Establishing Clean Conditions in the Laboratory

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Contents

I. Introduction 1
II. Concept 2
III. Implementation 3
A. Personnel Entry and Utility Room 3
B. The Car Wash, Corridor Junction, and the Control Room 3
C. The Cavity Dome, Cavity, and Cavity-Ramp Room. 4
D. The Fine Cleaning 4
IV. Monitoring and Acceptance 5
References 6
Figures 7-10

I. Introduction

The first element in the cleanliness program[1-3] is to establish clean conditions in the laboratory. Once this has been achieved, clean construction, i.e., - the assembly of the detector, can begin. Clean conditions in the laboratory means that all sources of mine dust on surfaces have been removed or immobilized, that the HVAC system provides appropriately filtered air to all areas within the laboratory, and that the personnel entry and car wash are in operation. Since the average level of dust on the surfaces of the detector at the close of construction should not exceed 0.4 $\mu g/cm^2$ (some areas may have

more, some less), the initial conditions at the start of clean construction should be better than this. This document describes how that will be achieved. Previous discussions of this phase of the cleanliness program are found in refs. 4-7.

II. Concept

The construction plan is sufficiently complicated (and always evolving) such that the details of the steps leading to clean conditions are correspondingly involved. However, in each of the areas (utility room, cavity, etc.) there is a basic procedure. That procedure is:

1. The application of an epoxy primer and two coats of epoxy paint after all concrete work in that area is completed. The specifications for the ceiling, wall, and floor finishes are given in ref. 8. This epoxy paint, which covers all exposed concrete and metal surfaces, is a crucial barrier preventing the introduction of dust into the laboratory. (In the case of the cavity, the equivalent of the epoxy paint is the plastic liner.) This first step includes whatever rough cleaning is required prior to painting, and it is done using INCO air for ventilation and cooling. INCO compressed air and water pipes should also be primed and painted if they are to remain. Once the floors are painted, personnel entering these areas must have boots or shoes free of mud and dirt.

2. Installation of utilities, including the HVAC system.

3. A switch-over from INCO air to the HVAC system.

4. Implementing full use of the personnel entry (change of clothes, shower) and washing of incoming containers in the car wash.

5. Installation of HEPA filters (where called for) on duct outlets.

6. Fine cleaning of all surfaces.

The complications arise in the different schedules for dirty construction in the different areas. The steps for establishing clean

conditions must be coordinated in such a way that construction work in one area does not negate the progress toward cleanliness made in another area.

III. Implementation

The implementation of the plan to establish clean conditions in the laboratory is described in the following text and illustrated in the time lines of Fig. 1 and for different stages in Figs. 2.1 to 2.3.

A. Personnel Entry and Utility Room

These will be the first areas in which concrete work is finished and that can be readied for painting (see Fig. 1). These areas are separated from the corridor junction by doors that also serve as air barriers. After painting, boot cleaners will be installed at the entrances to these areas, since there are no concrete floors in the corridor junction or car-wash area yet. After the utilities and the air handling units (AHU) 1, 3, 4, and 5 have been installed, the air units serving the personnel entry and the utility room (AHU 1,4, and 5) will be commissioned and used to supply cooled filtered air (Fig. 2.1). The temporary INCO air-supply ducts in these areas will be removed. The personnel drift and utility drift each will have a lunch area, and temporary construction offices will be located in the utility room. The utility room will be used for material storage as well, and later on during the clean construction period the water systems will be installed. The personnel entry and utility room will continue to be used in these respective ways until the entire laboratory is ready for the fine cleaning.

B. The Car Wash, Corridor Junction, and the Control Room

The concrete floors in these areas will not be poured until the excavation of the cavity is complete. Until that time they will receive INCO air for ventilation and cooling, and heavy equipment will move through these areas. After the concrete floor has been poured and received its first coat of paint (along with the ceiling and walls), AHU 2, duct work, and any remaining utilities will be installed in these areas. AHU 3 can be turned on and the supply of INCO air to the corridor junction terminated. AHU 2 will not be turned on, however, until the installation of the cavity liner is (essentially) complete. Until then, INCO air will be supplied to the control room by small

vents off the large, main supply duct, which empties into the cavity dome. The temporary INCO duct will pass through two doors, located at the entrance and at the exit of the control room, which serve as air barriers. Through the completion of the concrete work in the cavity and the installation of the plastic liner:

1. INCO air will be used to ventilate the cavity, entering at the top in the cavity dome and exhausting through the ramp at the bottom.

2. Cement will be supplied via the ramp, stored in the ramp, and mixed only in the ramp at the bottom of the cavity.

3. Concrete workers will enter and exit work via the ramp, and use the control room as a lunch area. The control room will also be equipped with a portable toilet.

The entrance to the control room from the corridor junction thus forms a temporary boundary (for air and for personnel) between activities that generate little dust and those that generate a lot of dust (concrete work in the cavity.)

C. The Cavity Dome, Cavity, and Cavity-Ramp Room.

When all concrete work in the cavity and cavity dome is complete, all surfaces, including the cavity construction platform will need a rough cleaning prior to painting or commencing the installation of the plastic liner. After the liner has been installed and the dome, deck, and cavity ramp areas have been painted, the installation of the remaining duct work associated with AHU 2 can begin. When AHU 2 is operational, the remainder of the temporary INCO supply ducting is removed and AHU 2 can be used to supply cooling and ventilation to the control room, dome, and cavity. The HEPA filters are then installed and tested.

D. The Fine Cleaning

In preparation for the fine cleaning, the personnel entry and the car wash are to become fully operational. All construction material and equipment brought into the laboratory should satisfy the cleanliness standards, the containers of material and equipment should be washed and dried, and all personnel should shower and change into clean clothes. Use of the air showers at the exits of the

personnel entry and utility room will begin. All air-handling systems are operational and all filters in place. Any floor finishes that have become damaged so as to make their cleaning difficult should be refinished at this time. Cleaning will proceed from the personnel entry and car wash toward the cavity.

The cleaning of rough surfaces, such as painted shotcrete, and particularly hard-to-reach areas may be done with high-velocity, low volume portable spray units as specified for use in the car wash. A detergent phase (using brushes where needed) and a rinse phase are planned. Surfaces that cannot be wet, such as electrical equipment and HEPA filters, must be covered. On relatively smooth surfaces, such as the cavity liner, spraying may not be needed, and conventional washing with sponges, etc. may be advantageous. The optimum methods of washing have to be developed.

The fine cleaning of the laboratory should be done "all at once," without other work going on that would compromise the level of cleanliness.

IV. Monitoring and Acceptance

The surfaces that could not be painted (duct insulation, for example) have to be checked for residual mine dust with wipe tests and, e.g., tape-lift tests and X-ray fluorescence. The dust level should be less than 0.4 $\mu g/cm^2$ - indeed, clean enough that dust cannot be seen with the naked eye. After a few days of air circulation, the aerosol particle counts in the HEPA-filtered areas should, during periods of no physical activity, correspond to Class 10, 000 conditions or better. (Class 10,000 means not more than 10,000 particles per cubic foot that are larger than 0.5 micron in diameter.)

At this point, the laboratory is ready for the clean phase of construction to begin. A program of regular janitorial cleaning will begin, and air- and surface-cleanliness monitoring will commence for quality control.

References

1. "Establishing a Cleanliness Program and Specifications for the Sudbury Neutrino Laboratory," E.D. Hallman and R.G. Stokstad, SNO-STR-91-009, October 22, 1991.

2. "Delivering Clean Components to the Cavity," R.G. Stokstad, Ed. SNO-STR-91-066, January 17, 1992.

3. "Final Cleanliness Measures: A Conceptual Plan," R.G. Stokstad, SNO-STR-92-023, July 1, 1992.

4. "Cleanliness Considerations for Construction of the SNO Detector," H. Evans and H.W. Lee, SNO-STR-88-73.

5. H.C. Evans, Collection of Overheads Presented to DOE/NSERC/NRC Technical Review Committee, Ottawa SNO-89-17

6. R. Stokstad, SNO Meeting Minutes, Collaboration Meeting at Berkeley, 12/91

7. E.D. Hallman, SNO Meeting Minutes, Collaboration Meeting at Kingston, 5/92

8. "Laboratory Wall and Ceiling Finish Specifications (Design Criteria), E. D. Hallman and H.C. Evans, SNO-STR-91-067, November 15, 1991

Figure Captions

Fig. 1. Time lines for the different areas of the laboratory indicating:

1. Finish shotcrete
2. Finish Floor
3. Finish all concrete work
4. Application of epoxy paint
5. Utilities installed
6. Switch-over from INCO to SNO air
7. Install HEPA filters
8. Fine cleaning

Figs. 2.1-2.3 Location of air handling units and air barriers for three stages of the construction leading up to clean conditions.

SUDBURY NEUTRINO OBSERVATORY

CONSTRUCTION ACTIVITIES LEADING TO CLEAN CONDITIONS

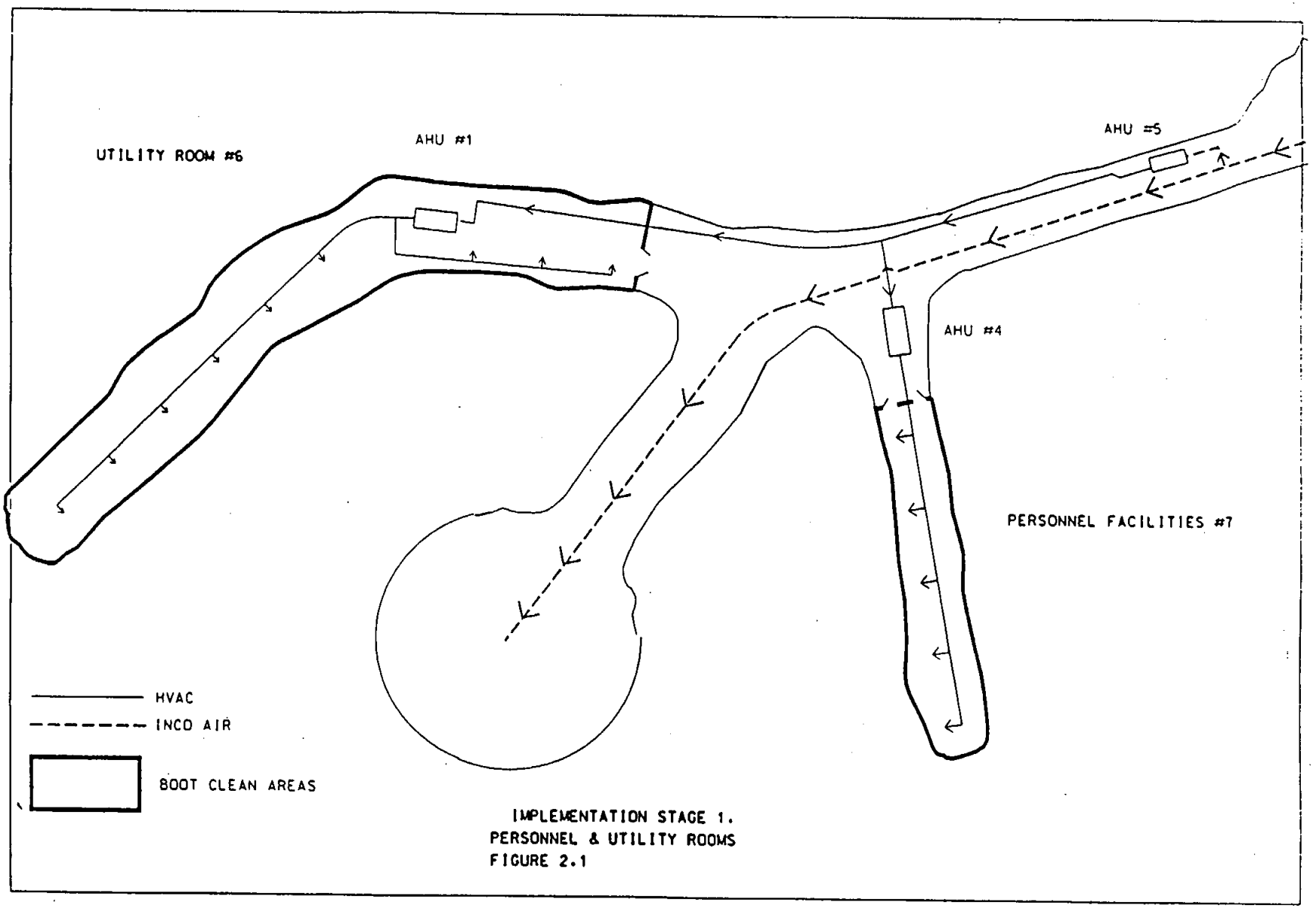
TIMELINES

	Oct. '92	Nov	Dec	Jan.'93	Feb	Mar	April	May	June	July
Personnel Entry	1 2	3					4 5		6,8	
Utility Room	1	2 3,4			5				6 8	→ Activate personnel entry and car wash. Start fine clean up. 6/17/93
Car Wash	1			2	3 4		5		6,8	
Corridor Junction	1			2	3 4		5		6 8	
Control Room	1			2	3		4	5	6,7 8	→ Clean conditions established. 6/24/93
Cavity Dome	1						2,3	4,5	6,7 8	
Cavity Ramp	1						3	4 5	6 8	
Cavity					1,2 <---Liner Installation--->				5	6,7,8

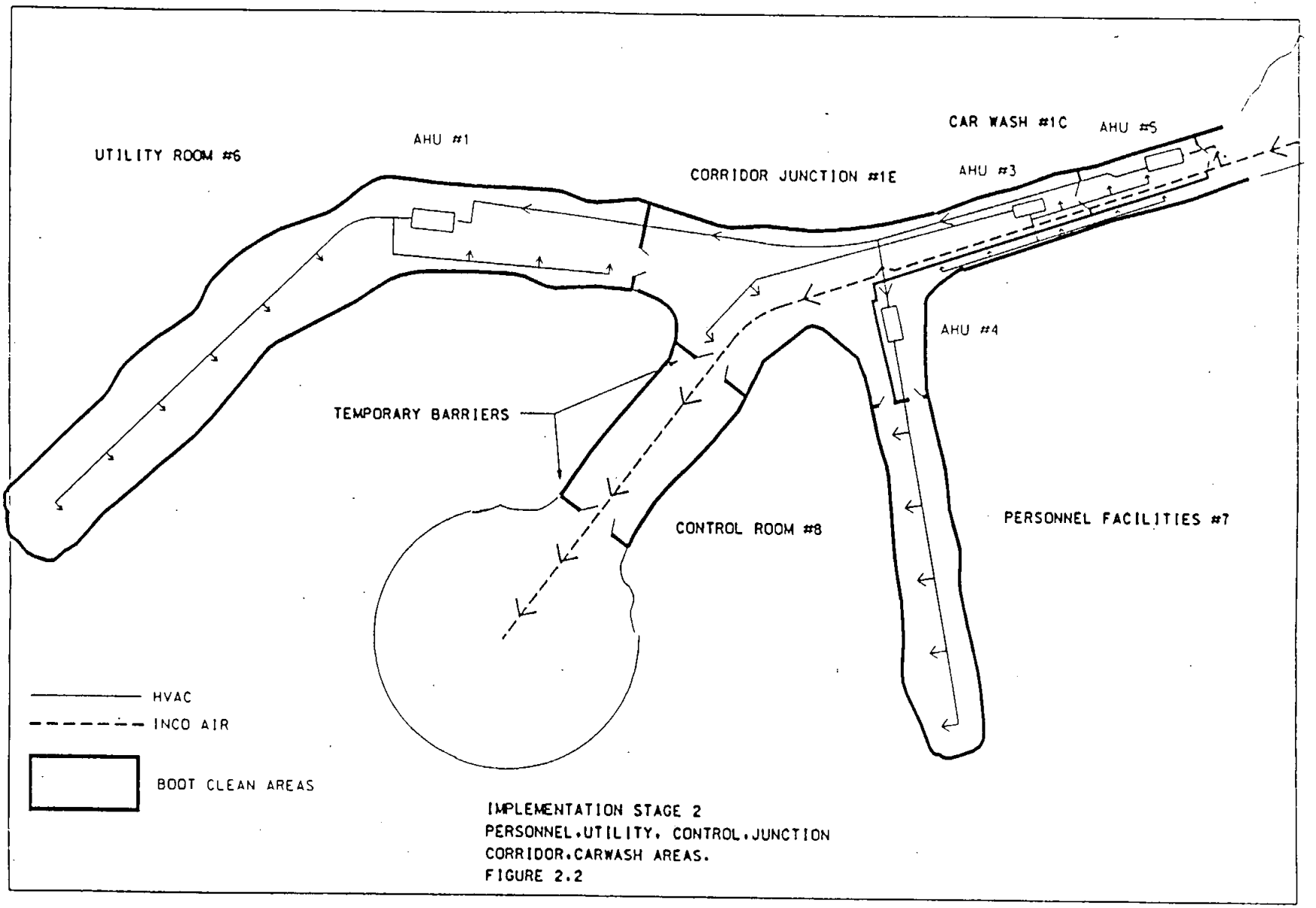
KEY:

1. Finish Shotcrete
2. Finish floor
3. Finish all Concrete
4. Paint all Surfaces
5. Utilities installed
6. INCO-SNO AIR
7. Install HEPA Filter
8. Fine Cleaning

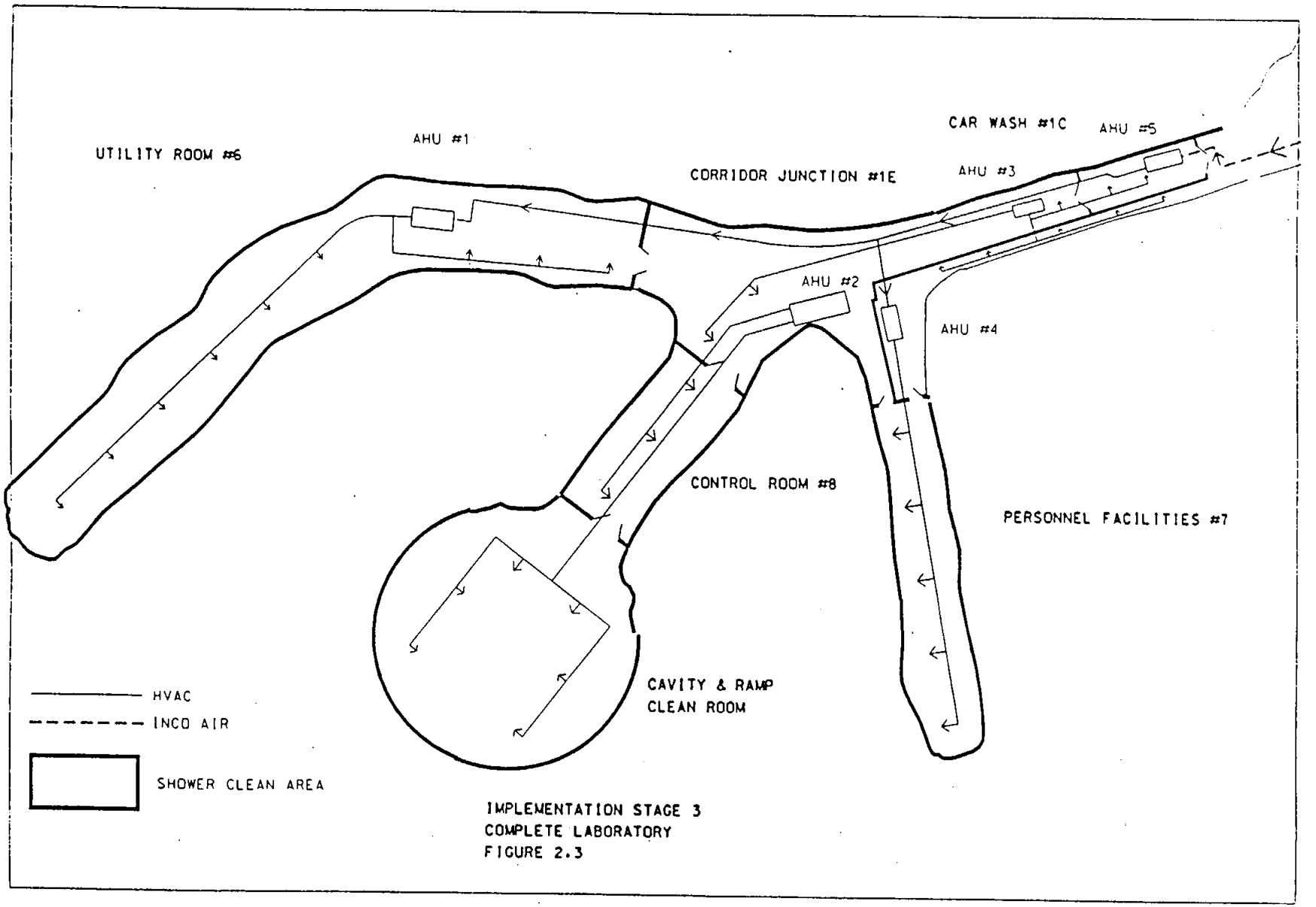
Figure 1



IMPLEMENTATION STAGE 1.
PERSONNEL & UTILITY ROOMS
FIGURE 2.1



IMPLEMENTATION STAGE 2
PERSONNEL, UTILITY, CONTROL, JUNCTION
CORRIDOR, CARWASH AREAS.
FIGURE 2.2



IMPLEMENTATION STAGE 3
COMPLETE LABORATORY
FIGURE 2.3