SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT (WIPP)

TEST PLAN, TP 02-03

SALADO MASS CONCRETE TEST PLAN

Revision 0

TASK 1.3.5.4.3.2

Effective Date: 04/23/02

Prepared by:

Terry L. MacDonald, 6822

Sandia National Laboratories
Carlsbad, NM

1.0 APPROVAL PAGE

Author:	*Original signed by Terry L. MacDonald* Terry L. MacDonald, 6822	*03-07-02* Date
Technical Reviewer:	*Original signed by Steve W. Wagner* Steve W. Wagner, 6823/J. Hart Assoc.	*3-12-02* Date
Management Reviewer	*Original signed by Francis D. Hansen* Francis D. Hansen, 6822	*3/12/2002* Date
ES&H Reviewer	*Original signed by Diane G. Gibson* Diane G. Gibson, 6800	*3-7-2002* Date
QA Reviewer	*Original signed by Mario J. Chavez* Mario J. Chavez, 6820	*3/12/2002* Date
WTS Approval	*Original signed by Gary R. Maples* Gary R. Maples, WTS	*3-12-02* Date
DOE/CBFO Approval	*Original signed by Daryl Mercer* Daryl Mercer, CBFO	*4/18/02* Date

2.0 TABLE OF CONTENTS

3.0 LIST OF ABBREVIATIONS AND ACRONYMS

3-D	Three-Dimensional
Appendix G	NMED RCRA WIPP Hazardous Waste Facilities Permit, Attachment I1, Appendix G
Cal Lab	SNL Primary Standards Calibration Laboratory
Carlsbad Airport	Cavern City Air Terminal Airport, Carlsbad, NM
COC	Chain of Custody
Constructors	Constructors, Incorporated
Drill Crew	WTS Mine Drill Crew
CTB	Concrete Test Block
DAS	Data Acquisition System
DOE	Department of Energy
DOE/CBFO	Department of Energy/Carlsbad Field Office
ES&H	Environment, Safety, & Health
HA	Hazard Assessment
HWFP	NMED RCRA WIPP Hazardous Waste Facilities Permit
ID	Inside Diameter
I/O	In/Out
Mine Ops	WTS Mine Operations Department
MOC	Managing and Operations Contractor
NMED	New Mexico Environment Department
NOAA	National Oceanic and Atmospheric Administration
NP	National Waste Management Program Procedure
NWMP	Nuclear Waste Management Program
NWS	Nuclear Weather Service
OD	Outside Diameter
PA	Performance Assessment
PHS	Primary Hazard Screen
PI	SNL/CB Principal Investigator, or Designee
QA	Quality Assurance
QAPD	Quality Assurance Program Directives
RCRA	Resource Conservation Recovery Act
SHHCD	Safety and Health Hazards Control Document
SMC	Salado Mass Concrete
SNL	Sandia National Laboratories
SNL/CB	Sandia National Laboratories/Carlsbad Programs Group
SP	Activity/Project Specific Procedure
Test Plan	Salado Mass Concrete Test Plan
US	United States
VOCs	Volatile Organic Compounds
Weather Station	NOAA NWS Weather Station at the Carlsbad Airport
WIPP	Waste Isolation Pilot Plant
WTS	Westinghouse TRU Solutions Inc.
yd^3	cubic yard

4.0 REVISION HISTORY

This is the first version of the Salado Mass Concrete Test Plan (Test Plan). Subsequent revisions will be made in accordance with the Sandia National Laboratories (SNL) Nuclear Waste Management Program (NWMP) Procedures (NP): NP 20-1 *Test Plans*, NP 6-1 *Document Review Process* and NP 6-2 *Document Control Process*.

5.0 PURPOSE AND SCOPE

The Waste Isolation Pilot Plant (WIPP) is a United States (US) Department of Energy (DOE) facility designed for the safe disposal of transuranic wastes resulting from the US defense programs. The New Mexico Environment Department (NMED) Resource Conservation Recovery Act (RCRA) regulations require the installation of the panel closure system in the WIPP repository to limit the migration of volatile organic compounds (VOCs) during the operational period of the repository.

The activities described in this Test Plan constitute one component of the WIPP program to demonstrate the ability to install the "Option D" concrete monolith panel closure system as WIPP waste panels are filled and closed off from the remainder of the repository, as described in the NMED RCRA *Waste Isolation Pilot Plant Hazardous Waste Facilities Permit* (HWFP) Attachment I1, Appendix G (Appendix G: NMED, 2001). Construction of such a monolith at the WIPP site has not been attempted to date, but construction is anticipated in the near future as a condition of the HWFP. A similar concrete monolith panel was constructed *in-situ* at Whiteshell Laboratories, Pinawa, Manitoba (Chandler et al, 2001), which provides technical guidance for this Test Plan. Westinghouse TRU Solutions (WTS), the WIPP Managing and Operations Contractor (MOC) has planned the Salado Mass Concrete (SMC) Test to demonstrate the ability to construct the concrete monolith in accordance with specifications outlined in Appendix G. The SMC Test is briefly described below, followed by the summary of the Sandia National Laboratories/Carlsbad Programs Group-specific (SNL/CB) activities, and their objectives, described in this Test Plan.

5.1 PURPOSE OF THE SALADO MASS CONCRETE TEST

Appendix G lists material specifications that shall be met during the installation of a panel closure in the WIPP repository. Some of these requirements relate to the Salado Mass Concrete used in the construction of the panel closure system. The SMC Test proposed by WTS has the following primary objectives:

- Locate sources of materials and procure materials in sufficient quantities to complete a 30 cubic yard (yd^3) SMC concrete pour, a 5-yd^3 SMC concrete pour for testing pumpability, and bench-scale batches for verifying fresh and hardened concrete properties (low-shrinkage, salt-saturated concrete).
- Determine the ability of SMC concrete to meet Appendix G target properties (e.g., slump, compressive strength, etc) and demonstrate the workability and handling of the concrete.

- Obtain quality data for the mass heat test temperature rise in the 30-yd^3 SMC concrete test block (CTB) during curing (56 days minimum).
- Prepare a final report documenting the results of the SMC concrete test pours. The final report will likely be included with future bid packages submitted to contractors when, or if, a SMC panel closure needs to be emplaced in the WIPP repository.

Secondary objective:

- In contrast to mixing the SMC concrete above ground during actual WIPP repository panel closure emplacement, WTS is evaluating a plan in which mixing will be performed underground using dry batch materials stored underground in a staging area. However, the current Appendix G revision specifically states that the ambient temperature cannot exceed 70^{o}F during mixing (the WIPP repository ambient temperature is approximately 80 to 85^{o}F). Information gathered from the SMC concrete test pours might be used to apply for a permit modification to Appendix G to allow mixing at higher temperatures.

To implement the SMC Test, WTS requested the assistance of Constructors Inc. (Constructors). Constructors' responsibilities include:

- Mix and dispense the SMC concrete for the 30-yd^3, the 5-yd^3, and the bench-scale concrete pours at their facility in Carlsbad, NM;
- Construct the CTB framework (**Figure 1**) for the 30-yd^3 concrete pour at their facility;
- Mix and dispense the SMC concrete for the 5-yd^3 and the bench-scale concrete pours prior to the 30-yd^3 concrete pour. A portion of the 5-yd^3 concrete pour will be poured into a 55-gal drum for testing by SNL/CB; and
- Support SNL/CB facility requirements during the SMC Test activities.

5.2 PURPOSE AND SCOPE OF SNL/CB SUPPORT OF THE SMC TEST

WTS requested the assistance of SNL/CB in studying several of the concrete specifications listed in Appendix G during the SMC Test. SNL/CB's responsibilities include:

- Determine the mass heat test maximum temperature rise of the SMC concrete in the concrete test block for the 30-yd^3 pour;
  - Purchase and calibrate the instrumentation (i.e., data acquisition system (DAS), thermocouples, thermistors, etc.).
  - Design the framework (**Figure 2**) for positioning the instrumentation and purchase the required materials.
  - Design and assemble the data acquisition system.
- "Shakedown" the instrumentation during the 5-yd^3 pour;
- Prepare a report summarizing the SMC Test, mass heat test measurements. The report may be included as an appendix to the WTS SMC Test report; and
- Other activities conducted by SNL/CB in support of the SMC Test may include:
  - Performing laboratory analysis on concrete core samples obtained from the cured 30-yd^3 concrete test block.
  - Performing *in-situ* permeability tests, with a SNL/CB designed permeability-testing system, in the 30-yd^3 concrete test block by utilizing the concrete core samples boreholes (if extracted), or in new holes drilled by the concrete coring contractor.

The WTS Mine Drill Crew (Drill Crew) or a concrete coring contractor may extract SMC concrete core samples from the cured concrete test block. The SNL/CB Laboratory facility will perform the analysis of the concrete core samples, if extracted. Laboratory analyses of the concrete cores samples may include:

- Aggregate segregation;
- Moisture content;
- Permeability (Tidwell and Wilson, 1997); and
- Porosity.

Concrete core samples may also be provided to a WTS contractor laboratory for fracture breaks and permeability testing. Upon the completion of the SMC concrete core samples analyses, the SNL/CB Laboratory will prepare a supplemental report summarizing the results of the laboratory analyses for presentation to WTS.

6.0 EXPERIMENTAL PROCESS DESCRIPTION

This section of the Test Plan describes the experimental processes that SNL/CB will perform to monitor and analyze the SMC concrete specifications listed in Appendix G. All of the SMC Test activities conducted at the Constructors facility will be coordinated through the cognizant Constructors representative. All of these activities will be documented in a scientific notebook(s). Any SMC concrete core sample laboratory analyses performed at the SNL/CB Laboratory facility will be coordinated through the Laboratory Facility Supervisor. All concrete core sample laboratory analyses will be documented in a scientific notebook(s).

6.1 SALADO MASS CONCRETE TEST 5-YD^3 POUR

The SMC Test 5-yd^3 concrete pour will provide Constructors and WTS information on the pumpability of the SMC concrete prior to the 30-yd^3 concrete pour. This pour will also provide SNL/CB with an opportunity to "shakedown" the data acquisition system (DAS), thermistors, and thermocouples that will be used to monitor the mass heat test temperatures during the 30-yd^3 concrete pour. The analysis of the temperature data collected during the 5-yd^3 concrete pour should provide an indication of the maximum temperature expected during the curing of the SMC concrete during the 30-yd^3 concrete pour. Data collected by the DAS during the 5-yd^3 concrete pour are not quality affecting, but are a means by which to evaluate the system.

For the 5-yd^3 concrete pour, the sequence of the SNL/CB activities will be as follows:

1. The thermistors and thermocouples will be sent to the SNL Primary Standards Calibration Laboratory (Cal Lab) for calibration.
2. Perform a voltage calibration of the DAS per the manufacturer's recommended voltmeter calibration service note or procedure.
3. A thermistor and two thermocouples will be attached to the DAS and a "shakedown" performed to insure the DAS, thermistor, and thermocouples are working properly.
4. SMC concrete from the 5-yd^3 concrete pour will be collected in a 55-gal steel barrel provided by Constructors.

5. The thermistors and two thermocouples will be placed, and supported, in the center of the concrete in the barrel.
6. The DAS will monitor temperatures of the curing concrete for a period of two weeks, or for a period of time determined by the SNL/CB Principal Investigator (PI) or his designee.

6.2 SALADO MASS CONCRETE TEST 30-YD^3 POUR

The SMC Test 30-yd^3 concrete pour will provide WTS information on Appendix G concrete specifications. The main SMC concrete specification provided by SNL/CB during the 30-yd^3 concrete pour is the mass heat test maximum temperature. Determining the mass heat test maximum temperature will require the monitoring of the temperature rise during the curing of the concrete test block. The greatest temperature rise is expected to occur at the CTB center. Thermistors and thermocouples (or equivalent) were selected to measure the temperature rise during the curing of the concrete test block.

The thermistors and thermocouples will be systematically placed inside the CTB formwork on tensioned support wires attached to the formwork steel support beams. It is important that the support wires only pass through the CTB framework plywood skin and not place undo stress onto the plywood, which may damage the plywood. The thermistor and thermocouple concentration will be denser near the center of the concrete test block to monitor the highest temperature rise. Additional thermocouples may be emplaced near the center of the concrete block for backup. The primary role of the thermistors is redundancy; they may provide data backup in event of thermocouple failures. The final position of the support wires may need to be altered to avoid concrete pumping nipples or other forming structures attached to the plywood skin on one side of the CTB formwork. The PI will determine the need to relocate the thermocouple wires.

The temperature gradient across the formwork plywood skin and the CTB support slab will be monitored to determine thermal loss. The thermistors and thermocouples will be emplaced on the cables in the concrete test block framework. The thermistor and thermocouple wires may be bundled and run through the CTB plywood skin at several locations. Care will be taken to ensure the plywood penetrations will not leak freshly poured concrete. The thermistor and thermocouple wires outside the CTB formwork will be run in flexible conduit (or equivalent) for protection. The three-dimensional (3-D) coordinates of the thermistors and thermocouples will be measured manually, and the WTS Survey Crew may verify the 3-D coordinates of each thermistor and thermocouple from a common reference point. The coordinates will be referenced from a common point (i.e., 0,0,0) conveniently located on the CTB framework. Each individual coordinate point will be tied to the serial number, assigned by the Cal Lab, of a specific thermistor or thermocouple.

The thermistors and thermocouples temperature readings will be recorded on a DAS at time intervals determined by the PI. The thermistors and thermocouples will be monitored by the DAS for a minimal period of 56 days, or as determined by the PI, commencing with the initial pour of the SMC concrete into the CTB framework. Periodic weather data may be collected from the National Oceanic and Atmospheric Administration (NOAA) National Weather Service

(NWS) weather station located at the Cavern City Air Terminal Airport, Carlsbad, New Mexico (Carlsbad Airport) to compliment the CTB mass heat test temperature data. At the conclusion of the mass heat test, the collected temperature data will be analyzed and the results compiled into a report for presentation to WTS. The report may be included as an appendix to the WTS SMC Test report.

For the SMC Test 30-yd^3 concrete pour the sequence of activities will be as follows:

1. The thermistors and thermocouples will be sent to the Cal Lab for calibration.
2. Perform a voltage calibration of the DAS per the manufacturer's recommended voltmeter calibration service note or procedure.
3. Two thermocouples will be emplaced below the center of the CTB support slab prior to the pouring of the concrete slab.
4. The horizontal thermocouple support wires will be secured around the concrete test block framework outside steel frame, tensioned with a come-along (or equivalent), and the wire ends crimped to the wires to eliminate sag in the support wires. It is important to insure the support wires do not place undo stress on the CTB framework plywood skin to prevent structural damage to the plywood.
5. The vertical thermocouple support wire will be stretched between a wire loop (or equivalent) embedded in the CTB support slab and a length of steel U-channel (or equivalent) running across, and attached to, the top of the CTB framework. The support wire will be tensioned with a come-along (or equivalent), and the wire ends crimped to the wires to eliminate sag in the support wires.
6. The thermistors and thermocouples will be attached to their predetermined positions on the support wires, their 3-D position measured with a carpenter's tape to $\pm$1 inch, and their position recorded in the scientific notebook(s) (**Figure 2**).
7. A pair of thermocouples will be placed on the CTB support slab, directly above the previously emplaced thermocouples. An additional pair of thermocouples will be attached to the inner and outer sides of the CTB framework plywood skin, directly across from each other.
8. A thermocouple will be placed near the CTB framework to record ambient temperature.
9. The thermistor and thermocouple wires will be bundled and run through the CTB plywood skin at several locations. Care will be taken to ensure the plywood penetrations will not leak freshly poured concrete.
10. The thermistor and thermocouple wires outside the CTB formwork will be run in flexible conduit (or equivalent) for protection.
11. The WTS Survey Crew may verify the 3-D coordinates of each thermistor and thermocouple from a common reference point. Each thermocouple's 3-D coordinates will be tied to its serial number.
12. The thermocouple flexible conduits will be routed to a common point for termination to the DAS protective enclosure (i.e., Hoffman™ box).
13. The DAS steel protective enclosure (**Figure 2**) will be mounted to the CTB framework's outer steel frame on unistrut™ (or equivalent).
14. The DAS will be mounted in its protective enclosure, which will remain locked when SNL/CB personnel are not present.
15. The thermistor and thermocouple wires will be fed into the DAS protective enclosure and terminated at the DAS In/Out (I/O) ports, one thermocouple per port.

16. A "shakedown" will be performed on the DAS to insure it is reading temperature changes on every thermistor and thermocouple.
17. Upon the initial pour of the SMC concrete into the CTB framework, the DAS will commence monitoring the thermistors and thermocouples temperatures, for a minimum of 56 days, or as determined by the PI.
18. Periodic weather data (i.e., temperature, humidity, barometric pressure, etc.) may be collected from the Carlsbad Airport weather station to compliment the thermocouple mass heat test temperature data.
19. The PI will analyze the mass heat test temperature data and the results compiled into a report for presentation to WTS.

6.3 CONCRETE CORES EXTRACTION AND TESTING

Additional Appendix G concrete specifications information may be obtained on the SMC concrete following the completion of the SMC Test 30-yd^3 concrete pour. Additional information may be obtained by performing lab analyses on SMC concrete cores samples. These studies may require the extraction of 2-in to 4-in outside diameter (OD) vertical and/or horizontal concrete cores samples from the cured concrete test block. The specific number, diameter, depth, and location of the core samples will be determined by the PI, based partially upon the analysis of the mass heat test temperature data. The Drill Crew or a concrete coring contractor will cut the core samples. The WTS Mine Operations Dept. (Mine Ops) recommends cutting the core samples with a diamond surfaced, 2-in to 4-in inside diameter (ID) core barrel. Mine Ops also recommends cutting the core samples with air as the cutting fluid to preserve their mechanical properties. The extracted core samples will be logged, and wrapped and bagged for preservation. All extracted core samples will undergo destructive laboratory testing; no core samples will be retained for future use.

Should SMC concrete core samples be extracted from the cured concrete test block, the SNL/CB Laboratory facility will perform the analysis of the core samples. Laboratory analyses of the core samples may include:

- Aggregate segregation;
- Moisture content;
- Permeability (Tidwell and Wilson, 1997); and
- Porosity.

Concrete core samples may be provided to a WTS contractor laboratory for compressive strength testing and/or permeability testing. SMC concrete core sample laboratory analyses will be documented in a scientific notebook(s). Upon the completion of the SMC concrete core samples analyses, the SNL/CB Laboratory will prepare a supplemental report summarizing the results of the laboratory analyses for presentation to WTS.

For SMC concrete core samples extraction and testing, the sequence of activities will be as follows:

1. The PI will determine the specific number, depth, and location of the core samples to be extracted from the concrete test block.

2. The Drill Crew or a concrete coring contractor will cut the 2-in to 4-in OD core samples out of the concrete test block at the predetermined locations.
3. Immediately upon the extraction of a core sample from the concrete test block, it will be logged, and wrapped and bagged for preservation.
4. Upon the completion of the concrete core samples extraction activities, a Chain of Custody will be generated for the core samples, and the core samples will be transported to the SNL/CB Laboratory facility.
5. The extracted concrete core samples will undergo laboratory analyses by the SNL/CB Laboratory facility.
6. The SNL/CB Laboratory will prepare a supplemental report, summarizing the results of the laboratory analyses, for presentation to WTS.

6.4 CONCRETE TEST BLOCK *IN-SITU* PERMEABILITY TESTS

To further validate the Appendix G permeability specifications of the SMC concrete, *in-situ* permeability tests may be performed in the cured concrete test block. The *in-situ* permeability tests may be performed in the concrete core samples boreholes, if extracted, or in smaller boreholes (i.e., 1½-in OD) drilled by the Drill Crew or a concrete coring contractor selected by SNL/CB. An inventory of existing permeability testing equipment by cognizant SNL/CB personnel will determine if permeability tests can be performed, and what size boreholes are required to perform the tests. A typical permeability test includes pressuring an interval(s) of a borehole, using a multi-packer tool, with a pressurized inert gas (i.e., nitrogen) and monitoring the decay of pressure. Additional types of permeability tests (e.g., constant-pressure brine permeability tests) may also be performed. The pressure decay may be recorded manually or on a DAS. All permeability-testing activities will be detailed in a scientific notebook(s). Upon the completion of permeability tests in the concrete test block, the PI will prepare a supplemental report summarizing the results for presentation to WTS.

6.5 MODIFICATIONS TO EXPERIMENTAL PROCESS

Modifications to test procedures outlined in the Test Plan Experimental Process Description (Section 6.0) may be required during the SNL/CB activities supporting the SMC Test. These modifications will be conducted at the direction of the PI, and will be documented in the scientific notebook(s) as part of the Quality Assurance (QA) records. Such modifications are not deviations and will not be reported as non-conformances that require corrective action.

7.0 MEASURING AND TEST EQUIPMENT

Equipment required for the SMC Test may consist of equipment to monitor the temperature rise during the 30 yd^3 concrete pour mass heat test and the 5-yd^3 concrete pour, equipment to extract SMC concrete core samples from the cured cement test block, and equipment to perform permeability testing in CTB boreholes. The equipment will consist of either "off the shelf" items ordered directly from qualified suppliers, or standard equipment provided by qualified service companies, as required, to complete the contracted tasks. No specially-designed equipment is

anticipated. All equipment used will follow the supplier's operation and calibration recommendations and will be documented as part of the Quality Assurance (QA) records and controlled following NP 12-1, *Control of Measuring and Test Equipment*.

7.1 MASS HEAT TEST MONITORING EQUIPMENT

The SMC mass heat test will be conducted utilizing equipment mounted inside and outside of the 30 yd^3 concrete pour CTB framework. This equipment will receive a "shakedown" during the 5-yd^3 concrete pour. Additional information may be obtained from the WTS Survey Crew survey equipment, and weather station equipment at the Carlsbad Airport. SNL/CB equipment will be operated observing relevant SNL and Constructors Environment, Safety, & Health (ES&H) procedures (Day, 1999) and protocols. The mass heat test equipment will include thermocouples, thermistors, thermocouple/thermistor support wires, a DAS, and information provided from surveying equipment and a weather station.

7.1.1 Thermocouples

The temperatures of the curing SMC concrete in the 55-gal drum and under the 30-yd^3 CTB support slab will be measured using Watlow-Gordon, Type "E" thermocouples (or equivalent). Watlow-Gordon, Type "T" thermocouples, which provide a greater accuracy ($\leq$0.5°C/0.9°F typical) for the temperature range (0°C/32°F to 80°C/176°F) expected during the curing of concrete, will be used in the CTB mass heat test. Sufficient cabling is attached to each thermocouple to allow for routing to a common point outside the drum, and through several penetrations in the CTB framework plywood skin, for termination in the DAS protective enclosure. Additional, redundant thermocouples may be placed near the center of the CTB for backup. Thermocouple wires outside the CTB formwork will be protected by flexible conduit (or equivalent). The thermocouples will be calibrated and receive a serial number at the Cal Lab in accordance with NP 12-1 prior to their emplacement within the drum, CTB support slab, and the CTB framework.

7.1.2 Thermistors

The temperatures of the curing SMC concrete in the 55-gal drum and the CTB mass heat test will also be monitored by several Watlow-Gordon thermistors, with a temperature range of 0°C/32°F to 80°C/176°F (or equivalent). The thermistors will be emplaced for redundancy, and may serve as backup temperature monitoring gauges in event of thermocouple failures. The thermistors will be calibrated and installed in the same manner as the thermocouples.

7.1.3 Thermocouple/Thermistor Support Wires

An array of 3/16-in, multi-strand stainless steel wires will be strung across the interior of the CTB framework to support the thermistors and thermocouples at their designated monitoring points (**Figure 2**). The horizontal thermocouple/thermistor support wires will be secured around the concrete test block framework outside steel frame, tensioned with a come-along (or equivalent), and the wire ends crimped to the wires to eliminate sag in the support wires. In

contrast, the vertical thermocouple/thermistor support wire will be stretched between a wire loop (or equivalent) embedded in the CTB support slab and a length of steel U-channel (or equivalent) running across, and attached to, the top of the CTB framework. The support wire will be tensioned with a come-along (or equivalent), and the wire ends crimped to the wires to eliminate sag in the support wires. The support wires may pass through minimal ID holes in the framework plywood sheathing. It is important that the support wires only pass through the CTB framework plywood skin and not place undo stress onto the plywood, which may cause structural damage to the plywood. Care must be taken to seal the holes to prevent the leakage of uncured concrete during the initial pour. The final position of the support wires may need to be altered to avoid concrete pumping nipples or other forming structures attached to the plywood skin on one side of the CTB formwork. The PI will determine the need to relocate the thermocouple/thermistor support wires. Once the support wires are in position, the thermocouples will be attached to predetermined positions on the support wires.

Several pairs of thermocouples will be used to measure the ambient temperature, and the temperature gradient across the support slab and the CTB framework plywood sheathing. In these instances, thermocouple support wires are not required. The thermocouples will be attached directly to the surfaces whose temperature they will monitor.

7.1.4 Data-Acquisition System

A Geomation, Inc. Model 2380 "off the shelf" DAS (or equivalent) will be used to control and monitor all instrumentation used during the SMC Test. The DAS will send and receive signals to/from the thermistors, thermocouples, and other gauges and record their responses. The DAS will collect and process the gauges' input signals and store the data using resident data-acquisition software. The raw data are downloaded to a computer hard disk and other storage media for storage and viewing. Geomation "off the shelf" GEONET Suite software (or equivalent) is used to configure and control the DAS, as well as viewing the data downloaded from the DAS. The GEONET Suite software meets the requirements of NP 19-1 *Software Requirements*. A voltage calibration of the DAS voltmeter will be performed according to the appropriate Geomation (Geomation, 2001) service note (or equivalent).

7.1.5 Surveying Equipment

The WTS Survey Crew may survey the 3-D location of each thermocouple monitoring the CTB mass heat test temperatures, using a computer-controlled surveying system, to verify manually recorded thermocouple locations. Each thermocouple's surveyed position will be tied to its serial number, assigned by the Cal Lab, for identification.

7.1.6 Weather Station

Periodic weather information may be collected from a NOAA NWS weather station located at the Carlsbad Airport. This information will be downloaded in an electronic format, if available. This information will compliment the temperature data collected during the SMC Test, mass heat test.

7.2 CONCRETE CORING AND PERMEABILITY EQUIPMENT

The Drill Crew or a concrete coring contractor selected by SNL/CB will perform the extraction of the SMC concrete cores from the cured concrete test block. Equipment will be operated observing relevant contractor and Constructors ES&H procedures (Day, 1999) and protocols. The concrete coring equipment will include a Drill Crew or contractor-designated coring drill and coring barrel.

7.2.1 Coring Drill

The WTS Drill Crew or coring contractor will select the coring drill used to extract the SMC concrete core samples from the cured concrete test block. WTS Mine Ops recommends using a manually fed, electrical-powered drill. Mine Ops also recommends using air as the cutting fluid for cutting the core samples to preserve their mechanical properties. The Drill Crew or contractor may also drill (non-core producing) boreholes for the concrete test block permeability tests. The contractor is responsible for providing all equipment, air, and power required to complete this task.

7.2.2 Core Barrel

The coring contractor will select the core barrel used to extract the SMC concrete cores from the cured concrete test block. WTS Mine Ops recommends using a 2-in to 4-in ID diamond impregnated core barrel to extract the core. Mine Ops also recommends using air as the cutting fluid for cutting the core samples to preserve their mechanical properties. The contractor may also drill the boreholes for the concrete test block permeability tests. These boreholes may be drilled with a standard concrete drill bit/barrel. The contractor will provide the core barrels to complete this task.

7.2.3 Permeability Testing System

The *in-situ* permeability tests may be performed in the CTB boreholes using a permeability testing system previously developed by SNL/CB for use in the WIPP repository. Permeability tests conducted in the CTB boreholes will be recorded in a scientific notebook(s), or performed under the auspices of a "TP" or test plan addendum written specifically for the permeability testing system. An inventory of the permeability testing system equipment by cognizant SNL/CB personnel will determine if permeability tests can be performed. Equipment (i.e., pressure gages, stainless steel tubing, gauges, packers, etc.) may need to be purchased prior to permeability testing. The permeability testing system consists of a pressurized cylinder of compressed inert gas (i.e., nitrogen), a down-hole, multi-packer tool, and a control panel to pressurize and monitor the multi-packer tool. The multi-packer tool, pressure decay may be recorded manually or on a DAS (i.e., the Geomation DAS). The selection of the multi-packer tool used (i.e., packer diameter, tool length, etc.) is dependent upon the diameter and length of the CTB boreholes. Constant-pressure brine permeability tests may be performed in lieu of the gas permeability tests.

8.0 DATA-ACQUISITION PLAN

Both manually and electronically collected data will be acquired during the SMC Test activities. The following types of data may be recorded:

- Electronically-collected mass heat test temperature data from the DAS;
- Electronically-collected thermocouple location survey data from WTS Survey Crew equipment;
- Electronically-collected weather station data from the Carlsbad Airport;
- Electronically/manually-collected permeability test pressure data;
- Manually-collected concrete core location data;
- Manually-collected concrete core log data; and
- Manually-collected data on equipment and instrument configurations associated with the concrete test block.

8.1 SCIENTIFIC NOTEBOOK(S)

A Scientific notebook(s) will be used in accordance with NP 20-2 *Scientific Notebooks* to document all SNL/CB activities and decisions during the Test Plan. Specific information that may be entered in the scientific notebook(s) consists of:

- A statement of the objectives and description of work to be performed, as well as a reference to this Test Plan;
- A written account of all activities associated with the concrete test block;
- Documentation of safety meetings;
- A list of equipment used during each activity, including make, model, and operating system (if applicable);
- Traceable references to calibration information for instruments and/or gauges calibrated elsewhere;
- A listing of the manually-read thermocouple 3-D locations inside the concrete test block framework.
- A sketch, showing dimensions, of the location of extracted SMC concrete core samples from the concrete test block;
- A brief description and listing of the core identifiers for the SMC concrete cores samples (boreholes) extracted from the cured concrete test block;
- Detailed description of the concrete test block permeability test, which will include testing processes used, equipment used, personnel, (manual) data collected, and other pertinent test information (See NP 20-2).
- Entries providing the names, start times, and stop times of all data files created with the Geomation DAS (or equivalent), as well as tables showing any configuration information entered into the GEONET Suite software (or equivalent) to initiate each data file; and
- Discussions of the information and/or observations leading to decisions to initiate, terminate, or modify SMC Test activities.

All entries in the scientific notebook(s) will be signed and dated by the person making the entry. The scientific notebook(s) for this Test Plan will be reviewed by an independent, technically-qualified individual within 30 days of the end of the activities governed by this Test

Plan to verify that sufficient detail has been recorded to retrace the activities and confirm the results.

Manually-collected concrete core log data and permeability test pressure data may also be recorded on specially-prepared forms rather than in the scientific notebook(s) when that process will provide a more efficient means of data collection and tracking. Use of such forms will be noted in the scientific notebook(s) and these forms will be technically reviewed and submitted as QA records.

8.2 ELECTRONIC DATA ACQUISITION

The DAS will be used to record instrumentation data during the SMC Test. Additional electronic data may be acquired from the WTS Survey crew for the thermistors and thermocouples locations, as well as weather data from the Carlsbad Airport weather station. Electronic data file-management information will be documented in the scientific notebook(s) for these activities. These electronic data files will be submitted as QA records according to NP 17-1 *Records*.

8.3 MANUAL DATA ACQUISITION

Manual data collection will be carried out during the SMC Test using a scientific notebook(s) or forms designed specifically for each activity or data type. Information will be documented such that duplication of information will be minimized. The PI will determine the means of documenting manually-acquired data and will ensure that all quality-affecting information is documented.

8.4 ON-SITE VALIDATION

During the SMC Test activities, the PI will evaluate the data, as they are acquired. The data will be diagnosed for any equipment failure and/or procedure-induced effect that may affect the data quality. The PI will take immediate action (if required) to make any necessary changes to the equipment configuration or the procedures to assure the data quality is consistent with the objectives of these activities.

The PI will use real-time evaluation of the acquired data during any given SMC Test activity to assure that the data are usable in a detailed interpretation, the conditions can be maintained over the planned duration of the activity, and that an activity will not be terminated before the minimum objectives can be achieved under the given time restraints. The PI may utilize some or all of the following procedures and analytical tools:

- To assure that the acquired data satisfy SMC Test requirements, the PI may use the same interpretation techniques during the data validation process as will be used in later interpretation of these data.
- The PI may use specialized plots to interpret the information response and to identify the time domain of that response, such as the recorded mass heat test temperatures or other response phases.

- The PI may use real-time analysis of the acquired data to determine the time when the activity will provide no further improvement in the interpreted results within the SMC Test's time and budget restraints.
- The PI may use real-time analysis to determine whether or not an activity can be terminated earlier than planned, with concurrence from cognizant WTS personnel, and to develop a revised schedule as appropriate.

If at any time the PI determines that an SMC Test activity objective cannot be accomplished due to time constraints, problems concerning the performance of the equipment, or unsuitability of initial conditions, the PI will consult with cognizant WTS personnel to terminate the activity, or develop a recovery plan. The PI will document all real-time evaluation of data and conditions in the scientific notebook(s).

9.0 SAMPLING AND SAMPLE CONTROL

Upon completion of the SMC Test, mass heat test, SMC concrete core samples may be extracted from the cured concrete test block. The PI, upon review of the mass heat test data, will determine the exact number, diameter, depth, and location of the core samples to be extracted. The core samples will be collected for laboratory analyses. The cores samples will be collected and controlled in accordance with NP 13-1 *Sample Control*. The extracted core samples will immediately be logged and preserved in accordance with SNL NWMP Activity/Project Specific Procedure (SP) 13-2 *Logging and Management of WIPP Core Samples*. The chain of custody for the core samples will be established in accordance with SP 13-1 *Chain of Custody*. All extracted core samples will undergo destructive laboratory testing; no core samples will be retained for future use.

10.0 TRAINING

All personnel who will perform quality-affecting activities under this Test Plan will have training in the SNL QA program (NWMP Form NP 2-1-1 *Qualification and Training* and have received Annual SNL QA Refresher Training, or have reviewed the latest revision of the SNL QA Refresher Video). These personnel will read NP's 12-1, 13-1, and 20-2, and SP's 13-1 and 13-2. They will also read SNL/CB and/or Constructors safety-related documentation (Day, 1999) related to the Salado Mass Concrete Test, and receive any additional training outlined in the documentation. NWMP Form NP 2-1-2 *Training Roster* will be used to document the reading of all required NP's and safety-related documentation. No other special training requirements are anticipated in addition to that listed above and the safety briefings section of the Test Plan.

11.0 QUALITY ASSURANCE

11.1 HIERARCHY OF DOCUMENTS

Several types of documents are used to control work performed under this Test Plan. If inconsistencies or conflicts exist among the requirements specified in this document, the following hierarchy will apply:

- Memoranda or other written instructions from the WTS Projector Leader or PI used to modify or clarify the requirements of the Test Plan (most recent instructions having precedence over previous instructions);
- SNL NWMP Test Plan TP 02-03 *Salado Mass Concrete Test Plan;*
- SNL NWMP Procedures (NP's);
- SNL NWMP Activity/Project-Specific Procedures (SP's); and
- Manufacturer's procedures (i.e., calibration).

SNL Quality Assurance (QA) concurrence will be obtained and/or corrective action reports will be written for modifications to QA Procedures implemented for work conducted under this Test Plan.

11.2 QUALITY-AFFECTING ACTIVITIES

Activities performed under this Test Plan are quality affecting with the following exceptions:

- Operation of concrete core drilling equipment;
- Assistance provided by WTS and/or Constructors in the installation of equipment;
- Support services for tasks that do not involve data collection, such as electrical power, compressed air, etc.; and
- Waste disposal.

11.3 QUALITY ASSURANCE PROGRAM DESCRIPTION

SNL/CB activities are conducted in accordance with the requirements specified in the latest revision of the DOE/CBFO Quality Assurance Program Document (QAPD), CAO-94-1012. The requirements of the DOE/CBFO QAPD, and any revisions thereto, are passed down and implemented through the SNL NWMP QA Procedures.

11.4 ACTIVITY-SPECIFIC PROCEDURES

The Activity-Specific Procedures (SP's) that may apply to work performed under this Test Plan include:

- SP 13-1 *Chain of Custody*
- SP 13-2 *Logging and Management of WIPP Core Samples*

Modification to these procedures may be required during field activities. Such modifications are not deviations and will not be reported as non-conformances that require corrective action.

However, the PI will document modifications to the SP's in the scientific notebook(s) as they occur as part of the QA records.

11.5 MANUFACTURERS QA PROCEDURES

Manufacturers QA procedures that may apply to work performed under this Test Plan include:

- Geomation *2380 MCU Voltmeter Calibration* Service Note (Geomation, 2001)

Modification to these procedures may be required during field activities. Such modifications are not deviations and will not be reported as non-conformances that require corrective action. However, the PI will document modifications to the SP's in the scientific notebook(s) as they occur as part of the QA records.

11.6 DATA INTEGRITY

Care will be taken throughout the performance of the operations for this Test Plan to ensure the integrity of all data collected including documentation on hard copy and data collected on storage media. Duplicate copies of all data will be produced as quickly as possible and the duplicate copies will be maintained at a location separate from the test site to ensure that data are not lost.

11.7 RECORDS

Records will be maintained as described in this Test Plan and applicable QA implementing procedures. These records may consist of bound scientific notebook(s), loose-leaf pages, forms, printouts, or information stored on storage media. The PI will ensure that the required records are maintained and are submitted to the SNL/CB NWMP Records Center according to NP 17-1 *Records*.

11.7.1 Required QA Records

As a minimum, QA records will include:

- Scientific notebook(s);
- SP's used;
- Calibration records for all controlled equipment;
- Equipment-specification sheets or information (if available);
- Data files collected by the DAS, with a log listing the files and defining their contents;
- All forms containing manually-collected data;
- Core logs of all CTB concrete core samples (if extracted); and
- Reports (i.e., laboratory analysis of concrete cores) provided by SNL/CB Laboratory facility personnel.

11.7.2 Miscellaneous Non-QA Records

Additional records that are useful in documenting the history of the activities, but are considered non-QA records, may be maintained and submitted to the SNL/CB NWMP Records Center. These records include:

- Safety briefings
- ES&H documentation;
- As-built diagrams of equipment supplied by contractors;
- As-built diagrams of equipment supplied by vendors;
- Equipment manuals and specifications;
- Equipment manifests; and
- Cost and billing information regarding contracted services.

These records do not support Performance Assessment (PA) or regulatory compliance and, therefore, are not quality-affecting information.

11.7.3 Submittal of Records

Records resulting from work conducted under this Test Plan, including forms and data stored on storage media, may be submitted to the SNL/CB QA Dept. for review and approval in individual pieces. Where possible, the records will be assembled into a records package(s), which will be reviewed by the PI before being submitted for QA review.

12.0 HEALTH AND SAFETY

SNL/CB field operations will be conducted on property owned by Constructors Inc. and the field operations team assembled for this Test Plan will follow all Constructors safety practices and polices, as outlined in the Constructor *Comprehensive Safety Program* document (Day, 1999). At a minimum, these safety practices and polices will meet the requirements of the SNL ES&H Manual. Operational safety for individual SNL/CB field operations will be addressed through a Safety and Health Hazards Control Document (SHHCD), an ES&H Primary Hazard Screening (PHS), a Hazard Analysis (HA), and a Pressure Safety Data Package (if required) developed by SNL.

All SNL/CB personnel assigned to the field operations in this Test Plan will receive a safety briefing before the beginning of each SMC Test field activity. In addition, the PI may conduct daily safety briefings at the beginning of daily operations. All daily safety briefings will be documented in the scientific notebook(s) and will include the name of the participants. The work location will maintain a mobile communication system (i.e., cellular telephone). In case of an accident, injury, or sudden illness, local emergency services will be contacted (as required) and cognizant Constructors personnel and the SNL/CB Facility Manager will be notified.

13.0 PERMITTING/LICENSING

There are no special licenses or permitting requirements for the work described in this test plan.

14.0 REFERENCES

Chandler, N.A., J.B. Martino, and D.A. Dixon, 2001, *The Tunnel Sealing Experiment – Five Year Report*, Revision 0, AECL-12127, Whiteshell Laboratories, Pinawa, Manitoba, August 8, 2001

Day, D., 1999, *Comprehensive Safety Plan*, Constructors, Inc., Carlsbad, NM, November 1999

Geomation, Inc., 2001, *Geomation System 2300 Operations and Maintenance Training*, June 5-6, 2001 Golden, CO

New Mexico Environment Department, 2001, *Technical Specifications: Panel Closure System, Waste Isolation Pilot Plan, Carlsbad, New Mexico*, RCRA WIPP Hazardous Waste Permit 4890139088-TSDF, Attachment I1, Appendix G, Aug. 31, 2001

Tidwell, V.C., J.L. Wilson, Laboratory method for investigating permeability upscaling, *Water Resources Research*, Vol. 33, No. 7, pp. 1607-1616, July 1997

15.0 FIGURES

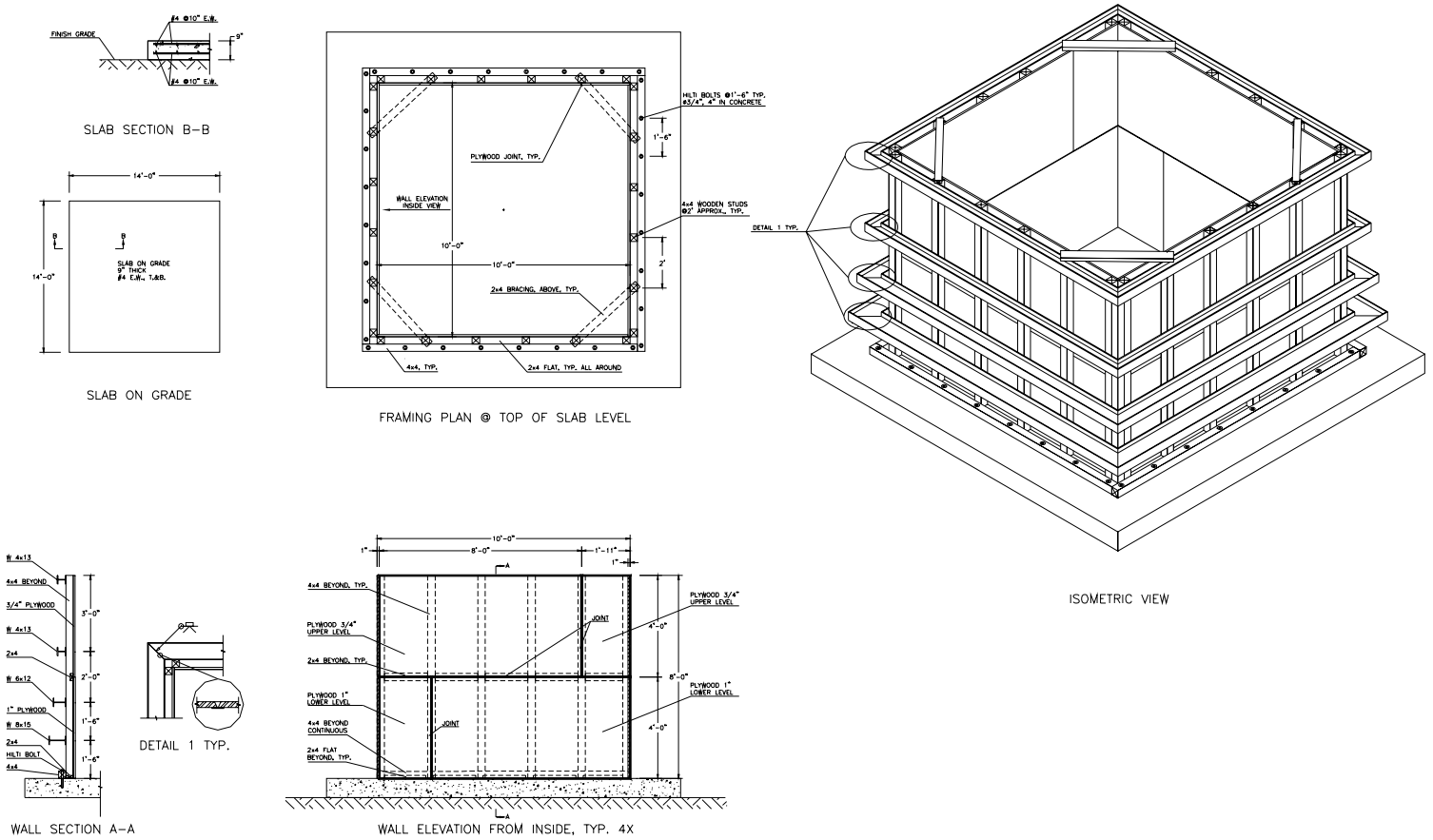

Figure 1. Sketch of the Concrete Test Block Framework.

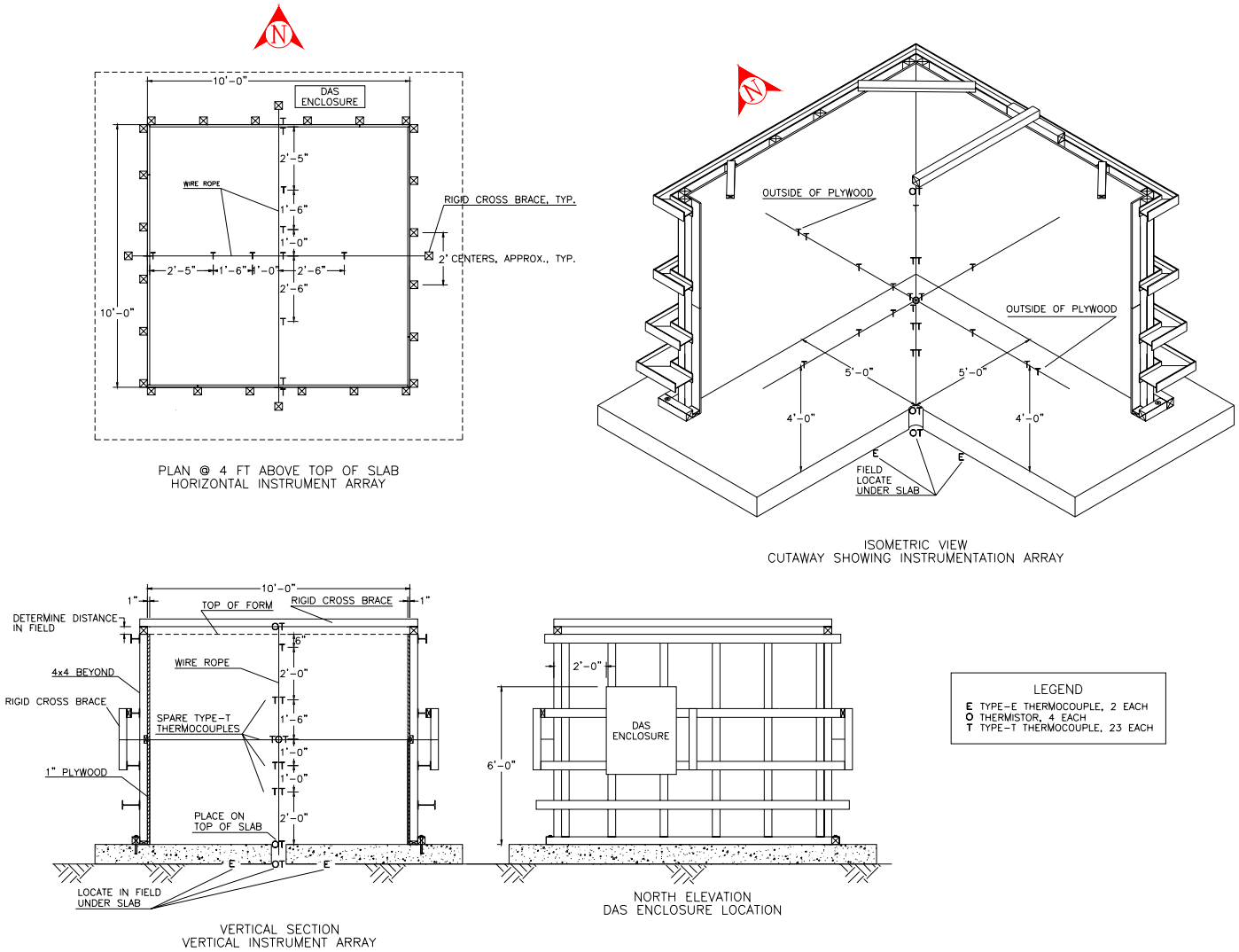

Figure 2. Sketch of Thermistors, Thermocouples and Thermocouple Support Wires Layout.