PROCESS CONTROL PROGRAM FOR SAN ONOFRE UNITS 2 AND UNIT 3

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PROCESS CONTROL PROGRAM FOR SAN ONOFRE UNIT 2 AND UNIT 3

1.0 OBJECTIVE

1.1 The purpose of the Process Control Program for San Onofre, Unit Nos. 2 and 3, is to establish a set of process parameters which provide reasonable assurance of complete solidification of various liquid radioactive "wet wastes" including resin slurries, evaporator bottoms, and filter sludges, in accordance with applicable Department of Transportation (DOT) and California State Regulation and Nuclear Regulatory Commission (NRC) and licensed burial Facility's 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 8.6.

2.0 REFERENCES

2.1 Cross-reference to Licensing Commitment Requirements

2.1.1 Topical Quality Assurance Manual for San Onofre Unit 2 and Unit 3

2.1.2 SONGS 2 and SONGS 3 Technical Specifications Section 3/4.11.3, Solid Radioactive Waste

2.1.3 Final Safety Analysis Report for San Onofre Unit 2 and Unit 3

.1 Section 11.2, Liquid Waste Management System

.2 Section 11.4, Solid Waste Management System

.3 Section 12.1, Ensuring that Occupational Radiation Exposures are as Low as is Reasonably Achievable (ALARA)

.4 Section 13.5, Plant Procedures

.5 Chapter 16, Technical Specifications

2.2 Station Procedures

2.2.1 SO123-VII-3.5, ALARA Program

2.2.2 SO123-VII-3.0, ALARA Job Review

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

2.2.4 SO123-VII-8.2, Shipment of Radioactive Material

2.0 REFERENCES (Continued)

2.2.5 SO123-VII-8.5, Radwaste Solidification

2.2.6 SO123-SD-OP-022, Operating Procedure for CNSI Portable Cement Solidification Unit No. 24 (PSU-C-24) (when issued)

2.2.7 SO123-SD-OP-021, Assembly and Disassembly Procedure for CNSI Portable Cement Solidification Unit No. 24 (PSU-C-24) (when issued)

2.3 Other

2.3.1 49 CFR, Transportation

2.3.2 10 CFR Part, 71, Packaging of Radioactive Waste...

2.3.3 10 CFR Part, 20, Standards for Protection Against Radiation

2.3.4 10 CFR Part, 61, Licensing Requirements for Land Disposal of Radioactive Waste

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

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

2.3.7 NRC Regulating Guide 1.143, Design Guides for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear power Plants

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

2.3.9 U.S. Ecology's Washington State Disposal Site Licenses and Site Criteria

2.3.10 California Administrative Code, Title 17, Public Health Chapter 5, Subchapter 4, Radiation

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

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

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

2.3.14 CNSI Procedure QA-AD-001, CNSI Quality Assurance Program

2.3.15 CNSI Procedure SD-OP-003, Rev. M, Process Control Program for CNSI Cement Solidification Units

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 This instruction must be reviewed and approved by the USNRC before implementation in accordance with Reference 2.1.2. The Station Manager shall assure the performance of a review by a qualified individual/organization of changes to the Process Control Program, and any changes identified to the Manager of Nuclear Operations, and the Nuclear Safety Group. Change(s) shall be submitted to the USNRC in the semi-annual Radioactive Effluent Release Report for the period in which the change(s) was made in accordance with Reference 2.1.3.5.

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 8.1 are available or SCE/CNSI approved substitutes are available.

3.5 Ensure Attachments 8.1 through 8.6 are consistent with the latest revision of the CNSI Process Control Program for cement solidification units.

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 2.2.7.

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.

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

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 operating procedure, Reference 2.2.5.

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 CHECK-OFF LIST(S)

5.1 Data Record Form

6.0 PROCEDURE

6.1 SYSTEM DESCRIPTION

6.1.1 Process Description

The process used at San Onofre Units 2/3 is the CNSI Cement Solidification Unit. This unit is specifically designed to facilitate solidification of various radioactive wastes, including evaporator bottoms, ion exchange resin slurries, and filter sludges. 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

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.

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 8.2 through 8.5.

6.1.3 Solidification Unit Description

.1 The CNSI Cement Solidification Unit System contains all piping, support, control and monitoring equipment necessary to solidify radioactive liquid waste 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 150 amps)

.2.1.2 120V AC ("House Current")

.2.1.3 Resin Dewater Return - 2" pipe size, connection 150# R. F. flange, material 304 stainless steel

.2.1.4 Service Water - 3/4" pipe size, connection 3/4" quick disconnect fitting, material 304 stainless steel, minimum 30 gpm at $\geq$ 80 psig

6.0 PROCEDURE (Continued)

6.1.3.2.1.5 Plant OFF Gas - 2-1/2" pipe size, connection 2 1/2" quick disconnect fitting, material 304 stainless steel

.2.1.6 Plant Waste - 1-1/2" pipe size, connection 150# R. F. flange, material 304 stainless steel

.2.1.7 Service Air - 1" pipe size, 3/4" quick disconnect, carbon steel

.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, 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 including the cement storage trailer.

.2.8 SCE personnel have designated an area in the truck bay to be used for test solidifications.

.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 2 and Unit 3, Quality Assurance Program for San Onofee Unit 2 and Unit 3, ALARA Program for San Onofre Unit 2 and Unit 3, and Health Physics Program for San Onofre Unit 2 and Unit 3 as addressed in Reference 2.3.13.

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 waste processing 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 8.2 through 8.5.

.3 Actual full scale solidification shall then be conducted in accordance with the Operating Procedures (Ref. 2.2.6) 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 2.2.6. The dewatering line from the solidification system will be returned to the applicable portion of the Miscellaneous Radwaste 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 Tanks (T-059, T-060), Concentrated Misc. Waste Storage Tanks (T-061, T-062), Backflushable Filter Crud Tank T-073. 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 chemical addition usually with no effect on the process, however, it must remain in operation during the addition of chemicals and/or cement.

6.0 PROCEDURE (Continued)

6.1.6 Waste-to-Cement Ratio (by volume)

The normal waste-to-cement/conditioner ratio (by volume) will be approximately 2 to 1 for evaporator concentrates and 2.5 to 1 for resins, powdex and other solids. If recommended ratios are exceeded, cure time may be delayed and the solidified product may have free-standing water in the vessel after solidification.

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 2.2.3 and will comply with applicable DOT regulations, state regulations, NRC and burial facility acceptance criteria, and 10 CFR Part 61 for packaging and shipment to an approved offsite burial site.

6.2 REQUIREMENTS FOR SAMPLE TESTING

6.2.1 Waste Recirculation

.1 Due to the importance of obtaining a representative sample for an accurate isotopic analysis and use in the verification procedure, the Radwaste Health Physics personnel shall confirm that the contents of the selected waste storage tank (as listed in step 6.1.4.5) have been adequately mixed to achieve a homogenous mixture.

.2 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 to the transfer mode and a representative sample shall be taken.

.3 Any number of mechanical operations of the selected waste storage tank (as listed in step 6.1.4.5) may negate the effects of the previous recirculation/agitation period. These operations include the following:

.3.1 Introduction of additional waste into the selected storage tank after recirculation and/or transfer has commenced.

.3.2 Securing of recirculation and/or transfer while drawing the verification sample.

.3.3 Securing the isolok sampler prior to completion of transfer if used.

6.0 PROCEDURE (Continued)

6.2.1.4 If any of the situations listed above occur, it will be necessary to repeat the recirculation process and sample verification procedure of Section 6.5 in order to reestablish the solidification process parameters.

6.2.2 Sampling Miscellaneous Wastes and Sludges

.1 Radwaste Health Physics personnel shall verify that the contents of the waste storage container are adequately mixed to obtain a representative sample for an accurate isotopic analysis and use in the verification procedure.

6.2.3 Waste Identification

.1 The Chemistry Department shall provide chemical analyses, this analyses will provide the basic chemical composition
QHP and properties of the selected waste stream as requested by the Radwaste Group. The CNSI operator shall record the chemical composition and properties on Attachments 8.2 through 8.5 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.

6.2.4 Equipment

Equipment required for the sample verification procedure is listed in Attachment 8.1. The table indicates the recommended quantity to begin a verification procedure.

QHP 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 QA) 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.

6.0 PROCEDURE (Continued)

6.4 Requirements for Sample Verification

6.4.1 QHP Verify that all materials listed in Attachment 8.1 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 8.2 through 8.5, 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.

.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 Prior to every full scale solidification, the waste composition shall be verified on Form SO(123) 159 "SCE Solidification Verification Worksheet."

.5 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.

6.0 PROCEDURE (Continued)

6.5.2 Use the appropriate attachment (Attachments 8.2 through 8.5) 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 QA Engineer.

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.

8.0 ATTACHMENTS

8.1 Equipment Recommended for Testing Sample

8.2 PCP Solidification of Boric Acid Concentrates (N-24, Cement, Lime Sequence)

8.3 PCP Solidifications of Particulate Wastes (Resin Beads, Powdex and Diatomaceous Earth Slurries)

8.4 PCP Solidification of Miscellaneous Aqueous Wastes

8.5 PCP for Preparation of Fluid Mixture for In-situ Solidifications

8.6 Liner and Cask Calculations

8.7 Form SO(123) 159, SCE Solidification Verification Worksheet

8.8 Data Record Form

EQUIPMENT RECOMMENDED FOR TESTING SAMPLE

250 ML Plastic Beakers with Lids (12)
600-1000 ML Containers (12)
Wide Blade Spatulas (2)
Pipettes (2)
Pipettor
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)
50 ML Buret (2)
Ring Stand
Buret Clamp (2)
Marking Pen
Sample Heating Oven, Thermostatically Controlled from 100° to 180°F. (See Note)
Kitchen Strainer, 1/16" Openings
Graduated Cylinders, 250 ml (2)

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

NOTE: WASTE SOLIDIFIED ON A SMALL SCALE WILL CURE MUCH SLOWER BECAUSE OF THE EXCESSIVE SURFACE TO VOLUME RATIO FOR HEAT TRANSFER. SAMPLE STORAGE IN AN APPROVED CONSTANT TEMPERATURE OVEN WILL ENABLE MORE MEANINGFUL EVALUATION AFTER 24 HOURS.

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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.

1.1 From past experience and the analysis supplied by the utility, determine the appropriate PCP solidification formula using the table below. Note that boric acid waste that has been partly neutralized unintentionally or to reduce storage temperature may require different or 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.

Table

Boron Content (ppm)	Boric Acid Equivalent	Waste Volume	*WT. of CNSI Agent N-24	*WT of CNSI Agent N-50	Weight of Cement	Weight of Lime
0- 6,900	0-4%	200-210 ML	5 GM	0-5 GM	170-210 GM	60-80 GM
7,000-21,000	4-12%	210-240 ML	10 GM	0-10 GM	130-180 GM	60-80 GM
Above 21,000	Above 12%	220-250 ML	15 GM	0-15 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.

QHP 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.

QHP 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 note maximum temperature reached during the 30 seconds of stirring after addition. Record temperature on CNSI Solidification Worksheet I, Item (b). If temperature does not increase by about 6-10°F, it may be necessary to add other Agents to ensure desired solidification.

1.5 Add immediately the required weight of CNSI Agent N-50 and cement, and disperse thoroughly with spatula. Use minimum cement weight in accordance with experience, and add CNSI Agent N-50, only as necessary.

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.

NOTE: For wastes that have been partially neutralized to reduce storage temperature, it has been necessary to incorporate other additives to assure a reasonably short setting time. According to experience and PCP verification, CNSI Agent S-4 may be added after lime addition as required.

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.

QHP 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 solidification weight and waste radiation level is consistent with allowable transportation regulations and requirements.

SCE/CNSI SOLIDIFICATION WORKSHEET I (PCP Solidification of Boric Acid Concentrates)

Waste Identification Date: _____ Operator: _____

Shipment No. _____

Boron Content _____ppm or Boric Acid Content _____%

Specific Gravity _____

pH _____

Temperature _____ °F (In Waste Tank)

Physical Appearance (color, clarity, sediment) _____

_____

Sample Preparation

(a) Volume of Waste: _____ml

(b) Weight of Lime: _____gms

(c) Weight of Calcium Chloride: _____gms

(d) CNSI Moderator S-4, If used: _____gms

pH After Mixing for 3 Minutes _____

(e) Additional Lime Added, If Any: _____gms

Final pH (If More Lime Required) _____

(f) Weight of Cement: _____gms

Oven Temperature at Start of Test _____ °F

Time Sample in Oven (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) _____

_____

Completed By: _____ / _____
Date

SCE/CNSI SOLIDIFICATION WORKSHEET II (Full Scale Solidification of Boric Acid Concentrates) in 14-195 or larger liner

Volume Information

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

(b) Liner Ft^3/Inch of Height (Fig. 4) _____ Ft^3/Inch

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

Waste Identification

Type: _____
Date: _____
Operator: _____
Shipment No: _____

NOTE: BE SURE THAT VOLUME (c) IS LESS THAN 68% OF VOLUME (a).

(d) Weight of Lime = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\text{\_\_\_\_\_}}{\text{(Lime, Table 2.2)}}$ = _____ Lbs. ± 10% (__)

(e) Weight of Cement = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\text{\_\_\_\_\_}}{\text{(Cement, Table 2.2)}}$ = _____ Lbs. ± 10% (__)

(f) Weight of Calcium Chloride = $\frac{\text{(e)}}{\text{(Cement Wt.)}} \times 0.015$ = _____ Lbs. ± 10% (__)

(g) WT. of CNSI Moderator S-4, If Needed = $\frac{\text{(e)}}{\text{(Cement WT.)}} \times 0.045$ = _____ Lbs. ± 10% (__)

NOTE: ADD CALCIUM CHLORIDE AND CNSI MODERATOR S-4 TO THE NEAREST HUNDREDWEIGHT.

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

*Average Waste Specific for Calculation Purpose.

(i) Total WT. After Cement Addition = (d)+(e)+(f)+(g)+(h) = _____ Lbs.

Alarm Heights (To the Nearest 0.1 Inch)

(j) Lime Height = $\frac{\text{(d)}}{\text{(Lime Wt.)}} \div 400$ Lbs./In. = _____ Inches

NOTE: FOR 21-235 AND 21-300 LINERS, USE 450 LBS.IN.

SCE/CNSI SOLIDIFICATION WORKSHEET II (Full Scale Solidification of Boric Acid Concentrates) in 14-195 or larger liner (Continued)

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

(l) Waste Alarm Ht. =(j)+(k) (If lime is preloaded) = _____ Inches
Or =(k) (If lime is added after waste)= _____ Inches

(m) Cement Height = $\frac{\text{(e)}}{\text{(Cement Wt.)}} \div 173^{**} \div \frac{\text{(b)}}{\text{(V/H Ratio)}}$ = _____ Inches

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

(n) Cement Alarm Height = (j) + (k) + (m) = _____ Inches

Completed By: _____ / _____
Date

TYPICAL SAMPLE CALCULATIONS FOR WORKSHEET II (Boric Acid Concentrates)

120 cubic feet of waste at 170° containing 9% Boric Acid is to be solidified in a L14-195 Liner that is pre-loaded with lime at 16.0 lbs. per Ft^3 of waste, and CNSI Moderator S-4 is required in the normal amount. Based on PCP and past experience, the cement factor is 54.0 lbs. per Ft^3 of waste.

(a) Usable Liner Volume (Figure 4) = 190 Ft^3

(b) Liner Volume/Height Ratio (Figure 4) = 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 Lime = 120 x 16.0 = 1,920 Lbs.

(e) Weight of Cement = 120 x 54.0 = 6,480 Lbs.

(f) Weight of Calcium Chloride = 6480 x 0.015 = 100 Lbs.*

(g) WT. of CNSI Moderator S-4 = 6480 x 0.045 = 300 Lbs.*

*Expressed to Nearest Hundredweight

(h) Weight of Waste = 120 x 62.4 x 1.02 = 7,638 Lbs.

(i) Total Weight after Cement Addition = 16,438 Lbs.

(j) Lime Height = 1920 ÷ 400 = 4.8 Inches

(k) Waste Height = 120 ÷ 2.62 = 45.8 Inches

(l) Waste Alarm Height = 4.8 + 45.8 = 50.6 Inches

(m) Cement Height = 6480 ÷ 173 ÷ 2.62 = 14.3 Inches

(n) Cement Alarm Height = 4.8 + 45.8 + 14.3 = 64.9 Inches

SCE/CNSI SOLIDIFICATION WORKSHEET III
(Process Summary - Boric Acid Concentrates)

Utility _____
Operator _____
Waste Tank _____
Shipment No. _____

1. Lime Added:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Weight _____Lbs.

2. Calcium Chloride and CNSI Moderator S-4 Added:

   Time _____ Date _____ Weight _____Lbs.($CaCl_2$)
   Weight _____Lbs.(S-4)

3. Receive Waste:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Estimated Weight* _____Lbs.

*From Worksheet II, Item (h)

4. Temperature after Mixing in Waste: _____°F

5. Cement Added:

   Start Time _____ Date _____

   Finish Time _____ Date _____ Weight _____Lbs.

6. Temperature After All Cement Added: _____°F

7. Agitation Stopped: Time _____ Date _____

8. 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

9. First Peak Temp.: Time _____ Date _____ _____°F

10. Second Peak Temp.: Time _____ Date _____ _____°F

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

SCE/CNSI SOLIDIFICATION WORKSHEET III
(Process Summary - Boric Acid Concentrates) (Continued)

12. Fillhead Removed: Time _____ Date _____

13. Liner Capped: Time _____ Date _____

14. Observations, Additional Comments: _____

_____

_____

_____

Completed By: _____ / _____
Date

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

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 disposable beaker and allow solids to settle. Typically, there will be a layer of water on top of the resin beads.

NOTE: 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 If pH is less than 6, add a minimum amount of lime while stirring until the pH is above 7. Record the amount of lime required (in grams) on SCE/CNSI worksheet I for particulate wastes. If pH is above 6, do not add any lime.

QHP 1.5 Add a dry blended mixture of 2 parts cement and 1 part CNSI Agent M-5 cement slowly while stirring until a smooth homogenous mix is obtained. The amount added for a 100 ml waste sample may be 100 to 200 gms depending on resin type. Determine the individual amounts of cement and Agent M-5 added, and record the weights (in grams) on SCE/CNSI Solidification Worksheet.

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

QHP 1.7 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.

1.8 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 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 SCE/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)

Waste Identification Date: _____ Operator: _____ Utility: _____

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) Alkaline Agent To Be Added: _____(6 or greater no lime needed)

(d) pH Adjustment Summary

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

(e) Additional Lime _____gm _____

(f) M-5 added _____gm

(g) 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.

Oven Temperature At Start Of Test _____°F
Time Sample In Oven (Sealed) _____hrs.
Oven Temperature When Sample Removed _____°F
Time Outside Oven Before Unsealing _____hrs.

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

(h) Repeat the PCP using 90% of the lime (Item f) and 90% of the cement (Item g).

- o M-5 Added _____gm (90% OF Item f)
- o Cement Added _____gm (90% Of Item g)

Oven Temperature At Start Of Test	_____°F
Time Sample In Oven (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) _____

_____

Completed By: _____/_____
Date

CNSI SOLIDIFICATION WORKSHEET II
(Full-Scale Solidification Of Particulate Wastes)

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: _____ Utility: _____

Shipment No. _____

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

(b) Liner Ft^3/Inch of Height (Fig. 4) _____ 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 result 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 SATISFACTORILY AS CONCERNS HARDNESS AND ABSENCE OF FREE-STANDING LIQUID. ANY SUCH INCREASE MUST BE APPROVED BY THE MANAGER, SOLIDIFICATION 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

(g) M-5 WT. = $\frac{\text{gm}}{}$ x 0.623** x $\frac{\text{(c)}}{\text{(Waste Vol.)}}$ = ___ Lbs. ±10% (___ Lbs.)

(h) M-5 Height = $\frac{\text{(g)}}{\text{(M-5 WT.)}} \div 173^{****} \div \frac{\text{(b)}}{}$ = _____ Inches

NOTE: THIS IS TO VERIFY THAT AN ACCEPTABLE PRODUCT WILL BE PRODUCED EVEN WITH SIGNIFICANT UN-ANTICIPATED REDUCTION OF CHEMICAL ADDITION. AN EXCESS OF CHEMICALS WITHIN THE ACCEPTABLE LINER VOLUME WILL NOT HINDER THE SOLIDIFICATION PROCESS.

Cement Weight And Alarm Height (Nearest Lb. and 0.1 Inch)
*****

(i) Cement WT. = _____gm x 0.623** x _____(c) = ____Lbs. ±10% (____ Lbs.)
SW I, (g) (Waste Vol.)

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

(j) Cement Height = _____(g) ÷ 173**** ÷ _____(b) = _____Inches

****Typical true cement M-5 density, Lbs./Ft^3

(k) Cement Alarm Height - (d)+(f)+(h)+(j) = _____Inches

*****When using a cyclonaire transfer system, the estimated number of transfers

= _____lbs. of cement required ÷ _____lbs./transfer = _____transfers.

Completed By: _____/_____
Date

TYPICAL SAMPLE CALCULATIONS FOR WORKSHEET II
(Particulate Wastes)

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 (4) four 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)

Utility: _____ Operator: _____ Waste Tank _____

1. Waste 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 Re-Fluidize, If Necessary: Estimated Volume
   Time _____ Date _____ 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

9. M-5 Added:

NOTE: M-5/CEMENT ADDITION MUST BE WITHIN + 10% OF SOLIDIFICATION WORKSHEET II ITEMS (g, i). NET EXCESS OF LIME AND CEMENT SHOULD NOT EXCEED VOLUME OF CONTAINER.

   Start Time _____ Date _____
   Finish Time _____ Date _____ Weight _____ Lbs.

10. Cement Added:

    Start Time _____ Date _____
    Finish Time _____ Date _____ Weight _____ Lbs.

11. Additional Cement Added, If Necessary: _____Lbs.

12. Temperature After All M-5 and Cement Added: _____°F

13. Agitation Stopped: Time _____ Date _____

14. 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

15. Peak Temperature Time _____ Date _____

16. Fillhead Removed Time _____ Date _____

17. Liner Capped Time _____ Date _____

18. Observations, Additional Comments: _____

_____

_____

_____

_____

Completed By: _____ / _____
Date

PCP SOLIDIFICATION OF MISCELLANEOUS AQUEOUS WASTES (NOT REPRESENTING TYPICAL PWR CONCENTRATES)

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.

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.

QHP 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.

QHP 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 8.7 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 BWR or PWR Concentrates)

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) _____

_____

Completed by _____ _____
Date

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

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 = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\text{\_\_\_\_\_}}{\text{SW-I, Item (b)}} \times .312$ = _____ Lbs. ± 10% (__)

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

(f) Weight of Other Additive, If Used = $\frac{\text{(c)}}{\text{(Waste Vol.)}} \times \frac{\text{\_\_\_\_\_}}{\text{SW-I, Item (d)}} \times .312$ = _____ 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

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

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

***Typical True Lime Density, Lbs./Ft³

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

Completed By: _____ / _____
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 (Figure 5) = 190 Ft^3

(b) Liner Volume/Height Ratio (Figure 5) = 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)

Utility _____ 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: _____

_____

Completed by _____ _____
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.

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).

Sodium Sulfate, Anhydrous	16.0 gm
Lime, Hydrated	40.0 gm
Boric Acid, Granular	2.0 gm

QHP 1.3 From a graduate, add 200 ml of water to the dry ingredients and blend thoroughly with spatula. Check pH with narrow range paper to confirm that the mixture is 11.5 or greater.

QHP 1.4 Add in 190-230 grams of Portland Cement and mix well with spatula to assure uniformity. Control the flow characteristics of the mix to a smooth, fluid consistency.

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 CEMENT WEIGHT AS NECESSARY TO OBTAIN DESIRED TEXTURE.

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

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

QHP 1.7 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 VERIFICATON (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.

SCE/CNSI SOLIDIFICATION WORKSHEET I
FULL-SCALE IN-SITU SOLIDIFICATION OF SUSPENDED OBJECTS

Date _____ Utility _____ Technician _____

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	120	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. Calculate amount of water to add to the mixing liner.

(_____ Ft^3) x .66 = _____ Ft^3
Cement Mix Vol. Item 1 | Water Vol.

3. Calculate amount of dry cement to add to mixing liner.

(_____ gms) ÷ 200 x (_____ Ft^3) x 62.4 = _____ lbs. ±10% (____)
PCP Cement Item 1.5 | Water Vol., Item 2 | WT. Cement

4. Calculate amount of lime to add to mixing liner.

(_____ Lbs.) x .20 = _____ Lbs. ±10% (_____)
WT. Of Cement Item 3 | WT. Of Lime

5. Calculate weight of boric acid to add to mixing liner.

(_____ Lbs.) x .01 = _____ Lbs. ±10% (_____) = _____ (50 Lb. Bags)
WT. of Cement Item 3 | WT. Of Boric Acid

6. Calculate weight of sodium sulfate to add to mixing liner.

(_____ Lbs.) x .08 = _____ Lbs. ±10% (_____) = _____ (100 Lb. Bags)
WT. Of Cement Item 3 | WT. Of Sodium Sulfate

NOTE: ADD BORIC ACID TO THE NEAREST 50 POUND BAG. ADD SODIUM SULFATE TO THE NEAREST HALF BAG, IF SUPPLIED IN 100 POUND BAGS.

Example:

Assume In-Situ solidification of filters in a L14-195 liner. Cage volume utilization by the waste is assumed to be 60%. Assume 210 gms of cement added for PCP.

1. Calculate volume of wet cement mixture required.

(196 Cubic Feet) - (2 x 2.62) - (110 x .6) = 125 Cubic Feet
Total Liner Vol. 2 x V/H Ratio Est. Waste Vol. Mix Vol.

2. Calculate amount of water to add to mix liner.

125 Cubic Feet x .66 = 83.3 Cubic Feet
Cement Mix Vol. Item 1 Water Vol.

3. Calculate amount of dry cement to add to mix liner.

(210 gms) ÷ 200 x 83.3 Cubic Feet x 62.4 = 5458 Lbs.
PCP Cement WT. Water Vol. Item 2 WT. Cement

4. Calculate the amount of lime to add to mix liner.

5458 Lbs. x .20 = 1092 Lbs.
WT. Of Cement, Item 3 WT. Of Lime

5. Calculate the amount of boric acid to add to mix liner.

5458 Lbs. x .01 = 54.6 Lbs. = 1 (50 Lb. Bags)
WT. Of Cement, Item 3 WT. Of Boric Acid

6. Calculate the amount of sodium sulfate to add to mix liner.

5458 Lbs. x .08 = 437 Lbs. = 4.5 (100 Lb. Bags)
WT. Of Cement, Item 3 WT. Of Sodium Sulfate

Completed by _____ _____
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 Volume, Ft^3 (2" Safety Factor)	311	235	190	169	116	88	79
Ft^3/In. Of Height	3.05	3.05	2.62	2.52	1.69	2.52	1.53
Weight, Lbs.	2400	1800	1650	1550	1100	1250	950
Cask Payload, Lbs. (Including Liner Weight)	27250	27250	17700	14000	20000	13000	7500

SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 AND 3

HEALTH PHYSICS PROCEDURE SO23-VII-8.5.1
REVISION 0 PAGE 1 OF 1
ATTACHMENT 8.7

SCE SOLIDIFICATION VERIFICATION WORKSHEET

Date: _____ Shipment #: _____ Cask #: _____

1. Waste Type: _____ Tank: _____ _____ Initial

2. Date PCP last performed _____ for _____ waste type _____ Initial.

3. Verify with Operations that waste has not been added to _____ tank since date of PCP addressed in step 2.

   Date _____ Confirmed by _____.

   If additional waste has been added, then perform new PCP test solidification. New PCP required?

   Yes _____ No _____ Initial _____

4. Number of full-scale solidifications done since PCP in step 2 last performed _____ _____ Initial.

5. Initial if number of solidifications in step 5 are less than 10 _____. If ≥ 10, then a new PCP test is required.

Reviewed by Radwaste Supervisor or Radwaste Foreman: _____

Facsimile

DATA RECORD FORM

PROCESS CONTROL PROGRAM FOR SAN ONOFRE UNITS 2 AND 3

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

Prerequisites Met _____ / _____
Signature Date

Cask No./Shipment No. _____ / _____

Step No.	Description	Data	Acceptance Criteria	Recorder/Verifier Signature/Date
6.2.3	Waste Identification	SAT ____ UNSAT ____	Chemical Analysis Waste provides proper information	____ / ____ QHP Verified
6.2.4	Equipment	SAT ____ UNSAT ____	All necessary equipment available or approved substitutes	____ / ____ QHP Verified
6.3.1 6.3.1.1 6.3.1.2	Sample Acceptance	SAT ____ UNSAT ____	Uniform, dry, Freestanding resists penetration	____ / ____ QHP Verified
6.4.1	Test Equipment Available	SAT ____ UNSAT ____	All Equipment on Attachment 8.1 is available	____ / ____ QHP Verified
6.4.3.4	Form SO(123)	SAT ____ UNSAT ____	Form completed satisfactorily	____ / ____ QHP Verified
6.5.1	Test Documentation	SAT ____ UNSAT ____	SCE/CNSI Worksheets have been completed	____ / ____ QHP Verified

Step No.	Description	Data	Acceptance Criteria	Recorder/Verifier Signature/Date
Attachment 8.2				
1.3	Crystallized Sample	SAT ____ UNSAT ____ N/A ____	Sample Heated to 140°F or above and completely dissolved	____/____ ____/____ QHP Verified
1.4	Sample Preparation	SAT ____ UNSAT ____ N/A ____	Amount of N-24 recorded Temp. 160°F Temp. after addition recorded	____/____ ____/____ QHP Verified
1.6	Solidification Agent Addition	SAT ____ UNSAT ____ N/A ____	Proper amount of lime added, pH 11 or above	____/____ ____/____ QHP Verified
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
Attachment 8.3				
1.3	Sample Preparation	SAT ____ UNSAT ____ ml ____	Sample volume at least 100 ml less if Rad levels high	____/____ ____/____ QHP Verified
1.4	pH Adjustment with Lime	SAT ____ UNSAT ____ N/A ____	If pH <6 add lime until pH above 7 record lime in grams if pH >6 no lime necessary	____/____ ____/____ QHP Verified
1.5	Solidification Agent Addition	SAT ____ UNSAT ____	Sample mixed thoroughly cement and M-50 weight used in grams recorded	____/____ ____/____ QHP Verified
1.7	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 120-130°F Maintained sealed in sample oven for 18-24 hours	____/____ ____/____ QHP Verified

Step No.	Description	Data	Acceptance Criteria	Recorder/Verifier Signature/Date
Attachment 8.4				
1.2	Sample Preparation	SAT ____ UNSAT ____	200 ml waste sample transferred to disposable beaker	____/____ ____/____ QHP Verified
1.3	Cement Addition	SAT ____ UNSAT ____	120 to 140 gms added mixed thoroughly	____/____ ____/____ QHP Verified
1.4	Lime Addition	SAT ____ UNSAT ____	80 to 100 gms added mixed thoroughly	____/____ ____/____ QHP Verified
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	____/____ ____/____ QHP Verified
1.7	Sample Cooling	SAT ____ UNSAT ____	>2 hours after removal from oven	____/____ ____/____ QHP Verified
Attachment 8.5				
1.2	Material Dry Weight	SAT ____ UNSAT ____	Dry weight of materials recorded	____/____ ____/____ QHP Verified
1.3	pH after ingredients added	SAT ____ UNSAT ____	pH 11.5 or greater	____/____ ____/____ QHP Verified
1.4	Cement Addition	SAT ____ UNSAT ____	190 to 230 gms added mixed thoroughly	____/____ ____/____ QHP Verified
1.7	Oven Setting Sample Cure Time	SAT ____ UNSAT ____ N/A ____	Oven Temp 130-140°F Maintained sealed in sample oven for 18-24 hours	____/____ ____/____ QHP Verified