World Nuclear Association

Pilot Project Proposal from WNA-CORDEL

Prof Nawal K Prinja, CORDEL Codes and Standards Task Force chairman

MDEP Conference, Paris 15-16 Sept 2011

Pilot Project for Harmonisation of Codes & Standards applicable to nuclear reactor designs

Content

1. Introduction to WNA and CORDEL

2. Link with the MDEP Code Comparison Project

3. Scope of the Pilot Project

4. Design
   - **Allowable Stress Limits**
   - **Analysis methods**
   - **NDE methods**

5. Qualifications
   - **Engineers**
   - **Welders**
   - **NDE operators**

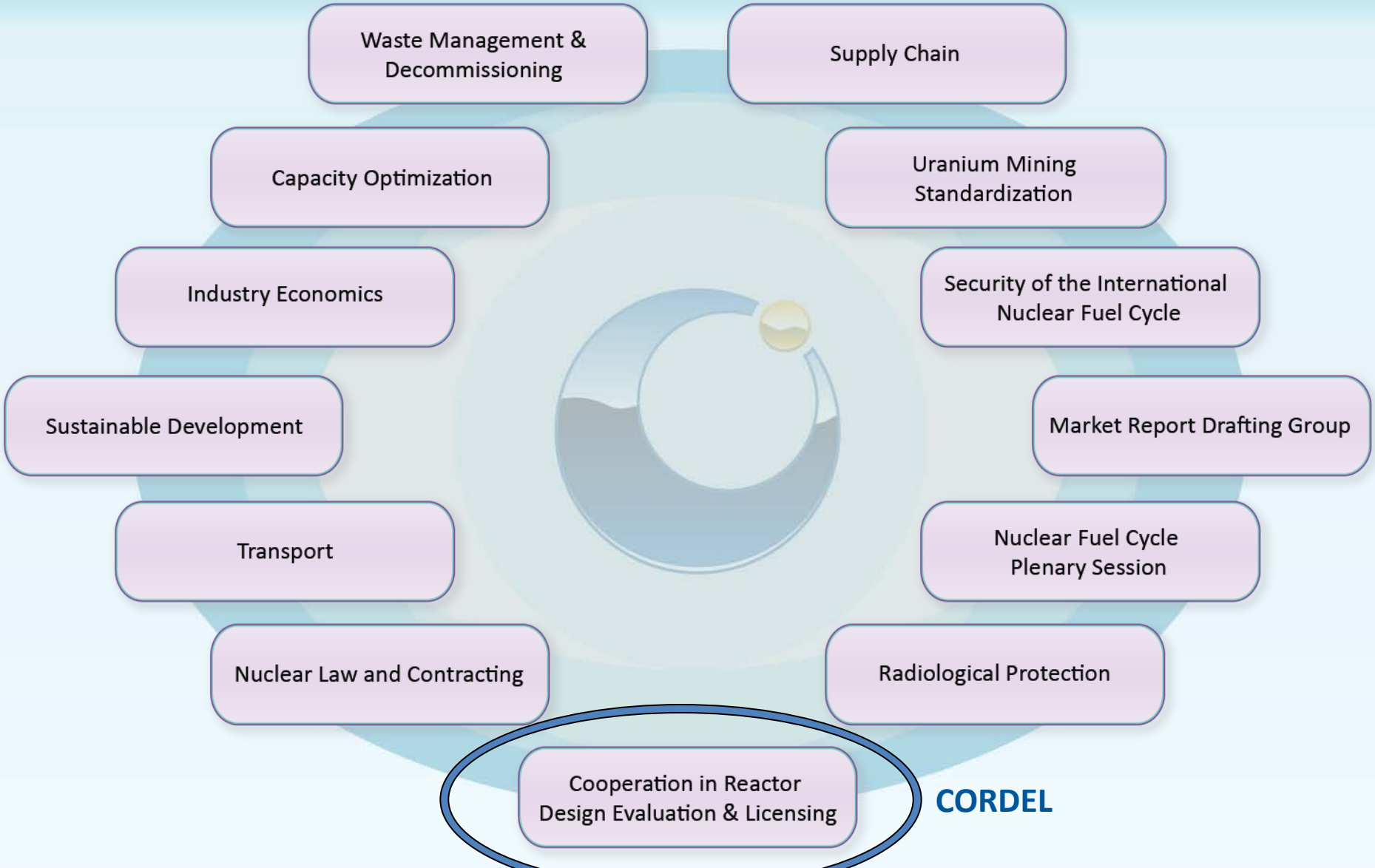
6. Project Plan

7. Resources

World Nuclear Association

Enabling Industry Contacts & Cooperation:

WNA Working Groups



The CORDEL Working Group

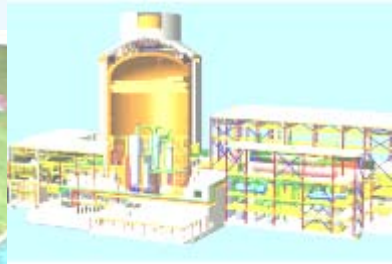
CORDEL - Cooperation in Reactor Design Evaluation and Licensing

- **Main aim: promoting international standardization**

- **Membership**: all major vendors, utilities interested in new build, service companies and observers from int'l organisations

- **International standardization means** that each vendor's design can be built in any country under national regulations which have been "harmonized" to a set of international requirements and standards

- **Standardized advanced plants will bring economic advantage and additional safety layers in all stages: design, construction, operation and decommissioning**



CORDEL – commitment from industry

13 April 2010, 12 Leading Nuclear Companies' CEOs published a letter of support for CORDEL:

- John Ritch, DG, WNA
- Anne Lauvergeon,CEO, Areva
- Hugh MacDiarmid, CEO, AECL
- Henri Proglio, CEO, EDF
- Wulf H Bernotat, CEO, E.On
- Christopher Crane, President & CNO, Exelon
- Jack Fuller, CEO, GE-Hitachi
- Masaharu Hanyu, President, Hitachi-GE
- Akira Sawa, Director, Nuclear Systems, Mitsubishi Heavy Industries
- Ichiro Takekuro, CNO, Tokyo Electric Power Co
- Yashuharu Igarashi, CEO, Power Systems Toshiba
- Aris Candris, CEO, Westinghouse

Recipients:

- Yukiya Amano, DG, IAEA
- André-Claude Lacoste, Chairman, Multinational Design Evaluation Program (MDEP)
- Luis Echávarri, DG, OECD-NEA
- Andrej Stritar, Chairman, ENSREG

cc: Laurent Stricker, Chairman, WANO

See www.world-nuclear.org → Publications

2008

2010

WNA Board

Board Mentor for CORDEL is Aris Candris, CEO of Westinghouse

CORDEL Group

(representatives of 48 companies and organisations)

Steering Committee

Chairman, Vice Chairman

12-15 Representatives of Vendors and Utilities

Task Forces

- Design Change Manage-ment
- Licensing & Permitting
- Codes & Standards
- IAEA Safety Standards revision
- Probabi-lisitic Safety Goals
- Others

TF Chairs : experts from WNA member companies

CORDEL - Action Plan 2011

- **Interaction with MDEP** & other regulatory initiatives
- **IAEA safety standards**: continuous participation in revision
- **Design Change Management Task Force (TF):** develop institutional mechanisms in the industry to enable compliance with standardization throughout standard fleet's lifetime
- **Standards and codes TF:** cooperation with SDOs of various countries in convergence of industry codes
- **Probabilistic safety goals TF:** promotion of harmonization of industry's methodologies and values
- **Licensing and permitting TF:** industry interests – efficiency & risks reduction; also in support of emerging markets
- **SMRs TF:** encouraging commercial development

Promotion of Harmonization of Standards and Codes

- **WNA CORDEL is one of many stakeholder in the Industry sector**
  - Interfaces with regulators and standardization organisations
- **Support to existing initiatives for comparison and towards harmonization of standards and codes**
  - MDEP working group on digital instrumentation and controls (with IEEE and IEC)
  - Contacts with ISO TC85 for more ISO endorsements of national standards
  - Possible future initiative on concrete structures codes
  - **MDEP work on mechanical codes : ASME III, AFCEN (RCC-M), KEA (KEPIC), JSME (S-NC1): 1st priority**

11

MDEP Code Comparison Project

Main Reasons for Differences in the Codes & Standards

- General Requirement Practices
  - Quality Assurance Requirements (NQA-1, ISO 9001, IAEA 50/SG)
  - Conformity Assessment (Stamping, RPE)
  - Local qualifications for welding and NDE
  - Local reference materials
- Scope of Codes
  - CSA – Candu reactors
  - AFCEN – PWR
  - ASME, JSME, KEA, and CSA – BWR, PWR, Candu
- Flexibilities allowed due to variation in country practices
  - Operational experience (prescribed in AFCEN)
  - Design and Analysis Flexibility (analysis methodology specified in AFCEN)

Harmonisation

- It is recognised that all differences cannot be resolved but some progress towards convergence and mutual recognition could be achieved in the short- to medium-term.
- The proposed Pilot Project will be focused on design codes and standards only in the two areas :
  - Technical design
  - Personnel qualifications.
- The need to harmonise does not imply non-compliance but should be considered as achieving equivalent status in other countries.

Scope of the Pilot Project

- Select some of the specific topics from the Code Comparison Project
- The proposal is based on the discussions held with the SDOs and MDEP/CSWG in April 2011 and Aug 2011.
- There are two areas of priority :

  1) the stress allowables and analysis methods used in the design of pressure equipment

  2) qualifications of welding and NDE/T operators.

- The pilot project is to be run in agreement with the SDOs and Regulators (CSWG members) based on the acceptance in principle to harmonise the design codes and the associated QA requirements.

Design Issues

<u>In order of priority</u>

- Allowable stress limits
- Nonlinear analysis
- Permitted Analysis Methods
  - Plastic collapse, shakedown, fatigue, seismic
- NDE methods
- Evaluation of Nozzle Loads
- Vessel openings/ Penetrations and Reinforcements
- Material specifications
- Mechanical Joint Design Methods
- Jurisdictional boundaries
- Overpressure protection

Basis for stress categorisation

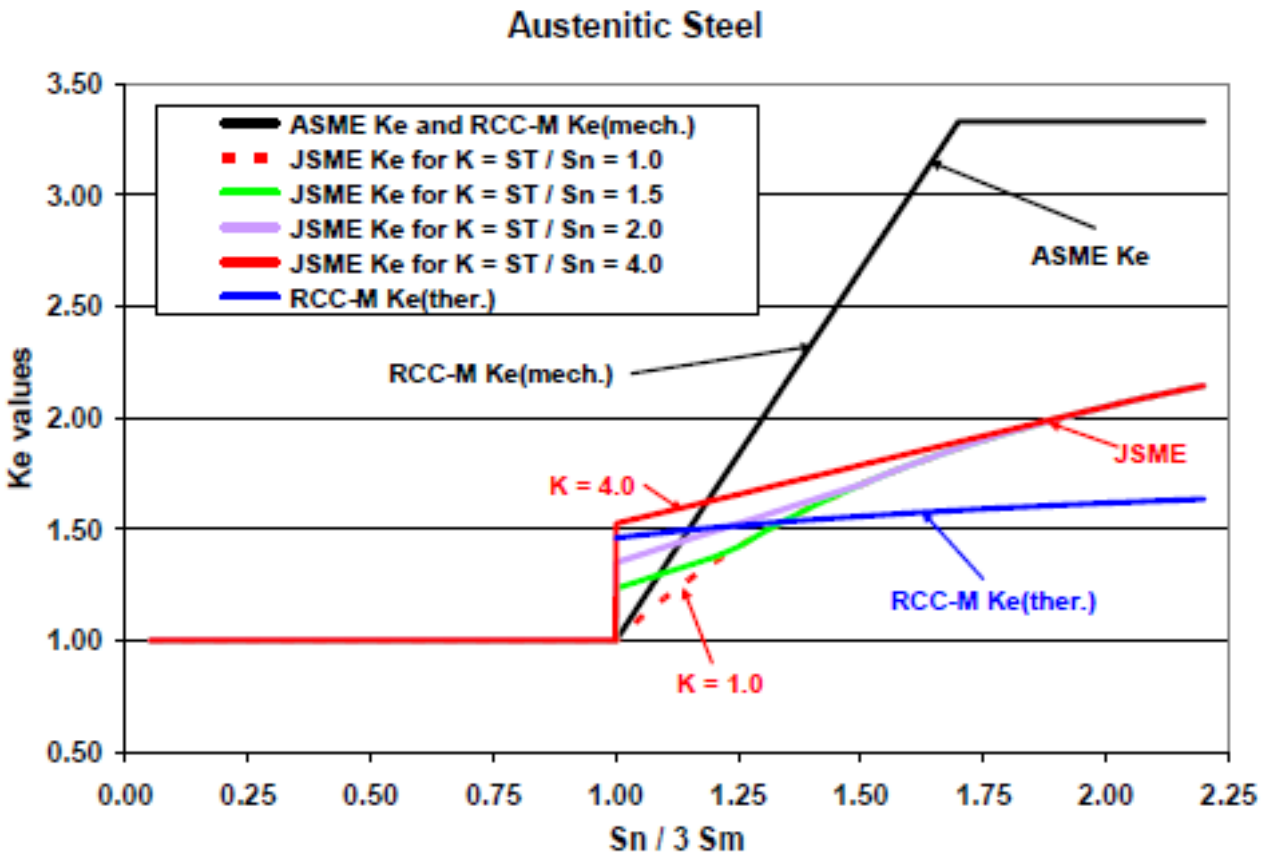
- Codes do not correlate FEA stress distribution to failure modes. So it is open to interpretation.
- Code limits were developed for 1D or 2D geometries but now it is common to use FEA for 3D geometries
- Harmonisation of methods to extract membrane & bending stresses from 3D nonlinear distributions
- Harmonisation of Primary + Secondary range
- General guidance on linearisation and design code compliance

Allowable Stress Limits

- The standard classification of stresses used in design codes
- Harmonised definition of events under "normal", "upset", "emergency" and "faulted" conditions. Earthquake and other dynamic events also assessed differently. These approaches should also be harmonized
- The allowable stress limits (Primary, Secondary, Peak and their combinations for different Service levels representing normal, abnormal and extreme events)
- Limits for cyclic loads (mechanical, thermal and combinations) and analysis methods
- The numerical procedures used to post-process stress analysis results particularly the application of stress linearisation procedures

Example: Variation in the Ke Factor for Fatigue Assessment in Different Codes

Figure 1: Comparison of Ke functions [ASME-Code vs. JSME-Code vs. RCC-M]



Notes:
1.) the RCC-M Ke(ther.) is to be applied on the axial temperature gradient stress range (Ta / Tb stress) and on the radial temperature gradient stress range (DT1 and DT2 stresses)
2.) the B31.7 Methodology is not shown in the Figure above.

K is the Stress Conc Factor

Taken from SMiRT -19, Toronto paper F04/2 by Rami Hawileh et al (Areva)

Qualifications

- Registered Professional Engineers
  - Competency measures for analysis and design
  - Survey of available competency profiles
  - Draft harmonised profile
- Welding qualifications
  - Types of welds
  - Performance qualifications
  - Renewal of qualifications
  - Harmonised training profile
- NDE/T personnel certification
  - Training and experience hours
  - Testing and recording of competency

Professional Engineer Qualifications

- We understand ASME is considering to update its section NB5500
- That could be an opportunity to work with ISO and achieve harmonisation with ISO 9712
- EU is funding EASIT2 project for harmonisation of analysts skills and training
- To be focussed on design and analysis competencies

Project Plan

- Develop details after discussions with SDOs on 6 Aug in Boston
- CORDEL members to nominate experts from their companies to participate in this work.
- 13 September 2011, London: CORDEL C&S TF meeting
- 15-16 September, Paris: CORDEL C&STF reports at the MDEP Conference. The future actions will be determined accordingly.
- Appoint experienced consultants to conduct technical reviews of codes comparison.
- A communication plan of promoting Codes and Standards harmonization with governments and law makers to be developed.
- Seminar on C&S Harmonisation.
- Interactions with the following standards organisations is planned:
  - ISO
  - IEEE, IEC and other electrical and Digital I&C standards organisations
  - Civil & structural codes organisations (ASCE, ACI and Eurocode committees etc)
- Further plans to be determined during CORDEL September 2011 and January 2012 meetings.

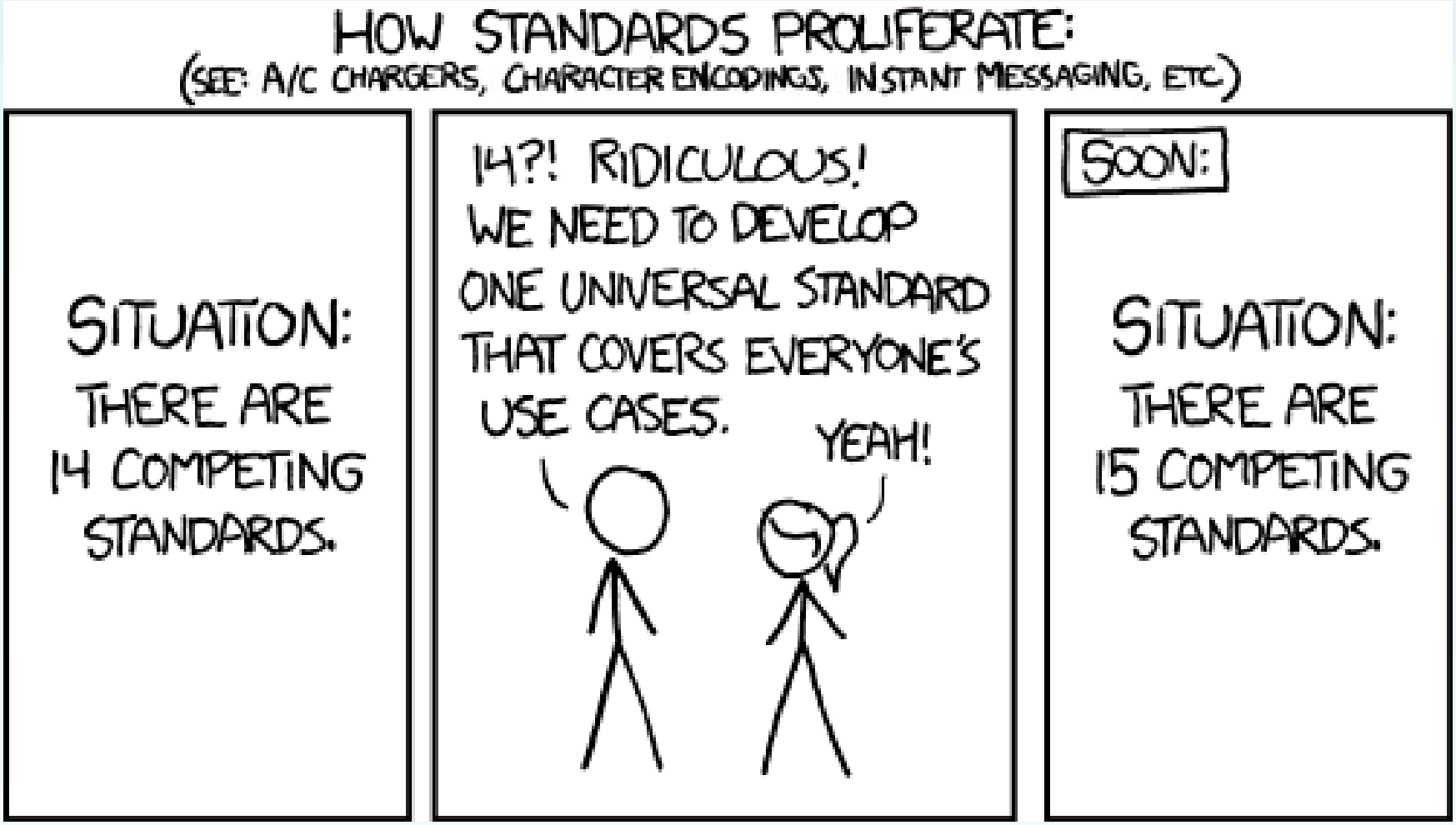
Resources

- CORDEL C&S TF Chair: Professor Nawal Prinja (Technical Director of AMEC and Hindustan Construction Company), over 31 years of experience in different types of nuclear reactors with specific responsibility for codes and standards in his company
- International Experts: One or two experts on NDE/T qualifications and certification will be engaged by CORDEL as consultants for this pilot project.
- Technical Officer: WNA has employed a PhD researcher Andrew Wasylyk who has knowledge and experience of structural integrity issues.
- Administration: The project will be administered by the WNA Secretariat in London under supervision of Irina Borysova.

Dissemination

- The outcome of this Pilot Project will be disseminated through
  - SDOs
  - MDEP
  - ISO
  - WNA / WNU
  - Stakeholders from Industry

Thank you!


HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)
SITUATION: THERE ARE 14 COMPETING STANDARDS.
14?! RIDICULOUS! WE NEED TO DEVELOP ONE UNIVERSAL STANDARD THAT COVERS EVERYONE'S USE CASES.
YEAH!
SOON:
SITUATION: THERE ARE 15 COMPETING STANDARDS.

World Nuclear Association

Visit us at

www.world-nuclear.org