PROCESS CONTROL PROGRAM FOR SAN ONOFRE UNIT 1

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PROCESS CONTROL PROGRAM FOR SAN ONOFRE UNIT 1

1.0 OBJECTIVES

1.1 The purpose of the Process Control Program for San Onofre Unit No. 1, is to establish a set of process parameters which provide reasonable assurance of complete solidification of various liquid radioactive "wet wastes" including resin slurries, tank and sump sludges, filters; and Class B and Class C waste requiring stabilization (i.e., encapsulation), in accordance with applicable Department of Transportation (DOT) and California State Regulations and Nuclear Regulatory Commission (NRC) and licensed burial Facilities' acceptance criteria for packaging and shipment to an approved offsite burial site.

1.2 This instruction shall be used by all personnel operating the CNSI cement solidification unit. This procedure is applicable to all liners listed on Attachment 5.

2.0 REFERENCES

2.1 Licensing Commitments

2.1.1 SONGS 1 Technical Specifications Section 3.19 "Solid Radioactive Waste," (when implemented)

2.1.2 Final Safety Analysis Report for San Onofre Unit 1

2.1.3 Topical Quality Assurance Manual for San Onofre Unit 1, Unit 2, and Unit 3

2.2 Procedures

2.2.1 SO123-VII-8.1, Solid Radioactive Waste Packaging, Labeling and Shipping

2.2.2 SO123-VII-8.5.2, "Radwaste Solidification with CNSI Portable Solidification Unit (PSU-C-125) (when issued)

2.2.3 SO123-SD-OP-063, "Assembly and Disassembly Procedure for CNSI Portable Cement Solidification Unit No. 125"

2.3 Other

2.3.1 10 CFR Part, 20, Standards for Protection Against Radiation

2.3.2 Chem-Nuclear Topical Report CNSI-WF-C-01-NP "10 CFR 61 Waste Form Certification-Cement," November 30, 1983

2.3.3 CNSI Topical Report, CNSI-2, 4313-01354-OIP-A January 1983, Revision 2

3.0 PREREQUISITIES

3.1 Prior to use of an uncontrolled (pink) copy of this Station Document to perform work, verify it is current by utilizing one of the following methods:

3.1.1 Checking a controlled copy and any TCNs;

3.1.2 Accessing an SCE Document Configuration System (SDCS) TSO Terminal;

3.1.3 Referencing a current (within one week) Configuration Control Log and associated daily update;

3.1.4 Contacting CDM by telephone or through counter inquiry;

3.1.5 Obtaining an uncontrolled (pink) copy of the Station Document from CDM.

3.2 The Station Manager shall assure the performance of a review by a qualified individual/organization of changes to the Process Control Program. Change(s) shall be submitted to the USNRC in the semiannual Radioactive Effluent Release Report for the period in which the change(s) was made.

3.3 The CNSI operator shall ensure that additives received comply with the chemical composition necessary for this process. Conditioning chemicals are purchased from reputable suppliers and, in most cases, are available through national distribution networks. The final reliability criteria is the satisfactory performance of the chemical in a laboratory solidification formula containing material sampled from the actual bags or drums intended for subsequent use.

3.4 The CNSI operator shall ensure that all the necessary equipment described in Attachment 1 are available or SCE/CNSI approved substitutes are available.

3.5 Ensure Attachments 1 through 6 are consistent with the latest revision of the CNSI Process Control Program for cement solidification units and Reference 2.3.2.

3.6 A Radiation Exposure Permit SO(123) 100 must be obtained prior to commencing this procedure.

3.7 The Portable cement solidification unit shall have been assembled and tested in accordance with Reference 2.2.3.

3.8 Ensure QC inspector is present when portions of the procedure are being performed which contain Quality Hold Points (QHP). Inspections required shall be documented on Data Record Form for this procedure.

3.8 An ALARA review must be performed prior to beginning this Procedure.

3.0 PREREQUISITIES (Continued)

HP 3.9 Ensure scale used to weigh process chemicals for test samples has been verified accurate prior to each use, over the scale range, using certified standard weights. Scale accuracy will be ± 1% of the standard weight used.

4.0 PRECAUTIONS

4.1 The chemicals and cement used are considered non-toxic and safe to handle, however, care should be used to avoid breathing dust, follow the safety precautions outlined in the appropriate Radwaste Solidification procedures, Reference 2.2.2 (SO123-VII-8.5.2).

4.2 If difficulties are encountered with any part of this verification procedure or unexpected results are obtained, contact the Chem-Nuclear Solidification Manager, or Supervisor, and the SCE Radwaste Supervisor or his designee.

4.3 The CNSI technician(s) shall be subject to the applicable Health Physics and safety precautions of the Health Physics Program.

4.4 Laboratory gloves, face shield and an apron shall be worn by the CNSI technician(s) while handling, collecting and testing of all samples.

4.5 Health Physics personnel shall ensure that radiologically clean and contaminated zones are established in the sample process area to prevent the possible spread of contamination.

5.0 CHECKLIST

5.1 Data Record Form

6.0 PROCEDURE

6.1 SYSTEM DESCRIPTION

6.1.1 Process Description

The process used at San Onofre Unit 1 is the CNSI Cement Solidification Unit. This unit is specifically designed to facilitate solidification of various radioactive wastes, including ion exchange resin slurries, tank and sump sludges, filters, and Class B and Class C waste requiring stabilization (encapsulation). Immobilization of the waste is accomplished using readily available Portland cement in conjunction with hydrated lime and particular process additives. The waste is solidified in a disposable liner which may already contain some of the required conditioning chemicals. Pre-installed mixer blades permit continuous agitation until a thick cement paste has formed that will set to a hard, uniform, water-free matrix. The end product is a true cement structure formed in accordance with established principals of concrete technology.

6.0 PROCEDURE (Continued)

6.1.2 Process Parameters

.1 Portland Cement combines with water through several intermediate reactions to form stable hydrates from chemically combined mixtures of calcium, silicon, aluminum, and iron oxides. These reactions are exothermic (heat producing) and do not progress rapidly unless a strongly alkaline pH (11-12) is maintained. Waste streams may contain certain metallic radionuclides that are chemically bonded (and not leached) in the cement structure without loss of product strength. Other waste chemicals can significantly accelerate or retard cement set, and must be controlled by the addition of selected chemical agents.

.2 Judicious control of total cement content maximizes waste volume efficiency and minimizes heat development for large volume solidifications. Preferred waste to additive solidification ratios have been determined by the CNSI Research and Development Program, but it is recognized that waste stream composition and density are variable, and that verification of the solidification formula is necessary for each new lot of waste liquid. This important consideration is detailed by waste form in Attachments 2 through 6.

6.1.3 Solidification Unit Description

.1 The CNSI Cement Solidification Unit System contains all piping, support, control and monitoring equipment necessary to solidify either radioactive liquid waste or Class B or Class C waste requiring stabilization (encapsulation) using the cement process.

.2 The unit is composed of several processing systems, each controlling a specific function of the cement process. These subsystems include waste transfer, chemical addition, cement conveyor, vent, and dewater systems. Control functions for the unit are incorporated into the pneumatic and main control panels. The following services are provided which satisfy the interface requirements for the portable cement solidification unit:

.2.1 General Requirements:

.2.1.1 480V AC (3 Phase 100 amps)

.2.1.2 120V AC ("House Current")

.2.1.3 Resin Dewater Return - 1-1/2" connection 150# R. F. flange

.2.1.4 Service Water - connection 3/4" quick disconnect fitting, minimum 30 gpm at $\geq$ 80 psig

6.0 PROCEDURE (Continued)

6.1.3.2.1.5 Plant OFF Gas - connection 2 1/2" quick disconnect fitting

.2.1.6 Plant Waste - 1-1/2" connection 150# R. F. flange

.2.1.7 Service Air - 3/4" quick disconnect, 75 CFM 100 ± 20 psig

.2.2 Appropriate communication systems will be provided between the plant operator and the CNSI mobile unit operator. Telephone service will be provided for local and long distance business calls.

.2.3 Prior arrangements for shipping of the solidified material will be made by SCE. An approved vendor will provide the shipping casks.

.2.4 SCE is prepared to accept cement shipments prior to the arrival of the unit onsite. Cement for solidification has already arrived and is stored for use in the bulk cement storage trailer.

.2.5 A Radiation Exposure Permit (REP) must be obtained before any radwaste solidification operations begins.

.2.6 SCE shall provide to the CNSI operator(s), in the same manner as available for plant personnel, any clothing or equipment necessary for radiation protection.

.2.7 A Red Badge Zone will be established around the processing area.

.2.8 SCE personnel have designated an area to be used for test solidification.

.2.9 SCE will provide crane services, torque wrenches and other necessary materials for loading the liners and preparing the solidified waste for shipment.

.2.10 SCE will have available a forklift capable of 4,000 pounds at 6 foot movement arm to unload the removable skids and place them in position for full-scale solidification.

.3 The equipment, components and structures that interface with the mobile cement solidification system comply with the applicable criteria of Regulatory Guide 1.143, Revision 1, Branch Technical position ETBS 11-3, Final Safety Analysis Report for San Onofre Unit 1, TQAM for SONGS Units 1, 2 and 3, ALARA Program for San Onofre Unit 1, and Health Physics Program for San Onofre Unit 1.

6.0 PROCEDURE (Continued)

6.1.3.4 Most of the unit components are arranged on portable frameworks (skids) to provide flexibility of operations for either indoor or outdoor use. The cement conveyor, control panel, pump skid, hydraulic skid and fillhead contain most of the major elements of the mobile unit.

.5 A closed-circuit television system is an integral part of the unit and allows the operator to monitor the solidification process.

6.1.4 System Operation

.1 Before beginning any solidification operations with the Cement Solidification Unit, the CNSI operator shall complete a successful sample verification in accordance with the Sample Verification Procedure described in Sections 6.2 through 6.4.

.2 The sample solidification calculations are recorded on a SCE/CNSI Solidification Worksheet. Full scale solidification values are determined from Attachments 2 through 6.

.3 Actual full scale solidification shall then be conducted in accordance with the Radwaste Solidification Procedure Reference 2.2.2 (SO123-VII-8.5.2) using the parameters calculated on SCE/CNSI Solidification Worksheets.

.4 Dewatering of resin or other slurries to be solidified will be performed in specially designed CNSI cement solidification liners in accordance with Reference 2.2.2. The dewatering line from the solidification system will be returned to the applicable portion of the Plant system for the waste stream being transferred in accordance with the proper transfer procedure.

.5 The primary waste streams to be solidified by the CNSI cement solidification system will come from the following tanks: Spent Resin Storage Tank, the Liquid Waste Hold-up Tanks, and the Monitor Tank. Other wastes to be solidified will include cartridge filters, misc. sludges, filter media and class B and C wastes required to be stabilized by 10 CFR Part 61.

6.1.5 Sequence of Operation

The conditioning chemicals may be preloaded into the liner or added to the waste while mixing. The addition of chemicals or waste may be interrupted at any time. The mixer may also be secured during waste or pretreatment chemical addition with no effect on the process, however, it must remain in operation during the addition of solidification chemicals and/or cement.

6.0 PROCEDURE (Continued)

6.1.6 Waste-to-Cement Ratio (by volume)

The normal volume ratio of waste to solidification components will be approximately 2 to 1 up to 3 to 1 for liquids, resins, powdex and other solids. It is necessary to control the waste-to-cement ratios at certified levels to ensure product integrity and to meet burial requirements.

6.1.7 Cure Time

Cure time will usually be 12 to 36 hours as shown by a continuing temperature rise. The liner should be ventilated until temperature begins to decrease indicating safe completion of the solidification process.

6.1.8 Shipping

The finished product will be shipped in accordance with Reference 2.2.1 (SO123-VII-8.1) and will comply with applicable DOT regulations, state regulations, NRC and burial facility acceptance criteria, 10 CFR Part 61, and 10 CFR 20.311 for packaging and shipment to an approved offsite burial site.

6.2 REQUIREMENTS FOR SAMPLE TESTING

6.2.1 Representive Sampling

.1 Due to the importance of obtaining a representative sample for waste classification (Reference 2.1.1) and to use in the verification procedure, the Radwaste Health Physics personnel shall confirm that the sample is representative of the contents of the selected waste storage tank (as listed in step 6.1.4.5) or the shipping container.

.2 If possible, samples shall be drawn after the contents of the selected waste storage tank have been adequately mixed. The system will be shifted directly from recirculation/agitation mode to the transfer mode and a representative sample shall be taken.

.3 For miscellaneous sludges, liquids, and storage tanks which do not allow adequate mixing of the contents, samples will be taken after the waste has been transferred into the shipping container as follows:

.3.1 After the shipping container has received all the waste, the contents of the shipping container shall be mixed, with the installed mixing system, for a minimum of 15 minutes.

6.0 PROCEDURE (Continued)

6.2.1.3.2 A grab sample will be taken as soon as possible after completion of mixing.

.3.3 For any additional transfers of the same waste stream, which are controlled by the sample taken in step 6.2.1.3.2 and in accordance with step 6.4.3, a grab sample will be taken during the transfer of each consecutive shipping container to verify proper classification and that the process parameters have not changed. If the process parameters have changed from the initial sample, a new verification sample is required.

.4 For wastes requiring encapsulation (i.e., filters, wet solids with special nuclear material, and other Class B and C solids) a representative sample will be taken prior to loading waste into the specially designed solidification liner. This sample will be used for the Verification sample.

.5 Any one of a number of operations involving the selected waste storage tank or the shipping container may negate the previous sample results. These operations include the following:

.5.1 introduction of additional waste into the selected storage tank or shipping container after verification sample was taken;

.5.2 securing of recirculation and/or transfer while drawing the verification sample.

.6 If any of the situations listed above or a situation deemed, by the Radwaste Supervisor or his designee, to be detrimental should occur, it will be necessary to repeat the sample process and sample verification procedure of Section 6.5 in order to re-establish the solidification process parameters.

6.2.2 Waste Identification

.1 The Chemistry Department shall provide chemical analyses. These analyses will provide the basic chemical composition and properties of the selected
QHP waste stream as requested by the Radwaste Group. The CNSI operator shall record the chemical composition and properties on Attachments 2 through 6 as required and may confirm waste density and pH as necessary.

NOTE: Waste containing oil above one percent by volume shall not be solidified by this PCP.

6.0 PROCEDURE (Continued)

6.2.3 Equipment

Equipment required for the sample verification procedure is listed in Attachment 1. The table indicates the recommended quantity to begin a verification procedure.

HP The CNSI operator shall ensure that all necessary equipment is available or SCE/CNSI approved substitutes are available.

6.3 Sample Acceptance Criteria

6.3.1 The sample verification (CNSI, SCE/QC) is performed by examination of lab compositions containing actual waste material. The test confirms the correct process constituents. The acceptance criteria for a good solidified product are as follows:

QHP .1 Visual inspection of the end product after solidification indicates a uniform, dry, free-standing monolith;

QHP .2 The end product resists penetration when probed with a spatula or other firm object.

6.4 Requirements for Sample Verification

6.4.1 HP Verify that all materials listed in Attachment 1 are available and ready to use in the area selected by the Health Physics Group for solidification testing.

6.4.2 Be prepared to complete the test procedures outlined in Attachments 2 through 6, as applicable, when conducting sample verifications.

6.4.3 Sample Requirements

.1 A sample shall be solidified prior to the initial full scale solidification of a particular waste stream. If the test sample meets the acceptance criteria and there is no change in the chemical composition of the waste as verified by Radwaste Health Physics personnel (Ref. step 6.2), test results and full scale solidification parameters will be considered reproducible. Thereafter, a sample solidification will be conducted prior to the tenth batch solidified from the same source of waste.

.2 If any test sample fails to meet the acceptance criteria, the full scale solidification shall be suspended until a new sample is obtained in accordance with step 6.2, alternate parameters are established for the waste stream, and a subsequent test sample meets the acceptance criteria. Full scale solidification can then be resumed using the alternate solidification parameters as determined by the verification procedure.

6.0 PROCEDURE (Continued)

6.4.3.3 If the initial test sample from a batch of waste fails to meet the acceptance criteria, a test sample shall be performed prior to full scale solidification for each consecutive batch of the same type of waste until at least 3 consecutive initial test samples meet the acceptance criteria.

.4 The CNSI operator and the Radwaste Health Physics Personnel shall ensure, as much as possible, that the test sample is representative (i.e., thoroughly mixed) (Ref. step 6.2).

6.5 TEST DOCUMENTATION

6.5.1 QHP Calculate and record the available information on the CNSI/SCE Solidification Worksheets for all waste type sample verifications.

6.5.2 Use the appropriate attachment (Attachments 2 through 6) for test instructions and documentation for the various waste forms to be solidified.

7.0 RECORDS

7.1 All forms for each solidification must be gathered and filed with the shipping papers in a single package in CDM. This will require coordination with the Radwaste Foreman and QC.

7.2 The CNSI operator shall forward a copy of each completed CNSI/SCE Solidification Worksheet to the Chem-Nuclear Manager, Solidification Services and the SCE Radwaste Supervisor for review following completion of liner solidification.

7.3 The CNSI/SCE Solidification Worksheet and related instruction sheets are considered as proprietary information and not to be distributed outside of Chem-Nuclear Systems Inc. or required SCE personnel. Each CNSI operator shall maintain a controlled file of these documents. This file is subject to audit by CNSI or SCE Quality Assurance.

EQUIPMENT RECOMMENDED FOR TESTING SAMPLE

250 ML Plastic Beakers with Lids (12)
600-1000 ML Containers (12)
Wide Blade Spatulas (2)
0-212°F Thermometer (3)
pH Paper: Wide Range (0. to 9.0)
Narrow Range (9.0 to 13.0)
Hydrometers, Range 1.000 - 1.200 and 1.200 - 1.400, or equivalent
0-600 or 0-1000 gm Triple Beam Balance
Hot Plate, variable temperature control
Pyrex Beakers, 600 ml capacity (12)
Marking Pen
Sample Heating Oven, Thermostatically Controlled from 100° to 180°F. (See Note 2)
Graduated Cylinders, 250 ml (2)

NOTE 1: Chemicals to be used should be taken from the full scale solidification chemicals. These should be stored in capped containers.

NOTE 2: Waste Solidified with cement on a small scale at ambient temperature will set much more slowly due to removal of exothermic heat. Sample conditioning in a temperature-controlled oven permits more meaningful evaluation of solidification results in 6-24 hours as specified for the waste form, or as established by experience at a particular utility.

PCP SOLIDIFICATION OF BORIC ACID CONCENTRATES (N-24, CEMENT, LIME SEQUENCE)

1.0 SAMPLE VERIFICATION

NOTE: The chemical additives used for PCP preparation should be those actually used in full scale solidification and should be stored in capped containers. The sequence for chemical addition for PCP preparation and full scale solidification shall be the same.

1.1 From past experience and the analysis supplied by the utility, determine the appropriate PCP solidification formula using the amounts below. Note that boric acid waste that has been partly neutralized unintentionally or to reduce storage temperature may require additional solidification agents and result in less efficient waste handling. Waste temperature must also be considered in determining the preferred PCP formula and full scale material requirements. The sample volumes are listed below:

Amounts

Boron Content (ppm)	Boric Acid Equivalent	Waste Volume	*WT. of CNSI Agent N-24	*WT. of CNSI Agent P-14	Weight of Cement	Weight of Lime
0- 6,900	0-4%	200-210 ML	5 GM	0-20 GM	170-210 GM	60-80 GM
7,000-21,000	4-12%	210-240 ML	10 GM	0-20 GM	130-180 GM	60-80 GM
Above 21,000	Above 12%	220-250 ML	15 GM	0-20 GM	120-170 BM	60-80 GM

*Typical Amount or As Required by Test Results

1.2 Notify Radwaste Health Physics personnel that preparations for verification testing are complete and that a sample is required.

HP 1.3 If waste sample has crystallized and is non-uniform, the entire sample must be heated to 140°F or above until crystals have re-dissolved. Then measure out waste volume required in 250 ml graduate and immediately transfer to a 600 ml pyrex beaker.

HP 1.4 If sample is less than 160°F, heat sample to 160°F on the hot plate using a glass rod to occasionally stir contents. Then remove beaker from the hot plate and, when temperature is just 160°F, immediately add required weight of CNSI Agent N-24. Stir vigorously to disperse powder in hot liquid, and to determine if foaming may occur in the full scale solidification. Note maximum temperature reached during the 30 seconds of stirring after addition. Record temperature on CNSI Solidification Worksheet I, Item (b).

1.0 SAMPLE VERIFICATION (Continued)

NOTE: If any foam is created due to the agitation of the waste, then small quantities of a CNSI chemist-approved anti-foam shall be added (less than or equal to 1 ML) while agitating the sample. The total amount of anti-foam added to subside the foam shall not exceed 2% of the total waste volume without prior approval from the SCE Radwaste Supervisor or CNSI Manager of solidification services.

QHP 1.6 Proceed directly with lime addition and using minimum weight for first lime addition, or if experience with the particular waste form indicates that the required pH will be achieved with a quantity of lime different than the minimum indicated on the table, that quantity may be used for the first lime addition. Mix with spatula and check pH with litmus paper to confirm a value of 11 or above. Add more lime if pH is low or if mix is too watery.

QHP 1.7 Transfer entire sample to a 250 ml container using spatula. Attach lid firmly and place sample in oven at 165 $\pm$ 5°F.

HP 1.8 Maintain sealed sample in oven for 6-24 hours according to past experience at that particular utility. Then remove sample from oven and allow to cool for at least 2 hours before unsealing and evaluating solidification results according to guidelines of paragraph 6.3.

NOTE: The 2-hour cooling period can be deleted if experience with this particular waste stream indicates that no water is standing on the sample and it meets the requirements of paragraph 6.3.

2.0 FULL SCALE CALCULATIONS

2.1 Determine the volume (cubic feet) of waste to be received by completing SCE/CNSI Solidification Worksheet II or according to past experience at the particular utility.

2.2 Be sure that total solidificaton weight and waste radiation level is consistent with allowable transportation regulations and requirements.

SCE/CNSI SOLIDIFICATION WORKSHEET I (SW-I)

(PCP SOLIDIFICATION OF BORIC ACID CONCENTRATES)
N-24, CEMENT, LIME SEQUENCE

Waste Identification Date: _____ Operator: _____ Unit: _____

Boron Content _____ ppm or Boric Acid Content _____

Specific Gravity _____

pH: _____

Temperature _____ °F (In Waste Tank)

Physical Appearance (color, clarity, sediment) _____

_____

_____

Sample Preparation Shipment No. _____

(a) Volume Of Waste: _____ ml

(b) Weight of N-24: _____ gm (_____ °F)

(c) Antifoam Agent Required: _____ Yes _____ No

(d) Weight of P-14: _____ gm

(e) Weight of Cement: _____ gm

(f) Weight of Lime: _____ gm

pH After Mixing in Lime _____

(g) Additional Lime Added, If Any: _____ gm

pH After Mixing in Lime

(h) Total Lime Added (f&g) _____ gm

Oven Temperature at Start of Test _____ °F

Time Sample in Over (Sealed) _____ hrs

Oven Temperature When Sample Removed _____ °F

Time Outside Oven Before Unsealing _____ hrs

Solidification Results

Free Liquid, If Any _____ml (Approximate)

Relative Set (Very Hard, Firm, Soft) _____

Unusual Appearance (Color, Foam, Stratification): _____

_____

_____

PREPARED BY: _____ / _____
Date

REVIEW/APPROVED BY: _____ / _____
Radwaste Foreman Date

SCE/CNSI SOLIDIFICATION WORKSHEET II (SW-II)

(Full-Scale solidification of boric acid concentrate)
N-24, Cement, Lime Sequence)

Volume Information

Waste Identification
Tank: _____
Date: _____
Operator: _____

(a) Usable Liner Volume (Attachment 7) _____ Ft^3

(b) Liner Ft^3 Inch of Height (Attachment 7) _____ Ft^3/Inch

(c) Waste Volume to be Solidified _____ Ft^3 (See Note)

NOTE: MAXIMUM WASTE VOL. (FT^3 = _____ (PCP Waste Vol. SW-I, Item (a)) ÷ 200
(Round off to next lowest 5 Ft^3 Level) x _____ (Usable Vol.) (a) x .632 = _____ Ft^3

Waste Calculations (To Nearest Pound)

(d) Weight of N-24 = _____ (c) (Waste Vol.) x _____ (PCP Wt. of Add. SW-I, Item (b)) ÷ _____ (PCP Waste Vol. SW-I, Item (a))

x 62.4 = _____ Lbs ± 10% _____ lbs

(e) Weight of P-14 = _____ (c) (Waste Vol.) x _____ (PCP Wt. of Add. SW-I, Item (b)) ÷ _____ (PCP Waste Vol. SW-I, Item (a))

x 62.4 = _____ Lbs ± 10% _____ lbs

(f) Weight of Cement = _____ (c) (Waste Vol.) x _____ (PCP Wt. of Add. SW-I, Item (b)) ÷ _____ (PCP Waste Vol. SW-I, Item (a))

x 62.4 = _____ Lbs ± 10% _____ lbs

(g) Weight of Lime = _____ (c) (Waste Vol.) x _____ (PCP Lime Wt. SW-I, Item (h)) ÷ _____ (PCP Waste Vol. SW-I, Item (a))

x 62.4 = _____ Lbs ± 10% _____ lbs

Weight Calculations (To Nearest Pound)

(h) Weight of Waste = $\frac{\text{(c)}}{\text{(Waste Vol.)}}$ x 62.4 x 1.02* = _____Lbs.

*Average Waste Specific for Calculation Purpose.

(i) Estimated Total Wt to be Added = (d)+(e)+(f)+(g)+(h) = _____Lbs.

Level Heights (To The Nearest 0.1 Inch)

(j) Waste Alarm Height = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$ = _____Inches

(k) Cement Height = $\frac{\text{(f)}}{\text{(Cement Wt)}} \div 173^{**} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$

= _____Inches

**Typical True Cement Density, Lbs/Ft³

(l) Cement Alarm Level = (j) + (k) = _____Inches

(m) Lime Height = $\frac{\text{(g)}}{\text{(Lime Wt.)}} \div 137^{***} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$

= _____Inches

(n) Lime Level (Estimated = (l) + (m) = _____Inches

***Typical True Lime Density, Lbs/Ft³

(o) High Level Alarm = (n) + 2 Inches = * _____Inches

*Round Up to Next Nearest Inch.

PREPARED BY: _____ / _____
Date

REVIEW/APPROVED BY: _____ / _____
Radwaste Foreman Date

FIGURE 1 - TYPICAL SAMPLE CALCULATIONS FOR WORKSHEET II (PWR WASTES)

140 cubic feet of waste at 170°F containing 12% un-neutralized boric acid is to be solidified in a 14-195 liner. A satisfactory PCP test was completed using 240 ml of hot waste, 10 gm of N-24, 10 gm of P-14, 130 gm of cement and 70 gm of lime.

(a) Usable Liner Volume (Attachment 7) = 190 Ft^3

(b) Liner Volume/Height Ratio (Attachment 7) = 2.62 Ft^3/Inch

(c) Volume of Waste to be Received = 140 Ft^3

NOTE: Maximum Waste Volume = 240 ÷ 200 x 190 x .632 = 144.1 Ft^3
(Round off to 140 Ft^3

(d) Weight of Additive N-24 = 140 x 10 ÷ 240 x 62.4 = 364 Lbs

(e) Weight of Additive P-14 = 140 x 10 ÷ 240 x 62.4 = 364 Lbs

(f) Weight of Cement = 140 x 130 ÷ 240 x 62.4 = 4,732 Lbs

(g) Weight of Lime = 140 x 70 ÷ 240 x 62.4 = 2,548 Lbs

(h) Weight of Waste = 140 x 62.4 x 1.02 = 8,911 Lbs

(i) Estimated Total Weight To Be Added = 16,891 Lbs

(j) Waste Height = 140 ÷ 2.62 = 53.4 Inches

(k) Cement Height = 4332 ÷ 173 ÷ 2.62 = 10.4 Inches

(l) Cement Level = 53.4 + 10.4 = 63.8 Inches

(m) Lime Height = 2548 ÷ 137 ÷ 2.62 = 7.1 Inches

(n) Lime Level (Estimated) = 63.8 + 7.1 = 70.9 Inches

(o) High Level Alarm = 70.9 + 2 = 73 Inches**

**Round up to next inch

NOTE: Weight (Item i) plus 14-195 liner weight (Attachment 8.5) would exceed cask payload weight for a 14-195 cask and shipment utilizing a cask would require a 21-300 cask. Consideration must also be given for allowable radiation levels in cask selection.

FIGURE 1 - CNSI SOLIDIFICATON WORKSHEET III (SW-III)
(Process Summary - Boric Acid Concentrates)

Unit _____
Operator _____
Waste Tank _____

1. Waste Added:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Estimated Weight _____Lbs.

   From WS-II, Item (h)

2. Temperature After Waste Added: _____°F

3. Agent N-24 Added: Time _____ Date _____ Weight _____ ± 10% _____lbs

4. Temperature After N-24 Added: _____°F

5. Agent P-14 Added: Time _____ Date _____ Weight _____ ± 10% _____lbs

6. Antifoam Agent Added (If Required) Time _____ Date _____ Vol. _____

7. Cement Added:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Weight _____ ± 10% _____lbs

8. Temperature after Mixing in Cement: _____°F

9. Lime Added:

   Start Time _____ Date _____ Hydraulic Pressure ___psi

   Finish Time _____ Date _____ Hydraulic Pressure ___psi Weight ___Lbs

10. Temperature After All Lime Added: _____°F

11. Agitation Stopped: Time _____ Date _____ Hydraulic Pressure ___psi

FIGURE 1 - CNSI SOLIDIFICATON WORKSHEET III (SW-III)
(Process Summary - Boric Acid Concentrates) (Continued)

12. Initial Temperature After Agitation Stopped _____°F

    6 Hours Later (From Chart Recorder) _____°F

    12 Hours Later (From Chart Recorder) _____°F

    24 Hours Later (From Chart Recorder) _____°F

13. Peak Temp.: Time _____ Date _____

14. Temp. Under 160°F: Time _____ Date _____

15. Fillhead Removed: Time _____ Date _____

16. Liner Capped: Time _____ Date _____

17. Observations, Additional

    Comments: _____

_____

_____

_____

_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

PCP SOLIDIFICATION OF PARTICULATE WASTES (RESIN BEADS, POWDEX, DIATOMACEOUS EARTH SLURRIES, AND OTHER PARTICULATE SLURRIES

1.0 Sample Verification

NOTE: The chemical additives used for PCP preparation should be those actually used in full scale solidification and should be stored in capped containers. The cement and Agent M-5 should be blended together for PCP preparation with a ratio of 2 parts cement to one part Agent M-5 by weight.

1.1 Arrange with the Radwaste Health Physics personnel to assign a special test area which contains adequate protection from the anticipated high radiation levels of bead resins.

1.2 Notify Radwaste Health Physics that the preparations for verification testing have been completed and a waste sample is required.

QHP 1.3 Transfer 100 ml of resin from the sample container to a 250 ml graduated cylinder and allow solids to settle. Control resin bead level at 75-80 ml with 20-25 ml of water on top for the 100 ml sample. Pour the sample into 250 ml disposable beaker.

NOTE 2: When radiation levels are excessive in accordance with Health Physics Guidelines, the sample amount may be reduced to as little as 25 ml. Be sure to reduce other additives by the same ratio.

QHP 1.4 Measure and record on SCE/CNSI Solidification Worksheet the waste pH, using the wide range pH paper.

NOTE 3: If pH of waste is above 10.5, it will not be necessary to use alkaline agents (i.e., lime). However, if the pH is less than 10.5, add lime in accordance with paragraph 1.4.1 until pH is about 11.0 prior to adding cement and Agent M-5 in accordance with paragraph 1.5.

1.4.1 Add lime ($CA(OH)_2$) in 0.5 gm increments until a pH of approximately 11.0 is reached. The pH should be evaluated using a narrow range (9-13) pH paper. Stir thoroughly after each addition of lime. Record the total amount of lime added on SCE/CNSI Solidification Worksheet I for particulate wastes.

1.0 Sample Verification (Continued)

QHP 1.5 Add cement/agent M-5 blend (ration of 2 parts cement to one part Agent M-5 by weight) slowly (e.g., increments of ≤10 gms) while stirring until a smooth homogeneous mix is obtained. The amount added for a 100 ml waste sample may be 95 to 110 gms depending on resin type, and amount of water in the slurry. Record amount of cement/agent M-5 blend added on the SCE/CNSI Solidification Worksheet.

NOTE 4: Do not exceed 110 grams of cement/agent M-5 blend without authorization of the SCE Radwaste Supervisor or CNSI Manager of Solidification Services. If mixture becomes too thick before 95 grams of cement/agent M-5 blend has been added, add additional water as necessary to allow a maximum of 95 grams of binder (cement/agent M-5 blend) to be mixed to a smooth homogeneous mix. Full scale waste volume calculations must include the water as part of waste volume.

HP 1.6 Place the lid over the beaker and store the sealed mix in an oven controlled at 120-130°F for 18-24 hours. Then allow to cool for at least 2 hours before removing lid and evaluating solidification.

1.7 Evaluate the sample using the guidelines of paragraph 6.3. If the sample does not meet the acceptance criteria, contact the CNSI Supervisor, Solidification Services, and SCE Radwaste Supervisor, for possible formula modifications.

2.0 Full Scale Calculations (Bead-type of particulate wastes)

2.1 Determine the volume of waste material to be received and the amounts of cement and lime required by completing the SCE/CNSI Solidification Worksheet for bead-type of particulate wastes. Reduce the calculated amounts as necessary to comply with weight and radiation limitations imposed by waste activity and shielding requirements.

SCE/CNSI SOLIDIFICATION WORKSHEET I (SW-I)
(PCP Solidification of Particulate Wastes)

Waste Identification Date: _____ Operator: _____ Unit: _____

Type of Waste: (Resin Beads, Powdex, Sludge) _____
Waste Activity: (Reported Curie Content) _____
pH: (Reported by Utility) _____
Description: (Color, Uniformity, Free Liquid) _____

Sample Preparation

(a) Volume of Waste (In 250 ml Container):

_____ ml resin; _____ ml total water + resin (Notes 1 and 2)

NOTE 1: The volume of fluidized waste must be controlled as nearly as possible to the 100 ml mark in the graduated cylinder and contain 75-80 ml of resin beads with 20-25 ml of water on top of beads. Remove water from or add water to the waste sample received as necessary to acquire the right level.

NOTE 2: If the radiation level of the waste prevents using a 100 ml sample, the test may run with less waste material, but the CNSI Solidification Supervisor must be contacted for verification of the full-scale formula.

(b) pH of sample: (Tested By CNSI) _____

NOTE 3: If pH of waste is above 10.5, it will not be necessary to use alkaline agents. However, if the PCP sample fails to solidify in the required time, notify CNSI Solidification Supervisor or Manager and add lime until pH is about 11.0 prior to adding cement/agent M-5 blend. Without previous history, use lime as the preferred alkaline agent.

(c) pH Adjustment (If Necessary) (Add lime in 0.5 gm increments):

Total Lime Added _____gm; Final pH _____

NOTE 4: Add cement/agent M-5 slowly (e.g., increments of ≤ 10 gms). DO NOT EXCEED 110 grams of cement/agent M-5 blend per 100 ml of waste without authorization of SCE Radwaste Supervisor of CNSI Manager of Solidification Services. If mixture becomes too thick before 95 grams of cement/agent M-5 blend has been added, add additional water as necessary in 1 ml increments to allow a maximum of 95 grams of binder (cement/agent M-5 blend) to be mixed to a smooth homogenous mix.

Sample Preparation (Continued)

(d) Cement/Agent M-5 Blend Added to Obtain Smooth, Uniform Mix

NOTE 5: Add up to 95 gms; then continue to add cement/agent M-5 blend in approximately 2 gm increments (if possible) until one of the following occurs:

(1) The sample becomes too thick to mix (at which point, stop addition of binder (cement/agent M-5 blend) and record the total binder added; or

(2) The total weight of cement/agent M-5 blend added reaches 105-110 gms (do not exceed 110 gms).
Record total binder added. _____ gms

(e) Total Additional Water Added (If Necessary) (Add in 1 ml increments):

_____ ml

Oven Temperature at Start of Test: _____ °F
Time Sample in Oven (Sealed): _____ hrs; Date: _____
Oven Temperature When Sample Removed: _____ °F
Time Outside Oven Before Unsealing: _____ hrs; Date: _____

NOTE 6: Allowable oven temperature range is 120°-130°F.

Solidification Results

Free Liquid, If any: _____ ml (Approximate)
Relative Set (Very Hard, Firm, Soft): _____
Unusual Appearance (Color, Foam, Stratification): _____

(f) Repeat the PCP for a second sample using only 95gms of the Cement/Agent M-5 Blend.

Cement/Agent M-5 Blend: _____ gm

Additional Water Added (If Required): _____ ml
Lime Added (If Necessary): _____ ml

Oven Temperature at Start of Test: _____ °F
Time Sample in Oven (Sealed): _____ hrs; Date: _____
Oven Temperature When Sample Removed: _____ °F
Time Outside Oven Before Unsealing: _____ hrs; Date: _____

Solidification Results

Free Liquid, If any: _____ml (Approximate)
Relative Set (Very Hard, Firm, Soft): _____
Unusual Appearance (Color, Foam, Stratification): _____
_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman, or Designee Date

SCE/CNSI SOLIDIFICATION WORKSHEET II (SW-II)
(Full-Scale Solidification of Particulate Wastes)

NOTE 1: This worksheet is intended to provide a solidification formula consistent with the waste liner selected. The amounts of additives required are for calculation purposes only, and do not restrict the quantities actually added to achieve an acceptable solidification product.

NOTE 2: A line-by-line explanation of this worksheet is provided at the end of the worksheet.

Date: _____ Operator: _____ Unit: _____

a) Useable Liner Volume (LV) (Attachment 7): LV = _____ ft^3

b) Volume to Height (V/H) ratio (Attachment 7): V/H = _____ ft^3/in

c) Waste Volume to Binder (WV/B) ratio (Attachment 7): WV/B = _____

d) Waste Volume (WV) = a x c

WV = _____ x _____ WV = _____ ft^3

e) Waste Alarm Height (WAH) = d ÷ b

WAH = _____ ÷ _____ WAH = _____ in.

f) Water Volume Factor (WtVF) (Attachment 7): WtVF = _____

g) Water Volume (WtV) = a x f

WtV = _____ x _____ WTV = _____ ft^3

h) Process Volume (PV) = d + g

PV = _____ + _____ PV = _____ ft^3

i) Additional Water volume (AWV) added to PCP sample (from Worksheet I (SW-I), item e): AWV = _____ ml

j) Additional Water Volume-Liner (AWV-L) = i x h x 0.01

AWV-L = _____ x _____ x 0.01 AWV-L = _____ ft^3

k) Line Weight (LW) added to PCP sample (from Worksheet I (SW-I), item c): LW = _____ gms

1) Lime Weight - Liner (LW-L) = h x k x 0.623

LW-L = _____ x _____ x 0.623 LW-L = _____lbs
(allowable deviation = ± 10% = _____lbs)

m) Lime Height (LH) = [l ÷ b] ÷ 137

LH = [_____ ÷ _____] ÷ 137 LH = _____in.

n) Cement/Agent M-5 weight (CMW) added to PCP sample
(from Worksheet I (SW-I), item d): CMW = _____gms

o) Agent M-5 Weight-Liner (MW-L) = n x h x 0.208

MW-L = _____ x _____ x 0.208 MW-L = _____lbs
(Allowable deviation = ± 10% = _____lbs)

p) Agent M-5 Weight (MH) = o ÷ 6 ÷ 173

MH = _____ ÷ _____ ÷ 173 MH = _____in.

q) Water Height above waste level in liner (WtH-L):

WtH-L = [g + j] ÷ b
WtH-L = [_____ + _____] ÷ _____ WtH-L = _____in.

r) Water Height in mix tank (WtH-T):

WtH-T [g + j] ÷ 1.53
WtH-T = [_____ + _____] ÷ 1.53 WtH-T = _____in.

s) Total Mix Tank Height (MTH) = r + [o ÷ 264.7] MTH = _____in.
_____ + [_____ ÷ 264.7]

t) Cement Weight - Liner (CW-L) = 2 x o

CW-L = 2 x _____ CW-L = _____lbs
(Allowable deviation = ± 10% = _____ lbs)

u) Cememt Height (CH = 2 x p

CH = 2 x _____ CH = _____ in.

v) Cement Alarm Height (CAH) = e + m + p + q + u

CAH = _____ + _____ + _____ + _____ + _____ CAH = _____ in.

w) Liner High Alarm Level (HAL) = v + 2

HAL = _____ + 2 (round to the next highest inch) HAL = _____ in.

x) Solidification Process

1) Fill mix tank to r inches (_____ inches) with water.

2) Energize mixer.

3) Slowly add o lbs (_____ lbs ± _____ lbs) of agent M-5 to mix tank. Do not exceed total mix Tank Height (item s above).

4) Slowly add t lbs (_____ lbs ± _____ lbs) of cement to liner along with agent M-5 and water slurry. DO NOT EXCEED Liner High Alarm Level (item w above).

y) Approximate Weight Calculation of Solidification Liner

Sum the following:

1) Liner Weight (Attachment 7): W = _____ lbs

2) Water Weight (WtW) = [g + j] x 62.4
WtW = [_____ + _____] x 62.4 WtW = _____ lbs

3) Agent M-5 Weight Liner (item o) MW-L = _____ lbs

4) Cement Weight-Liner (item t) CW-L = _____ lbs

5) Lime Weight-Liner (item 1) LW-L = _____ lbs

6) Resin Weight (RW) = d x 70
RW = _____ x 70 RW = _____ lbs

7) Total Weight (TW) = sum of 1-6 above TW = _____ lbs

PREPARED BY: _____ / _____
Solidification Operator / Date

VERIFIED BY: _____ / _____
Radwaste Foreman, or Designee / Date

APPROVED BY: _____ / _____
Radwaste Foreman / Date

Explanation of Worksheet II (SW-II)

a) Useable Liner Volume (LV): From Attachment 7

b) Volume Height (V/H) ratio: From Attachment 7

c) Waste Volume to Binder (WV/B) ratio: From Attachment 7

d) Waste Volume (WV) = Liner Volume x Waste Volume to Binder Ratio

e) Waste Alarm Height (WAH) = Waste Volume ÷ Volume to Height Ratio

f) Water Volume Factor (WtVF): From Attachment 7

g) Water Volume (WTV) = Liner Volume X Waste Volume Factor

h) Process Volume (PV) = Waste Volume + Water Volume

i) Additional Water Volume (AWV) added to PCP (from Worksheet I [SW-I], item e)

j) Additional Water Volume in Liner (AWV-L) = Additional Water Volume (AWV) x Process Volume x 0.623 (Note A) ÷ 62.4 (Note B)

NOTE A: A factor converting gms PCP additive weight per 100 ml waste sample to pounds required per ft^3 of waste.

NOTE B: A factor to convert pounds to ft^3.

k) Lime Weight (LW) added to PCP sample (from Worksheet I [SW-I], item c)

l) Lime Weight in Liner (LW-L) = Process Volume x Lime Weight

m) Lime Height (LH) = Lime Weight in Liner (LW-L) ÷ Volume to Height ratio (V/H) ÷ 137 (Note C)

NOTE C: Approximate fluid lime density, lbs/ft^3

n) Cement/Agent M-5 Weight (CMW) added to PCP sample (from Worksheet I [SW-I], item d)

o) Agent M-5 Weight in Liner (MW-L) = Cement/Agent M-5 Weight (CMW) x Process Volume x 1/3 (Note D) x 0.623

NOTE D: 1/3 is the M-5 component of the 2 to 1 cement/M-5 ratio.

p) Agent M-5 Height (MH) - Agent M-5 Weight in Liner (MW-L) ÷ Volume to Height ratio (V/H) ÷ 173 (Note E)

NOTE E: Typical true agent M-5 Density, lbs/ft^3.

q) Water height above waste level in liner (WtH-L) = [Water volume + Additional Water Volume in Liner (AWV-L]: ÷ Volume to Height ratio (V/H)

r) Water Height in Mix Tank (WtH-T) = [Water Volume + Additional Water Volume in Liner (AWV-L)] ÷ 1.53 (Note F)

NOTE F: Volume to Height ratio in Mix Tank.

s) Total Mix Tank Height (MTH) = Water Height in Mix Tank (WtH-T) + [Agent M-5 Weight in Liner (MW-L)] ÷ 173 ÷ 1.53

t) Cement Weight in Liner (CW-L) = twice the Agent M-5 Weight in Liner (MW-L) based on the 2 to 1 cement to M-5 ratio

u) Cement Height (CH) = twice the Agent M-5 Height based on the 2 to 1 cement to M-5 ratio

v) Cement Alarm Height (CAH) = the combined heights of waste alarm height, lime height, Agent M-5 height, water height above waste level, and cement height

w) Liner High Alarm Level (HAL) = 2 inches higher than cement alarm height

SCE/CNSI SOLIDIFICAITON WORKSHEET III (SW-III)
(PROCESS SUMMARY - PARTICULATE WASTES

Unit: _____
Operator: _____
Waste Tank: _____

1. Waste Slurry Addition No. 1:

   Start Time _____ Date _____
   Finish Time _____ Date _____

2. Dewatering No. 1, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

3. Waste Slurry Addition No. 2, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

4. Dewatering No. 2, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

NOTE 1: Waste Slurry to be at the waste volume Item C of Solidification Worksheet II and water level initially even with top of resin.

5. Waste Temperature After Mixing: _____ °F

6. Actual Amount of Lime Added (if necessary):

   Start Time _____ Date _____
   Finish Time _____ Date _____ Weight _____ lbs

NOTE 2: Lime addition must be within ± 10% of solidification worksheet II item (L). Net excess of lime and M-5/cement slurry should not exceed volume of container.

7. Temperature After Mixing in Lime (if necessary): _____ °F

8. Time and Date Agent M-5 Slurry Prepared: Time _____ Date _____

9. Weight of Agent M-5 in Slurry: _____ lbs

10. Time and Date Agent M-5 Slurry Actually Added:

Start Time _____ Date _____
Finish Time _____ Date _____

NOTE 3: When visual (TV camera) observation shows a fluid mix, cement addition may begin while adding agent M-5 slurry.

11. Cement added:

Start Time _____ Date _____
Finish Time _____ Date _____ Weight _____ lbs

NOTE 4: M-5/cement addition must be within ± 10% of solidification worksheet II item (o) and (t). Net excess of lime and M-5/cement slurry should not exceed volume of container.

12. Additional Cement Added, If Necessary: _____ lbs

13. Temperature After All Cement Added: _____°F

14. Agitation Stopped: Time _____ Date _____

15. Initial Temperature After Agitation Stopped _____°F

6 Hours Later (From Chart Recorder) _____°F
12 Hours Later (From Chart Recorder) _____°F
24 Hours Later (From Chart Recorder) _____°F

16. Peak Temperature Time _____ Date _____

17. Fillhead Removed Time _____ Date _____

18. Liner Capped Time _____ Date _____

19. Observations and Additional Comments: _____

_____

_____

_____

_____

PREPARED BY: _____ / _____
Solidification Operator / Date

REVIEWED BY: _____ / _____
Radwaste Foreman / Date

PCP FOR PREPARATION OF FLUID MIXTURE FOR IN-SITU SOLIDIFICATIONS

1.0 Sample Verification

NOTE: The chemical additives for PCP preparation should be those actually used in full-scale solidifications and should be stored in capped containers. The sequence for chemical addition for PCP and full scale solidification shall be the same.

1.1 Secure representative samples of all components to be used in the actual solidification.

QHP 1.2 To a 600-1000 ml plastic beaker, weigh in the dry materials listed and record values on SCE/CNSI Solidification Worksheet (for In-Situ Solidifications).

Portland Cement	200 gm
CNSI Agent M-5	100 gm

QHP 1.3 Add water to the dry ingredients and mix well with spatula. Control the flow characteristics of the mix to a smooth, fluid consistency, record the weight of water added. Normally 125-150 gm of water will be required.

NOTE: The requirement for IN-SITU solidification is a cement composition that can be pumped as a fluid, but will set hard with little or no bleed liquid after placement. The proper consistency is best described as a "heavy cream to a soft ice cream" texture. Adjust water added as necessary to obtain desired texture.

1.4 After confirming the proper weight of M-5/cement needed to control the flow characteristics of the mix, note this value on the SCE/CNSI Solidification Worksheet (for In-Situ Solidifications.)

1.5 Transfer fluid cement mixture to a 250 ml container to about 1/4 inch of the top, and then attach lid firmly.

HP 1.6 Place sealed container in an oven controlled at about 130-140°F for 18-24 hours. Then remove the container and allow to cool before unsealing. Examine product and record approximate volume of free liquid, if any, and the apparent relative hardness.

1.0 Sample Verification (Continued)

NOTE: If an oven is not available, the test solidification may be completed at warm room temperature (75-85°F), but will not necessarily give the same results over the same time period. Small samples do not retain the normal exothermic heat of cement hydration that accelerates hardening of bulk mixtures.

2.0 Determine the volume of waste material to be received and the amounts of cement, lime, sodium sulfate, and boric acid required by completing SCE/CNSI Solidification Worksheet for In-Situ Solidifications. Chemical amounts may be changed with supervisor approval as necessary to comply with weight and radiation limitations imposed by waste activity and shielding requirements.

NOTE: The cement encapsulation mixture employed by CNSI represents a controlled formula that has been tested for strength and resistance to water degradation. The test results for simular mixtures containing waste products demonstrate that all requirements to 10 CFR 61 are satisfied.

SCE/CNSI SOLIDIFICATION WORKSHEET I (SW-I)

FULL-SCALE IN-SITU SOLIDIFICATION OF SUSPENDED OBJECTS

Shipment No. _____

Volume and Weight Constants	L6-80	L8-120	L14-170	L14-195
(a) Internal Liner Height	54"	71.5"	69.3"	75.5"
(b) Total Liner Volume (FT^3)	82	174	174	196
(c) Volume Of Expanded Metal Cage (FT^3)	38.2	59.7	98.5	110
(d) Liner V/H Ratio (Ft^3/In)	1.53	1.69	2.52	2.62

NOTE: The waste volume added to the cage will vary with object size, type, and number loaded. The technician must estimate waste volume. Typically this will be 40-70% of cage volume. The estimated waste volume is a critical number and should be conservative to the low side volume.

1. Calculate the volume of wet cement mixture required.

(_____ Ft^3) - (_____) - (_____) = _____ Ft^3
Tot. Liner Vol. | 2 x V/H Ratio | Est. Waste Vol. | Mix Vol.

2. Weight of Water Added to PCP = _____ gm

3. PCP Volume:

_____ + (_____ ÷ 2.77) + (_____ ÷2.77) = _____ ml
PCP gm H_2O | PCP gm cement | PCP gm M-5

4. Water Volume:

(_____ ÷ _____) x _____ x 7.48 = _____ gal. water
PCP gm H_2O | PCP volume (Item 3) | mix volume (Item 1)

5. Water Height for M-5 Mix Tank for Slurry:

_____ x 2/3 ÷ 7.48 ÷ 1.53 = _____ inches ± 1/2 inch
Water volume (Item 4) | gal/ft^3 | V/H ratio Mix tank

6. Agent M-5 Weight:

_____ ÷ 2.77 ÷ _____ x _____ x 173 = _____ lbs M-5 ± 10% _____ lbs
PCP gm M-5 | PCP Vol. (Item 3) | Mix Vol. (Item 1)

7. Additional Water Height for Addition to M-5 mix tank:

_____ x 1/3 ÷ 7.48 ÷ 1.53 = _____ inches ± 1/2 inch
Water Volume
(Item 4)

8. Cement Weight:

_____ ÷ 2.77 ÷ _____ x _____ x 173 = _____ lbs cement ____ lb
PCP gm cement PCP Vol. (Item 3) Mix Vol. (Item 1) ± 10%

Add water (Item 5) to Agent M-5 slurry tank, start mixer and add Agent M-5 (Item 6) to make slurry. Pump slurry into in-situ mix tank. Add (Item 7) additional water volume as water to flush Agent M-5 slurry tank into in-situ mix tank. The total water used (Item 4) in the in-situ mix must be added as either Agent M-5 slurry or flush water.

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

PCP Solidification of Particulate Wastes (Class A Unstable Waste Form Only) (Resin Beads, Powdex, Diatomaceous Earth Slurries), and Other Particulate Wastes

1.0 Sample Verification

NOTE: The chemical additives used for PCP preparation should be those actually used in full scale solidification and should be stored in capped containers. The sequence for chemical addition for PCP preparation and full scale solidification shall be the same.

1.1 Arrange with Radwaste Health Physics personnel to assign a special test area which contains adequate protection from the anticipated higher radiation levels of bead resins.

1.2 Notify Radwaste Health Physics personnel that the preparations for verification testing have been completed and that a waste sample is required.

QHP 1.3 Transfer 100 ml of resin from the sample container to a 250 ml disposable beaker and allow solids to settle. Typically, there will be a layer of water on top of the resin beads. Centrifuged powdex will show no separation of liquid.

NOTE: When radiation levels are excessive in accordance with the utility guidelines, the sample amount may be reduced to as little as 25 ML. Be sure to reduce other additives by the same ratio.

QHP 1.4 Measure and record on CNSI Solidification Worksheet the waste pH using the wide range pH paper. Add lime ($Ca(OH)_2$) in 0.5 gm increments until pH of 10.5 to 11.5 is reached by narrow (9-13) range pH paper. Stir thoroughly after each addition of lime and add 3 more grams after the desired pH range is reached. Record the total amount of lime added on SCE/CNSI Solidification Worksheet I for particulate wastes.

QHP 1.5 Add cement slowly (e.g., increments of $\leq$ 10 gms) while stirring until a smooth homogeneous mix is obtained. The amount added for a 100 ml waste sample may be 80 to 150 gms depending on resin type, quantity of lime added and amount of water in the slurry. Record amount of cement added on the CNSI Solidification Worksheet.

HP 1.6 Place the lid over the beaker and store the sealed mix in an oven controlled at 120° - 130°F for 18-24 hours. Then allow sample to cool for at least 2 hours before removing lid and evaluating solidification.

1.0 Sample Verification (Continued)

1.7 Evaluate the sample using the guidelines of Paragraph 6.3. If the sample does not meet the acceptance criteria, contact Supervisor, Solidification Services for possible formula modifications.

2.0 Full Scale Calculations (Bead-Type or Particulate Wastes)

2.1 Determine the volume of waste material to be received and the amounts of cement and lime required by completing the CNSI Solidification Worksheet for bead-type or particulate wastes. Reduce the calculated amounts as necessary to comply with weight and radiation limitations imposed by waste activity and shielding requirements.

SCE/CNSI SOLIDIFICATION WORKSHEET I
(PCP Solidification of Particulate Wastes)

Class A Unstable Waste Form Only

Waste Identification Date: _____ Operator: _____ Unit: ____

Type of Waste: (Resin Beads, Powdex, Sludge) _____
Waste Activity: (Reported Curie Content) _____
pH (Reported by Utility) _____
Description: (Color, Uniformity, Free Liquid) _____

Sample Preparation Shipment No. _____

(a) Volume of Waste (In 250 ml Container): ml (Notes 1 and 2)

NOTE 1: The volume of fluidized waste must be controlled as nearly as possible to the 100 ml mark in the 250 ml test beaker, since full-scale calculations are normally figured on this amount. Remove water from, or add water to, the waste sample received as necessary so that a fluid material is formed. No more than about 1/16-1/8 inch of liquid should separate quickly from the 100 ml test sample.

NOTE 2: If the radiation level of the waste prevents using a 100 ml sample, the test may be run with less waste material, but the solidification supervisor must be contacted for verification of the full-scale formula.

(b) pH of Sample: (Tested by CNSI) _____

(c) pH Adjustment Summary

Increment	Amount	pH After Mixing
1	_____	_____
2	_____	_____
3	_____	_____
4	_____	_____

(d) Total Lime Added _____gm

(e) Cement Added _____gm

NOTE 3: Do not exceed 100 grams of cement per 100 ml of waste unless an earlier test using the same waste sample indicated that more cement was required. Add cement slowly (e.g., increments of ≤10gms).

Oven Temerature at Start of Test _____ °F
Time Sample in Oven (Sealed) _____ hrs.
Oven Temperature When Sample Removed _____ °F
Time Outside Before Unsealing _____ hrs.

SCE/CNSI SOLIDIFICATION WORKSHEET I
(PCP Solidification of Particulate Wastes) (Continued)

Class A Unstable Waste Form Only

(f) Repeat the PCP using 90% of the lime (Item d) and 90% of the cement (Item e).

- Lime Added _____gm (90% of Item d)
- Cement Added _____gm (90% of Item e)

Oven Temerature at Start of Test	_____	°F
Time Sample in Oven (Sealed)	_____	hrs.
Oven Temperature When Sample Removed	_____	°F
Time Outside Before Unsealing	_____	hrs.

Solidification Results

Free Liquid, if any _____ ml (approximate)

Relative Set (Very Hard, Firm, Soft) _____

Unusual Apperance (Color, Foam, Stratification) _____

_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

SCE/CNSI SOLIDIFICATION WORKSHEET II
(Full-Scale Solidification of Particulate Wastes)

Class A Unstable Waste Form Only

NOTE: This worksheet is intended to provide a solidification formula consistent with the waste liner selected. The amounts of additives required are for calculation purposes only, and do not restrict the quantities actually added to achieve an acceptable solidification product.

Volume Information Date: _____ Operator: _____ Unit: ____

Shipment No. _____

(a) Usable Liner Volume (Attachment 7) ____ Ft^3

(b) Liner Ft^3/Inch of Height (Attachment 7) ____ Ft^3/Inch

Waste Alarm Height (To the nearest 0.1 inch).

(c) Waste Volume = $\frac{\text{(a)}}{\text{(Liner Vol.)}} \times 0.643^* =$ ____ Ft^3

*A factor providing for 2.5 to 1.0 waste volume to binder ratio, and a 10% volume allowance for additional cement, if required, to assure a satisfactory mix. Express results to the nearest cubic foot.

NOTE: For particulate waste slurries where the water content is consistently controlled (such as by centrifugation), it may be possible to increase waste volume as long as the PCP product is clearly satisfactory as concerns hardness and absence of free-standing liquid. Any such increase must be approved by the manager, solidificaiton services prior to implementation.

(d) Waste Alarm Height = $\frac{\text{(c)}}{\text{Waste Vol.)}} \div \frac{\text{(b)}}{\text{(V/H Ratio)}} =$ _____ Inches

Lime Weight and Height (Nearest Lb. and 0.1 Inch)
(If lime is not to be used, this section is N/A.)

(e) Lime WT. = $\frac{\text{gm}}{\text{SW I, (f) Lime}} \times 0.623^{**} \times \frac{\text{(c)}}{\text{(Waste Vol.)}} =$ ___Lbs. ± 10% (__Lbs.)

(f) Lime Height = $\frac{\text{(e)}}{\text{(Lime WT.)}} \div 137^{***} \div \frac{\text{(b)}}{\text{(V/H Ratio)}} =$ _____ Inches

***Approximate fluid lime density, Lbs./Ft^3

NOTE: This is to verify that an acceptable product will be produced even with significant unanticipated reduction of chemical addition. An excess of chemicals within acceptable liner volume will not hinder the solidification process.

Cement Weight and Alarm Height (Nearest Lb. and 0.1 inch)

(g) Cement WT. = $\frac{\text{\_\_\_\_\_ gm}}{\text{SW I, (g)}}$ x 0.623** x $\frac{\text{\_\_\_\_\_ (c)}}{\text{(Waste Vol.)}}$ = ___ Lbs. ±10% (___ Lbs)

**A factor converting grams PCP additive weight per 100 ml waste sample to pounds required per Ft^3 waste.

(h) Cement Height = _____ (g) ÷ 173**** ÷ _____ (b) = _____ Inches

****Typical true cement density, Lbs/Ft^3

(i) Cement Alarm Height - (d)+(f)+(h) = _____ Inches

*****When using a cyclonaire transfer system, the estimated number of transfers = _____ lbs. of cement required ÷ ____ lbs./transfer = _____ transfers.

PREPARED BY: _____ / _____
Date

VERIFIED BY: _____ / _____
Date

APPROVED BY: _____ / _____
Radwaste Foreman Date

TYPICAL SAMPLE CALCULATIONS FOR WORKSHEET II
(Particulate Wates)

Class A Unstable Waste Form Only

A slurry of radioactive mixed bed resin beads is to be dewatered and solidified in a L6-80 liner. After adjusting a laboratory sample so that 100 ml of fluidized material was measured for testing, it was found that four (4) portions of lime (2 grams each) raised the pH to about 11. Addition of three more grams of lime and 90 grams of cement formed a smooth mix, which set firm and dry in the sealed container after 20 hours in an oven controlled at about 125°F.

(a) Usable Liner Volume (Fig. 4) = 79 Ft^3

(b) Liner Volume/Height Ratio (Fig. 4) = 1.53 Ft^3/Inch

(c) Waste Volume - 79 x 0.643 = 51 Ft^3

(d) Waste Alarm Height = 51 ÷ 1.53 = 33.3 Inches

(e) Lime Weight = 11 x 0.623 x 51 = 350 Lbs.

(f) Lime Height = 350 ÷ 137 ÷ 1.53 = 1.7 Inches

(g) Cement Weight 90 x 0.623 x 51 = 2860 Lbs.

(h) Cement Height = 2860 ÷ 173 ÷ 1.53 = 10.8 Inches

(i) Cement Alarm Height = 33.3 + 1.7 + 10.8 = 45.8 Inches

SCE/CNSI SOLIDIFICATION WORKSHEET III (Process Summary - Particulate Wastes)

Class A Unstable Waste Form Only

Unit: _____ Operator: _____ Waste Tank: _____

1. Wate Slurry Addition No. 1: Shipment No.: _____

   Start Time _____ Date _____
   Finish Time _____ Date _____

2. Dewatering No. 1, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

3. Waste Slurry Addition No. 2, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

4. Dewatering No. 2, If Necessary:

   Start Time _____ Date _____
   Finish Time _____ Date _____

5. Water Added to Refluidize, If Necessary:

   Time _____ Date _____ Estimated Volume Added _____Gal.

NOTE: Waste height must be within ± 1 inch of solidification worksheet II Item (d).

6. Waste Temperature After Mixing: _____°F

7. Lime Added:

NOTE: Lime addition must be within ± 10% of solidification Worksheet II Item (e). Net excess of lime and cement should not exceed volume of container.

Start Time _____ Date _____
Finish Time _____ Date _____ Weight _____Lbs.

8. Temperature After Mixing In Lime: _____°F

NOTE: Cement addition must be within ± 10% of solidification Worksheet II Item (g). Net excess of lime and cement should not exceed volume of container.

9. Cement Added:

Start Time _____ Date _____
Finish Time _____ Date _____ Weight _____Lbs.

10. Additional Cement Added, If Necessary: _____Lbs.

11. Temperature After All Cement Added: _____°F

12. Agitation Stopped: Time _____ Date _____

13. Initial Temperature After Agitation Stopped _____°F

6 Hours Later (From Chart Recorder) _____°F
12 Hours Later (From Chart Recorder) _____°F
24 Hours Later (From Chart Recorder) _____°F

14. Peak Temperature Time _____ Date _____

15. Fillhead Removed Time _____ Date _____

16. Liner Capped Time _____ Date _____

17. Observations, Additional Comments: _____

_____

_____

_____

_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

PCP SOLIDIFICATION OF MISCELLANEOUS AQUEOUS WASTES
NOT REPRESENTING TYPICAL CONCENTRATES)
Class A Unstable Waste Form Only

1.0 SAMPLE VERIFICATION

NOTE: The chemical additives used for PCP testing should be those actually used in full scale solidification and should be stored in capped containers.

1.1 Notify the Radwaste Health Physics personnel that preparations for verification testing have been completed and that a sample is required.

QHP 1.2 Measure out 200 ml of radwaste sample in a 600-1000 ml disposable container. Then vigorously agitate to determine if foaming may occur in the full scale solidification.

NOTE: If any foam is created due to the agitation of the waste, then small quantities of a commercially available antifoam shall be added (less than or equal to 1 ml) while agitating the sample. The total amount of antifoam added to subside the foam shall not exceed 2% of the total waste volume without prior approval from the supervisor or manager of solidification services and the SCE radwaste supervisor.

QHP 1.3 Add 120 to 140 grams of Portland Cement and mix well with spatula.

QHP 1.4 Add 80 to 100 grams of lime and mix well with spatula.

NOTE: On a new waste sample, start with minimum quantities of cement and lime to form a smooth mix not producing excessive bleed liquid.

1.5 Transfer (pour) sample mixture into 250 ml plastic beaker, filling to within 1/4 inch of the top.

HP 1.6 Press lid tightly over sample container and store in an approved constant-temperature oven. The sealed sample should be held at 120-130°F for 18-24 hours.

NOTE: It is necessary to hold sample mixtures at elevated temperatures to simulate solidification conditions of full scale operations.

1.0 SAMPLE VERIFICATION (Continued)

HP 1.7 Remove sample from oven and allow to cool for at least 2 hours before unsealing. Evaluate solidification using guidelines of paragraph 6.3.

1.8 Contact the CNSI Supervisor, Solidification Services, and the SCE Radwaste Supervisor, if the test sample containing maximum amounts of cement and lime still fails to meet solidification requirements. A significant change in typical cement to lime ratio or reformulation with an approved additive may be necessary.

2.0 FULL SCALE CALCULATIONS

2.1 Determine the volume (cubic feet) of waste to be received, referring to the table in Attachment 7 for usable liner volumes.

2.2 Complete the SCE/CNSI Solidification Worksheet II for Miscellaneous Aqueous wastes to determine actual chemical requirements and level control settings.

SCE/CNSI SOLIDIFICATION WORKSHEET I (PCP Solidification of Miscellaneous Aqueous Wastes)
(Not Representing Typical PWR Concentrates)
(Class A Unstable Waste Form Only)

Waste Identification Date: _____ Operator: _____ Shipment # _____

Solids Content (If Known) _____ppm or _____ Weight%

Principal Mineral Ions (If Known) _____ (Such as Calcium, Sodium, Sulfate Chloride, etc.)

Specific Gravity _____

pH _____

Temperature _____°F (In Waste Tank)

Physical Appearance (color, clarity, sediment) _____

_____

Sample Preparation

(a) Volume of Waste: _____ml

(b) Weight of Cement: _____gms

(c) Weight of Lime _____gms

(d) Weight of Other Additive, if used _____gms _____
Additive Name or Code #

Oven Temperature at Start of Test _____°F

Hours Sample In Oven (Sealed) _____

Oven Temperature When Sample Removed _____°F

Hours Outside Oven Before Unsealing _____

Solidification Results

Free Liquid, If Any: _____ml (Approximate)

Relative Set (Very Hard, Firm, Soft) _____

Unusual Appearance (color, foam, stratification) _____

_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

SCE/CNSI SOLIDIFICATION WORKSHEET II (Full Scale Solidification Of Miscellaneous Aqueous Wastes Class A unstable Waste Form Only)

Volume Information

(a) Usable Liner Volume (Fig. 5) _____ Ft^3 Date: _____

(b) Liner Ft^3/Inch of Height (Fig. 5) _____ Ft^3/Inch Operator: _____

(c) Waste Volume to be Solidified _____ Ft^3 Utility: _____

Shipment No.: _____

NOTE: Be sure that volume (c) is less than 68% of volume (a).

Weight Calculations (To The Nearest Pound)

(d) Weight of Cement = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\quad}{\text{SW-I, Item (b)}} \times .312$ = _____ Lbs. ± 10% ( )

(e) Weight of Lime = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\quad}{\text{SW-I, Item (c)}} \times .312$ = _____ Lbs. ± 10% ( )

(f) Weight of Other Additive, If Used = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\quad}{\text{SW-I, Item (d)}} \times .312$ = _____ Lbs. ± 10% ( )
(_____)
Additive Name Or #

(g) Weight Of Waste = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times 62.4 \times 1.02^*$ = _____ Lbs.

*Use 1.02 or Actual Waste Specific Gravity, If Known.

(h) Total WT. Of Waste And Additives = (d)+(e)+(f)+(g) = _____ Lbs.

Level Heights (To The Nearest 0.1 Inch)

(i) Waste Level = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$ = _____ Inches

(j) Volume Height Occupied By Cement = $\frac{\text{(d)}}{\text{(Cement WT.)}} \div 173^{**} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$ = _____ Inches

**Typical True Cement Density, Lbs./Ft^3

(k) Cement Level = (i) + (j) = _____ Inches

SCE/CNSI SOLIDIFICATION WORKSHEET II (Full Scale Solidification Of Miscellaneous Aqueous Wastes) (Continued)

(l) Volume Height Occupied By Cement = $\frac{\text{(e)}}{\text{(Lime WT.)}} \div 137^{***} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$ = _____ Inches

***Typical True Lime Density, Lbs./Ft^3

(m) Lime Level = (k) + (l) = _____ Inches

PREPARED BY: _____ / _____
Date

VERIFIED BY: _____ / _____
Date

APPROVED BY: _____ / _____
Radwaste Foreman Date

TYPICAL SAMPLE CALCULATIONS FOR WORKSHEET II (Miscellaneous Aqueous Wastes)

120 cubic feet of reverse osmosis waste liquid containing about 2% sodium chloride is to be solidified in a L14-195 liner. Test results indicate 130 grams of cement and 100 grams of lime were required to solidify 200 ml of waste liquid. No other additive was used.

(a) Usable Liner Volume (Attachment 7) = 190 Ft^3

(b) Liner Volume/Height Ratio (Attachment 7) = 2.62 Ft^3/In

(c) Volume of Waste to be Received = 120 Ft^3

NOTE: (c)/(a) x 100 = 63% (Less than 68%)

(d) Weight of Cement = 120 x 130 x 0.312 = 4,867 Lbs.

(e) Weight of Lime = 120 x 100 x 0.312 = 3,744 Lbs.

(f) (Not Applicable)

(g) WT. of Waste = 120 x 62.4 x 1.02 = 7,638 Lbs.

(h) Total WT. Of Waste And Additives = 16,249 Lbs.

(i) Waste Level = 120 ÷ 2.62 = 45.8 Inches

(j) Vol. HT. Occupied By Cement = 4,867 ÷ 173 ÷ 2.62 = 10.7 Inches

(k) Cement Level = 45.8 + 10.7 = 56.5 Inches

(l) Vol. HT. Occupied By Lime = 3,744 ÷ 137 ÷ 2.62 = 10.4 Inches

(m) Lime Level = 56.5 + 10.4 = 66.9 Inches

SCE/CNSI SOLIDIFICATION WORKSHEET III
(Process Summary - Miscellaneous Aqueous Wastes)
Class A Unstable Waste Form Only

Unit _____ Operator _____ Waste Tank No. _____

Shipment No. _____

1. Receive Waste:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Estimated Weight _____Lbs.

2. Add Cement:

   Time _____ Date _____

   Time _____ Date _____ Weight _____Lbs.

3. Add Lime:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Weight _____Lbs.

4. Other Additive (Code # _____) Time _____ Date _____ Weight _____Lbs.

5. Temperature After All Ingredients Added: _____°F

6. Agitation Stopped: Time _____ Date _____

7. Initial Temperature After Agitation Stopped _____°F

   6 Hours Later (From Chart Recorder) _____°F

   12 Hours Later (From Chart Recorder) _____°F

   24 Hours Later (From Chart Recorder) _____°F

8. Peak Temp: Time _____ Date _____ _____°F

9. Temp. Under 160°F Time _____ Date _____

10. Fillhead Removed: Time _____ Date _____

11. Liner Capped: Time _____ Date _____

12. Observations, Additional Comments: _____

_____

PREPARED BY: _____ / _____
Date

REVIEWED/APPROVED BY: _____ / _____
Radwaste Foreman Date

LINER AND CASK CALCULATIONS

Liner	L21-300	L21-235	L14-195	L14-170	L8-120	L7-100	L6-80
Diameter	82"	82"	76"	74"	61"	74.5"	58"
Height	104.5"	79"	75.5"	69.37"	71.5"	37"	54"
Total Volume, Ft^3	317	241	196	174	120	93	82
Usable Liner Volume, (LV), Ft (2" Safety Factor)	311	235	190	169	116	88	79
Volume/Height (V/H) Ratio FT^3/Inst	3.05	3.05	2.62	2.52	1.69	2.52	1.53
Weight (W), Lbs.	2400	1800	1650	1550	1100	1250	950
Cask Payload, Lbs. (Including Liner Weight)	27250	27250	17700	14000	20000	13000	7500
Waste Volume to Binder Ratio (WV/B) for Resin Beads	0.54	0.54	0.54	0.54	0.54	0.54	0.50
Water Volume Factor (WtVF)	0.13	0.13	0.13	0.13	0.13	0.13	0.10

NOTE 1: A factor providing for proper waste volume to binder ratio (WV/B), and an allowance for additional binder, if required, to assure a satisfactory mix. For resin beads, based on liner weight and height limits for liner L6-80, use factor 0.50. For other liners, use a factor of 0.54. Waste volume for sludge will vary depending upon sludge characteristics. The CNSI Solidification Supervisor or Manager must be contacted to verify waste volume and correct factor for use based on sludge characteristics. These ratios apply only to Attachment 3.

NOTE 2: A factor to provide correct water volume (WtVF) for Agent M-5 slurry. Based on liner weight and height limits for liner L6-80, use factor 0.10. For other liners, use a factor of 0.13.

DATA RECORD FORM

PROCESS CONTROL PROGRAM FOR
SAN ONOFRE UNIT 1

CDM File No. _____ M.O. NO. _____

Prerequisites Met _____ / _____
Signature Date

Cask No./Shipment No. _____ / _____

Step No.	Description	Data	Acceptance Criteria	PERFORMED BY Signature/Date
3.9	Scale Accuracy Verification	SAT ____ UNSAT ____	Accuracy verified last 6 months over scale range in 50 gm increments (i.e., 50 gm, 100 gm, 150 gm ...to upper range)	____/____
			HP VERIFIED BY:	____/____
6.2.2	Waste Identification	SAT ____ UNSAT ____	Chemical Analysis Waste provides proper information	____/____
			QHP VERIFIED BY:	____/____
6.2.3	Equipment	SAT ____ UNSAT ____	All necessary equipment available or approved substitutes	____/____
			HP VERIFIED BY:	____/____
6.3.1.1 6.3.1.2	Sample Acceptance	SAT ____ UNSAT ____	Uniform, dry, Freestanding resists penetration	____/____
			QHP VERIFIED BY:	____/____

Step No.	Description	Data	Acceptance Criteria	PERFORMED BY Signature/Date
6.4.1	Test Equipment Available	SAT _____ UNSAT _____	All Equipment on Attachment 1 is available	_____/_____
			HP VERIFIED BY:	_____/_____
6.4.3.4	Form SO(123) 159	SAT _____ UNSAT _____	Form completed satisfactorily	_____/_____
			VERIFIED BY:	_____/_____
6.5.1	Test Documentation	SAT _____ UNSAT _____	SCE/CNSI Worksheets have been completed	_____/_____
			QHP VERIFIED BY:	_____/_____
Attachment 2				
1.3	Crystallized Sample	SAT _____ UNSAT _____ N/A _____	Sample Heated to 140°F or above and completely dissolved	_____/_____
			HP VERIFIED BY:	_____/_____
1.4	Sample Preparation	SAT _____ UNSAT _____ N/A _____	Amount of N-24 recorded Temp. 160°F Temp. after addition recorded	_____/_____
			HP VERIFIED BY:	_____/_____
1.6	Solidification Agent Addition	SAT _____ UNSAT _____ N/A _____	Proper amount of lime added, pH 11 or above	_____/_____
			QHP VERIFIED BY:	_____/_____

Step No.	Description	Data	Acceptance Criteria	PERFORMED BY Signature/Date
1.7 1.8	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 165 ±°F Maintained sealed in sample oven for 6-24 hours	____/____
			QHP VERIFIED BY:	____/____
Attachment 3				
1.3	Sample Preparation	SAT ____ UNSAT ____ ml	Sample volume at least 100 ml, less if Rad levels high	____/____
			QHP VERIFIED BY:	____/____
1.4	pH Adjustment with Lime	SAT ____ UNSAT ____	pH recorded on worksheet	____/____
			QHP VERIFIED BY:	____/____
1.5	Solidification Agent Addition	SAT ____ UNSAT ____	Sample mixed thoroughly cement and M-5 weight used in grams recorded	____/____
			QHP VERIFIED BY:	____/____
1.6	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 120-130°F Maintained sealed in sample oven for 18-24 hours	____/____
			HP VERIFIED BY:	____/____
Attachment 4				
1.2	Material Dry Weight	SAT ____ UNSAT ____	Dry weight of materials recorded	____/____
			QHP VERIFIED BY:	____/____

Step No.	Description	Data	Acceptance Criteria	PERFORMED BY Signature/Date
1.3	M-5/Cement Addition	SAT ____ UNSAT ____	300 gms added mixed thoroughly	____/____
			QHP VERIFIED BY:	____/____
1.6	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 130-140°F Maintained sealed in sample oven for 18-24 hours	____/____
			HP VERIFIED BY:	____/____
Attachment 5				
1.3	Sample Preparation	SAT ____ UNSAT ____ ml ____	Sample volume at least 100 ml less if Rad levels high	____/____
			QHP VERIFIED BY:	____/____
1.4	pH Adjustment with Lime	SAT ____ UNSAT ____ N/A ____	Lime added in 0.5 gm increments until pH of 10.5 to 11.5 is reached.	____/____
			QHP VERIFIED BY:	____/____
1.5	Solidification Agent Addition	SAT ____ UNSAT ____	Sample mixed thoroughly, cement weight used in grams recorded	____/____
			QHP VERIFIED BY:	____/____
1.6	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 120-130°F Maintained sealed in sample oven for 18-24 hours	____/____
			HP VERIFIED BY:	____/____

Step No.	Description	Data	Acceptance Criteria	PERFORMED BY Signature/Date
Attachment 6				
1.2	Sample Preparation	SAT ____ UNSAT ____	200 ml waste sample transferred to disposable beaker	____/____
			QHP VERIFIED BY:	____/____
1.3	Cement Addition	SAT ____ UNSAT ____	120 to 140 gms added mixed thoroughly	____/____
			QHP VERIFIED BY:	____/____
1.4	Lime Addition	SAT ____ UNSAT ____	80 to 100 gms added mixed thoroughly	____/____
			QHP VERIFIED BY:	____/____
1.6	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 120-130°F Maintained sealed in sample oven for 18-24 hours	____/____
			HP VERIFIED BY:	____/____
1.7	Sample Cooling	SAT ____ UNSAT ____	>2 hours after removal from oven	____/____
			HP VERIFIED BY:	____/____

DEVELOPMENTAL RESOURCES

A. Procedures

1. SO124-VII-3.5, ALARA Program
2. SO123-VII-3.0, ALARA Job Review
3. SO123-VII-8.2, Shipment of Radioactive Material
4. SO123-VII-8.15, "10 CFR 61 Waste Sampling Program"
5. SO123-VII-8.4, "Transfer of Radioactive/Waste Materials Between Units 2/3 and Unit 1"
6. CNSI Procedure QA-AD-001, CNS Quality Assurance Program
7. SO23-VII-8.5.1, CNSI Procedure SD-OP-003, Rev. N, Process Control Program for CNSI Cement Solidification Units
8. SO123-SD-OP-630, CNSI "Assembly and Disassembly Procedure for the Portable Cement Soldification Unit No. 125 (PSV-C-125)"

DEVELOPMENTAL RESOURCES (Continued)

B. Other

1. NRC Regulatory Guide 1.143, Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants

2. Standard Review Plan 11.4, Revision 2, July 1981, Solid Waste Management Systems

3. California Adminitrative Code, Title 17, Public Health Chapter 5, Subchapter 4, Radiation

4. Design and Control of Concrete Mixtures, 12th Edition, Portland Cement Association

5. CNSI Topical Report, CNI-2, 4313-01354-OIP, January 1983, Revision 2

6. Letter from K. P Baskin to F. Miraglia of USNRC, providing responses to METB questions on PCP for San Onofre, Unit 2 and Unit 3, dated June 3, 1982

7. Additional Guidance on the Implementation of 10 CFR 61, USNRC, February 1984

8. State of Nevada license to U. S. Ecology, No. 13-11-0043-02, with amendments

9. State of Washington license to U. S. Ecology, No. WN-1019-2. with amendments

10. Hanford Special Nuclear Material License issued to U. S. Ecology, License No. 16-19204-01

11. USNRC Low-Level Waste Licensing Branch Technical Position on Radioactive Waste Classification, Rev. 0, May 1983

12. USNRC Low-Level Waste Licensing Branch Technical Position on Radioactive Waste Form, Rev. 0, May 1983

13. 49-CFR, Transportation

14. 10 CFR Part, 71, Packaging of Radioactive Waste

15. 10 CFR Part, 61, Licensing Requirements for Land Disposal of Radioactive Waste