Summary of Infrastructure Development Working Group (IDWG) Activities

Dr. Alex R. Burkart and Mr. John Mathieson

Co-Chairs, Infrastructure Development Working Group

IFNEC Steering Group Meeting
May 9, 2014
Bucharest Romania
The Executive Committee expresses its particular appreciation for the Infrastructure Development Working Group’s efforts on:

- human capital development,
- regional use of infrastructure,
- international cooperation on nuclear safety, safeguards and nuclear security,
- learning of industry perspectives on infrastructure challenges,
- engaging stakeholders,
- emergency response, and
- other important infrastructure matters.

The Infrastructure Development Working Group should continue to address important issues in developing the national infrastructures countries need for safe and secure pursuit of a nuclear energy program, including:

- human capital development,
- regulatory development,
- emergency management planning,
- waste management,
- reactor technology choices, and
- needs assessments.
Meeting Agenda

- Romania’s National Nuclear and Waste Power Program
- Japan’s SMR Designs
- SC-HTGR
- International Safeguards, Security and Regulatory Aspects of U.S. Light Water Small Modular Reactors
- Waste Management Issues for SMRs
- Costing and Financing Waste Management and Decommissioning
- Human Resource Development in a Re-emerging Country – Bulgaria
- IAEA Services for Owner/Operators in Emerging States
- Shared Use of Research Reactors for Infrastructure Development
- UK Human Resource Development Activities
- Demonstrable Competence and Certification for Nuclear Security
- Role of Professional Societies in Human Resource Development
Main Institutions in Romanian Nuclear Field
- IFIN-HH
- INR-Pitesti
- S.N. Nuclearelectrica S.A.
- CITON
- CNCAN

Radioactive Waste Management Overview
- Institutional and legal framework
- National Strategy for RWM
- Sources and types of RW
- Storage and Disposal Facilities
- Public Involvement
- ANDR short-time objectives
- New Challenges
INR - ALFRED Project

Main objective: to demonstrate the viability of LFR technology
- to perform all preparatory activities (technical design, licensing, siting,...)
- to build a demonstration installation of 125 MWe
The National Strategy for Safe Management of Radioactive Waste - Low & Intermediate Level Waste -

- Existing: LILW-SL
  - NPP
    - NPP TREATMENT FACILITY
      - LILW N-S REPOSITORY
      - INTERIM STORAGE ON NPP SITE
  - RR / INSTITUTIONAL
    - RR TREATMENT FACILITIES
      - BAITA BIHOR REPOSITORY
  - INTERIM STORAGE ON NPP SITE

- Planned: LILW-LL
  - NPP
    - NPP TREATMENT FACILITY
    - INTERIM STORAGE ON NPP SITE
      - DISPOSAL IN GEOLOGICAL REPOSITORY
  - RR / INSTITUTIONAL
    - RR TREATMENT FACILITIES
    - INTERIM STORAGE ON RR's SITE
  - NUCLEAR FUEL PLANT
    - DISPOSAL IN SURFACE TRENCHES
    - IN SITU CAPPING / RELOCATING IN MINES
  - Mining
    - STORAGE IN TAILING PONDS
  - Milling
    - CLOSURE OF TAILING PONDS
Radioactive Waste Storage Solution

- After 7 years of cooling in the spent fuel bay, the nuclear fuel removed from the reactor is transferred in an intermediate dry spent fuel storage, on site.

- On December 31, 2013, at the dry storage facility there were 55,000 irradiated fuel bundles.

By courtesy of S.N. Nuclearelectrica S.A.
Japan’s Leading Edge Technologies in HTGR

- **Quartet coating technology** for cladding to have heat resistance
  - Confinement of radioactive materials for about three times longer than of LWR
  - Temperatures up to 1600 °C

- **Hot-pressurizing technology** for graphite to have isotropy
  - High strength, thermal conductivity, and radioactive-resistance
  - Temperatures up to 2400 °C

- **Fortifying technology** for metal to have heat resistance

- **High-temp. structural technology** for components

- **Helium-handling technology** for coolant to reduce leakage
  - (Chemical, mechanical and nuclear-physical stability)

Utilization of heat at high temperature of 950 °C

**HTTR**
(30MW, 950 °C)
HTGR Test Reactor of JAEA at Oarai Japan
**Integrated Modular Reactor**

- **Integrate the primary system into the reactor Vessel**
- **Safety: LOCA avoidance**
- **Economic: Small and simple**
  - The volume of containment is 1/10 of the this classes PWR

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric output</td>
<td>350MWe</td>
</tr>
<tr>
<td>Coolant</td>
<td>light water</td>
</tr>
<tr>
<td>Fuel type</td>
<td>PWR fuel assembly</td>
</tr>
<tr>
<td>Modular unit</td>
<td>Power uprate by multiple modules</td>
</tr>
</tbody>
</table>

**Diagram**

- Steel containment vessel
- Main steam pipe
- RV decompression valve
- Feed water pipe
- Core
- RV shielding wall
- Control rod drive mechanism
- Reactor vessel
- Steam generator
- Core internal structure
- Riser

**Note**

The conceptual design was performed by MHI and JAPC.

JAPC: The Japan Atomic Power Company (Electric utility)
LOCA: Loss of coolant accident
Compact Containment Boiling Water Reactor

- Economical and Safety SMR
  - 300～600 MWe

- Economic competitiveness
  - Simplified direct cycle & natural circulation
  - Passive safety systems
  - High pressure resistible Compact PCV
    - *design pressure*: 4 MPa
  - Short construction period: 24 months

- Comprehensive safety
  - Large reactor coolant inventory
  - Bottom-located core
  - Passive Reactor cooling
  - Simplified RPV bottom
    - with no pipings or nozzles

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**4S (Super-Safe, Small & Simple)**

- Distributed Power Supply
- Sodium-Cooled Fast Reactor (10MWe/50MWe)
- No Refueling for 30 Years
  Metallic Fuel & Long Cylindrical core with small diameter
- Passive Safety
  Negative reactivity feedback of metallic core
  & Decay Heat Removal System Utilizing Natural Air Draught
- Law Maintenance Requirement by Passive Components and Minimal Moving Parts by EMP
- High Security & Safeguards
  Reactor building is below grade
Steam Cycle - High Temperature Gas Reactor: Key Features

- Targeting mainly process heat delivery
- Prismatic block annular core
- Helium cooled primary
- Steam cycle secondary
- Modular design
- Intrinsic safety characteristics
  - Passive decay heat removal
  - Large thermal inertia
  - Large negative temp/reactivity feedback
- Minimal reliance on active safety systems
- Sized to optimize steam production cost/passive safety
- Fully embedded reactor building
  - Partially embedded alternative possible
High Temperature Reactor R&D in USA: Sponsored by DOE

- Advanced Gas Reactor (AGR) fuel research program
  - DOE sponsored R&D program began in 2004
  - Purpose: TRISO Fuel Characterization and Qualification
  - Currently at phase 4 (AGR-3/4) of an 8 phase program
  - Irradiation and characterization work performed at DOE Laboratories
  - UCO fuel manufactured by B&W
  - UO2 fuel manufactured by AREVA and South African PBMR Pty

- Codes and Methods Development

- Advanced Graphite Characterization (AGC)
  - Nuclear grade graphite R&D
  - Design tools and ASME standards development
  - Irradiation at INL ATR reactor
  - A variety of Nuclear grade graphite

- University programs
  - Oregon State University, University of Wisconsin, Texas A&M and others
  - Air/Water ingress studies
  - RCCS performance studies
DOE/NNSA Study of US LW SMRs

- A look at the security (physical protection), international safeguards, and regulatory aspects of the US LW SMRs
- Challenges: the 4 designs are at various stages of development and still evolving; proprietary and security information involved
- Identified 10 technical features that can be found in US designs
  - below-grade siting,
  - redundant safety equipment separation,
  - factory fabrication,
  - multi-modularity,
  - small source term,
  - ultimate heat sink,
  - passive safety,
  - fuel type,
  - fuel cycle management,
  - integrated primary components
- In addition, looked at 4 characteristics of SMR deployment
  - host state infrastructure,
  - host state international commitments,
  - reactor mission,
  - reactor location
Takeaways

- Reviewed the IAEA’s “Milestones in the Development of a National Infrastructure for Nuclear Power” document
  - No identified differences in how a country would need to develop its national infrastructure for LW SMR deployment versus a large reactor (i.e., no steps that could be skipped)
- IAEA should be able to effectively safeguard LW SMRs, they may just be more resource intensive on a per MW basis (or even a per site basis)
- Several technical features provide advantages against subnational threats
- Overall, features indicate only small safeguards and physical protection differences relative to deployment of conventional LWRs
- There are uncertainties to this assessment, as LW SMR designs are still evolving
Radioactive Waste Management Discussions

• Waste Management Issues for SMR’s
  • Dan Mathers, NNL, UK

• Costing and Financing Waste Management & Decommissioning
  • John Mathieson, NDA, UK
Small Modular Reactors & waste management issues

8th May 2014, Bucharest
International Framework For Nuclear Energy Cooperation – Infrastructure development working group meeting

Dan Mathers
Business Leader Fuel Cycle Solutions
Many SMR designs are under development world-wide
- Dominated by Light Water Reactors (LWRs)
- LWR designs heavily based on existing design experience and therefore closest to potential deployment
- Furthest developed designs are probably at least 10 years from commercial deployment
- US Department of Energy helping to finance design of two prototypes
- Less developed designs at least 15 to 20 years from deployment
- Difficult to compare the pros and cons of the different designs because they are at different stages of development
- Utilities will decide which are deployed and they will be focusing on economics and financing considerations
- Only a few of the many proposed designs will ever make it to commercial deployment

<table>
<thead>
<tr>
<th>Name</th>
<th>Capacity</th>
<th>Type</th>
<th>Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNP-300</td>
<td>300 MWe</td>
<td>PWR</td>
<td>CNNC, operational in Pakistan</td>
</tr>
<tr>
<td>PHWR-220</td>
<td>220 MWe</td>
<td>PHWR</td>
<td>NPCIL, India</td>
</tr>
<tr>
<td>KLT-40S</td>
<td>35 MWe</td>
<td>PWR</td>
<td>OKBM, Russia</td>
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<tr>
<td>CAREM</td>
<td>27 MWe</td>
<td>PWR</td>
<td>CNEA &amp; INVAP, Argentina</td>
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<tr>
<td>HTR-PM</td>
<td>2x105 MWe</td>
<td>HTR</td>
<td>INET &amp; Huanci, China</td>
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<tr>
<td>VBER-300</td>
<td>300 MWe</td>
<td>PWR</td>
<td>OKBM, Russia</td>
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<td>IRIS</td>
<td>100-335 MWe</td>
<td>PWR</td>
<td>Westinghouse-led, international</td>
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<td>Westinghouse SMRmPower</td>
<td>225 MWe</td>
<td>PWR</td>
<td>Westinghouse, USA</td>
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<td>SMR-160</td>
<td>180 MWe</td>
<td>PWR</td>
<td>Babcock &amp; Wilcox + Bechtel, USA</td>
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<tr>
<td>ACP100</td>
<td>160 MWe</td>
<td>PWR</td>
<td>Holtec, USA</td>
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<td>SMART</td>
<td>100 MWe</td>
<td>PWR</td>
<td>KAERI, South Korea</td>
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<tr>
<td>NuScale</td>
<td>45 MWe</td>
<td>PWR</td>
<td>NuScale Power + Fluor, USA</td>
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<tr>
<td>PBMR</td>
<td>165 MWe</td>
<td>HTR</td>
<td>PBMR, South Africa; NPMC, USA</td>
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<tr>
<td>Prism</td>
<td>311 MWe</td>
<td>FNR</td>
<td>GE-Hitachi, USA</td>
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<tr>
<td>BREST</td>
<td>300 MWe</td>
<td>FNR</td>
<td>RDPE, Russia</td>
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<td>SVBR-100</td>
<td>100 MWe</td>
<td>FNR</td>
<td>AKME-engineering, Russia</td>
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<td>EM2</td>
<td>240 MWe</td>
<td>HTR, FNR</td>
<td>General Atomics (USA)</td>
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<td>VK-300</td>
<td>300 MWe</td>
<td>BWR</td>
<td>RDPE, Russia</td>
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<td>AHWR-300 LEU</td>
<td>300 MWe</td>
<td>PHWR</td>
<td>BARC, India</td>
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<tr>
<td>CAP150</td>
<td>150 MWe</td>
<td>PWR</td>
<td>SNERDI, China</td>
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<tr>
<td>SC-HTGR (Antares)</td>
<td>250 MWe</td>
<td>HTR</td>
<td>Areva</td>
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<tr>
<td>Gen4 module</td>
<td>25 MWe</td>
<td>FNR</td>
<td>Gen4 (Hyperion), USA</td>
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<tr>
<td>IMR</td>
<td>350 MWe</td>
<td>PWR</td>
<td>Mitsubishi, Japan</td>
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<tr>
<td>Fuji MSR</td>
<td>100-200 MWe</td>
<td>MSR</td>
<td>ITHMSI, Japan-Russia-USA</td>
</tr>
</tbody>
</table>

Source: World Nuclear Association
SMR Economic Challenges

- All the drivers in favour of SMR economics are currently theoretical and need to be demonstrated to work in practice – this is the biggest challenge they face
  - No current SMR has a complete engineering design which is needed before a full engineering cost estimate can be made
  - Economic figures for SMR designs are often just projections with little supporting basis
  - In many cases the projected economics might look attractive at the conceptual stage, but may no longer do so when engineering reality sets in
SMR System Features

- **Simplified or passive safety**
  - Integral systems layout
  - Large coolant masses for high thermal inertia
  - High vertical heights to enhance natural convection
  - Passive designs
  - Need to address multiple units in close proximity after Fukushima
  - Some designs use natural circulation in normal operation

- **Underground siting of cores**

- **Long refuelling cycles**
  - Autonomous power sources have very long life cartridge cores (15 to 30 years)
Small PWR’s

If no change in fuel then:

- Fuel waste per GWe similar to PWR’s but: fuel may not achieve high burnups (inability to shuffle in small cores), fuel throughput could be higher therefore greater volume of spent fuel
- Slightly larger % of structural waste (pressure vessel is larger fraction of total surface to volume ratio)
- Assume fuel is pond stored for ~20yrs, followed by dry store or repro
- Key issues remain for plant decommissioning Co-60 from vessel/pipes/internals, C-14, Ni and Fe isotopes.
Small HTR’s

- Triso fuels possible – retain fission products, impractical to reprocess: assume high proliferation resistance (aqueous and pyro-processing both not practical)
- Assume fuel is stored 100-150 years (may require He gas coolant)
- Key issues remain for plant decommissioning from activated cylindrical steel core and graphite brick reflector C-14, Cl-36 isotopes. (He cooled so no graphite weight loss as in AGR)
SMR Conclusions

- SMRs represent an alternative to large scale nuclear
  - Potentially a good fit in the international context for developing or small countries
  - Expands options for nuclear contribution to energy decarbonisation

- Theoretical advantages abound
  - But economic and business case will be the over-riding factor
  - Need to be careful not to exaggerate the potential benefits

- Though there are many SMR designs being promoted, many are not developed to the point where there exists an engineered design
  - By definition, any new design starts off with all the advantages
  - The question is whether these advantages will remain once engineering reality intervenes
IFNEC IDWG

Costing and Financing Radioactive Waste Management and Decommissioning

May 8th 2014, Bucharest

John Mathieson, Nuclear Decommissioning Authority
Overview

• Requirements & general principles
• Costing methodologies
• Financing mechanisms
• Some country examples

• References
Requirements (1)

• Joint Convention:
  – “adequate financial resources are available … for spent fuel … and radioactive waste management … and for decommissioning”.

• COUNCIL DIRECTIVE 2011/70/EURATOM … for the responsible and safe management of spent fuel and radioactive waste
  – “Member States shall ensure that … adequate financial resources be available when needed … for the management of spent fuel and radioactive waste”.
  – N.B. Directive is brought into law so there is sanction if the Member State does not comply!

• IAEA Milestones
  – “Funding” – fiscal responsibility of the Government in establishing the nuclear programme
  – “Financing” – fiscal responsibility of the owner/operator (which could be government or utility)
  – 3.4.1. Funding and financing: Milestone 1
    • Long term financing to ensure safe and secure handling of spent fuel, radioactive waste, plant decommissioning, and the options for disposal
  – 3.4.2. Funding and financing: Milestone 2
    • Plans in place to fully finance long term waste management and decommissioning
Basic Principles

• Need to ensure that nuclear liabilities are adequately funded
• Most countries require developers to have fully funded decommissioning & SF disposal programmes (FDP)* before NPP construction
• This comprises:
  – a decommissioning and waste management plan (DWMP)* which generates a cost estimate, and
  – a funding assurance plan (FAP)* to establish the fund
    • utility makes contributions over the lifetime of the plant
    • the fund grows from contributions and interest
    • pays out as the liabilities are discharged
    • (utility operational waste management not covered by the fund)
• Implements the "polluter pays" principle (usually!)

*UK terminology
Costing & Financing

• **What is being costed and financed?**
  – Interim storage facility (needed if repository not available)
  – Near surface repository
  – Decommissioning of NPP
  – Spent fuel disposal
  – Geological disposal facility

• **Who pays?**
  a) Utility (costs passed on to electricity consumers)
  b) Government (costs passed on to taxpayers)
  c) Mixture of both
    • New build a)
    • Legacy b) if no provision made or there is a shortfall

• **Who spends?**
  – Utility
  – Waste Management Organisation (WMO)
  – (Regulators)
NPP Decommissioning Costing

- Reactor type – waste streams
- Decommissioning strategy
  - Prompt or deferred
- Availability of disposal routes
- Purpose
  - Establish decommissioning funds & payments, & “strike price” for New Build
  - Establish contract baseline for decomm.)
  - Project development & implementation – other inputs documentation (e.g. EIA at this time)
  - Estimates
- Costing
  - Good international support (NEA, IAEA)
  - Not straightforward
  - Timeframes
  - Risks?
- Would include SF management as well
Geological Disposal

- **Timeframes**
  - Decades to implement
  - Decades of operation
  - Centuries of post closure phase
- **Not many published examples**
  - (IAEA Drafting guidance)
  - Difficult to benchmark internationally – why??
  - EDRAM has done some work on comparisons
- **High fixed costs / high variable costs**
- **High risks to programme (delays)**
- **Purpose**
  - Project financing
  - Fund establishment & charge determination
  - Contract baseline for development
  - Charge determination for disposers
  - New nuclear build – New Build organisations need assurance on disposal costs for their financing model including decommissioning planning
Cost output - Spain

Future RW Management Cost

Feeds into funding requirements development

Note values are “discounted” and money value year quoted

Total estimated cost = 14,000 M€07 (1985-2070)
Cost incurred up to 2006: 24%
Pending to be collected: 5,200 M€07 (discounted)
The Fund

• Similar to a pension or other savings / investment scheme!
• Fund should grow – combination of contributions & interest
  – Must have good investment strategy
  – Good governance, including transparency
• “Good” lifetime cost estimation essential
  – To ensure charges / fees / contributions are fair
  – Amount of the waste / wasteforms – may change during lifetime
• Fund is very long term
  – Growth > inflation, but low risk investments
  – Should be segregated & protected from “raiding”
  – Issue for NPPs nearing end of life, or disposal facility required sooner than the fund allows
  – Single or separate decommissioning and disposal funds?
  – One national fund, or individual funds?
Netherlands

- **HLW storage 100 years**
  - Then disposal decision
  - R&D now (clay/ salt)
  - storage of all wastes at Vlissingen

- **1986 (what happened in 1986??)**
  - Geological disposal in salt for all Dutch radioactive waste
  - Cost was estimated at €1230M (€820M HLW)
  - Real interest rate of 3.5% and a discounting period of 130 years was used

- **When utilities pay fees, they discharge all liabilities to COVRA**
  - All producers pay contribution per m³

- **Post ‘86 new nuclear policy (i.e. no new build as before)**
  - COVRA had a shortfall of funds (not enough waste)
    - So they raised the tariff
    - Utilities responded by producing less waste!
    - Therefore less money to cover the liability

- **(now) Capital growth fund**
  - HLW : LILW = 2 : 1
  - After 100-130 years: € 2 billion
  - Real interest rate 2.3%
  - Safe investments
  - State as back-up
Sweden

- SSM is the Nuclear Regulator
Human Resource Development – Country Specific Presentations

• Panel Moderator
  • Lee Peddicord, Texas A&M (US)

• HRD in an Emerging Country – Kenya
  • Prof. Joseph Malo, University of Nairobi / Nuclear Electricity Board

• HRD in an a Re-emerging Country – Bulgaria
  • Assoc. Prof. Dimitar Tonev, Director Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences

• UK HRD Activities
  • Natasha Hanson, Head of People Relations, NDA
HUMAN RESOURCE DEVELOPMENT IN AN EMERGING COUNTRY; CASE STUDY OF KENYA

PROF. JOSEPH MALO
BOARD MEMBER,
KENYA NUCLEAR ELECTRICITY BOARD

INTERNATIONAL FRAMEWORK FOR NUCLEAR ENERGY COOPERATION

INFRASTRUCTURE DEVELOPMENT WORKING GROUP MEETING

May 8, 2014
Outline

- Kenya’s profile
- Current power capacity
- Background to Kenya’s NPP
- Justifications for NPP in Kenya
- The Human resource Development Status
- Challenges in HRD
- Conclusion
Currently, PFS has been completed and currently under review.

**Milestone 1**
- Political Decision to go Nuclear,
- Nuclear included in the energy Mix

**Milestone 2**
- Roadmap for Phase 2
  - Setting up a comprehensive legal & regulatory framework in progress
  - Capacity building programs
  - Implement PFS findings

**Commissioning of the first NPP in Kenya, target by 2022, contributing 1000MW to the national grid**
The Pre-Feasibility Study established that Kenya does not have adequate human resource capacity to implement the nuclear power programme.

The PFS further recommended that Kenya will need to train at least adequate specialized nuclear engineers and scientists gradually before the commissioning of the first unit of NPP.

Kenya has a strong education system and produces an average of 20,000 graduates annually in Sciences and Engineering, but with limited component of Nuclear Science.

Education and Training will incorporate both local and international institutions, but the foreign component is expected to be bigger.

KNEB has started various institutional and human resource capacity building efforts both locally and internationally.

The IAEA has been a major partner in Kenya’s capacity building efforts through Fellowships, Scientific Visits, Trainings and workshops.
Conclusion

- Kenya has embarked on Nuclear HRD and enhancement of local capacity to play a major role;
- International support will remain key in HRD efforts in newcomer countries;
- Financial and Institutional resources and capacity remain the major issues for newcomers;
- The IAEA, IFNEC, WNA and other international organizations should consider taking up major roles to assist HRD in developing countries.
Human Resource Development in a Re-emerging Country - Bulgaria

Assoc. Prof. Dimitar Tonev
Institute for Nuclear Research and Nuclear Energy
Bulgarian Academy of Sciences

Infrastructure Development Working Group Meeting, 8 May 2014, Bucharest, Romania
Kozloduy NPP is the only nuclear power plant in Bulgaria, providing more than one third of the total annual electricity output of the country.
International collaboration

Participation in prestigious international projects

- Nuclear Reactor Integrated Simulation Project, 2009-2012,

**SARNET** Network of Excellence for a Sustainable Integration of European Research on Severe Accident Phenomenology and Management – Phase 2, 2009-2013

**NEWLANCER**/ Member States Linking for an AdvanNced Cohesion in Euratom Research, 2011-2013

- Establishment of a Regional Center of Competence for WWER Technology and Nuclear Applications, 2011-2014

- **CESAM** - Code for European Severe Accident Management, 2013-2014

**CORONA**
International collaboration

International Atomic Energy Agency

Institutes of the Joint Research Centre of EC

Organizations of the AER on WWER reactor physics and safety

Leading European institutes - CEA France, IRSN France, UPM Spain, GRS Germany etc.

Department of Energy, USA

PennState University, USA, MoU
Texas A&M University, MoU

European Technical Safety Organizations Network
Training and qualification

- Teaching on “Neutron and Reactor Physics”, “Nuclear reactors” and “Radiochemistry” of Bachelor, MSc., PhD students in collaboration with SU”Sv. Kl. Ohridski” and TU-Sofia
- Supervising of PhD students from Kozloduy NPP
- Specialized training – BNRA license, 2014
- Training of personnel and instructors for identification of commodity with possible double usage
- Participation in national and international schools and conferences
- CORONA Pilot training for non-nuclear specialists

FP7 EURATOM Project CORONA - Establishment of Regional Center of Competence for VVER Technology and Nuclear Applications, CSA-CA, 11 participants from 8 countries +JRC,EC; 2011-2014
INRNE Activity with Ministry of Interior and Police Academy

Education, Training and Scientific support in the field of Nuclear Forensics

Police Academy Sofia

Radiation Detection and Response Course
13–15 September 2010 – Sofia, Bulgaria
Conclusions

- INRNE performs research of its own and actively participates in European projects for the development and validation of the new generation software for reactor simulation and safety analysis.

- Current results and planned activities aim to improve the performance and safety of the Kozloduy NPP.

- The scientific and technical support of the nuclear industry, government organizations and the education of young specialists contribute to the sustainable development of nuclear power in Bulgaria.
Nuclear Decommissioning Authority

Infrastructure Development Working Group Meeting

8 May 2014

Natasha Hanson
Head of People Relations
Skills Challenges

Growing Global Demand for Nuclear Skills

An Ageing Workforce
NDA Estate Wide & New Nuclear Build Requirements

NDA Estate and New Build Requirements

Full Time Equivalent Number

Year

NDA Estate
New Build
Total
Skills Priorities

High Priorities
- Project / Programme Managers
- Construction Project Managers
- Steel Fixing
- High Integrity Welders
- Safety Case Authors
- R&D Personnel
- Basic Requirements and Nuclear Awareness
- Site Construction Supervisors
- Apprenticeships and Higher Apprenticeships

Other Priorities
- Design Engineers / Technicians
- Quality Assurance
- C&I Engineers
- NDT Engineers
- Safety Safeguards
- Nuclear Regulators
- Health Physics
Select Services for Future Owner/Operators

• Leadership and Management Courses
  • Argonne National Laboratory
  • International Nuclear Leadership Education Program at MIT
  • Texas A&M University
  • IAEA Management Schools

• Operational Safety Missions
  • Operational Safety Review Team
  • Independent Safety Culture Assessment
Select Services for Future Owner/Operators

- Expert Missions to Review:
  - NPP Owner/Operator's Human Resources Development Plan
  - Bid Invitation Specifications
  - Owner/Operator's Integrated Management System
  - Construction Management Process of the first NPP
Select Services for Future Owner/Operators

- Available Workshops
  - Establishment of the NPP Owner/Operator Organization
  - How to Become a Knowledgeable Customer
  - Interfaces with NPP Owner/Operator in a BOO/BOOT Approach
  - Integrated Management System, Leadership and Safety Culture for the NPP Owner/Operator Organization
  - NPP Project Management
  - Management of NPP Construction and Commissioning
  - Interfaces of NPP Owner/Operator with Regulatory Bodies for Licensing of the First NPP
Construction Readiness Review (CORR)

- CORR Guidelines: Preparing and Conducting Review Missions of Construction Project Readiness for Nuclear Power Plants

- Mission to provide a detailed assessment of readiness for construction, construction progress, readiness for turnover, as well as recommendations for improvement.
Overview of Research Reactor Worldwide

Diversity of
- Age (58% > 40y)
- Power level / flux
- Application
- Utilization
- Design
- Fuel type
- Organizational size, structure and ‘context’
- Funding mechanism.
Research Reactor Use in Nuclear Power Staff Training and Education

• For some countries an existing RR is a useful tool for training and education:
  • understanding of applied physics and nuclear engineering,
  • practical exercises on an operating reactor (criticality, rod worth determination, coefficients of reactivity),
  • experience of facility operation and maintenance (safety, radiation protection and waste management)
• Countries without an RR may still access the capabilities by:
  • joining an RR coalition and benefit from direct access to an RR.
    • Participation welcome even without a reactor.
  • establish a remote reactor project in cooperation with an RR.

IAEA
Conclusions

• Nuclear research and education infrastructure played an important role in the historical development of NP infrastructure

• Future role may depend on:
  • the specific expertise and experience (technical and other) that the RR Infrastructure can offer;
  • choices of national participation and technology transfer;
  • the comparative advantage offered by RRs as opposed to other options;
  • the availability of required services & expertise (indigenous or via networking).
1. Subscribe to NSS 20 (Nuclear Security Fundamentals)

2. Incorporate NSS13 – NSS15

3. Self assessment and peer review

4. “Ensure that management and personnel with accountability for nuclear security are demonstrably competent”
## Competency Framework

<table>
<thead>
<tr>
<th>CORPORATE &amp; FUNCTIONAL DIRECTORS</th>
<th>OPERATORS</th>
<th>OFF-SITE ORGANISATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive/Board Member</td>
<td>Operations Director</td>
<td>Local Law Enforcement/Police</td>
</tr>
<tr>
<td>Human Resources Director</td>
<td>Site Shift Manager</td>
<td>National Law Enforcement/Police</td>
</tr>
<tr>
<td>Legal Director</td>
<td>Engineering and Technology Manager</td>
<td>Government Security Regulator</td>
</tr>
<tr>
<td>Safety Director</td>
<td>Site Security Manager</td>
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</tr>
<tr>
<td>Procurement and Purchasing Director</td>
<td>Emergency Response Team Leader</td>
<td></td>
</tr>
<tr>
<td>Engineering and Technology Director</td>
<td>Health and Safety Manager</td>
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<tr>
<td>Information Systems Director</td>
<td>Nuclear Material Custodian</td>
<td></td>
</tr>
<tr>
<td>Corporate Head of Security</td>
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</tbody>
</table>
Design of the Academy Programme

- Elective for Scientists, Technicians and Engineers
- Elective for Response Force Managers
- Elective for Senior Administrators and Board Directors
- Elective for Security Programme Managers
- Elective for Executive Managers
- Elective for Regulators
- Elective for Radioactive Materials Managers
- Elective for Civil Society Engagement
Sustainable Partnerships

The WINS Academy Security Certification Programme

PARTNERSHIP FOR DEMONSTRABLE COMPETENCE

Partner with the WINS Academy to increase your market, reputation and prestige

FOR LEARNING AND TRAINING CENTRES
Guilds and Guild Halls

Guild systems promoted levels of mastery as well as exclusionary and protective business practices.

Precursor to establishment of unions and accreditation & certification systems.
Basic Characteristics of Professional Societies

• Defined professional requirements (versus social societies)
• Established Code of Conduct /Ethics
• Member continuing education
• Public information and policy positions
• Advocacy of the profession rather than an industry (versus trade association)
Professional Society Benefits: Conclusions

• Provide an essential **bridge** from the academic environment to professional standing.
• Code of Conduct, Skill Certification, and advocacy of Professional excellence are benefits in **stakeholder dialogue**
• Trans-national sharing of information needed to **promote professional conduct**
• Building blocks for **sustainable capacity**.
Opportunities and Challenges Associated with the Development of Nuclear Energy in Africa

Week of August 11, 2014
Accra, Ghana