

## Use of ARGOS in Ireland

30 March 2007

### Introduction

In Ireland a plan – the National Emergency Plan for Nuclear Accidents (NEPNA) – has been developed to provide the framework for co-ordinating the emergency response to large scale nuclear incidents with the potential to contaminate a wide area in Ireland.

Events covered by the plan include:

- an accident or terrorist attack at a nuclear installation abroad;
- the detonation of a nuclear bomb abroad; and
- the re-entry of a nuclear powered satellite over Ireland.

NEPNA may also be invoked as part of the emergency response to the following scale incidents affecting a limited area:

- accidents involving nuclear powered ships or ships transporting radioactive substances in waters close to the Irish coast; and
- local dispersal of radioactive substances by spillages, fires, dumping, water supply contamination or by any other means.

NEPNA outlines emergency notification and alerting, responsibilities of the relevant State bodies, interagency coordination, implementation of countermeasures and communication with the public.

The Radiological Protection Institute of Ireland (RPII) has been assigned particular functions under this plan covering early warning, technical assessment of the incident, provision of technical advice on countermeasures and monitoring of the environment and the food chain. These responsibilities can be divided into those related to emergency preparedness and emergency response:

To fulfil its emergency preparedness role the RPII:

- acts as the National Competent Authority (NCA) for the ECURIE (European Community Urgent Radiological Information Exchange) and IAEA's EMERCON early notification arrangements for nuclear emergencies;
- operates an on-call system to facilitate a rapid response to notification of a nuclear accident. Arrangements are in place so that a duty officer, a senior member of RPII staff, can be contacted at any time following such a notification;
- operates and maintains a national monitoring network comprising gamma dose rate stations, which are intended to provide early indication of elevated ambient gamma dose rates and air sampling stations which allow the concentration of radioactivity in the air to be assessed. In an emergency the network would be supplemented by results from Reserve Defence Forces mobile survey teams;
- exchanges gamma dose rate data between the UK Radioactive Incident Monitoring Network (RIMNET) and the Irish network;

- participates in the European Radiological Data Exchange Platform (EURDEP) whereby monitoring data is routinely exchanged between partner states in order to ensure that such data will be available to all member states in the event of an emergency;
- provides advice to the Irish Government on radiological emergency preparedness issues including: nuclear/ radiological threats, the adequacy of emergency preparedness arrangements and nuclear emergency exercises;
- participates in a range of internal, national and international exercises;
- maintains a number of systems to support its emergency response operational procedures including the nuclear decision support system ARGOS (Accident Reporting and Guidance System) and a web based Emergency Response Management Information System (ERMIS) to facilitate the efficient sharing of critical information within the Institute during an emergency or crisis; and
- operate a radioanalytical laboratory to maintain capability for the measurement of radioactivity in food and environmental samples.

To fulfil its emergency response role the RPII would be required to:

- make a technical assessment of the consequences of accidents with the potential to impact on Ireland by gathering all of the available information relevant to such an accident and to assess the consequence for the Irish population; and
- provide technical advice on protective measures to minimise the radiation exposure to the Irish population;
- analyse environmental and food samples. In the early phase of a response the analysis of air filters and other environmental samples will be crucial to making an accurate assessment of the accident consequences. In the longer term testing of foodstuff is vital to the implementation of effective foodstuffs controls;
- respond to media enquires and issue information in relation to the nature of the emergency and its potential consequences;
- provide other services, where required, such as technical and advisory support to other agencies involved in monitoring.

Since 2001 the RPII has used ARGOS as its primary tool for technical assessment of, and preparedness for, a nuclear or radiological emergency. The installation of ARGOS in the RPII features the following components:

- the ARGOS database which contains radiological monitoring data<sup>1</sup>; nuclear base data (e.g. dose coefficients, nuclear reactor characteristics, etc); and meteorological data (weather forecasts and radar rainfall measurements);
- RIMPUFF (RISØ-Mesoscale-PUFF), an atmospheric dispersion model driven by meteorological forecast data provided by Met Éireann (the Irish National Meteorological Service), which enables the transport and dispersal of radioactive contamination to be predicted;

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<sup>1</sup> Currently gamma dose rate data from the Irish monitoring network, RIMNET and EURDEP is included. Once the RPII's new Laboratory Information Management System (LIMS) has been successfully commissioned it is planned to extend the database to include environmental and food samples.

- FDM (Food and Dose Module), a model for simulation of contamination of the food chain and assessment of doses following a nuclear or radiological emergency; and
- the PMS (Permanent Monitoring Stations) database which is used for display and reporting of gamma dose rate data from the Irish monitoring network and RIMNET. In the case of elevated values being recorded, alerts are generated from this database and sent to the duty officer.

The ability to overlay measured data and model results on geographical maps and to export these to standard Geographical Information Systems (GIS) for further analysis are considered by the RPII to be particularly useful functions of ARGOS.

### **Technical Assessment<sup>2</sup>**

The RPII considers the function of technical assessment of a nuclear or radiological emergency as follows:

- to establish the current and future radiological situation based on latest available information;
- to report results in the most efficient and useful format; and
- to provide technical advice on possible countermeasures.

In the pre-release and release phases of an accident, RIMPUFF would be used to predict whether the incident has radiological consequences for Ireland and, if so, to predict airborne activity concentrations, deposition rates and doses. The results would be compared with pre-defined intervention levels in order to estimate the areas affected and to formulate advice on countermeasures.

This process would be repeated regularly as the situation evolved and as more information became available. A simple sensitivity analysis would also be performed by varying model input parameters (e.g. the release time and duration, the quantities of radionuclides released etc) to ensure confidence in the results for the particular location of the release and the prevailing weather situation. Trajectory modelling (also using RIMPUFF) would be performed in order to assess the sensitivity of the model to different release heights (the effective release height, which is a function of convection or the heat content of the release, is an input parameter particularly associated with high levels of uncertainty).

RIMPUFF results would also be exported to a GIS and compared with independent models and calculations, both within the RPII and from sources such as the World Meteorological Organisation (WMO) and the European Commission's ENSEMBLE project.

Once a release had occurred, more information would be available on the status of the nuclear facility and the potential evolution of the accident, including an estimate of the

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<sup>2</sup> The RPII's technical assessment procedures are currently undergoing an extensive review.

source term (by this stage possibly corroborated by measurements from stack or site monitors). The above modelling process would be repeated once more at this stage. Advice on countermeasures would be reviewed and the results from RIMPUFF would be used to determine an environmental sampling strategy.

ARGOS would be used to compare atmospheric dispersion model results with initial measurements from permanent and mobile monitoring stations in order to assess confidence in the predictions. Radar rainfall data would be overlaid with atmospheric dispersion model results in order to identify potential hotspots (areas where wet deposition has taken place potentially leading to higher levels of contamination).

As the emergency evolved, FDM would be used to predict elevated activity concentrations in food and animal feed. These calculations would be used by the RPII, the Department of Agriculture and Food (DAF) and the Food Safety Authority of Ireland (FSAI) to formulate advice regarding late countermeasures.

In the late phase (once the release has stopped), the importance of model results gradually decreases as more monitoring results become available, both from monitoring networks and from environmental sampling. By displaying these measurements on geographical maps in ARGOS it is possible to define more clearly what areas are affected and to what extent. However FDM would still be used to predict future concentrations and to influence the choice of countermeasures.

### **Case Study 1: Integration of ARGOS with the RPII's Emergency Response Management Information System (ERMIS)**

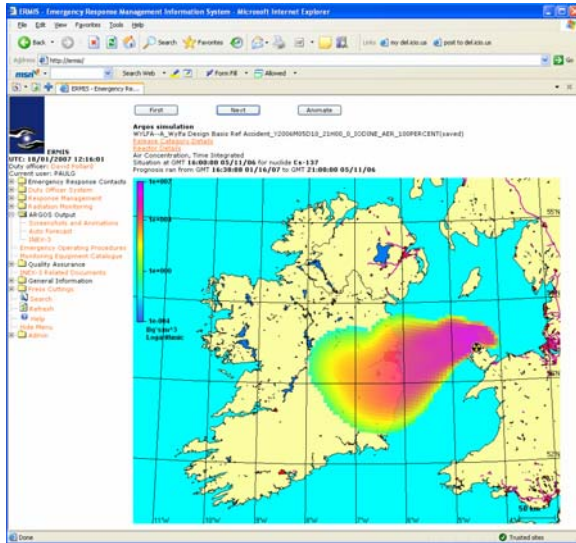
ERMIS supports the RPII's role under NEPNA. It is an intranet application intended for use specifically by RPII staff, although it can be accessed remotely, and is in effect a portal for all information which would be required by RPII staff during the response to a nuclear or radiological emergency. Features of the application include:

- a simple message board application for use during a crisis response situation whereby users can enter information relevant to the decision making process;
- an emergency contact database; and
- the latest information from international and bilateral notification systems.

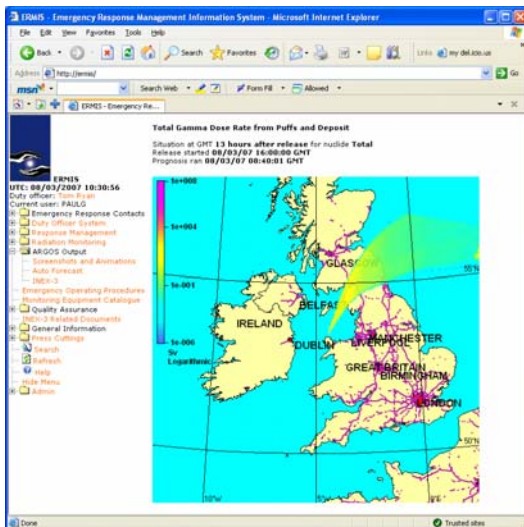
The system is interfaced with the ARGOS decision support system to provide a number of important functions:

- **Publication of ARGOS results**  
All data that can be displayed in ARGOS can be published to any properly configured website. This feature is considered especially useful by the RPII for dissemination of RIMPUFF and FDM results. As a result, all staff can access these model results, regardless of whether or not they have been trained to operate the models. In the case of RIMPUFF, links from ERMIS to the ARGOS database allow the source term and the reactor inventory used in each model run to be accessed. When published on ERMIS, RIMPUFF results can take the form of a

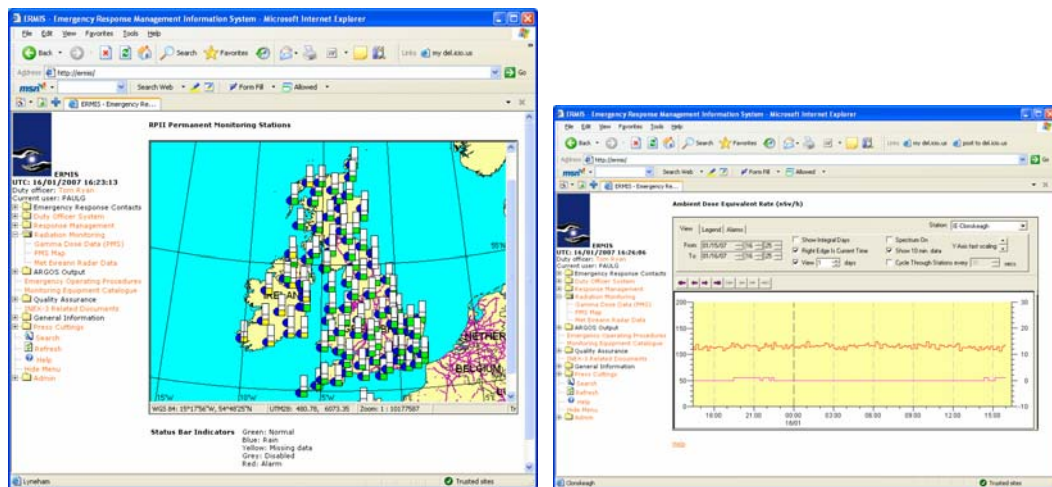
single snapshot image or animated sequences of images for each timestep of the of the model run.



- **RIMPUFF ‘Auto-forecasts’**  
ARGOS includes the functionality to execute, at scheduled times, predefined RIMPUFF prognoses driven by the latest HIRLAM weather forecast which is updated every six hours. The input parameters employed in these model runs have been carefully chosen in order to generate the widest possible area of contamination (or worst case scenario). These ‘auto-forecasts’ are transferred to ERMIS where they would provide, to the duty officer, an immediate assessment of the possible consequences of an accident at any of the featured reactor sites. In a real emergency these results would be quickly superseded by more rigorous modelling of the accident situation.



- **Radiation monitoring.** Gamma dose rate measurements from the Irish and UK networks are continuously transferred to the PMS database and can be viewed on ERMIS. Meteorological data recorded by the Irish stations are also available. A map showing all gamma dose rate stations is also featured. Each station icon is linked to current and historical data. Both of these functions are achieved by using ActiveX components included in NucInfo which is part of the ARGOS package.



Developments proposed for the RPII in the future are to implement an improved logging system to ensure that all decisions and actions taken are transparent and traceable. It is also planned to implement better integration of both ARGOS and ERMIS with the RPII laboratory's database in order to provide access to environmental and food sample data.

## Case Study 2: FDM: Implementation and Use in a National Emergency Exercise

### *FDM Configuration for Irish Conditions*

The transfer of radionuclides through food chains and the calculation of the potential resultant exposure of the population due to ingestion of contaminated foodstuffs is highly sensitive to the characteristics of the region where deposition takes place. For this reason, many model input parameters, such as those describing the climate and agricultural production systems, have to be adjusted before it can be applied to a given region. In 2005 FDM was configured for Irish conditions by the RPII. The input data which were sourced and used as input to FDM include:

- administrative regional boundaries;
- main agricultural crops and their production in each region;
- growing season, maturity and foliar coverage of the plant throughout this season and harvest dates for each crop;
- main domestic animal products and their production in each region;
- feeding rations throughout the year for each animal;
- human consumption rates for the main domestically produced foodstuffs; and
- soil types.

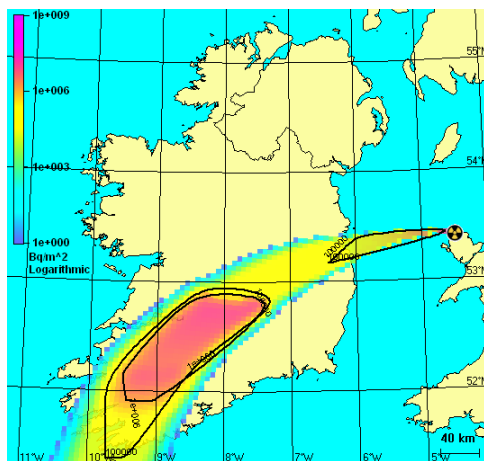
Using DBEditor, a utility provided with ARGOS, this data can be easily entered into the ARGOS database and modified easily. Often this data is available in the ESRI GIS Shapefile format which can be imported directly into the ARGOS database.

### *INEX-3 Exercise*

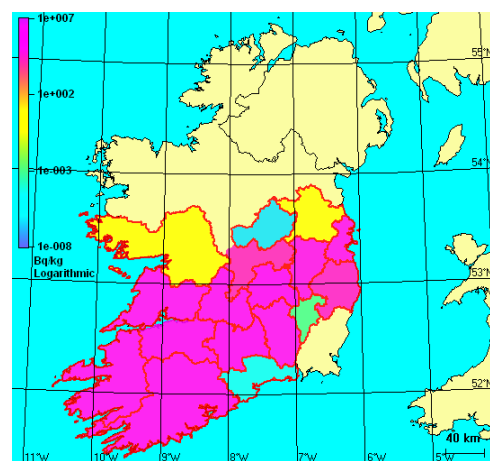
The INEX exercise programme is an international series of exercises co-ordinated by the Nuclear Energy Agency of the OECD. INEX-3 was the first to concentrate on later phase intervention and countermeasures.

Ireland's INEX-3 exercise took place on 18<sup>th</sup> November 2005 and involved players from all Government departments and State bodies with responsibilities under NEPNA. For exercise purposes it was assumed that a major accidental release had taken place at the nearest nuclear facility to Ireland, the Wylfa Magnox reactor on the west coast of Wales, 110 km from the east coast of Ireland.

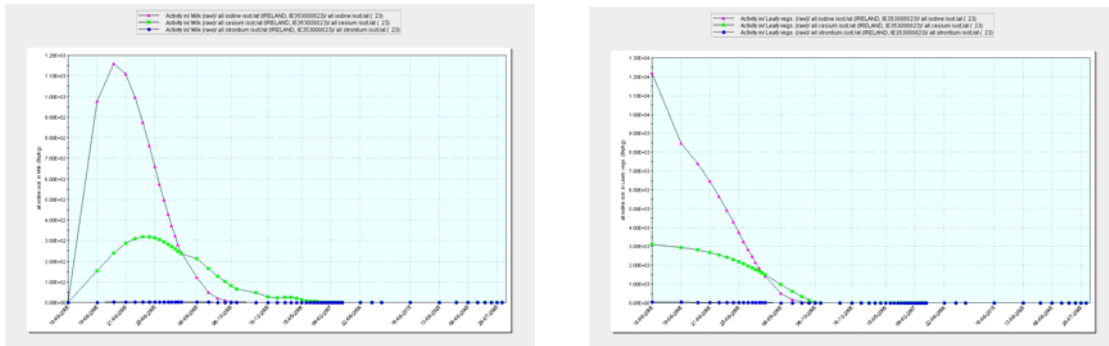
INEX-3 provided the opportunity to test the consequence management issues of a major radiological incident affecting Ireland with particular focus on food and agricultural countermeasures. It was an ideal opportunity to 'test' the adapted FDM. The model was used to predict enhanced activity concentrations in selected food products and animal feeds arising from the accidental release. Ingestion doses for the selected foodstuffs were also calculated. The results were successfully used by the RPII and by Agricultural and Food Safety response teams to formulate and justify advice on countermeasures.



**Figure 1:** Predicted Cs-137 Deposition Pattern. The isocurves show 100 kBq/m<sup>2</sup> and 1000 kBq/m<sup>2</sup>



**Figure 2:** Elevated Radioiodine Concentration in Cow's Milk Calculated by County



**Figure 3:** Variation of Elevated Radioiodine, Radiocaesium and Radiostrontium Concentrations in a) Cow's Milk; and b) Leafy Vegetables; over the 100 Years Following the Release (non-linear time axis)

A future development may be to implement a countermeasure model in the Irish ARGOS system. Currently FDM results provide a picture of the worst case situation as it is assumed that no actions are taken to mitigate the effects of radioactive contamination and that 'normal life' continues as before. In reality food restrictions and agricultural controls would be implemented to reduce the potential ingestion dose. A countermeasure model would enable the RPII to assess the benefits in terms of dose reduction of such actions or combinations of actions. This would enable a more realistic simulation of the consequences of an accident to be provided.