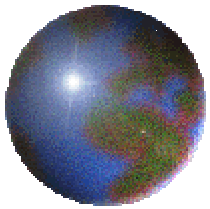


***UN**attended **A**nd **R**emote **M**onitoring*

The Integration of Radiation Monitoring and Video Surveillance

October 1, 2003
Kelly Michel
Safeguards Science and Technology Group
Los Alamos National Laboratory

Where are **UNARM** Systems?

CANADA
Darlington

BELGIUM
WBFP*

LITHUANIA
Ignalina*

KAZAKSTAN
Aqtau
BN350 FBR

JAPAN
Rokkasho -
RSFRSF
Tokai-Mura -
PFPF, PPFF, PCDF, TRF, TVF
O-arai -
HTTR, JOYO FBR
Tsurga -
MONJU FBR
FUGEN ATR

USA
Multiple Homeland Defense Sites

SOUTH KOREA
DFDF
Younwong3*

ARGENTINA
RAK-*
Embalse**

UKRAINE
Chernobyl*

**Sandia Installation

* IAEA Installation

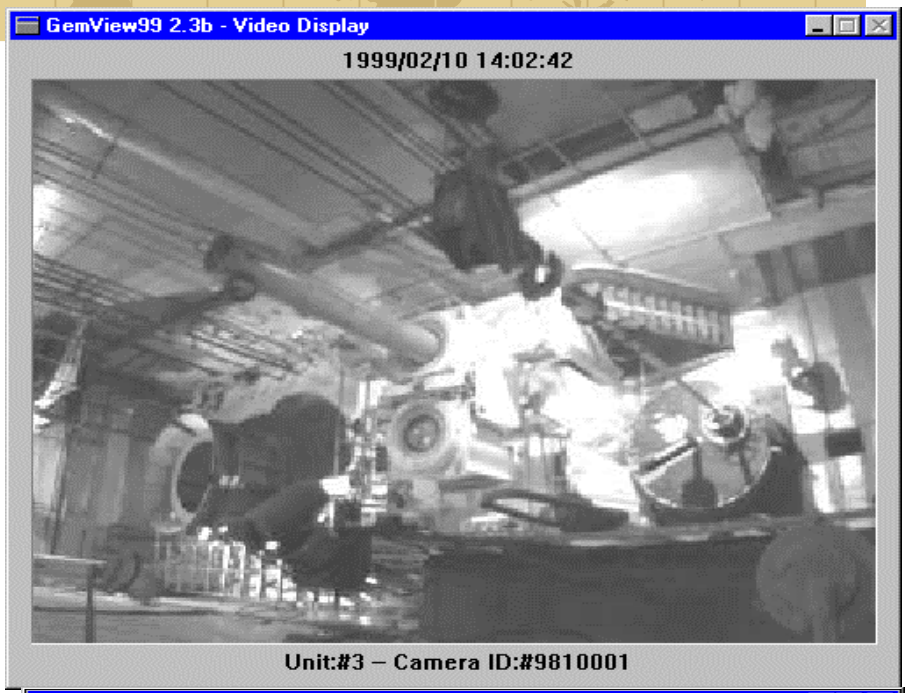
Part of the Solution: ***UNARM***

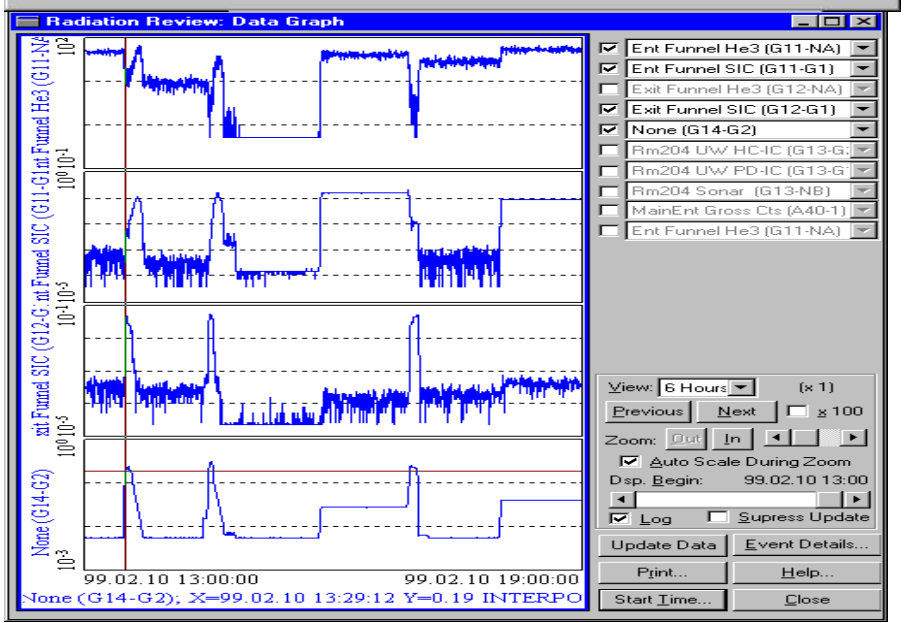
- Enables inspectors to cover more facilities with limited manpower, time and money budgets.
- Provides inspectors with tools to collect and analyze data so that conclusions can be drawn to certify compliance of a facility to treaty or other agreement obligations.
- Robust, reliable data acquisition & data storage, combined with easy access for analysis.

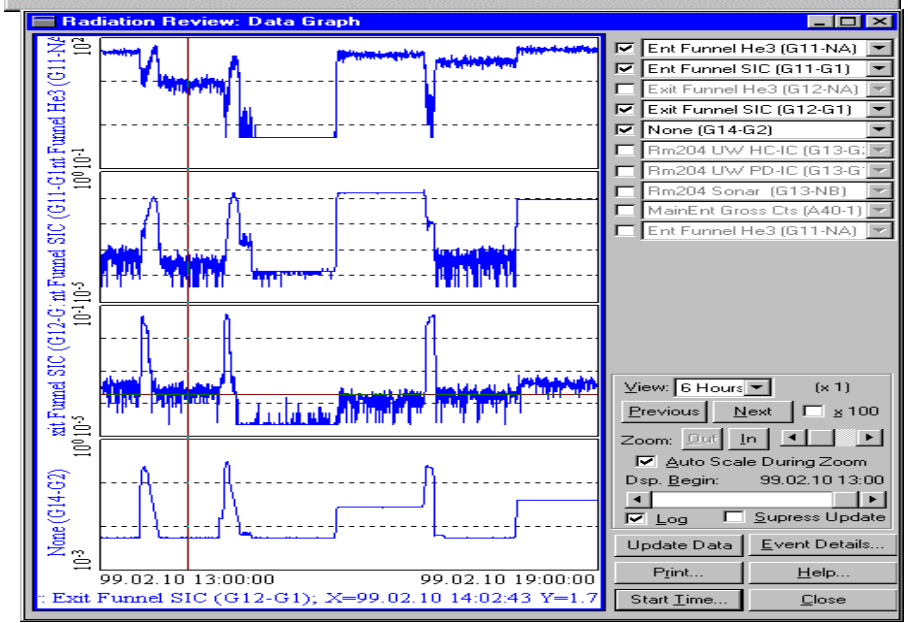
*Part of the Solution: **UNARM***

- UNARM – Unattended and Remote Monitoring system.
- Composed of instruments and software to monitor activities in facility during absence of inspector.
- Provides for secure data collection and archive.
- Provides a convenient and effective method to review and analyze this data.
- Radiation-based, usually supplemented with video assessment.

Real-time Radiation Triggered Video

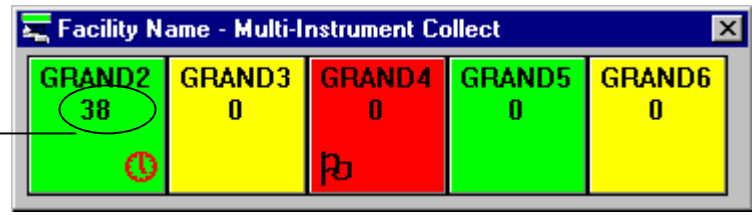






Multi-Instrument Collect
"Status-At-A-Glance" Technology

- Current Status Displayed
  - GRAND2 (green = ok)
    - 38 bytes in BBM
    - Working OK
    - Time Discrepancy
  - GRAND4 (red = problem)
    - Communications Error
  - GRAND3 and 6 (Yellow = ?)
    - Waiting for Response
  - GRAND5 (green = ok)
    - Working OK
    - 0 bytes in BBM



RED, YELLOW, GREEN, CYAN

= Time Discrepancy

= Communication Error

= Alarm (MII) (not sticky)

= BBM or Power Problem

= Configuration Error

= DEAD - Long Term Reset

= Cannot Save Data (flashing to white or cyan)

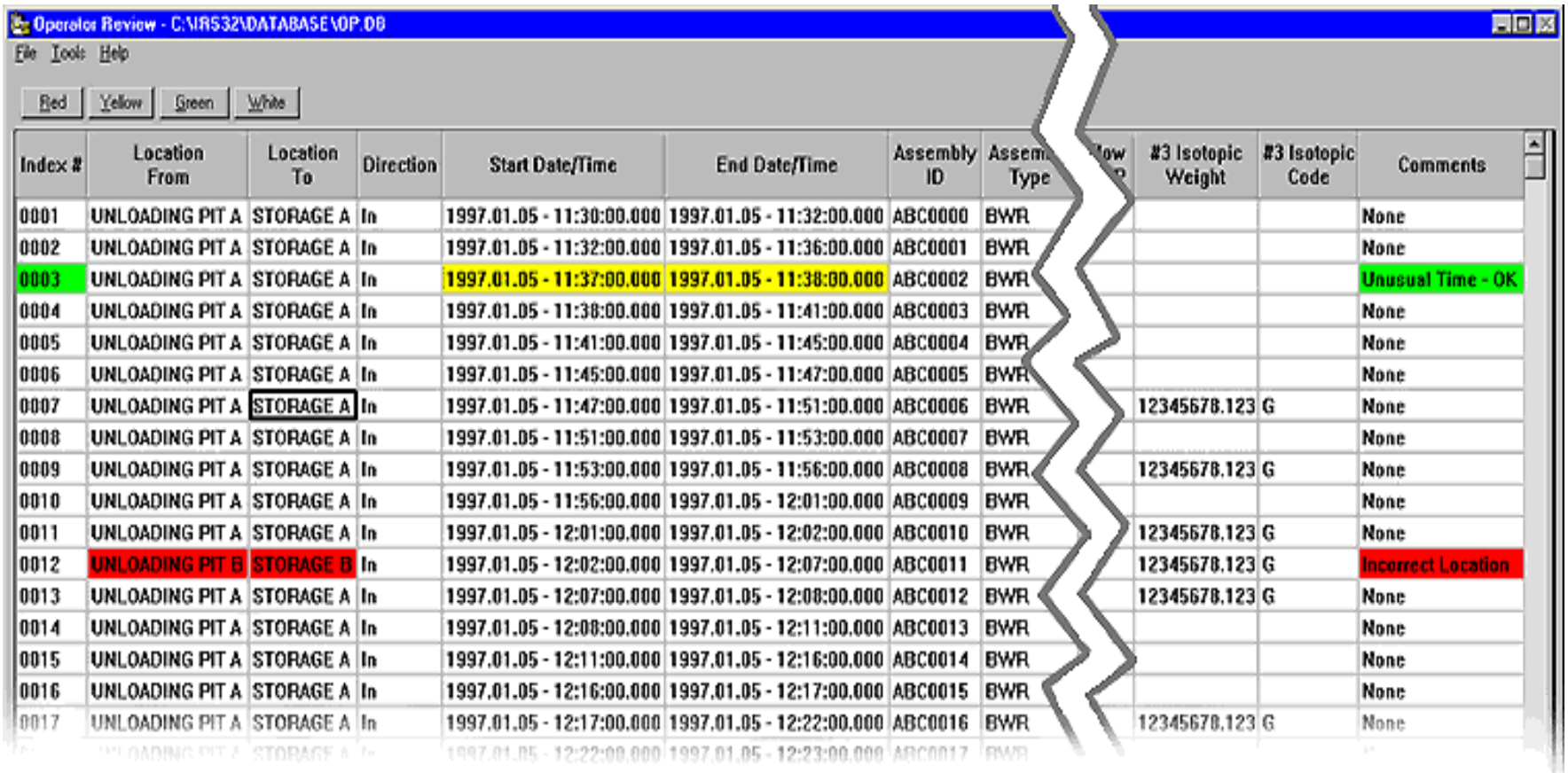
Part of the Solution: ***UNARM***

- Can handle a variety of data types
  - Radiation monitoring data
  - Gamma spectra – Isotope identification
  - Coincidence/multiplicity data
  - 2-D photo images – analog or digital
  - Binary sensors
  - Seals
  - Operator declarations
  - GPS data
  - …….

UNARM System Data Must Be…

- **Definitive**
  - The data must clearly define and differentiate the activities *of interest* in the area being monitored.
- **Decisive**
  - If an anomaly occurs, the system data should guarantee that no alternative counter conclusions are possible.
- **Defendable**
  - System integrity must be clearly established so conclusions cannot be questioned because the system was not functioning properly.

Review: Operator Review

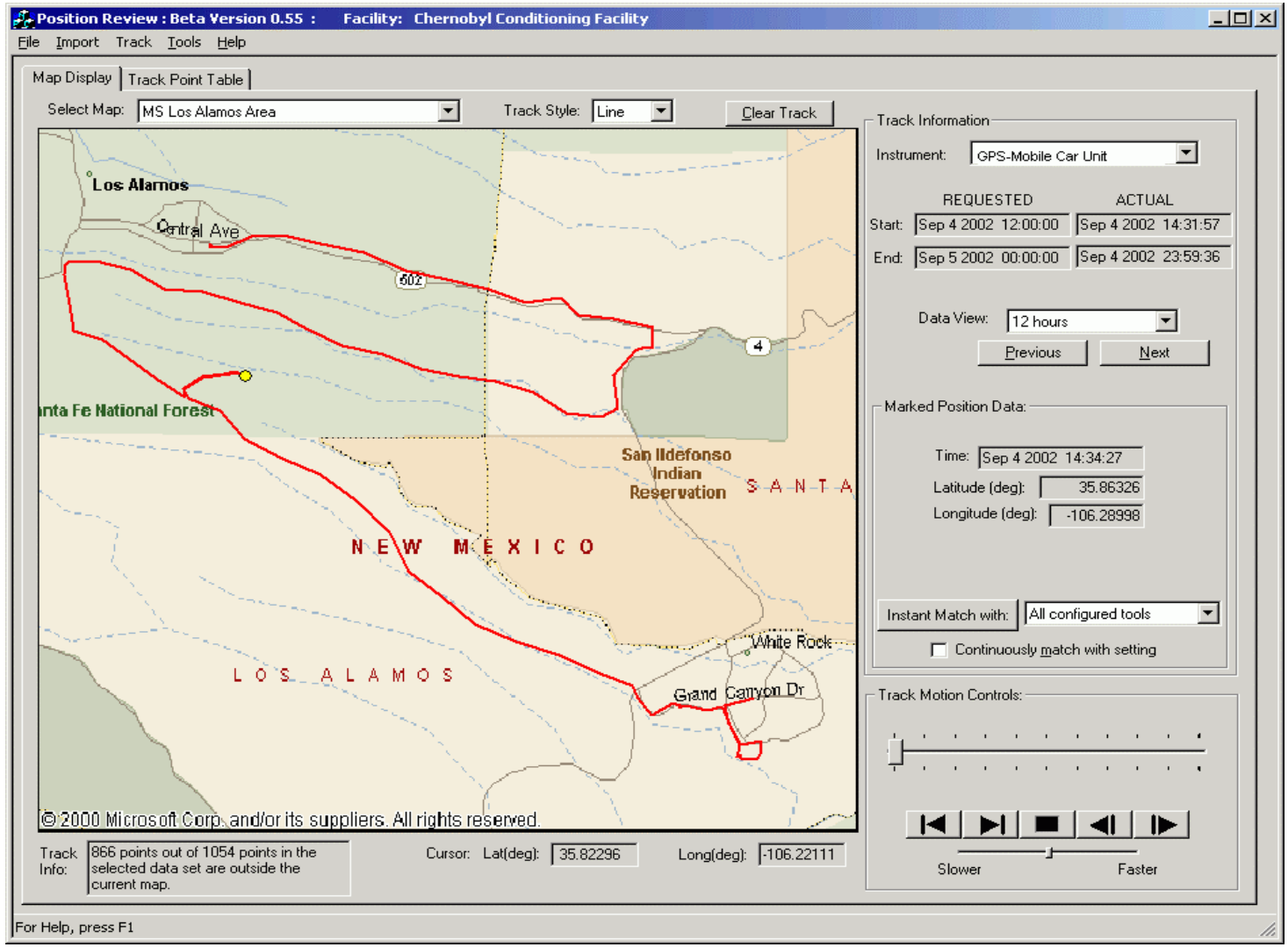


Index #	Location From	Location To	Direction	Start Date/Time	End Date/Time	Assembly ID	Assem Type	ow P	#3 Isotopic Weight	#3 Isotopic Code	Comments
0001	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:30:00.000	1997.01.05 - 11:32:00.000	ABC0000	BWR				None
0002	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:32:00.000	1997.01.05 - 11:36:00.000	ABC0001	BWR				None
0003	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:37:00.000	1997.01.05 - 11:38:00.000	ABC0002	BWR				Unusual Time - OK
0004	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:38:00.000	1997.01.05 - 11:41:00.000	ABC0003	BWR				None
0005	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:41:00.000	1997.01.05 - 11:45:00.000	ABC0004	BWR				None
0006	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:45:00.000	1997.01.05 - 11:47:00.000	ABC0005	BWR				None
0007	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:47:00.000	1997.01.05 - 11:51:00.000	ABC0006	BWR		12345678.123	G	None
0008	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:51:00.000	1997.01.05 - 11:53:00.000	ABC0007	BWR				None
0009	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:53:00.000	1997.01.05 - 11:56:00.000	ABC0008	BWR		12345678.123	G	None
0010	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 11:56:00.000	1997.01.05 - 12:01:00.000	ABC0009	BWR				None
0011	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:01:00.000	1997.01.05 - 12:02:00.000	ABC0010	BWR		12345678.123	G	None
0012	UNLOADING PIT B	STORAGE B	In	1997.01.05 - 12:02:00.000	1997.01.05 - 12:07:00.000	ABC0011	BWR		12345678.123	G	Incorrect Location
0013	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:07:00.000	1997.01.05 - 12:08:00.000	ABC0012	BWR		12345678.123	G	None
0014	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:08:00.000	1997.01.05 - 12:11:00.000	ABC0013	BWR				None
0015	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:11:00.000	1997.01.05 - 12:16:00.000	ABC0014	BWR				None
0016	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:16:00.000	1997.01.05 - 12:17:00.000	ABC0015	BWR				None
0017	UNLOADING PIT A	STORAGE A	In	1997.01.05 - 12:17:00.000	1997.01.05 - 12:22:00.000	ABC0016	BWR		12345678.123	G	None

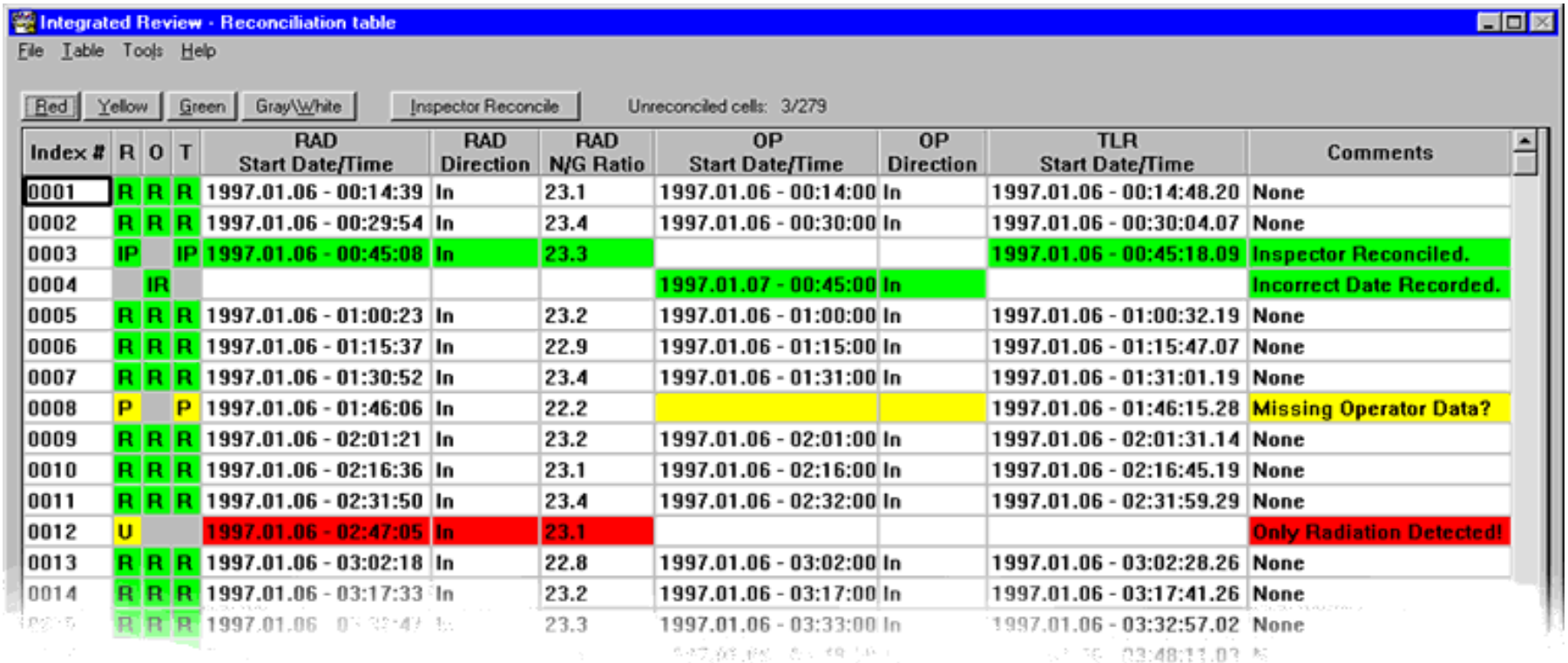
- Displays all operator declarations made for the facility in the facility-specific format required
- Incorrect data entry is flagged RED

Review: Position Review

- Displays GPS latitude, longitude on an area map
- Vehicle movement can be played like video



Review: Integrated Review



Index #	R	O	T	RAD Start Date/Time	RAD Direction	RAD N/G Ratio	OP Start Date/Time	OP Direction	TLR Start Date/Time	Comments
0001	R	R	R	1997.01.06 - 00:14:39	In	23.1	1997.01.06 - 00:14:00	In	1997.01.06 - 00:14:48.20	None
0002	R	R	R	1997.01.06 - 00:29:54	In	23.4	1997.01.06 - 00:30:00	In	1997.01.06 - 00:30:04.07	None
0003	IP		IP	1997.01.06 - 00:45:08	In	23.3			1997.01.06 - 00:45:18.09	Inspector Reconciled.
0004		IR					1997.01.07 - 00:45:00	In		Incorrect Date Recorded.
0005	R	R	R	1997.01.06 - 01:00:23	In	23.2	1997.01.06 - 01:00:00	In	1997.01.06 - 01:00:32.19	None
0006	R	R	R	1997.01.06 - 01:15:37	In	22.9	1997.01.06 - 01:15:00	In	1997.01.06 - 01:15:47.07	None
0007	R	R	R	1997.01.06 - 01:30:52	In	23.4	1997.01.06 - 01:31:00	In	1997.01.06 - 01:31:01.19	None
0008	P		P	1997.01.06 - 01:46:06	In	22.2			1997.01.06 - 01:46:15.28	Missing Operator Data?
0009	R	R	R	1997.01.06 - 02:01:21	In	23.2	1997.01.06 - 02:01:00	In	1997.01.06 - 02:01:31.14	None
0010	R	R	R	1997.01.06 - 02:16:36	In	23.1	1997.01.06 - 02:16:00	In	1997.01.06 - 02:16:45.19	None
0011	R	R	R	1997.01.06 - 02:31:50	In	23.4	1997.01.06 - 02:32:00	In	1997.01.06 - 02:31:59.29	None
0012	U			1997.01.06 - 02:47:05	In	23.1				Only Radiation Detected!
0013	R	R	R	1997.01.06 - 03:02:18	In	22.8	1997.01.06 - 03:02:00	In	1997.01.06 - 03:02:28.26	None
0014	R	R	R	1997.01.06 - 03:17:33	In	23.2	1997.01.06 - 03:17:00	In	1997.01.06 - 03:17:41.26	None
	R	R	R	1997.01.06		23.3	1997.01.06 - 03:33:00	In	1997.01.06 - 03:32:57.02	None

- Integrates data from other review software tools into a table
- Pass/fail criteria is set and configurable
- Results can be overridden by inspectors
- Summary can be used in inspection reports

*Plug and Play **UNARM***

- Seeking to open the **UNARM** system to contributions from 3rd party vendors
  - Includes instruments, software, and analysis capability
- Prototyped and developed software for field using plug and play technology
  - Technology is extensible and has unbounded potential for augmenting inspector capabilities
    - Automation
    - Analysis
    - Technical review of implemented systems

Surveillance – Possibilities for the Future

- Two way State-of-Health
- Additional Camera Features
  - IPIX, or X-10
    - low cost
- Bio-ID for operator declarations
- Commercial Robotics with picture, radiation sensor, and environmental sensors?

Remote Technology: Two Way State-of-Health

- Given political limitations, the remote access to data at facilities has not been used to it's full potential
  - Benefits found in having inspector presence at facilities
- Possible to remote state of health information to IAEA headquarters
  - Issues to resolve are minimal
  - Provides virtual inspector presence at facility on frequent basis
  - Quicker turn around and attention paid to system issues

Technology Possibilities: Additional Camera Features

- IPix immersive video
  - Commercially available technology
  - 360 degree views possible (multi-camera) or 180 degree with single camera
  - Images knit together to provide comprehensive view of environment
  - Viewer can *pan/tilt* and “immerse” themselves into the video with *full zoom* capability
    - True video – not serial still images
    - Immersive still images are an option if video is not required

Technology Possibilities:
Additional Camera Features

- X-10 internet camera images
  - Inexpensive and commercially available technology
  - Low band-width requirement to ship images to destination (IAEA headquarters in Vienna)
  - Still images or video an option
  - Multiple cameras can be installed for low cost

Technology Possibilities:
Biological Identification

- Bio Identification (BioID)
  - Verify which Operator Declared!
  - Commercially available technology
  - Using images and pattern recognition to automatically identify and record personnel movement in a facility
    - Includes time of movement
    - Includes image triggering and/or sensor triggering capability

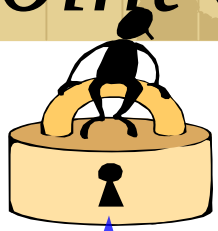
Commercial Robots –

What are we missing?

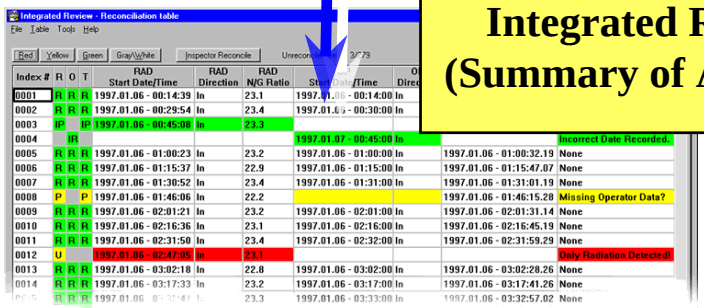
- Low cost, reliable robotic platforms available with warranties & maintenance included in the base price?
- Mount the sensors of your choice?
  - Infrared object avoidance technology
- Adjust parameters & motion remotely?
- Move the robot *primarily* during non-peak hours to reduce facility impact?
- ..... In real time?

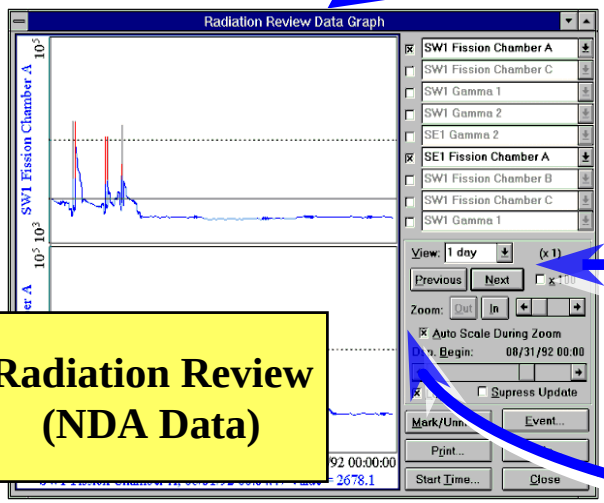
Inspector point of view

- Complex Review system solution, but ….
- Simple interface for the Inspector
- Inspector gets prompted by list of options
- Inspector makes informed decisions
- System reminds Inspector of alternate options

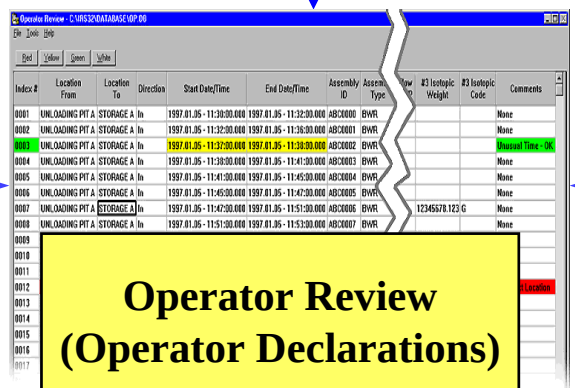


Integrated Review (Summary of All Data)

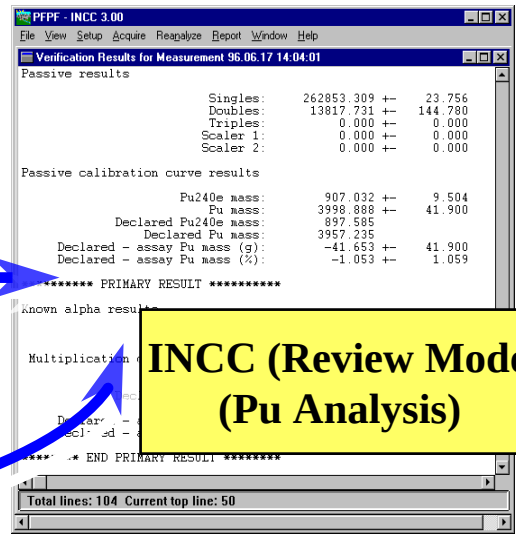




Radiation Review (NDA Data)



Operator Review (Operator Declarations)



INCC (Review Mode) (Pu Analysis)

Summary

- The current UNARM system has been crucial in assisting inspectors to perform their duties.
- The UNARM system future is one that allows for quick integration of third-party software and instruments
- The UNARM systems of the future will employ technological capabilities that serve to enhance the inspection capabilities of the IAEA.