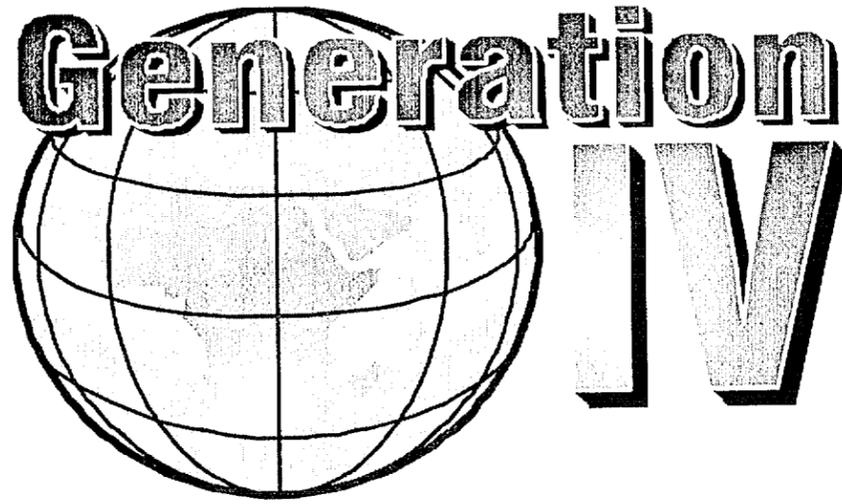


Status of Initial Activities of the Technical Working Groups



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***



Evaluation Methodology Group

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

**** 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***



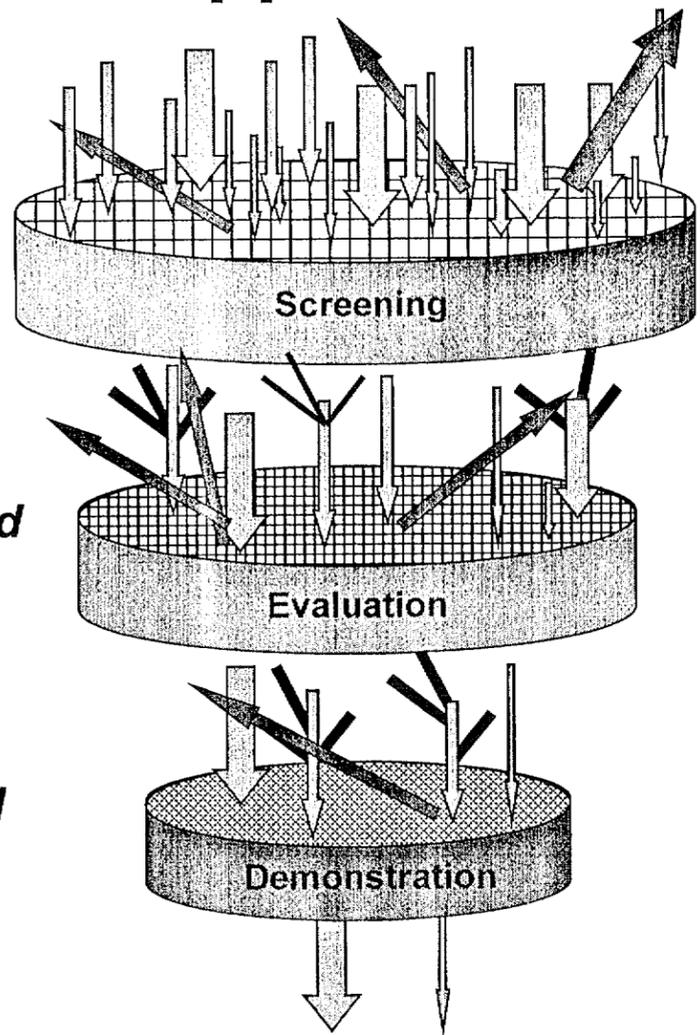
Activities of the EMG

-
- ***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*



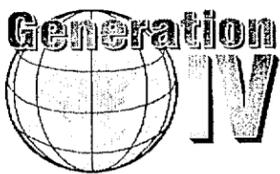
Roadmap Conceptual Approach

- *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*



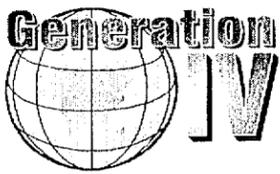
Evaluation Methodology Development

- ***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

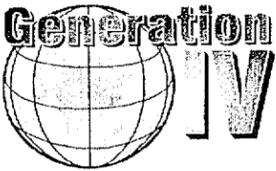
Metric: A standard of measurement (figure of merit)

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*



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

$$\text{Metric: } M = [(F/R)_0 / (F/R)_i]$$

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

Corradini, Mike

****Devine, Jack***

Diamond, Dave

****MacDonald, Phil***

Smith, Noval

Was, Gary

Westinghouse

U Wisconsin

Polestar

BNL

INEEL

Dominion

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 thorium reactors***
- ***LWRs with homogeneous thorium-uranium fuel***
- ***LWRs with heterogeneous thorium-uranium fuel***
- ***DUPIC fuel cycle (with AIROX processing) for LWRs and CANDUs***



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

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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)*
- *CO₂ 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



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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

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



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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

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



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***

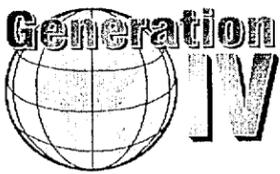
ANL



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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***

