CONSTRUCTION EXPERIENCE PROGRAM (CONEX)

Atlanta NEA/CNRA International Workshop

24-26 October 2012

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CSN

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Presentation Outline

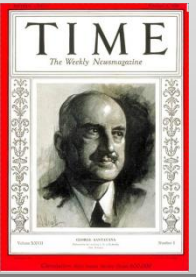
1. Rationale and goals of CONEX program
2. CONEX database structure
3. Uses of CONEX to create KNOWLEDGE:
   - ❑ CONEX reports
   - ❑ Application to inspector training (safety cards)
   - ❑ Application to inspection procedure

1. RATIONALE AND GOALS OF CONEX PROGRAM

Rationale and goals of the ConEx Program

CAN WE LEARN FROM PAST CONSTRUCTION EXPERIENCES OR ARE WE CONDEMNED TO REPEAT THEM?

- ***CONEX PROGRAM MAY BE ONE OF THE ANSWERS***

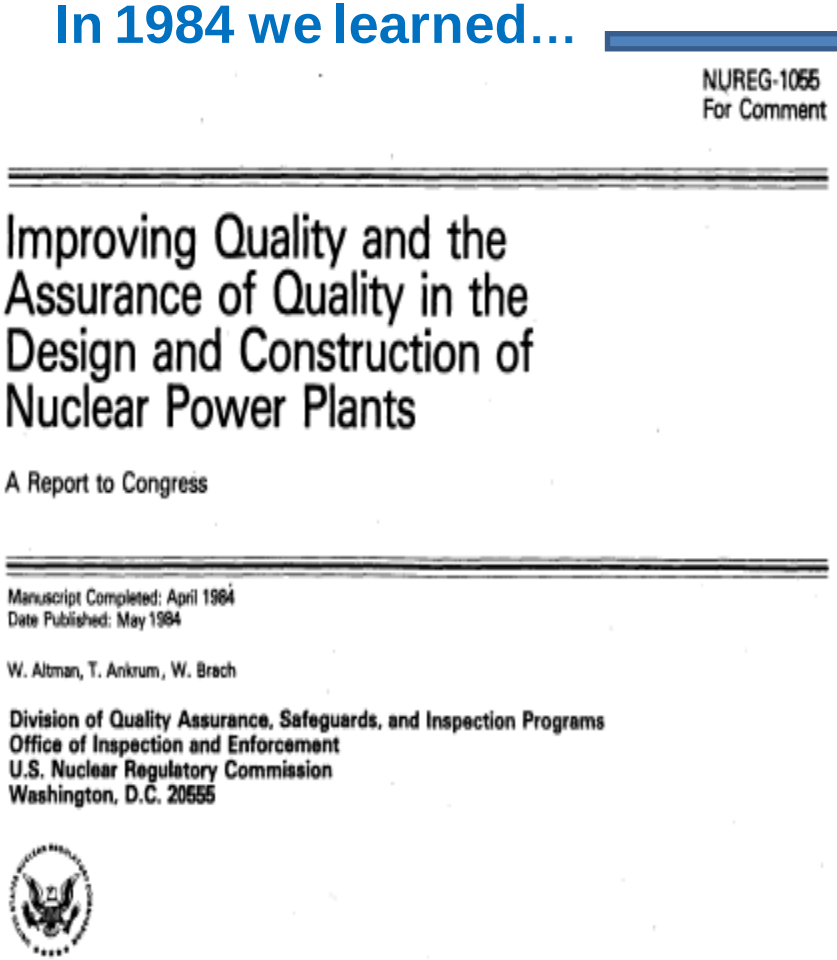


Those who cannot remember the past are condemned to repeat it.

George Santayana, The Life of Reason, Volume 1, 1905
US (Spanish-born) philosopher (1863 – 1952)

Rationale and goals of the ConEx Program

In 1984 we learned…



NUREG-1055
For Comment

Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants

A Report to Congress

Manuscript Completed: April 1984
Date Published: May 1984

W. Altman, T. Ankrum, W. Brach

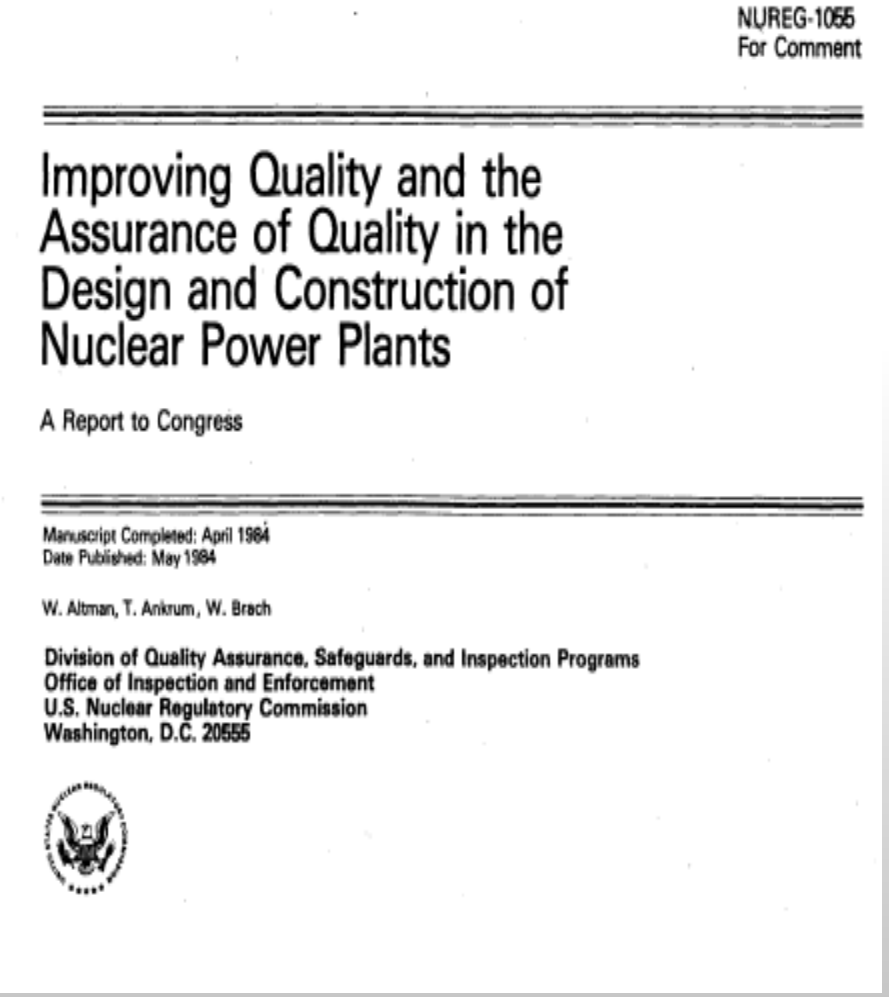
Division of Quality Assurance, Safeguards, and Inspection Programs
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

LESSONS FOR THE NUCLEAR INDUSTRY

- Experienced Project Team (architect, vendor, contructors, etc)
- Maximum degree of design completion before construction
- Monitor contractor performance
- Management commitment to quality
- Management oversight of the project and contractors
- Encourage problem communication through effective communications vertically and horizontally in the project organization

Rationale and goals of the ConEx Program

In 1984 we also learned…



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LESSONS FOR THE NRC

- Audit licensee experience and qualifications (not uniform level of industry and licensee competence)
- Audit complete QA program
- Comprehensive picture with a global Inspection Program. Focus not only on paperwork but in work in progress and QA implementation
- Third party audits to supplement NRC inspections
- Definition of contractor support needs to NRC inspections

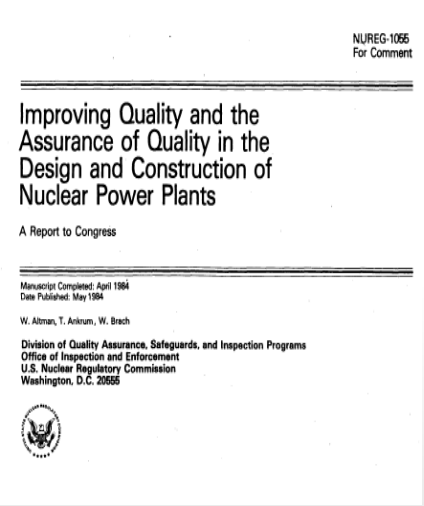
Rationale and goals of the ConEx Program

In 2012 from ongoing projects new lessons have come up !!

- Regulatory framework in the country of construction (clear safety criteria, early definition of hold points, etc)
- Design completion and management (change management, interfaces, clear requirements,etc)
- Experience and know how of the licensee and vendor, management of subcontractors (length of supply chain, experienced contractors, human resources,etc)
- New and advanced manufacturing technology (qualification of new methods, qualification of manufacture first pieces, etc)
- Role of Quality Management (definition non conformances, nuclear requirements vs conventional ones, etc)
- Licensee's responsibility. Safety culture
- Regulatory oversight and inspections

Rationale and goals of the ConEx Program

Conex will allow to transform past experience into knowledge for current and future projects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1984 — Construction initiation — 2005 — 2006 — 2009 — 2010 — 2011 — 2012

Commercial Operation Dates

Olikuoto 3 and Flamanville 3 in 2013

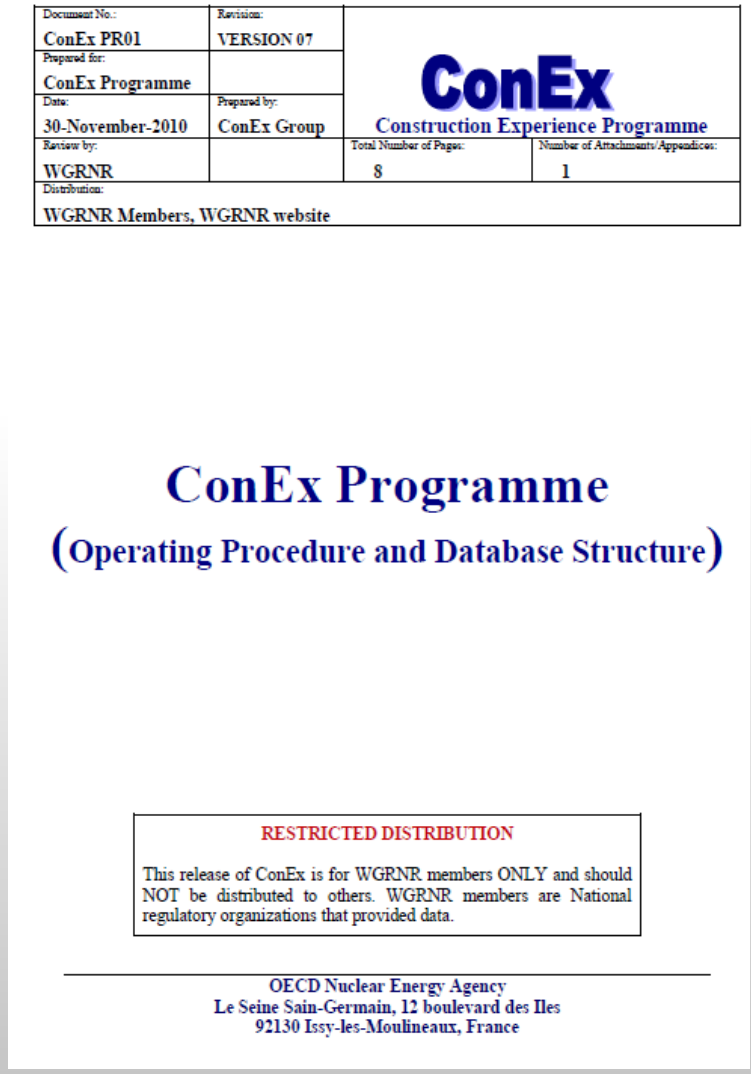
Taishan Unit 1, Sanmen 1 and Haiyan 1 in 2013

Bakra commercial operation 2017

Votgle 2016

2. CONEX DATABASE STRUCTURE

CONEX database structure



Document No.: ConEx PR01	Revision: VERSION 07	ConEx Construction Experience Programme	
Prepared for: ConEx Programme			
Date: 30-November-2010	Prepared by: ConEx Group		
Review by: WGRNR		Total Number of Pages: 8	Number of Attachments/Appendices: 1
Distribution: WGRNR Members, WGRNR website			

ConEx Programme

(Operating Procedure and Database Structure)

RESTRICTED DISTRIBUTION

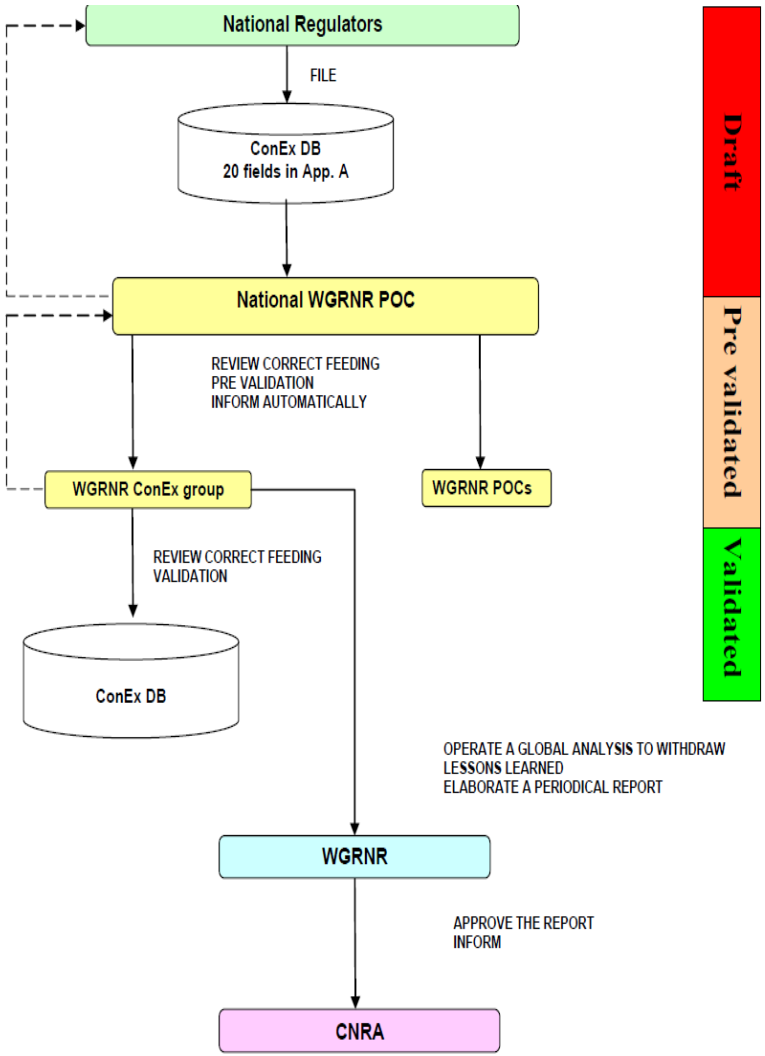
This release of ConEx is for WGRNR members ONLY and should NOT be distributed to others. WGRNR members are National regulatory organizations that provided data.

OECD Nuclear Energy Agency
Le Seine Sain-Germain, 12 boulevard des Iles
92130 Issy-les-Moulineaux, France

Goal: To capture events initiated before the first fuel loading related to manufacturing on-site or off-site, construction, commissioning and design and detected at any stage of the plant life:

- Events involving vendors, contractors, sub-contractors, manufacturers, designers, licensees
- Events presenting a potential interest to other regulators (lessons learned)
- Events with real or potential safety impact or radiation protection impact on workers or public
- Recurrent events that would indicate quality assurance or safety culture problems in any of the organizations involved in the design or construction

CONEX database structure



NEA
- administrator of the database
- interface and assure compatibility with IRS

National Regulators
- routinely assess construction experience information
- provide reports to the ConEx database

National PoC (Point of Contact)
- check its reports for consistency and completeness
- ask for additional information if necessary

WGRNR ConEx group
- review and validate the input
- produce a global analysis to draw lessons learned, trends, good practices and report to WGRNR
- produce topical report on a selected periods/subjects

CONEX database structure. Field definition

Item No.	Field Name	Type	Description
001	EID	Auto number	Automatically generated record number
002	EVENT TITLE	Text	Very short characterisation of the event, with emphasis on its most significant features
003	EVENT DATE	Date	Date of event discovery
004	COUNTRY ID	Text	Roll down menu with options
005	REACTOR TYPE	Text	Roll down menu with options
006	PLANT NAME	Text	Plant name is automatically returned
007	PLANT STATUS	Text	Plant operational state (at the time of discovery)
008	SAFETY FUNCTION CHALLENGED	Text	Roll down menu with the options
009	FAILED/AFFECTED SYSTEM	Text	Roll down menu based on IRS
010	COMPONENT SAFETY RELEVANT	Text	Roll down menu based on IRS
011	ORGANISATIONS INVOLVED	Text	Roll down menu with options
012	EVENT NARRATIVE	Memo	Description of plant features, conditions and organisational data

CONEX database structure. Field definition

Item No.	Field Name	Type	Description
013	CAUSE ANALYSIS	Memo	Direct Causes as well as the Indirect or Underlying Causes of the event
014	CAUSE OF THE EVENT	Text	Possibility to select several items Roll down menu based on IRS
015	SAFETY ASSESSMENT	Memo	Potential or real consequences of the event and should include the failure mode analysis.
016	CORRECTIVE AND PREVENTIVE ACTIONS	Memo	Corrective and preventive actions taken by licensee/vendor/contractor/manufacturer
017	REGULATORY ACTIONS	Memo	Description of the Regulatory Body's actions taken in response to the event.
018	LESSONS LEARNED	Memo	Licensee, vendor, manufacturer, contractor and regulator lessons learned.
019	STATUS OF THE REPORT	Automatic field (workflow)	- Draft - Pre-validated - Validated
020	ATTACHEMENTS	Hyperlinks (facultative)	Possibility to upload and attach documents related to the events

CONEX database structure

EID	Status	Plant	Date	Title	Created	by	Updated	by	Action
65	Draft	Olkiluoto 3	2010/06/23	Non-conformities on valve body surface	2012/09/19	suksi	2012/09/19	suksi	View Edit
64	Draft	All NPPs	2012/04/24	Ineffective Use of Vendor Technical Recommendations	2012/08/15	patel	2012/08/15	patel	View Edit
63	Draft	All NPPs	2012/01/26	Seismic Considerations - Principally Issues Involving Tanks	2012/08/15	patel	2012/08/15	patel	View Edit
62	Ready QA	Flamanville 3	2012/03/01	Non-conformity concerning the surface finish of pipes	2012/04/24	fraysse	2012/04/25	houdre	View Edit
61	Ready QA	Flamanville 3	2010/11/01	Heavy Component Manufacturing : Reactor pressure vessel closure head	2012/04/24	fraysse	2012/04/25	houdre	View Edit
60	Approved	Flamanville 3	2011/06/01	Heavy Component Manufacturing : Vessel closure head buttering thickness	2012/04/24	fraysse	2012/09/12	balmisa	View Edit
59	Ready QA	Flamanville 3	2009/11/01	Defects in prestressing ducts	2012/04/23	fraysse	2012/04/24	houdre	View Edit
58	Ready QA	Flamanville 3	2010/12/01	Pouring activities of pools or tanks - high rebar density areas and high pouring lift issues	2012/04/23	fraysse	2012/04/24	houdre	View Edit
57	Ready QA	Flamanville 3	2009/02/11	Defects in joint treatments between two concreted parts	2012/04/23	fraysse	2012/04/24	houdre	View Edit
56	Ready QA	Flamanville 3	2010/06/08	Damage of the 400 kV Power cable of Flamanville 2 during Flamanville 3 construction	2012/04/23	fraysse	2012/04/24	houdre	View Edit
55	Ready QA	Flamanville 3	2008/10/01	Absence of joint treatment between two concreting lifts in the gousset area	2012/04/23	fraysse	2012/04/24	houdre	View Edit
54	Ready QA	Flamanville 3	2008/01/01	Appearance of cracks in the concrete basemat of the reactor building of Flamanville 3	2012/04/23	fraysse	2012/04/24	houdre	View Edit
53	Ready QA	Olkiluoto 3	2009/12/15	General corrosion of OL3 pressurizer and steam generators during transportation and storage prior to installation	2012/03/21	suksi	2012/03/21	virolainen	View Edit
52	Draft	Olkiluoto 3	2010/06/01	EPR Non-conformities on valve body surface	2012/03/21	suksi	2012/03/22	nevalainen	View Edit
51	Ready QA	Olkiluoto 3	2009/04/12	Deficient hydrostatic pressure test arrangement of valves	2012/03/21	suksi	2012/03/21	virolainen	View Edit
50	Draft	Darlington 4	2010/04/21	Problem Report Analysis or Research Finding: Adjuster Rod Electronics Issue	2012/02/14	mendoza	2012/02/14	mendoza	View Edit
49	Draft	Darlington 3	2011/07/28	U3 Transient: Odd SOR Dropped in Core	2012/02/14	mendoza	2012/06/13	mendoza	View Edit
48	Ready PoC	Darlington 4	2010/04/10	D1041 [Darlington Unit 4] Spurious SDS2 Trip	2012/02/14	mendoza	2012/03/26	webster	View Edit
47	Ready PoC	All NPPs	2011/02/15	Commercial-Grade Dedication Issues Indentifed during Inspections IDENTIFIED DURING NRC INSPECTIONS	2012/01/19	patel	2012/09/12	balmisa	View Edit
46	Draft	All PWRs	2011/02/23	Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Stee Piping in PWRs	2012/01/11	patel	2012/03/21	bollock	View Edit
45	Approved	All NPPs	2011/07/18	Component Cooling Water System Gas Accumlation and Otehr Performance Issues	2012/01/11	patel	2012/03/23	balmisa	View Edit
44	Draft	Seabrook	2009/06/01	Seabrook - Adverse Concrete Conditions Due to Distress from Alkali-Silica Reaction (ASR)	2011/12/15	patel	2011/12/15	patel	View Edit
43	Ready QA	Olkiluoto 3	2009/03/02	Closing gate damage of the spent fuel interim storage pumping station at Olkiluoto NPP	2011/09/20	suksi	2012/03/21	virolainen	View Edit
42	Ready QA	Olkiluoto 3	2010/07/27	Main Coolant Lines (Hot and Cold Legs) manufacturing - internal indications in bended areas	2011/09/18	suksi	2012/03/21	virolainen	View Edit
41	Ready QA	Olkiluoto 3	2009/10/06	Main Coolant Lines (Hot and Cold Legs) manufacturing - non-documented weld repairs	2011/09/18	suksi	2012/03/21	virolainen	View Edit
40	Ready QA	Olkiluoto 3	2009/02/10	Main Coolant Lines (Hot and Cold Legs) manufacturing - heat-affected zone (HAZ) micro-cracking	2011/09/18	suksi	2012/03/21	virolainen	View Edit
34	Draft	Nine Mile Point-2	2000/03/26	Instrument Air Header Failure	2011/03/14	craffey	2011/03/14	craffey	View Edit
28	Draft	Browns Ferry-1	2007/10/04	Refueling Floor Crane Cable Deformation	2011/03/14	craffey	2011/03/15	craffey	View Edit
26	Draft	McGuire-1	2007/08/06	Service Water Inoperable due to Valve Modification	2011/03/14	craffey	2011/03/15	craffey	View Edit
22	Draft	Oconee-1	2007/02/15	Switchyard Transient Leads to Dual Unit Trip	2011/03/11	craffey	2011/03/11	craffey	View Edit

3. USES OF CONEX TO CREATE KNOWLEDGE:

- ❑ EVENTS AND LESSONS LEARNED
- ❑ APPLICATION TO INSPECTOR TRAINING
- ❑ APPLICATION TO INSPECTION PROCEDURE

Applications of CONEX

CONEX

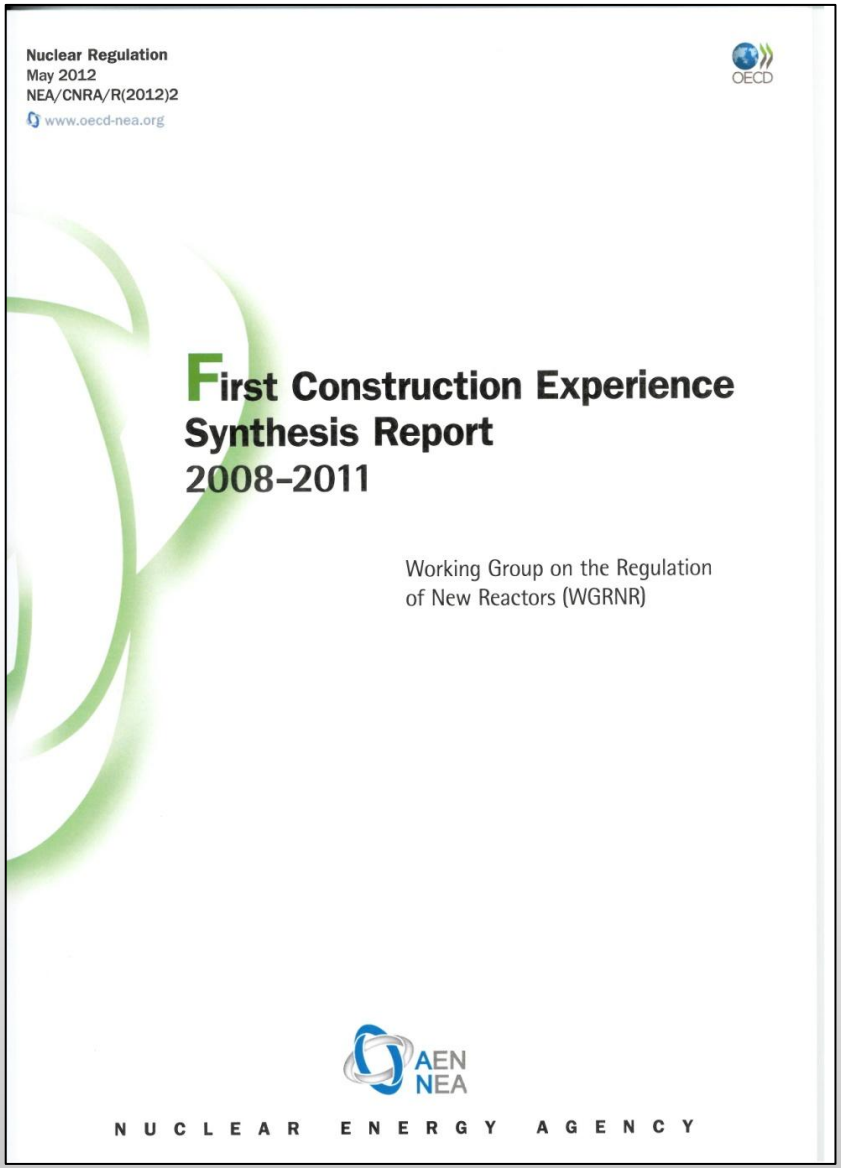
Construction experience worldwide

WGRNR (NEA) Event Analysis. Lessons Learned

- **Events lessons learned reports.**
- **Applications to**
  - **Inspector training (safety cards)**
  - **Inspector procedures**

Events and lessons learned

- Currently there are 44 conex events (mainly US, France, Finland, Japan and Canada)
- First ConEx synthetic report (2008-2011)
- Working on the draft of a 2nd report on event lessons learned 2011-2012
- New “products” to learn
  - Friendly learning “Safety Cards” from new events
  - Table matching Construction Inspections and events lessons learned

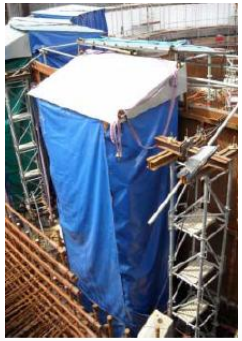


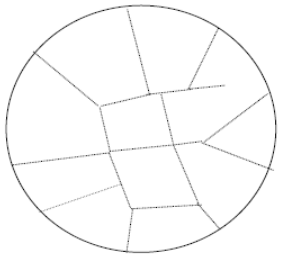
Events and lessons learned

Construction events

- **Olkiluoto 3** - Strength of the base slab concrete for the reactor building.
- **Olkiluoto 3** - Leak tightness of the containment.
- **Olkiluoto 3** - Integrity of the primary pipes.
- **Flamanville-3**. Cracks in the poured concrete basemat of the reactor building (January 2008).
- **Flamanville-3**. Non compliances with steel reinforcement requirements at several buildings (March- July 2008).
- **Flamanville-3**. Welding process deficiencies (June 2008-February 2009).
- **Flamanville-3**. Deficiencies of the joint treatment of the steel reinforcement of the gusset area of the reactor building (December 2008)

Steel liner Olkiluoto 3 and Flamanville 3 welding deficiences

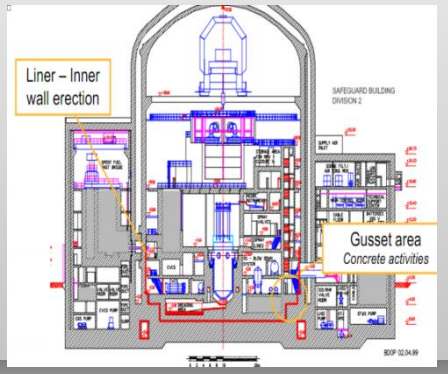




Configuration of cracks in the circular basemat

Flamanville 3 cracks in concrete basemat

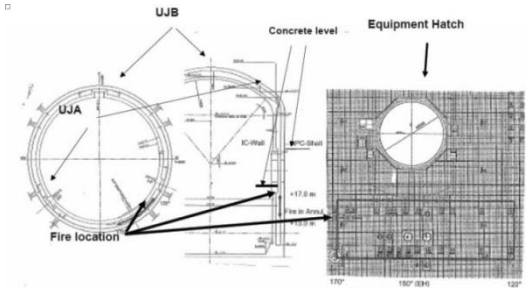
Flamanville 3. Joint treatment deficiences of the steel reinforcement of the gusset area in the reactor building



Events and lessons learned

Lessons learned from other events reported to the WGRNR

- Fires
- Cables
- Containment / liner
- Essential service water / component cooling water
- Welds
- Seismic events



Olkiluoto 3. Fire in the annulus space (space between the containment and reactor building wall)

Events related to cables:

-Penly-2. France. 2001. Defective cable insulation.

-Cattenom. France. 2004. Fire in electrical cable penetration due to faulty design

-Palisades. 2007. Degraded electrical cables for CCW and SW due to the close proximity to an uninsulated section of a carbon steel steam generator blowdown line that was routinely as hot as *248C*

"SAFETY CARDS" FOR INSPECTOR TRAINING

CONEX 45

Designing or inspecting the CCW (Component cooling water) ?
PAY ATTENTION TO

1

WHAT HAPPENED
2008-09 St. Lucie : air intrusion into CCW.
2010 Wolf Creek: Gas pockets in CCW trains
2006 San Onofre Nuclear. CCW system gas voids

2

THE PROBLEM
Gas accumulation in nuclear power plant systems can cause water hammer, gas binding of pumps, and inadvertent relief valve actuation that may damage pumps, valves, piping, and supports and may render the CCW system inoperable

3

LESSONS LEARNED ON CCW DESIGN AND CONSTRUCTION INSPECTION

-Design to avoid the potential gas intrution into the CCW.
- During construction inspect in the "construction testing" inspection of the CCW the potential intrusion/accumulation of gas/air in the CCW

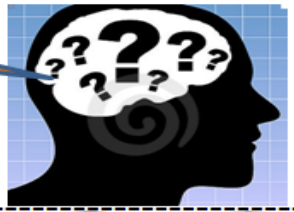
4

OBSERVATIONS

-Applicable to new reactors .
- Design issue – Potential gas/air accumulation in CCW system.
- Potential detection during construction testing

"SAFETY CARDS" FOR INSPECTOR TRAINING

CONEX 47



Inspecting Commercial-grade Dedication (CDG) programmes?

PAY ATTENTION TO

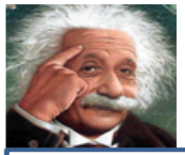
1

WHAT HAPPENED. FINDINGS FROM VENDOR/SUBSAPPLIER INSPECTIONS

-Several examples of **lack of engineering justification** during dedication process.
- Vendor and Licensee **deficiencies to document** (critical characteristics, acceptance criteria and methods) the CDG.
- **Licensee failed to review and approve CGD** before dedication.
- **Deficiencies in vendor´s surveys** to verify subvendor´s quality controls (material traceability and batch controls).
-**Deficiencies in sampling** of commericial-grade items during dedication.
-

2

LESSONS LEARNED CCW CONSTRUCTION TESTING INSPECTION



Acceptable dedication program:

-Technical evaluation that identifies the critical characteristics (CC) and acceptance criteria for the item to be dedicated
- Acceptance methods that verify that the CCs have been met.
- Documentation of the steps taken during the dedication process.
- Complete documentation and auditable records of the rationale, justifications, and engineering analyses must be available as part of the dedication package
-Purchaser or licensee review and approval before the dedication of the item should be part of the process.

-References: EPRI NP-5652

"SAFETY CARDS" FOR INSPECTOR TRAINING

CONEX 46

INSPECTING PIPING ?

PAY ATTENTION TO

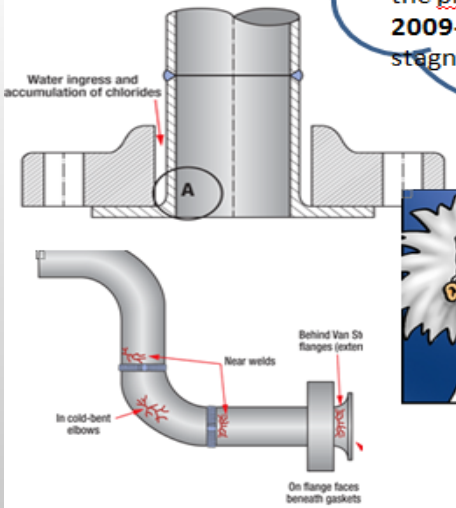
1

WHAT HAPPENED

2008 Callaway: Transgranular Stress Corrosion Cracking (TGSCC) (Type 304 SS Pressurizer auxiliary spray pipe)

2009 Wolf Creek: Transgranular Stress Corrosion Cracking (TGSCC). Several axial indications beneath the pipe support clamps of the pressurizer auxiliary spray line.

2009-2100 San Onofre Nuclear. Several cracks, stagnant coolant, marine atmosphere



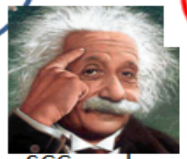
2

THE PROBLEM

Transgranular Stress Corrosion Cracking (TGSCC)

-Environmental conditions Moisture in containment/chloric contamination/marine atmosphere environment.

- Stagnant coolant pipes



3

LESSONS FOR PIPING INSPECTION

SCC can be managed effectively to minimize the potential for catastrophic pipe failure through stainless steel piping cleanliness control and limiting the contact with fluids (including sweat from personnel) or condensation that may contain halogens (chlorides and fluorides). Water chemistry can be used to minimize the adverse effect of oxygen and chloride on SCC. When welding piping joints or attachments, appropriate procedures can be followed to minimize stainless steel sensitization. Periodic inspections of the susceptible piping systems as part of the existing boric acid corrosion control program per the April 2008 Nuclear Energy Institute report NEI 03-08, Revision 1, "Guideline for the Management of Materials Issues," or as part of routine walkdowns have been instrumental in detecting SCC in stainless steel piping.

Application to Inspection Procedures

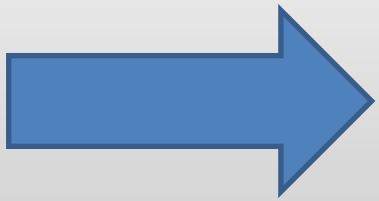
STUK

GUIDE **YVL 1.15** / 28 APRIL 2008

MECHANICAL EQUIPMENT AND STRUCTURES OF NUCLEAR FACILITIES

Construction inspection

Transgranular Stress Corrosion Cracking events



ATTACHMENT 65001.B

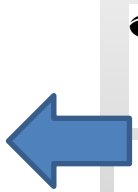
INSPECTION OF THE ITAAC-RELATED WELDING PROGRAM

PROGRAM APPLICABILITY: 2503, 2504

TABLE OF REGULATORY BODY INSPECTION VS CONEX EVENTS LESSONS LEARNED

Note: this is based mainly on IMC 2503.docx (set of inspections for ITAAC process)

Column Classification.docx Row classification.docx	AS-BUILT INSPECTION checks for location, alignment, dimensions, sizing, and measurements, and may include functional checks	WELDING	CONSTR. TESTING quality of component fabrication and construction activities, to include quality acceptance tests	OPERATING TESTING check component and system function by measuring operational parameters (e.g., flow requirements	QUALITY CRITERIA seismic qualification, environmental qualification (EQ) and other qualification programs	DESIGN/FAB REQ requirements for the fabrication of material and components or discuss the adequacy of design by reference to analyses, calculations, bounding condition checks, functional assessments, engineering evaluations and other design reports	INSPECTION PROCEDURE
1. FOUNDATIONS & BUILDINGS							
2. STRUCTURAL CONCRETE			CONEX 44 Seabrook – Adverse Concrete Conditions Due to Distress from Alkali-Silica Reaction (ASR).docx			CONEX 68 Pouring process FLA-6.pdf	
3. PIPING		CONEX 46 CONEX Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Stee Piping in PWRs.docx		CONEX 45 gas accumulation in CCW.docx		CONEX 62 Fig 6 – Surface finish for hot extruded piping.pdf CONEX 42 Main coolant pipes defects OL-6.docx	
4. PIPE SUPPORT & RESTRAINTS							
5. REACTOR		conex 60					



Application to Inspection Procedures

Column Classification.docx Row classification.docx	AS-BUILT INSPECTION checks for location, alignment, dimensions, sizing, and measurements, and may include functional checks	WELDING	CONSTR. TESTING quality of component fabrication and construction activities, to include quality acceptance tests	OPERATING TESTING check component and system function by measuring operational parameters (e.g., flow requirements	QUALITY CRITERIA seismic qualification, environmental qualification (EQ) and other qualification programs	DESIGN/FAB REQ requirements for the fabrication of material and components or discuss the adequacy of design by reference to analyses, calculations, bounding condition checks, functional assessments, engineering evaluations and other design reports	INSPECTION PROCEDURE
PRESSURE VESSEL AND INTERNALS		Fla 3 - Buttering thickness.pdf CONEX 61 Vessel Head defect indications FLA-3pdf					
6. MECHANICAL COMPONENTS				CONEX 66 Tanks seismic considerations.pdf		CONEX 66 Tanks seismic considerations.pdf	
7. VALVES			CONEX 66 Valves			CONEX 66 Valves manufacturing deficiencies	

On behalf of WGRNR:

Thank you for your attention