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Joint ICTP-IAEA School of Nuclear Knowledge Management

1 - 5 September 2008

Nuclear Knowledge Management - Experience from Standardized Implementation in Operating US Reactors can assist Existing and Emerging Nuclear Power Countries

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Nuclear Knowledge Management (NKM)

EXCEL Approach to NKM
Existing/Emerging Nuclear Power Countries
New Plant Construction Risk Management

IAEA School of Nuclear Knowledge Management
Trieste, Italy - September 1, 2008

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PART I

EXCEL Approach to NKM

NKM Definition

- **NKM is a well-structured and focused management process:**
  - to fully utilize all relevant information and experience all the time
  - to ensure best possible business performance
- **NKM is a business "Meta-process" (Process made of up of parts of other processes):**
  - a clearly defined and recognized part of nuclear power plant operations
  - ensures sustained optimum performance and economics.

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NKM Drivers

- **NKM became "hot issue" because of generation shift:**
  - most NPP's are nearing 30-40 years in service
  - highly skilled / experienced work force retiring
  - NPP's are refurbished / re-licensed for another 20 years
  - talks about 80 - 100 years NPP life time
  - this means 3 - 4 employee generations
- **NKM has become very important topic in international conferences**
- **IAEA established an NKM Unit (12 staff) in 2002**

NKM – Basic Definitions

- **Knowledge = Information + Skill/Experience**
- **Knowledge means having the skill/experience to use the relevant information appropriately in each situation**
- **Relevant information and sufficient skills are required for correct & efficient actions to be taken.**
- ***NOTE: Possessing relevant knowledge is no guarantee that it will be used appropriately in all situations.***

NKM Scope

Asset Classes:

Physical Capital

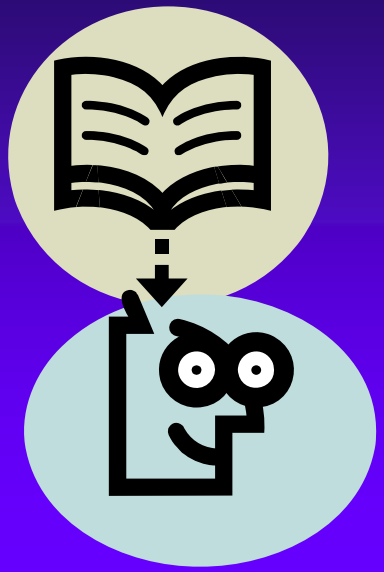
- ***Equipment/Hardware***

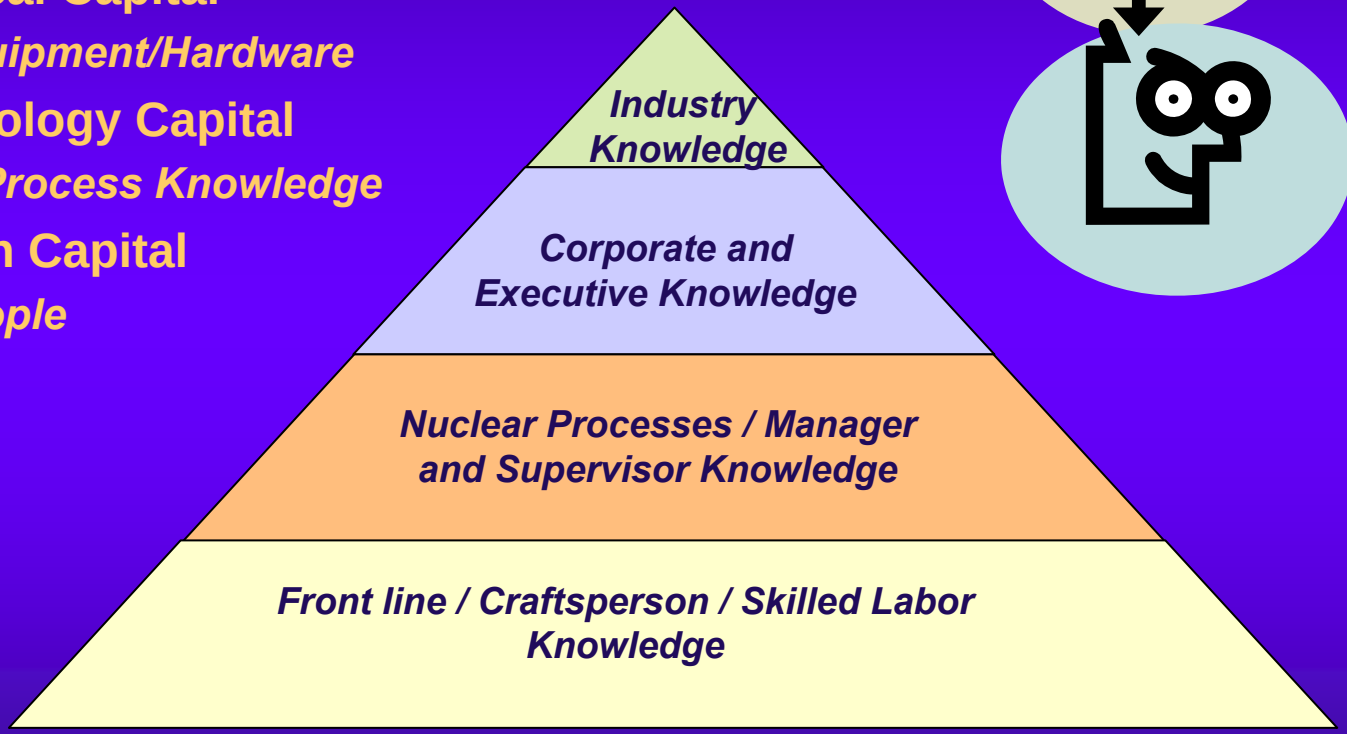
Technology Capital

- ***IT/Process Knowledge***

Human Capital

- ***People***





Each Level and Asset Class requires specific strategies and tools

DEFINITION - Knowledge

Information
Relevant
Up-to-date

Understanding

Skill / Experience
sufficient

ACTIONS
Correct
Efficient
Optimum performance

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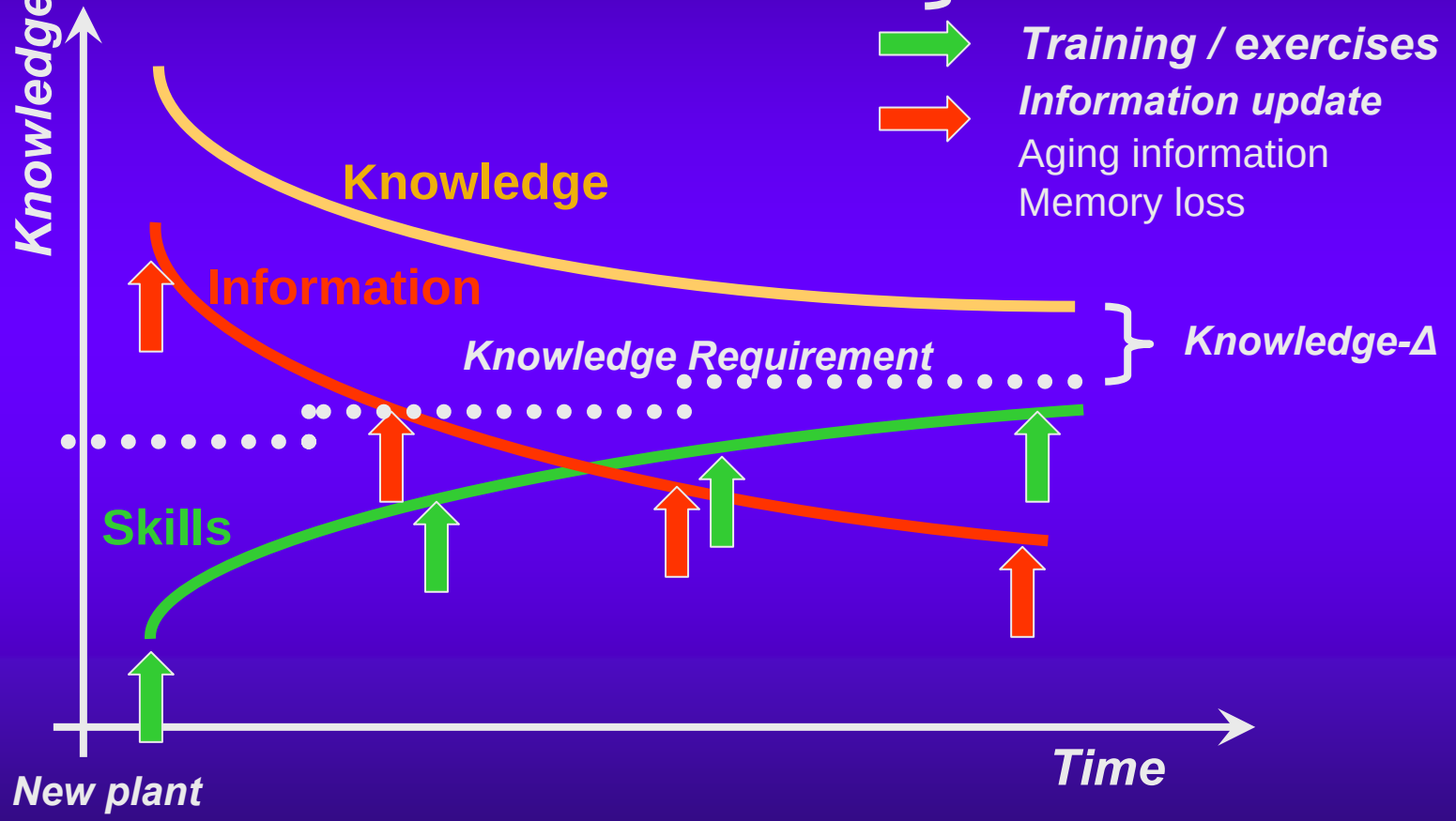
NKM for each Job Position or Team



Need Industry Standard for Knowledge Requirements and Knowledge-Δ

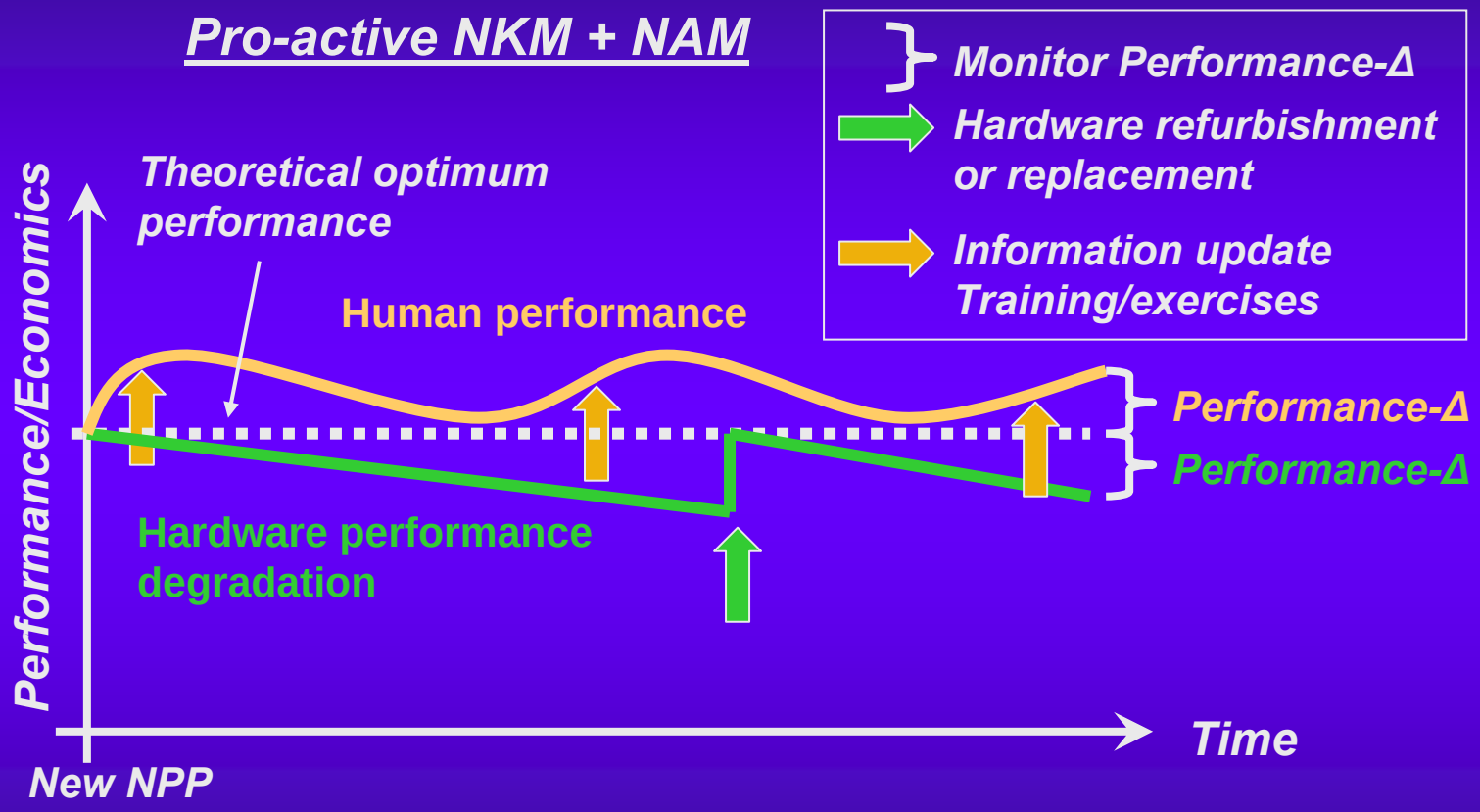
NKM - Focus on People

- **NKM focuses on people and organizational culture to:**
  - stimulate and nurture sharing and use of knowledge on processes or methods
  - find, create, capture and share knowledge
  - use technology to store and make knowledge accessible
  - allow people work together without being located together
- **People are the most fragile component**
- **Managing knowledge depends upon people's willingness to share and reuse knowledge**

NKM in NPP's Today - Description

- **Today - NKM is often:**
  - left to individual managers using their own judgment
  - not explicitly required by their job descriptions
  - not measured nor followed up on systematically
- **Exceptions are directly 'safety-related' jobs:**
  - NPP Reactor Operator Training
  - NPP Emergency Response Team Training
  - NKM is relevant to NPP Safety and is "enforced" under NRC's ROP Rules
  - This is the only NKM standard used/enforced today!

Sustaining Optimum Performance



NKM = managing Knowledge ➔ optimum human performance

NAM = managing assets ➔ optimum hardware performance

NKM + NAM ➔ sustained optimum NPP performance

NKM -Technical Support

- **IAEA – the NKM Leader today**
  - NKM TecDoc-1510 (useful for NKM Self Assessment)
  - NKM Workshop Proceedings 2004, 2005, 2006, 2007
  - International Conferences
  - NKM for Decommissioning
  - NKM for Breeder Reactors
  - NKM Unit (12 people)
- **IAEA/ASSIST (new NKM <u>Review Team</u>):**
  - Darlington
  - Bruce
  - Krsko
  - Kozloduy
  - Paks

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NKM -Technical Support

- **EPRI**
  - Relevant projects aligned to SNPM
  - Equipment Reliability
  - Human Performance
  - Nuclear Asset Management (NAM)
  - Life Cycle Management
  - Materials and Services (Supply Chain Engineering, Item Equivalency and Obsolescence Strategies)
- **High priority projects can be performed jointly with NEI and INPO**

NKM Support – Communities of Practice

- **A Community of Practice (CoP) is:**
  - Expert Peer Groups for most key processes/many international organizations
- **NEI/INPO/EPRI facilitate coordination of CoP's:**
  - **Ownership of Process Methods**
  - **CoP Functions:**
    - Support further benchmarking
    - Cost Definitions
    - Performance Indicators
    - Interface with other CoP's
- **EXCEL is "Informal Integrator" for all CoP outputs**

NKM Support – US NRC

- **ADAMS Web record system**
- **Licensee Docket File for each US reactor unit**
- **Licensee Event Report Data Base (plant events)**
- **Regulatory Oversight Process Data**
- **Generic PRA Models for each reactor technology**
- **NKM program just beginning (EXCEL supporting)**

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NKM Support – INPO & WANO

INPO

- Plant Evaluation Files
- EPIX Equipment Failure Network
- INPO Operating Experience Network
- Robust website / Industry Document Center

WANO

- Peer Evaluations and some assistance

NKM – Why it makes sense

- **Without a fully functional NKM, the NPP Owners risk to lose a large amount of money before end-of-plant life, by:**
  - long term sub-optimum plant performance, and/or
  - a costly incident that could have been avoided
- **Good NKM by itself is not a sufficient condition to achieve sustainable optimum NPP performance and economics, but it is a necessary condition, to avoid potentially costly incidents.**

NKM – Recommendations

- **Develop unified "Total NKM" process and integrate it into the Standard Nuclear Performance Model (SNPM) including:**
  - **existing process to update relevant *Information (Information Management Process NEI AP-907)***
  - **standard process for *Knowledge Requirements***
  - **standard process to measure/monitor *Knowledge-Δ (gap)***
  - **standard Performance Index for *Knowledge-Δ (gap)***
- **Document this standard Total NKM process in a new IAEA NKM Guide (mid-2009).**

KM Generic Process

KM Measurement
- Valuation
- Metrics
- (Effectiveness)
- Diagnosis
- Feedback

Knowledge Implementation
- Culture
- Roadmap
- Maturity

Knowledge Building
- Knowledge Acquisition
- Capture/Augmentation
- Knowledge Utilization
- Knowledge Reuse
- KM Tools
- KM Practices

Knowledge Dissemination
- Knowledge Transfer
- Knowledge Sharing

Knowledge Infrastructure
- KM Body of Knowledge
- Knowledge Retention
- Knowledge Preservation

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KM - Theory linked to NPP Performance

KM Processes

Quality of **KM** Practices

Organizational Effectiveness

Business Results

Surveys, Assist Missions and Meetings

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Proposed NKM Road Map Simplified

- **Visioning Phase**
- **Planning Phase**
- **Performing Phase**
- **Ongoing Phase**

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Proposed NKM Roadmap Detailed

Visioning Phase

- Sponsorship
- Management Planning with Staff and Key Suppliers
- Name Process Owners
- Strategy & Vision
- Complete Survey and Business Case
- Map Culture Path

Planning Phase

- Designate NKM Leadership – Conduct Training
- Establish IAEA NKM Model & NKM Base Platform
- Assess NKM Processes NKM on Inside
- Change Management Plan and Align to NKM Industry partners

Performing Phase

- NPP NKM Process Alignment
- Portal Design
- Key NKM Processes HR, IT, WM, ER, NAM, PI/CAP
- Begin applying NKM to Benchmarking & CoPs
- Cost and Performance Measures
- Performance Management

Ongoing Phase

- Continue Implementation
- Ongoing NKM Benchmarking
- CoP Case Studies
- Continuous Improvement

Summary

- EXCEL is working with the Process-Based IAEA Global NKM Standard Development
- EXCEL is “Thought Leader” for NKM within the American Nuclear Society (ANS)
- EXCEL is collaborating in NKM with the Nuclear Energy Institute (NEI)
- EXCEL is working on NKM with U.S. NRC
- EXCEL’s NKM Implementation Road Map is the right place to start

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PART II

NKM in Existing and Emerging Nuclear Power Countries

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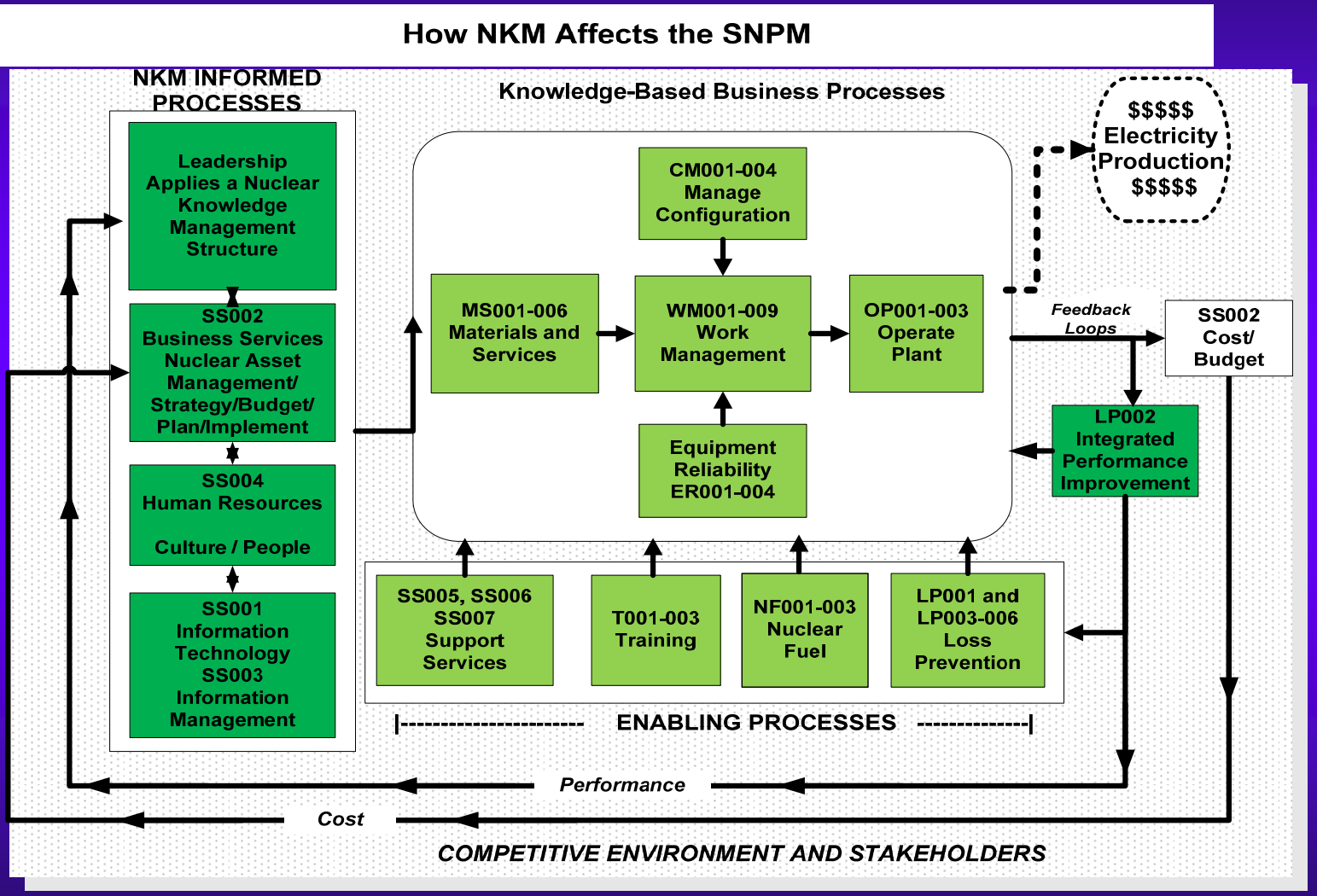
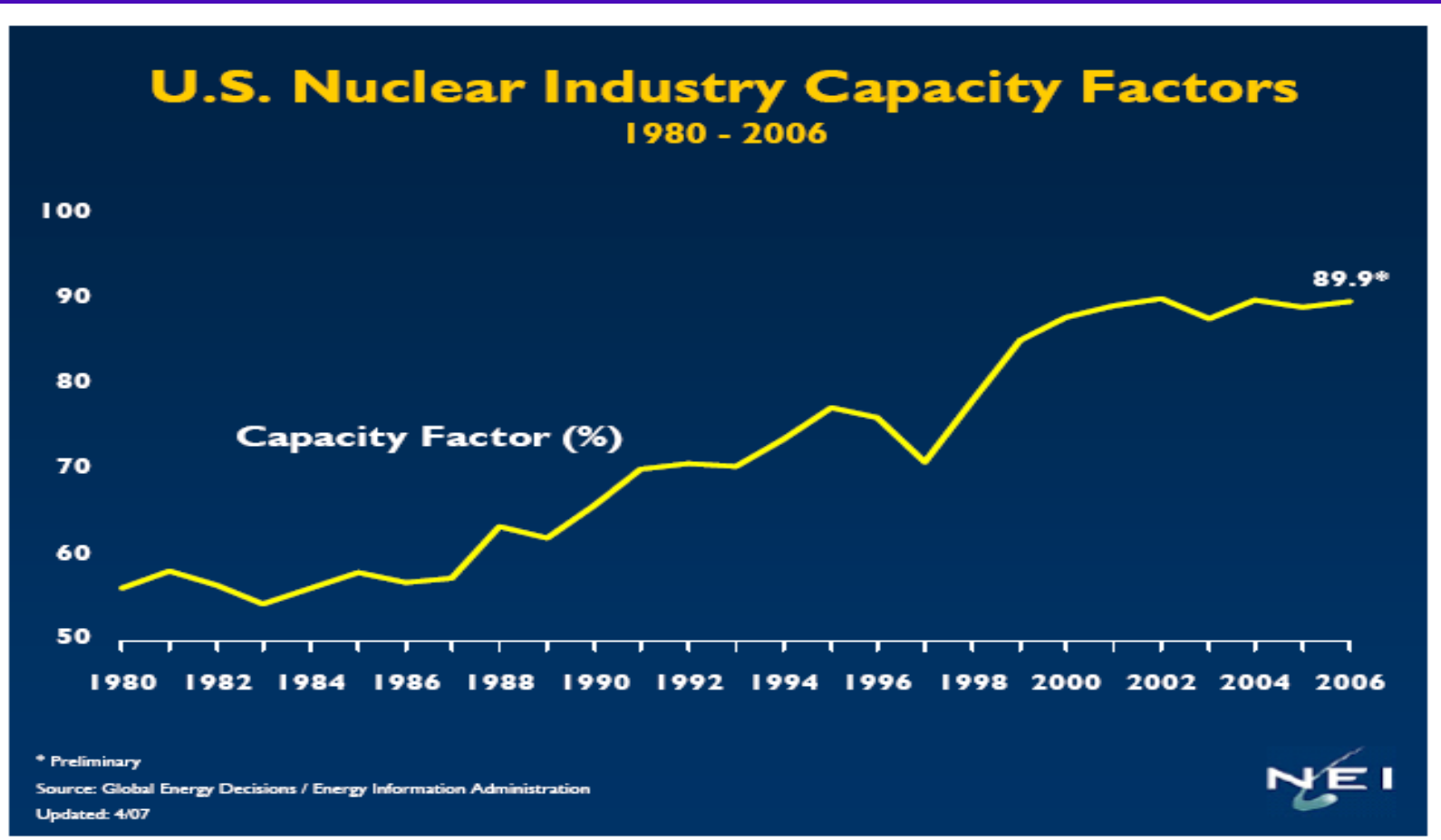
Reasons for applying NKM in "nuclear power" countries

- To increase efficiency of NPP operations driven by deregulation and consolidation
- To capture and manage knowledge for new generations of NPP staff in existing plants
- To apply best practices available through improved technology and expert systems
- To transfer valuable knowledge to new build NPPs – to "flatten the learning curve"

NKM and NPP Performance in U.S.



NKM – Positive Impact
U.S. Capacity Factor Performance



NOTE: Preliminary Capacity Factor for 2006 has been replaced by final value of 90.13%.

Why NKM is a "must" for the Nuclear Community

- Nuclear Industry is a complex business
- All NPPs must perform well for the industry to maintain a good safety reputation
- Sharing of Operating Experience can prevent repeat events
- Sharing of Best Practices creates an increasing knowledge base and improved NPP performance
- NKM is best possible assurance against a major nuclear reactor event

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Benefits of applying NKM in developing countries and future “nuclear” countries

- Applying NKM reduces time and costs to achieve NPP Operational Excellence
- Using NKM from start - re-assures Investors, Insurance Companies, Authorities and Public – that NPP’s will be built and operated by “certified” knowledgeable staff
- No reason for any country to start from “zero” - actually that is not desirable from a Nuclear Community view point
- NKM can help new countries establish proper expectations and good NPP performance in shortest possible time
- Developing countries and future nuclear countries will benefit in short term and long term from NKM by utilizing the vast knowledge and experience base available

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Areas for Potential International Cooperation on NKM

- Licensing and Regulatory Knowledge
- Performance Improvement Methodologies
- Cost and Performance Knowledge
  - WANO Performance Measures
  - Utility Cost and Business Data sharing
- Communities of Practice –Process Knowledge
- IAEA Technical Documents and Guides such as the NKM Implementation Guide for NPPs coming in mid-2009

Summary

- NPPs are looking for practical NKM Guidance
- EXCEL is working with IAEA on a NPP Global NKM Standard (expected by mid-2009)
- EXCEL is
  - "Thought Leader" for NKM within the American Nuclear Society
  - Working on NKM with Nuclear Energy Institute (NEI)
  - Working on NKM with U.S. NRC
- EXCEL's Implementation Road Map is an excellent place to start national NKM programs.

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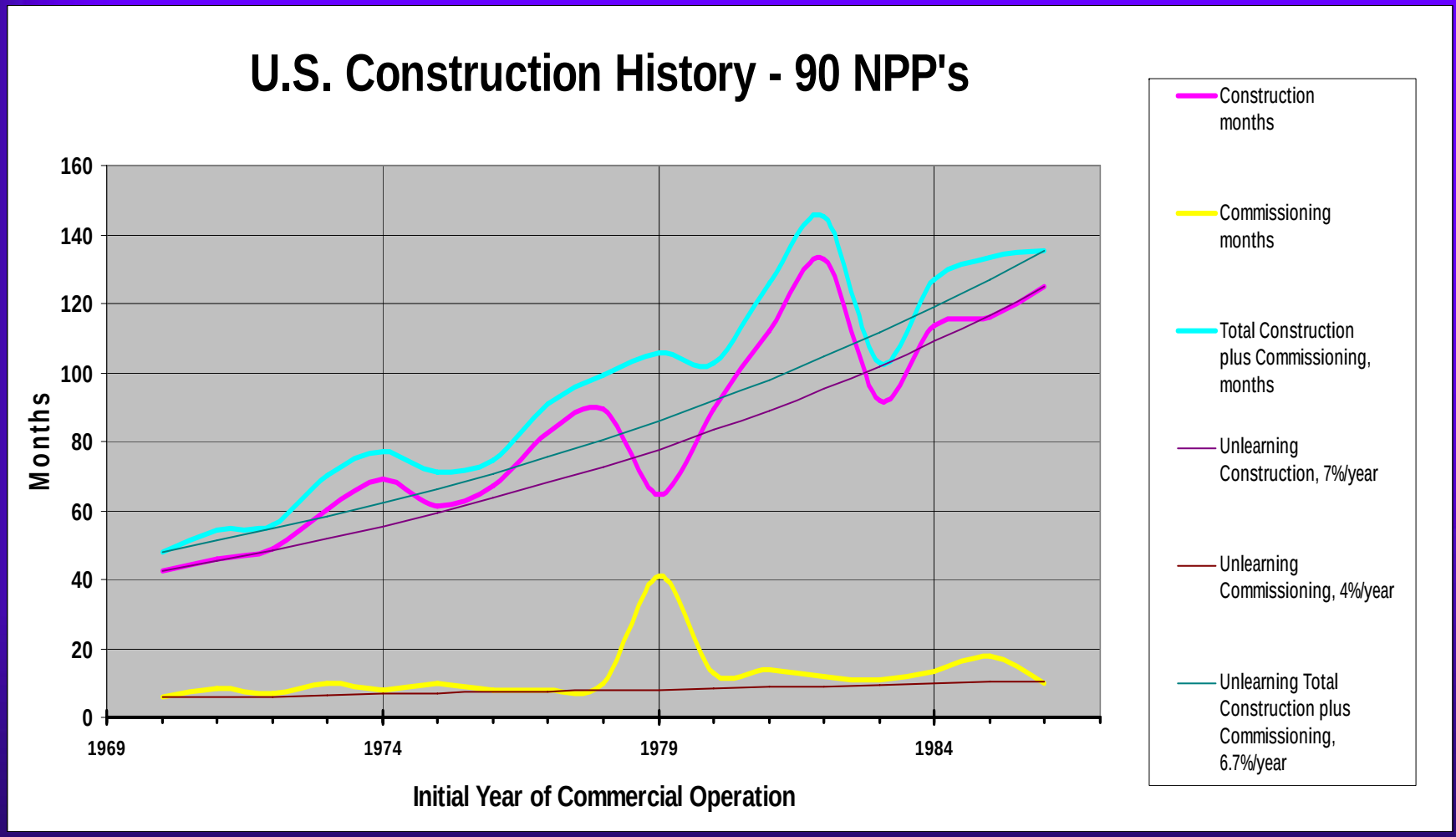
PART III

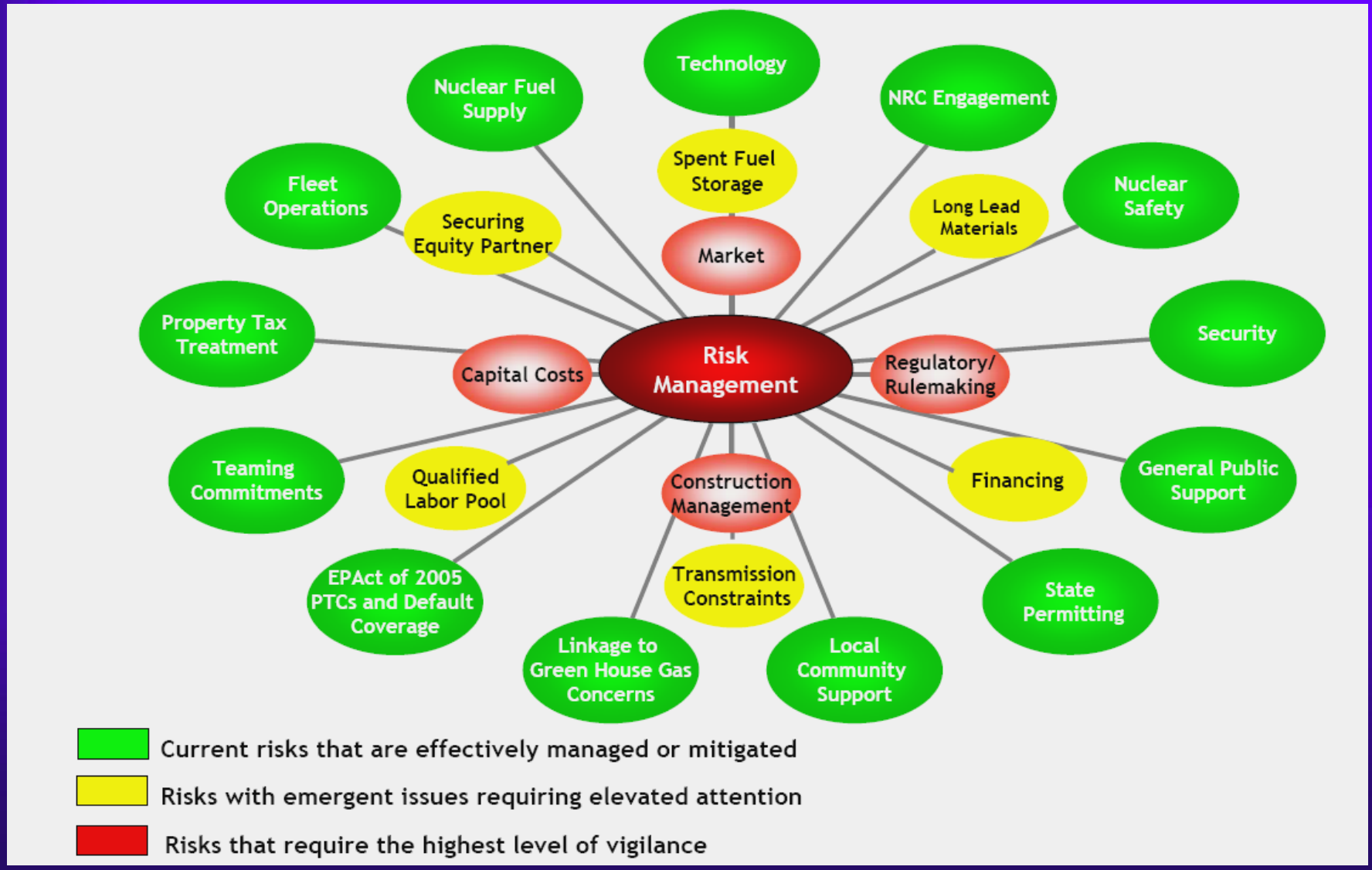
NKM Applications for New Plant Construction Risk Management

Why NKM is needed?



Source: Info Data, Nuclear Power Facts and Figures, Atomic Industrial Forum, July 1987

Major Risk Factors to Consider for NPPs



Source: (Constellation 2007, p.18)

Regulatory Risk During Construction

Managing Risks by Implementing NKM

IAEA Guide: Process-oriented NKM Implementation

- **IAEA project established Dec 2007 – NKM Guide available by mid-2009**
- **Scope of NKM Guide**
  - Role of Leaders
  - Introduction/History/Objectives/Scope/How to use Manual
  - Linking NKM to NPP Processes and Performance
    - Benefits
    - Process Overview and examples of "Where is the Knowledge"
    - Value of process integration
    - Example: Integration of Performance Improvement
    - Examples of Key Performance Indicators
- Summary of NKM Approaches
- Implementation and NKM Road Map
- Periodic NKM Assessment/Survey
- Conclusions and Recommendations

New Plant Construction Risks

Construction Risks to be mitigated	Examples of NKM Applications/Tools
Lack of Utility NPP Construction Experience	*NKM Guide* *NPDPM Tool, COT*
Lack of Managers with NPP Construction Experience	*NKM Guide* *NPDPM Tool, COT*
Lack of experienced NPP construction workforce	*NKM Guide* *NPDPM Tool, COT*
Lack of new Plant Licensing Experience	*RCM Tool*
NPP design work incomplete at construction start	*RCM Tool* *COL process*
Lack of FOAK construction experience for new build plant designs	*NKM Guide* *NPDPM Tool, COT*

New Plant Construction Risks

Construction Risks to be mitigated	Examples of NKM Applications/Tools
Lack of nuclear construction QA & Safety culture (self inspection inefficient)	*NKM Guide* *NPDPM Tool, COT* *NEI 08-02 Guide*
Unrealistic cost estimates and time schedules	*NPDPM Tool*
Over confidence in new plant planning tools	*COT*
Lack of experience managing / coordinating a large project with up to ~2500 subcontractors (impact of culture differences)	*NKM Guide* *NPDPM Tool, COT* *NEI 08-02 Guide*
Lack of focus on conventional BOP and TG island	*NKM Guide* *NPDPM Tool, COT* *NEI 08-02 Guide*

New Plant Construction Risks

Construction Risks to be mitigated	Examples of NKM Applications/Tools
Configuration Management during New Plant Construction	*RCM Tool*
Lack of Utility, Vendor, Constructor understanding of ITAAC Process	*RCM Tool* *NEI 08-01 Guide*
Insufficient training of new Operators and Plant Staff	*ITS*
Insufficient Supplier Capacity – supply bottlenecks	*NPDPM Tool*
Financial risks – cost/schedule overruns, interest during construction	*NPDPM Tool* *COT*
Political risks – loss of public/political support dependent on successful project execution	*NPDPM Tool* *COT*

Examples of NKM Applications/Tools

- **New Plant Deployment Program Model (NPDPM)**
- **Improved Technical Specifications (ITS)**
- **Regulatory Compliance Matrix (RCM)**
- **Construction Oversight Tool (COT)**
- **These NKM Applications/Tools are useful/valuable for all stakeholders of existing NPPs and new Plants:**
  - **Regulators (simplify compliance/verification & communication)**
  - **Utilities/Owners/Consumers/PUC (independent/3rd party)**
  - **Vendors (requirements defined)**
  - **Plant Operators (best practices/experience sharing)**
  - **Investors (reduced risk premium)**
  - **Insurance (risk monitoring/understanding)**
- **Allow generation-shift and worldwide experience sharing**
- **Capture/implement lessons from FOAK new build NPPs**

Description - NKM Applications

- **New Plant Deployment Program Model (NPDPM)**
  - Addresses site selection, licensing, financing, and overall plant deployment
  - Characterizes all activities from decision-making to commercial operation, including activity durations, logic relations, and support requirements
  - Includes vendor selection, contracting strategy, site configurations, control room design, contractor procurement, regulatory engagement, transmission access, and emergency planning
  - Activities and actions are summarized in a deployment schedule that is linked to an underlying assumptions table
  - Assists in developing initial schedules for new plant deployment
  - Provides a central repository of expert opinion on a variety of deployment topical areas, as a check-and-balance for a utility's scheduling activities
  - Useful for developing comprehensive schedules, identifying and analyzing critical path activities, preparing first-order estimates of resource requirements, and monitoring progress, as well as in documenting assumptions, limitations, information gaps, and uncertainties.

Description - NKM Applications

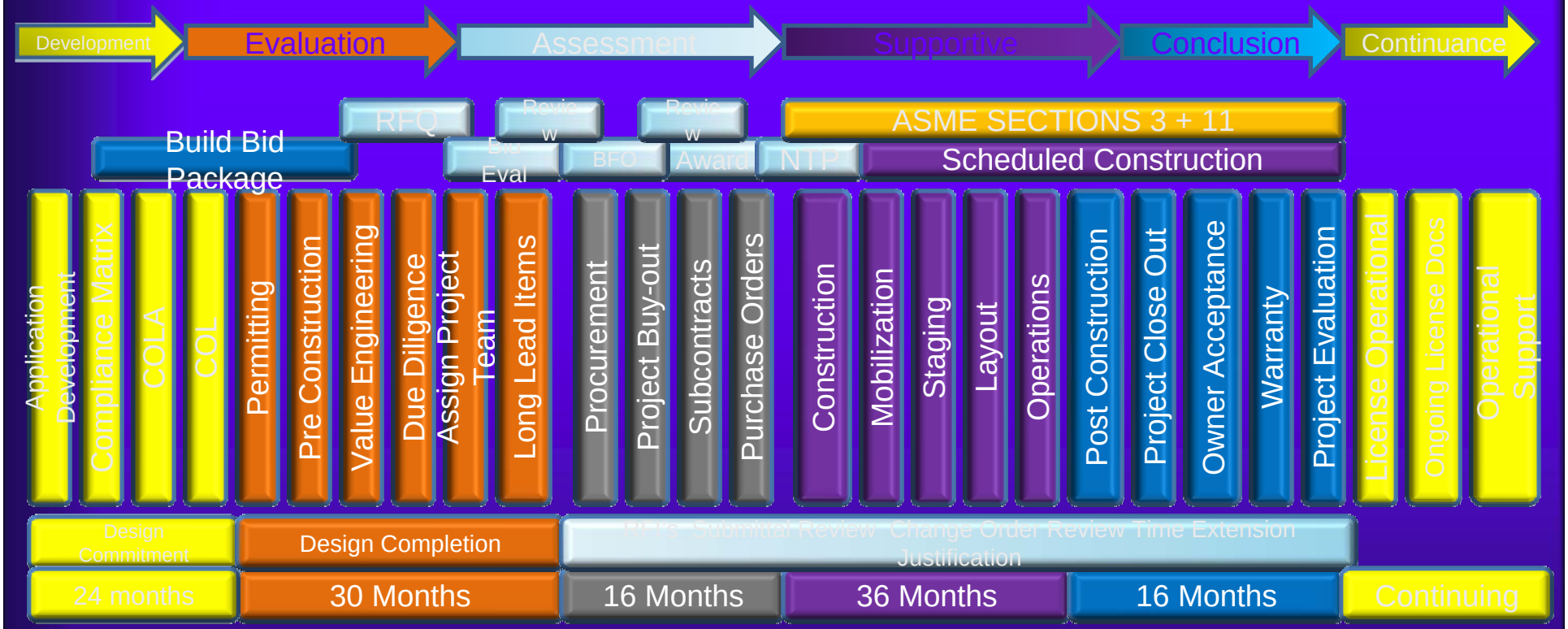
- **Improved Technical Specifications (ITS)**
  - **Captures & preserves valuable knowledge from experienced operating staff from existing NPP fleet**
  - **Allows industry-wide sharing of best practices**
  - **76 of 104 US NPPs use ITS today**
  - **All U.S. new build NPPs (ABWR, MHI/APWR, AP-1000, EPR, ESBWR) use ITS**
  - **AES-92 and ACR-1000 have not adopted ITS**

Description - NKM Applications

- **Regulatory Compliance Matrix (RCM)**
- **Place all regulatory requirements (e.g., local, NRC) in a clickable-link Table (Matrix) with columns for the Regulator, Supplier and Utility - to show/document:**
  - **Compliance Status**
  - **Compliance Issues**
  - **Recommended courses of action**
- **Identify each method (clickable link to Ref Doc) credited to meet the requirements**
  - **Identify issues associated with partial- or non-compliance**
  - **Identify recommended courses of action to solve the issues**
- **Develop RCM as part of the Technical Specification package for a new build NPP (eliminate uncertainties)**

Description - NKM Applications

Construction Oversight Tool for new build NPPs



Prior to bid release the Construction Oversight Tool helps establish milestones that will set the pace and accountability. Once commitment to construction has commenced all efforts will focus on monitoring and meeting schedule and budget – pro-active Construction Oversight helps avoid costly surprises.

Summary

- New Plant Construction Risks can be managed and minimized using available NKM Applications/Tools. Examples of newly developed NKM Tools/Guides are:
  - **New Plant Deployment Program Model (NPDPM) – Planning Tool**
  - **Construction Oversight Tool (COT) – Independent Construction Oversight/Monitoring**
  - **Regulatory Compliance Matrix (RCM) Tool –Well-defined Regulatory Requirements & Communications between Vendor/Utility/Regulator**
  - ***IAEA NKM Guide for NPPs (mid-2009)***
  - ***NEI 08-01: ITAAC Closure - Guidance Document***
  - ***NEI 08-02: Problem Identification and Resolution for New Power Plants During Construction, Draft Rev 0***

Summary
NKM for New Plant Construction

- Goal is to avoid repeating earlier U.S. NPP fleet construction history
- Absent an experienced Construction Team building their 10th NPP, Utilities can only resort to using best available practices and lessons learned on FOAK new plant construction sites
- NKM Applications/Tools are excellent options to achieve successful transfer of valuable experiences and best available practices – albeit still not covering all aspects/risks of new build NPP projects.