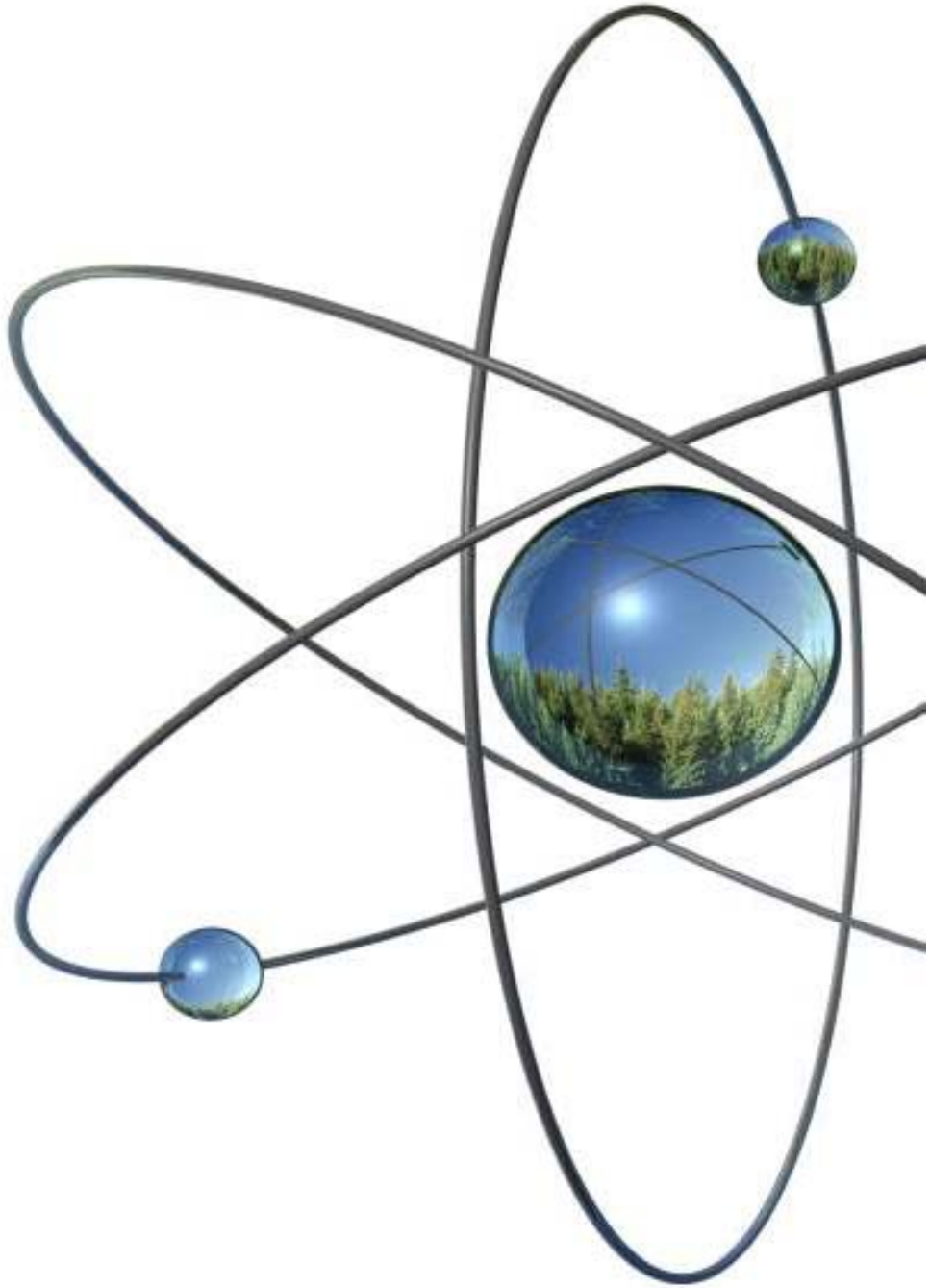
GE Hitachi Nuclear Energy

An Overview of GEH Nuclear Criticality Safety Fuel Cycle Activities

Lon Paulson

Session II: Current Status and Expectations on Progress of Fuel Cycle Issues

OECD-NEA NCS Workshop
Future Criticality Safety Research Needs
September 21-22, 2009
Idaho State University
Pocatello, Idaho



Overview

- Introduction to GEH
- Wilmington Site
- NCS Technical Support Activities
  - 10CFR70.61 Performance Requirements
  - Quantitative Risk Assessment
  - SNM-1097 License Renewal (GLE Test Loop, GNF-A)
  - GLE CF License Application
  - GEH Canada and LEU License Application
  - VNC SNM-960 License Renewal
  - NCS Methods Advancements
  - Nuclear Packaging – Global Standardization
- Fuel Cycle R&D Opportunities
- Conclusions

Introduction to GEH

GE's Portfolio

- 4 businesses operating in more than 160 countries … 125+ years
- Over 300,000 employees worldwide
- 2008 revenue $183B

Energy Infrastructure	Technology Infrastructure	GE Capital	NBC Universal
• Energy • Oil & Gas	• Aviation • Enterprise Solutions • Healthcare • Transportation	• Aviation Financial Services • Commercial Finance • Energy Financial Services • GE Money • Treasury	• Cable • Film • International • Network • Sports & Olympics

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GE Energy Infrastructure

Employees: 65,000 • '08 revenue: $38.6B • Operating in 140 countries

GE Energy

Power & Water

- Power generation
- Renewables
- Nuclear
- Smart Grid
- Wastewater treatment
- Process chemicals

Energy Services

- Contractual agreements
- Field services
- Parts & repairs
- Optimization technologies
- Plant management

GE Oil & Gas

- Onshore & offshore natural gas
- Transportation
- Processing
- Pipeline inspection
- Subsea
- Extraction

GE Hitachi Nuclear Energy

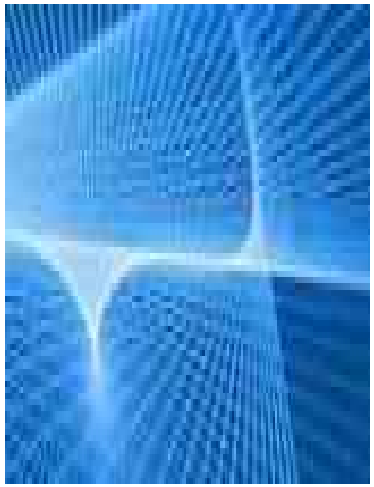
Nuclear Power Plants

- Lungmen Project
- ABWR and ESBWR design
- New plant development and proposal activity

Nuclear Services

- Inspections
- Maintenance
- Repairs
- Modifications
- Life Extension
- Power Uprates
- Water Chemistry
- Parts

GEH "Fuel Cycle" Business



- Core Design
- Uranium Supply
- UF6 Conversion
- UO2 Powder Prod
- BWR Fuel Fabric.
- CANDU Fuel Fabric.
- MOX – Japan
- Neutron Radiography
- Hot Cell Facility
- Spent Fuel Storage
- Advanced Recycling Technologies

- Laser Enrichment Technology
- Test Loop Design & Licensing
- Commercial Facility Design & Licensing

GEH Nuclear Fuel Cycle

GLE scope
Parent scope
Out of scope

Fuel fabrication
- BWR Fresh Fuel
- BWR RU Fuel
- CANDU Fuel
- MOX Fuel

Nuclear plant operation

Re-conversion to UO_2 powder

Core design
Fuel design
Mixed oxide fuel design

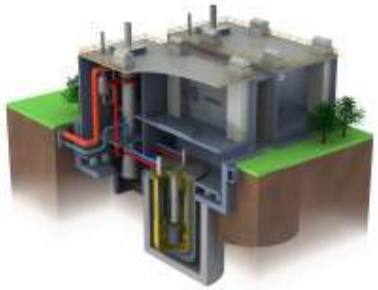
Spent fuel storage

UF_6 enrichment

Spent fuel reprocessing
(Advanced technologies)

Conversion to UF_6 gas

Uranium mining



Licensed Nuclear Activities

Wilmington

UF6 Conversion

UO2 Powder and BWR Fuel Fabrication

Nuclear Packaging

GLE Classified Technology

Kurihama

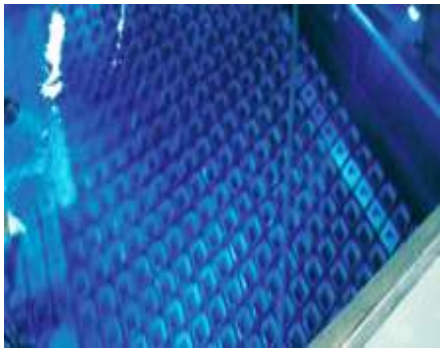
Nuclear Material and Fuel Fabrication

Vallecitos

Spent Fuel Storage

Operating Nuclear Test Reactor

Hot Cell / Lab Facilities



Morris

Spent Fuel Storage Facility

Picture does not depict fuel stored at Morris

Canada

Natural Uranium Processing and Fuel Fabrication

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Wilmington Site

Wilmington site history

- 1,650 acres (300 developed)
- Over 2 million square feet footprint
- Over 2,000 employees

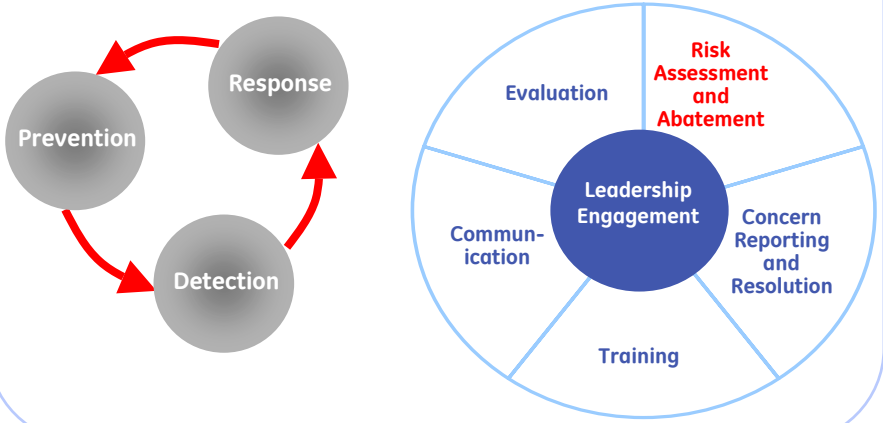
Ground breaking	GE Aircraft Engines	Fuel collocation	Dry powder conversion	GNF JV formation	GENE HQ relocation	GEH JV formation	GEH, Cameco venture
1967	1980	1994	1997	2000	2003	2007	2008

Nuclear Regulations

Nuclear Safety & Security

Nuclear Business Regulation

Keys To Effective Compliance Program



Potential risks to worker, public, and environment from nuclear materials, safety, and security = pervasive regulations

What is Global Laser Enrichment?

Third-Generation Enrichment Technology

Uranium hexafluoride "UF_6" is vaporized into a gaseous form and exposed to a laser beam that preferentially excites the ^{235}U isotope, which enables separation of natural uranium into enriched and depleted uranium. The process operation, while technically complex, is potentially more efficient than existing second-generation centrifuge enrichment technology.

Modular

Value Fit

Scalable

GLE exclusive technology rights

GE Energy

4200 Wildwood Parkway
Atlanta, GA 30339

News Release

GE, SILEX RECEIVE U.S. GOVERNMENT AUTHORIZATIONS REQUIRED TO PROCEED WITH URANIUM ENRICHMENT TECHNOLOGY DEAL

WILMINGTON, N.C. – October 4, 2006 – GE Energy's nuclear business and Australia materials technology developer Silex Systems Limited have received the U.S. government authorizations required to proceed with an agreement granting GE exclusive rights to develop and commercialize Silex's advanced, laser-based uranium enrichment technology.

The 'SILEX' Technology is the world's first, third-generation process for enriching uranium used as fuel in commercial nuclear reactors. It is designed to be an ultra-efficient, more cost-effective production system than existing, extremely energy-intensive gaseous diffusion or capital-intensive centrifuge enrichment methods.

The agreement provides for a phased approach to the commercialization of the SILEX technology and the potential construction of a commercial enrichment facility. These operations would be funded by GE and built at GE's existing nuclear energy headquarters and technology site in Wilmington, N.C. or another suitable location in the United States. In return, GE will provide Silex with a series of scheduled payments as specific technology development milestones are reached, and ultimately royalty payments based on revenues generated by commercial operations using the SILEX Technology.

-more-

2

comes at an ideal time, just as the global nuclear
actors around the world," said Andy White, president
siness. "These new reactors will require a steady
he SILEX Technology to help us fulfill the industry's

ho founded Silex in 1988, noted that the commercial
with its best opportunity to see its years of work

3

com/energy) is one of the world's leading suppliers of
delivery technologies, with 2005 revenue of $16.5 billion.
E Energy works in all areas of the energy industry including
lear energy, renewable resources such as water, wind, solar
tive fuels.

WILMINGTON, N.C. – October 4, 2006 – GE and Silex Systems Limited receive U.S. government authorizations required to proceed…

…with an agreement granting <u>exclusive</u> rights to develop and commercialize Silex's advanced, laser-based uranium enrichment technology.

Global Laser Enrichment (GLE)

A business venture of GE, Hitachi, and Cameco

Ownership structure

HITACHI (25%)

(51%)

Cameco (24%)

GLE

Strategic global program

- GE acquires license rights to SILEX tech - 2006
- Hitachi purchases share - 2007
- Cameco purchases share – 2008
  - Leading industry player endorsement
- Anticipate 3-6 million US-based SWU capacity

Test Loop Construction (2008)

Project Status

- ✓ Submitted NRC license application June 2009
- ✓ Test Loop construction complete July 2009
- ✓ Initiated Test Loop operation July 2009
- ✓ GLE license application accepted by NRC August 2009
- ✓ Commercial contracting underway
- Detailed conceptual design – 2010
- NRC license expected – Dec 2011

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Laser enrichment … technology differentiator

Technology Evolution

Gaseous Diffusion

Centrifuge

Laser

Process operations

> SILEX – "Separation of Isotopes by Laser Excitation"

> Natural UF_6 transport and handling … proven technology

> Vaporization of Uranium Hexafluoride … proven technology

> Laser directed at vapor to selectively excite ^{235}U … known science

> Separation technology … classified (DOE-Q)

> UF6 withdrawal … proven technology

Process benefits

- **Enhance U.S. energy security/independence**
- **Address climate change, use less energy, smaller infrastructure footprint**
- **Create jobs, stimulate economy**

NCS Technical Support

{caution: fasten your seatbelts☺}

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10CFR70 & ISA

10CFR70.61 Performance Requirements - I

§ 70.61 Performance requirements.

(a) Each applicant or licensee shall evaluate, in the integrated safety analysis performed in accordance with § 70.62, its compliance with the performance requirements in paragraphs (b), (c), and (d) of this section.

(b) **The risk of each credible high-consequence event must be limited**. Engineered controls, administrative controls, or both, shall be applied to the extent needed to reduce the likelihood of occurrence of the event so that, upon implementation of such controls, the event is highly unlikely or its consequences are less severe than those in paragraphs (b)(1)-(4) of this section. High consequence events are those internally or externally initiated events that result in: (1), (2), . . .

(c) The risk of each credible intermediate-consequence event must be limited. Engineered controls, administrative controls, or both shall be applied to the extent needed so that, upon implementation of such controls, the event is unlikely or its consequences are less than those in paragraphs (c)(1)-(4) of this section. Intermediate consequence events are those internally or externally initiated events that are not high consequence events, that result in: (1), (2), . . .

(d) In addition to complying with paragraphs (b) and (c) of this section, **the risk of nuclear criticality accidents must be limited by assuring that under normal and credible abnormal conditions, all nuclear processes are subcritical**, including use of an approved margin of subcriticality for safety. Preventive controls and measures must be the primary means of protection against nuclear criticality accidents.

(e) Each engineered or administrative control or control system necessary to comply with paragraphs (b), (c), or (d) of this section shall be designated as an item relied on for safety. The safety program, established and maintained pursuant to § 70.62 of this subpart, shall ensure that each item relied on for safety will be available and reliable to perform its intended function when needed and in the context of the performance requirements of this section.

Per ISG-03: To meet regulations and prevent criticality accidents, an applicant / licensee may use one of the three approaches below:

- **Demonstrate compliance with 70.61(d); or**
- **Demonstrate compliance with 70.61(b), considering only preventative controls and including an approve margin of subcriticality; or**
- **Separately demonstrate compliance with both 70.61(d) and 70.61(b)**

10CFR70.61 Performance Requirements -II

- Ambiguity exists regarding the relationship between 70.61(b) and 70.61(d). ISG-03 points out that while the intent of the NRC was to have a single performance requirement for nuclear criticality accidents, this cannot be substantiated by a literal examination of the final rule
- The rule does not define the terms "highly unlikely", "unlikely," and "credible, but instead states that the definitions of these terms must be included in the applicant's ISA Summary.
- 10CFR70.61 requires that all credible accident sequences for which the consequences could exceed the performance requirements must be controlled to be unlikely or highly unlikely, as appropriate.

For NCS accident sequences at GEH Wilmington Site:

Highly Unlikely (GNF-A ISA Summary) = 1e-04 per year threshold {existing facility}

Highly Unlikely (GLE CF ISA Summary) = 1e-05 per year threshold {new facility}

10CFR70.61 Performance Requirements -III

Per NUREG-1520 on credible and not credible sequences,

Any one of the following three independent acceptable sets of qualities **could define** an event as **not credible**:

a. an **external event** for which the frequency of occurrence can conservatively be estimated as less than once in a million years

b. a **process deviation that consists of a sequence of many unlikely human actions** or errors for which there is no reason or motive (In determining that there is no reason for such actions, a wide range of possible motives, short of intent to cause harm, must be considered. Necessarily, no such sequence of events can ever have actually happened in any fuel cycle facility.)

c. **process deviations for which there is a convincing argument, given physical laws, that they are not possible**, or are unquestionably extremely unlikely (The validity of the argument must not depend on any feature of the design or materials controlled by the facility's system of IROFS or management measures.)

The IROFS Debate

Industry and NRC are currently working on the proper interpretation of Rule and declaration of certain "design features" as IROFS

- Regulator position - all design features used to prevent or mitigate credible NCS accident sequences must be declared as IROFS
- Industry position – not all passive design features need be declared IROFS

Hence the debate…

GEH Recommended Expectation?

Active participation in the Revised Fuel Cycle Oversight Process (RFCOP) as well as the NEI WG and the NRC WG formed to address the design features vs. IROFS issue. Specifically the 10CFR70.61(b), 70.61(d) vs. 70.61(e) debate in light of NUREG-1520 and ISG-3.

Quantitative Risk Assessment

Credible Criticality Accident Sequences: Evolution of Overall Likelihood (OL) Determination

- Original NRC-approved OL methodology – simple form (2002):

$$L_T = \sum_{i=1}^{i=N-1} (\lambda_{f,i} + \lambda_{d,i}) \bullet \lambda_{cmf,i}] + [\lambda_{f,N}]$$

- After ~5 years of implementation, regulator expectations changed....
- Final GEH NRC-approved OL methodology - general form (2007):

$$L_T = \lambda_{IE} + \sum_{k=1}^{M} P_{E,k} + [\sum_{i=1}^{i=N-1} (\lambda_{f,i} + \lambda_{(T/2+MTTR),i}) \bullet \lambda_{IND,i}] + [\lambda_{f,N} + \lambda_{(T/2+MTTR),N}]$$

The quantitative approach developed by GEH is rigorous and adequately covers p-type and f-type criticality controls used to prevent credible criticality accident sequences.

Design & Licensing

GNF-A SNM-1097 License Amendment

- **SNM 1097 License Amendment Timeline**
  - **Application for installation of Laser Enrichment Test Loop submitted 6/29/07**
    - SPPP developed per 10CFR95
    - ISA Summary – process installation inside existing FMO facility
    - SNM-1097 (existing) – page changes
  - **1st Request for Additional Information 10/22/07 (GNF-A replied 2/14/08)**
- **NRC Approves Amendment Request on 5/12/08**
  - **Closed Test Loop system is loaded with initial charge of natural UF6**
  - **Double contingency established on assuring less than safe ^{235}U mass**
  - **Defense-in-depth parameter controls on enrichment, moderation**
  - **Enriched UF6 product to be recombined back to natural UF6**

7 Criticality Safety Analyses (CSAs) Required to Support GLE TL

GNF-A SNM-1097 License Renewal

- **SNM 1097 License Renewal Timeline**
  - Application submitted 4/2/07 (Timely Renewal)
  - Environmental Request for Additional Information 3/27/08 (GNF-A replied 5/14/08)
  - Fire, Crit, Rad, & ISA Request for Additional Information 9/12/08 (GNF-A replied 11/25/08)
  - 2nd Environmental Request for Additional Information 11/18/08 (GNF-A replied 12/17/08)
  - 2nd Rad, Fire & Crit Request for Additional Information 1/15/09 & 2/9/09 (GNF-A replied 2/24/09)
- **NRC Approved ISA Summary Report on 9/22/08**
- **NRC Issued Renewed SNM-1097 License on 5/19/09**
- **Valid for 40-years**

A few CSAs revised to support GNF-A OL methodology and ISA Summary

GNF-A SNM-1097 License Renewal

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 19, 2009

Mr. Scott P. Murray, CHP
Manager, Licensing & Liabilities COE
GE Energy
3901 Castle Hayne Road
P.O. Box 780, M/C K-84
Wilmington, NC 28402

SUBJECT: RENEWAL OF LICENSE SNM-1097 (TAC L32629)

Dear Mr. Murray:

This letter refers to your request for renewal of special nuclear materials license SNM-1097, transmitted by letter dated April 2, 2007, and supplemented by responses to Requests for Additional Information dated November 25, 2008 and January 8, 2009.

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 70, Materials License SNM-1097 is hereby renewed for a period of 40 years, expiring on May 19, 2049.

Safety Condition S-1 contains the dates of April 7, 2007, November 25, 2008, and January 8, 2009. S-1 also retains the dates of June 29, 2007, and February 12 and 14, 2008, from the previous license to include revisions to the Standard Practices and Procedures Plan for the laser enrichment test loop.

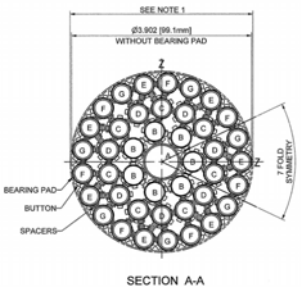
GNF
Global Nuclear Fuel
A Joint Venture of GE, Toshiba, & Hitachi

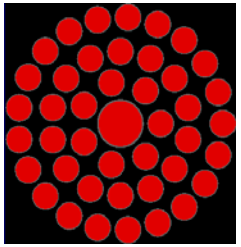
Process Takeaways

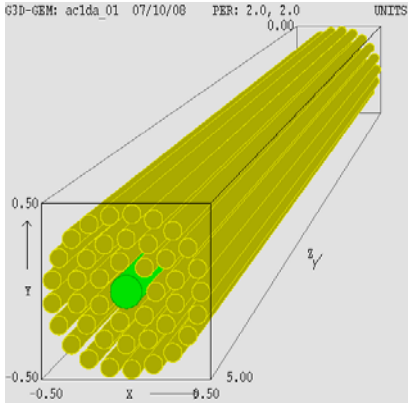
- Proactive engagement & communication with regulator a must (meet early and often)
- Broad scope license application structured to match NUREG-1520 chapter structure
- Program commitment language used: "WHAT" not the "HOW"
- ISA program flexibility, *general form* OL methodology developed
- ISA team reviews never die…

GEH Canada LEU License

GEH Canada Division/Peterborough, Ontario







- Existing CNSC Licensed fuel fab facility – Nat. U Only
- Future CNSC Licensed fuel fab facility – LEU up to 5% ENR
- Augmented staffing, visit to parent GEH HQ in Wilmington, NC – formal CSE training program
- Candidates now actively engaged in generating necessary design, licensing constraints for LEU fuel fabrication in documented criticality safety analyses to support planned ACR reactor technology.
- Licensing process involves public meeting, CNSC reviews of application (similar to NRC process under 10CFR70)
- ISA program and ISA Summary required
- MCNP5 CAAS studies / GEMER lattice studies – ongoing (GEMER model constructs shown using GEM2D.EXE, G3D.EXE).

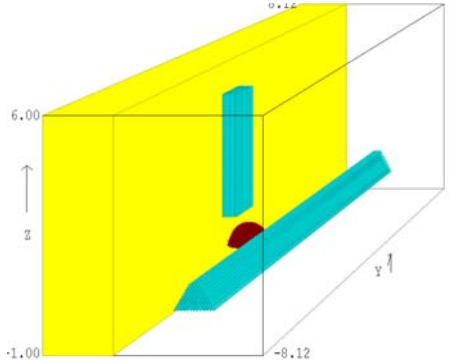
GEH-Canada criticality safety staff – capitalizing on existing NCS program infrastructure located at GEH-Wilmington

Vallecitos SNM-960 License Renewal

VNC / Sunol, California

- Existing SNM-960 License: 2-part structure
- New SNM-960 License: Compliant with NUREG-1520 chapter structure.
- Rebaselined CSAs – consolidate / modernize computational basis for derived subcritical limits (e.g., GEMER Monte Carlo Code); meet internal GEH format/content requirements.
- VNC CSA rebaseline effort recently completed; SNM-960 timely renewal planned September 2009.

Hot Cell #3

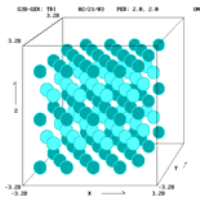


VNC EHS safety staff augmented by GEH Wilmington NCS staff

8 Rebaselined CSAs developed to support existing VNC operations

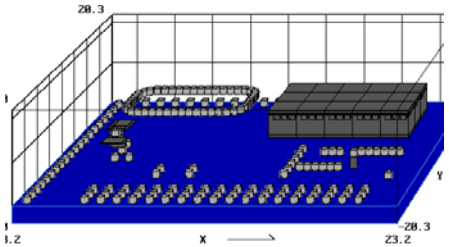
NCS Methods Advancements

NCS Methods Advancements - I



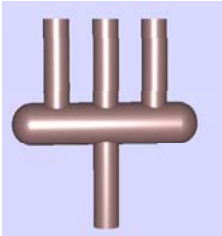
GEMER Monte Carlo Code

- Monte Carlo neutron transport code with advanced geometry package (see ICNC99, ANS TANSO 2004, 2005, 2006) developed by GEH; uses 190-group cross-section library to calculate the k_{eff} using ENDF/B-IV [NOTE: XSEC.LIB using ENDF/B-VII under development].
- GEMER V1.1 - Lahey FORTRAN-95 version, released for production May 2008



GEMER Validation

- Validation of GEMER code (current rev. 05, 2009) is extensive for uranium applications spanning the full enrichment range (280 benchmarks used)
- Established 6 active AOAs governing LEU / HEU / u-metal systems
- Statistical basis for GEMER bias and associated bias uncertainty developed using the sophisticated GEH *Upper Subcriticality Limit Statistical Analysis* [USLSA] methodology (see ANS TANSO 2007, ICNC2007)

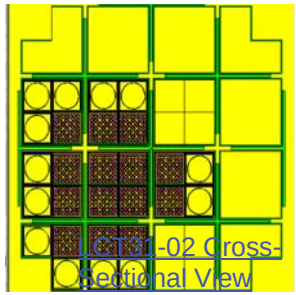


GEMER contains *patented*, optimized geometry package to assist productivity of NCS staff. Current validation consistent with ANSI/ANS-8.24 (2007) national consensus standard "Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations"

NCS Methods Advancements -II

MCNP5 (Monte Carlo N-Particle Transport Code)

- Internationally Recognized Stochastic Transport Code
- Utilizes latest ENDF/B-VII.0 Cross Section
- Previously, MCNP5 LUE USLs not Calculated for NCS use at GEH
- MCNP5 validation with ENDF/B-VII.0 provides an internationally recognized tool for criticality analyses



MCNP5 LEU Validation

- Validation of MCNP5 at GEH (rev. 0, 2008) is extensive fissile low-enriched uranium (LEU) applications (270 benchmarks used)
- Established 5 active AOAs governing LEU homogeneous/heterogeneous systems
  - homogeneous LEU solution systems
  - heterogeneous LEU systems without poisons
  - heterogeneous LEU systems with cadmium
  - heterogeneous LEU systems with boron
  - heterogeneous LEU systems with gadolinium
- MCNP5 bias and associated bias uncertainty developed using GEH USLSA methodology (see ANS TANSO 2008)

MCNP5 LUE addition to GEH NCS analytic tool chest enables support of LEU fuel manufacturing, storage, and nuclear packaging design/licensing activities

NCS Methods Advancements -III

MCNP5 U-Pu Validation

Plutonium Jezebel Sphere

- Validation of MCNP5 at GEH (rev. 0, 2009) covers uranium/plutonium metal applications (U-Pu) applications (253 benchmarks used)
- Established 4 active AOAs governing U-Pu metal systems
  - AOA 1:Low Enriched Uranium Metal: <10% U-235
  - AOA 2:Mixed Enrichment Uranium Metal Systems
  - AOA 3:Uranium and Plutonium Mixed Metal Systems
  - AOA 4:Plutonium Metal Systems
- MCNP5 U-Pu bias and associated bias uncertainty also developed using GEH USLSA methodology (see ANS TANSO 2009 - TBP)

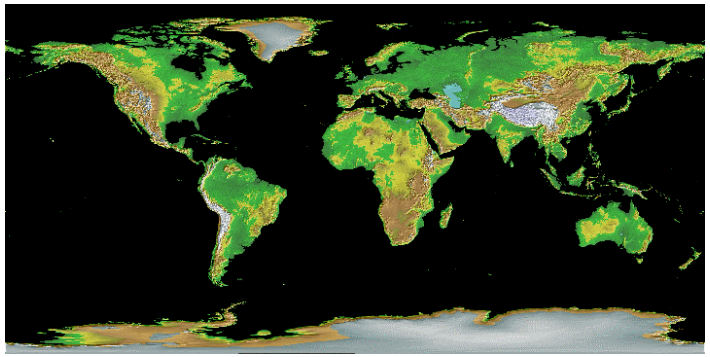
MCNP5 U-Pu addition to GEH NCS analytic tool chest enables support of closed nuclear fuel cycle electrometallurgical processing, NCS design studies, future licensing activities.

Nuclear Packaging

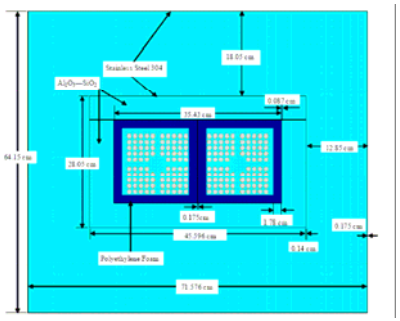
GEH Nuclear Packaging Fleet

NCS Interface with NRC, USDOT, Foreign Competent Authorities

Countries of interest:
France, Germany, Belgium, Sweden, Spain, Finland, U.K., Canada, Russia, Kazakhstan

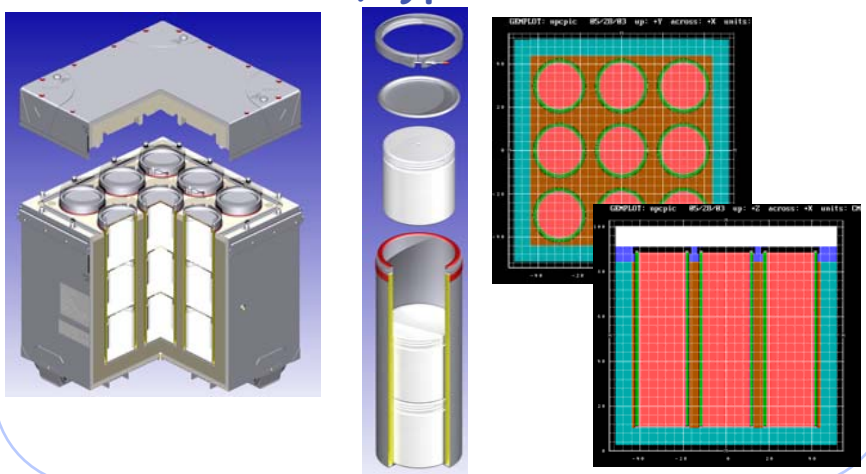


RAJ-II, Type B Fissile



Parameter	Units	Type	Type	Type	Type
Fuel Assembly Type	Rods	8x8	9x9	FANP 10x10	GNF 10x10

NPC, Type A Fissile



GEH philosophy is to create *globally accepted fleet* for LEU material and BWR fuel shipments [NCS Methods Used to Support SARs ➔ GEMER, MCNP5, SCALE5]
Industry partnerships for technical, testing, domestic/international licensing

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UF6 Cylinder Fleet

NCS Interface with NRC, USDOT, Foreign Competent Authorities

Competent Authority Certifications

Certificate ID	Cylinder Type [overpack]	Countries of Applicability	Max. U-235 Enr (wt.%)	Nominal Package Gross Wt. (kgs)	Maximum Package Net UF6 Wt. (kgs)	CSI [≤ H/U Limit]	Max. U-235 (kgs)	Comments
0406/AF-96	30B [21PF-1]	IAEA/U.S. /Japan	5%	3,960	2,277	0.0 [0.068]		Special DOT transport considerations / inspection requirements; re: phenolic foam degradation in 21PF-1B overpack
0411/AF	30B 48Y	IAEA/U.S.	5% 4.5%	2,912 14,860	11.3 22.7	0.0 [0.068]	0.363 0.690	Residual heels only
0411/H(U)-96	30B 48Y	IAEA/U.S.	1% 1%	2,912 14,860	11.3 22.7	0.0 [0.068]	0.015 0.015	Residual heels only
0575/H(U)-96	1S in 10-gal. drum	IAEA/U.S.	5%	N/A	0.450	N/A	N/A	2000 MED Package for 1S sample cylinder; must meet IAEA para. 825
0585/AF-96	30B [MST-30]	IAEA/U.S. /Japan	5%	4,170	2,277	5.0 [0.068]		Mitsubishi Nuclear Fuel Co. design 30B overpack
0592/H(M)-96	48X+VPA 48Y+VPA	IAEA/U.S.	1% 1%	11,560 14,860	9,539 [22.7] 12,501[22.7]	0.0 [0.068]	0.153* 0.153*	Loaded cylinders require VPA per N14.1 (2001, Addendum 1); residual heels restricted to 22.7 kgs UF6
0679/H(U)-96	48X [BTP] 48Y [BTP]	IAEA/U.S. /GB	1% 1%	11,657 15,300	9,539 [148.3]* 12,501 [197.75]*	0.0 [0.068]	1.002* 1.337*	Outer blanket thermal protector (BTP) per Cogema specs.
0680/H(U)-96	48X [CTP] 48Y [CTP]	IAEA/U.S. /GB	1% 1%	15,111 15,450	9,539 [148.3]* 12,501 [197.75]*	0.0 [0.068]	1.002* 1.337*	Outer composite thermal protector (CTP) per BNFL spec.
0681/H(U)-96	48X+VPA 48Y+VPA 48X/48Y, no VPA	IAEA/U.S. /GB	1% 1% 1%	2,200 2,568 15,450	148.3* 197.75* 22.7	0.0 [0.068]	1.002* 1.337* 0.153*	Residual heels only; bare cylinder with and without valve protector assembly (VPA)
4909/AF	30A+VPD 30B+VPD [21PF-1A] [21PF-1B]	IAEA/U.S.	5%	4,000	2,247 2,282	5.0 [0.068]		NCI overpacks authorized with valve protection device (model no. USEC-VPD-1996); N14.1 valve stemplug tinning variance permitted; special overpack storage, insp., weighing req'ts. re: phenolic foam degradation
9194/AF-96	30B 30C+VPC [UX-30]	IAEA/U.S.	5%	3,751	2,277	5.0 (30B) 0.0 (30C) [0.068]		Duratek overpack w/ 7.5-9.5 PCF foam. 30C is essentially a 30B cylinder equipped w/ valve protective cover (VPC); 30C fab., tested, mnt. Under N14.1-2001, Addendum 2.
9234/B(U)F	30B+VPD [NCI-21PF-1]	IAEA/U.S.	5%	4,025	2,277	5.0 [0.068]		CHT overpack NCI 21PF-1 containing 30B must be equipped with USEC valve protection device (VPD).

* Calculated mass U-235 (kgs) for residual heel cylinder only.
* Maximum quantity net UF6 for residual heel cylinder only.

At least 11 distinct USDOT competent authority certifications govern domestic/international shipments of authorized UF_6 nuclear packages. Development need – could simplify structure to 2 governing 30-inch and 48-inch cylinder designs/contents/configurations.

HITACHI

Fuel Cycle R&D Needs
&
Conclusions

Criticality Safety R&D Needs

Research

- Methods – Teaming agreement with university graduate programs –software development
- Methods – Continue to expand GEMER AOAs , MCNP5 AOAs
- Experiments – Expand intermediate *homogeneous solution* benchmarks (5-10%)

Development

- Regulatory – Revise 10CFR70 rule. Performance requirement language can be improved [e.g., eliminate or clarify 10FR70.61(d)]
- Regulatory - Resolve design features vs. IROFS issue via next NUREG-1520 revision (underway); listen to industry concerns and seek WGs consensus.
- Regulatory – Enhance or improve regulatory guidance governing *risk informed oversight*, with emphasis on plant operations, for fuel cycle facility ISA inspections.
- Policy - International certification of Type A, B Fissile nuclear packaging; if IAEA member state approves / issues certificate – no separate certificate of competent authority regulatory SAR review required. Remove political posturing of regulatory agencies from licensing process.
- Policy - Competent Authority Certification structure governing uranium hexafluoride (UF6) 30-inch and 48-inch design cylinders can and should be simplified and streamlined.

Conclusions

- **GEH nuclear businesses remain committed to expanded role in the nuclear fuel cycle** [record of accomplishments spans more than six decades]
- **GEH is developing front/back end technology to expand, improve, and lower cost of existing fuel cycle capabilities (e.g, 3rd generation laser enrichment, electrometallurgical processing, etc.)**
- **GEH professional nuclear criticality safety staff involvement in these technology advancements is vital to design, licensing, and operation processes**
- **Active industry involvement in the regulatory policy/rule-making process is an expectation**