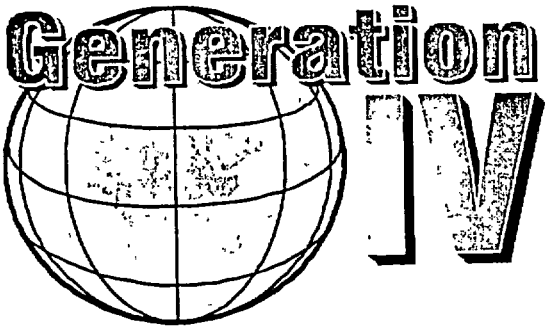
Status of Initial Activities of the Technical Working Groups



Attachment 7

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Release

D/4

First Meeting (Denver) Activities

EMG (all three days)

- *Confirm charter and milestones*
- *Continue to develop evaluation process (Who – What – When)*
- *Continue on criteria and metrics*
- *Begin work on methodology*

TWGs (first two days)

- *Confirm charter and milestones*
- *Draft a set of initial concepts*
- *Detail steps/tasks to reach milestones*
- *Assign members to begin concept summaries*
- *Feedback comments*

NTDG and FCCG (third day)

- *Define products and assignments*

Generation IV

Evaluation Methodology Group

Bennett, Deborah	*LANL*
Bley, Dennis	*Buttonwood*
Crawford, Doug	*ANL*
Dixon, Brent	*INEEL*
Golay, Michael	*MIT*
Halsey, Bill	*LLNL*
Petersen, Per	*UC Berkeley*
**Rasin, Bill*	*Duke (ret.)*
**Roglans, Jordi*	*ANL*
Rothwell, Geoffrey	*Stanford*

** co-Chair*

Specific Objectives of the EMG

During the roadmap:

- *Develop the evaluation process (work flow) with the RIT*
- *Develop criteria, metrics and methods to be used in screening and evaluation*
- *Assist groups with application of the methods*
- *Review TWG evaluations for consistency*

For the long-term:

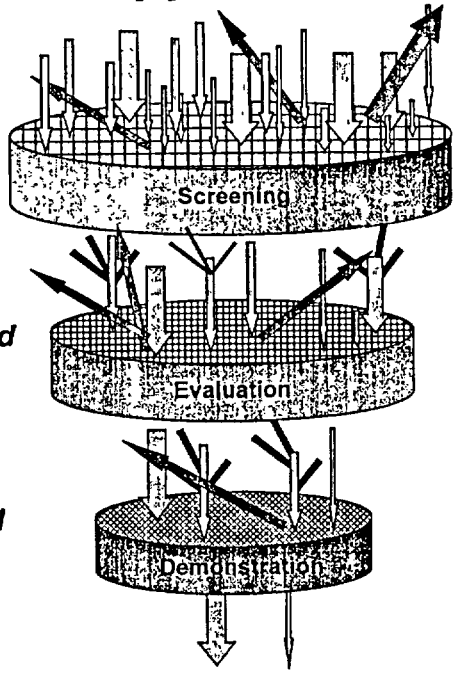
- *Recommend R&D on evaluation methodologies and their application, for use by industry*

Activities of the EMG

- *November 15, 2000 in Washington D.C.*
  - *Roadmap overview*
  - *EMG charter*
  - *Evaluation issues and candidate approaches*
- *February 1-2, 2000 in Berkeley, CA*
  - *Roadmap update*
  - *Draft goals*
  - *Evaluation criteria, metrics, and methods*
- *March 7-8, 2001 in Washington D.C.*
  - *Review of initial criteria / metrics with the GRNS*

Roadmap Conceptual Approach

- *Many concepts are screened for consideration in the roadmap*
- *The best concepts are evaluated and recommended for the R&D program*
- *Industry selects a few concepts for design, demonstration and eventual deployment*



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Generation IV

Evaluation Methodology Development

- *Ensure consideration of promising and innovative concepts*
  - *Membership with diverse backgrounds*
  - *Wide survey of ideas*
- *Provide a common methodology for evaluations*
  - *Broad base of criteria, metrics and methods*
  - *Consistent evaluation of concepts against goals*
- *Provide basis for overall prioritization of R&D*
  - *Benefit of R&D in relation to costs and risks*

Early Screening of Concepts

- *Screen out concepts that do not meet the Gen IV definition*
- *Adopt and/or synthesize concepts*
  - *Use criteria (and some metrics) to assess strengths and weaknesses of concepts and generate a practical set*
- *Evaluate and prioritize concepts*
  - *Further eliminate (or move to the bottom of the list) those concepts that are clearly inferior on most counts*
  - *Analyze metrics to the extent possible*
  - *Evaluate using expert judgment (e.g., multi-attribute or pair-wise comparisons)*

Evaluation Issues

- *Lack or variability of concept information, especially during early stages of the roadmap*
  - *Use broad screening criteria based on goals*
  - *Focus on basic drivers of performance*
  - *Value innovation*
- *Weighing 'scores' among diverse evaluation criteria*
  - *Assign a relative importance to various criteria*
- *Treatment of similar concepts in roadmap*
  - *Adopt concept families vs. point design*
  - *Combine favorable features of similar concepts*

Evaluation Issues (cont'd)

- *Keep the ability to introduce new concepts during the roadmap process*
- *Treatment of uncertainties in concept features and performance*
  - *Use probability distributions and expert judgment*
- *Handling of proprietary information*
  - *None accepted during roadmap phase*
  - *Accommodate in later stages, but strive for transparency*

Important Definitions

Goal: A broad statement of what is to be achieved

Evaluation Criterion: A measurable indication of performance relative to goal

Metric: A standard of measurement (figure of merit)

Concept: An example of a Generation IV nuclear energy system

Process: The sequence and timing of actions taken to accomplish the evaluation objectives

Method: A systematic procedure or technique for performing an evaluation task

Methodology: The body of methods, criteria, information, and postulates employed in the evaluation

Examples of Criteria

- *Sustainability Goal 1*
  - *Fuel utilization*
  - *Fuel cycle compatibility with environment*
  - *Utilization of other resources*
- *Sustainability Goal 2*
  - *Waste minimization*
  - *Environmental impact*
  - *Stewardship burden*
- *Sustainability Goal 3*
  - *Life-cycle intrinsic barriers to diversion, theft and misuse*
  - *Inherent features to simplify safeguards*

Generation IV

Examples of Criteria

- *Safety and Reliability Goal 1*
  - *Risk to public health - minimization of transients (reliability), plant damage frequency (passive safety, simplicity)*
  - *Worker safety*
  - *Power plant performance*
- *Safety and Reliability Goal 2*
  - *Simple and well characterized dominant phenomena and plant states*
  - *Large safety margins*

Examples of Criteria

- *Safety and Reliability Goal 3*
  - *Damage, transport and releases well understood*
  - *Likelihood of releases exceeding allowable dose*
- *Economic Goals 1 and 2 (combined)*
  - *Development costs*
  - *Capital costs, including required infrastructure*
  - *Operations and maintenance*

Sample Metric: Fuel Utilization

Assess depletion of fuel resources in terms of consumption per unit energy compared to the economically accessible resource

Metric: $M = [(F/R)_0 / (F/R)_i]$

F = specific fuel consumption *R = fuel resources*

0 = LWR (reference) cycle *i = evaluated fuel cycle*

Initial screening: Rank concepts qualitatively

Later evaluations: Rank concepts quantitatively

Future Activities of the EMG

- Draft the initial evaluation process with RIT
  - Proposed evaluation process review by GRNS (March 2001)
  - Incorporate international input (May 2001)
- Develop evaluation criteria and metrics
  - Review at GRNS meetings (March & May 2001)
  - Written report on criteria & metrics (June 2001)
- Further develop process, criteria and metrics
  - Refine process, criteria and metrics (Aug and Nov 2001)
  - Final report on criteria and metrics (Feb 2002)
- Determine R&D requirements for evaluation methodologies
  - Report on recommended R&D (July 2002)

Water-cooled Concepts TWG

Carelli, Mario	*Westinghouse*
Corradini, Mike	*U Wisconsin*
**Devine, Jack*	*Polestar*
Diamond, Dave	*BNL*
**MacDonald, Phil*	*INEEL*
Smith, Noval	*Dominion*
Was, Gary	*U Michigan*

** co-Chair*

System Candidates – Initial Listing

- *Supercritical water-cooled fast reactor*
- *Supercritical water-cooled thermal reactor*
- *Supercritical water-cooled CANDU reactor*
- *IRIS*
- *Small, modular, integral natural circulation LWRs*
- *Tight Lattice BWR thoria reactors*
- *LWRs with homogeneous thoria-urania fuel*
- *LWRs with heterogeneous thoria-urania fuel*
- *DUPIC fuel cycle (with AIROX processing) for LWRs and CANDUs*

Generation IV

Gas-cooled Concepts TWG

Ball, Syd	*ORNL*
Bement, Arden	*Purdue*
Finck, Phillip	*ANL*
**Hildebrandt, Phil*	*Eng. Mgmt. Tech. Inc.*
Kadak, Andy	*MIT*
Shenoy, Arkal	*General Atomics*
**Southworth, Finis*	*INEEL*

**co-Chair*

System Candidates – Initial Listing

- *GT-MHR – Gas Turbine Modular Helium Reactor*
- *Pebble Bed Modular Reactor (PBMR)*
- *Fast Gas Reactor*
- *Very High Temperature Reactor*
- *REMHD – Reactor-Enhanced MHD*
- *Fluidized Particle Bed Reactor (Petten)*
- *Hydrogen Cooled Reactor ("Light-bulb")*
- *AD-MHR: accelerator driven – modular helium reactor (based on ATW)*
- *Industrial Pebble Bed Reactor (Petten – Acacia)*
- *CO_2 AGR Reactor System*
- *Steam Cycle MHTGR*

Liquid-Metal-cooled Concepts TWG

Boardman, Charles	*General Electric*
Lee, John	*U Michigan*
Li, Ning	*LANL*
**Lineberry, Mike*	*ANL*
Omberg, Ron	*PNNL*
**Rosen, Steve*	*So. Texas (ret.)*
Tuohy, Jack	*Burns & Roe*
Wade, Dave	*ANL*

**co-Chair*

System Candidates – Initial Listing

- *EFR, BN-800, DFBR*
- *S-PRISM*
- *BREST*
- *SVBR*
- *4S*
- *STAR-LM and ENHS*
- *STAR (high temperature)*
- *Advanced Energy Conversion*
- *Other liquid metal coolant or fuel*

Non-classical Concepts TWG

*Anghaie, Samim	U Florida
Forsberg, Charles	ORNL
Herring, Steve	INEEL
Klein, Andy	Oregon State U
*Lewis, Dave	ANL
Peddicord, Lee	Texas A&M
Pickard, Paul	SNL
Wilson, Paul	U Wisconsin

*co-Chair

System Candidates – Initial Listing

- *Minimum Entropy Power Reactors: Direct FF energy conversion, nuclear enhanced MHD, ultrahigh temperature cycles*
- *Molten Salt & Organic Cooled Reactors: Graphite matrix core, CERMET core*
- *Liquid and Aerosol Reactors: Molten salt core, granular core*
- *Gas Core & Vapor Core Reactors: Combined fuel & coolant concepts, externally moderated GCR, heterogeneous GCR*
- *Static Nuclear Power Conversion: Thermionics, thermoelectric & AMTEC topping cycles, TPV & photon capture*

System Candidates – Initial Listing

continued:

- *Ultra Low Waste Fuel Cycle Reactors: Integrated actinide burner*
- *Integrated Power & Chemical Cycle Reactors: Power & hydrogen, power & water, process heat*
- *Conductively & Heatpipe-cooled Reactors*
- *One-Piece, Multi-piece Modular Reactors*
- *Advanced Fuel Systems*

Near-Term Deployment Group

Beckjord, Eric	*Consultant*
Braun, Chaim	*Altos Mgmt.*
Davis, George	*ABB Westinghouse*
Hill, David	*ANL*
Klevans, Ed	*Penn State*
**Long, Lou*	*Southern Co.*
**McConnell,Tony*	*Duke Engineering Svcs.*
Rao, Atam	*GE*
Roberts, Tom	*Exelon*
Taylor, John	*EPRI (ret.)*

**co-Chair*

NTDG Charter

- *Describe the actions necessary to successfully deploy new reactors in the U.S. by 2010*
- *Define generation options in a range of sizes to meet variation in market needs*
- *Recommend near term funding for work that will advance near-term deployment*
- *Submit report to U.S. industry and federal agencies*

NTDG Approach

- *Issue a request for information (RFI) to appropriate industry organizations to define current technology, regulatory and institutional conditions*
- *RFI responses will identify perceived gaps or barriers to cost effective implementation*
- *Consolidate and characterize the technical, regulatory and institutional gaps*
- *Develop recommendations to close the gaps*
- *Issue final report to DOE and industry by 30 Sep 2001*

Specific NTDG Steps

- *Recommend joint federal and industry cost-shared efforts to address immediate needs*
- *Meet with industry Task Force to identify current activities and needs*
- *Support development of a new risk-informed regulatory framework for NPPs slated for near term deployment*
- *Plan for demonstration of the early site permitting process by qualifying multiple sites*
- *Standardize economic assessments of plants considering market requirements*
- *Accelerate present efforts on advanced information management and virtual construction simulation*

Fuel Cycle Crosscut Group

Bement, Arden	*Purdue U*
Boardman, Charles	*General Electric*
Crawford, Doug	*ANL*
**Forsberg, Charles*	*ORNL*
Herring, Steven	*INEEL*
Lewis, Dave	*ANL*
Petersen, Per	*UC Berkeley*
**Wade, Dave*	*ANL*

**co-Chair*

Fuel Cycle Categories

- *Once-Through*
- *Non-Recycle Resource Extension in Thermal reactors*
- *Once/Twice Recycle Resource Extension in Thermal Reactors*
- *Non Recycle & Once/Twice Recycle followed by Partitioning/Transmutation*
- *Multiple Recycle in Fast Spectrum Reactors*
- *Multiple Recycle in Thermal Spectrum Reactors*
- *An overview of proposed sustainable cycles based on fast or thermal reactors with waste self-consumption*

Next Roadmap Quarterly Meeting

- *Chicago, IL (held near ANL)*
- *May 8–10 (begins 8 A.M., ends 3 P.M. on 10th)*

- *International participants will attend*
- *Similar format to Denver*

- *Plenary Agenda (May 8, 8 A.M. – Noon)*
  - *Roadmap overview*
  - *Status of Working Groups*
  - *FCCG Report*
  - *Major assignment: Concept summaries*

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