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Joint ICTP-IAEA School of Nuclear Energy Management

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Safeguards Implementation

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IAEA, Vienna
Austria

Joint IAEA/ICTP School of Nuclear Energy Management

The IAEA and its Safeguards System

D. Zahradnik
Section for Safeguards Training

IAEA
International Atomic Energy Agency

Main Topic Outline

- International Atomic Energy Agency (IAEA)
- The Department of Safeguards
- IAEA Safeguards System
- Summary

The International Atomic Energy Agency (IAEA)

- **Independent, intergovernmental, science and technology-based organisation**

- **Within the UN system**

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IAEA's Objective

"The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose."

(Article II, Statute)

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IAEA (cont'd.)

- Created in 1957
- Composed of
  - *Policy Making Organs*
    - Board of Governors (35 Members)
    - General Conference (151 States as of 2010)

    Secretariat
    - ca 2300 Professionals and Support staff

IAEA (cont'd.)

Three Main Pillars:

1. Science and Technology

   Assists Member States to mobilize peaceful applications of nuclear science and technology for critical needs in developing countries.

2. Safety and Security

   Deals with the protection of people and the environment against radiation exposure, while responding to the safety and security related needs of the Member States.

3. Safeguards and Verification

   Verifies correctness of a State's declaration to provide meaningful assurance to the non-diversion of declared nuclear material; verifies completeness of a State's declaration to provide credible assurance on the absence of undeclared nuclear material and activities.

Secretariat Structure

The current Senior Officers of the IAEA Secretariat are:

Mr. Yukiya Amano
IAEA Director General

Mr. Werner Burkart
Deputy Director General
Department of Nuclear Sciences and Applications

Mr. David Waller
Deputy Director General
Department of Management

Mr. Alexander Bychkov
Deputy Director General
Department of Nuclear Energy

Ms. Ana Maria Cetto
Deputy Director General
Department of Technical Co-operation

Mr. Denis Flory
Deputy Director General
Department of Nuclear Safety and Security

Mr. Herman Nackaerts
Deputy Director General
Department of Safeguards

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Department of Safeguards

Evolution of SG Human Resources

1957 Staff of 8

1969 Staff of 56

1979 Staff of 282

At the end of 2008: Staff of 564 Professionals including 246 approved SG Inspectors from the Divisions of Operations and a further 108 Professional staff members from the Support Divisions were available for inspection purposes.

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Department of Safeguards (cont'd)

SG Implementation Information - 2008

On-site Inspection Effort:

No. of Facilities/LOF's*	1131
No. of Facilities/LOF's inspected	597
No. of Inspections	2036

*LOF = Locations Outside Facilities

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IAEA SAFEGUARDS SYSTEM

- INFCIRC/153
- Evolution of the safeguards system
- Strengthening of the safeguards system
- Integrated safeguards

INFCIRC/153

The Structure and Content of Agreements between the Agency and States required in connection with the Treaty on the Non-Proliferation of Nuclear Weapons

(Comprehensive Safeguards Agreement- CSA)

INFCIRC/153 (cont'd)

Application of Safeguards

…. on *all source or special fissionable material* in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of *verifying that such material is not diverted* to nuclear weapons or other nuclear explosive devices.

Part I, para. 2 of INFCIRC/153

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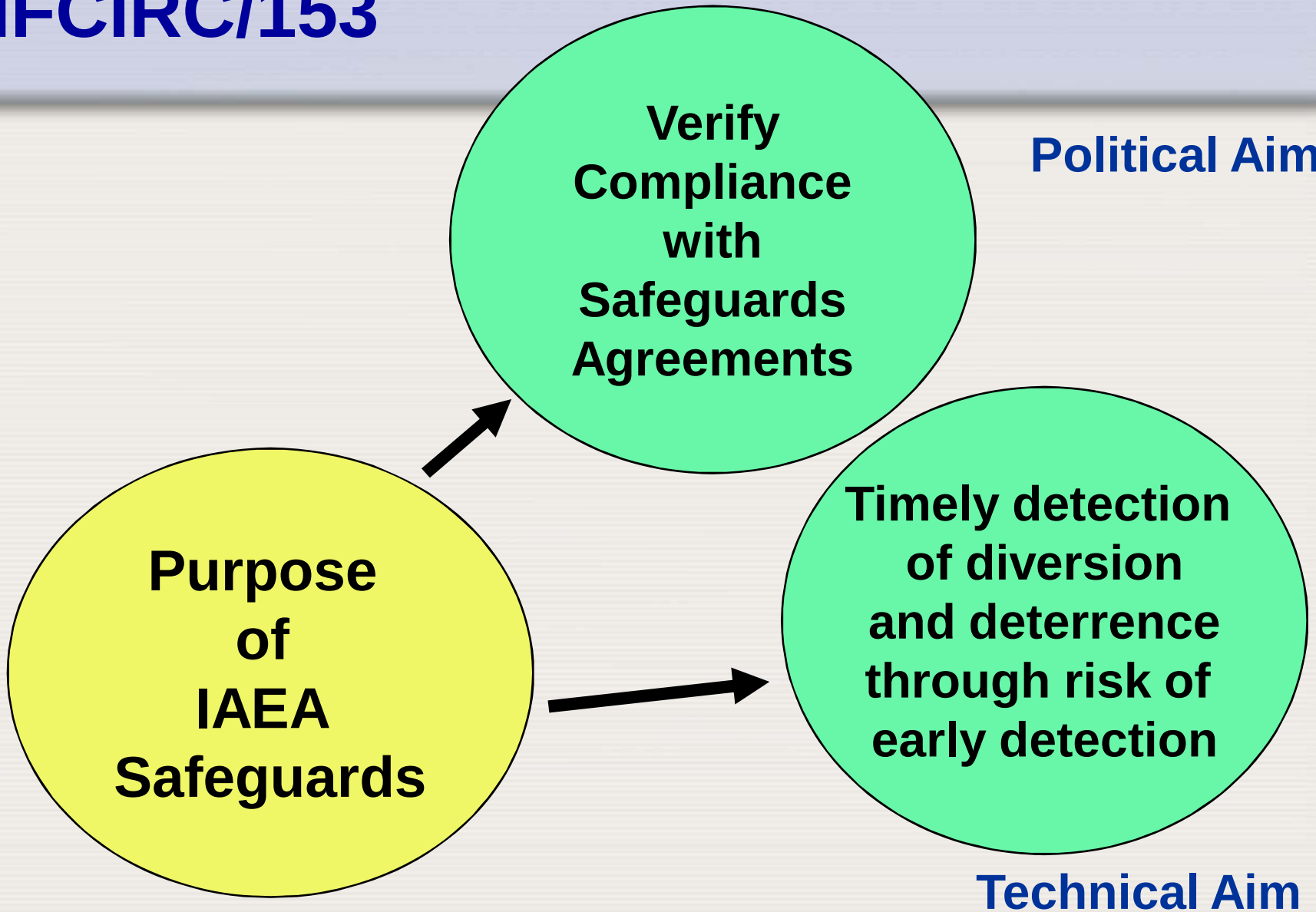
INFCIRC/153



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Procedures for the Implementation of Safeguards (Part II, INFCIRC/153)

- National System of Accounting for and Control of Nuclear Material (MBAs: Material Balance Areas, KMPs: Key Measurement Points)
- Design Information
- Records System
- Reports System
- Inspection
- Starting and ending point of Safeguards

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Concept of Verification

- **Significant Quantity (Quantity Goal)**

  what material, how much?

- **Detection Time (Timeliness Goal)**

  how long?

Material of interest

Source materials:

- natural Uranium,
- depleted Uranium,
- Thorium

Special fissionable material:

- Enriched Uranium (z=92) $^{233, 235}U$
- Plutonium (Z=94) ^{239}Pu

Significant Quantities

Direct use:

- Plutonium — 8 Kg Pu (total element)
- U^{233} — 8 Kg U^{233} (total isotope)
- HEU ($U^{235} \geq 20\%$) — 25 Kg U^{235}

Indirect use:

- U (DNLEU, $U^{235} < 20\%$) — 75 Kg U^{235} (or 10 t NU or 20 t DU)
- Th — 20 t Th (total element)

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Significant Quantity

Approximate quantity of nuclear material in respect of which the possibility of manufacturing a nuclear explosive device cannot be excluded

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Detection/Conversion Time

Material Category	Timeliness Goal
• Unirradiated direct use	1 month
• Irradiated direct use	3 months
• Indirect use	12 months

This generally indicates the time required for detection and conversion of nuclear material to an explosive device – it also determines the frequency of inspections

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Safeguards Approaches

Essential Steps (for each facility):

- Design Information Questionnaire (DIQ): DIE/DIV (DIExamination)/(DIVerification)
- Diversion path analysis
- Define safeguards measures
  - Material Balance Areas (MBAs), Key Measurement Points (KMPs): reports, verification (Safeguards Criteria)
  - Containment and Surveillance
  - Un-announced inspections
- Facility Attachment (FA) - agreed between State and the Agency

Nuclear Material Verification

The basic verification method
used by the IAEA is

Nuclear material accountancy (NMA)

with

Containment and surveillance (C/S)

As important complementary measures

Inspection Activities

- Auditing/Examination of Accounting and Operating Records
- Comparison of Records and Reports
- Verification of
  - Inventory Changes
  - Inventories
- Application and use of Containment and Surveillance
- Evaluation of data gathered
- Reporting of results and conclusions

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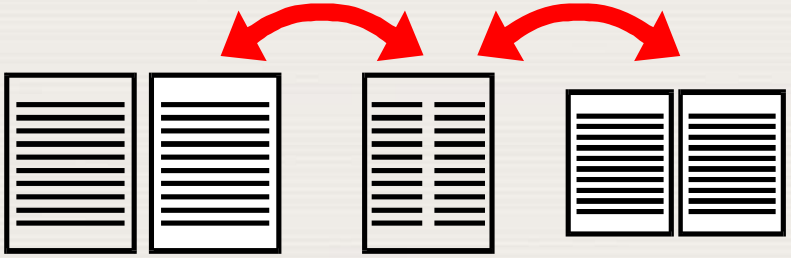
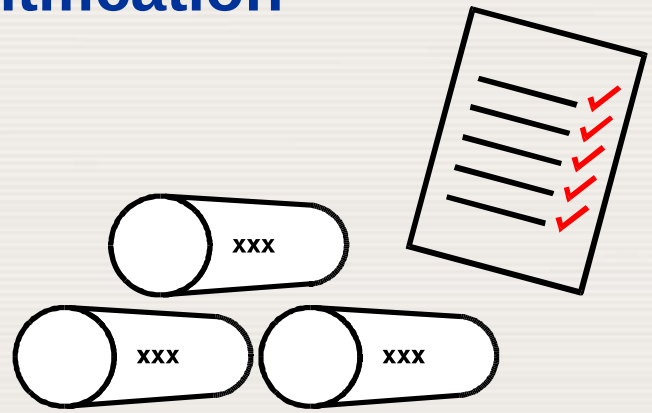
Nuclear Material Accountancy

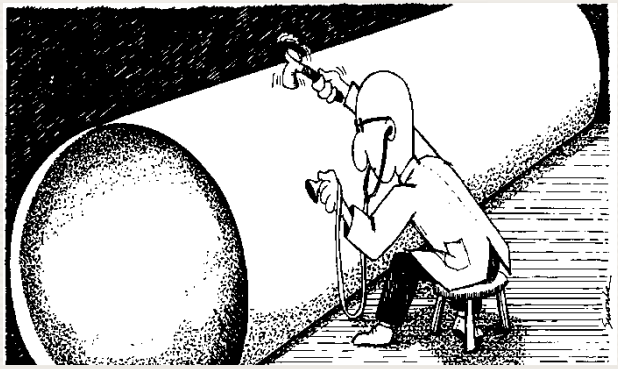
Records Examination



Item Counting and Identification



Independent Measurements



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Materials Measured

Uranium and/or Plutonium in:

- Feed, product and tails
- In-process materials
- Fresh fuel
- Spent fuel

Measurement Techniques

***NDA* = *N*on *D*estructive *A*ssay**

Measuring quantity or specific attribute(s) of nuclear material ***without physically affecting the measured item.***

***DA* = *D*estructive *A*ssay**

Measuring quantity or specific attribute(s) of nuclear material ***by chemical analyses.***

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Mini MCA* with CdZnTe Detector (MMCC)

Materials: U, Pu, MOX, fresh & spent fuel

Detectors: NaI, CdZnTe (shown), HPGe, ^{3}He (n)

Verification of Fresh Fuel

*multi-channel analyzer

Cerenkov Viewing Device (CVD)

Material: **Spent Fuel**

Technique: **Observe Cerenkov glow**

Detector: **Enhanced night vision device. UV filter allows operation with lights on**

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

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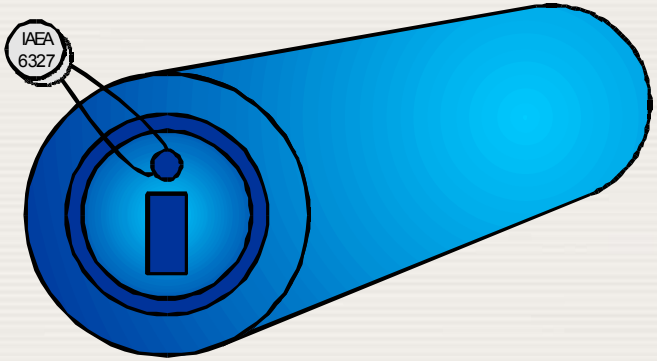
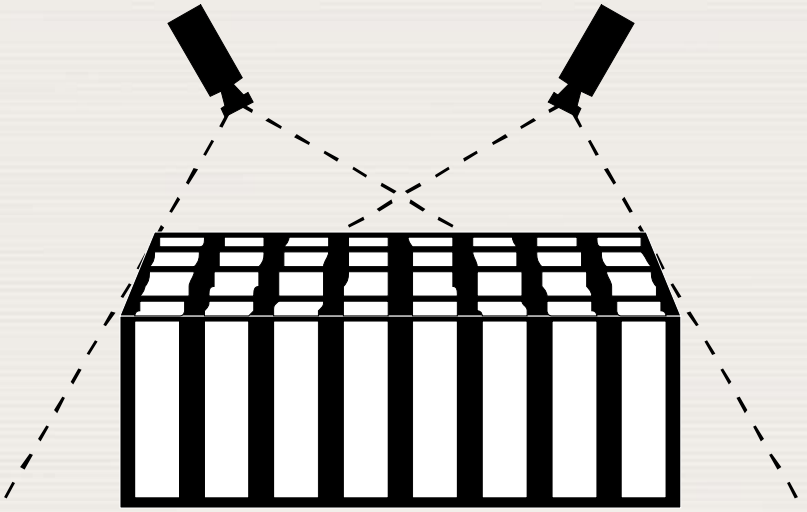
Verification of Spent Fuels at a Facility

Containment and Surveillance (C/S)



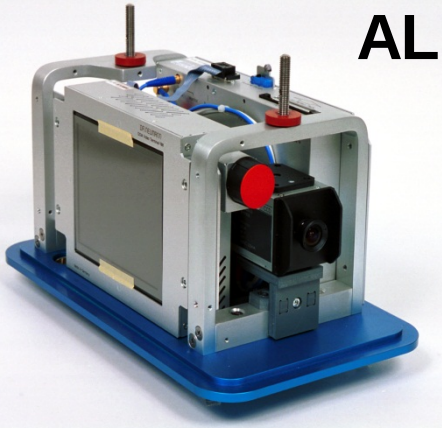
Seals



Cameras/Video

C/S Devices: Surveillance Systems

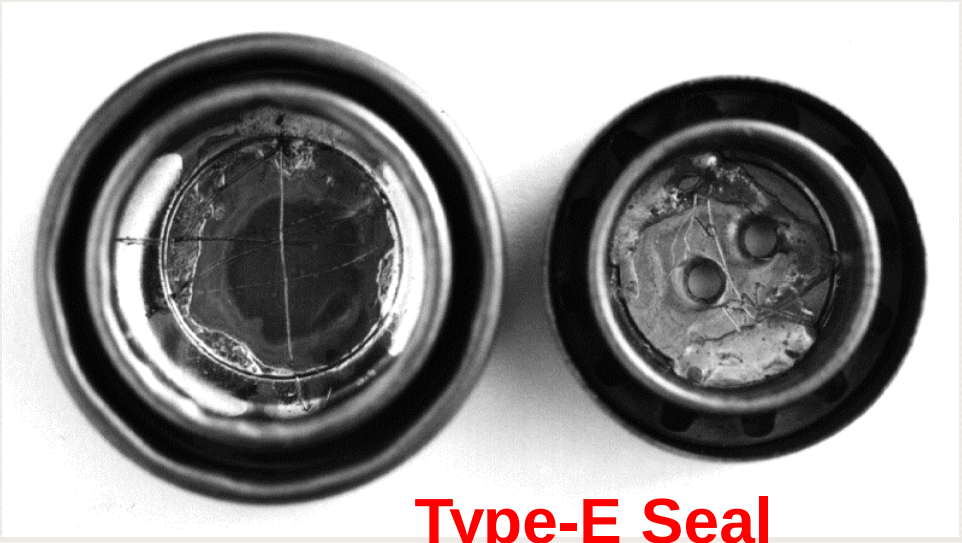
ALIS



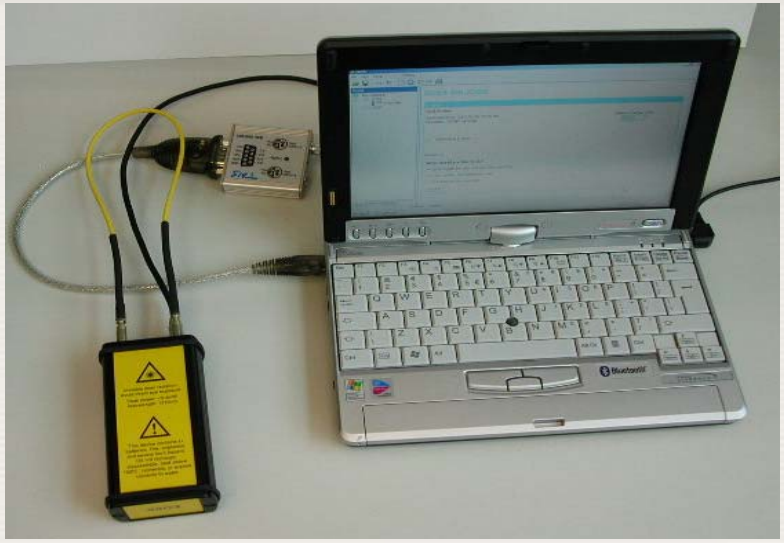
DSOS

HDIS

C/S Devices : Sealing Systems



Type-E Seal



EOSS Sealing System

Metallic Seals

Type-E (CAPS)

Advanced Seals

Fibre-optic (COBRA)	(FBOS)
Fibre-optic (VACOSS)	(VCOS)
Ultrasonic (ARC)	(ULCS)
Electronic Optical	(EOSS)

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C/S Measures at a Reactor Facility

EVOLUTION OF THE SAFEGUARDS SYSTEM

A changing Political Framework 1991-95:

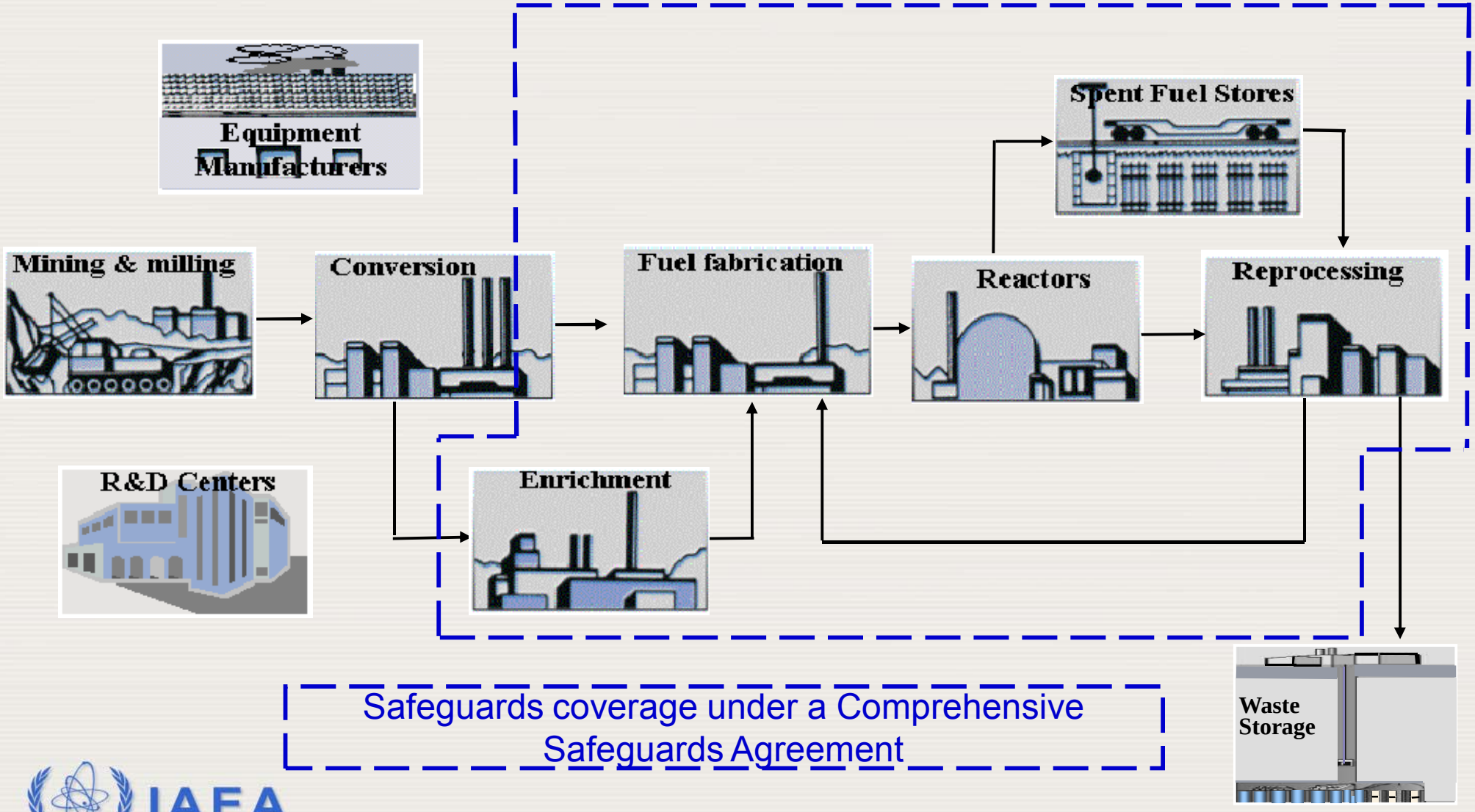
- The dissolution of the former Soviet Union
- Iraq, South Africa, DPRK
- Other disarmament initiatives (CTBTO, FMCT)
- Indefinite extension of NPT

additionally IAEA Member States' interest in strengthened and more cost-effective safeguards

Limitations of Safeguards - INFCIRC/153

- Provides assurance mainly regarding the correctness of State's declaration but not completeness
- Only partial coverage which is not continuous [mines, waste]
- Focus is on declared materials at strategic points at declared facilities
- Assumes a State declares everything
- Does not prevent a State from under-declaring its initial inventory
- Does not prevent a State from building secret facilities

Legal Authority – INFCIRC/153



Strengthening of the SG system- Conceptual Approach

Features of strengthened safeguards:

- More information about locations and activities
- More access to locations of interest
- New technical measures [e.g. Environmental Sampling (ES), Remote Monitoring (RM)]
- Re-Emphasize: DIQ/DIE/DIV

Evaluation of all information available to the IAEA

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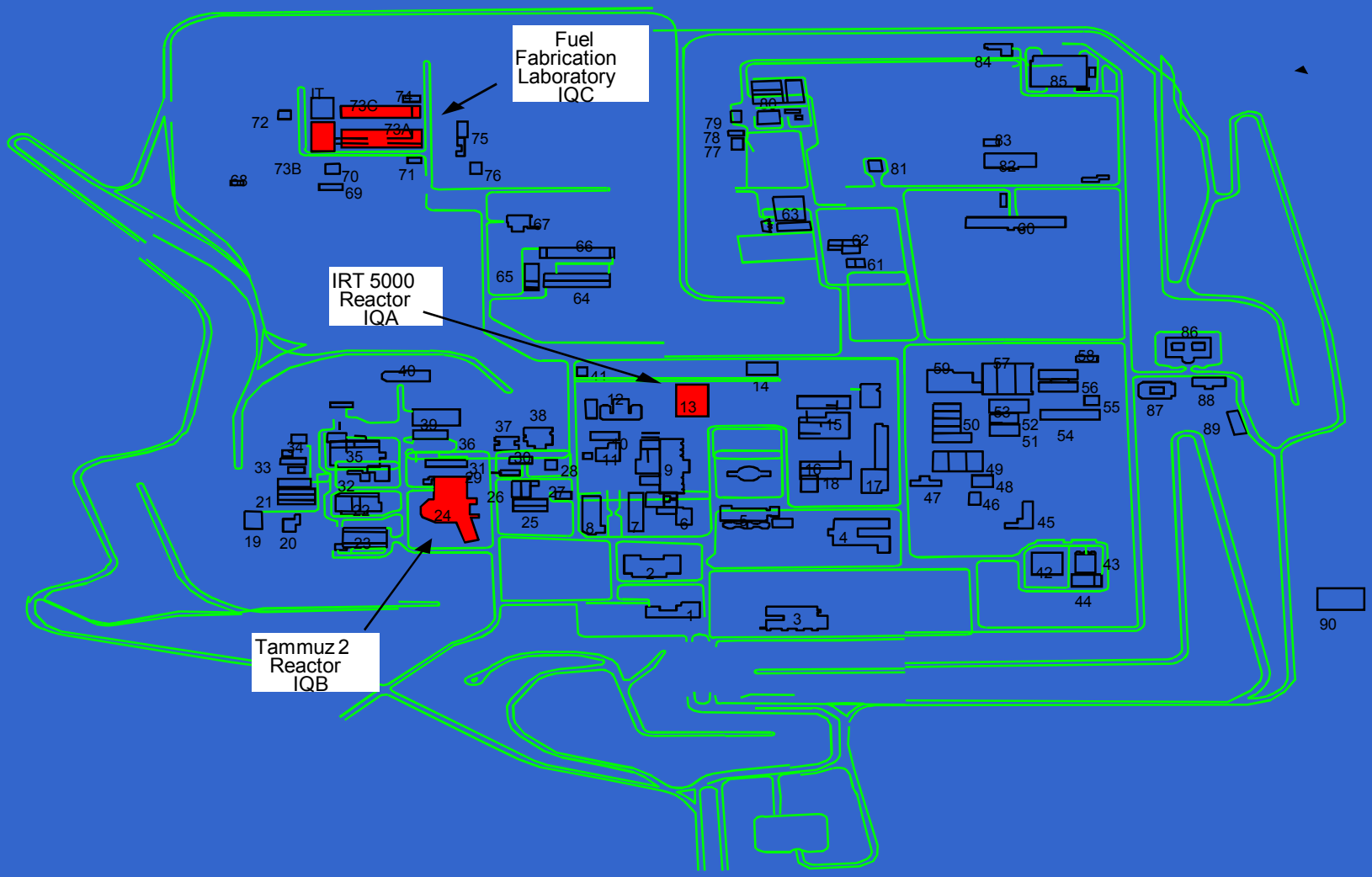
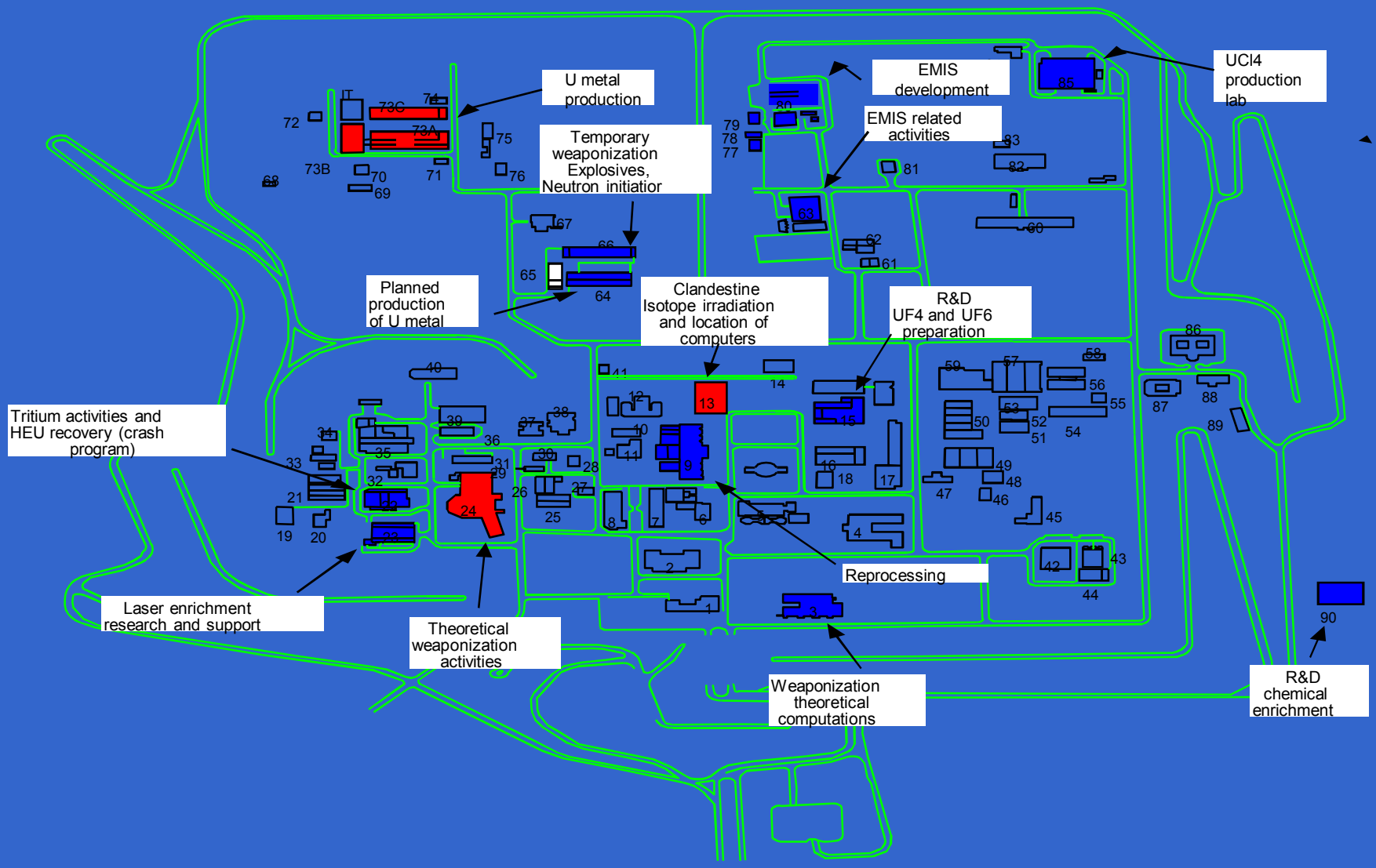
TUWAITHA
Activities Declared Prior to 1991



TUWAITHA
Clandestine Nuclear Weapons Activities



Strengthening IAEA Safeguards

Measures under Safeguards Agreements

- Agency access to undeclared locations
- Early provision of facility design information
- Environmental sampling
- Use of satellite imagery

Measures requiring Additional Authority

- Additional information
- Broader access
- Simplified inspector designation and visa requirements

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1997 - Additional Protocol - AP

Board approved the Model Additional Protocol **INFCIRC/540:**

Authority for increased access to information and expanded access to relevant locations in the State.

Measures Contained in the Additional Protocol

- Information on, and inspector access to, all aspects of a State's nuclear fuel cycle

- From mines to nuclear waste -

- Information on, and short-notice inspector access to, all buildings on a nuclear site
- Information on, and inspector access to, other locations where nuclear material is present (mines, pre-safeguards, exempted, waste)
- Information on, and mechanisms for inspector access to, nuclear fuel cycle-related Research & Development (R&D)

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What's New?

Additional Information

- Sites of nuclear facilities/LOFs
- R&D without nuclear material
- Nuclear material not otherwise reported under the CSA
- Manufacturing & export of components/equipment

Complementary Access

- To places beyond nuclear material and facilities
- Short notice (2/24 hours) – not unannounced
- Managed access to protect sensitive information

Administrative Measures

- Simplified inspector designation
- Reduced visa requirements

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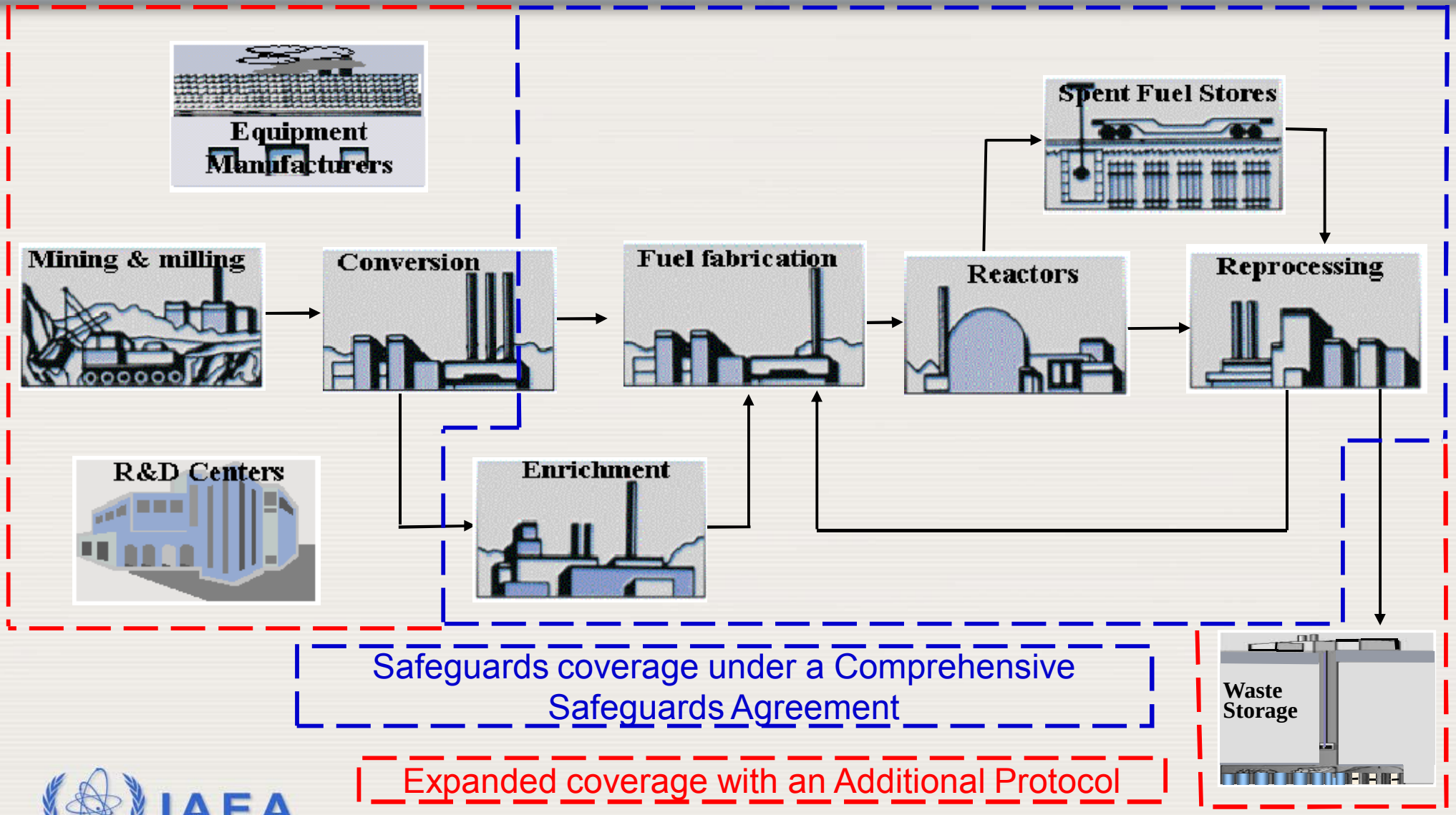
Legal Authority – INFCIRC/153 and INFCIRC/540



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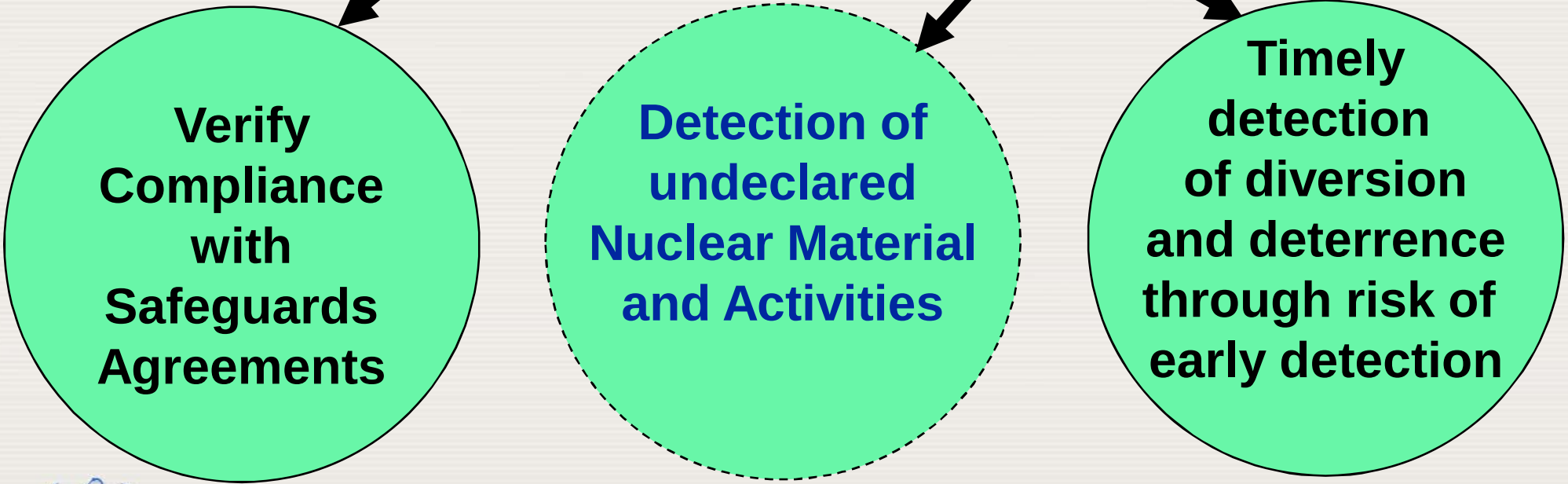
INFCIRC/153

INFCIRC/540

Purpose of IAEA Safeguards

Political Aim

Technical Aim



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Verification Activities: INFCIRC/540-AP

Analysis for consistency of:

- State's declarations (Information from Mines to Waste)
- Open sources (incl. satellite images)

- Complementary Access (CA)
  - Visual observations
  - Environmental samples
  - Radiation detection equipment
  - Examination of records

Verification Activities: Visual Observations

Visual Observations during Inspections, DI visits and CA:

- Able to observe/follow the process and the use of relevant equipment
- Process may range from simple to very complex
- Able to check consistency of observations with declarations
- Able to ask questions to better understand and/or clarify
- Complements / substitute the use of a camera
- Challenges your professional competence

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Use of Satellite Imagery

IAEA Safeguards Elements

Verification activities are performed in order to confirm correctness and completeness

INFCIRC/153

- Precise declarations on nuclear material and facilities
- Inspections of nuclear material and verification of design information

Agency is not able to provide credible assurance of the absence of undeclared nuclear material and activities for the State as a whole.

INFCIRC/540

- Descriptive declarations on other relevant materials and activities
- Complementary access to relevant locations

Improved capability to draw conclusion on the absence of undeclared nuclear material and activities in a State

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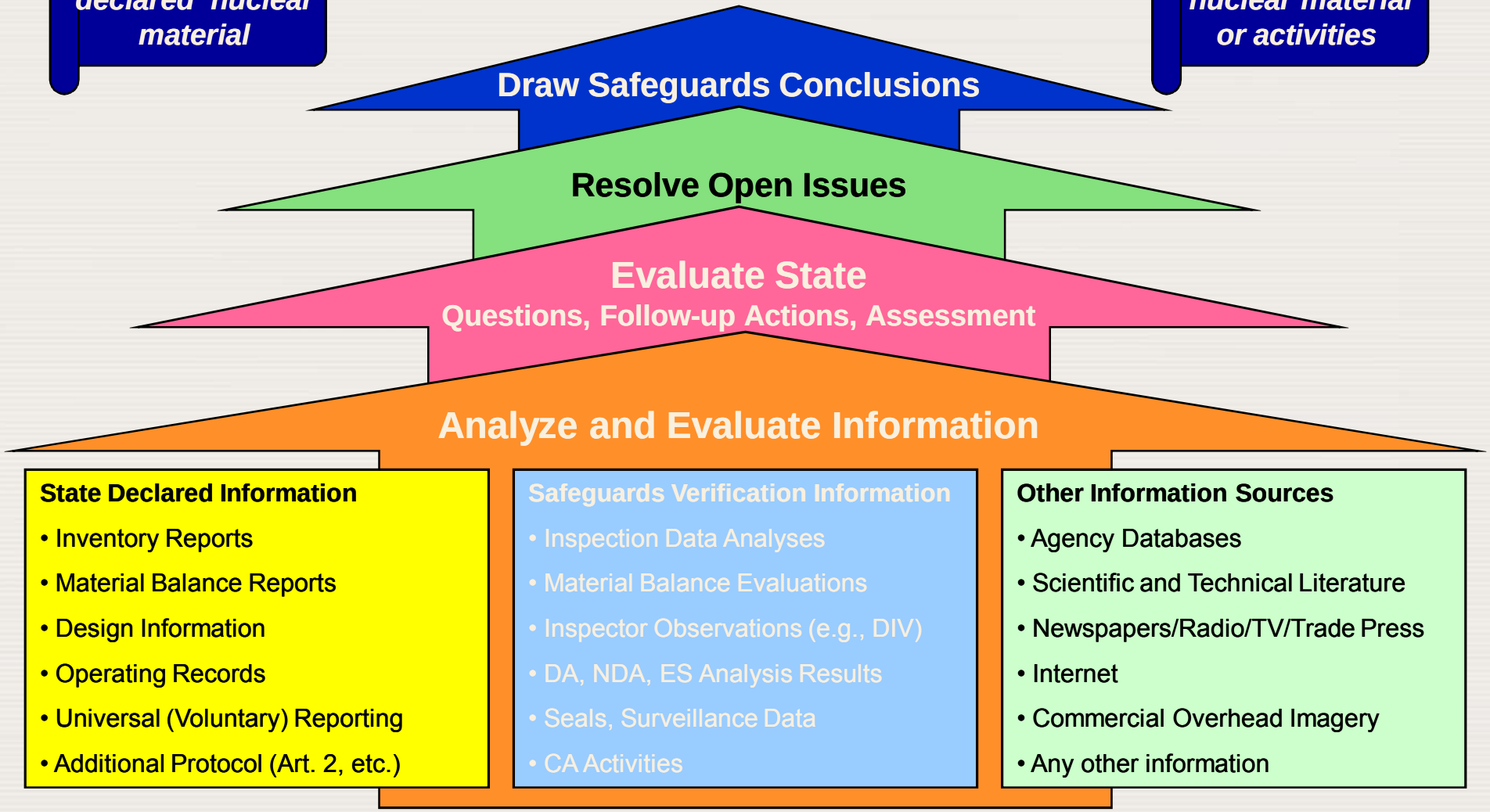
State Information Evaluation Process

No evidence of diversion of declared nuclear material

No evidence of undeclared nuclear material or activities



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INTEGRATED SAFEGUARDS (IS)

Integrated Safeguards is defined as an optimized combination of all safeguards measures available to the Agency under comprehensive safeguards agreements and additional protocols to maximize effectiveness and efficiency in meeting the Agency's safeguards obligations within the available resources.

- The expectation: optimization will result in a reduction of field inspection activities:
  - Irradiated fuel (timeliness: 12 months)
  - Fresh MOX fuel in LWRs (timeliness: 3 months)
  - Verification of indirect use of material (method: one level lower)
- ***However,*** increase in activities at HQ related to information analysis (e.g. AP declarations, RM data, State evaluations); reflecting a shift to information-driven safeguards.

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Summary

- Safeguards is a system for assuring exclusive peaceful use of nuclear material and facilities
- Based on State's declarations
- Is an audit system
- Nuclear Material Accountancy
  Uranium, Plutonium, (Thorium)
  complemented by Containment/Surveillance
- Provides assurances on the **correctness and completeness** of States' declaration signatories of the Additional Protocol to the Safeguards Agreement

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Conclusion

SAFEGUARDS

is an essential component of the Nuclear Non-Proliferation Regime

However,

no Safeguards system, no matter how extensive the measures are, can provide absolute assurance that there has been no diversion of nuclear material or that there are no undeclared nuclear activities in a State.