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Mr. Leo Higginbotham
Chief, Low-Level Waste Licensing Branch
Division of Waste Management
Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20910

Dear Mr. Higginbotham:

REFERENCE: CNSI TOPICAL REPORT SUBMITTAL, "WASTE FORM CERTIFICATION-CEMENT, CNSI-WF-C-01-NP," NOVEMBER 30, 1983

Over the past five (5) years, Chem-Nuclear Systems, Inc. has been actively pursuing improved waste form certification programs. Attachment (1) provides a chronological listing of the key events during this period. This attachment shows the continuing changes, developments, and improvements CNSI has made in the area of solidification chemistry.

CNSI feels that the approval of a continuous (living) waste form certification program rather than fixed specific chemistry formulas is essential to the entire nuclear industry radioactive waste disposal program. Attachment (2) supplies specific detail of CNSI's perception of such a continuing (living) waste form certification program.

Considering the information discussed herein, CNSI is ready to submit a revision to the CNSI Topical Report submittal, "CNSI-WF-C-01-NP," to not only respond to the NRC's questions specific to that report, but also to further expand the report to include a continuing (living) waste certification program. This letter is a request for NRC approval of this concept. Please do not hesitate to contact us if we can provide additional information or justification.

Very truly yours,

CHEM-NUCLEAR SYSTEMS, INC.

L. K. Poppe
Director, Licensing

LKP:psw

cc: Mr. Timothy C. Johnson, Nuclear Regulatory Commission
Mr. Kenneth C. Jackson

ATTACHMENT #1

Chronology of Key Events in the CNSI Waste Certification Process

Chem-Nuclear Systems, Inc. has been processing low-level radioactive wastes for the nuclear industry since 1975. It was recognized very early that standard existing immobilization techniques were frequently unacceptable. A research and development program was established to develop process control boundaries to identify waste pre-treatments and additives and to select the proper media wherein each waste type could be properly stabilized. The results of this continuing development program have been swift and exciting.

The December issue of "Science '82" reported university and large research and development corporation findings which clearly showed that cement could be modified to suit needs other than construction. The authors cited studies of Roman cements poured underwater which are intact and structurally sound today. Sea water and rain water have not permeated into the structures nearly 2000 years after formation. These studies led our research to appropriate additives and pre-treatments which attempt to duplicate long term integrity of this type cement. The primary focus of Chem-Nuclear testing is commercially produced Portland Cement (in combination with proprietary additives). CNSI found, however, cement by itself or cement and caustic alone cannot be applied universally to radioactive wastes of varying chemical properties. Pre-treatments of the waste streams as well as additives to the final product were necessary to ensure complete, homogenous solidification. Each waste stream must be treated as a unique chemical process.

In November, 1983, Chem-Nuclear published "CNSI-WF-01-NP Waste Form Certification Topical Report." This report guarantees compliance with all of the long term stability requirements of the NRC 10CFR Part 61 Branch Technical Position on waste form. Chem-Nuclear's solidification formulas have been used at dozens of operating utilities in the United States over the past two years. These formulas, with modification, are also being used to process non-utility waste such as organics and pyrophoric materials. The final waste form products EXCEEDS all current State and Federal stability requirements.

Chem-Nuclear's development program has expanded during the past several years. We have certified more waste forms than any other corporation in the U.S. There are currently 13 waste forms exceeding the stabilization requirements and another five undergoing certification testing. NuReg/CR-3829 published in May 1984, "An Evaluation of the Stability Tests Recommended in the Branch Technical Position on Waste Form and Container Materials" (Brookhaven National Laboratory) cites Chem-Nuclear Systems, Inc. as "the only company having long term leach results available during the course of this study of stability requirements." The NRC has commissioned EG&G, Idaho, to conduct "real world" leaching studies of waste forms. Through 1984, Chem-Nuclear's leach results have been found to meet or exceed these criteria.

1) Background

In May, 1983, the Nuclear Regulatory Commission (NRC) issued two technical position papers (branch technical position papers, BTP) on Radioactive Waste Classification and Waste Form. These documents were intended to further clarify and provide guidelines for 10CFR61 issued in December, 1982. The impact of this regulation and subsequent position papers upon radioactive waste management and processing has been significant. The practical impact of these position papers has been to clarify and segregate radwaste by type of nuclide, specific activity and physical form (i.e. solid, liquid or gas).

Most Licensee's took immediate steps to develop programs to classify the radioactive waste according to the BTP. In most cases, this program involved obtaining and analyzing samples of the various waste streams. Quality Control in the sampling, analysis, processing and packaging of the radwaste was also an important part of their programs.

Compliance with the second technical paper, dealing with Waste Form was more difficult for most licensees. This paper set forth a number of test criteria that a "stable waste form" was required to meet. These criteria include 90 day water immersion (followed by compression testing to 50 psi).

- 90 day water immersion (followed by compression testing to 50 psi)
- Leach testing
- Freeze Testing (cycling waste between (60°C and -40°C)
- Irradiation testing (100 Megarads total dose)
- Biodegradation Testing (exposure to fungus and bacteria)

Chem-Nuclear Systems, Inc. in the interests of continuing to serve its customers, added the necessary personnel and equipment to develop a new set of solidification formulas to meet the various waste forms encountered during utility operation. The goal in undertaking the research and testing program was to develop formulas which maximized waste loadings and yet meet or exceeded the test criteria.

(2) Chemistry

Chem-Nuclear was the first and only radioactive waste processor, disposal operator and shipper to submit a complete topical report on five waste formulas by December 27, 1983. Following the cement topical submittal, Chem-Nuclear continued to optimize and develop solidification formulas for the increasing numbers of decontamination solutions, oils, acids, solvents and other chemicals found in nuclear plants.

Chem-Nuclear solidification formulas are unique in that all waste types (except oil and resins), are chemically altered. This makes the waste an integral part of the solidified cement matrix. These new formulas (much of the work is under patent) have allowed Chem-Nuclear to continue to increase waste loadings (up to 72%) and thereby reducing customer costs. Our "new formulas" are also a dramatic improvement over early formulas in that achievement of higher compression strengths and lighter solidified products is possible.

3. Quality Assurance

In conjunction with the research and development efforts at Chem-Nuclear, two important programs insure the highest level of quality products. The programs are the Process Control Program (PCP) and the Quality Control Program.

The Process Control Program (PCP) was developed by Chem-Nuclear to meet internal corporate quality requirements. The Process Control Program includes check lists, procedures, and bench scale analysis of waste batches prior to treatment and solidification. Controlled procedures and customer audits are an important part of the program. Chem-Nuclear technicians are required by procedure to maintain a log, complete Process Control Program worksheets and full scale solidification worksheets. These documents are filed in Chem-Nuclear's Corporate office and become a permanent record of field operations.

Chem-Nuclear's Quality Control Program is an important part of product development work. Our laboratory is periodically audited to review instrument calibrations, use of correct procedures, and compliance with test standards.

Further, Quality Assurance inspectors witness various phases of Process Control Program development on an unannounced schedule.

After the laboratory phase of development is complete the data and final procedure(s) is/are submitted to the company Safety Review Board for review for possible approval.

In Summary:
Chem-Nuclear Systems, Inc. has been conducting Research and Development on Radwaste Solidification Chemistry since 1979. The original chemistry and stability results were published in "Topical Report CNSI-2 (4313-01354-01P-1) in 1981, a report found acceptable by the NRC in April, 1983. This report contained chemistry, compressive strengths, leach results and full scale test results for several generic waste forms processed with cement. The 10CFR61 BTP-Waste Form - added additional criteria and, with slight formula changes, a report was issued in November, 1983, "CNSI-WF-C-01-NP" (summarized on following pages) subsequent to that publication, new waste forms identified, and new laboratory developments have created a very dynamic situation as demonstrated Figure 3 of Attachment 2.

ATTACHMENT #2

CHEM-NUCLEAR SYSTEMS, INC.
PROPOSED "LIVING" WASTE FORM CERTIFICATION PROGRAM

ATTACHMENT 2

Proposed specific details of Chem-Nuclear Systems, Inc. Continuous (Living) Waste Form Certification Program.

Since November, 1983, CNSI has continued to make significant improvements in waste solidification chemistry. These improvements have been realized through the development of proprietary chemical additives designed for specific waste chemistries.(See Figure 5) These new additives have resulted in allowing Chem-Nuclear to achieve higher waste loadings and improved properties (such as higher compression strengths and better leach resistance). (See Figure 2)

In order to bring these improved solidification formulas to the customer promptly, CNSI proposes the adoption of a "Living Process Control Certification Program." This program would be analogous to the "USAR," or "Updated Safety Analysis Report" program found in the nuclear industry, and approved by the NRC. Due to the daily changes made in plant safety systems status, the SAR is considered a dynamic document subject to continuous update.

CNSI proposed to establish a similar or analogous program to certify solidification chemistry for various waste forms. Regulatory control of the Program would be based upon three foundations:

1) CNSI Regulatory Affairs

2) CNSI Quality Assurance

3) CNSI Product Development

Each new (or improved) formula would be quality controlled under the program as outlined in the original topical submission of 30 Nov. 1983, with updated management responsibilities as shown in Figure (1). In addition, a Quality Assurance Inspector would be specifically designated to assure compliance with test procedures and standards. QA responsibilities would extend throughout the test program (from small scale "bench" testing of the formula to the full scale test liners.

Finally, CNSI Product Development has established a computerized file of all solidification worksheets performed for our customers. Continuous review of these documents by Product Development personnel would provide an additional quality check on new solidification formulas.

Figure 1 - Illustrates CNSI organization and responsibilities under the proposed "Living Process Control Certification Program."

Figure 2 - A summary of data submitted in the original topical of 30 November 1983.

Figure 3 - Illustrates the generation of new waste types requiring formula development, testing and certification. The five initial certifications start the graph in November of 1983. The graph continues to show additional waste forms in certification and testing up until December 1985. The development and improvement of new waste stream certifications are expected to continue in response to the changing requirements of the nuclear industry.

Figure 4 - Illustrates specific examples of chemistry improvements resulting in final improved products. The most notable improvement is the reduced Cs^{137} leach rates.

Figure 5 - CNSI cement additives and resulting improvements.

Chem-Nuclear Systems, Inc.

Waste Form Certification Management Responsibilities and Communications

Regulatory Affairs	Product Development	Operations
Oversees license activity	Characterization evaluation of radwaste streams	Process Control Program/ Solidification Procedure Revision
Interface with Regulatory Agencies	Development & Testing of cement additives	On-site waste evaluation and Processing
	New Formula Certification	
Audits Product Development & operations for compliance with established CNSI QA Program including: -instrument calibrations -procedure preparation, usage -& review appropriate test -criteria evaluates new -regulations for input on CNSI. -disseminates new regulations -Safety Review Board approval of new & revised solidification procedures	On-site Waste Evaluation Collection/Storage/ Evaluation of Solidi-ficaton Worksheets	Worksheet Completion & Transmittal to Product Development

Figure 1
Attachment 2
Page 4

CNSI - WF - C - 01 - NP

10CFR Waste Form Certification Topical Report
November 30, 1983
( ) Indicate formula improvements

Waste Type	Leach Test (Lix) Cs-137	Leach Test (Lix) Sr-85	90 Day Water Immersion (PSI)	Freeze Therm Test (PSI)	Biodegradation* Test (PSI)	108 Rad Irradiation (PSI)	Comments
BWR 69	6.6	10.3	1800	1241	1573	805**	
PWR 66*	6.1 (8.3)	8.5	1963 (2300)	1416 (2000)	1340	1331 (2113)	
Powdex	6.9	9.2	2375	2228	2129	1493	
Resin*	7.3 (8.5)	10.3	1600 (2000)	1273	816	1045 (2119)	
D.E.	8.3	9.8	2625	2674	1804	2446	

*Note: Fungal & Bacterial Tests were averaged together.

**Note: This value was for BWR-73 (a 4% higher waste loading than BWR 69).

* Note: New formulas for boric increase to 72% volume efficiency vice 66% and resin from 69% to 72% demonstrating increased loading as well as increased stability/integrity.(1036A)

Figure 2
Attachment 2
Page 1

CHEM-NUCLEAR SYSTEMS, INC.
Increased Numbers of Waste Types undergoing Certification Testing
1983 thru 1984

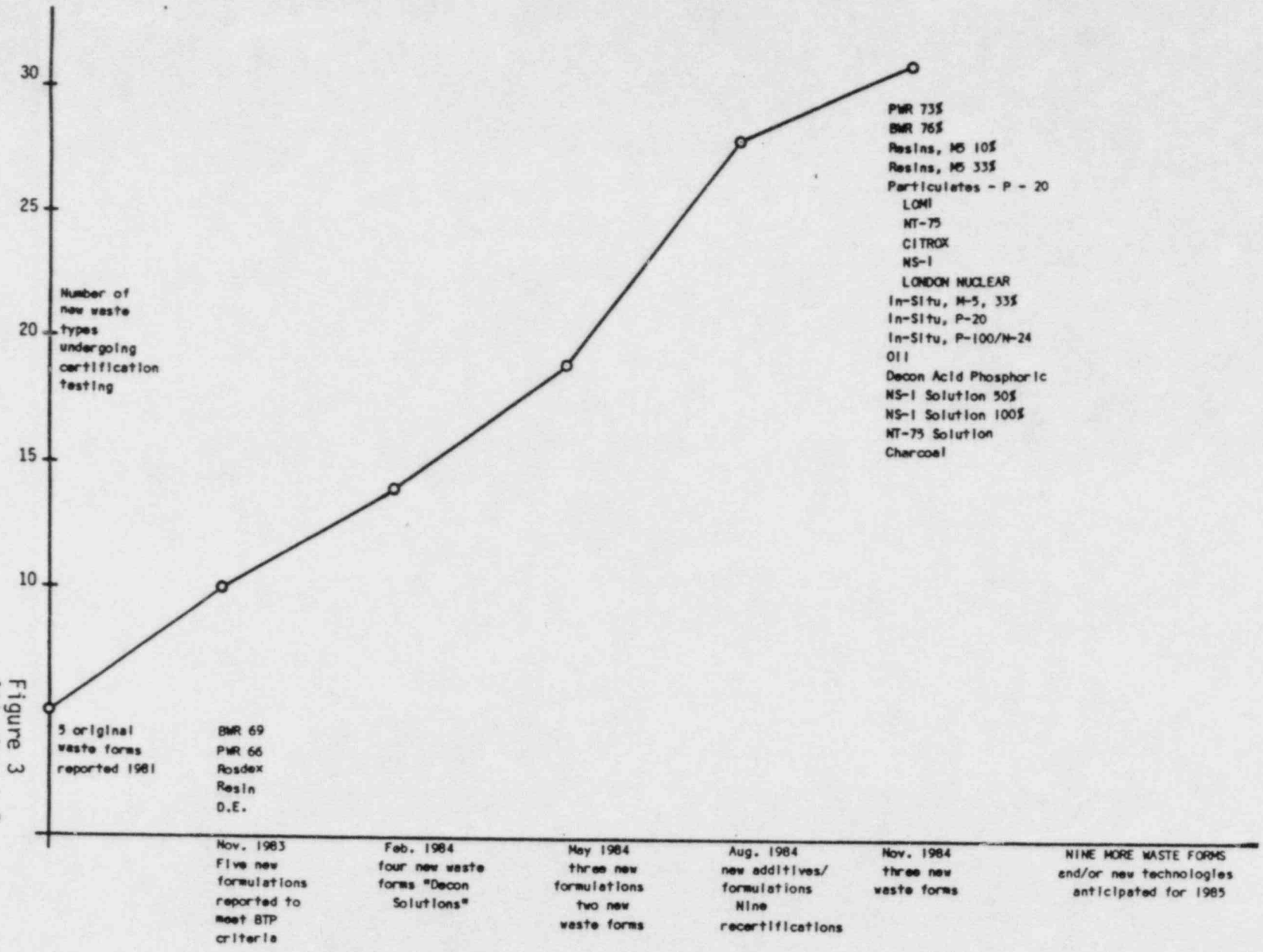

Figure 3
Attachment 2
page 6

FIGURE 4

Improvement in In-Situ waste formula

	Type I Cement & 20% M-5	Type I Cement & 10% M-5	1-P Cement
10^8R Irradiation			
Comp. Str. Before	1375 psi	1250 psi	1650 psi
Comp. Str. After	2131 psi	2313 psi	2119 psi
90-Day Water Immersion			
Comp. Str. Before	1375 psi	1250 psi	1750 psi
Comp. Str. After	1419 psi	1261 psi	2144 psi
Change in Weight	+8.3%	+8.7%	+5.8%
Leachability in D.I. Water			
Cesium$_{137}$ Leached, 90 Days	33.2%	33.5%	14.9%
Leachability Index, Avg.	7.8	7.8	8.6%
Thermal Cycling, 30 Cycles			
Comp. Str. Before	N/A	N/A	1695 psi
Comp. Str. After	1035 psi		
Development Date	1983	1984	1985

CNSI ADDITIVES FOR CEMENTITIOUS SOLIDIFICATIONS

P-14	A stable additive improving retention of certain radionuclides for better control of leachability.
N-24	This substance reacts with boric acid waste solution to allow solidification at higher waste volume percentages.
N-50	A stable chemical promoter used in combination with N-24 to form a novel cementitious binder that is not as pH dependent as Portland cement and sets hard much more rapidly.
P-100	A modifier of Portland cement imparting improved water resistance and leachability.
P-20	A type of Portland cement containing a pre-blended additive for sulfate resistance.
S-4	This soluble chemical accelerates the rate of cement hydration, and is particularly useful in certain boric acid and oil waste solidifications.
S-3 & S-7	These commercial surfactants are used singly or in combination to emulsify oily wastes prior to cementitious solidification.
K-17	A reactive chemical especially useful for solidification of very highly concentrated boric acid waste.
A-27	This stable additive assists in the solidification of certain waste chelate solutions that would normally inhibit cement set.
M-5	A finely divided mineral powder minimizing the separation of bleed liquid from low viscosity cement/waste mixtures.
K-4	A reactive chemical used to destroy or reduce the concentration of organic chelates in waste solutions.

Figure 5
Attachment 2
PP-8