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IAEA Safeguards Implementation, Concepts and Practices

John Kinney
Head, IAEA Toronto Regional Office

IAEA
International Atomic Energy Agency

Outline

- Scope of IAEA Safeguards
- Safeguards purposes & objectives
- Concepts
- Practices
- Safeguards conclusions

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Scope of IAEA Safeguards

Agreement Type	How Many (end 2007)	Scope
INFCIRC/153 (NNWS)	154 States + TW (excluding DPRK)	All nuclear material
INCIRC/66	3 (India, Israel & Pakistan)	Specified nuclear material, facilities & other items
VOA	5 NWS	Nuclear material in selected facilities
None	30 States party to NPT	-

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Purpose and Objectives

- Purpose: *To provide assurance about the exclusively peaceful use of nuclear material and facilities*
- Technical objective: *Timely detection of diversion and deterrence through risk of early detection*

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IAEA Board of Governors March 1995

"...the safeguards system for implementing comprehensive safeguards agreements should be designed to provide for verification by the Agency of the correctness and completeness of States' declarations, so that there is credible assurance of the non-diversion of nuclear material from declared activities and of the absence of undeclared nuclear activities."

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Concepts and Definitions

- Safeguards Approach
  - Information on State's nuclear fuel cycle

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Concepts and Definitions

- Safeguards Approach
  - Information on State's nuclear fuel cycle
  - Acquisition path analysis

Concepts and Definitions

- Safeguards Approach
  - Information on State's nuclear fuel cycle
  - Acquisition path analysis
    - Diversion strategies

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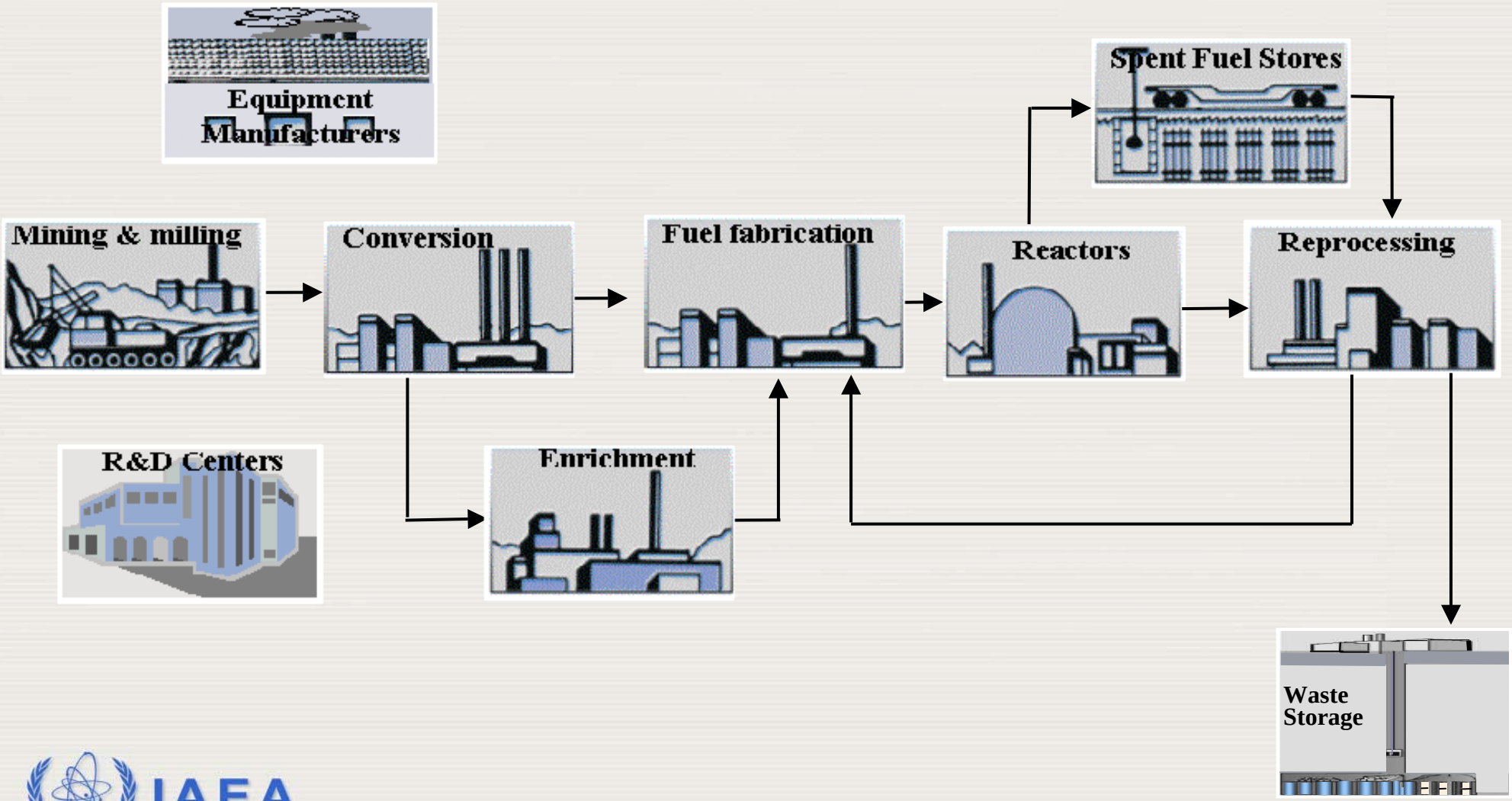
Nuclear Fuel Cycle



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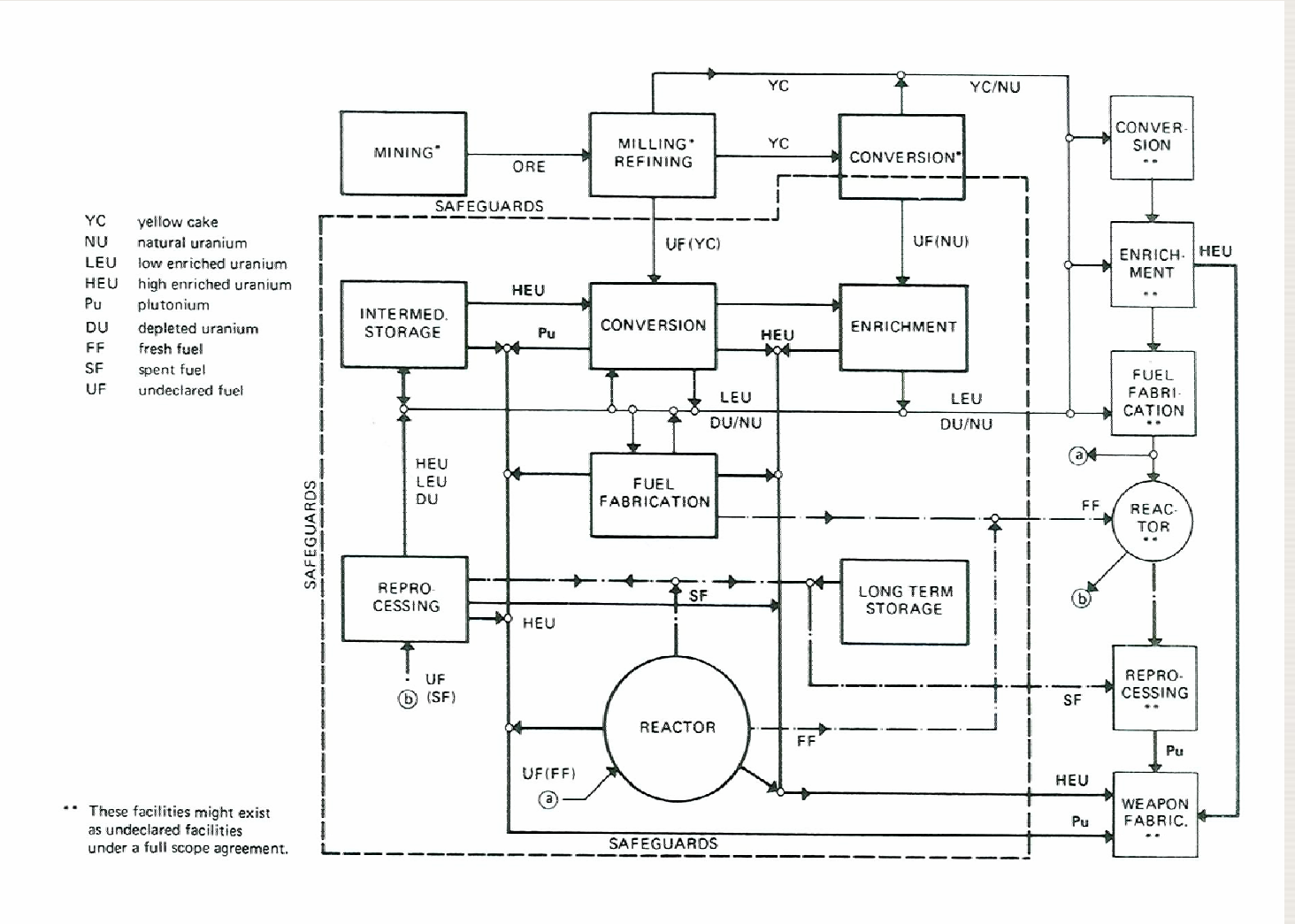
Concepts and Definitions

- Acquisition Path Analysis



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Concepts and Definitions

- Safeguards Approach
  - Information on State's nuclear fuel cycle
  - Acquisition path analysis
    - Diversion strategies
  - Technical capability
  - External factors

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Concepts and Definitions

- External factors
  - Threshold amounts:
    - Pu (Pu-239 > 95%) – 8 kg Pu-239
    - U (U-235> 90-95%) – 25 kg U
    - U-233 – 8kg U-233
  - Conversion time
    - Pu, HEU or U-233 metal – order of days (7 -10)
    - Unirradiated Pu, HEU or U-233 compounds – order of weeks (1-3)
    - Pu, HEU or U-233 in irradiated fuel – order of months (1-3)
    - U containing <20 U-235 and U-233 – order of one year

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Concepts and Definitions

- Safeguards Approach
  - Information on State's nuclear fuel cycle
  - Acquisition path analysis
    - Diversion strategies
  - Technical capability
  - External factors
- =>SG procedures and guidelines, criteria
- => Safeguards Implementation

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State-level Safeguards Approach for a State with a CSA

- Prescribes the State-specific level and focus of safeguards activities needed.
- Considers State's nuclear capabilities and factors identified in the State evaluation.
- Addresses overarching objectives:
  - Verify non-diversion of declared material
  - Seek to detect indications of undeclared nuclear material and activities
  - Respond to newly-arising issues (e.g. questions and inconsistencies)
- Based on internal guidelines and reviewed periodically.

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Concepts and Definitions

- Safeguards definitions
  - Material type: Pu, HEU, LEU, Nat & Dep U, Th
  - Material category: Unirradiated direct-use (UDU), irradiated DU, indirect use material
  - Significant Quantity (SQ): Pu & U-233= 8 kg, HEU = 25kg of U-235, DNLEU = 75kg U-235, Th = 20 te
  - Timeliness detection goal: UDU=1 month, IDU=3 months, Ind=1 year

Safeguards Practices

Safeguards practices can be summarized in one word: Verification

To verify: to ‘establish the truth’ of statements regarding the amounts, presence and use of nuclear material or other items subject to safeguards and those regarding nuclear and nuclear-related activities in the State

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Safeguards Measures

- Information analysis
  - State-supplied information
  - Results of verification activities
  - Other information

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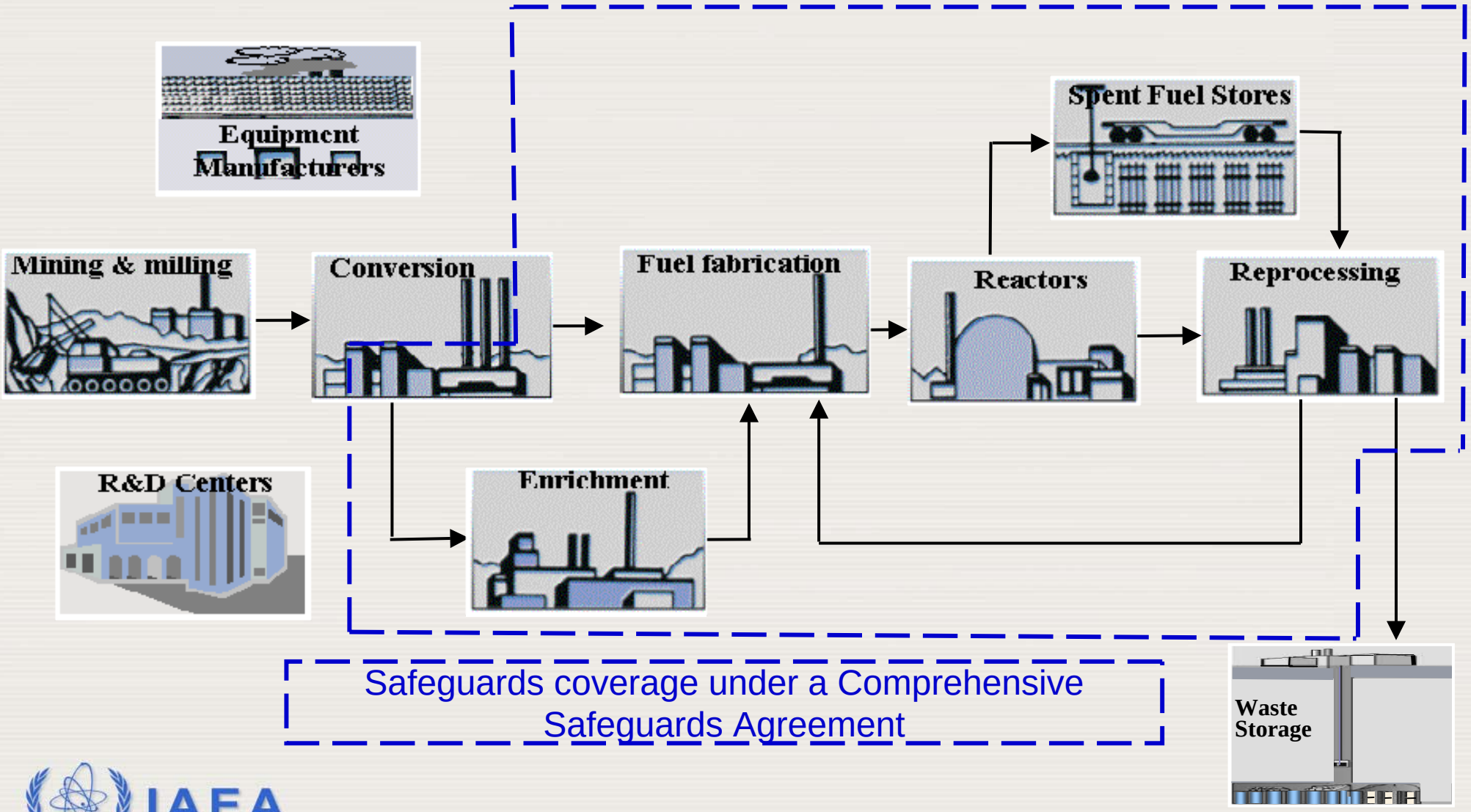
Nuclear Fuel Cycle Coverage



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State Evaluation Process

For States with comprehensive safeguards agreements, the State evaluation process seeks to answer:

- Is all relevant information on the State's nuclear programme consistent?
- Is the "picture" of the State's present and planned nuclear programme complete?
- Is there sufficient information available on which to draw a conclusion?

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State Evaluation

- Provides picture of a State's nuclear and nuclear-related activities
  - Involves comparison and assessment of all information available
  - Identifies issues requiring follow up
- Documented in annual 'State Evaluation Report'
- Forms basis for safeguards conclusions

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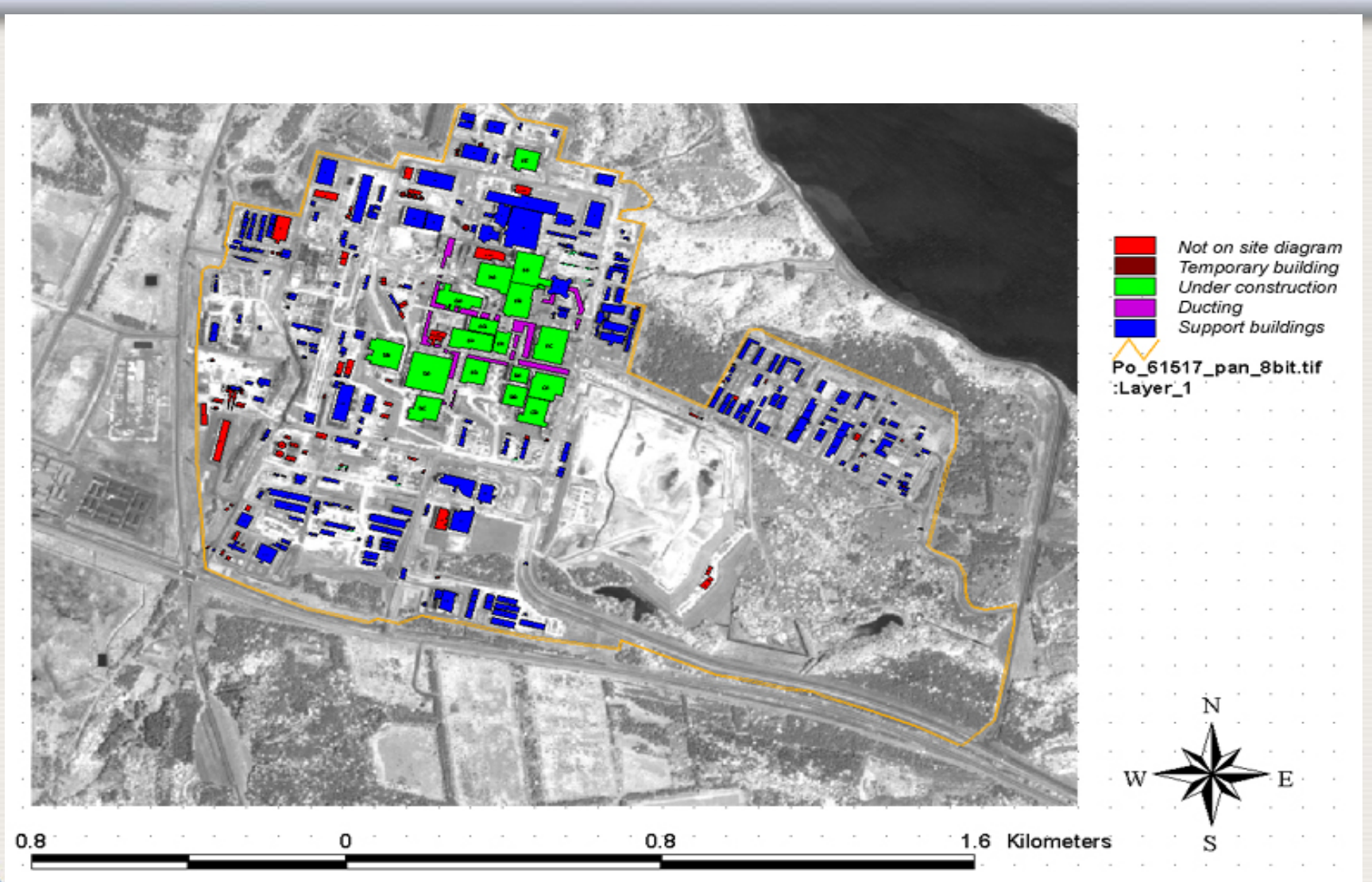
Advanced Technologies - Satellite Imagery



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Safeguards Measures

- Information analysis – consistency
  - State-supplied information
  - Results of verification activities
  - Other information
- Design information verification

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Design Information Verification

- Provision of design information as soon as a decision to construct or to authorize construction of a new facility has been taken (all States with CSAs and significant nuclear activities have agreed)
- Verification of design information over the life cycle of the facility

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Safeguards Measures

- Information analysis – consistency
  - State-supplied information
  - Results of verification activities
  - Other information
- Design information verification
- Inspection: nuclear material accountancy supplemented by containment & surveillance

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Inspection

- Why? To verify inventory & flow of material and absence of unreported production
- How?
  - Nuclear materials accountancy
    - Comparison of records and reports
    - Identification
    - Non-destructive assay
    - Destructive assay
    - Environmental sampling
  - With containment & surveillance measures
- How often? Depends on amount and category of material and facility type

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Nuclear Materials Accountancy

Inspectors counting and identifying fresh fuel at a power reactor

Verification of UF_6 cylinders

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NDA verification

- Gamma spectroscopy
- Neutron Coincidence Counting
- X-ray fluorescence
- Cerenkov radiation

Gamma spectroscopy

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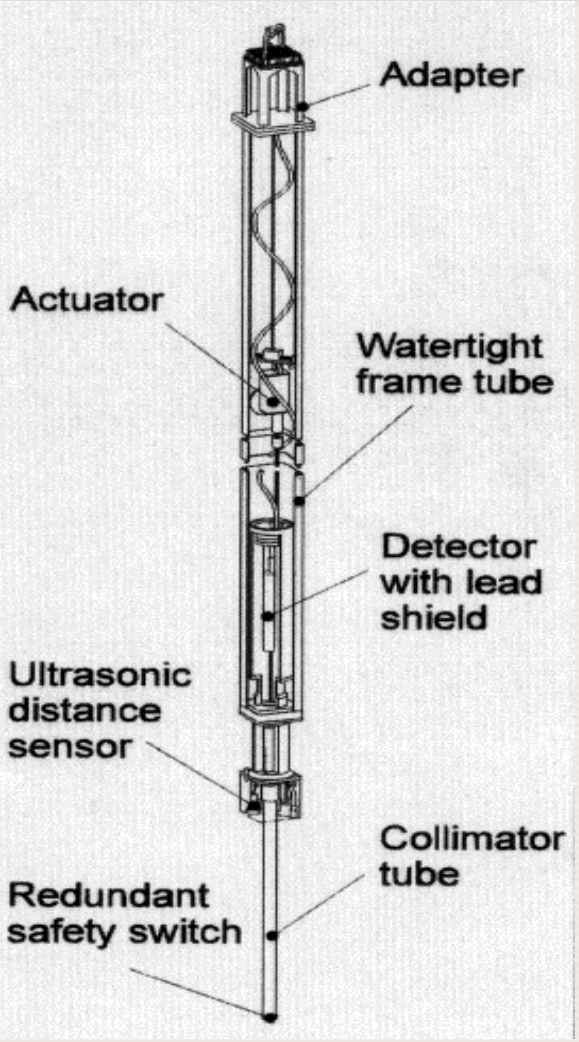
Spent-Fuel Attribute Tester (SFAT)



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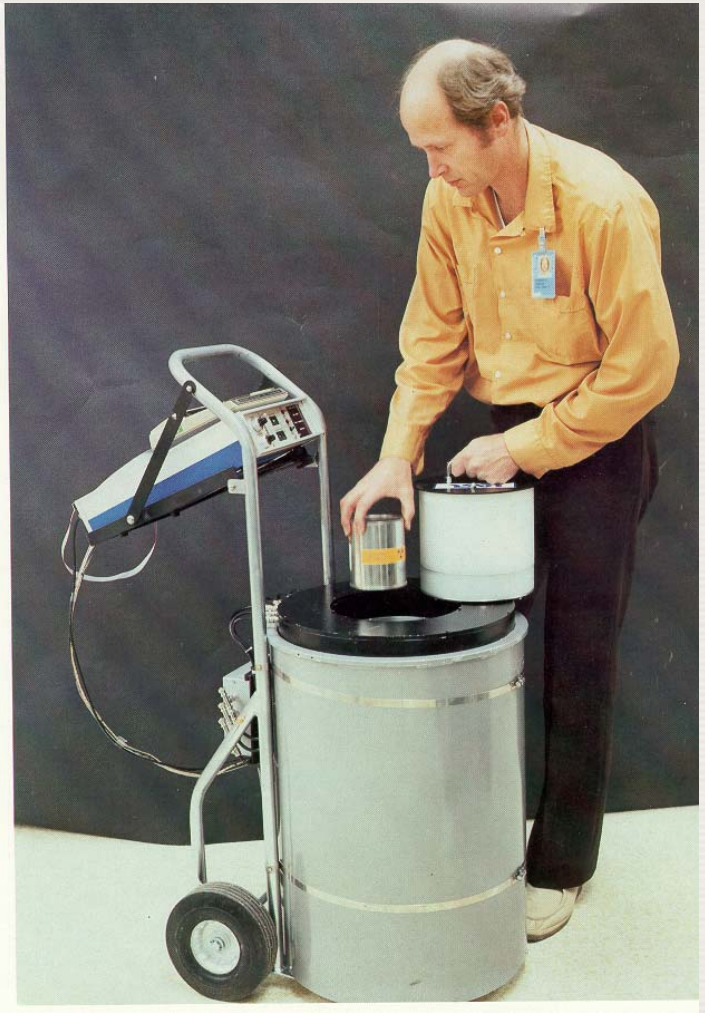
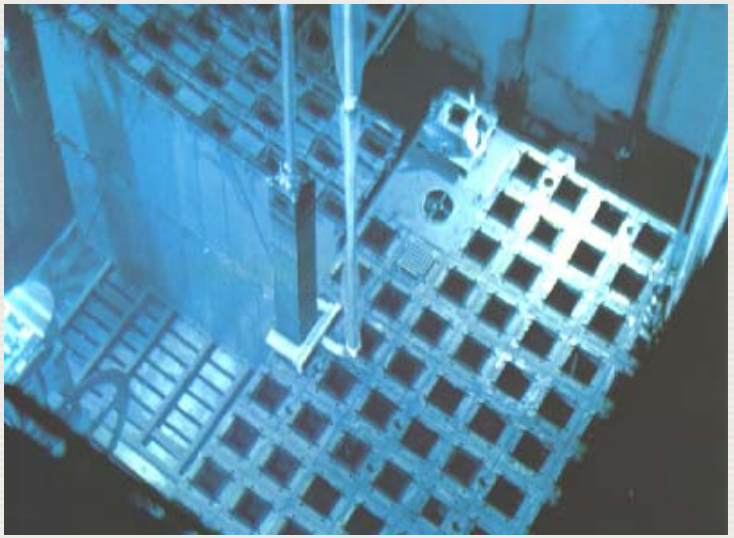
Neutron coincidence counting



GRAND and Fork Detector

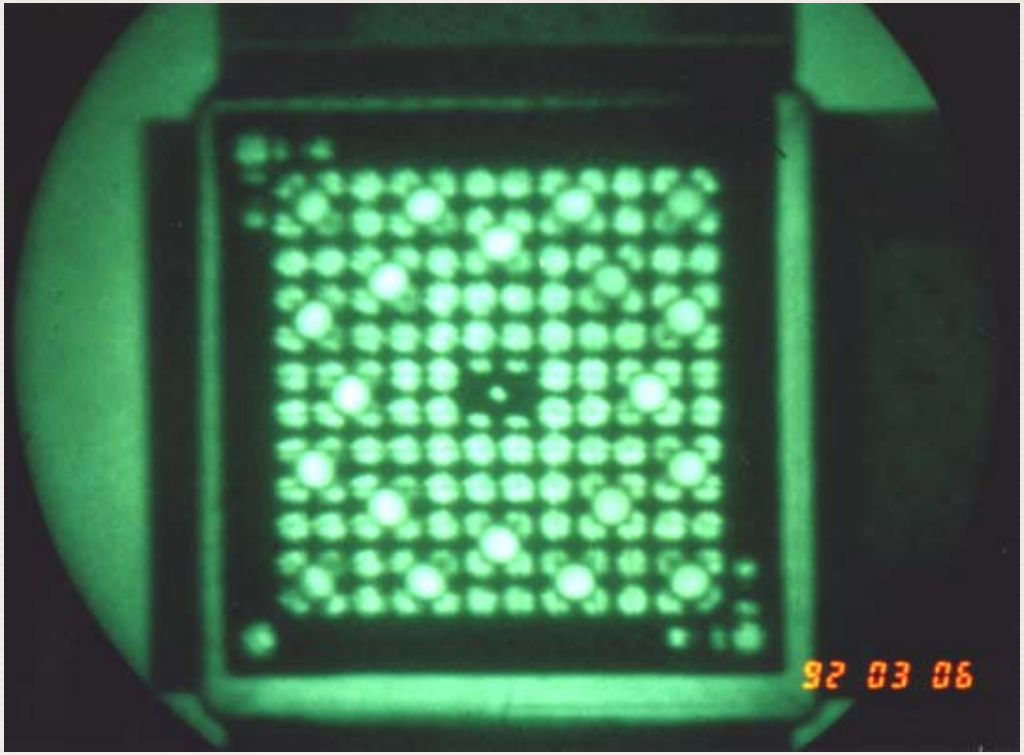
Material: **Spent Fuel**

Technique: **Simultaneous neutron and gamma measurements**



Purpose: **Attribute verification of spent LWR assemblies**

Cerenkov Viewing Device (ICVD)



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X-ray fluorescence

Material: **Uranium**

Technique: **High resolution X-ray spectrometry**

Detector: **Ge, multichannel analyser**

Usage: **Uranium enrichment in UF_6 headers**

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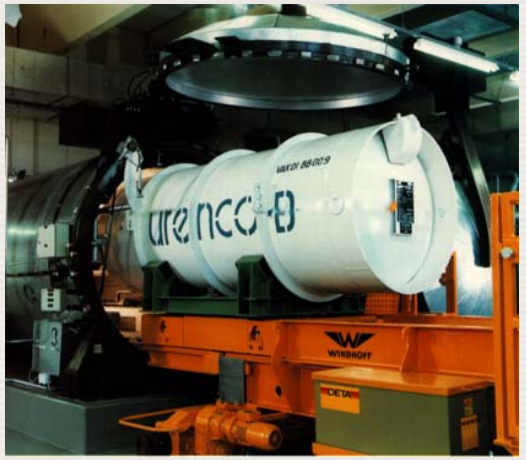
Environmental Sampling Points - Enrichment Plant

- Header pipe connections
- Sampling stations
- Chemical traps
- Cylinder connections
- Surface of moveable equipment

Cascade Hall

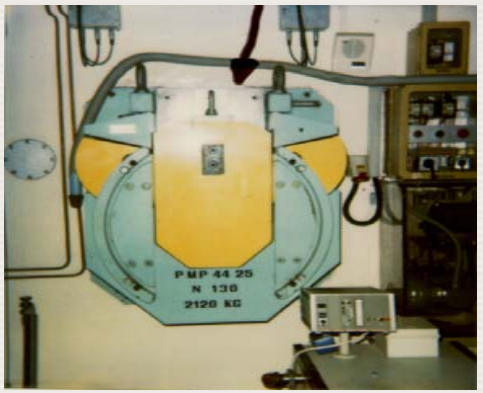


Autoclave

Sampling Points - Hot Cells

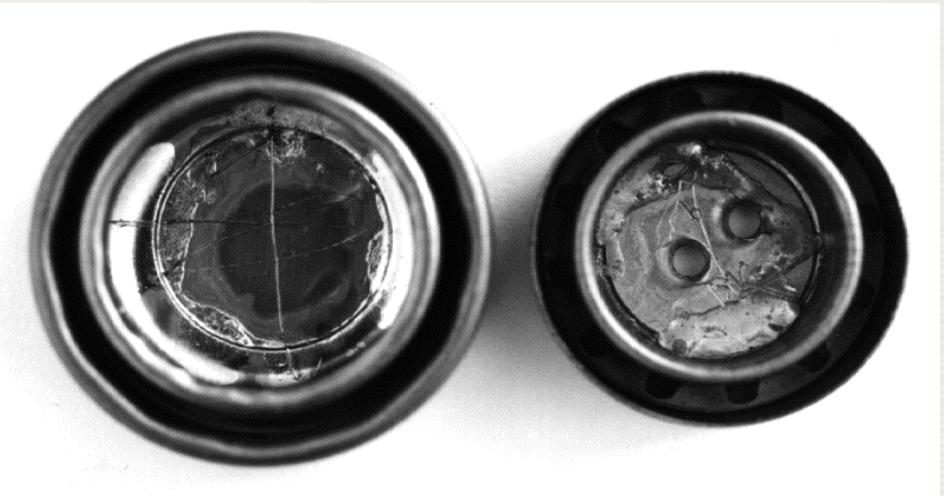
- Doors and other entry ways
- Transfer ports
- Interior working surfaces
- Ventilation ducts
- Waste transfer points

Hot Cells (rear access)

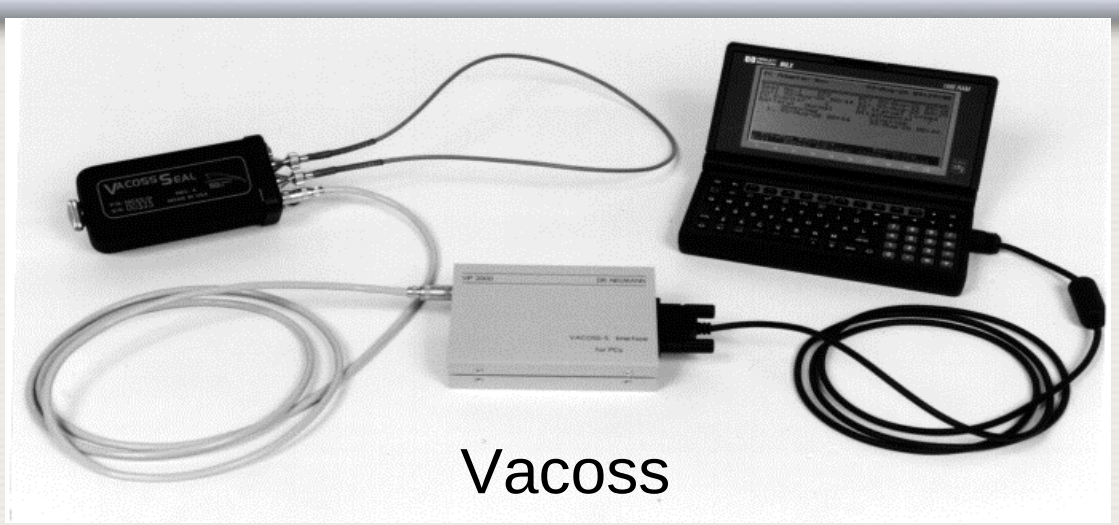


Transfer Connection Point

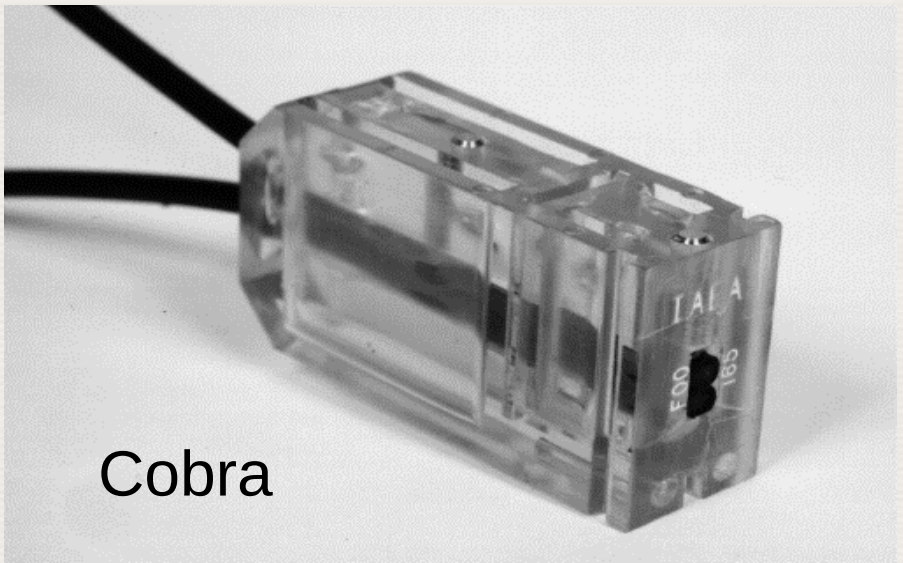
Containment devices



E-type



Vacoss



Cobra

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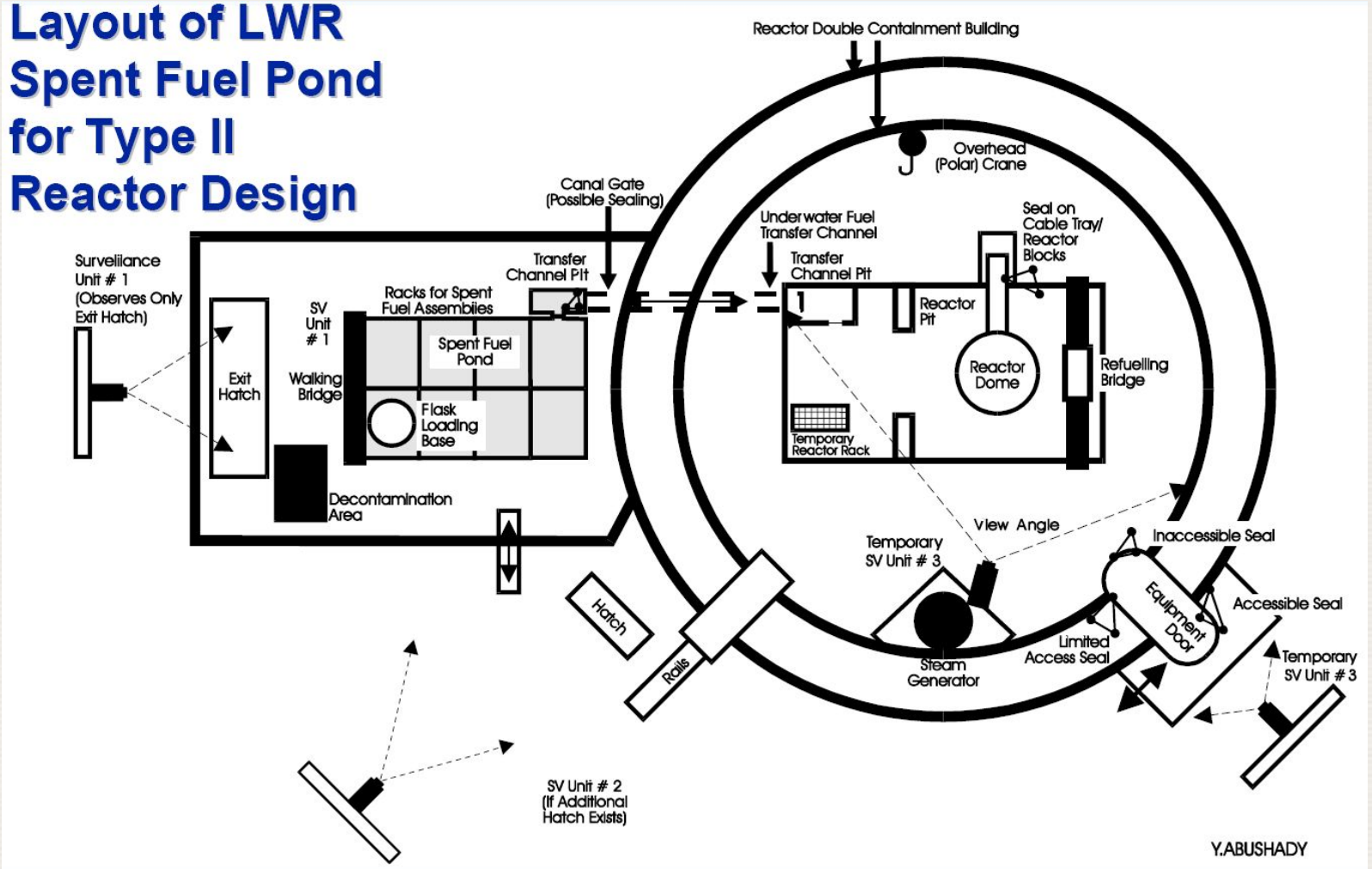
Surveillance Systems

COSMOS

ALIS

Review Station

Combined surveillance and containment



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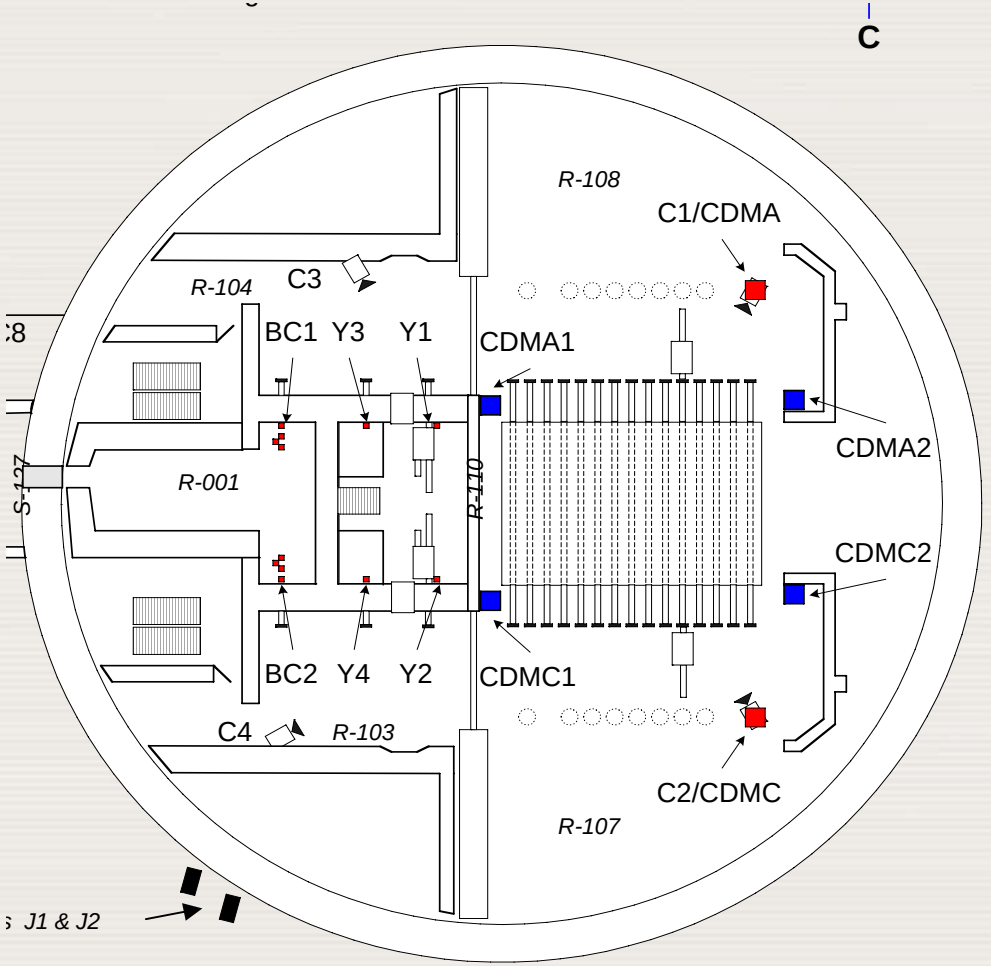
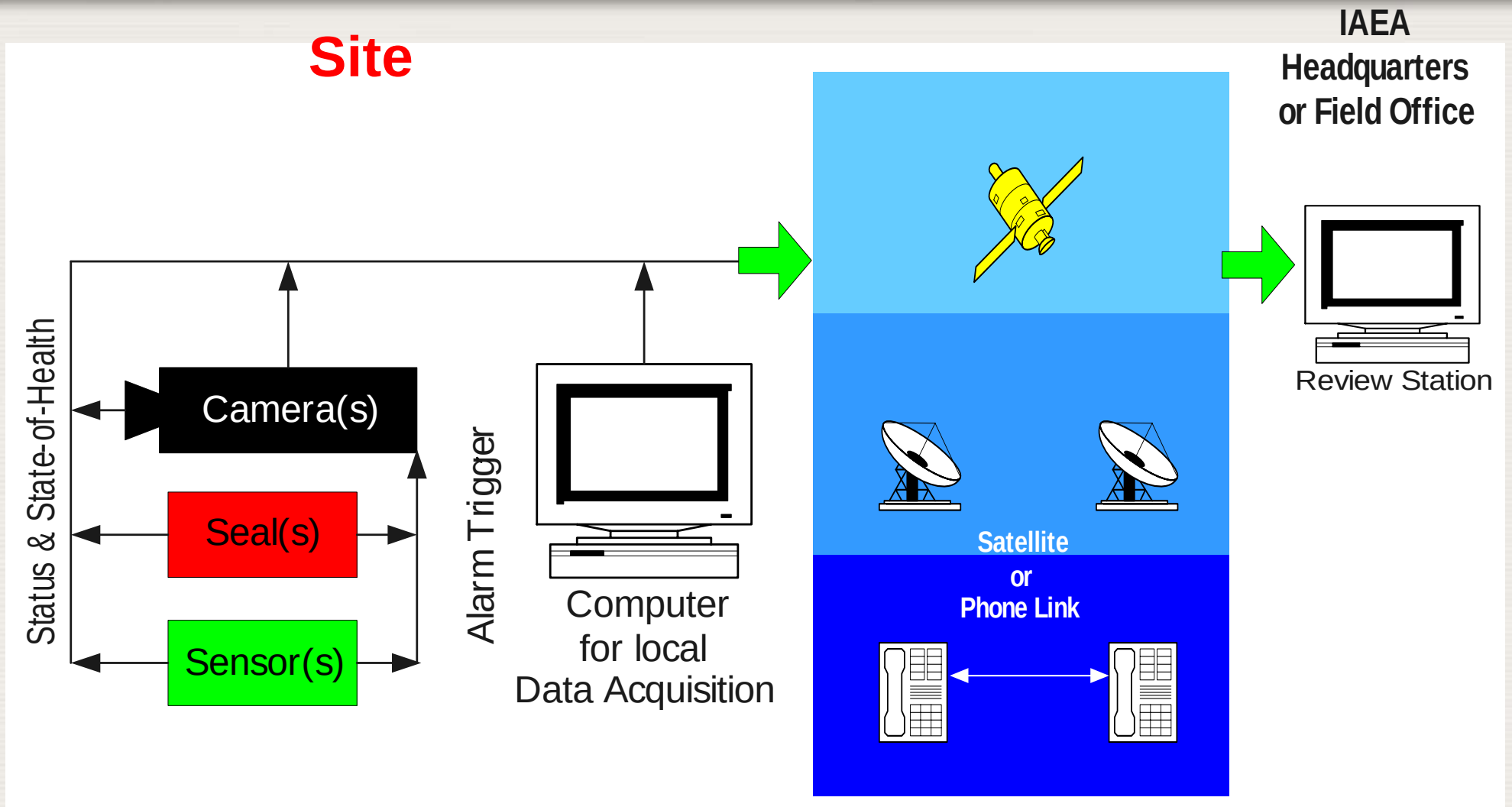
Unattended sytems - CDM



Remote Monitoring



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Safeguards Measures

- Information analysis – consistency
  - State-supplied information
  - Results of verification activities
  - Other information
- Design information verification
- Inspection: nuclear material accountancy supplemented by containment & surveillance
- For Additional Protocol States – complementary access

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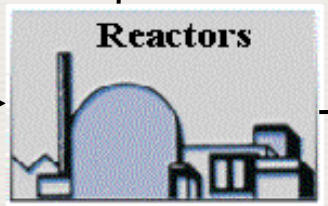
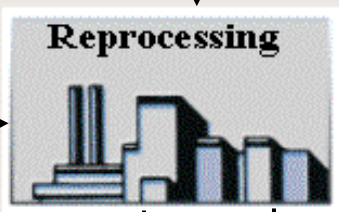
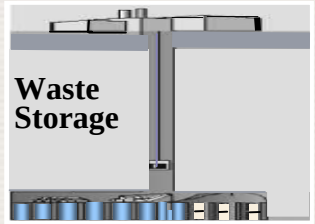
Expanded Legal Authority







Safeguards coverage under a Comprehensive Safeguards Agreement

Expanded coverage with an Additional Protocol

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Complementary Access

- Why? To assure the absence of undeclared nuclear material and activities in the State
- Where?
  - Anywhere on a site
  - Mines & mills
  - Location of exempted/terminated material
  - Location of Annex 1 activities & Annex 2 equipment, R&D
- How? Records, NDA, DA, seals, env. sampling
- How often? Information driven, on a selective basis (with guidelines)

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Scope of IAEA Safeguards in 2007

- Facilities under safeguards = 949
- Nuclear material = 151 749SQs
- Number of inspections = 2122
- Complementary access = 107 times
- Environmental samples = 333
- DA samples = 259
- Surveillance media reviewed = 3180
- Seals = 16 795 e-type, 8372 other types

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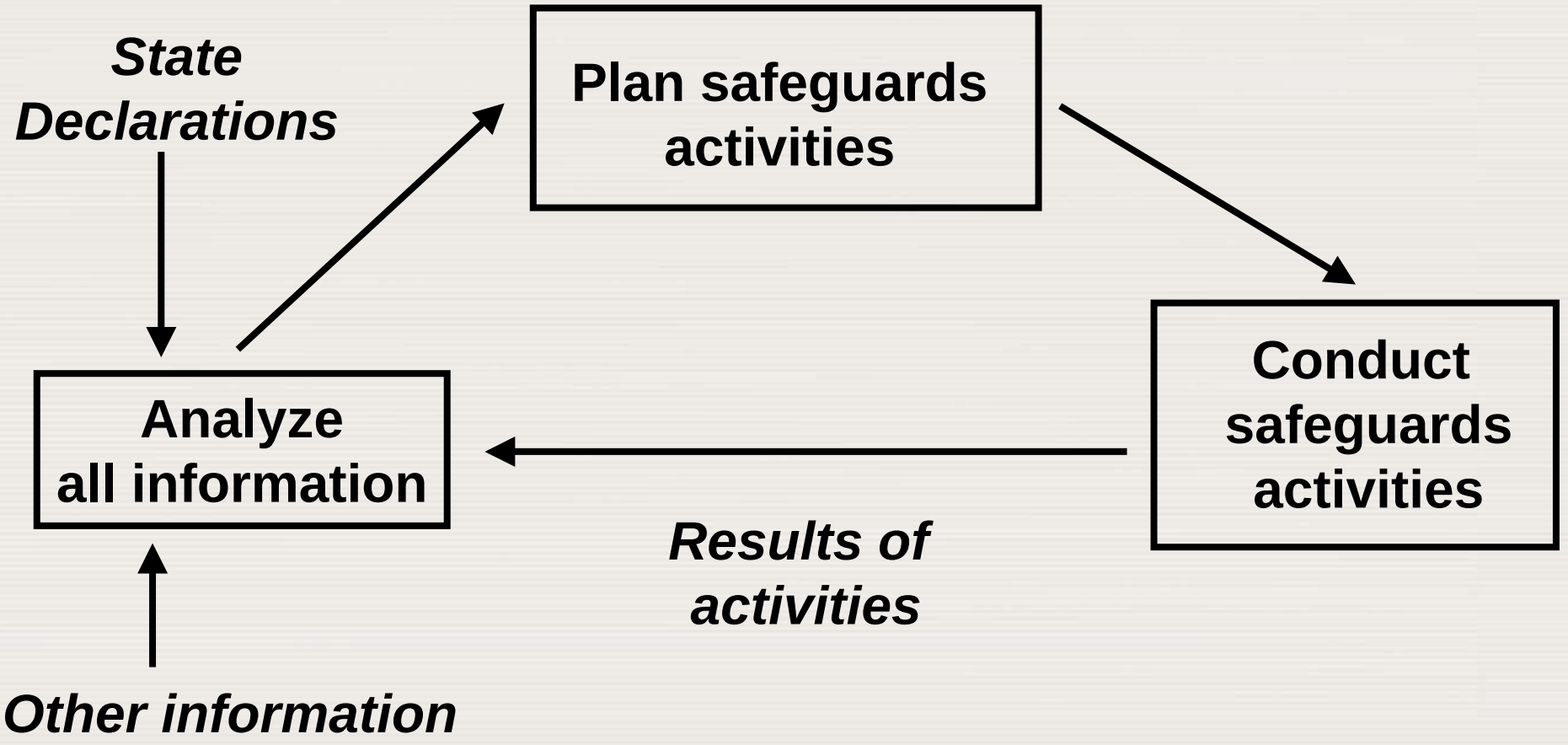
Information Driven Safeguards



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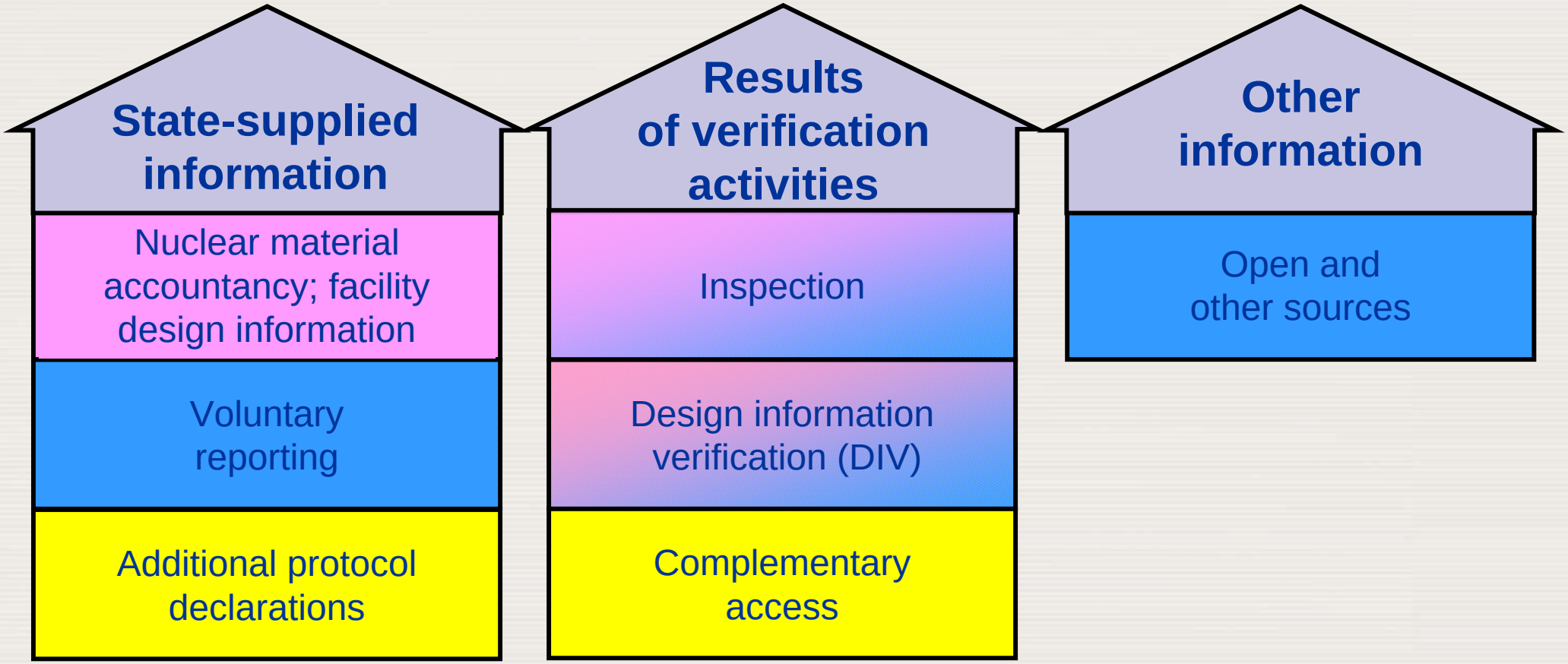
Evaluation of “State as a whole” to draw Safeguards Conclusions



Additional information and access provided under an additional protocol are essential to draw a broad conclusion

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Safeguards Conclusions

- Annual statement made by the Agency for every State with a safeguards agreement regarding States' compliance with their safeguards obligations
- Based on evaluation of all information available to the Agency on States' nuclear activities
- Reported annually in the Agency's Safeguards Implementation Report (SIR)

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Safeguards Conclusions

For States with safeguards agreements:

- … the nuclear material and other items placed under safeguards remained in peaceful activities …

For States with comprehensive safeguards agreements and additional protocols:

- … all nuclear material remained in peaceful activities …

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Integrated Safeguards

For States with comprehensive safeguards agreements and additional protocols

- When the broader safeguards conclusion regarding the non-diversion of declared nuclear material and the absence of undeclared nuclear material and activities can be drawn, safeguards measures can be 'optimised'.
- This optimisation of all safeguards measures available under comprehensive safeguards agreements and additional protocols is known as integrated safeguards.

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Conclusion

- Safeguards is about verification
- Measures are evaluation of information, inspection, DIV and complementary access
- Conclusion on absence of undeclared nuclear material & activities in the State ‘as a whole’ enables Integrated Safeguards

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