGOS.

SCOPE

This scenario involves the release of a Chlorine source in Brisbane city. This region is currently outside of the Numerical Weather Prediction (NWP) area available, so meteorological data will be defined manually.

REFERENCED DOCUMENTS

ARGOS Manual

SOFTWARE

ARGOS Evaluation Version 8.2 Final.
PROCEDURE

1. Open a chemical basemap.

Open a chemical basemap via the menu bar at the top of the window; File – Open – Open C. Navigate to c:\Ausmaps\WorldAustralia\WorldAustralia\argosbasic.mas Click Open.

2. Find the region of interest.

A version of the map should now be present, as well as the overhead menus and icons for a chemical release. Use the Find feature (and choose to find a point or text) to locate Sydney. If point is chosen then the coordinate system must be chosen – choose WGS84, then enter the longitude and latitude and then Find. If text is chosen, type in Sydney. For text searches the Find feature can also be used by clicking on the binoculars icon which is located about half way across in the icon bar beneath the Menu bar. Alternatively, zoom out and use your mouse to utilize the drag/drop feature to isolate a part of the map. For this Brisbane release the coordinates are Longitude 153°1’40”E, Latitude 27°28’4”S. Note: This scenario is best viewed with screen approximately 1.5 degrees horizontal and 0.5 degrees vertical.

3. Save the file

When happy with the map area, save the file by choosing File – Save as...on the menu bar. Choose the filename (e.g. Scenario 1 – Brisbane Chemical.cams).

4. Enable the Rimpuff Model Window

Click R (located on the icon menu bar) to enable the RIMPUFF model window. This changes some icons and menus. The menus should be checked before a prognosis is sought; however for the run considered here no changes are required.
5. Clear any old data from the Rimpuff Prognosis window.

Click on Prognosis and press Clear, (located on the right hand side of the Rimpuff Prognosis window) to clear any old data (if present). We will now work our way around the options in this window. Note that the top two boxes enable cycling between alternative scenarios (on the left) and settings (on the right) with a single click.

6. Start a new scenario, choose the release substance and release location.

Click New and write in a relevant description (e.g. Scenario 1 - Brisbane Chlorine Release). Choose the substance from dropdown menu (Chlorine in this case), and enter the coordinates for the release (as above – note that the format is 153°14'40 and -27°28'4). The coordinate system should remain as WGS84 (World Geodetic System 1984).

7. Start the release and define the time of interest.

Click Release Start (located half way down the left side of the Rimpuff Prognosis Window) to define the time of interest. This can be set at the current time (for Emergency situations) or a specific time (for forecasting and hindcasting). For this situation we can use the current time (as NWP wind data is unavailable we will define the wind field) – NOTE THAT THIS IS THE TIME IN UTC.
8. Set the prognosis length.

Set the prognosis length for 6 hours. Click *Automatic Mode* to enable automatic stopping of the prognosis and locking in of model parameters (these can be altered later if required).

9. Define the release source.

Define the release source by clicking on the *Sourceterm* button which is located at the bottom and half way across the Rimpuff Prognosis window... For this scenario the user can define the source. A suggestion is:

<table>
<thead>
<tr>
<th>Interval (mins)</th>
<th>Release (kg/s)</th>
<th>Height (m)</th>
<th>Heat (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>1.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The source term profile should be shown in the plot on the prognosis screen.

10. Navigate the Settings box. Set the release substance to Chlorine.

The ‘Setting’ box should now be navigated. The first data input is for the RELEASE, which opens the ‘Chemical Release’ window. The substance should be set to *Chlorine* (using the dropdown menu) for the purposes of this simulation. Definition of templates in the lower box includes options that require NWP wind fields.

11. Check the release coordinates are set correctly.

The next option in the ‘Setting’ box is ADDRESS. Street address databases are not populated for Australia, so ignore these options. The release coordinates should be repeated in the ‘Coordinates’ box. Check this. The *Find* button will re-centre the map over the release point.

12. Set the meteorological options.

The MET option in the ‘Setting’ box should now be clicked. The two options given are NWP (Numerical Weather Prediction) and Manual. For this area a NWP database is currently not available, so the Manual tab should be checked. Click *Met setup* and create a new data file by clicking *Yes* and *New Edit* the met data file (answer *Yes* to the next query) and the meteorological input popup will appear. Add in some new items by clicking in the white space near the bottom of the popup. This data includes wind speed (m/s) and direction (degrees true) – data for current conditions can be found on the BOM website (latest weather observations). An example for Brisbane is 9km/h NNW and 25 degrees, which is equivalent to 2.5m/s, 347.5 degrees true North.
These data (or an alternative) can be entered into the data field. Ensure that times for the wind data cover that required for the model run. The value of the surface height should be set to at least 1m, and then click Save. Click Save again on the next popup.

13. Set the required grid size.

The MODEL option in the ‘Setting’ box has an automatic and manual mode. The user always has the option of increasing or reducing the grid size, and it is recommended that the highest value is used for the initial application of the model. This can be refined in the future.

14. Leave the UDM setting off.

The final option in the ‘Setting’ box is the UDM (Urban Displacement Model), which is not implemented in the Australian Version of the software. Leave this off.

15. Start the prognosis.

Start (located on bottom right hand side of the Rimpuff Prognosis window) the prognosis.

16. View the output.

A RIMPUFF output file will appear in the directory tree to the left of the map. If an error appears the prognosis tool will automatically provide guidance on how best to resolve the error.
The user can view output graphically by selecting the relevant output quantity (e.g., Instantaneous Air Concentration) and cycling through various views – this includes a frame-by-frame output. Note the options for logarithmic and auto-scaling, as these can alter the look of the output significantly. Another prognosis may need to be performed with an altered map (drag the map using the ‘hand’ icon) if the plume exits the defined area too soon. The user can view output graphically by selecting the relevant output quantity (Time of Arrival; Air Concentration, Time Integrated; Air Concentration, Instantaneous; Air Concentration, Maximum Instantaneous; Air Concentration Probit; UDM Air concentration, Time Integrated; UDM Air concentration, (Instantaneous; UDM deposition on Ground) and cycling through various views – this includes a frame-by-frame output.

Note the options for logarithmic and auto-scaling, as these can alter the look of the output significantly. Another prognosis may need to be performed with an altered map if the plume exits the defined area too soon.

The image below shows an example of Air Concentration, Instantaneous output:

17. Save the prognosis.

The prognosis may be saved by clicking the Save button at the right of the output menus. These can be accessed and amended at a later time as required. To open a saved prognosis, click the Load button at the right of the prognosis window, expand the ‘Incident’ directory tree, highlight the required prognosis, and click the Load button.
ARPANSA QUALITY SYSTEM
ENVIRONMENTAL AND RADIATION HEALTH BRANCH
HEALTH PHYSICS SECTION

STANDARD OPERATING PROCEDURE

ERH-HP-MS-SOP-0002

Running a Biological Release Scenario in ARGOS

Version: 1
Issue Date: 6th May 2008

Prepared by: Marcus Grzechnik and Milly Cox
PURPOSE

This document explains how to run a Biological release scenario in ARGOS.

SCOPE

This scenario involves the release of a Bacillus anthracis (the causative agent of anthrax) source in Canberra (Parliament House). This region is currently within of the Numerical Weather Prediction (NWP) area available, so detailed Bureau of Meteorology MESO-LAPS meteorological data from 0:00 22/10/2007 to 22:00 24/10/2007 (UTC) can be used.

REFERENCED DOCUMENTS

ARGOS Manual

SOFTWARE

ARGOS Evaluation Version 8.2 Final
PROCEDURE

1. Open a biological basemap

   Open a biological basemap via the menu bar at the top of the window; *File – Open – Open B*. Navigate to *c:\Ausmaps\WorldAustralia\WorldAustralia\argosbasic.mas* Click *Open*.

2. Find the region of interest.

   A version of the map should now be present, as well as the overhead menus and icons for a biological release. Use the *Find* feature (and choose to find a *point* or *text* to locate Canberra. If *point* is chosen then the coordinate system must be chosen – choose WGS84, then enter the longitude and latitude and then *Find*. If *text* is chosen, type in *Canberra*. For text searches the *Find* feature can also be used by clicking on the binoculars icon which is located about half way across in the icon bar beneath the Menu bar. Alternatively, zoom out and use your mouse to utilize the drag/drop feature to isolate a part of the map. For this Canberra release the coordinates are Longitude 149°7’30”E, Latitude 35°18’45”S. This scenario is best viewed with screen approximately 1.5 degrees horizontal and 0.5 degrees vertical.

3. Save the file

   When happy with the map area, save the file by choosing *File – Save as*... on the menu bar. Choose the filename (e.g. Scenario 2 – Canberra Biological.bams).

4. Enable the Rimpuff Model Window and display the wind field data.

   Click *R* (located on the icon menu bar) to enable the RIMPUFF model window. This changes some icons and menus. The menus should be checked before a prognosis is sought; however for the run considered here no changes are required. Of the most interest here is the visualisation of the wind data. This can be seen by clicking on the menu bar, *Meteorology – Show Wind Fields*. In the popup menu, leave the Area ID at 40, check the level (surface or level1), and select the time of the field you wish to view. Then click *OK*. The wind field data should populate the map as wind roses. These can be removed by clicking on the wind rose icon on the icons menu.
5. Clear any old data from the Rimpuff Prognosis window.

Click on `Prognosis` and press `Clear`, (located on the right hand side of the Rimpuff Prognosis window) to clear any old data (if present). We will now work our way around the options in this window. Note that the top two boxes enable cycling between alternative scenarios (on the left) and settings (on the right) with a single click.

6. Start a new scenario, choose the release substance and release location.

Click `New` and write in a relevant description (e.g. `Scenario 2 - Canberra Anthrax Release`). Fill in Bio entity from dropdown menu (Bacillus anthracis is currently the only possibility in this part of the model), and the substance (xxxx). Enter the coordinates for the release (as above – note that the format is 149°7.30 and -35°18.45. The coordinate system should remain as WGS84 (World Geodetic System 1984).

7. Start the release and define the time of interest.

Click `Release Start` (located on the half way down the left side of the Rimpuff Prognosis Window) to define the time of interest. This can be set at the current time (for Emergency situations) or a specific time (for forecasting and hindcasting). For this situation we must define a time between 0:00 22/10/2007 and 22:00 24/10/2007 (as NWP wind data is only available within these times) – NOTE THAT THIS IS THE TIME IN UTC.
8. Set the prognosis length.

Set the prognosis length for 6 hours. Click *Automatic Mode* to enable automatic stopping of the prognosis and locking in of model parameters (these can be altered later if required).

9. Define the release source.

Define the release source by clicking on the *Sourceterm* button which is located at the bottom and half way across the Rimpuff Prognosis window. For biological scenarios the user can define the source. A suggestion is:

<table>
<thead>
<tr>
<th>Interval (mins)</th>
<th>Release (kg/s)</th>
<th>Height (m)</th>
<th>Heat (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>5.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>60</td>
<td>4.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>120</td>
<td>3.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Click on *OK* when completed. The source term profile should be shown in the plot on the prognosis screen.

10. Navigate the Settings box. Set the release substance to Chlorine.

The ‘Setting’ box should now be navigated. The first data input is for the RELEASE, which opens the ‘Biological Release’ window. The substance should be set to *Bacillus anthracis*, xxx (using the dropdown menu).

11. Check the release coordinates are set correctly.

The next option in the ‘Setting’ box is ADDRESS (or LOCATION). Street address databases are not populated for Australia, so ignore these options. The release coordinates should be repeated in the ‘Coordinates’ box. Check this. The *Find* button will re-centre the map over the release point. These coordinates can be locked in if desired.

12. Navigate the Settings box.

The MET option in the ‘Setting’ box should now be clicked. The two options given are NWP (Numerical Weather Prediction) and Manual. For this area a NWP database available, so leave NWP checked. The final option in the ‘Setting’ box is the UDM (Urban Displacement Model), which is not implemented in the Australian Version of the software. Leave this off.

13. Choose the grid size.

The MODEL option in the ‘Setting’ box has an automatic (generally used) and manual mode (where the user can specify the form of the output and other options). The user always has the option of increasing or reducing the grid size, and it is recommended that the highest value is used for the initial application of the model. This can be refined in the future.
14. Leave the UDM setting off.

   The final option in the ‘Setting’ box is the UDM (Urban Displacement Model), which is not implemented in the Australian Version of the software. Leave this off.

15. Start the Prognosis

   Start (located on bottom right hand side of the Rimpuff Prognosis window) the prognosis.

16. View the output.

   Assuming the model has not had any errors due to incorrectly specifying inputs, a RIMPUFF output file will appear in the directory tree to the left of the map.

   The user can view output graphically by selecting the relevant output quantity (Time of Arrival; Air Concentration, Time Inetgrated; Air Concentration, Instantaneous; Air ConcentrationMaximum Instantaneous; UDM Air Concentration, Time Integrated; UDM Air Concentration, Instantaneous; UDM deposition on Ground) and cycling through various views – this includes a frame-by-frame output.

   Note the options for logarithmic and auto-scaling, as these can alter the look of the output significantly. Another prognosis may need to be performed with an altered map if the plume exits the defined area too soon.
The image below shows an example of Air Concentration, Maximum Instantaneous:

17. Save the prognosis

The prognosis may be saved by clicking the Save button at the right of the output menus. These can be accessed and amended at a later time as required. To open a saved prognosis, click the Load button at the right of the prognosis window, expand the ‘Incident’ directory tree, highlight the required prognosis, and click the Load button.
Running a Radiological Release Scenario in ARGOS

Version: 1
Issue Date: 6th May 2008

Prepared by: Marcus Grzechnik and Milly Cox
PURPOSE

This document explains how to run a radiological release scenario in ARGOS.

SCOPE

This scenario involves the release of Radiological material from a ‘dirty bomb’ explosion in Sydney (80TBq CsCl powder). This region is currently within of the Numerical Weather Prediction (NWP) area available, so detailed Bureau of Meteorology MESO-LAPS meteorological data from 0:00 22/10/2007 to 22:00 24/10/2007 (UTC) can be used.

For this scenario a new reactor type has been defined, Dirty Bomb Sydney Opera House. The inventories and releases are based on those defined by malicious misuse scenarios.

REFERENCED DOCUMENTS

ARGOS Manual

SOFTWARE

ARGOS Evaluation Version 8.2 Final.
PROCEDURE

1. Open a nuclear basemap.

   Open a nuclear basemap via the menu bar at the top of the window; *File – Open – Open N*. Navigate to
   `c:\Ausmaps\WorldAustralia\WorldAustralia\argosbasic.mas` Click *Open*.

2. Find the region of interest.

   A version of the map should now be present, as well as the overhead menus and icons for a radiological release. Use the *Find* feature (Located under the *Map* option on the Menu bar) and choose to find a point or text to locate Sydney. If *point* is chosen then the coordinate system must be chosen – choose WGS84, then enter the longitude and latitude and then *Find*. If *text* is chosen, type in Sydney. For text searches the Find feature can also be used by clicking on the binoculars icon located in the icon bar beneath the Menu bar. Alternatively, zoom out and use your mouse to utilize the drag/drop feature to isolate a part of the map. For this release the coordinates are Longitude 151°12'41"E, Latitude 33°51'35"S. Note: This scenario is best viewed with screen approximately 2.5 degrees horizontal and 1.5 degrees vertical.

3. Save the file.

   When happy with the map area, save the file by choosing *File – Save as...* on the menu bar. Choose the filename (e.g. Scenario 3 – Sydney Opera House Cs137.nams).

4. Enable the Rimpuff Model Window and display the wind field data.

   Click *R* (located on the icon menu bar) to enable the RIMPUFF model window. This changes some icons and menus. The menus should be checked before a prognosis is sought; however for the run considered here no changes are required. Of the most interest here is the visualisation of the wind data. This can be seen by clicking on the menu bar, *Meteorology – Show Wind Fields...* In the popup menu, leave the Area ID at 40, check the level (surface or level1), and select the time of the field you wish to view. Then click *OK*. The wind field data should populate the map as wind roses. These can be removed by clicking on the wind rose icon on the icons menu.
5. Select the source term.

Also of interest is the Basedata – Reactors located on the menu bar. This enables the user to create new reactor types or other source terms where required. In this case, a reactor has been created for use in the scenario. Information about the reactor definition can be viewed by scrolling to Dirty Bomb Sydney Opera House and choosing Select.

6. Clear any old data from the Rimpuff Prognosis window.

Click on Prognosis and press Clear, (located on the right hand side of the Rimpuff Prognosis window) to clear any old data (if present). We will now work our way around the options in this window. Note that the top two boxes enable cycling between alternative scenarios (on the left) and settings (on the right) with a single click.
7. Start a new scenario, and choose the source term and category.

   Click `New` (located on the top left side of the Rimpuff Prognosis window) and write in a relevant description (e.g. `Scenario 3 – Opera House Cs137`). Choose Reactor from the menu bar, select `Dirty Bomb Sydney Opera House`, and cycle through a few release categories. The final category can be chosen by viewing the release profile on the table to the bottom left of the prognosis, otherwise a new category can be created. Select the category `Cs137 bomb`. The category `Cs137 Bomb` has been created to give a 15 minute burst of radionuclides at 100m height. The release profile can be viewed on the table to the left of the prognosis window, otherwise a new category can be created.

8. Start the release and define the time of interest.

   Click `Release Start` (located half way down the left side of the Rimpuff Prognosis Window) to define the time of interest. This can be set at the current time (for emergency situations) or a specific time (for forecasting and hindcasting). For this situation we must define a time between 0:00 22/10/2007 and 22:00 24/10/2007 (as Numerical Weather Prediction (NWP) wind data is only available within these times) – NOTE THAT THIS IS THE TIME IN UTC.

9. Set the prognosis length.

   Set the prognosis length for 6 hours. Click `Automatic Mode` to enable automatic stopping of the prognosis.
10. Navigate the Settings box.

The ‘Setting’ box (located on the top right hand side of the Rimpuff Prognosis window) should now be navigated. The first data input is for the RELEASE, which should already be populated.

11. Select the meteorological options.

The MET option in the ‘Setting’ box should now be clicked. The two options given are NWP and Manual. For this area a NWP database is available, so leave NWP checked.

12. Choose the grid size.

The MODEL option in the ‘Setting’ box has an automatic and manual mode. The user always has the option of increasing or reducing the grid size, and it is recommended that the largest grid size is used for the initial application of the model. This can be refined in the future. Note that smaller grid sizes require longer computational times. Run a new prognosis if a smaller, high resolution grid is required.

13. Set the Detector Point and FDM Save to ‘off’.

The final two options in the ‘Setting’ box (DETECTOR POINTS and FDM SAVE) should both be set to ‘off’ at this stage.

14. Start the Prognosis.

Start (located on bottom right hand side of the Rimpuff Prognosis window) the prognosis.

15. View the output.

A RIMPUFF output file will appear in the directory tree to the left of the map. If an error appears the prognosis tool will automatically provide guidance on how best to resolve the error. The user can view output graphically by selecting the relevant output quantity (e.g. Instantaneous Air Concentration) and cycling through various views – this includes a frame-by-frame output.

Note the options for logarithmic and auto-scaling, as these can alter the look of the output significantly. Another prognosis may need to be performed with an altered map (drag the map using the ‘hand’ icon) if the plume exits the defined area too soon.

The user can view output graphically by selecting the relevant output quantity (Total Effective Dose, Inhalation Dose; Thyroid Dose; External Gamma Dose; Time of Arrival; Total Gamma dose rate from Puffs and Deposit; Gamma Dose rate from Deposit; Air Concentration, Time Integrated; Air Concentration, Instantaneous; Deposition on Ground) and cycling through various views – this includes a frame-by-frame output. Note the options for logarithmic and auto-scaling, as these can alter the look of the output significantly. Another prognosis may need to be
performed with an altered map if the plume exits the defined area too soon.

The image below shows an example of Inhalation Dose output:

16. Save the prognosis

The prognosis may be saved by clicking the Save button at the right of the output menus. These can be accessed and amended at a later time as required. To open a saved prognosis, click the Load button at the right of the prognosis window, expand the ‘Incident’ directory tree, highlight the required prognosis, and click the Load button.
ARPANSA QUALITY SYSTEM

ENVIRONMENTAL AND RADIATION HEALTH BRANCH

HEALTH PHYSICS SECTION

STANDARD OPERATING PROCEDURE

ERH-HP-MS-SOP-0004

*Importing Maps into ARGOS*

Version: 1
Issue Date: 17th June 2008

Prepared by: Milly Cox
PURPOSE
This document explains how to import maps into ARGOS.

SCOPE
This document explains the method required to open maps of differing formats into ARGOS.

REFERENCED DOCUMENTS
ARGOS Manual.

SOFTWARE
ARGOS Evaluation Version 8.2 Final
Mapinfo Version 9 or older versions of Mapinfo.
Global Mapper Version 9.
PROCEDURE
If you have MapInfo9

1. Open the Mapinfo TAB file.

   Open the TAB file by either:
   Using your mouse to double click on it, or;
   Open MapInfo, and on the menu bar select File, and then Open. Navigate to the required file and click Open.
   The map should now be displayed in the MapInfo window.

2. Change the Map Projection to WGS84.

   From the menu bar select Table, Raster, and click on Modify image registration.
   Click on Projection.
   Two menus will appear in the window;
   From the top (drop down) menu select Longitude/Latitude.
   From the bottom menu select WGS84.
   Press OK.
3. Enable image reprojection

   From the menu bar, click on Map, Options, Image Processing, Reprojection, and click Always.

4. Save the image in Geotiff format.

   From the menu bar select File, and Save Window as. Select Geotiff as the file type, and enter the filename.

5. In ARGOS, Open a chemical, biological or nuclear basemap.

   For example, for a nuclear basemap: Open a chemical basemap via the menu bar at the top of the window; File – Open – Open N. Navigate to c:\Ausmaps\WorldAustralia\WorldAustralia\argosbasic.mas Click Open.
6. Insert the Geotiff into ARGOS.

From the Argos menubar select Map, and then Insert Geotiff.
Enter the required data as follows into the input box:
Directory/Filename: Type in the required path and filename for Geotiff file
or select ‘…’ to navigate to it.
Description: Select Rastermap from the drop down menu
Reference Scale 1: 50 000
Select ‘Show Always’
After layer code: Leave as it is for now
Select ‘Use UTM’ and for UTM Zone type 55
Ellipsoid: Select WGS84 from the drop down list.

Press OK
Examples of the ARGOS screen with the Geotiff layer follow:
PROCEDURE
If you don’t have MapInfo9

1. Open the Mapinfo TAB file.

   Open the TAB file by either:
   Using your mouse to double click on it, or;
   Open MapInfo, and on the menu bar select File, and then Open. Navigate to the required file you want and click Open.
   The map should now be displayed in the MapInfo window.

2. Change the Map Projection to WGS84.

   From the menu bar select Table, Raster, and click on Modify image registration.
   Click on Projection.
   Two menus will appear in the window;
   From the top (drop down) menu select Longitude/Latitude.
   From the bottom menu select WGS84.
   Press OK.
3. Open the .Tab file in GlobalMapper and change the projection.

Open GlobalMapper 9. Choose ‘Open your own data files’ and locate the tab file you want to open. From the menu bar choose Tools, Configure, and click on the Projection tab. From the drop-down menus choose the following options: For ‘Projection’ choose UTM, for ‘Zone’ choose -55 (144°E - 150°E – Southern Hemisphere), and from the ‘Planar Units’ choose Meters. Press OK.
4. Export the raster as a GeoTIFF file.

   From the Menubar chose File, Export Raster and Elevation Data, and then Export GeoTIFF. Press OK when the GeoTiff Export Option box appears. Choose a filename and save as type GeoTiff. Press OK.

5. In ARGOS, Open a chemical, biological or nuclear basemap.

   For example, for a nuclear basemap: Open a nuclear basemap via the menu bar at the top of the window; File – Open – Open N. Navigate to c:\Ausmaps\WorldAustralia\WorldAustralia\argosbasic.mas Click Open.
6. Insert the Geotiff into ARGOS.

   From the Argos menubar select Map, and then Insert Geotiff. Enter the required data as follows into the input box:
   Directory/Filename: Type in required path and filename;
   Description: Select Rastermap from the drop down menu;
   Reference Scale 1: 50 000;
   Select ‘Show Always’;
   After layer code: Leave as it is for now;
   Select ‘Use UTM’ and for UTM Zone type 55;
   Ellipsoid: Select WGS84 from the drop down list.

   Press OK.
Examples of the ARGOS screen with the Geotiff layer follow:
Evaluation of ARGOS in Australia for USA-193 Satellite Re-entry Scenarios

March 2008

Author | Version | Date
-------|---------|----
Dr Marcus Grzechnik | 1.0 | March 2008

Reformatted for inclusion as an appendix
Executive Summary

On February 21st 2008 an out-of-radio-range US military satellite (USA-193) was intentionally fired upon at a height of approximately 250km above the Pacific Ocean. The satellite was destroyed, and nearly all of the debris was expected to burn up on re-entry.

As a part of the Australian ARGOS Evaluation, various scenarios for crash-landing of the in-tact satellite have been considered and qualitatively compared to NOAA's Hy-Split model (as used by the Bureau of Meteorology, BOM). The satellite contained a confirmed fuel load of approximately 500kg Hydrazine (N₂H₄) and potentially some radioactive sources (unconfirmed). Incorporation of a new LAPS (Limited Area Prediction System) wind field for Australia (obtained from BOM) into ARGOS was undertaken, and the system was applied to chemical dispersal and radionuclide trajectory calculation.

During the exercise a number of issues were raised with the running of ARGOS in various situations. These included the nature of the ‘heat’ term in chemical dispersal and insufficient disk space on the VMWare virtual machine. Of the most concern was an apparent singularity at various release points – this is currently under further investigation from ARGOS developers.

Taking into account differing sources for wind data, ARGOS (NWP wind field) and Hy-split (observed wind field) trajectories are generally comparable in direction, with Hy-split trajectories showing greater displacement from the point of origin. A quantitative analysis of this data was considered to be outside the overall scope of this note, however some quantitative data for trajectories is provided.

Overall it is recommended that further work and clarification is undertaken during the evaluation of ARGOS to ensure that:

- ARGOS is suitable for larger-scale advection of pollutants in Australian Desert Areas.
- The use of BOM data in ARGOS is robust, with no restriction on source positions.
- Disk space for ‘virtual machines’ does not become a restrictive issue.
- Guidelines are given to succinctly specify which situations ARGOS should and should not be applied in.

It is expected that these tasks will be undertaken as part of the overall ARGOS evaluation later this year, and will include a quantification of development needs for Australian users and ARGOS' overseas developers.
1. Introduction

On February 21st 2008 an out-of-radio-range US military satellite (USA-193) was intentionally fired upon at a height of approximately 250km above the Pacific Ocean. The satellite was destroyed, and nearly all of the debris was expected to burn up on re-entry.

Initial emergency planning was based upon the re-entry of the satellite and a possible crash-landing in Australia. This was not an unrealistic scenario due to the orbit path of the Satellite over Australia and the Pacific Ocean. The satellite contained a confirmed fuel load of approximately 500kg Hydrazine (N₂H₄). Potentially some radioactive sources (used for heating) may have been contained within the satellite. This was neither confirmed nor denied.

As a part of the Australian ARGOS Evaluation, various scenarios have been considered and qualitatively compared to NOAA’s Hy-Split model (as used by the Bureau of Meteorology, BOM). The incorporation of a new LAPS (Limited Area Prediction System) wind field for Australia (obtained from BOM) into ARGOS was undertaken, and various lessons have been learned. These have been documented as part of this note (see Annex B).

It should be remembered that ARGOS is not designed to incorporate a moving source, so the original transverse velocity and momentum of the satellite is not taken into account. Additionally, it is intended that ARGOS be used primarily to assess situations where medium-length dispersal and risk assessment may be required. The situation investigated here may not be totally suitable for calculation with ARGOS due to the high probability that the satellite would crash in remote parts of Australia (or even in the ocean). This would mean that larger dispersal distances would need to be considered in order to assess the risk to population centres.

Two general scenarios (chemical release and radionuclide track) have been considered at four Australian locations. Releases over both ground and sea have been considered for completeness.
2. Meteorological Data

Data was obtained from the Bureau of Meteorology (BOM) for use in ARGOS. This included 72 hours of predictions from the LAPS (Limited Area Prediction System) model (0.375° resolution) at three hourly intervals from 0:00 20/2/2008 UTC. Data were given over 61 (staggered) sigma levels ranging from sea-level to 50 HPa (approximately 20km).

The data covered the whole of mainland Australia and a large part of the Oceania region (17.125°N to 65.000°S, 65.000°E to 184.625°E). An indication of the extent of the field is illustrated in Figure 1.

![Figure 1: Representation of the wind field extent. Note that the wind field resolution was much finer (at 0.375°) than that shown here, however the coarse field is representative of the general wind vectors for this snapshot.](image)

Overall 25 records were downloaded, taking over an hour and a half using ARPANSA’s ADSL link. These were (collectively) approximately 1 Gigabyte in size. Once obtained, the filenames may be easily edited by the ARGOS user (if required). A step-by-step guide on importing meteorological data for use in ARGOS is given in Annex A.
3. Regions Considered

The specific locations considered for tracking were based on various BOM Environmental Emergency Response Centre trajectory forecasts. These trajectories were considered for various heights (from 0m to 20000m) along the spacecraft re-entry path. For evaluation of ARGOS it is desirable to consider dispersion over both land and nearby waters as these are the most likely scenarios for public exposure. A simulation of the trajectory forecast at the following positions (based on various BOM trajectory forecasts for 1900 UTC 24/2/2008) have been considered:

A. 40°S, 125°E – Sea, South of Great Australian Bight (WA).
B. 30°S, 125°E – Land, WA desert.
C. 20°S, 130°E – Land, NT (near WA border).
D. 10°S, 135°E – Sea, North of NT.

The ARGOS trajectories have been compared with (NOAA) Hy-split trajectories run from 0:00 UTC 20th February 2008 (www.arl.noaa.gov/ready/) in order to give a more realistic comparison that takes into account the wind field used. Trajectories were considered at heights of 0m, 1000m and 5000m. ARGOS trajectories 5000m and above tend to follow the same path, so this altitude was selected as the ceiling for this investigation.

These four positions have been used as release points at the three relevant altitudes for the tracking of (radionuclide ^{137}Cs) particles to investigate the trajectory function of ARGOS. Additionally, a simulated release of 500kg Ammonia Gas (which behaves similarly to Hydrazine) has been conducted from sea level at each of the locations described by the longitude/latitude coordinates.

Figure 2: Release positions for trajectory and dispersion simulations.
4. Prognosis and Source Terms

Two types of prognosis for ARGOS have been considered. The first, known as Prognosis Type 1, involves a chemical release of 500kg of Ammonia (used to simulate hydrazine) at a height of 0m. The second (Prognosis Type 2) uses trajectory tracks of $^{137}$Cs to simulate potential radionuclide contamination at various positions and heights through the atmosphere. More detailed specification of the parameters used for each prognosis is described below, however all model runs have been conducted from 0:00 20/2/2008 for at least 24 and up to 48 hours.

**Prognosis Type 1 – Chemical release (0m)**

Source term: Ammonia release over 10 minutes at 0.83kg/s (total 500kg). Heat 1000kW.

Model type: Manual mode, Grid size 5km, Puff released every 1 minute and data output hourly. Advanced setup HIRLAM data to be interpolated 6 times (equivalent of wind data every half-hour).

**Prognosis Type 2 – Radionuclide release (various heights)**

Source term: 1GBq $^{137}$Cs released over 15 minutes

Model type: Manual mode, Grid size 5km, Puff released every 1 minute and data output three-hourly. Trajectory model specified with three levels of output, viz.;

- 0m
- 1000m
- 5000m

The time taken for each prognosis depends on the extent of the defined map, however typical maps used for this situation have covered an area of approximately 4º (latitude) by 8º (longitude). Each (48 hour) chemical dispersion simulation has taken approximately 30 minutes on the ARPANSA dual core laptop test machine, but this can also vary according to the area being considered. Depending on the extent of advection, trajectory prognoses range from 24 to 48 hours and are generally faster than Prognosis Type 1. Trajectory outputs have been shown for 24 hour prognoses.

It should also be noted that numerical weather prediction data provided by the BOM is used for ARGOS simulations, however observational data has been applied for the use of Hy-split. This adds an extra element of uncertainty to the comparison of the two methods.
5. Modelling Chemical Dispersion (Prognosis Type 1)

Four ARGOS runs of ammonia chemical dispersion (to simulate hydrazine) have been considered. Snapshots have been captured of the time integrated air concentration after 28 hours (at 4:00 21/2/08) with releases at the surface. This is intended to simulate the rupture of the hydrazine tanks and subsequent release of the chemical plume as the satellite strikes the ground (or ocean). Note that instantaneous releases show a near-circular dispersion that advects on the path indicated by the time-integrated dispersal graphics shown here.

**RUN A: 40ºS, 125ºE**

The first chemical dispersion is from a point to the south of the Great Australian Bight (see Figure 3). Over 28 hours the plume advects approximately 1000km ESE from the point of origin, and spreads by approximately 100km.

![Chemical dispersal from Prognosis Type 1, Run A (40ºS, 125ºE).](image)

*Figure 3: Chemical dispersal from Prognosis Type 1, Run A (40ºS, 125ºE).*
**RUN B: 30ºS, 125ºE**
The chemical advection and diffusion from the Western Australian desert (Point B) is shown in Figure 4. The plume travels approximately 800km WNW and spreads to a diameter of approximately 120km.

![Figure 4: Chemical dispersal from Prognosis Type 1, Run B (30ºS, 125ºE).](image)

**RUN C: 20ºS, 130ºE**
Figure 5 illustrates the dispersal of the chemical cloud from position C. This advects from the point of origin approximately 600km SW (in 28 hours), and spreads to 100km diameter.

![Figure 5: Chemical dispersal from Prognosis Type 1, Run C (20ºS, 130ºE).](image)
**RUN D: 10ºS, 135ºE**
The dispersal from position D shows some interesting behaviour (see Figure 6). The plume advects approximately 600km to the SE of the point of origin into the Gulf of Carpentaria. It then changes direction to head due E for 160km to the nearest land. The plume spreads to approximately 110km diameter in 28 hours.

![Figure 6: Chemical dispersal from Prognosis Type 1, Run D (10ºS, 135ºE).](image)
6. Consideration of Radionuclide Trajectories (Prognosis Type 2)

Radionuclide trajectories have been considered from the four positions (A-D) using ARGOS and the Hy-split trajectory model. These have been run for 24 hour periods at 0m (illustrated in red), 1000m (blue) and 5000m (green) heights. It should be noted that ARGOS output is shown at 3-hourly intervals and Hy-split 6-hourly.

There are a number of uncertainties associated with the direct comparison of outputs from both models. Firstly, ARGOS is not intended as a long-distance transport tool, and as such the calculated advection of materials over hundreds of kilometres should be considered tentatively. Rimpuff is intended to usually be applied on horizontal scales of up to 100km as it is usually used as a real-time prediction tool. Secondly, the current version of ARGOS for evaluation in Australia relies on wind fields from Numerical Weather Prediction (NWP). These have been provided by the Bureau of Meteorology. The Hy-split model considered here makes use of a network of surface wind observations (Global Data Assimilation System – GDAS).

The trajectory simulations (or ‘runs’) from each of the four positions are shown below in Figures 7 to 14. A short qualitative comparison has been provided, with the focus on the trajectory locations after 24 hours.
**RUN A: 40°S, 125°E**

The Hy-split model run from Position A is presented in Figure 7. When considering the trajectory after 24 hours (final mark on the plots) it can be seen that all three tracks have advected to the SE, with the 5000m track moving a greater distance than the 0m and 1000m trajectories.

![NOAA HYSPLIT MODEL](Image)

*Forward trajectories starting at 00 UTC 20 Feb 08
GDAS Meteorological Data*

*Figure 7: The Hy-split trajectory model from Position A.*
When Hy-split trajectories are compared to Figure 8 (ARGOS simulation) a similar general direction appears to be followed, however the NOAA model predicts a more southerly movement. This is particularly obvious at the 5000m altitude level, where Hy-split simulates the final point south of Latitude 45ºS.

Figure 8: The ARGOS trajectory model run for Prognosis Type 2, Position A.

For quantitative comparison, the positions of each release using the different methods are shown in Tables 1-3 at the end of this Section.
**RUN B: 30ºS, 125ºE**

The Hy-split model run from Position B is presented in Figure 9. When considering the trajectory after 24 hours (final mark on the plots) it can be seen that all three tracks have diverged, with the 0m and 1000m tracks moving (generally) towards W, and the 5000m trajectory to the E.

*Figure 9: The Hy-split trajectory model from Position B.*
When Figure 9’s Hy-split trajectories are compared to Figure 10 (ARGOS simulation) a similar divergence of the tracks is observed. The ARGOS trajectories do not cover as much distance as those predicted using Hy-split, however the directions and behaviours at each of the levels shows consistency between the two methods.

Figure 10: The ARGOS trajectory model run for Prognosis Type 2, Position B.

As mentioned previously, for quantitative comparison, the positions of each release using the two different methods are shown in Tables 1-3 at the end of this Section.
**RUN C: 20°S, 130°E**
The Hy-split model run from Position C is presented in Figure 11. When considering the trajectory after 24 hours (final mark on the plots) it can be seen that all three tracks have advected S to SW, with the 5000m track moving a greater distance than the 0m and 1000m trajectories.

**Figure 11: The Hy-split trajectory model from Position C.**
When Figure 11’s Hy-split trajectories are compared to Figure 12 (ARGOS simulation) a generally similar direction for the tracks are observed. The exception seems to be for the 5000m track, which moves W according to ARGOS and SW according to Hy-split. Again the ARGOS trajectories do not cover as much distance as those predicted using Hy-split, however the directions and behaviours generally show consistency between the two methods.

Figure 12: The ARGOS trajectory model run for Prognosis Type 2, Position C.

As mentioned previously, for quantitative comparison, the positions of each release using the two different methods are shown in Tables 1-3 at the end of this Section.
**RUN D: 10°S, 135°E**

The Hy-split model run from Position C is presented in Figure 13. When considering the trajectory after 24 hours (final mark on the plots) it can be seen that all three tracks have advected SE, with the 1000m track moving a greater distance than the 0m and 5000m trajectories. The 5000m trajectory in particular may have been slowed due to the proximity to land compared with the other two particles.

![NOAA HYSPLIT MODEL](image)

**Figure 13: The Hy-split trajectory model from Position D.**
When Figure 13’s Hy-split trajectories are compared to Figure 14 (ARGOS simulation) a generally similar direction for the 0m and 1000m tracks are observed. The 5000m track, which moves WSW according to ARGOS and SW according to Hy-split, is actually N of the other two tracks and subsequently avoids interaction from land masses until 21 hours pass. In this case the ARGOS trajectories cover similar (or greater) distances than those predicted using Hy-split, however the overall directions and behaviours generally show consistency between the two methods.

Figure 14: The ARGOS trajectory model run for Prognosis Type 2, Position D.

As mentioned previously, for quantitative comparison, the positions of each release using the two different methods are shown in Tables 1-3 (below).
The approximate distances travelled at each of the heights investigated show that in general the Hy-split model shows increased displacement of particles with increasing altitude. The only exception for Hy-split is from Position D, where the 5000m track appears to have been influenced by the land (see Figure 13). Interestingly, the ARGOS system does not display this overall behaviour. This suggests that further investigation of ARGOS’ performance at various altitudes using a number of different wind fields may be desirable.

**Table 1: Trajectory positions and overall displacement at 1000m for particles released at each of the four points.**

<table>
<thead>
<tr>
<th>Release (oh)</th>
<th>RUN A</th>
<th>RUN B</th>
<th>RUN C</th>
<th>RUN D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hy-Split</td>
<td>ARGOS</td>
<td>Hy-Split</td>
<td>ARGOS</td>
</tr>
<tr>
<td>24h</td>
<td>43.66S 130.628E</td>
<td>42.051S 132.394E</td>
<td>27.905S 117.422E</td>
<td>27.387S 118.965E</td>
</tr>
</tbody>
</table>

**Approx. Total Displacement (km)**

<table>
<thead>
<tr>
<th>RUN A</th>
<th>RUN B</th>
<th>RUN C</th>
<th>RUN D</th>
</tr>
</thead>
<tbody>
<tr>
<td>620</td>
<td>660</td>
<td>775</td>
<td>660</td>
</tr>
<tr>
<td>300</td>
<td>460</td>
<td>690</td>
<td>700</td>
</tr>
</tbody>
</table>

**Table 2: Trajectory positions and overall displacement at 1000m for particles released at each of the four points.**

<table>
<thead>
<tr>
<th>Release (oh)</th>
<th>RUN A</th>
<th>RUN B</th>
<th>RUN C</th>
<th>RUN D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hy-Split</td>
<td>ARGOS</td>
<td>Hy-Split</td>
<td>ARGOS</td>
</tr>
</tbody>
</table>

**Approx. Total Displacement (km)**

| 720 | 650 | 985 | 560 |
| 485 | 395 | 760 | 920 |
Table 3: Trajectory positions and overall displacement at 5000m for particles released at each of the four points.

<table>
<thead>
<tr>
<th>Release (oh)</th>
<th>RUN A</th>
<th>RUN B</th>
<th>RUN C</th>
<th>RUN D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hy-Split</td>
<td>ARGOS</td>
<td>Hy-Split</td>
<td>ARGOS</td>
</tr>
<tr>
<td></td>
<td>125E</td>
<td>125E</td>
<td>126.140E</td>
<td>125.167E</td>
</tr>
<tr>
<td></td>
<td>126.027E</td>
<td>127.475E</td>
<td>126.687E</td>
<td>126.87E</td>
</tr>
<tr>
<td></td>
<td>126.823E</td>
<td>127.605E</td>
<td>127.660E</td>
<td>127.64E</td>
</tr>
<tr>
<td></td>
<td>129.123E</td>
<td>129.108E</td>
<td>129.546E</td>
<td>127.901E</td>
</tr>
<tr>
<td></td>
<td>130.272E</td>
<td>135.234E</td>
<td>129.908E</td>
<td>124.885E</td>
</tr>
<tr>
<td></td>
<td>131.408E</td>
<td>137.410E</td>
<td>139.712E</td>
<td>124.661E</td>
</tr>
<tr>
<td></td>
<td>137.819E</td>
<td>139.369E</td>
<td>139.593E</td>
<td>124.789E</td>
</tr>
</tbody>
</table>

**Approx. Total Displacement (km)**

|              | 1245 | 725 | 1380 | 660 | 820 | 290 | 365 | 900 |

**Evaluation of ARGOS for use in Australia**

ARPANSA Technical Report No. 150
7. Conclusions

The Hy-split and ARGOS modelling tools have been applied to various situations for the grounding of satellite USA-193 in Australia. These situations have been used as a part of the ARGOS evaluation in simulations of chemical plume releases and radiological trajectories.

During the exercise a number of issues were raised with the running of ARGOS in various situations. These are presented in Annex B and it is expected that they will be discussed further through the ARGOS sharepoint site and within the ARGOS Evaluation Report. The BOM LAPS wind field was downloaded to ARPANSA successfully and imported into ARGOS. Annex A includes a detailed description of the steps required to import future wind fields into ARGOS.

Because of the nature of the input fields for wind in Hy-split and ARGOS, it has been difficult to directly compare the two outputs. Hy-split was run using archived wind observations, whereas ARGOS used LAPS output from the BOM’s numerical weather prediction model. While these would be expected to be similar, there could be variations expected. These uncertainties can be exacerbated when considering dispersion of particles due to the spatial variability expected in the wind fields, and can also depend on the resolution used. Additionally, the spatial scales involved in this situation (with 24 hour trajectories moving up to 1380km) may not fall within the intended use for the ARGOS system. Taking this into account, however, ARGOS and Hy-split trajectories are generally comparable in direction, with Hy-split trajectories showing greater displacement. A quantitative analysis of this data was considered to be outside the overall scope of this note.

Overall it is recommended that further work and clarification is undertaken in the evaluation of ARGOS to ensure that;

- ARGOS is suitable for larger-scale advection of pollutants in Australian Desert Areas.
- The use of BOM data in ARGOS is robust, with no restriction on source positions.
- Disk space for ‘virtual machines’ does not become a restrictive issue.
- Guidelines are given to succinctly specify which situations ARGOS should and should not be applied in.

These tasks will be undertaken as part of the overall ARGOS evaluation later this year, and will include a quantification of development needs for Australian users and ARGOS’ overseas developers.
Annex A – Importing Wind Fields to ARGOS

For easy use in ARGOS, data were provided as *.grb files, with filenames converted to the preferred format;

\textit{yyymmddAAFF\_nn}

Here \textit{yy} – represents the (2 digit) year (08 in this case),

\textit{mm} – represents the month (02),

\textit{dd} – represents the day for the first record (20),

\textit{AA} – represents the analysis hour for the initial record (e.g. 00 for 0:00 UTC, 12 for 12:00, etc.)

\textit{FF} – represents the hour offset from the initial record (00 for the initial record, 03 for three hours later, etc.)

\textit{nn} – represents a number assigned to the area (we use 41 here).

So, examples of the data provided by the BOM and interpreted by ARGOS for use with the satellite problem as follows;

0802200000\_41 – 20th February 2008 0:00, area 41,
0802200003\_41 – 20th February 2008 3:00, area 41,
0802200027\_41 – 21st February 2008 3:00, area 41 (i.e. 27 hours after the initial record).

The following steps should be followed to import the new wind field to ARGOS (note that ARGOS should be closed and the VMware player open);

1) Copy the downloaded files (described above) to the virtual machine directory \texttt{c:\\ARGOS-NT\\Services\\HirlamSvc\\Ftp}.

2) Using the ‘Services’ icon on the virtual machine desktop, open the Services window. Click on ‘ARGOS HIRLAM Import Service’ and press ‘Start’ to begin the service.

3) When the service has removed all of the meteorological files from \texttt{c:\\ARGOS-NT\\Services\\HirlamSvc\\Ftp} the service can be stopped.

4) Start ARGOS.

5) Go to the menu ‘Setup-General...’ and select the tab labelled HIRLAM. Click on ‘Add...’, select area 41 and name it ‘Australia Coarse Grid’ (or similar). Close by clicking ‘OK’.

6) Re-open the menu ‘Setup-General...’ and select the tab labelled ‘NWP level description’. Click ‘Add...’ and insert the following parameters;

Area ID: 41
SeqNo: 0
Level: 00
Description: Surface

Click on ‘OK’, then click on ‘Add...’ again and repeat for;

Area ID: 41
SeqNo: 1
Level: 01
Description: Level1

Click ‘OK’ and ‘OK’ to exit the menu.

7) Open an ARGOS map with Australian coverage. Once at the required resolution open the ‘Meteorology-Show Wind Fields...’ menu. Select Area ID 41, a desired Level (Surface or Level1, approximately 20km) and the specific wind field to be viewed. Click on ‘OK’ and the wind field will be displayed on the map. This can be removed by clicking the wind rose icon.
8) When running a prognosis ‘NWP’ should be selected in the ‘MET’ input screen. In the ‘MODEL’ input screen click on the ‘Advanced Setup...’ button. Select the ‘HIRLAM’ tab and click on ‘Manual’. The parameter describing the ‘Number of interpolations for each HIRLAM Windfield:’ should be set so that a wind field is approximated every half an hour. This should correspond to the number of half-hour segments within the wind field interval (in this case 3 hours), so the value of this parameter should be set to 6 in this case. Click on ‘OK’ to exit.

9) Open an explorer window in the virtual machine and navigate to

   C: \ARGOS-NT\LSMS\rimsetup

A file named hirlam.loc.41 is required – this can be created by copying and renaming one of the existing files. Open the file for editing using wordpad, and edit the relevant parameters as follows;

6   IDAHIR: Time between HIRLAM analysis data [hours] Local scale
3   IDPHIR: Time between HIRLAM prognoses data [hours] HIRLAM data
72  IMPHIR: Max HIRLAM prognoses time [hours] ‘_41’ HIRTRL: HIRLAM file name trailer

Save and close the file.

This setup should enable the user to apply a wind field over the whole of Australia from 0:00 20/2/2008 to 0:00 23/2/2008. On the first prognosis there will be a significant delay specified by a dialogue box (‘Extracting HIRLAM data...’). The time delay is due to the size of the dataset.
Annex B – Issues With ARGOS During This Application

Various issues were identified with ARGOS during the application to the satellite problem. Some of these were extremely minor and only required some adjustment on behalf of the user. Further in-depth research and programming development may be required to resolve more major issues that have been noted.

- **Heat term in Chemical Dispersal** – Clarification has been sought on the exact nature of the 'heat' term (kW) in the prognosis. ARGOS does not include explosive terms, and it is intended that this heat term refers to a fire at the source. Initial sensitivity studies have shown that the heat term is relatively insensitive below 10000kW, however it may be useful to conduct more rigorous studies if further information on this term is unavailable.

- **Virtual Machine Disk Space** – The VMWare virtual machine state for ARGOS evaluation has been set up with approximately 16GB of hard disk space. When the LAPS data over the whole of Australia provided for this exercise was added into the ARGOS system the virtual machine disk was totally filled. This prompted ‘low disk space’ warnings and hindered progress when running the ARGOS system. A temporary fix of compressing the virtual machine disk space leads to approximately 4GB of space being made available. It is intended that an updated enlarged VMWare machine will be created to overcome this difficulty.

- **Mathematical Error at Random Positions** – After installation of the LAPS data and when the HIRLAM option is selected the following error can be recreated at many positions around Australia:

```
Rimpull Prognostic Result

175 1 rinaape\84619_4
176 1 rinaape\84617_4
177 1 rinaape\83602_4
178 1 rinaape\83601_2
179 1 rinaape\83601_3
180 1 rinaape\84601_4
181 1 rinaape\84601_2
182 1 rinaape\83600_4
183 1 rinaape\83600_9
184 1 rinaape\84600_9
188 1 rinaape\84600_4
189 0 rinaape\Cassiel_U055_ero
190 0 rinaape\Cassiel_U055_ero
191 0 rinaape\Cassiel_U055_ero
192 0 rinaape\Cassiel_U055_ero

Map No. number of grid points set
Land use file: rinaape\land use asps
Map No. Priority file_name
1 1 rinaape\981_1c
2 1 rinaape\981_1c
3 1 rinaape\Cassiel_U055_1c
4 1 rinaape\Coriolis_lc_pmap2
5 1 rinaape\Coriolis_lc_pmap2
6 1 rinaape\Coriolis_lc_pmap2
7 1 rinaape\Coriolis_lc_pmap2
8 1 rinaape\Coriolis_lc_pmap2
9 1 rinaape\Coriolis_lc_pmap2
10 0 rinaape\Cassiel_U055_1c
11 0 rinaape\Cassiel_U055_1c

Number of grid points: 6844
Map No. number of grid points set
HIRLAM setup file: rinsetup\hirlas_1c
HIRLAM data file: rinhirola\0912290012.41
STOP F FUNCTION ATANH: X > 0.95
```

The positions used in this report (A-D) were chosen because this error does not present itself in these locations (for the current LAPS data). This particular error seems to be related to the wind field (HIRLAM data file is last
file read into RIMPUFF) and does not appear to be affected by increased interpolation specification within ARGOS.

A clarification request has been sent to the RIMPUFF developers to determine the cause and a possible solution. Further investigation with other BOM wind data sources will be undertaken to ensure that this does not become an ongoing issue.
Appendix C – Use of ARGOS in ConvEx-3 Emergency Exercise – Laguna Verde, Mexico, 9-10 July 2008

**Background**
The purpose of the ConvEx-3 exercises is to test and evaluate the exchange of information and coordination of the international assistance during a major nuclear emergency. The ConvEx-3 exercises provide an opportunity to identify shortcomings in the national and/or international emergency response systems that might hamper the response aimed at minimizing the consequences of a nuclear accident.

The ConvEx-3 exercise is conducted once every three to five years and is based on a national exercise being conducted in a State. The *Inter-Agency Committee on Response to Nuclear Accidents* (IACRNA) was established after the Chernobyl accident in 1986 as an *ad hoc* inter-agency mechanism to co-ordinate preparedness related to nuclear accidents. The IACRNA invites States to host the exercise and expects to receive offers at least two years in advance. The host country – Accident State – must:

- Be an IAEA Member State,
- Be Party to the Notification Convention,
- Apply current ENATOM arrangements,
- Be prepared to simulate an emergency involving serious release into the environment requiring off-site protective actions,
- Guarantee communication links and information exchange with the IAEA’s Incident and Emergency Centre throughout the exercise,
- Guarantee that National Warning Point, Competent Authority and NPP operator will participate in the exercise,
- Designate a contact person to work with the IACRNA WG-CIE in the exercise preparation, conduct and evaluation.

The first such jointly-sponsored international nuclear emergency exercise took place on 22 and 23 May 2001, and was based on a French national level nuclear emergency exercise at the French Gravelines nuclear power plant. The second, the ConvEx-3 (2005) exercise, was based on the Romanian national exercise at Cernavoda NPP and conducted on 11 and 12 May 2005.

The ConvEx-3 (2008) is the third exercise in this series, and was conducted on 9 and 10 July 2008 (Mexico City time). The scenario for the exercise was prepared by the Laguna Verde NPP together with the National Nuclear Safety and Safeguards Commission (CNSNS) – the Mexican Competent Authority – within the framework of the IAEA’s ENATOM arrangements for implementing the Early Notification and Assistance Conventions.

This appendix describes ARPANSA’s use of ARGOS in contributing to the ConvEx-3 Exercise in a real-time situation.
**NPP Location**
Laguna Verde Nuclear Power Plant is on the coast of the Gulf of Mexico in the Municipality of Alto Lucero in the state of Veracruz. It is located 70 km NNW of the city of Veracruz, 60 km WNW of the city of Xalapa, the state capital, and 290 km ENE of Mexico City.

The city of Veracruz is a major port city and municipality on the Gulf of Mexico in the Mexican state of Veracruz. As of the census of 2000, there were 500,000 people living in Veracruz City.
Laguna Verde Nuclear Power Plant
The Laguna Verde plant is a two-unit plant, each with a capacity of 682.44 MWe. The reactors are of the boiling water type (BWR-5) with MARK II containment for direct cycle. The nuclear steam supply was provided by General Electric and the turbine generator by Mitsubishi Heavy Industries.

With a certification provided by the CNSNS, the Energy Ministry granted the Federal Commission for Electricity (CFE – Comisión Federal de Electricidad) with a license for the commercial operation of the Unit 1 in July 1990 and the Unit 2 in April 1995.

Both units provide approximately 5% of the power generated in the national electric grid.

The reactor vessel is a carbon steel pressure container lined with stainless steel, about 21 m high and 5.3 m in diameter and 15 to 18 cm thick. Inside the vessel is the core made up of 444 fuel assemblies each containing a rod arrangement. Each rod contains uranium dioxide pellets enriched at 3% with uranium 235. Pellets are specially treated and designed to bear high pressures and temperatures. The fuel rods are made of a special zirconium alloy known as Zircalloy with a fusion point close to 2000°C.

The chain reaction is controlled by the 109 control rods and the reactor circulation system. Water is turned into steam and then piped into the high pressure turbine and then into low pressure turbine. The sea water from the Gulf of Mexico is used for cooling (circulating water system provides a continuous supply of cooling water to the condenser).

The Mark II primary containment is a tapered steel and concrete structure 1.5 m thick surrounding the reactor vessel. The reactor building (secondary containment) which surrounds the primary containment is a concrete and rebar structure with 60 cm thick walls from the ground up and 120 cm underground. The Ventilation and the Air Conditioning System maintain in the building the pressure that is below the atmospheric pressure.
ARGOS Version Control
The ‘live’ use of ARGOS for ConvEx3 was undertaken using Version 8.3 (Release Candidate 4). This was housed as an SQL server with two ‘fat’ clients that were used simultaneously during the exercise. Since the exercise was undertaken, ARGOS has been updated to Version 8.3 (Final), with an additional client machine. A number of improvements and bug fixes have been made to this version, including links to Google for underlying maps. This significantly decreases the time taken to produce outputs from ARGOS, and means that the input of RASTER images of the area is no longer required.

Please note that ARGOS Version 8.3 (Final) has been used throughout this appendix in a reproduction of the work undertaken in the ConvEx-3 Exercise.

Information Provided
The IAEA ENAC website kept participants in the exercise up-to-date with the latest local information. Specifically, the following information was provided;

- 20 minute release (unknown content),
- Release at 0:03, 7/10/2008 (UTC),
- Local wind: 2ms⁻¹, from 150°.
Initial Setup of ARGOS

The first step in setting up ARGOS for a prognosis is the opening of the underlying map. In Version 8.3 (Final) used here, there are two options:

1) Open the basic maps, specified in \d:\WorldAustralia\argosbasic.mas
2) Open Google Maps through the internet using \c:\ARGOS-NT\Documents\argos_google_maps.htm

For ConvEx3 the second option has been used. To zoom the map to Laguna Verde Nuclear Power Plant the ‘Map – Find...’ menu should be used. The following point will centre the map on the Power Plant (as provided in ARGOS’ databases or via Google):

Longitude -96°24’36"
Latitude 19°43’46"

The map can then be moved or zoomed as desired using the relevant GIS icons, as described in Appendix A. The map layer (Figure 1) can be replaced by satellite imagery if desired by pressing the button (see Figure 2). Return to the map by pressing .

Figure 1. The position of Laguna Verde and area map.
Figure 2. The position of Laguna Verde and satellite image.
**Event Mode**

For use in the exercise, ARGOS was initialised in ‘Event mode’. This can be easily accessed in the ‘Acci-Data – Events...’ menu, or by clicking on the `⚠️` icon. Prognoses for the event can be saved and recovered, and the map area is re-defined when a prognosis is loaded. The user is asked if they would like to join an active event when ARGOS is initialised, which can save time when using multiple clients in an event situation.

ConvEx-3 is an exercise, which is specified with a tick-box when the event mode is initialised. All outputs are marked as ‘Exercise’ in red print to ensure that the potential for confusion is reduced (see Figure 3).

Instructions and details for using the event mode are given in the ARGOS manual.

Figure 3. The Laguna Verde map window with event mode (Exercise) initialised.
Defining the RIMPUFF Prognosis

In order to begin a prognosis for dispersion the button should be clicked. As described in Appendix A, the main window for inputting to RIMPUFF and the ARGOS database is opened (a filled version is shown in Figure 4).

![Figure 4. The prognosis window, as filled for use in the Laguna Verde ConvEx-3 emergency exercise.](image)

Most options required for the exercise can be manipulated from this control window. The user is able to:
- Define a new release (reactor in this case rather than single-source),
- Specify release time,
- Select and edit the specific reactor,
- Select and edit the source term release type,
- Define meteorological data,
- Edit input parameters, such as grid size and puffs released.

Some values are shown in the snapshot given in Figure 4, however more complex definitions of source terms and meteorological data are described in the sections that follow.

It is worthy of note that a new feature of ARGOS V8.3 (Final) is the ability to view the map while the prognosis window is open. The button minimises the Prognosis window and shows the release location (see Figure 5). The user has the flexibility to move the release location on the map using ‘drag and drop’. This is very useful, particularly for releases within cities where more detailed mapping data is available.
Figure 5. The location of Laguna Verde NPP is marked on the map by pressing the ‘map’ button in the prognosis window.
Defining Reactor Inventory and Release Terms for ARGOS

There are a number of ways to define the reactor inventory. The user can edit an existing reactor contained within ARGOS, or create a new reactor completely. The data contained within ARGOS has been edited to ensure that the most recent information was used for the exercise. The default reactor inventory from the BWR reactor was defined, however other reactor types may also be used and individual radionuclides can be modified where required. Of most interest to ARPANSA in this case was the inventory of 6.7E+17Bq I-131 (see Figure 6). This would rarely be fully released to the atmosphere, however and is dependent on the sources released from containment.

Model source term releases were modified to take into account the 20 minute release specified as part of the exercise. This involved copying and renaming an existing release type (BWR2, BWR3 or BWR4 in this case), deleting the radiation interval and re-defining (see Figure 7). The releases considered were:

- BWR2 (90.7% I-131 released),
- BWR3 (10.7% I-131 released),
- BWR4 (0.15% I-131 released).

Figure 6. Defining the inventory of the Laguna Verde reactor.

Figure 7. Defining the model source term.
Defining Meteorological Data
Meteorological data were specified according to information provided by the IAEA on local conditions. Numerical weather prediction (HIRLAM) data were not available during the exercise, so a constant wind field was defined for use with ARGOS (see Figure 8).

Incorporation of Isocurves
In order to specify Operational Intervention Levels (OILs), isocurves were defined within ARGOS. These are specified by clicking the button, and adding specified curves.

For ConvEx-3 a focus was given to I-131 and the 30mGy OIL for iodine prophylaxis applied to children. The definition of the relevant isocurves in ARGOS is shown in Figure 9.
RIMPUFF Results
Because the release term was unknown, and there were no environmental monitoring data available, three separate scenarios were considered. Plots of I-131 concentrations outdoors with OIL isocurves included are shown in Figures 10, 11 and 12 for BWR4, BWR3 and BWR2 respectively.

Figure 10. I-131 contour with map background using BWR4 (0.15%) release scenario.

Figure 11. I-131 contour with satellite image background using BWR3 (10.7%) release scenario.
In order to see the underlying map a transparency slider for the plume is provided by clicking [image], as shown below;

Each of these plots show that the proportion of the inventory released for an accident or incident is extremely important in deciding dose levels. The isocurves are an extremely effective way of defining an area for intervention and allow for quick comparison.
**Export of Information**

ARGOS has a number of features which enable the fast export of information to web servers and files. This enables dissemination of data to decision makers quickly and efficiently. Two such features were investigated during this exercise,
- Publishing to the web (as a single picture or animation),
- Export of shape (*.shp) files.

The publishing of a sequence to an internal ARPANSA web site was performed relatively simply by clicking the button.

The user then specifies the title of the page and server, which will vary depending on the location of the ARGOS installation.

![Page Title and Server Selection](image)

Once the pages are uploaded (in a matter of seconds), a notification is provided where the newly-created web page may be accessed.

![Pages uploaded](image)

An example of the output (which may be animated) is provided in Figure 13. The web site link can easily be sent by email for other parties to access the graphical representation of the plume.

![Figure 13. ARGOS output animations exported to a web server.](image)
In order to share information with other organisations and to enable import of ARGOS’ data into GIS packages, information can be exported to shape files. This is relatively simple, with the first step through the menu ‘File – Export object to file...’ (shown below and in Figure 14).

Figure 14. Exporting isocurve data to alternative file format.

The user is given the option to export various features of the map data to shape or GeoTIFF formats. This includes the isocurve and meteorological data for the relevant area.
Exercise Summary
Step-by-step descriptions of the use of ARGOS in the ConvEx-3 exercise have been included this appendix. The server-client Version 8.3 (Release Candidate 4) in use at ARPANSA was originally applied at Laguna Verde and the wind field was manually defined according to local conditions published on the IAEA ENAC website. During the exercise, ARGOS was used for successful import of geotiff imagery, simulation of the specified release using RIMPUFF, specification of Australian Operation Intervention Level (OIL) isolines, and final production of web-based outputs and ESRI Shape files. All work on this exercise was conducted using the Event Mode of ARGOS, with all products stamped ‘Exercise’. Overall it was found that ARGOS successfully simulated and delivered a range of release scenarios from the Laguna Verde reactor.

Some teething problems with the server-client setup were observed during the exercise. It was found that the location for the reactor specified in ARGOS did not match precisely with that observed in Google Earth. This change was easily made, however it is worth noting. The source terms for Laguna Verde were not included in the database by default, however these were easily created with the knowledge that the reactor was a 682.44MW Boiling Water Reactor (BWR). Saving and loading of incidents and maps did not appear to work at all times. This aspect needs to be investigated further, and could be an artefact of the use of a number of client machines.

The reloading and reconstruction of these scenarios using ARGOS 8.3 (Final) has improved ARGOS’ performance. Internet links to mapping data have provided faster outputs. Significantly, file import and export reliability has been much improved. It is intended that ARGOS will be used by ARPANSA for the simulation of similar exercises in the future.
Appendix D – Radiological Simulation at Hypothetical Reactor, Southern Sydney

Introduction
One potential scenario for the dispersion of radioactivity is from an accident at a hypothetical reactor in Southern Sydney.

For the ARGOS Evaluation, the investigation of scenarios involved;
- The definition of source inventory for 20MW open pool research reactor (Frikken, 19976),
- The entry of source inventory into ARGOS database thus creating a new reactor type,
- A series of prognoses to investigate various releases.

Initial running of an accidental release scenario from this location was considered using the virtualised version of ARGOS 8.2, as released to stakeholders. When the server-client system was incorporated at ARPANSA, V8.3 Release Candidate 4 was applied. Most recently, ARGOS Version 8.3 (Final) was applied, as shown in this appendix. Accident scenarios can use specifically defined releases (based on reference accidents), or percentages of the total radionuclide inventory as defined by release categories in ARGOS (based on WASH-1400, 19757). In an emergency situation field measurements could be used to refine the release category and ensure the most realistic simulation.

In order to investigate some of the ARGOS features, a high-level release term (PWR3) is considered. This scenario releases 20% of the total I-131 inventory ($1.87 \times 10^{16}$Bq) over 90 minutes. It should be noted that this would require a significant loss of coolant event with a breach of containment to occur, which is considered a very low probability event. The source term used is approximately 20 times that which would most likely occur from an even of this type. Such a scenario is extreme, and it was chosen to provide measurable values to evaluate the isodose function.

Releases in this appendix were considered using MesoLAPS Numerical Weather Prediction (NWP) data obtained from BOM, however LAPS data were also used in this region for testing and results compared well. Further investigation will be considered in the future. Isolines for intervention purposes and the export of animations to web-based products were tested.

---

**Parameters Used**

A snapshot of the initial parameters applied is shown in the prognosis window snapshot in Figure 1. The new reactor ‘Sydney – Accident Inventory’ was defined in the database, and was also successfully saved and exported to an alternative database housed on a virtual machine (*.fac text file).

![Figure 1. The Sydney prognosis parameters – coarse grid.](image)

A course grid (2km) was applied, with a zoomed-out area around Sydney investigated. The initial run was released at 12:00 on 22\(^{nd}\) October 2007 using the PWR3 scenario specified previously, and additional releases have been shown as the local wind shifts at 18:00, 22:00 (on 22\(^{nd}\) October) and 0:00 on 23\(^{rd}\) October. A zoomed-in high resolution run (250m) was conducted at this final time to investigate local effects.

The overall prognosis was run for 12 hours, however the plume has often left the area of interest before this time. Data were output hourly, and puffs were released every minute. The large frequency of puff releases was mainly due to the ‘fingering’ of puffs during changing wind conditions.

Displays considered were;
- The *dose to the thyroid* of children due to outdoor exposure (due to all radionuclides – dominated by I-131). A 30mGy isocurve was added to these outputs to define iodine prophylaxis zones.
- The *ground deposition* of I-131. Isocurves were defined for the restriction of ingestion of milk (2kBq/m\(^2\)).
ARGOS/RIMPUFF Runs
Various snapshots of ARGOS/RIMPUFF plume dispersions are shown in Figures 2 to 9 below. Descriptions are given in the captions below each figure.

Coarse-Grid (2km) Prognoses

Figure 2. Plume released at 12:00 22/10/2007 (2km grid). Display of Thyroid dose to children is shown with 30mGy isodose boundary. The plume exits the area of interest to the south/south-west.

Figure 3. Plume released at 18:00 22/10/2007 (2km grid). Display of Thyroid dose to children is shown with 30mGy isodose boundary. The plume exits the area of interest to the south/south-east.
Figure 4. Plume released at 22:00 22/10/2007 (2km grid). Display of Thyroid dose to children is shown with 30mGy isodose boundary. The plume exits the area of interest to the east.

Figure 5. Plume released at 0:00 23/10/2007 (2km grid). Display of Thyroid dose to children is shown with 30mGy isodose boundary. There is an increased spread of the plume offshore due to the variable wind condition in the area, and a dose lower than the iodine tablet intervention level is received in the CBD of Sydney.
Figure 6. Plume released at 0:00 23/10/2007 (2km grid). Display of ground deposition of I-131 is shown. There is similar coverage to Figure 5, however the OIL for restriction of milk (2kBq/m²) would be in effect in Sydney’s CBD.

**Fine-Grid (250m) Prognoses**

Figure 7. Plume released at 0:00 23/10/2007 (250m grid). Zoomed, high resolution display of child thyroid dose. The OIL for iodine tablets (30mGy) can be seen in more detail than in Figure 5 and affects some suburbs but not the CBD.
Figure 8. Plume released at 0:00 23/10/2007 (250m grid). Zoomed, high resolution display of ground deposition of I-131 is shown. The OIL for restriction of milk (2kBq/m²) surrounds the CBD and can be seen in more detail than Figure 6.

Figure 9. Plume released at 0:00 23/10/2007 (250m grid). Zoomed, high resolution display of child thyroid dose (equivalent to Figure 7). The background map image has been substituted for satellite imagery.
Conclusions
Testing of ARGOS has been successfully undertaken for a hypothetical Southern Sydney reactor and surrounding areas. The test undertaken involved a PWR3 release of the reactor inventory (numerous radionuclides) over 90 minutes. Approximately 20% of the inventory ($1.87 \times 10^{16}$Bq) was released for I-131, the radionuclide given the most attention in this appendix. This high-release scenario has been considered to demonstrate/test ARGOS capability.

Some tasks that have been completed include;
- Reactor source term determined and input into the ARGOS database,
- Transfer of *.fac files to alternate database on VM-Ware,
- Prognoses with LAPS and MesoLAPS wind fields,
- Isocurves, zooming, finer grid models, mapping,
- Incorporation of Operational Intervention Levels.

Further work needs to be considered to include;
- Floating points for inputs to the source term database are not rounded off – e.g. when numbers were entered in as $1.9E+12$, the database would store the number as $189999999987$. This is a relatively minor inconvenience, as the overall result should not be affected (due to other uncertainties).
- The Food Dose Model has been given minor attention, and needs some future rigorous testing.
- ARGOS may be used in the future along with the Permanent Monitoring Station software to incorporate detector arrays in Australia. This will aid in the description of realistic source terms in the future.
- LAPS and MesoLAPS wind fields have been tested at this location. In the future these will be directly tested against one another to investigate uncertainties. The fine-grid MesoLAPS data will generally be applied.
- Batch jobs could be considered to investigate varying conditions.
- Specific colours for intervention level zones would be extremely useful (e.g. for shelter in place or iodine prophylaxis).
Appendix E – Nuclear Powered Warship Simulations

Introduction
An important driver in the use of ARGOS in Australia is in support of emergency planning and arrangements for nuclear powered warship (NPW) visits to Australian ports. Emergency Planning Zones for these ports are assessed through the use of a NPW reference accident (Frikken, 1997). ARGOS source terms have been defined for both NIMITZ aircraft carriers and nuclear powered submarines based on this NPW reference accident. Removal times in the case of an incident/accident are (generally) 24 hours for a submarine, 2 hours for an aircraft carrier.

Locations for approved berths and anchorages (with GPS coordinates) are given in OPSMAN1, and include;
- Western Australia
  - HMAS STIRLING/Cockburn Sound,
  - Gage Roads (near Fremantle),
  - Albany.
- Tasmania
  - Hobart.
- Queensland
  - Brisbane,
  - Gladstone.
- Northern Territory
  - Darwin.
- New South Wales
  - Jervis Bay.
- Victoria
  - Melbourne.

All of the 9 sites listed are covered by the coarse-grid LAPS wind field supplied by BOM. Currently, MesoLAPS (fine-grid) wind data is also available at Victorian, New South Wales and Tasmanian ports.

Examples considered for this appendix are;
- Western Australia – Gage Roads North (near Fremantle) for a Nimitz carrier,
- Tasmania – Remote anchorage off Hobart for a submarine (note that removal time is 6 hours rather than 24 hours in Hobart).

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Parameters Used
A snapshot of the initial parameters applied is shown in the prognosis window snapshot in Figure 1 for a NIMITZ Carrier (Perth), and Figure 2 for a Submarine (Hobart). The new reactors ‘Nimitz – Accident Template’, ‘Submarine – Accident Template’, ‘Nimitz – Perth’ and ‘Submarine – Hobart’ were defined in the database, and were also successfully saved and exported to an alternative database housed on a virtual machine (*.fac text file).

Figure 1. The NIMITZ prognosis parameters.

Figure 2. The Submarine prognosis parameters.

A fine grid (250m) was applied, with a BWR3 scenario (where 20% of I-131 is released). For the NIMITZ the standard 90 minute release is applied, and for the submarine this has been increased to 360 minutes. As with the scenarios in
Appendix D, the Reference Accident releases are very low probability scenarios involving loss of cooling accidents and are used here.

Each of the overall prognoses was run for 12 hours, however the plume has often left the area of interest before this time. Data were output hourly, and puffs were released every 10 minutes.

Displays considered were;

- The dose to the thyroid of children due to outdoor exposure (due to all radionuclides – dominated by I-131). A 30mGy isocurve was added to these outputs to define iodine prophylaxis zones.
- The ground deposition of I-131. Isocurves were defined for the restriction of ingestion of milk (2kBq/m²).
**Model Outputs**

Outputs from ARGOS/RIMPUFF are shown in Figures 3 to 6 for the two sites.

Figure 3. Ground deposition of I-131 (including 2kBq/m² isocurve) from a NIMITZ carrier off Fremantle, WA.

Figure 4. Outdoor total thyroid dose to children (including 30mGy isocurve) from a NIMITZ carrier off Fremantle, WA.
Figure 5. Ground deposition of I-131 (including 2kBq/m² isocurve) from a Submarine off Hobart, Tasmania.

Figure 6. Outdoor total thyroid dose to children (including 30mGy isocurve) from a Submarine off Hobart, Tasmania.
Conclusions
Various release scenarios and times consistent with the current Australian Reference Accident for NPWs were considered at locations for NPW visits around Australia. ARGOS has shown that it is a very useful tool for this type of situation and has proven to be easy to set up and apply. The scenario at each location has been saved for easy access in the future, enabling fast predictions to be made.

In the future, ARGOS can be used to;
   a) Contribute to emergency planning for each of the Ports by providing scenario-based simulations,
   b) Provide predictions of radionuclide dispersal 48 hours prior to NPW docking,
   c) Provide fast, up-to-date real-time simulations using current meteorological predictions,
   d) Produce information for possible countermeasures, including evacuation and iodine prophylaxis, in the case of a nuclear emergency.

Further work is planned to benchmark ARGOS against reference accidents that are currently in use for the planning of nuclear powered warship visits to Australia. These will be conducted for all ports.
Appendix F – Workshop Agenda and Slides

Agenda

Workshop on ARGOS Evaluation

ARPANSA, Melbourne, Australia
619 Lower Plenty Rd, Yallambie, VIC, 3085
Tel: +61 3 9433 2211

13th August 2008

Hosted by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

10:00 Welcome Peter Burns (ARPANSA)
10:05 Context and Scope Stephen Solomon (ARPANSA)
10:25 ARGOS Demonstration Marcus Grzechnik (ARPANSA)

11:00 Break

11:15 Assessment of Rad/Nuc Modelling Marcus Grzechnik (ARPANSA)
11:30 Assessment of Chemical Modelling Katherine Kirk (Qld Health)
11:45 Assessment of Biological Modelling Serena Abbondante (AFP)
12:00 Work Group ARGOS Evaluation Rick Tinker (ARPANSA)
   (including summary of Questionnaire)
12:30 Evaluation Discussion

13:00 Lunch

13:30 Modelling Project Ralph Gallis (DSTO)
13:40 New ARGOS features Marcus Grzechnik (ARPANSA)
   (Australian wish list for 2009 development)

14:10 Break

14:10 ARGOS Implementation Issues Stephen Solomon (ARPANSA)
   (Australian needs)
14:30 Workshop Recommendations Rick Tinker (ARPANSA)
   (Discussion and finalisation)
15:30 Workshop Summary Session

16:00 Workshop End
Evaluation of ARGOS in Australia

Dr Stephen Solomon
ARPANSA

ARGOS was originally developed to aid the Danish Emergency Management in dealing with accidents in nuclear power plants. Extended to deal with chemical, biological and radiological emergencies. 

ARGOS is administered as a partnership between the Danish Emergency Management Agency (DEMAn) and the Development Centre AVS (TNO). The ARGOS Consortium consists of central organizations responsible for Emergency Management in a country. The current eleven member countries by July 2006 are: Australia, Canada, Ireland, Denmark, Sweden, Norway, Poland, Estonia, Latvia, Lithuania and Montenegro.

Objective of ARGOS

To support the emergency organizations to make the best possible decisions in case of a CBRN incident.

The tools with ARGOS provide a means to:
- Get an overview of the situation.
- Create a prognosis of how the situation will evolve.
- Analyze and visualize measurements.
- Calculate the consequences of the accident.
- Decide on appropriate countermeasures.
- Handle information to the public.

More than just a model.

ARGOS in Australia

Australian ARGOS Consortium licence signed by ARPANSA in April 2007.
Financial support from the Department of Defence (Navy) and Emergency Management Australia (EMA)
Objective to evaluate the suitability of ARGOS for Australian CBRN emergency management.

ARGOS Working Group

Australian Federal Police, CBRNE Data Center
Defense Science & Technology Organisation
ANSTO
Bureau of Meteorology
CSCRO
Queensland Fire and Rescue Service
Chemistry Centre WA
NSW Fire Brigade
ACT Emergency Services

Dept of Health, Office of Health Protection
Navy, Vetting Ships Panel (Nuclear)
Emergency Management Australia

Work Plan

Progress Summary

April 2007: Australia entered the ARGOS Consortium.
April 2007: ARGANSA established a Cross Agency Working Group
June 2007: ARGANSA IT acquired Server to host ARGOS software
July 2007: Setup ARGOS portal for Australian ARGOS evaluation
Aug 2007: Creation of Jukebox/operational mass for ARGOS
Sept 2007: ARGOS Consortium release final version 9.2 of software
Oct 2007: ARGANSA IT builds first VMware Install of ARGOS
Nov 2007: BON provided test numerical/Weather Prediction data
Jan 2008: Software deployment to ING members begins (AFP, ACT Emergency Services, ARPANSA Steering Group)
June 2008: Jan Peterson POD builds ARGANSA Server/Glenn
July 2008: Distribution of Evaluation Questions
July 2008: ARGOS used for IAFIA COM/X3 Exercise
July 2008: ARGOS Consortium releases final version 9.1 of software
Objectives of the ARGOS Evaluation

To assess the applicability of ARGOS for Australian CBRN emergency management.
To assess the applicability of ARGOS for Australian NWP emergency decision support.
To assess the interoperability and consistency with Australian consequence management and modeling systems.
To assess the customisation requirements for the use of ARGOS in Australia.

Output from this Workshop...

Objectives of the ARGOS Evaluation (2)

To assess the implementation requirements and costs.
To assess any shortcomings with ARGOS for its use in Australia, including a comparison with other CBRN decision support systems.
To assess and advise on the potential science and technology research and development activities that would support the effective implementation of decision support systems such as ARGOS.

Further work...

Evaluation of ARGOS in Australia
Radiological and Nuclear Assessment

Dr Marcus Grzechalk
ARPANSA

Some Radiological Requirements

Accurate dispersion of radionuclides (including Urban & Explosives).
Integration of Field Measurements.
Real-time modeling.
Operational Intervention Levels (OILs) – RPE7 boundaries.
Open GIS compatible products.

What Does ARGOS Provide for Radioactivity Dispersion?

A relatively well developed system that includes:

- Local and Mesoscale dispersion
- RMPUFF (flow model and 3D Advection)
- USEPA dispersion models adapted to Australia

Source Terms – Extensive, easily updated/defined.

URSAN Dispersion including 3D view (V9.4)

Additional tools (installed but to be further tested at ARPANSA):
- Fixed dose modeling
- Permanent Monitoring Station Inputs.

Various Tools to Consider:

ARGOS – As discussed during this workshop.
HotSpot – Gaussian Plume Modeling (first order), Rad/Huc.
HPAC – CBRN capability, turbulence, and generic weapon simulation.
RnPuff (external) – As demonstrated in ARGOS incorporated into other GIS packages.
HiSPlt – Fast, long-range transport, dispersion and deposition using archive or forecast meteorological data.
Interchange Program.

Others?

Complementary or Alternatives?

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Achievements During ARGOS Evaluation

Construction of Server/Client system at ARPANSA
Regular provision of Met data (courtesy of BCM)
Scenario construction, including:
- Single source releases (CSIRO sites)
- ANSTO releases
- Dispersion from Satellite crash landing (+Chemco)

Meteorological Data (HIRLAM, LAPS, etc)

Release from ANSTO, Lucas Heights

Benchmarking – Satellite Trajectories

Emergency Exercise – CamEx3

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Biological Source Terms
- Current database of biologics is limited
  - Helicobacter, Escherichia coli, Yersinia pestis, pneumonic (mammalian and avian), varicella zoster
- All COLD list of biological agents to be regulated
  - Teth. (A) agents
  - Fowl, E. coli, H. influenzae
- Database flexibility and ease-of-use

Biological Source Terms
- Database Biologent information
  - Information incomplete and (in some cases) inaccurate
  - Neurological properties of agents
  - Particles, weight and structure
  - Concentration of particle sizes
  - Dynamic changes over time
  - Mobility/Dispersal of agent
  - UV, humidity, temperature and mechanical stress caused by dispersion devices

Biological Source Terms
- Delivery/Dispersion methods
  - Accidental
    - Spray devices – foggers or sprayers
    - Spill containment, fire and smoke size
  - Manual release
  - Unaided dispersion
  - Explosive dispersion
- Form of agent
  - Liquid, powder

Biological Outputs
- Outputs:
  - Additional output terms
    - Time integrated inhalation dose, maximum inhalation dose, ground contamination, wet and dry deposition
    - Indices for LD and IC parameters
    - Quarantine and isolation functions

Work Group ARGOS Evaluation –
Summary of Responses to questionnaire

Risk Tinker
ARPANSA

Initial Questionnaire Responses
Question 1: Which of the ARGOS capabilities are you interested in making use of?
- Database & SCL server, Rimpuff plume model, GIS/Mapping, Rain-radar, Food dose model

Question 2: Chemical, Biological or Radiological/nuclear focus?
- All situations of interest. Preferences driven by an Agency’s sphere of interest

Question 3(a): ARGOS use: In-field or office-based (check both).
- Preferred office based application to support field operations
- Capability as an incident planning tool and stand-alone use on laptops in the field was suggested for specific needs

Question 3(b): In-house or cross-government control of ARGOS.
- Preferred as an in-house tool
- Recognised that a cross-Governmental system during operational or incident management may be useful

Questionnaire
A questionnaire was sent to stakeholders in two parts
Initial Requirements
- The potential uses and requirements for the software
- Initial impressions of ARGOS were evaluated.

Formal Evaluation
- Stakeholder appraisal of the ARGOS software
- Comments on problems encountered.

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Evaluation Questionnaire Responses

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.
- GUI not particularly intuitive to initially use.
- Once a user becomes familiar with the program through training or general use, ARGOS could easily run and results could be examined effectively.

ARGOS performance

Totally Satisfied | Partially Satisfied | Not Satisfied
---|---|---
100% | 0% | 0%

Question 2: ARGOS includes the plane model known as RIMPUFF. How would you rate the outputs provided by this model?
- Users were happy with the outputs from RIMPUFF.
- Some users would like further analysis to validate results, including direct comparison with experimental data.

ARGOS performance

Totally Satisfied | Partially Satisfied | Not Satisfied
---|---|---
40% | 60% | 0%

Question 3: In what ways, do you think ARGOS can be utilised in the CBRN workplace? Which type of incident did you focus your efforts on, and how did ARGOS perform with the type of hazards of interest? Did it provide the right type of information for your needs?
- Radiological/Nuclear incidents were simulated easily.
- Biological databases needed significant addition and revision.
- Chemical reaction was considered to have performed well.

ARGOS performance

Totally Satisfied | Partially Satisfied | Not Satisfied
---|---|---
33% | 67% | 0%

Initial Questionnaire Responses

Question 4 (a): Which GIS systems do you currently use?
- Most use Mapinfo, ESRRI and Google Earth
- Other tools, such as vertical mapapers, open source (within Mapinfo), USB maps, FME, ArcGIS and Leica Cassiopae are also in use.

Question 4 (b): Which GIS tools would you prefer ARGOS to interact with?
- Google Earth, Mapinfo and ESRRI are the preferred tools.

Question 5: What additional improvements are required?
- Improvements to chemical and biological sources
- Accommodation of spatial data projections to suit northern and southern hemispheres
- Improved functionality for GIS aspects (e.g. pan, layer control, zoom, querying, etc.)
- (Refer to report for other suggestions)

Response Table:

<table>
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<th>Response</th>
<th>Totally Satisfied</th>
<th>Partially Satisfied</th>
<th>Not Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Analysis of Questionnaire Responses

Wide-range responses and backgrounds from each of the stakeholders are (understandably) difficult to collate and analyze.

Major Comments Raised

Main Dislikes:
- Main issue related to GIS capabilities.
- GIS not particularly intuitive to initially use.
- Definition of source terms issues for biological and chemical.
- Possibly not suitable for field application due to user interface and training requirements.

Main Likes:
- Once a user became familiar with the program ARGOS could be easily run and results could be examined effectively.
- Most stakeholders agreed that ARGOS was suitable as a research tool.
- Users were satisfied with outcomes and found databases simple and user friendly.

Suggested Improvements (SNAP SHOT)
- More descriptive map layers including roads, 3D features, horizontal and vertical isobars.
- The ability to import and export maps in various image and GIS formats.
- Improved manual.
- A function similar to in scenarios to enter new 'reactor' sites for C and S scenarios or a setup wizard.
- Implementation of ARGOS for more conventional chemical weapon agents, such as Mustard Gas.
- An easier and more intuitive interface with the database for data entry and amendment of CBR materials and agents.
- Inclusion of an Urban dispersion and explosive models (e.g. TNT and Limax).

Project Partners

- ARPA
dan - Stephen Solomon, Marian Groesnik, Rick Titler
- Bureau of Meteorology
  - Helen Holt
- CSIRO
  - Michael Borgis
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Project Scope

- First responders, post-incident
- ONLY atmospheric hazards at this stage
- Chemical
  - TC/TH (HC/CH), CWA
- Biological
  - BWA, Bio-terrorism
- NDS: give bio security issues, epidemiology, etc.
- Radiological
  - RDD/MBA bombs, IN3s

Phase 1

- The key = stakeholder engagement
- Stakeholder workshops review project scope & current options, receive stakeholder feedback about their current models, etc.
- What they view as the critical issues
  - MCF: Most important
  - MCF: Most critical
  - MCF: Most important
  - CH: Critical hazards
  - CWA: Critical weapons
  - RDD: Remote demolition devices
- Final joint workshop in Melbourne in November
- Self-funded interested parties are welcome
- Develop a set of stakeholder requirements, model functionalities and metrics for evaluation.
- Due May 2009

Phase 2

- Evaluate models with respect to user requirements and metrics
- Make recommendations on which combination of models would best support the desired Australian capability
- Make recommendations in terms of link partnerships between agencies, infrastructure requirements, and a coordinated, national approach
- Recommendations for addressing future scope - e.g. present post-incident requirements, decision support for higher levels of government, etc.
- Due Feb 2009

Contacts

Defence Science and Technology Organisation
DSTO Melbourne
500 Liner St
Fishermans Bend
VIC 3207

- Ralph Gallix, (03) 9625 5455,
  ralph.gallix@dst.defence.gov.au
- Peter Dawson, (03) 9625 5575,
  peter.dawson@dst.defence.gov.au
- Alex McLean, (03) 9625 7552,
  alex.mclean@dst.defence.gov.au

Evaluation of ARGOS in Australia
New ARGOS Features

Dr Marcus Graechen
ARPANSA

ARGOS 8.3 - Released 11 September 2008, as Demonstrated

- OSN extended to OSN - now pure radiological sources supported (no reactor definition required)
- New Event Registration System
- More data included when publishing to web
- Possibility of predefined iso-curves for RIMM/FLUFF progress and measurements
- Definition of hazard areas
- Definition of predefined 'locations' such as hospitals
- Georeferencing in map a configure and supports RT100
- Enhanced ERMM integration
- Bug fixes

Enhancements Suggested During ARGOS Evaluation Questionnaires
- Incorporate timeline where the event timeline needs
- Incorporate timeline where the event timeline needs
- More detailed information on how to use manual
- More detailed information on how to use manual
- More detailed information on how to use manual
- More detailed information on how to use manual
- More detailed information on how to use manual
Evaluation of ARGOS in Australia

ARGOS Implementation Issues

Dr Stephen Solomon
ARPANSA

Stakeholder Requirements
What does emergency management community require?

- Products outputs in what form?
- Delivered how?
- In what time frames?

DSTO lead Modelling Project Workshops

Implementation Model
Question
if use of ARGOS continues, does it
sit within single agency which delivers all CBRN product on demand or
is it to be used by individual Agencies or
some other combination?

Evaluation of ARGOS for use in Australia
ARPANSA Technical Report No. 150
Evaluation of ARGOS for use in Australia
ARPANSA Technical Report No. 150

Single Agency Implementation
Could a single Agency provide ARGOS support for:
- Databases and source terms
- Modelling of
  - Nuclear emergencies
  - Radiological emergencies
  - Chemical releases
  - Biological releases
- If so, who?

Multi-Agency Implementation
- Which Agencies would use it?
- Which parts of ARGOS would be used?
- How would Agenciee fund the cost of implementation on their systems
- Is BOM able to provide MM data to all ARGOS users
- Who would coordinate implementation and training?

ARPANSA position
ARGOS has proved to be a useful tool to support ARPANSA's role for provision of advice on protective measures for nuclear emergencies. ARPANSA will seek to implement the nuclear and radiological related parts of ARGOS and provide outputs to the Australian radiation emergency response community when needed.

Proposal
- Present Consortium License till end 2008
- ARPANSA will fund for 2009 license to further develop other nuclear/radiological parts within ARGOS
- ARPANSA will form an ARGOS User Working Group to coordinate use of ARGOS across CBRN users
- Prepare multi-Agency funding proposal second half 2009

Work Group ARGOS Evaluation – Summary of Responses to questionnaire
Rita Tinker
ARPANSA

Workshop Recommendations
- Executive Summary
  - Description of evaluation project and summary of questionnaire responses
- Assessment
  - Outcomes of evaluation
- Recommendations
  - Workshop outcomes and recommendations to stakeholders (e.g., first responders, EMA, government)

Workshop Recommendations
ARGOS is an advanced tool for the assessment of protective measures for support of nuclear emergencies. ARPANSA should continue the ongoing implementation of ARGOS as a tool to support Australian arrangements for nuclear and radiological emergency response. The full implementation and integration across the Australian government would require additional funding.

While ARGOS shows potential for the Chemistry and Biological releases for both normal and CBRN incidents, significant work is required to extend databases and source terms. Future planning and funding is required.

The optimum model for implementation needs further assessment. A Working Group should be established to assess the elements and core requirements of implementation. ARPANSA should submit to the ARGOS Consortium the following key areas where the software can be improved. Funding will be required to support these changes.
Appendix G – ARGOS Initial Questionnaires

ARGOS Evaluation Questionnaire – Initial Requirements

To be returned to argos@arpansa.gov.au by Friday 30th May

Organisation: Australian Chemical, Biological, Radiological and Nuclear Data Centre

Questions:

1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)

The CBRNDC is interested in all capabilities listed with their associated modules.

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?

All scenarios and situations will be investigated.

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

The CBRNDC intends to use ARGOS largely as an office-based tool with in-house control over internal databases and modelling. We would also need the capability to interact with a cross-Governmental system for operational or incident management work.

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   e. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?

   f. Which GIS tools would you prefer ARGOS to interact with?

   g. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

The CBRNDC would like ARGOS to produce map layers (e.g. roads, 3D features etc.), horizontal and vertical isolines and numerical output. We would also be interested in linking source information with GPS and graphical location e.g. graphical database of relevant facilities across Australia etc.

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?

The CBRNDC would be interested in:
- An easier and more intuitive interface with the database for data entry and amendment of CBR materials and agents.
- Incorporation of the “back tracking” function (previously demonstrated with ARGOS) to determine the origin of release using reverse wind field.
- A function similar to the Nuclear scenarios to enter new “reactor” sites for Chemical and Biological scenarios.
- A 3D view for the Urban Dispersion Model
- More user-friendly Graphical User Interface
- More descriptive explanation of outputs via a manual.

Submitted: 30 May 2008
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Ashwin Dyall
Organisation: Australian Federal Police
E-mail Address: ashwin.dyall@afp.gov.au

Questions;
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations? no

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

   The intention is to use ARGOS as an office-based tool. I am unsure as to what cross-government control would involve, therefore I am undecided.

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?

      We currently use a variety of software including FME, MAPinfo, ESRI’s ArcGIS and Leica Geosystems Ermapper.

   b. Which GIS tools would you prefer ARGOS to interact with?

      As far as I’m aware, ARGOS can only import .shp files and geotiffs. Therefore any software that use these formats would suffice. In what way would ARGOS interact with other software?

   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

      ARGOS should have the ability to import and export maps in various image and GIS formats. It should also have the ability to import data via spreadsheets for map creation.

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?
Further improvements should include making the software more user friendly and intuitive. It should accommodate a variety of datums/projections to suit northern and southern hemispheres. Generally, basic GIS-like functionality (pan, layer control, zoom, querying etc) should be included and is a must for any software of this nature.

**ARGOS Evaluation Questionnaire – Initial Requirements**
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Peter Dawson
Organisation: Human Protection and Performance Div, DSTO
E-mail Address: peter.dawson@dsto.defence.gov.au

Questions:
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)
   
   A, B, C

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?

   All, but in decreasing order of frequency: Chemical, Biological and Radiological/Nuclear

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

   Office based tool. No clear preference for in-house or Cross-Govt control

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
   b. Which GIS tools would you prefer ARGOS to interact with?
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

   A) Google Earth
   B) No strong preference
   C) Yes to map layers, isolines, numerical output options, but also movies of plume evolution with times clearly marked, instantaneous concentrations and time integrated doses, surface deposition maps, combinations of plume doses with population maps to give estimates of affected populations (yes I’m aware ARGOS already does much of this).

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html
import function. Do you envisage any particular requirements in addition to these improvements?

Improvements to the chemical and biological source terms, as well as the effects of these agents, within ARGOS
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Katherine Kirk
Organisation: Queensland Fire and Rescue Service Scientific Unit
E-mail Address: kkirk@emergency.qld.gov.au

Questions;
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction - NO
   b. Rimpuff (Plume Modelling) - YES
   c. GIS/Mapping - YES
   d. Other (please specify)

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?

   Our usage would primarily focus on chemical scenarios and situations, but may also include biological and radiological/nuclear scenarios and situations

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

   • ARGOS would be used both in the field (“front-line”) and as an office-based tool.
   • It would be used by Scientific Officers with both science qualifications and operational experience
   • At a medium-scale incident, ARGOS is more likely to be used on site on a laptop computer
   • At a large-scale or catastrophic incident, ARGOS is more likely to be used in the office or incident control room
   • In-house control of the system is preferred.

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
   b. Which GIS tools would you prefer ARGOS to interact with?
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

   • QFRS uses ESRI GIS Systems
   • For quick overlay (in the field) of initial models from other software, QFRS Scientific Unit also currently uses Google Earth and UBD maps.
   • Map layers, isolines and numerical output are all used depending on the situation.

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in
addition to these improvements?

- Advice from our GIS Section is that optimal GIS integration for our organisation would require WMS (Web Mapping Service), WFS (Web Feature Service) and WCS (Web Content Service) function.
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Graham Tait & Marina De Gabriele
Organisation: NSWFB
E-mail Address: Graham.Tait@fire.nsw.gov.au, Marina.DeGabriele@fire.nsw.gov.au

Questions:
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)
   Answer: Databases & SQL
           Rimpuff plume modeling

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?
   Answer: Toxic Industrial and CBR.

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?
   Answer: Yes and as a Pre Incident Planning Tool

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
      MapInfo & ESRI
   b. Which GIS tools would you prefer ARGOS to interact with?
      MapInfo & ESRI
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?
      Map layer (with appropriate attributes), isolines, numerical output

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?
   2D output map layer to specify height so 3D visualizations are possible.
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Shaiyena Williams
Organisation: Department of Health and Ageing
E-mail Address: Shaiyena.Williams@health.gov.au

Questions:
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
      Possibly
   b. Rimpuff (Plume Modelling)
      Possibly
   c. GIS/Mapping
      Yes

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?
   All, but primarily Chemical and Biological.

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool?
   Office-based tool
   Would you prefer in-house or cross-Government control of the system?
   No preference

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
      ESRI and Google
   b. Which GIS tools would you prefer ARGOS to interact with?
      ESRI and Google (in order of preference)
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?
      Map layer, isolines and numerical output

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?
   No specific additional requirements at this stage.
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Organisation: ANSTO

Questions:
1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)
   
   i. Interested in using RIMPUFF (b) and GIS/Mapping (c).
   ii. Possibly use Databases and SQL (a) depending on the compatibility with our fixed and mobile Gamma Detectors.
   iii. Possibly use rain-radar images.
   iv. Possibly use Food and Dose Module - requires further investigation.

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?
   Radiological/Nuclear scenarios only

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?
   Mainly an office-based tool, will be used periodically in support of field exercises.
   For ANSTO purposes in-house control would be suitable. To best cater for national Security requirements a Whole of government approach would be more suitable.

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
   b. Which GIS tools would you prefer ARGOS to interact with?
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?
   
   a. Currently use MapInfo software such as MapInfo Professional v8.0 and Vertical Mapper to view dispersion model output and database information. MapInfo supplied all layers including satellite photo (from SPOT 5 satellite, March 2005) and roads and rivers layers (obtained from MapInfo package called StreetPro, Oct 2007).
   b. At this stage ARGOS will be used in addition to our current system so there are no specific tool requirements, as long as it provides the layers mentioned in section ‘4c’ below.
   c. Satellite photo or aerial map, roads layer, rivers layer, contour line layer, numerical output.
5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?

I would like to be able to do the following:
– automatically input 15-min Met data from multiple stations (including tower data).
– use Met data and NWP data in the same run (haven’t been able to).
– have the RIMPUFF dispersion output in contours with specific intervention level/colours. Can add isocurves and change palette but they do not match up.
– move the colour legend (it is hard to read when over maps).
– have definitions of the RIMPUFF output (tree list on left hand side of screen).
– Input field data and update plume model particularly when an accurate source term is not known. A capability to interpolate the data to establish an unknown source term would be useful.
ARGOS Evaluation Questionnaire – Initial Requirements
To be returned to argos@arpansa.gov.au by Friday 30th May

Name: Steve Wilkinson
Organisation: Chemistry Centre WA
E-mail Address: swilkinson@ccwa.wa.gov.au

Questions;

1) Which of ARGOS’ capabilities are you interested in making use of?
   a. Databases & SQL server interaction
   b. Rimpuff (Plume Modelling)
   c. GIS/Mapping
   d. Other (please specify)

Answer: b. Rimpuff modeling

2) Are you likely to be focusing on Chemical, Biological and/or Radiological/Nuclear scenarios and situations?

Answer: Chemical

3) Is it your intention to use ARGOS in the field (‘front-line’) or as an office-based tool? Would you prefer in-house or cross-Government control of the system?

Answer: In the field and also office based

4) ARGOS can be applied as a GIS (Geographical Information System) tool – the following questions relate to GIS capabilities.
   a. Which GIS systems do you currently use (e.g. Mapinfo, ESRI, Google, Other)?
   b. Which GIS tools would you prefer ARGOS to interact with?
   c. What product would you like ARGOS to produce (e.g. map layer, isolines, numerical output)?

Answer: Not applicable

5) ARGOS has a program of development which includes the incorporation of an Urban Dispersion Model, an explosive term, Google Earth functionality and html import function. Do you envisage any particular requirements in addition to these improvements?

Answer: We would support the incorporation of these requirements
Appendix H – ARGOS Formal Questionnaires

ARGOS Evaluation Questionnaire – Formal Evaluation
To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Organisation: ANSTO

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
I found ARGOS easier to use once I read the ARPANSA Standard Operating Procedure (for running a Radiological Release Scenario) as it provides a quick and easy example of a basic run and most importantly the input order needed.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
It would be useful to also have a user's guide or procedure for the PMS database, NucSpec, FDM and Countermeasure module.

Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer:
Time for the input data and the mapping is good. However I would prefer a faster running time for high resolution cases since we are focusing on short range dispersion (if ARGOS was to replace our current system). As ARGOS stands now, it is still useful as an additional tool for our Emergency Response System for longer range predictions.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
A number of radiological cases were run with different inputs to RIMPUFF.
Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?

Answer:
The outputs are good.

Is it possible for us to move the colour legend though because it is difficult to read?

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
It would be good to have the definitions of each RIMPUFF output documented.
It might be useful to have the units written next to the output name.

Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer:
The manual input for reactors and source terms is good.

I haven’t imported any datasets because I wasn’t sure of the format. Ideally we would like to have Met data from ANSTO imported automatically every 15 min.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
In relation to met input data, I would like to use Met tower data as well as NWP in the same run as it says is possible in the Manual but it wasn’t allowing it.

I haven’t been able to put in more than one height level for met station data when setting it up manually.
Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

Answer:
I have not tried this.

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Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer:
Yes I believe it is an easy tool for re-running and comparing model outputs.

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Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

Answer:
We are interested in Radiological releases and yes it provides the right type of information such as dose and air concentration. We already use RIMPUFF as part of our Emergency Response System so we are happy with the models capabilities.

The only issue is that I can’t get our intervention level colours into contours/isocurves.

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Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

Answer:
No I haven’t used the export to web function. I don’t know at this stage if we would use it.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?

Answer:
We would not have ARGOS set up as a client-server or on the web due to security restrictions.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Question 11: Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?

Answer:
The Emergency Response System we have now is currently very similar to ARGOS except we don’t have the prediction tool using NWP from BOM and we are using a combination of programs/software/GUI. The advantage of ARGOS is that it is one whole system with a user friendly interface. Having a number of organizations within Australia using the same system would also provide opportunities for collaboration and support.

We would like to use ARGOS as an additional tool to our current Emergency Response System as it provides a more regional area prediction compared to our current local focus. If we find the model resolution is suitable for our local needs then it could replace our system in the future.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Answer:
To have intervention levels within contours for the plume.
Add units next to the RIMPUFF output names.
Numerical output for graphing.
Be able to move the colour legend.
ARGOS Evaluation Questionnaire – Formal Evaluation

To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Name: Steve Wilkinson
Organisation: Chemistry Centre WA
E-mail Address: swilkinson@ccwa.wa.gov.au

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
Not intuitive but could be used with formal training

Satisfaction with this aspect of ARGOS’ performance (tick one)  
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Hands on

Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer:
Possibly not fast enough for real-time decision making

Satisfaction with this aspect of ARGOS’ performance (tick one)  
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Hands on

Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?

Answer:
Outputs appear to be accurate

Satisfaction with this aspect of ARGOS’ performance (tick one)  
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Hands on, intuitive assessment
- we had problems with connection to met server (NwP) possibly due to University network constraints

Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer:
Manual data input was user friendly

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Manual data input only

Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

Answer:
Not attempted but inspection of ARGOS functionality indicates this is possible

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

N/A

Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer:
Not very flexible
Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

Answer:

Chemical only.

Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

Answer:

Could not get this to work. May be due to Uni network issues
Would be very useful if operational

Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?

Answer:

We have processes in place to ensure security
Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:
We are unable to comment accurately at this stage

Question 11: Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?

Answer:
With increase in speed and further development of the chemical side ARGOS could be used for DSS.

We currently use ALOHA which, while simple, is fit for purpose.

Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Answer:
Urban dispersion model and explosion (BLEVE, TNT and fireballs) models would be a high priority for us.

A “Wizard” style interface for the casual user would be high priority also.
ARGOS Evaluation Questionnaire – Formal Evaluation
To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Name: Peter Dawson
Organisation: Human Protection and Performance Division, DSTO
E-mail Address: peter.dawson@dsto.defence.gov.au

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
The GUI is good, allowing someone familiar with the program to easily run ARGOS and see the results, however it could benefit greatly from some improvements.

In particular, good aspects are:

the sliding time bar allowing the user to easily see the progression of the plume.

ease of entering new isolines.

resolution and ease of understanding of the plume plots.

ability to drag the map around with the cursor.

Aspects I feel could be improved are:

A simple but dramatic improvement would be the ability to pick up a source and move it with the cursor, to allow fine tuning of position quickly rather than having to type in new coordinates.

The small black numbers of the legend are often very difficult to read against the map. Placing the legend and numbers in a white box would eliminate this problem.

A major improvement would be the ability to download and use up-to-date weather information automatically. It is not clear to me how to import new weather information.

More complete source terms are needed, as well as data for more agents. For example, is a chlorine release meant to simulate the release of liquid or gaseous chlorine? It should be made clear which, and preferably a choice given. Also, sources such as “chlorine tanker ruptured by an explosion” could be generated, which would automatically estimate how much chlorine is dispersed and in what phase, if given the size of the tanker and explosive.

Acute Exposure Guide Line isolines (AEGL’s) are needed for chemical incidents (which are more informative than the ones provided) as well as Infectious Concentration by Time isolines for biological releases (for eg ICT50 equals infectious dose for 50% of those exposed).

A local time<->GMT time converter would make using this program for real incidents easier.

When entering location coordinates (in WGS 84) through Map->Find->Point the empty fields should instead be 0*0*0 to remind new users how to separate degrees, minutes and seconds.

A zoom-in button is needed

The Australian street address to coordinate mapping would be very useful.
Maps with street level detail for small scale releases.
Population density information and the ability for ARGOS to predict how many people lie in the affected zone.

Ability to control minimum concentrations/doses/etc tracked in plots, so that when presenting them as management aids, concentrations so low as to be irrelevant are not plotted.

A mass\textto Bq conversion for the input of dirty bomb sources would be very handy. As far as I could see, there is no option to do batch jobs. It would be handy for using ARGOS as a planning tool to be able to get ARGOS to rerun the same scenario many times for variations in wind conditions.

Documentation regarding the details of how source inputs into ARGOS are incorporated into a plume would increase confidence in the user in ARGOS’s results (see eg of chlorine above).

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<td>Comments: (Indicate how the activity was assessed, your expectations and the outcomes)</td>
<td>ARGOS was assessed through generating simulations of incidents, first based upon those in the ARPANSA tutorial and then upon work done within the DSTO.</td>
<td>I was quite pleased with the performance of ARGOS, however do feel it lacks some features that could improve it further, covered above.</td>
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Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer: Considering ARGOS should be faster when not in VMware, it’s speed is sufficient.

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Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?
Answer:
RIMPUFF’s results seem physically reasonable, however no validation material has been read by our group, nor any direct validation done against experiment.

I would appreciate the opportunity to determine the turbulence conditions directly though, rather than letting the algorithm infer them from lots of different inputs be the only option.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS was assessed through generating simulations of incidents, first based upon those in the ARPANSA tutorial and then upon work done within the DSTO.

Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer:
It was reasonably easy to enter data into the source terms through the GUI, however there was no explanation as to how the internal model uses this data to generate a release.

I haven’t evaluated the use of field measurements and importing data-sets., thus no box ticked below.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS was assessed through generating simulations of incidents, first based upon those in the ARPANSA tutorial and then upon work done within the DSTO.

Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

Answer:
The furthest extent I applied was exporting png images from the program to file, which is easy and straightforward.
Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer:

While it is easy to change the inputs to a vignette and rerun in ARGOS, for emergency planning purposes it would be beneficial to be able to run batch jobs form randomly selected representational weather.

Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

Answer:

I focused equally on C, B and R incidents. Considering that there is no source data yet for most Bio agents of concern, and no ICT isolines, it is for now not applicable to bio.

It did a fair job of C and N, however as mentioned earlier, there are some changes to the GUI which would make it a more powerful tool for the user/decision maker.

Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?
Answer:
Not used. It may be useful for first responders and those advising them. It could have some use for our group.

Satisfaction with this aspect of ARGOS’ performance (tick one) | Totally Satisfied | Partially Satisfied | Not Satisfied
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Not tested

Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?

Answer:
The client-server system could possibly be used on a restricted network within defence.

Satisfaction with this aspect of ARGOS’ performance (tick one) | Totally Satisfied | Partially Satisfied | Not Satisfied
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Not tested.

Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:
ARGOS was reliable except when manually editing the MODEL parameters within the PROGNOSIS. This often created array sizes too big for the program.

Satisfaction with this aspect of ARGOS’ performance (tick one) | Totally Satisfied | Partially Satisfied | Not Satisfied
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Tested through running and editing various vignettes.

Question 11: Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?
Answer:

I found ARGOS to be a good tool, with some strengths other similar simulations lacked, but also some weaknesses which need further development. While in its current state it could be used in decision support processes for Chemical and Radiological releases, there is other software which can perform the task as well, with their own strengths and weaknesses.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Compared to HPAC and a British urban dispersion modelling package.

Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Answer:

Besides the changes mentioned in the answer to question 1, I would suggest:

It would be useful if ARGOS could generate plots of 2D cross section concentration (instantaneous, time integrated, etc) at user defined points. If ARGOS could generate isolines based on the probability (due to plume/wind fluctuations) of local time integrated concentration exceeding a particular threshold (for example AEGL-2), it would make ARGOS a more powerful decision tool. For example, a local commander would know there is a 5% probability that people within the 5% AEGL-2 isoline have in excess of a 5% chance of getting in harms way. Is RIMPUFF capable of probability calculations of this nature? Implementation of ARGOS for more conventional chemical weapon agents, such as Mustard Gas, and G and V nerve agents. The radiation simulation has some good effects based metrics, such as preventative effects of taking iodine and staying indoors. It would be good if this theme could be extended to C and B as well, such as the effect of wearing gas masks, and wearing other protective equipment, staying indoors, etc. If the above effects based metrics could be combined with AEGL and ICT isolines to give adjusted regions where protected people would feel effects, this would also be a powerful decision tool.
ARGOS Evaluation Questionnaire – Formal Evaluation
To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Organisation: Australian Chemical Biological Radiological and Nuclear Data Centre

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
Overall, the ARGOS program is not user-friendly or intuitive for novice users. Significant time must be allocated to becoming familiar with setup parameters,

Inputs: ARGOS is not intuitive and errors not easily interpreted resulting in extended periods of time spent altering settings. We found the reactor inventory input function in N to be very useful, and a similar function within C and B would be valuable. Please note that several modules/functions did not work.

Outputs: Graphical reporting of outputs is good, however outputs terms are not clearly defined in the help menu or in the manual. Outputs in the B and C sections are not as comprehensive as in N.

Analysis tools: Sheltering and evacuation functions, isocurves, trajectory, decay calculation tool within N are useful, several functions aren’t available as database information has not been entered or links between the database and the program are compromised. The B and C sections lack most of the analysis tools that are present in the N section. Inclusion of the AEGL-1, -2, and -3 parameters in C and a similar parameter in B would be useful in the Australian context.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2 on laptop. Expectations: intuitiveness and ease-of-use, report of results in an efficient and useful format, ability to manipulate and analyse data.
Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS' contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer:
Setup: Once the user has a good understanding of the setup requirements and certain idiosyncrasies of the program, the setup time is satisfactory. In addition, the reactor inventory database can significantly accelerate setup time by preparing relevant scenarios prior to a prognosis run. Perhaps a wizard could be incorporated for scenario setup. Please note that numerous modules/functions did not work therefore the speed and performance could not be assessed.

Running Times: Depends largely on the input scenario. In certain scenarios ARGOS performed reasonably quickly (5-10 mins), whereas in other scenarios ARGOS took >1 hour to run. For our purposes, the longer running times would not be problematic, however this may not be acceptable for real-time/in-field scenarios or as an operational reach-back capability. A better understanding of how ARGOS handles input data would be welcomed to further understand this issue. We cannot accurately assess to what degree performance will increase once the platform has changed.

Mapping: Speed/performance is dependant on the size of the data. During testing, the datasets were clipped, minimized down to one to two MB but the performance did not improve greatly.

Satisfaction with this aspect of ARGOS' performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2 on a laptop. Hands-on assessment. Various scenarios were run based on available database information. Expectations: intuitive, easy-to-use, relatively fast running times.

Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?

Answer:
Graphical reporting of outputs is well presented and clear, however outputs terms are not clearly defined in the help menu or in the manual and are therefore difficult to interpret. Numerical output is good – Incorporation of a function to print off or display particular numerical values in a table format would be useful.

The availability of outputs from multiple scenarios for direct comparison is very useful. The anticipated inclusion of an UDM is welcomed.
Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer:
Manual input of reactors and source term data was relatively straightforward and useful for individualisation of scenarios. However, when creating a new reactor entry, data input into the release category did not always save and the data needed to be entered a number of times before it remained. Regardless, the “reactor” input function would be an essential addition to C and B prognoses in order to create catalogues (with source terms) of relevant C and B facilities.

Logging of field measurements and importation of datasets could not be assessed at this time.

Satisfaction with this aspect of ARGOS’ performance (tick one) | Totally Satisfied | Partially Satisfied | Not Satisfied
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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2. Hands-on assessment. Various scenarios were run based on available database information. Expectations: Easy input of data via reactor and source term functions.
Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

Answer:
Argos was tested for its GIS functionality and performed poorly in all sections. Importing geotiffs proved to be difficult as the software could not work well with co-ordinates in southern hemisphere. The process for loading geotiffs seemed convoluted also.

We eventually loaded geotiffs in Argos, but some tiff files were more precisely located than others. Argos seems to have issues with files that have been re-projected. One particular geotiff only displayed after modifying number of lines versus cells per line of the raster image.

We did not have any success in loading shapefiles into Argos. Formal training is recommended as the process of loading shapefiles was not intuitive.

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<td>The aim was to load geotiffs and shapefiles into Argos.</td>
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Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer:
To a novice user, ARGOS is not flexible. Initial assessments required a lot of trial-and-error. A training program might be beneficial once ARGOS is rolled-out.

Once a better understanding of the ARGOS system was reached re-running and refinement was much easier. Editing isocurves, sheltering and evacuation limits, wind fields etc was very straightforward. However as previously mentioned in question 2, minor variations can results in significant increases in running times that may not be suitable for real-time/in-the-field scenario assessments. Error messages were sometimes poorly defined.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2. Hands-on assessment. Various scenarios were run based on available database information. Expectations: Flexibility, simple re-running and refinement.

Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

Answer:
Chemical, biological, radiological and nuclear incidents were assessed. For our purposes, the outputs from ARGOS will be largely used in technical assessments and evaluations. The system may also be utilised for incident management work. Numerical, graphical and dose limit output as well as the ability to manipulate scenarios and compare outputs were very useful. The ability to export data in tabulated format would be valuable. Again, outputs (and some functions) need clearer definition.

All prognoses produced an output. ARGOS performed well for the radiological/nuclear incidents. Some functions were not available either due to errors in database connection or lack of specific data. As previously mentioned, we were able to easily enter “reactors” into the database.

The biological section requires significant addition and revision of biological entities and agents. In addition, the biological prognosis could not be thoroughly investigated as the “agent” was only available for one entity.

The chemical section performed well but certain functions were not available, such as Heavypuff. We would like to have AEGL parameters included in the exposure limit drop-down menu.

The CBRNDC will also be looking to link source information with GPS and graphical location to produce a graphical database of relevant facilities across Australia. Therefore a function similar to the “reactor” input function in N or a more user-friendly interface to input data would be useful. Also, an understanding of how the input data is utilised by the model would be beneficial.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2. Hands-on assessment. Various scenarios were run based on available database information. Expectations: Useful outputs, easy manipulation of data.
Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

Answer:
Argos was not tested for its ability to host or consume other web services.

However, this functionality would be extremely useful. For example, a plume model can be generated in Argos then deployed and integrated into another web service. Or another option would be to consume external data such as weather data feeds from BOM and integrate the data with plume models within Argos.

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N/A
Satisfaction rating was not provided as no assessment could be made.

Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?

Answer:
The fact that it can be used as a web-based product suggests that there is a potential for the data to be compromised and would need to undergo further, more stringent testing.

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N/A
Satisfaction rating was not provided as no assessment could be made.
Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:
Modelling:
From a modelling perspective ARGOS appears reliable. However:
Certain utilities/modules did not function, such as “Calculate” and “Heavypuff” within C, and the trajectory module within C and B.
In general, C and B lacks important outputs when compared with N, e.g. ground contamination etc.
For N, when creating a new reactor entry, data input into the release category did not always save. The data needed to be entered a number of times before it remained.
Within the B section, some of the database entity information is inaccurate.

In addition to resolution of the above, the CBRNDC is interested in utilising the Tanker/truck templates within the C prognosis and like to know how the database information is incorporated into modelling – i.e. a general understanding of what information is used to create the output.

GIS:
Argos has not been reliable and from a GIS perspective, it is well below standard. It may be worth assessing other GIS applications to attain a desired look and feel. The following needs to be addressed:
- Import and export functions should be easy to use and easily accessible.
- Shapefile import needs to be a lot simpler.
- The basic GIS tools offered such as pan, zoom needs to be refined and made more user-friendly.
- The table of contents pane is redundant unless it offers the ability to re-organise order of layers or change symbology.
- Needs to have the ability to work with a range of projections and datums.
- Needs to have the ability to export in a wide variety of formats.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2. Hands-on assessment. Various scenarios were run based on available database information.
Question 11: Taking into account all aspects of ARGOS' performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?

Answer:
ARGOS has the potential to be a very useful tool within the Australian context. However, there would need to be significant revisions to the programming, such as improving the overall user-friendliness, data entry and overall functionality. The speed and performance is satisfactory for our purposes, but may not be suitable for real-time/in-field assessments where outputs are time sensitive. This, however, may be overcome when the program is removed from the virtual machine.

From a GIS perspective, ARGOS needs to accommodate a variety of datums/projections to suit both northern and southern hemispheres.

There are various other programs such as HPAC and ALOHA that could perform a similar function to ARGOS. ARGOS however has the capability to maintain a database particularly suited to our requirements, as well as the potential for sensor input and the ability to trace and amend previous runs.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
ARGOS v8.2. Hands-on assessment. Various scenarios were run based on available database information.
Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS' usefulness in your work?

Answer:

The CBRNDC would be interested in:
An easier and more intuitive interface with the database for data entry and amendment of CBR materials and agents.
Incorporation of the “back tracking” function (previously demonstrated with ARGOS) to determine the origin of release using reverse wind field.
Tabulated numerical output
A function similar to N scenarios to enter new “reactor” sites for C and B scenarios or a setup wizard
A 3D view for the Urban Dispersion Model
Building infiltration and exfiltration
More user-friendly Graphical User Interface
More descriptive explanation of outputs via a manual.
More descriptive map layers including roads, 3D features, horizontal and vertical isolines
The ability to import and export maps in various image and GIS formats.
The ability to import data via spreadsheets for map creation.
Generally, basic GIS-like functionality (pan, layer control, zoom, querying etc) should be included and is a must for any software of this nature.
ARGOS Evaluation Questionnaire – Formal Evaluation
To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Name: Graham Tait & Marina De Gabriele
Organisation: NSWFB
E-mail Address: Graham.Tait@fire.nsw.gov.au, Marina.DeGabriele@fire.nsw.gov.au

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
The GUI appears to be not particularly intuitive, because it doesn’t follow the same logic as standard Windows-based programs (i.e. step-by-step “wizards”).

Not suitable for a novice user.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Demonstration, not hands-on.

Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer:
The speed appeared to be sufficient for operational purposes.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Demonstration, not hands-on.
Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?

Answer:
The outputs appeared to be satisfactory, although we would prefer to view the output in our GIS applications.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Demonstration, not hands-on.

Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer:
N/A.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Demonstration, not hands-on.

Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?
Answer:
Not as yet.

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Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer:
It appears to be reasonably flexible.

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Demonstration, not hands-on.

Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?
Answer:
Chemical & radiological.

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Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

Answer:
Have not used it, but it could be useful.

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Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?
Answer:
Processes are in place that would prevent this.

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Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:
N/A.

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Question 11: Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?
It could be applied in an Australian context, provided the requirements for GIS export as detailed above are included.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Answer:
No.
ARGOS Evaluation Questionnaire – Formal Evaluation
To be returned to argos@arpansa.gov.au by Friday 4th July
Boxes may be stretched for extended answers.

Name: Katherine Kirk
Organisation: Queensland Fire and Rescue Service (Scientific Unit)
E-mail Address: kkirk@emergency.qld.gov.au

Question 1: After becoming familiar with ARGOS, how would you rate the performance of its Graphical User Interface (GUI)? Would you consider ARGOS to be easy to use? Please consider inputs, outputs and analysis tools.

Answer:
With only the documentation provided with the evaluation version (v8.2), ARGOS is difficult to use initially. Many of the features of the software are not accessible without further information. Once the user knows the functions that are available and where to find them, the software becomes much easier to use. This covers input, output and analysis tools.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Assessed by running chemical release scenarios relevant to organisation.
Expectations relate to usage by chemical hazard experts in a first-response situation.

Question 2: Do you find the speed of ARGOS to be sufficient for your needs, both in setup, running times and mapping? This particularly applies when considering ARGOS’ contribution to the decision-making process. Note that an increase in performance is expected when the virtual machine environment is no longer applied.

Answer:
Main limitation in speed was actually in initializing the VM-ware environment. Once the software is operating, speed is adequate for chemical release models tested. Detailed models could not be made to work, so running time could not be assessed for these. Most modeling was performed using manual weather input. Meso-LAPS data would understandably slow the run times, but this would be used for more in-depth decision support.

Satisfaction with this aspect of ARGOS’ performance (tick one)

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 3: ARGOS includes the plume model known as RIMPUFF. How would you rate the outputs provided by this model?
Outputs provided were adequate for the chemical release models that could be entered. Unable to assess output for detailed release models.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 4: Data can be incorporated to ARGOS’ databases through manual input into reactors & source terms, through logging of field measurements, and through import of datasets. If you have utilised any of these features, have you found them useful and easy to apply?

Answer: These features were not utilized during assessment.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 5: Have you applied ARGOS as a Geographical Information System (GIS) tool? This may include imports/exports of maps and display of database information. Was data easily exported from ARGOS and applied in your current GIS applications?

Answer: For first response work, the ability to import maps to display results of initial modeling urgently is important. ARGOS performed poorly in this regard as no other maps could be imported. Included maps were insufficient for emergency response work. Other GIS features were not assessed.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)

Question 6: Do you find ARGOS to be flexible to the user? Does it enable simple re-running and refinement of modelled inputs and outputs?

Answer: For those chemical release models that could be tested, ARGOS displayed good flexibility. Flexibility of detailed release models still needs to be evaluated due to this feature not working in the evaluation version.

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Comments: (Indicate how the activity was assessed, your expectations and the outcomes)
Question 7: ARGOS can be applied to CBRN incidents. Which type of incident did you focus your efforts on, and how did ARGOS perform with the types of hazards of interest? Did it provide the right type of information for your needs?

Answer:
Focus on chemical release incidents (HAZMAT), both large and medium size. Basic model input using time, release rate, height and heat worked well in terms of providing the right type of information in output. Results were consistent with other software available and observed field measurements.

However, detailed chemical release modeling (templates section) did not work. This type of model input is very important for HAZMAT incidents.

Question 8: Information generated from ARGOS may be exported to the internet through a web server. Have you used this functionality, and do you see that it would be useful in your own application of the software?

Answer:
This functionality was not tested. However, it would be important for use at a large protracted chemical incident.

Question 9: As well as being available as a stand-alone application on a single PC, ARGOS can be set up on a client-server system or used as a web-based product. Does your experience suggest that this could compromise security of data, or are processes in place that would prevent this?
Answer:
For chemical release incidents where this organisation would use ARGOS, at least 50% would require use of the software on a laptop computer in the field (at the Incident Control or Forward Control Point).

Setting ARGOS up on a server system or as a web-based product would severely limit its ability to be applied by personnel in the field. For example, a significant proportion of chemical release incidents occur in remote areas.

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Question 10: Have you found ARGOS to be reliable? Please specify any particular problems that may have been encountered, as these will be forwarded to ARGOS developers.

Answer:
Apart from inability to access detailed chemical release models, some difficulties were experienced with run-time errors. These appeared to relate to grid size as compared with the size of the chemical release. Access to detailed documentation for the chemical release modeling features of the software would probably prevent these in most cases.

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Question 11: Taking into account all aspects of ARGOS’ performance, do you feel that the system could be effectively applied to decision support processes in an Australian context? Are there other applications available that would also achieve your goals?

Answer:
There is a considerable gap in the chemical release modeling software available in Australia, with all software currently available to this organisation having one or more substantial limitations. For example, ALOHA is limited to an incident duration of one hour.

Further analysis of the features and capability of ARGOS using the detailed chemical release models is necessary to determine if ARGOS will fill this gap.

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Evaluation of ARGOS for use in Australia
ARPANSA Technical Report No. 150
Question 12: Over the next 12 months new features will be added to ARGOS, including an Urban Dispersion Model, Explosion Model and Open-GIS tools. What other improvements would you suggest to enhance ARGOS’ usefulness in your work?

Answer:
Building infiltration/exfiltration and concentration of chemical contaminant by height would be useful. Most important is to get the detailed chemical models functional, so that the current capability of the software can be assessed.