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Seismic Evaluation of the U1a Complex at the Nevada Test Site

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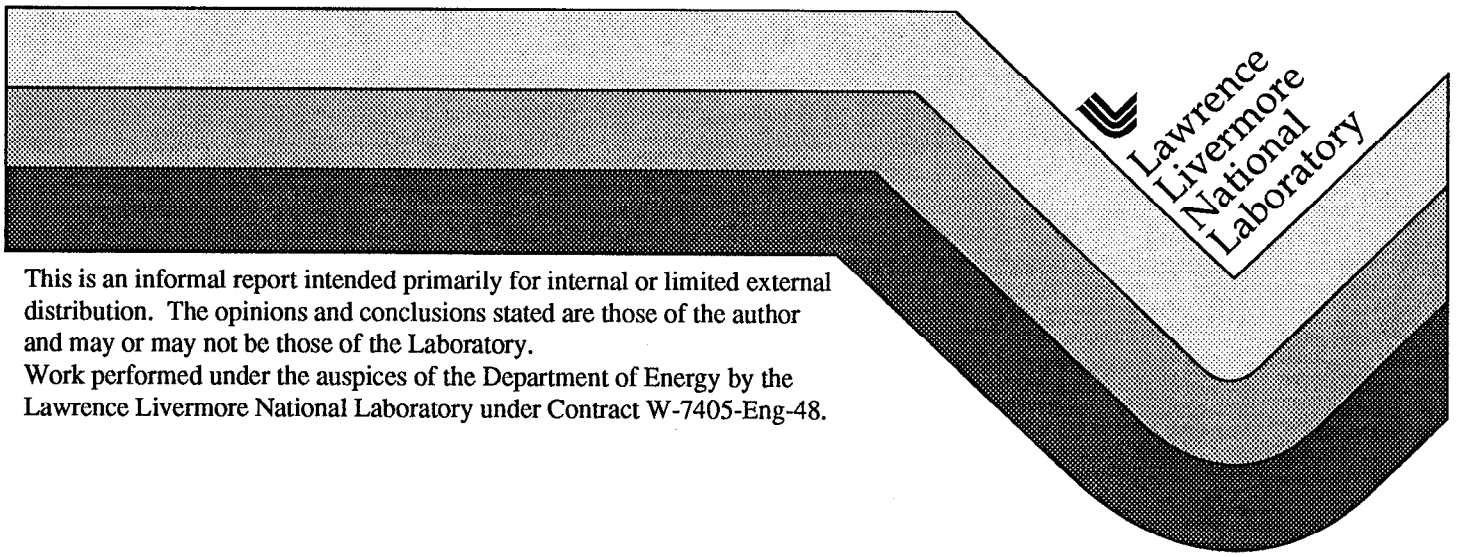
October 16, 1998



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Seismic Evaluation of the U1a Complex at the Nevada Test Site

Interim Report

SM98-24

by

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components that required action.

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1.0 Introduction

As part of an overall safety evaluation of the U1a Complex, a seismic evaluation of structures, systems, and components (SSC) was conducted. A team of seismic, safety, and operation engineers from Los Alamos National Laboratory (LANL), Bechtel Nevada (BN) and Lawrence Livermore National Laboratory (LLNL) was chartered to perform the seismic evaluation.

The U1A Complex is located in Area 1 of the Nevada Test Site (NTS) in Nevada. The complex is a test facility for physics experiments in support of the Science Based Stockpile Stewardship Program. The U1a Complex consists of surface and subsurface facilities. The subsurface facility is a tunnel complex located 963 feet below the surface.

The seismic evaluation of U1a Complex is required to comply with the DOE Natural Phenomena Policy. This policy consists of an order, an implementing guide, and standards which provide guidance for design and evaluation of SSCs, categorization of SSCs, characterization of site, and hazard level definition.

2.0 Overview of the U1a Complex

The U1a Complex is located at Longitude W 16^0 03' 29.65'' and Latitude N 37^0 00' 29.33'' in Area 1 of the Nevada Test Site. The U1a was identified as the project location in a circle in Figure 1. As shown in Figure 2, the surface facility consists of an air building, a trailer complex, workshops, storage, heavy equipment, and utilities, which are labeled individually.

In support of the physics experiments, the air building and workshops provide working, staging, and storage areas. The trailer complex provides office spaces for the scientists, engineers, and technicians as well as for control rooms and storage. The hoist equipment provides transportation for miners ascending and descending the shaft at U1a area while an additional shaft is available for emergency rescue at U1g area. The typical lifeline utilities provided to the subsurface facility are air, power, water, and communication. Storage tanks for shaft spray or power supply systems are also contained in the surface facility.

The subsurface facility is a tunnel complex mined at 963 feet below the surface. It consists of many alcoves branching off of the main drift. The physics experiments are conducted in the alcoves behind barriers. Figure 3 is a schematic layout of the tunnel complex. Mining is conducted intermittently in preparation for the physics experiments in the subsurface facility. Figure 3 is a snap shot of the tunnel complex as for February, 1998.

The subsurface facility consists of two refuge areas, alcoves, and equipment/instrumentation areas. The refuge areas are equipped with life support systems such as air supply, air quality monitoring, power, and communication. The main drift is denoted as the U1a. 01-drift. The U1a. 02-drift is dedicated for LANL experiments while the U1a. 100 and U1a. 101 are dedicated for LLNL experiments. The U1a. 04-detection and U1a Users alcoves are dedicated for instrumentation and control areas for LANL and LLNL, respectively.

Along the drifts, cable and conduits for lifelines and experiments are supported on the tunnel wall ribs with struts, hangers, and brackets. Power panels and air monitoring system are distributed throughout the subsurface facility. There is equipment which provides power supply and cooling to the instrumentation.

3.0 Seismic Criteria for the U1a Complex

Being a DOE facility, U1a is required to demonstrate that it is safe to perform the physics experiments by performing safety analyses. Seismic evaluation of the facilities provides input to the safety analyses report.

3.1 Overview of DOE Natural Phenomena Policy

For an existing DOE facility, such as the U1a Complex, the seismic evaluation includes SSCs screening, development of ground motion for structural evaluation, facility walkdown, and peer review. The seismic evaluation was conducted following the procedures developed in the Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities, DOE/EH-0545, Ref. 1, prepared by the Department of Energy. The procedures provided in this document is consistent with the DOE Natural Phenomena Hazards Order, DOE Order 420.1, Facility Safety, (Ref. 2) and Standards, DOE-STD-1020, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities, and DOE-STD-1021, Natural Phenomena Performance Categorization Guidelines for Structures, Systems, and Components, (Refs. 3 and 4). Additional standards, DOE-STD-1022, National Phenomena Hazards Characterization Criteria, and DOE-STD-1023, National Phenomena Hazard Assessment Criteria (Refs. 5 and 6), are available to determine the site hazard level.

The DOE Natural Phenomena Policy was developed over many years with major input from LLNL. A vigorous review process was conducted by all DOE elements and the Defense Nuclear Facility Safety Board (DNFSB). The policy was issued in January 1993 after numerous questions and comments were resolved and incorporated. It consists of DOE Order 420.1, its implementing

guide, and DOE Standards on design/evaluation criteria, categorization, and definition of the hazard level for the site.

DOE/EH-0545 was followed for the SSC screening and facility walkdown at the U1a Complex. A Seismic Review Team (SRT) was composed of safety professionals, system engineer, operation personnel, seismic capacity engineers, and structural engineers. The SRT determined the performance categorization of the SSCs based on their function and potential seismic damage impact to personnel and program safety. A consensus of team members was achieved on the appropriate performance category for each SSC in the U1a Complex. The guidance for performance categorization is provided in DOE-STD-1021. The SSC may be placed in one of the following five performance categories (PCs) as defined in DOE-STD-1021 as shown in Table 1.

Table 1. Five performance categories as defined in DOE-STD-1021

Performance Categories (PCs)	Design and Evaluation Criteria
1. PC 0	No Criteria
2. PC 1	Standard Building Code Criteria
3. PC 2	Building Code Criteria for Essential Facilities
4. PC 3	Intermediate Criteria above Building Codes and below Commercial Nuclear Power Plant Criteria
5. PC 4	Approaching Criteria used for Commercial Nuclear Power Plants.

3.2 Seismic Motion for U1a

To complement DOE-STD-1021, the DOE-STD-1020 provides guidance for the definition of the design basis earthquake (DBE). The DBE is used for design or evaluation of PC 1 through PC 4 SSCs. The criteria incorporates good practice and lessons learned from past earthquakes that have occurred world wide. The peak ground accelerations (PGAs) provided in DOE-STD-1020 for the Area 410 of the NTS are tabulated in Table 2 for PCs 1 thru 4:

Table 2. DOE-STD-1020 recommended seismic ground motion for the Area 410 of the Nevada Test Site.

Performance Categories (PC)	Design Basis Earthquake (DBE)
PC 1	0.30g PGA
PC 2	0.30g PGA
PC 3	0.34g PGA
PC 4	0.46g PGA

In March of 1995 a simplified probabilistic seismic hazard assessment (PSHA) was performed for the Device Assembly Facility (DAF) which is located about 15 miles south of U1a Complex. The resulting ground motion for a return period of 2,000 years was estimated to be 0.3g horizontal (Ref. 7). The seismic setting and soil condition of U1a Complex are similar to that of the DAF; therefore, the PSHA results are applicable. In addition to the DAF's PSHA, review of available seismic hazard information as documented in codes, standards, and manuals, led to the recommendation for the ground motion for U1a surface facility as tabulated in Table 3.

Table 3. Recommended seismic ground motion for U1a surface facility evaluation.

Performance Categories (PC)	Design Basis Earthquake (DBE)
PC 0	No criteria
PC 1	0.30g PGA
PC 2	0.30g PGA

For subsurface facility, some reduction in peak ground motion would be expected. Two methods were proposed to estimate the seismic ground motion for the U1a subsurface facility. Both methods require measurement of ground motion at the surface and subsurface of the site. Based on the experience of the seismic team at Sandia National Laboratory (SNL), it is expected that the U1a site may experience low level earthquakes of magnitudes 3 to 4 every 3 to 4 weeks. As requested by LANL and LLNL, the SNL team installed seismic monitoring instruments at the north end of the 01-Drift as labeled in Figure 3 and at its corresponding surface ground level as labeled in

Figure 2 (Ref. 8, Appendix A). Triaxial accelerometers were installed to record motions due to normal seismicity in three orthogonal directions; north-south, east-west, and vertical.

A task has been planned to analyze the measured data using an empirical Green's Function approach (Ref. 9) to obtain the reduction in surface ground motion at the tunnel level as a function of the frequency of the motion. Another task has also been planned to perform soil-structure interaction analyses using the SASSI (Ref. 10) computer code. The measured data will be applied to estimate the ground motion from tunnel level to ground surface. Both tasks are presently on hold; however, the seismic instrument have been left in place to record data through September 1998.

After discussion among geophysics, seismologists, geotechnical engineers and structural engineers, a consensus judgment on a 50% reduction from the surface motion was achieved for the seismic evaluation for the subsurface facility. This value is an estimate based on the engineering judgment and should be verified by analyses of the measured data. The recommended seismic criteria for the subsurface facilities are given in Table 4.

Table 4. Recommended seismic ground motion for U1a subsurface evaluation.

Performance Categories (PC)	Design Basis Earthquake (DBE)
PC 0	No criteria
PC 1	0.15g PGA
PC 2	0.15g PGA

4.0 Walkdown evaluation of U1a Complex

The seismic evaluation of the U1a Complex was initiated in January of 1998. The events and meetings are listed in Appendix B. In January 1998, a position paper (enclosed in Appendix C), was drafted to offer recommendation on conducting a seismic evaluation of the U1a Complex to the safety analyses management. A briefing was provided to the U1a facility personnel on lessons learned from past earthquakes, DOE Natural Phenomena Policy, the corresponding Orders and Standards, and walkdown procedures for seismic evaluation.

4.1 Seismic Walkdown of U1a facilities

A seismic review team was organized for facility walkdown inspection of surface and subsurface facilities. Notes and pictures were taken during the walkdown. Post walkdown meetings were held immediately after each walkdown to compare notes, to reach consensus, and to identify the need for reevaluation. Meeting minutes for the subsurface walkdown is included in Appendix D.

The first step of the walkdown was to identify the performance category (PC) for all the SSCs in the facility. During the walkdown, the operation and system engineers identified the function of the SSCs while the safety and seismic capacity engineers evaluated the potential seismic damage impact to personnel and programmatic safety. A consensus of the team led to the selection of a PC for each SSC. The second step was to inspect their supports, attachments, and interactions visually in the attempt to determine the structural integrity in case of a seismic event.

Tables were designed to document the PC and inspection results for each of the SSCs. Each SSC is identified with an unique number in the first column (see Figure 2 for location of SSCs); the item name is listed in the second column; and the PC is tabulated in the third column. An "N" in the fourth column means no evaluation needed which is confirmed in the fifth column, Comments. A "Y" in the fourth column means that evaluation is needed and recommendations are given in the fifth column. When the seismic survivability of the supports and attachments of the SSCs cannot be determined by visual inspection, additional evaluation was recommended. Simple recommendations are made in the Tables for some SSCs to improve the seismic survivability of their supports and attachments.

4.1.1 Seismic walkdown for surface structures, systems, and components

The results of the walkdown inspection of the surface facilities are included in the Appendix E. A total of 118 SSCs were identified in the walkdown. All SSCs were placed into a performance category ranging from 0 to 2. No PC-3 or PC-4 items were identified. The PC distribution of the SSCs is tabulated in the Appendix E. As shown in the tables, 70% of the SSCs were found to be well anchored and only 36 items were identified for evaluation. Table 5 gives the number of the SSCs (PC-2 through PC-0) that are recommended for evaluation.

Prioritization of action items is determined based on the item PC level, complexity of the evaluation, and cost. The PC-2 items has the high priority in action. Table 6 gives a list of 8 PC-2 SSCs and only six of them were identified for evaluation. Item #68, compressor pad-diesel tank appears to be well anchored and does not need evaluation. The head frame was not marked for action because it was evaluated by Bechtel Nevada in August 1996. The analyses of the head frame

were documented in Ref. 11 and is included in Appendix I. The structural computer code, Supersap, was used to analyze the frame for Seismic Zone 4 loading as specified in the Uniform Building Code (0.4g peak ground acceleration plus response spectra).

Recommendations were made to evaluate the Items #67 through #71 for lateral restraint. Figure 4 shows the air line being supported on timber (crib) and laterally restrained by wire. Such anchorage may not be sufficient for the air line system especially for the attached cantilevered valve (not shown in the Figure). Figure 5 depicts the wood block support for the emergency generator. Note that the block is smaller than the base plate of the generator; thus, evaluation was recommended.

Table 5. Only 30 % of the items were recommended for evaluation.

SSC Categories	PC-2	PC-1	PC-0
# of items categorized	8	45	65
# of items required action	6	28	11

Table 6. A list of the U1a surface PC-2 items.

Item #	Item names	PC	Action Y/N	Comments
1/34	Head Frame	2	N	No action required.
2/67	Air Line (10" Dia.) on Timber Supports on Ground	2	Y	Evaluate lateral restraint requirements to prevent pipe derailing from wood supports and lateral restraint at the dielectric insulator. Evaluate the entire system including items from 67 thru 71.
3/68	Compressor Pads - Diesel Tank	2	N	No action required.
4/69	Compressor Pads - Diesel Generators on Wheels	2	Y	Evaluate need for wheel chocks.
5/71	Compressor Pads - Air Cooler/Dryer	2	Y	Evaluate lateral restraint requirements.
6/72	Emergency Generator	2	Y	Evaluate lateral restraint requirements for trailer and supported equipment.
7/74	Air Line	2	Y	Evaluate the line including the attached cantilevered valve for lateral restraint requirements.
8/75	Emergency Evacuation Hoist	2	Y	Evaluate lateral restraint requirements and plate under columns for vertical support.

There are 28 PC-1 items marked for evaluation and they are tabulated in the Appendix F for easy access. Most of them are recommended for equipment anchorage. For example, Figure 6 shows missing bolts at the right corner of the cabinet. Figure 7 is an opposite view of Figure 6 showing a missing bolt and three conduits rigidly connected to cabinet on the right-hand-side of the Figure. The rigid connection is vulnerable to damage when the cabinet or the equipment is not properly anchored. Figure 8 is another example of free-standing equipment (high voltage switches) with rigid conduit connections.

Figure 9 shows a free-standing equipment with flexible cable connection. If uplifting loads exist at the legs the equipment should be tied down to avoid seismic movement. Note that the small rack may have interaction with the flexible cable causing avoidable damage to the cable.

There are several utility water tanks at the surface facility that need to be anchored to the ground. Two water tanks are part of the shaft spray system while two others are the construction water supply. One of the horizontal tanks for the shaft spray system buckled at the supports, as shown in Figure 10, and was marked for evaluation. The weldment on two legs were damaged and should be repaired. Figure 11 is a close-up view of the damaged weldment at the front leg.

Gas bottles are stored in the sheds, located north of the assembly building. As shown in Figure 12 some gas bottles which were not restrained to the side of the shed could fall over during earthquake. Similar situation is shown in Figure 13 where the rack was chained across its opening but the bottles were not chained to the side of the rack to keep them from falling.

Some trailers are supported on wood cribs up to several feet above ground as shown in Figure 14. It is not clear that the wood cribs could remain intact during an earthquake; therefore, recommendation was made to evaluate the stability of the cribs. Some trailers are supported on wheels on one end and on small tripods on the other end as shown in Figure 15. It is possible that the wheels might experience significant movement that the tripods could overturn. It was recommended to limit the wheel rolling by shimming with blocks.

Many air conditioning (A/C) units are installed on top of trailers. It is necessary to ensure that the A/C units do not damage the trailer and do not fall off causing personnel injury. The elevated trailers are equipped with detached metal and wood stairs. It is possible that such staircase may block the trailer door from opening after the trailer was displaced by seismic motion. The metal staircase should be attached to the trailers to mitigate the blockage.

The following general housekeeping actions are also recommended:

- Tie down of tall cabinets, especially those marked for flammable chemicals.
- Provide chains at top and bottom to keep the gas bottles from falling off the racks.
- Prevent falling objects from blocking the trailer personnel exit.
- Provide lips at the edge of the open shelves to keep tools or stored items from falling off the shelves.

4.1.2 Walkdown of subsurface structures, systems, and components

The results of the walkdown inspection of the subsurface facilities are included in Appendix G. Similar SSCs are provided in refuge areas and alcoves; therefore, it is necessary to uniquely identify the SSCs in Column 1 of the Table. A total of 157 SSCs were identified. All SSCs were placed into a performance category ranging from 0 to 2. No PC-3 or PC-4 items were identified. The PC distribution of the SSCs is tabulated in the Appendix G. As shown in the tables, 66% of the SSCs are well anchored and only 54 items were identified for evaluation. Table 7 gives the number of the SSCs that are recommended for evaluation. Table 8 gives a list of 14 PC-2 SSCs and only seven of them were identified for evaluation.

The walkdown of the subsurface facility started at the shaft. The cage traveled slowly and stopped at several staircase landings in order to inspect the supports and attachments of the lifelines as well as to verify the number and spacing of the soil bearing beams in the shaft supporting frame. The layout of the soil bearing beams are as shown on the drawings except for one insignificant deviation in spacing. The lifelines in the shaft are well anchored; therefore, no further evaluation is needed.

The U1a refuge area is located adjacent to the U1a shaft/cage. The only egress opens to heavy traffic area and a staging area for items that are waiting to be moved to or from the surface. It is essential that the egress is not blocked at all times by heavy equipment or other fallen items from the overflow staging area or from the shaft. A second, new egress is being built at the east end of U1a refuge area to improve the situation.

Table 7. Only 30 % of the items were recommended for evaluation.

SSC Category	PC-2	PC-1	PC-0
# of items categorized	14	139	4
# of items required action	7	46	1

Table 8. A list of U1a subsurface PC-2 items.

Item #	Item names	PC	Action Y/N	Comments
	U1a SHAFT			
1/SHF-6	Steel Sets, reinforced concrete, & Crib	2	Y	Evaluation being conducted by Bechtel Headquarters.
2/SHF-7	Emergency Egress (ladders)	2	N	No action required.
3/SHF-11	Compressed Air Line (4" dia.)	2	N	No action required.
4/SHF-13	Shaft (steel set)	2	Y	Require evaluation.
	U1a REFUGE			
5/REF-5	Compressed Air Line	2	Y	Add strap to filter at end of line.
6/REF-10	Refuge Chamber	2	Y	Add egress, clear obstruction.
	LANDING			
7/LAN-2	Air Lines	2	Y	Add lateral supports to wall.
	U1a SHOP			
8/SHP-6	Air Lines	2	Y	Add vertical and lateral supports when construction is complete.
	01 DRIFT			
9/01D-8	Compressed Air	2	N	No action required.
	03 DRIFT			
10/03D-3	Air Line	2	N	No action required.
	U1a 100 & U1a 101			
11/LLL-1	Compressed Air Line	2	N	No action required.
	U1g USERS ALCOVE			
12/U1G-1	Refuge Chamber	2	Y	Evaluate nest of cables at entrance - egress problem.
13/U1G-9	U1G Shaft Emergency Egress including cage	2	N	No action required.
14/U1G-11	Compressed Air	2	N	No action required.

The U1g refuge area is located in the Vent Drift, including the 15-psi bulkhead area and the U1g User Area. Many heavy cables are routed over the U1g refuge area egress as shown in Figure 16. The cable support and anchorage should be re-evaluated to prevent the cables from falling down and blocking the egress in case of an earthquake.

Figure 17 shows a typical redundant anchorage for the vent line. One cable supports from the bottom of the duct while another cable from the side. The weight of the cable is not consistent throughout the entire length of the vent line. Figure 18 is taken at an intersection of the vent line with larger duct sections. The cable is light weight and loosely wraps around the duct. *As shown in Table 8, recommendations for air line anchorage were made in various locations in the tunnel.*

There are 46 PC-1 SSCs marked for evaluation as tabulated in Appendix H. Traditionally, fire suppression system have not been a required system in the mining industry. Carrying this tradition, an agreement amount the authors was made that fire suppression system was not needed to remain functional in the subsurface facility after a seismic event. Consequently, the fire suppression system is categorized to be a PC-1 system. It is not clear if the hoist cage has been evaluated in the past. Since no such report was found, the hoist cage is categorized to PC-1 SSC and needs to be evaluated.

In the refuge area, refuge station supplies are kept in tall cabinets. Figure 19 shows a free-standing tall cabinet marked for emergency use. Recommendation was made to properly anchor the refuge station supply cabinet to the wall. In Figure 20, two tall cabinets are tied to the wall with loose cables. The interaction between two cabinets and the warning light is a concern to the seismic safety of the workers who take refuge in that area.

Figure 21 shows a typical anchorage of a backboard which is securely supported on the wall. The air quality monitoring system (AQMS) is also properly anchored to the wall as shown in Figure 22. The electrical cables are flexible and have sufficient length for seismic movement.

Figure 23 shows a typical, rigid conduit connection between the switches and the diesel generator. Both the switches stand and generator are free-standing and can move out-of-phase during earthquake. The diesel generator might be heavy enough not to have uplifting seismic forces while the switches do. Differential seismic displacement may be inevitably causing damage to the high voltage cables.

Figures 24 and 25 were taken in the DX-12 Alcove and U1g User Alcove, respectively. In these two alcoves, groups of instrumentation cabinets rest on timber blocks. The groups of cabinets might not overturn due its large foot print and restraint provided from the cables connection at the

top of the cabinets. However, evaluation is recommended to determine the stability of the cabinet group to ensure that the cable will not be separated from the instruments.

Typical cable tray anchorage is shown in Figure 26. Note that the tray is supported on two vertical rods. No lateral support is seen in this cable tray. Double deck cable trays are used in DX-12 and U1g Users Alcoves. They are also supported off the ceiling with rods and unistruts. Only one lateral support was found in the entire cable tray system in DX-12 Alcove. It is not clear this lateral strut is adequate for the entire system. Similar evaluation is also needed for the cable trays in U1g Users Alcove.

Some heavy equipment rests on platform on wheels. For example, Figure 27 shows an A/C unit rests on wheels. It is not sure that the ducts can provide restraint to the unit or that the ducts may be separated from rolling unit.

Heavy mining and construction were in progress during the walkdown. Several items were identified that proper anchorage was required after the construction was completed. Installation of new conduit for cables was also in progress. Figure 28 was taken along the 02-drift showing programmatic cable bundles along the drift wall. It was understood that many cables held by removable U-shape hog wires along the tunnel walls would be replaced with permanent supports.

A series of storage racks lined two adjacent walls in the 01 north shop are full of tools and stored items as shown in Figure 29. There is no safety mechanisms such as lip on the edge of the shelf or chains across the opening to keep the tool from falling off the shelf. These racks were marked for evaluation.

Only one PC-0 SSC (chiller system) was marked for evaluation. In addition, the following general housekeeping actions are also recommended:

- Anchor tall cabinets, especially those marked for flammable chemicals.
- Provide chains at top and bottom to keep the gas bottles from falling over.
- Improve anchorage of telephones.
- Strap off temporary equipment in area to prevent impact.
- Provide lips at the edge of the open shelves to keep tools and stored items from falling off the shelves.
- Place the fire extinguishers at an open area and support properly for easy excess.
- Do not store anything under fire extinguishers.

4.2 Additional Seismic Studies

Additional seismic studies were also planned by Bechtel Nevada (BN) to be carried out by Bechtel Headquarters and by Lawrence Livermore National Laboratory (LLNL) as follows:

1. Evaluate the integrity of the U1a access shaft due to an earthquake (by BN).
2. Evaluate the ground support of the tunnel due to a seismic event(by BN).
3. Estimate the seismic ground motion at the -963 foot elevation(by LLNL).

A meeting was held between LANL, LLNL, and Bechtel Headquarters to exchange information on these studies. The meeting minutes are also enclosed in Appendix D. A copy of the probabilistic seismic hazard assessment memorandum and a soil properties plot were provided to the Bechtel team. These tasks should be resumed as soon as possible.

5.0 Recommendations

The tables in Appendices E and G are the product of detailed inspection and discussion at length by the SRT team. The comments and recommendation tabulated in Column 5 of the tables deserve proper attention and should not be overlooked. Not all the re-evaluation leads to retrofit; however, some re-evaluation may require design effort. The recommended actions are presented in two categories as tabulated in Table 9.

Table 9. Recommended action s required to improve U1a Complex seismic safety.

Recommended actions required immediate action	**Recommended actions required to provide facility seismic safety**
1. Build a second egress for U1a refuge area (in progress). 2. Keep the egresses of both refuge areas clear from obstruction as discussed in Subsection 4.1.2 at all time. 3. Resume the ground motion analyses by Green function and SASSI methods to verify the ground motion of 0.15 g estimated for the subsurface facility. 4. Appendices E and G identify 13 PC-2 items that need evaluation. These 13 items are SSC's that are to remain functional after the earthquake; therefore, should be considered top priority for immediate action. 5. Resume work on the additional seismic studies by Bechtel Headquarters.	1. Identify the SSCs which require action. 2. Prioritize the action items based on the classification of the SSCs, the complexity of the evaluation, and the cost. 3. Schedule the evaluations in accordance with priority set in Step 2. 4. Perform the low cost and simple retrofits. 5. Establish standards for installation of systems and components at the U1a Complex that address the seismic concerns of anchorage and interaction (proximity, falling, flooding, seismic induced fire). 6. Schedule the structural evaluations and designs needed for retrofit. 7. Monitor the progress of the seismic safety actions. 8. Periodic seismic walkdowns should be conducted since new systems will be added and old systems modified. We recommend at least one walkdown per year, or more frequently as needed. 9. Establish guidance for experiment management that provides good practice in anchorage and bracing of experimental equipment. 10. Conduct periodic awareness training for earthquake evacuation procedures.

Figure 1: The U1a Complex is identified in a circle on a schematic layout of the Nevada Test Site.

Figure 1: The Ula Complex is identified in a circle on a schematic layout of the Nevada Test Site.

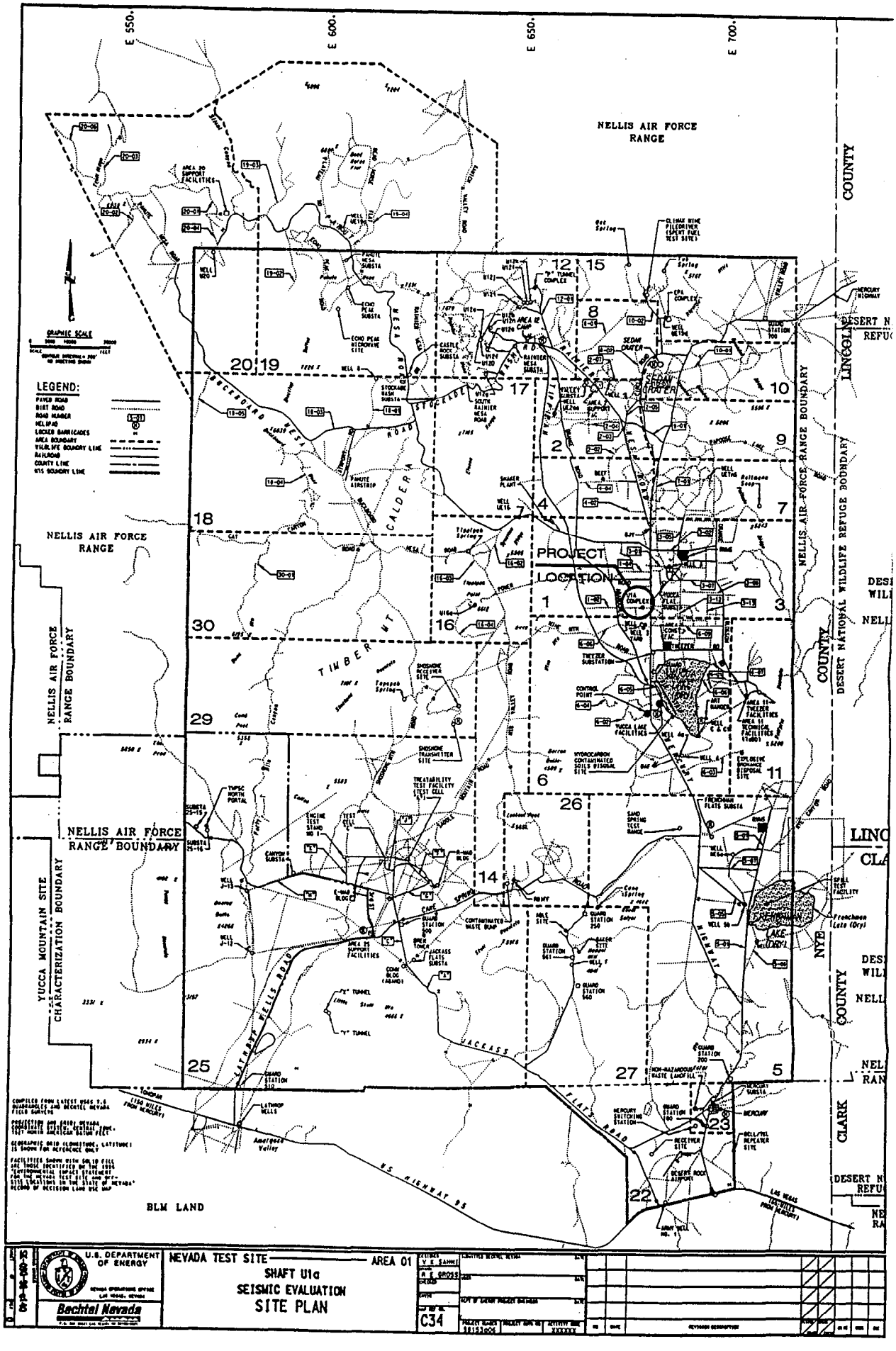


Figure 2: A schematic layout of the surface facility with its structures and systems individually labeled.

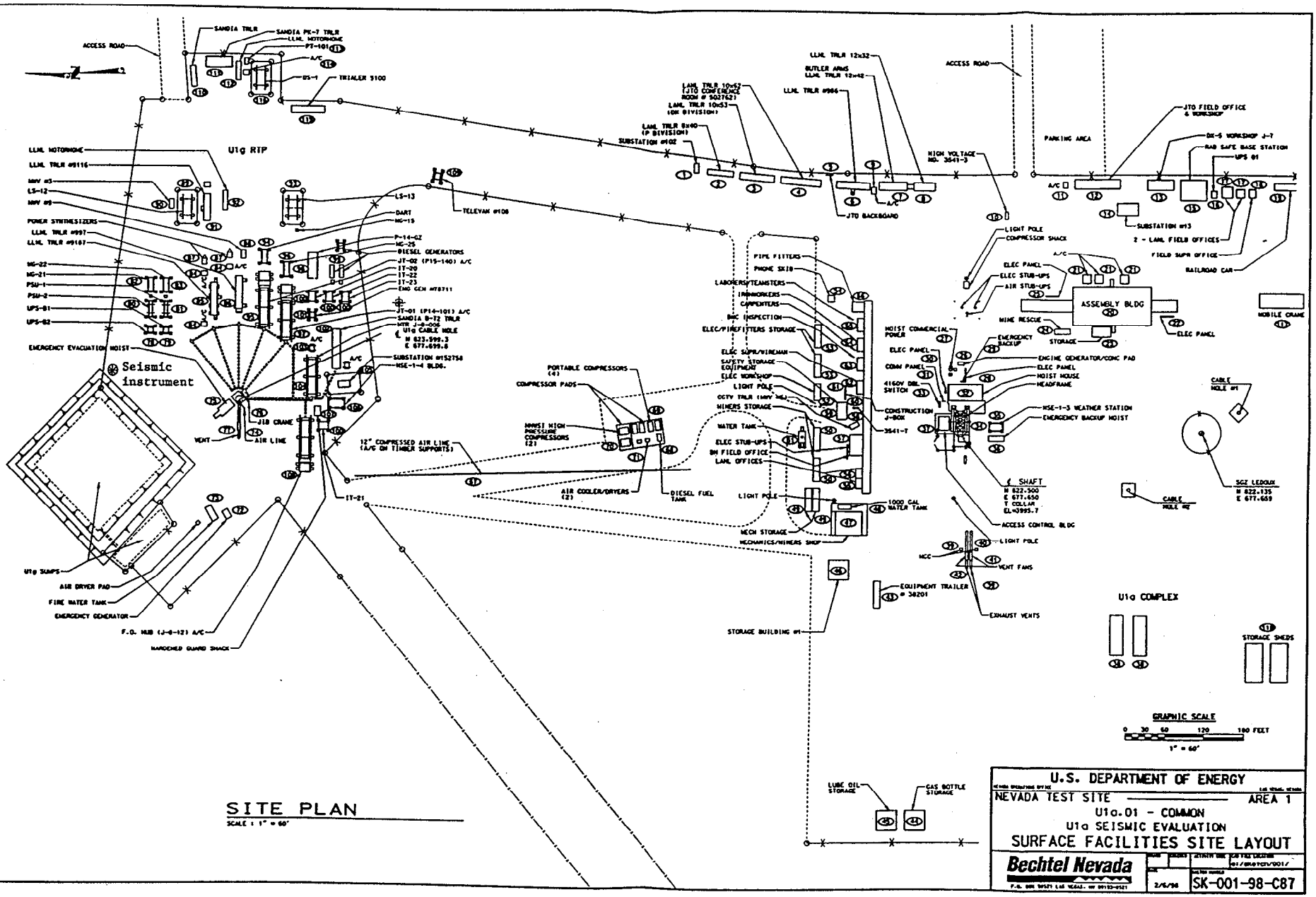
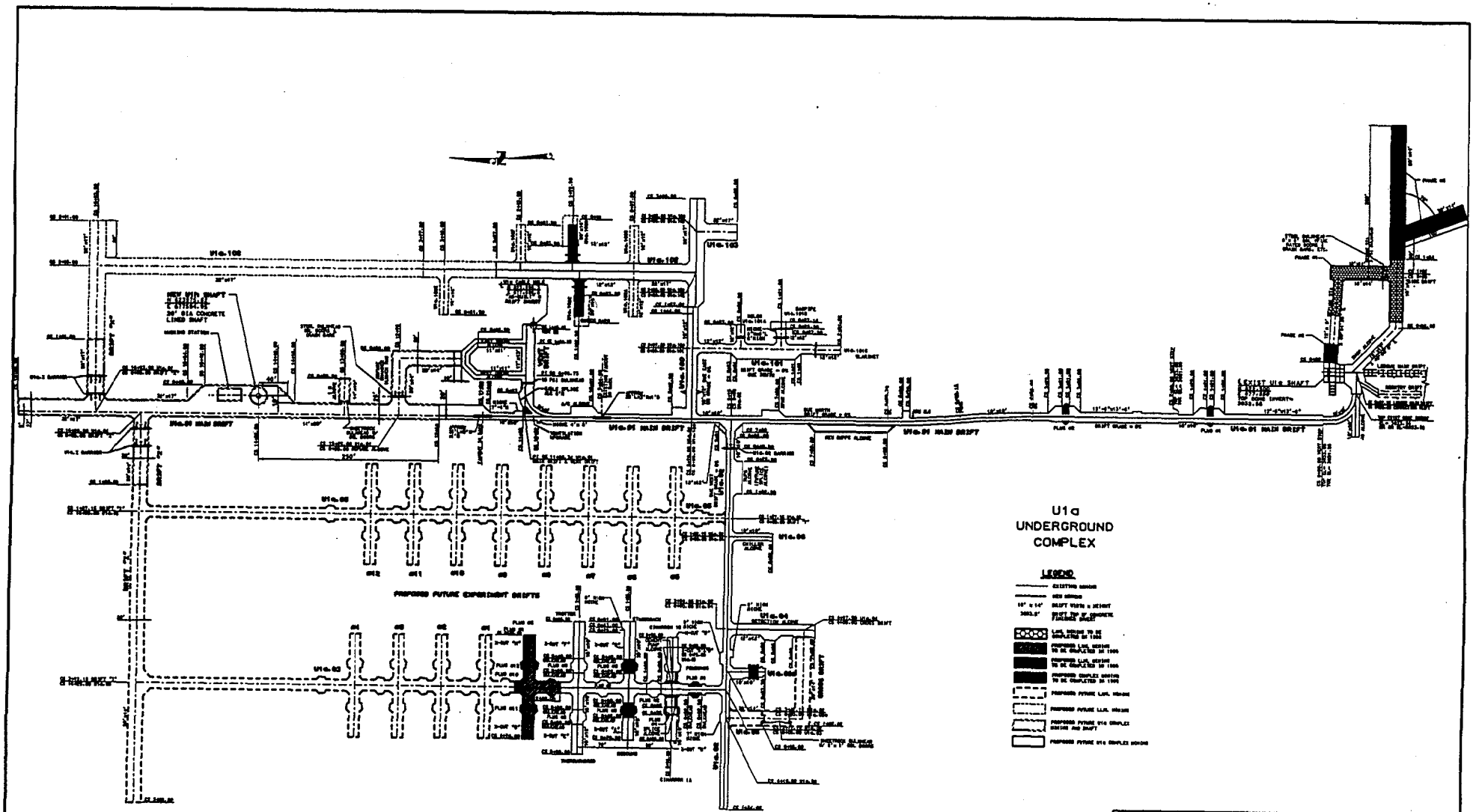


Figure 2: A schematic layout of the surface facility with its structures and systems individually labeled.

Figure 3: A schematic layout of the tunnel complex.



CURRENT STATUS AS OF 9-17-98

U.S. DEPARTMENT OF ENERGY

NEVADA TEST SITE - AREA 1 - JTO

U1a

PROPOSED DRIFT EXPANSION

LAYOUT

Bechtel Nevada

P.O. BOX 98521 LAS VEGAS, NV 89193-8521

SK-001-98-D-M01

N/A

Figure 4: The timber support and wire restraint for the air line piping.

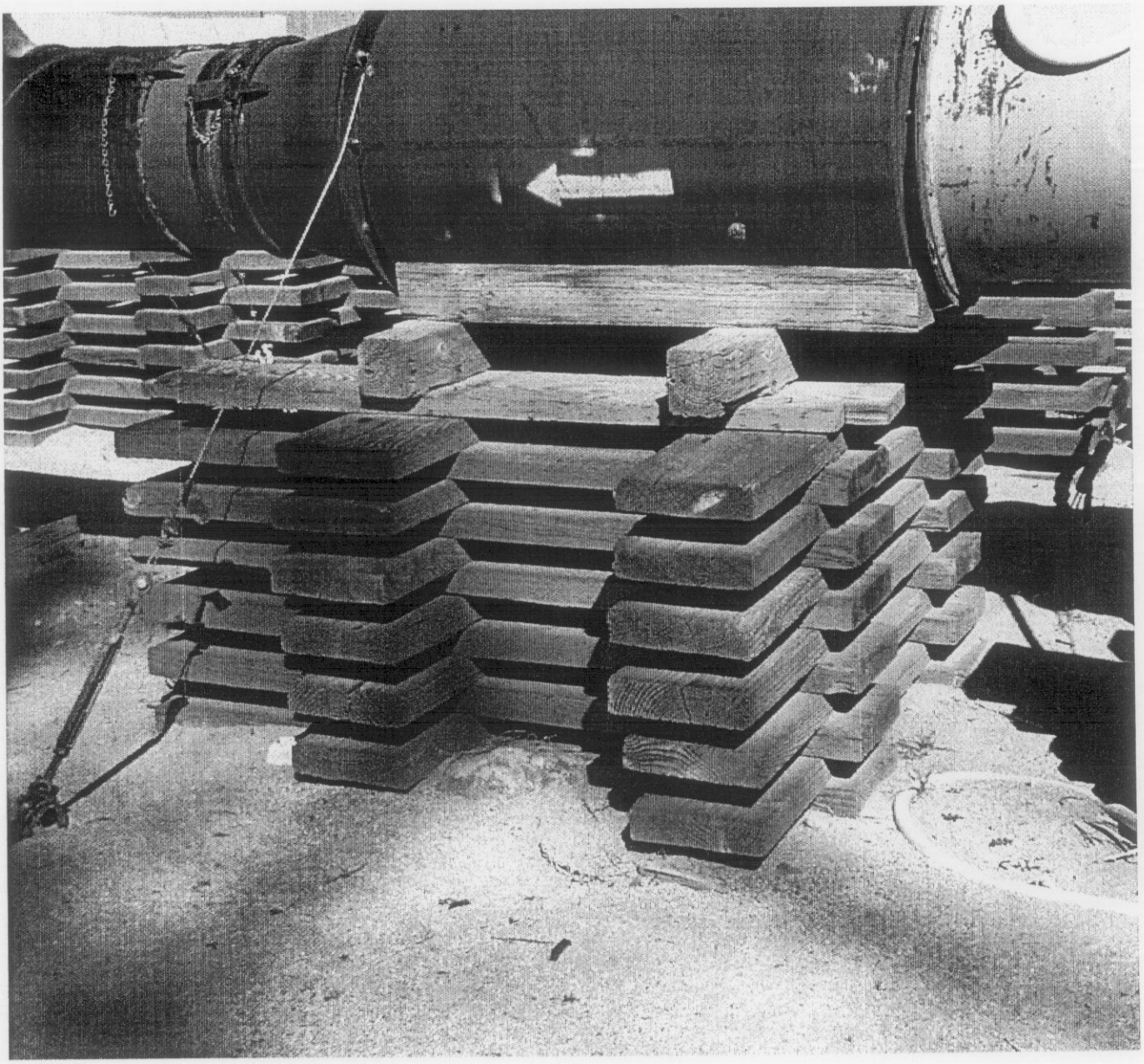


Figure 5: The supporting block is smaller than the base plate of the generator.

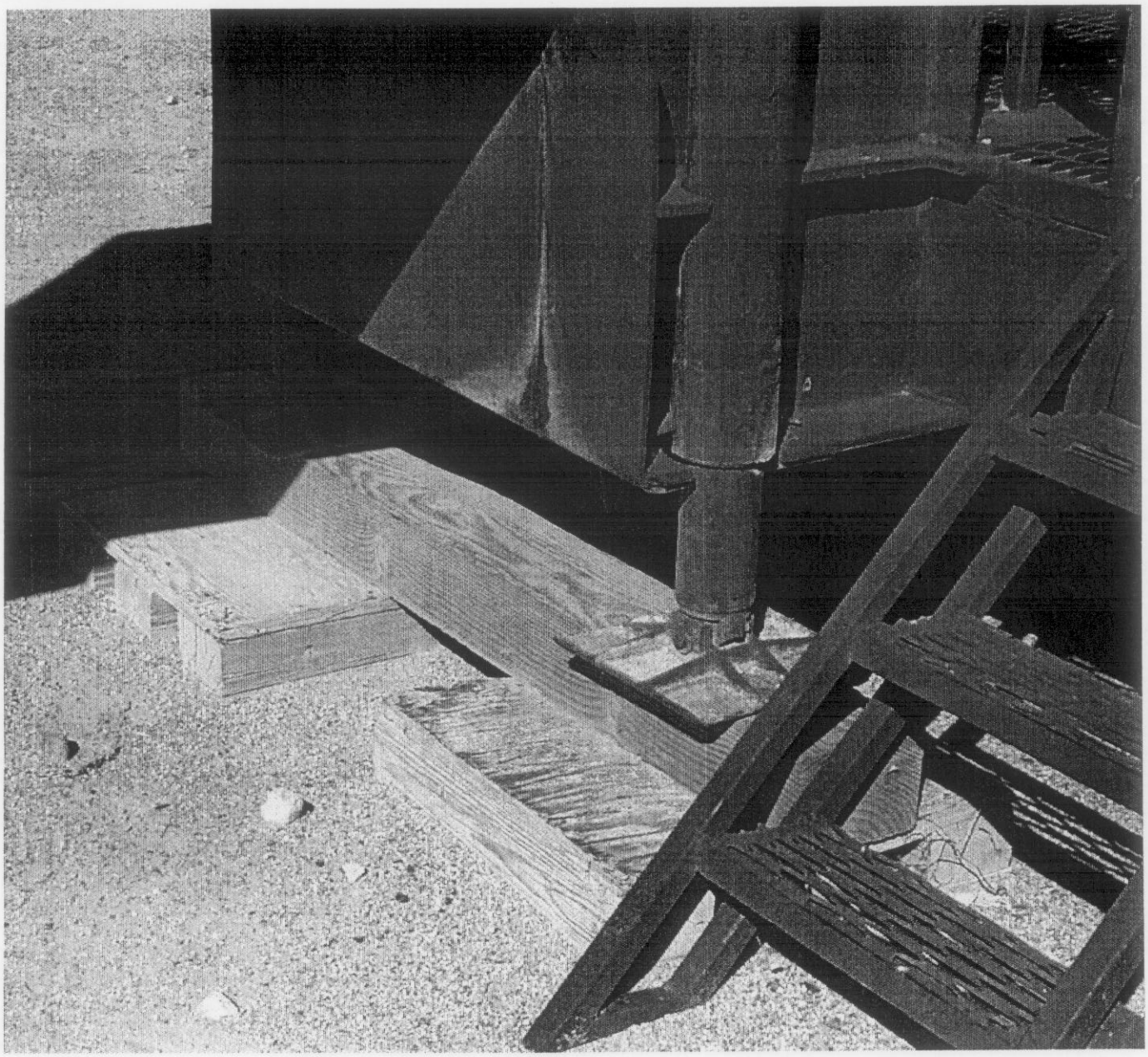


Figure 6: An anchor bolt is missing on the right side of the cabinet.

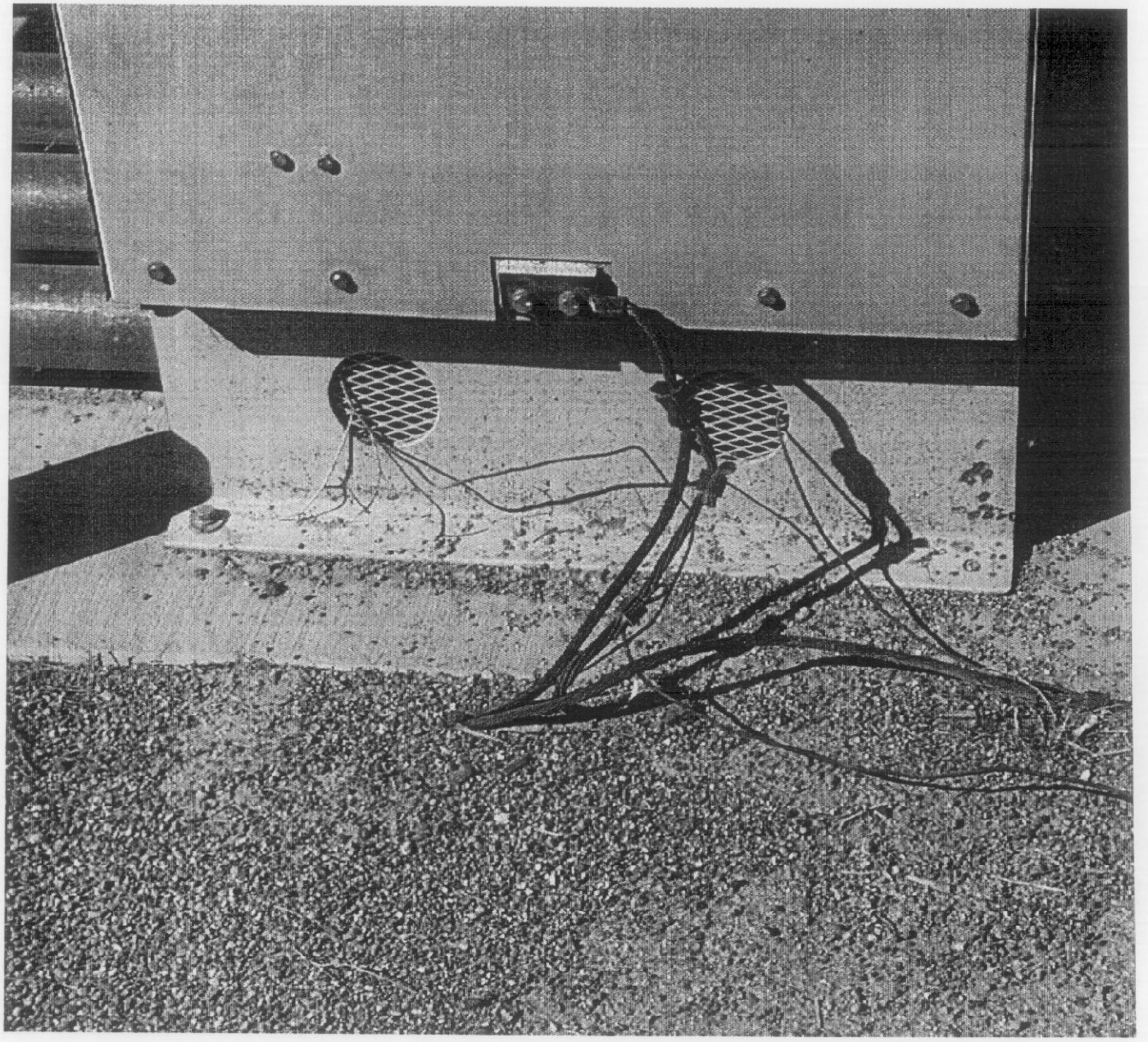


Figure 7: The conduits are rigidly connected to the cabinet.

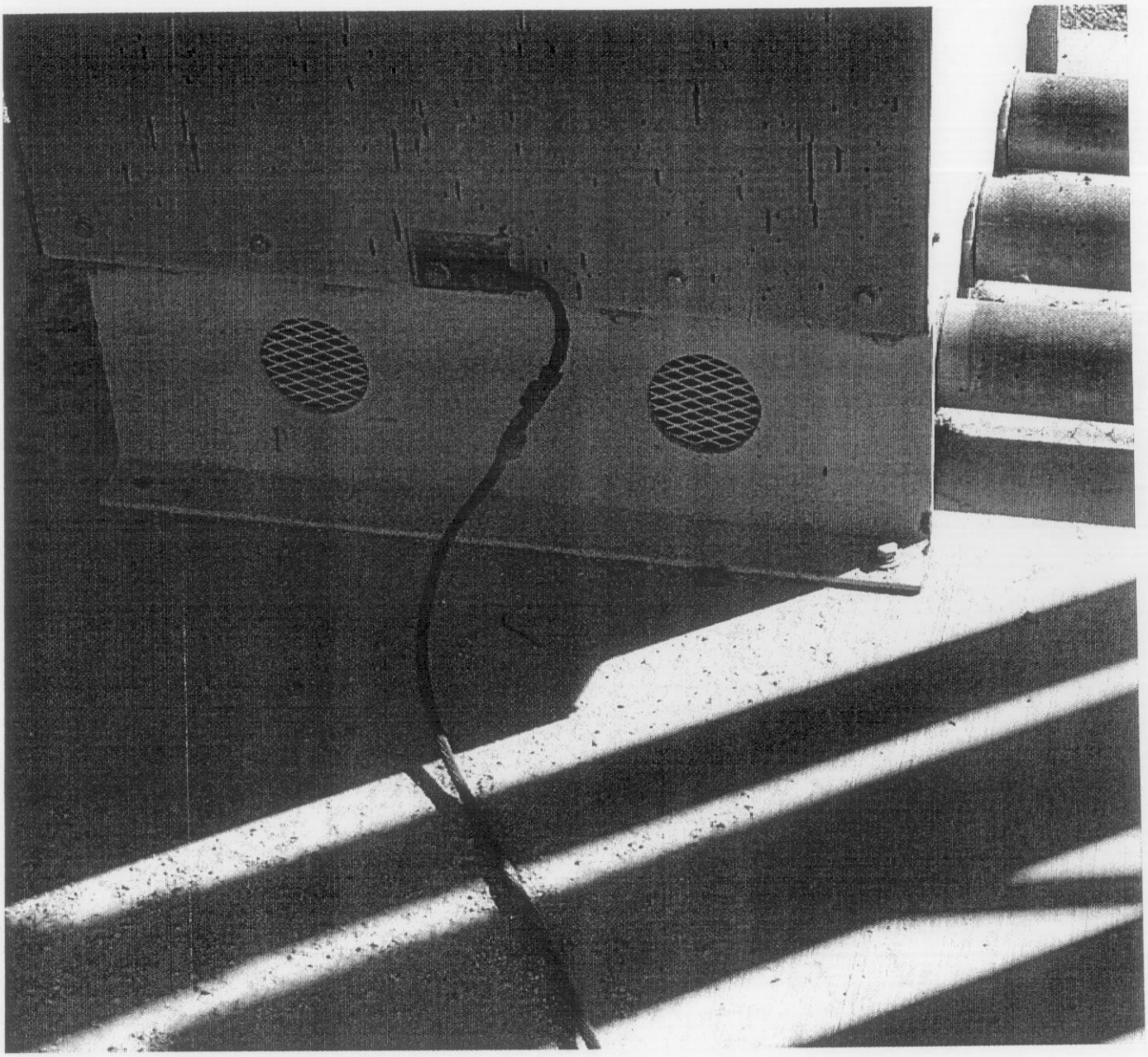


Figure 8: Free-standing high voltage switch cabinet with rigid connection to conduits.

Figure 9: Free-standing equipment with flexible connection to cable and possible interaction with adjacent rack.

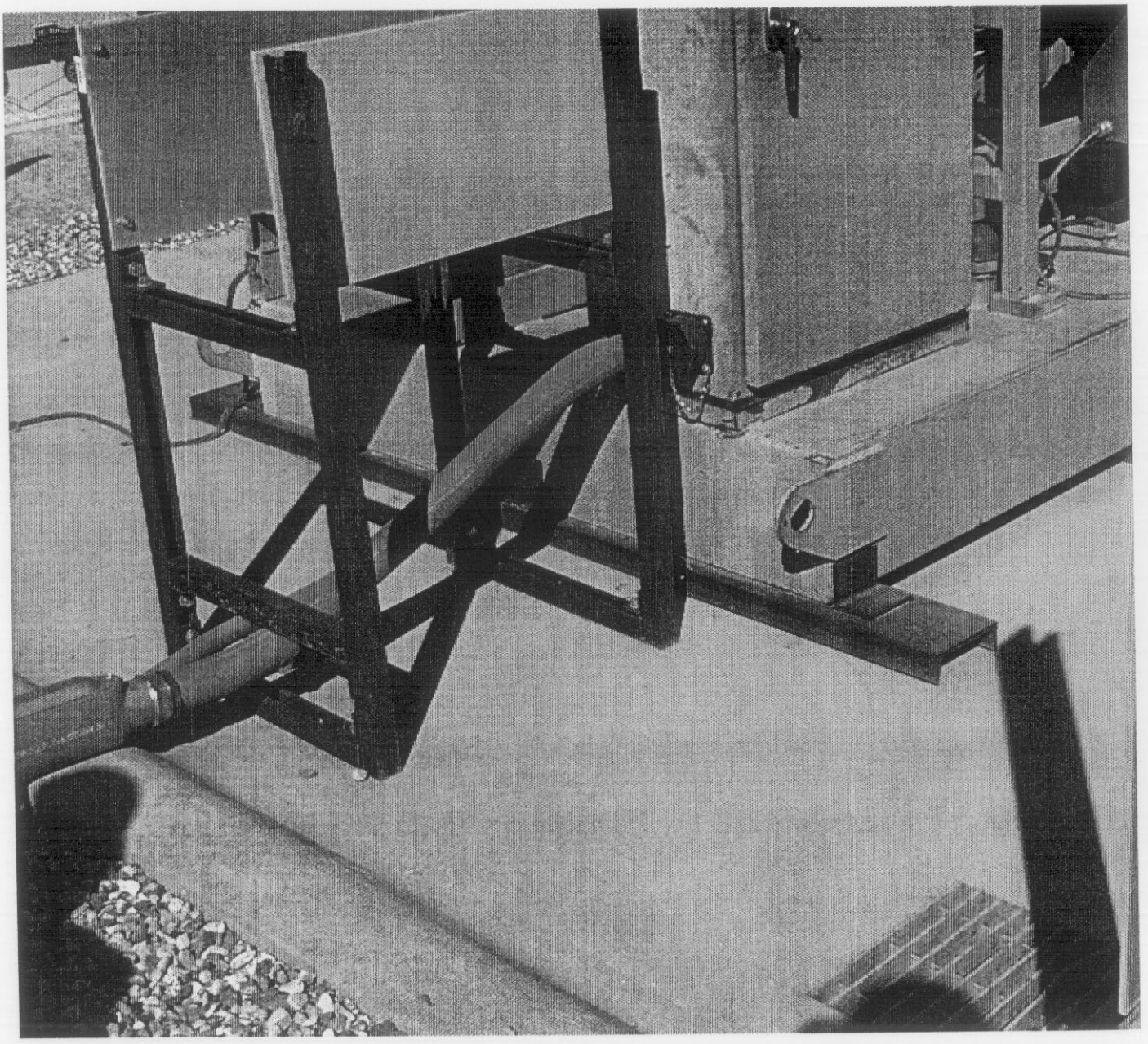


Figure 10: A water tank buckles at the support.

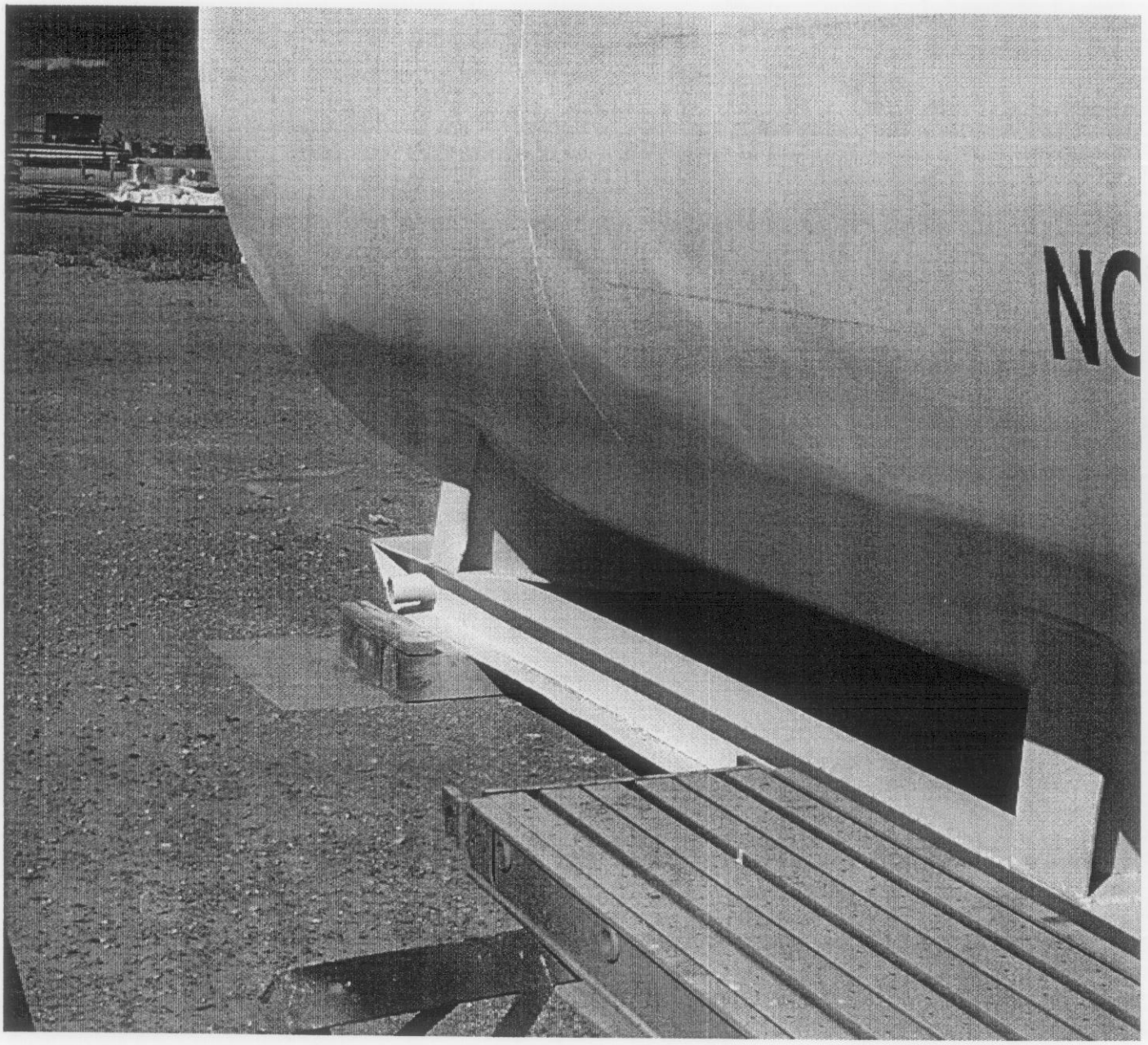


Figure 11: A close-up view a damaged weldment at the tank supports.

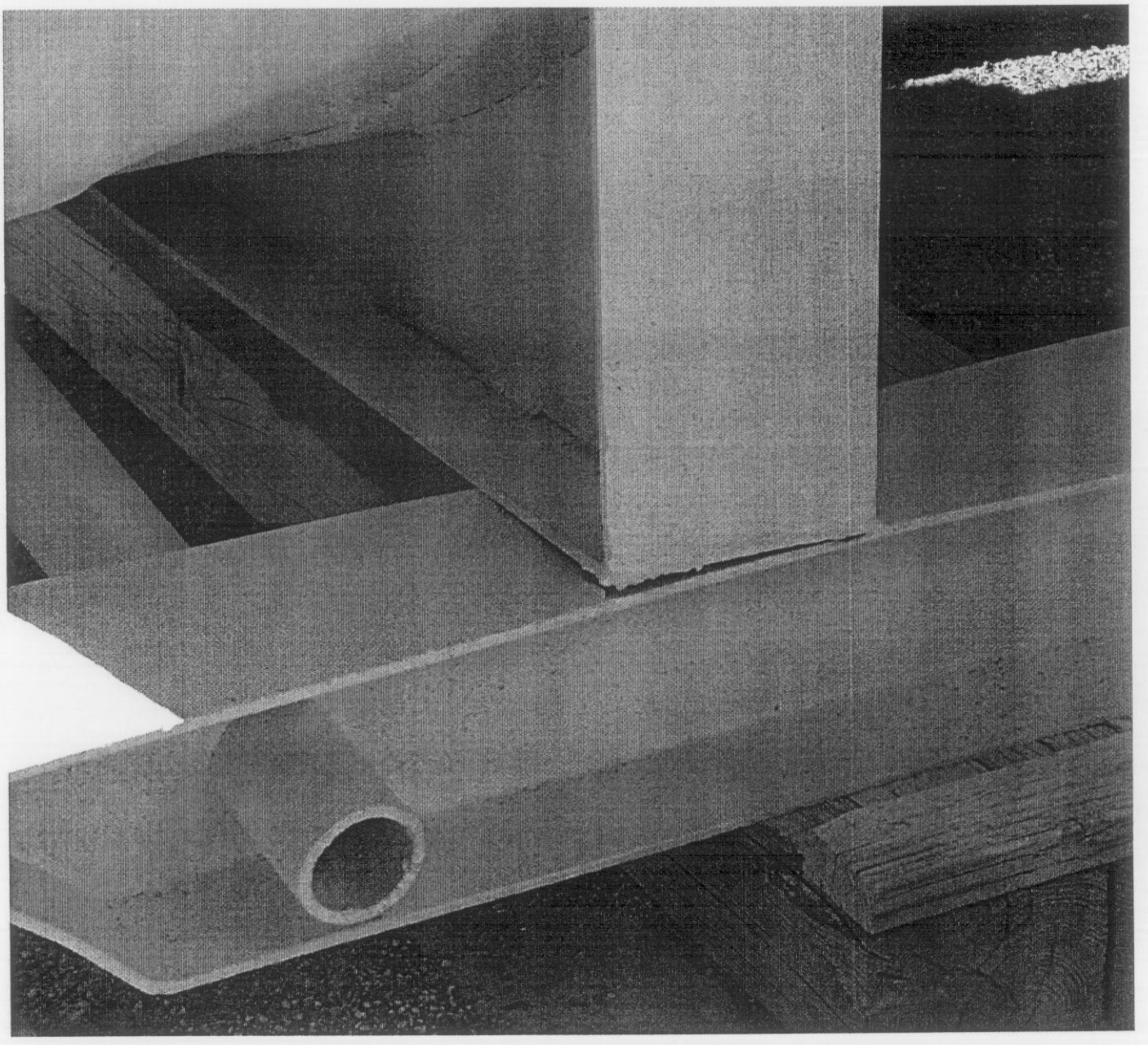


Figure 12: Free-standing bottles need to be restrained from falling.

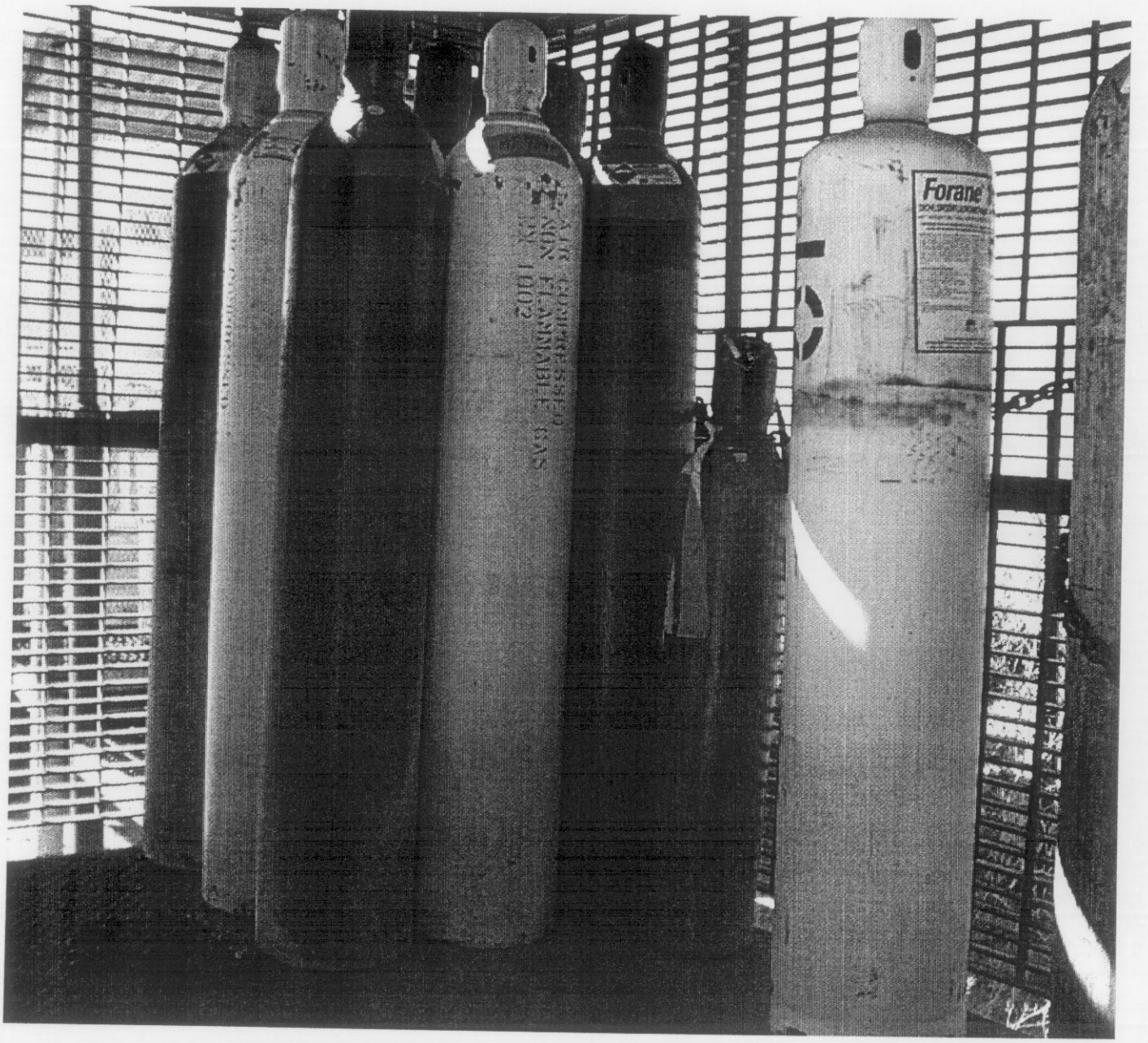


Figure 13: Chaining the opening of the rack does not keep the bottles from falling.

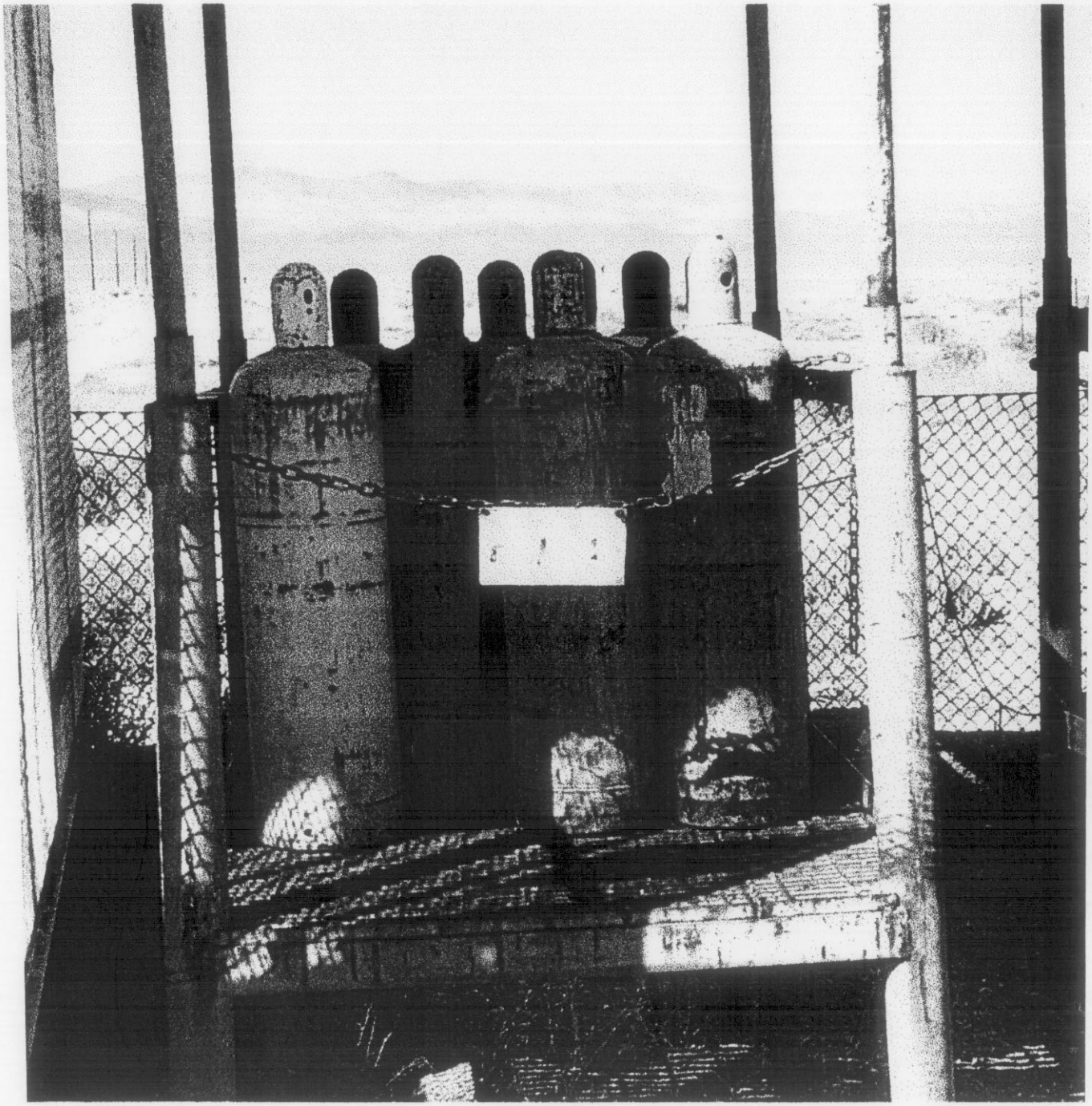


Figure 14: Evaluation of the timber-pile response to earthquake motion is recommended.

Figure 15: The trailer wheels may be restrained to limit seismic motion of the trailer.

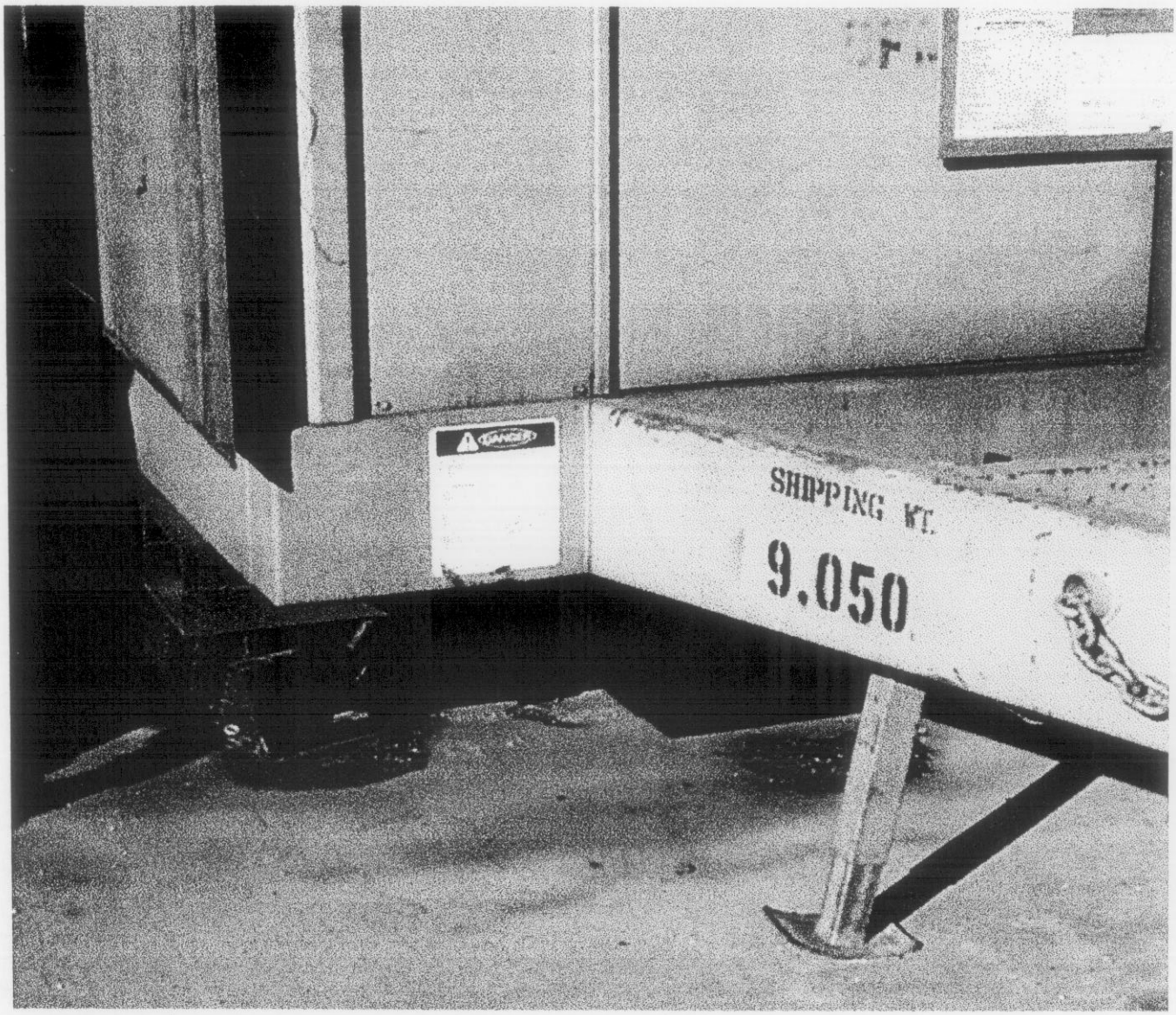


Figure 16: Large cable bundles run over and across the emergency egress of the U1g refuge area.

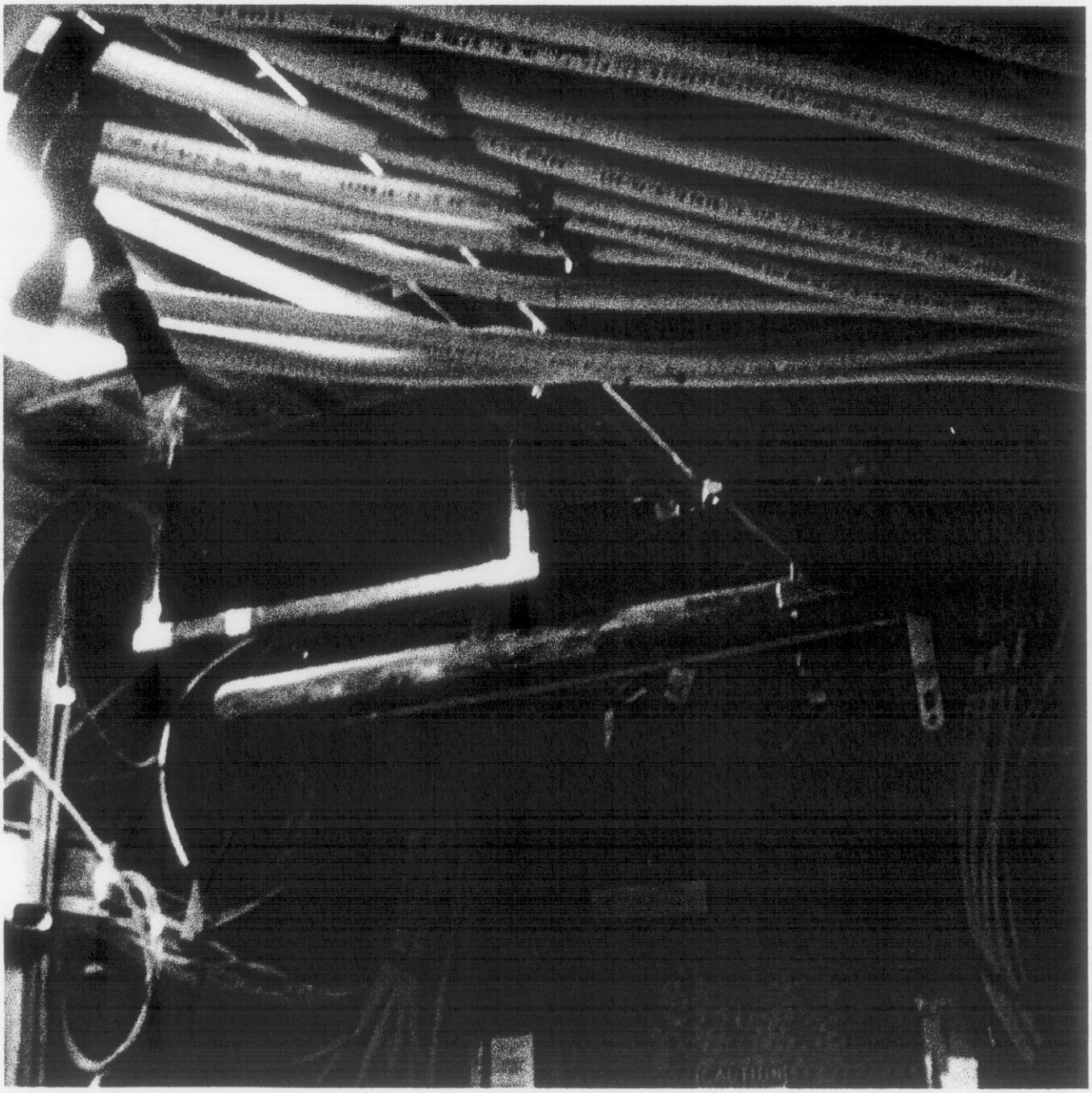


Figure 17: The vent line is supported on different weights of cables and wires.

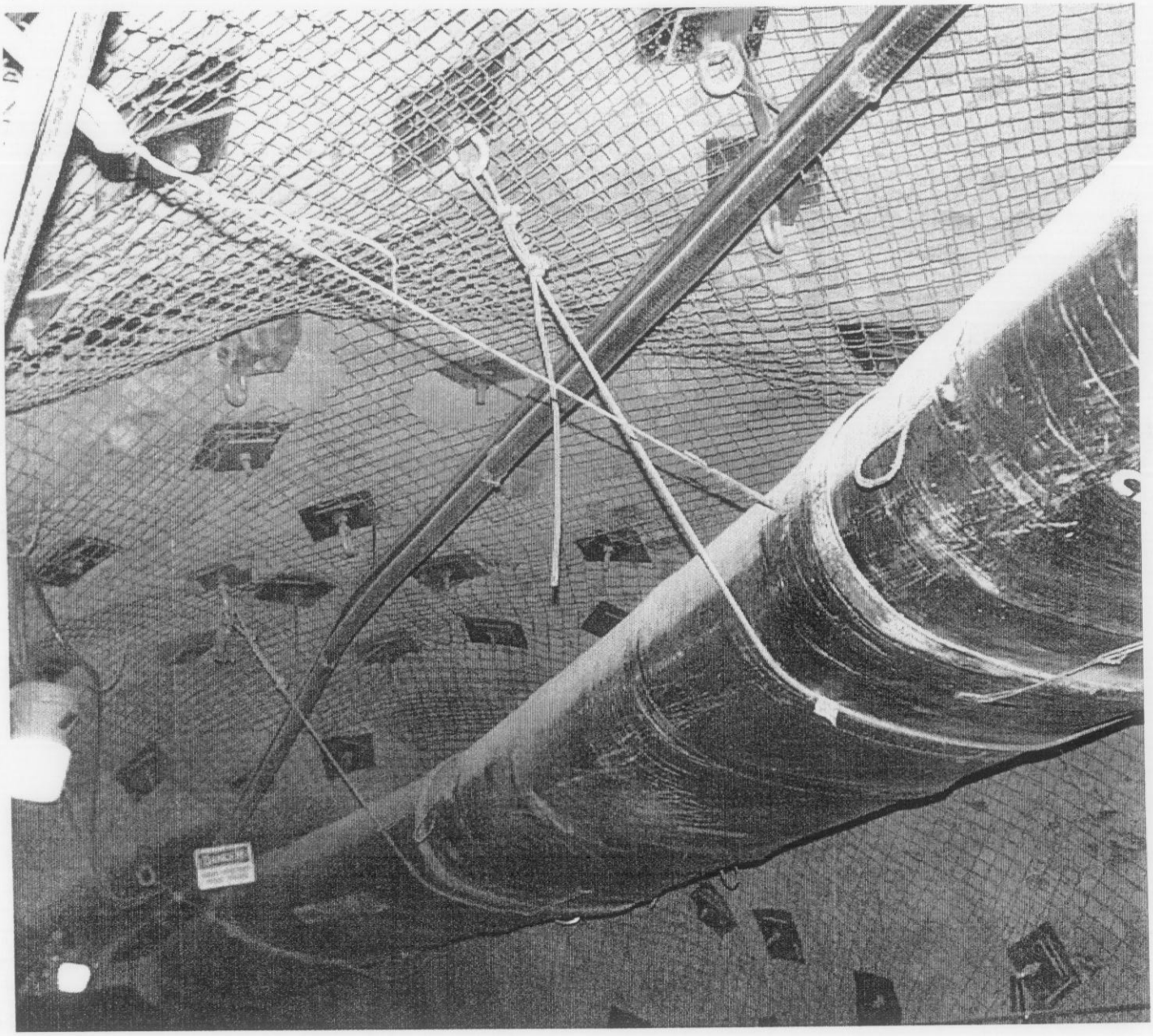


Figure 18: A loose cable does not appear to be adequate for the support of the intersection of large vent ducts.

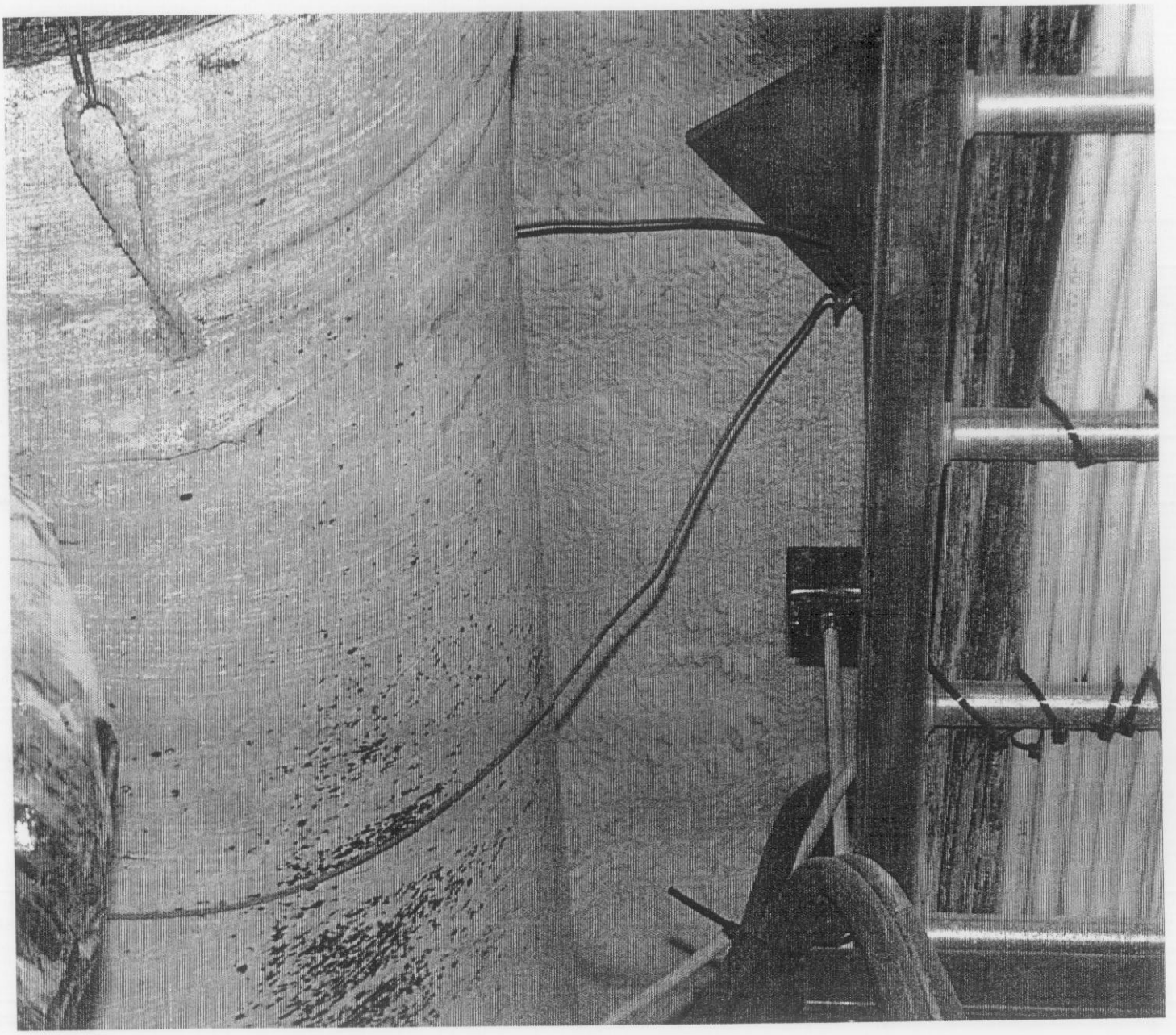


Figure 19: Free-standing cabinets are hazardous to worker safety in a refuge area during earthquake.

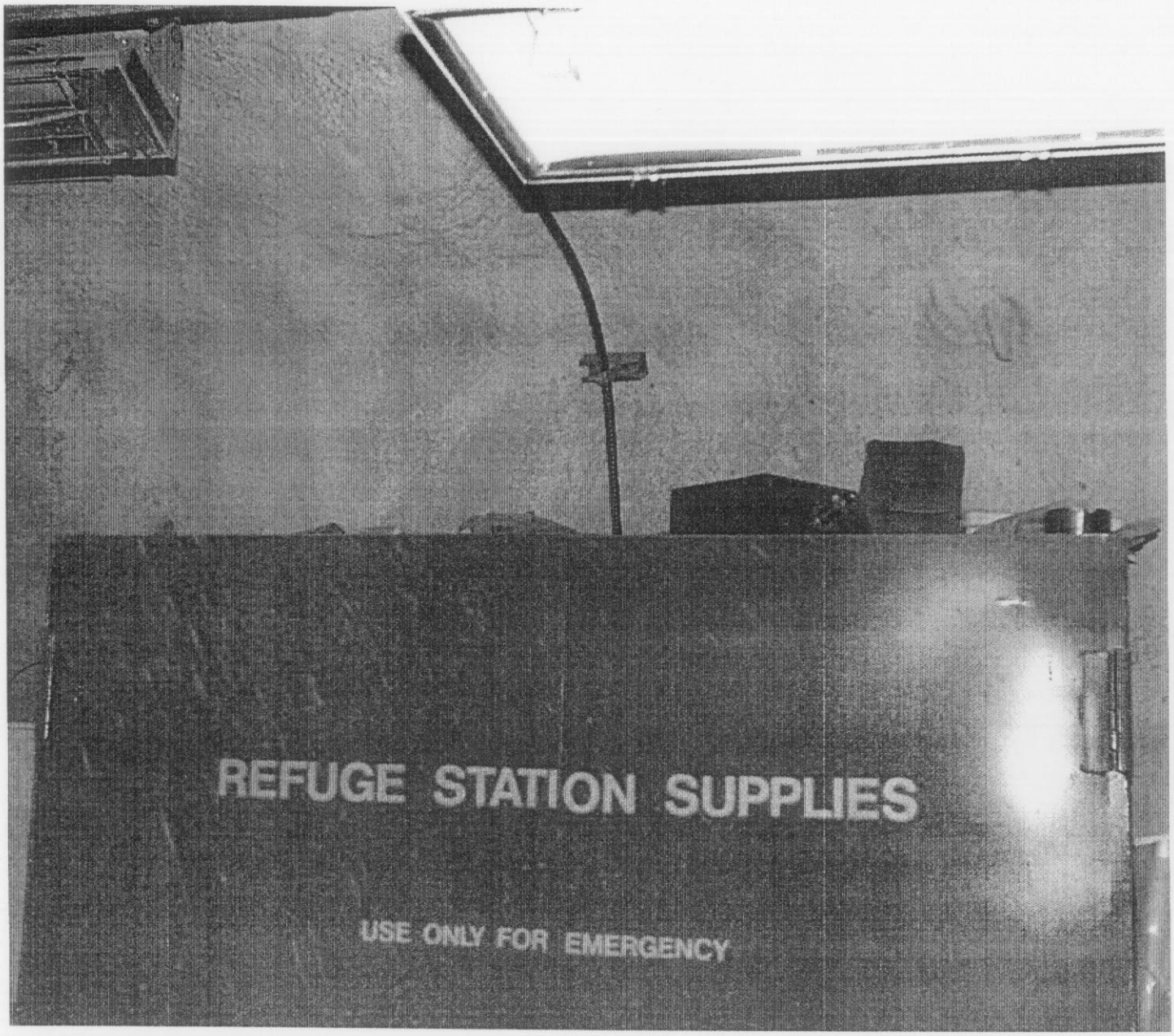


Figure 20: Loose wire restraint does not prevent interaction between the tall cabinets and may possibly damage the warning light.

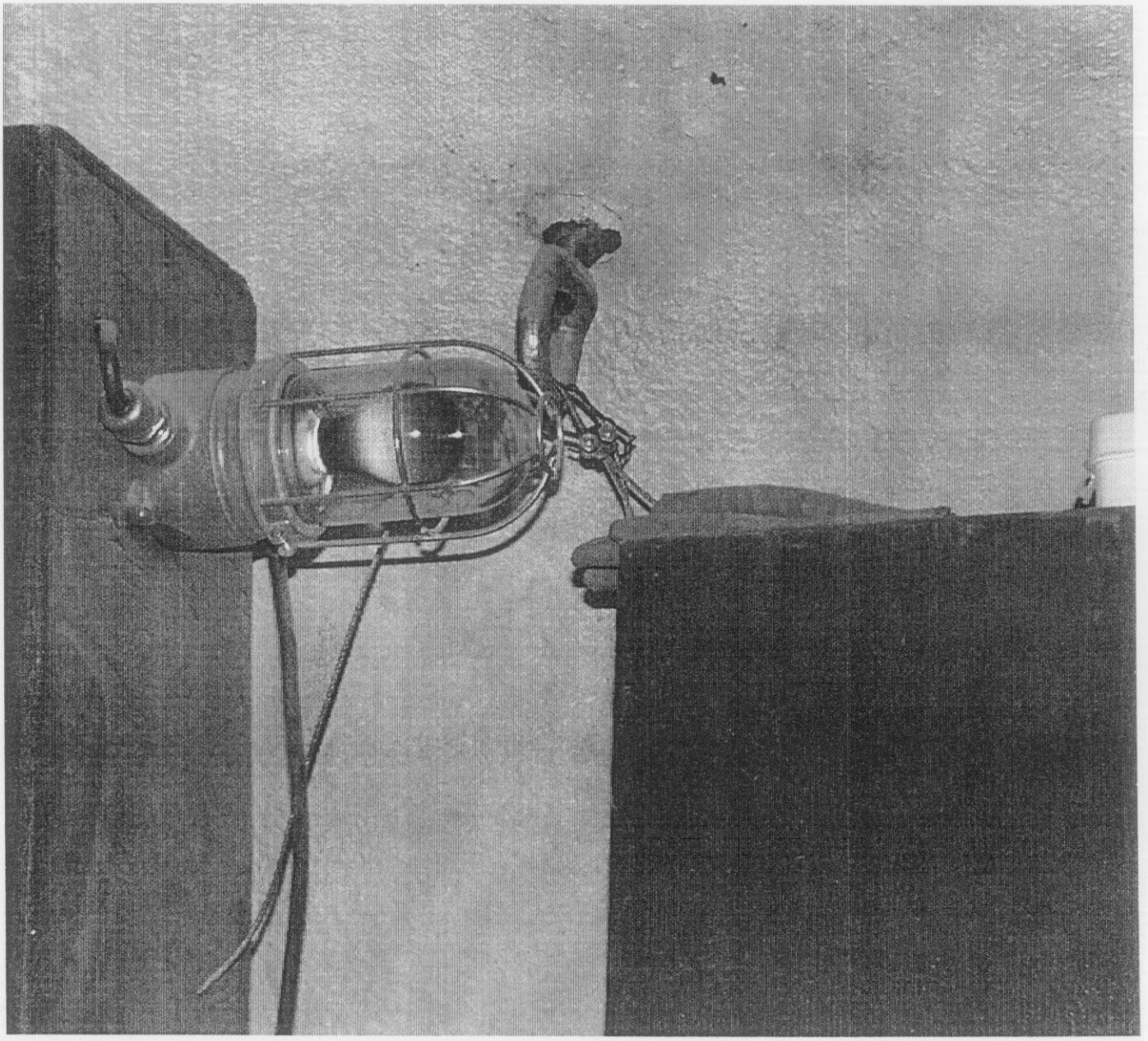


Figure 21: A typical anchorage of switch panel in the tunnel.

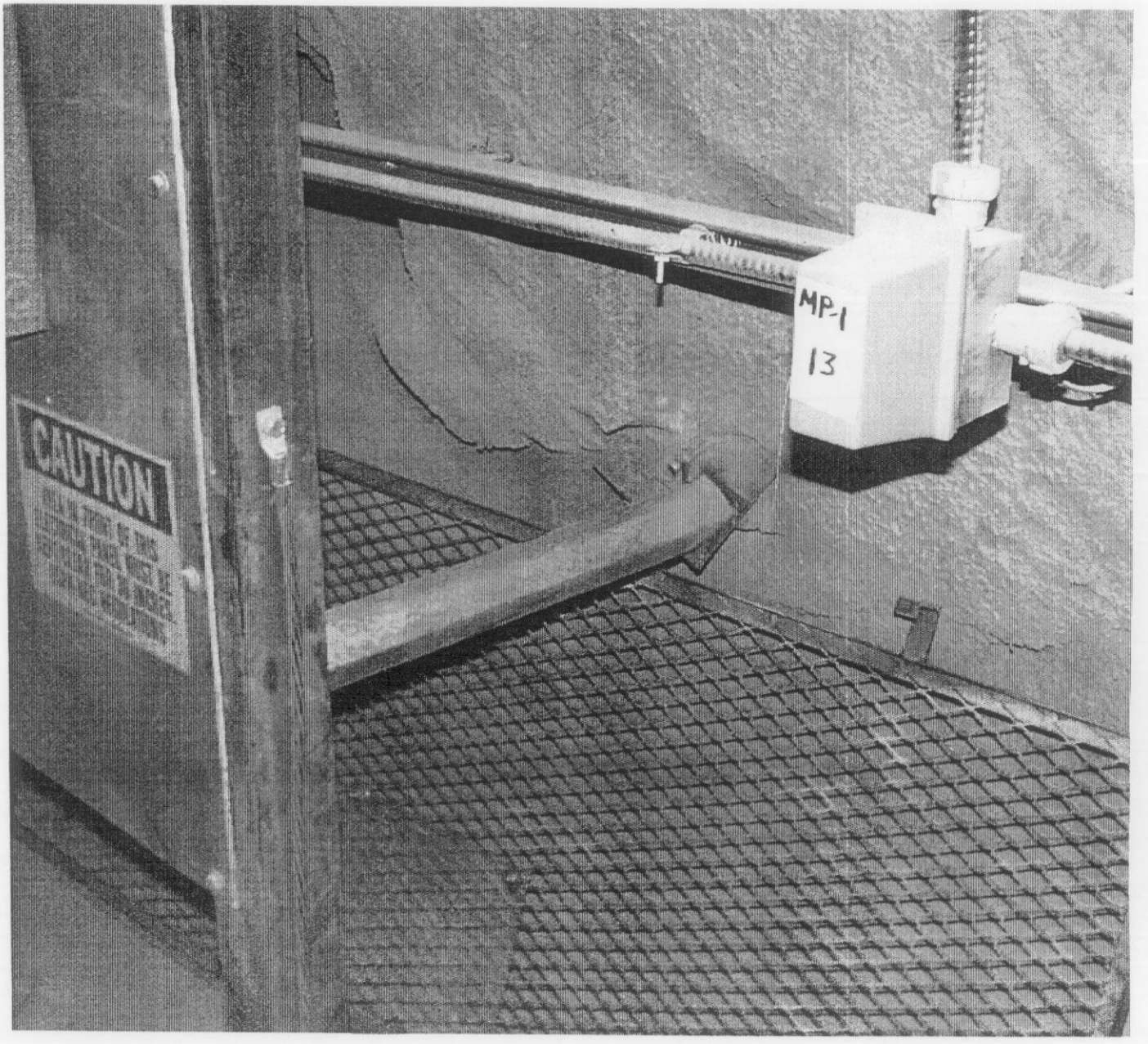


Figure 22: A typical anchorage of the air quality monitoring system.

Figure 23: Free-standing switches and diesel generator connected with rigid conduit.

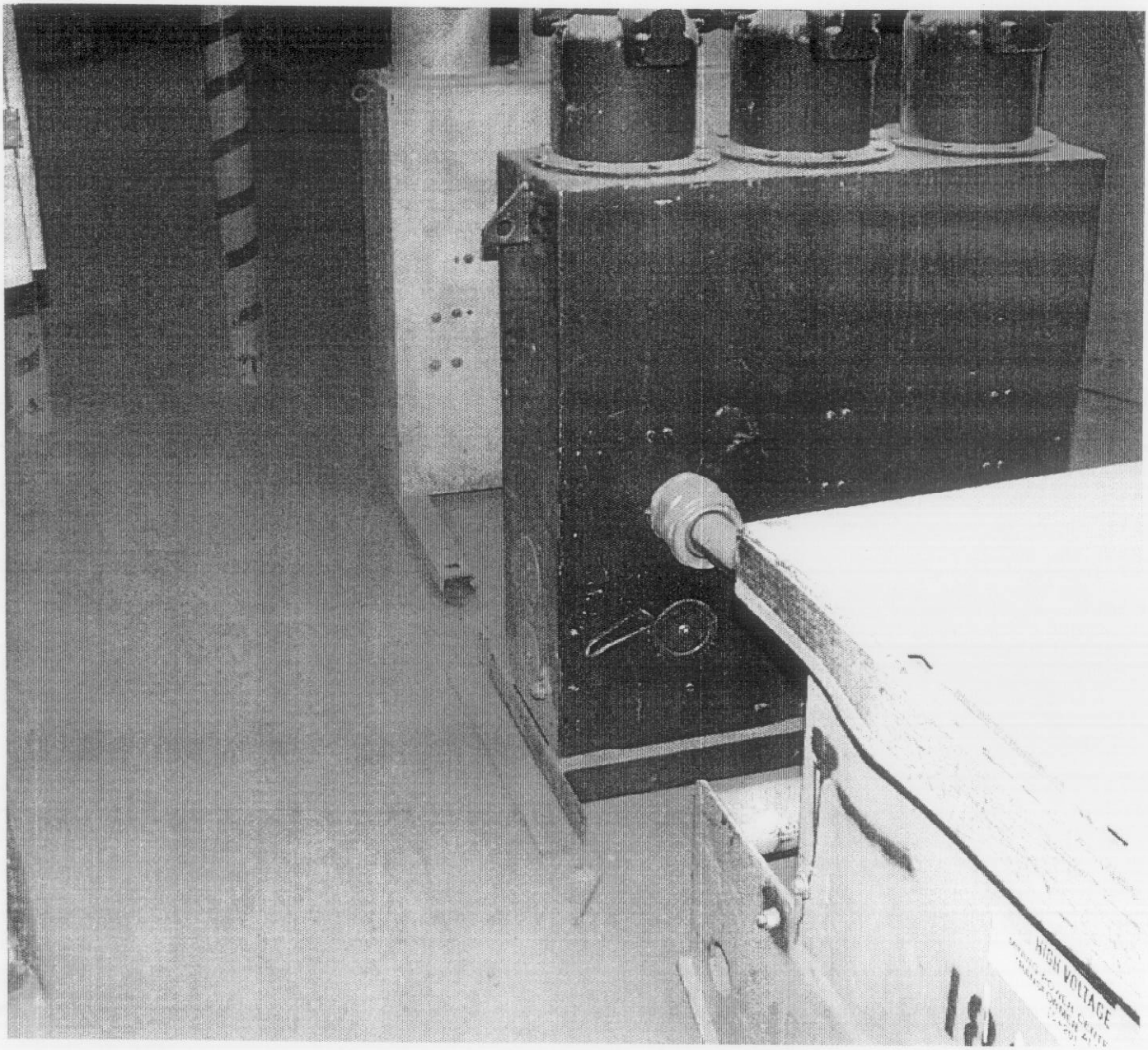


Figure 24: Groups of the instrumentation cabinets rest on timber blocks in the DX-12 Alcove.

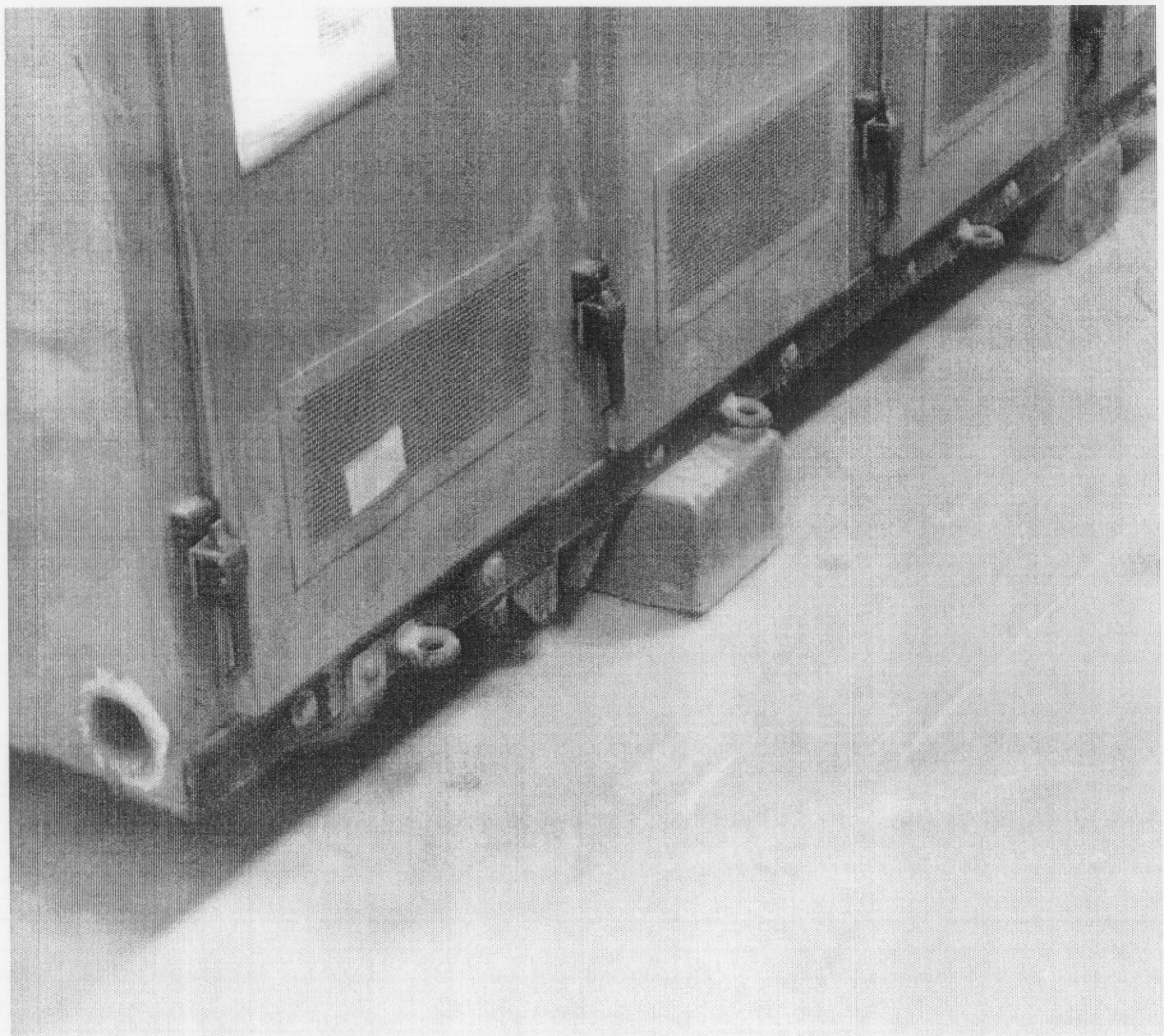


Figure 25: Groups of the instrumentation cabinets rest on timber blocks in the U1g Users Alcove.

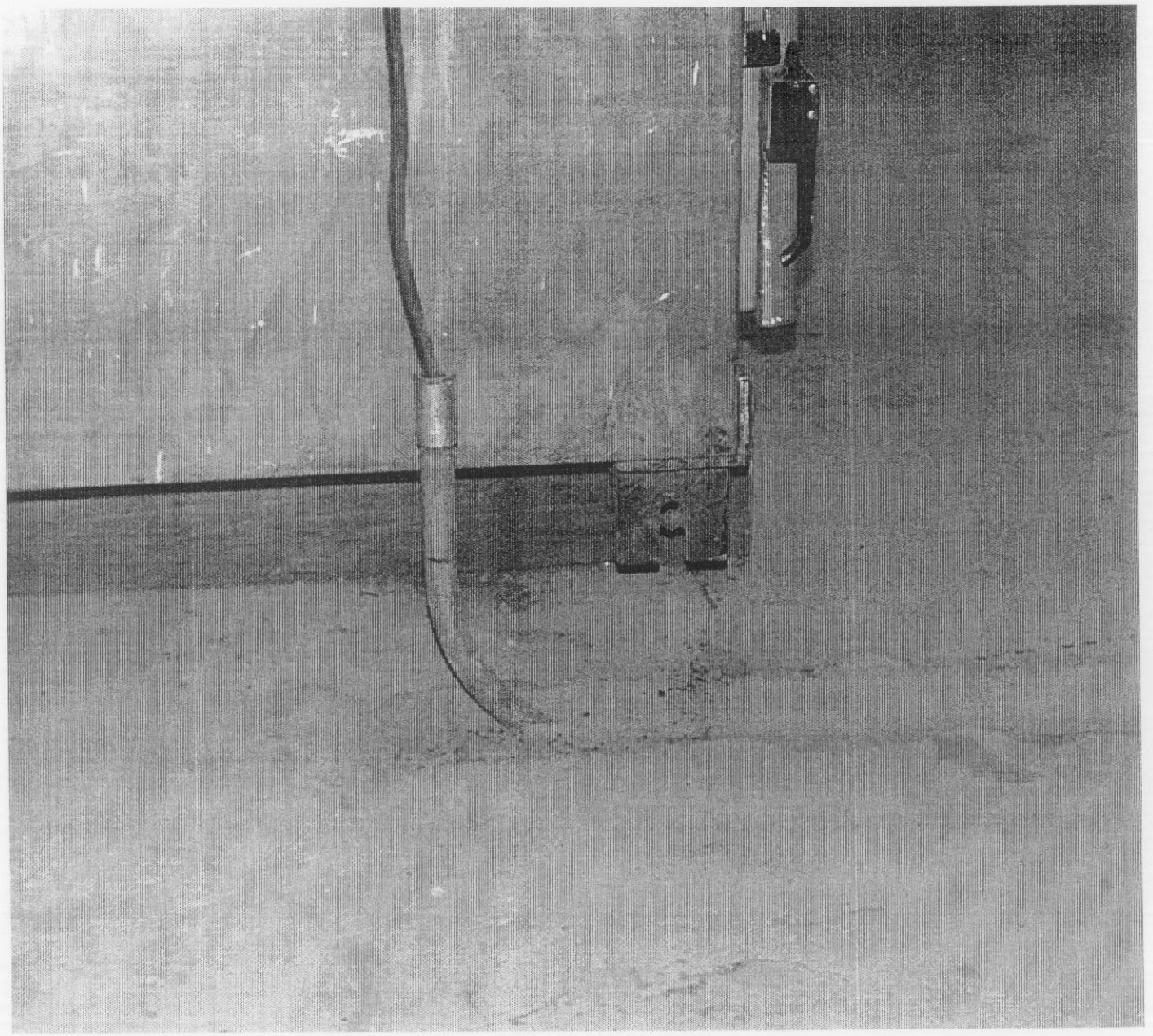


Figure 26: A typical anchorage for cable trays.

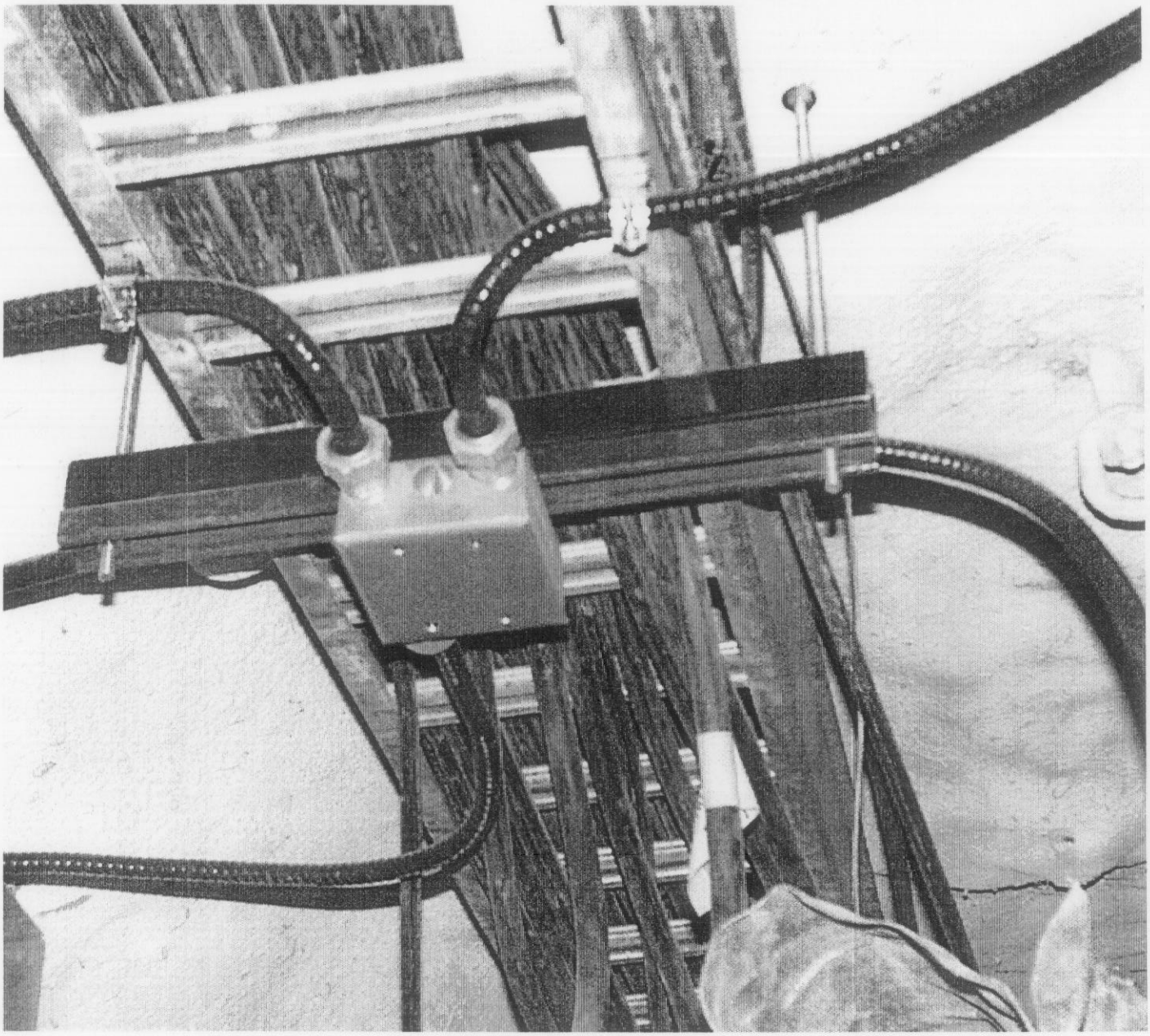


Figure 27: An A/C unit sits on four wheels and is connected to two ducts.

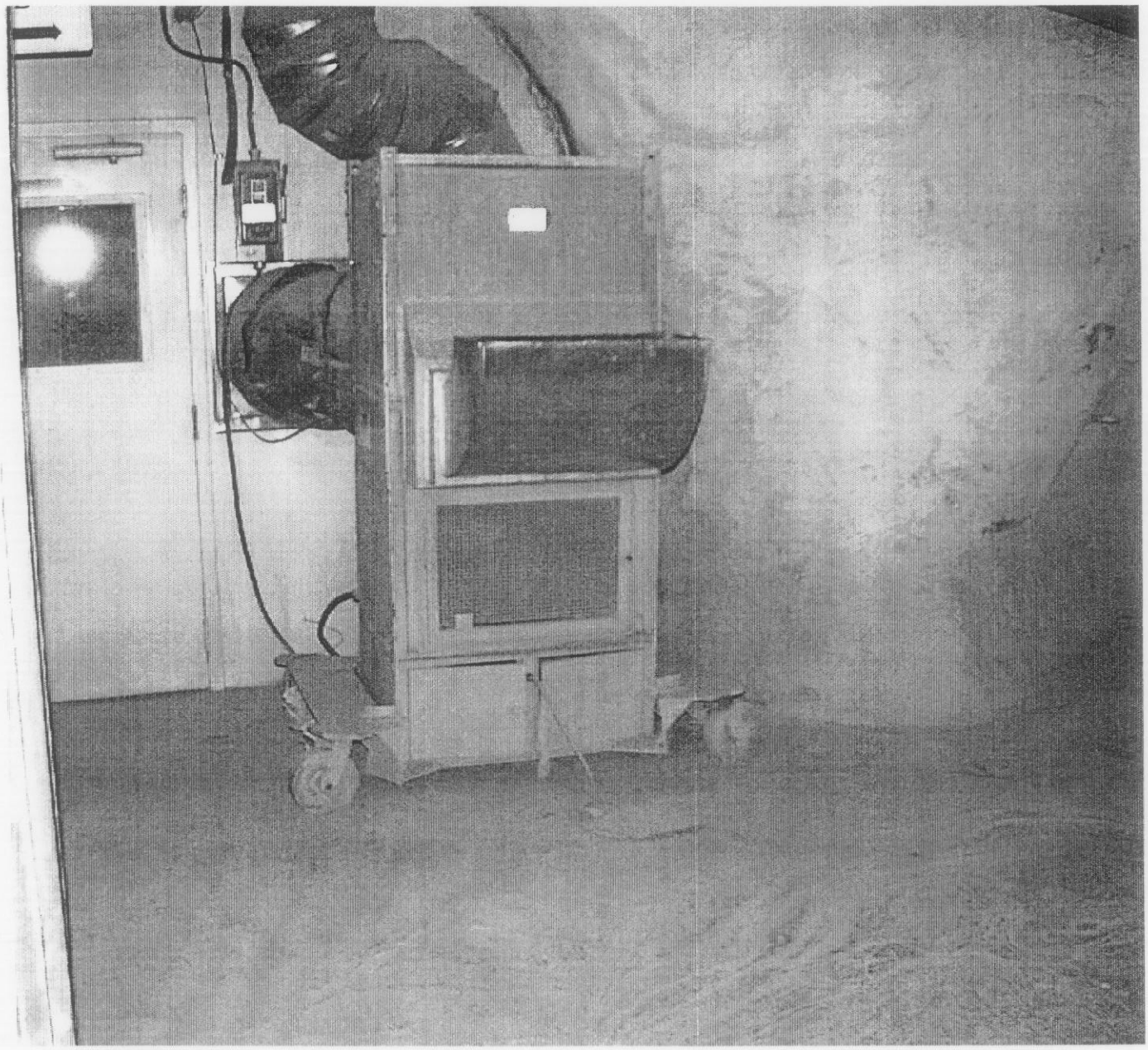


Figure 28: Multiple cable bundles are supported by U-shape hog wire.

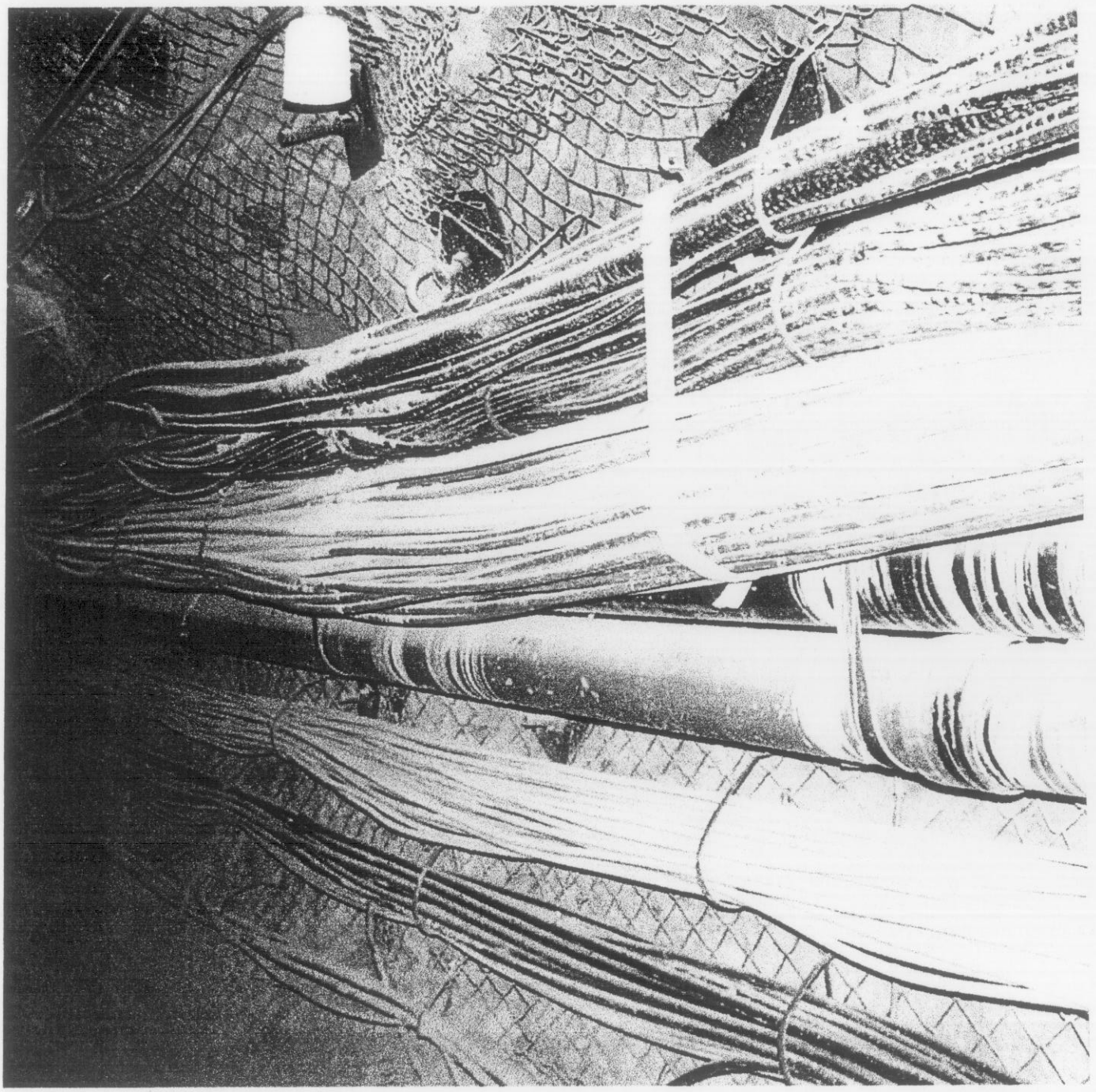


Figure 29: Storage racks do not have any safety mechanism to hold the contents in place.

6.0 References

Ref. 1 DOE/EH-0545, Seismic Evaluation Procedure for Equipment in U.S. Department of Energy Facilities, U.S. Department of Energy, Washington D.C., March 1997.

Ref. 2 DOE-ORDER 420.1, DOE Natural Phenomena Hazards Order, Washington D.C., DOE/SEP

Ref. 3 DOE-STD-1020-94, DOE Standard, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities, U.S. Department of Energy, Washington D.C., January 1996.

Ref. 4 DOE-STD-1021-93, DOE Standard, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components, U.S. Department of Energy, Washington D.C., January 1996.

Ref. 5 DOE-STD-1022-94, DOE Standard, Natural Phenomena Hazards Characterization Criteria, U.S. Department of Energy, Washington D.C., January 1996.

Ref. 6 DOE-STD-1023-95, DOE Standard, Natural Phenomena Hazards Performance Assessment Criteria, U.S. Department of Energy, Washington D.C., January 1996.

Ref. 7 K.J. Coppersmith, Simplified Seismic Hazard Analysis for Device Assembly Facility (DAF), Memorandum, Revised Report (2879), for Lawrence Livermore National Laboratory, March 1993.

Ref. 8 R.L. White, Status of U1a Seismic study, Interoffice memorandum, to Karl Hahn, Bechtel Nevada, RW-98-006, May 1998.

Ref. 9 L.J. Hutchings, S.P. Jarpe, P.W. Kasameyer, and W. Foxall, Synthetic Strong Ground Motions for Engineering Design Utilizing Empirical Green's Functions, Fourth Caldrons Seismic Research Workshop, July 9-11, 1996, UCRL-JC-123762, Preprint.

Ref. 10 Bechtel Corporation, System for Analysis of Soil Structure Interaction (SASSI) , Prepared for Lawrence Livermore National Laboratory, 1991.

Ref. 11 Robert Caccavale, U1a Head Frame Analysis, LLP-ENG-003, August 1996.

7.0 List of acronyms

A/C	Air conditioning unit
AQMS	Air quality monitoring system
BN	Bechtel Nevada
BNC	
CCTV	
DBE	Design Basis Earthquake
DBL	
DNFSB	Defence Nuclear Facility Safety Board
DOE	Department of Energy
DX-5	
DOE/EH	Department of Energy/Environment, Safety, and Health
F.O. HUB	
HSE	
HVAC	Heat, ventilation, and air conditioning
IT-20	
JTO	Joint Test Office
LANL	Las Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LS-12	
MCC	
MG	
MTR	
MWV	
NNWSI	
NTS	Nevada Test Site
P-14-GZ	
PC	Performance Category
PGA	Peak ground acceleration
PSU	
PT-101	
RAD	Radiation
SASSI	System for analysis of soil structure interaction analyses
SNL	Sandia National Laboratory
SRT	Seismic Review Team
SSC	Structure, system, and component
STD	Standard
Supr.	Supervisor
T & F	
UPS	Uninterrupted power supply

Interoffice Memorandum

To: Karl Hahn

Date: November 4, 1998

From: R. L. White
Scientific Specialist, BN

No.: RW-98-005

Subject: Status of U1A Seismic Study

The study is now operational. The electricians finally got a pig-tail pulled to the transformer alcove for us around noon yesterday. We had the instruments hooked within one hour after that. The data logger is now running using parameters that have been verified by Larry Hutchings. We will collect data for the next eight weeks. The unit has a 500 Mbyte drive on it, and if we see the drive is filling up (not very likely), we will dump data and send it on to Larry. Otherwise we will collect for the full period and then send the final data to Larry.

There is an issue that has not been considered. The Stagecoach event. At this time it is my intention, with Rod Shear's concurrence, to leave this system on event trigger. If the test causes a trigger, fine, if not, that's also fine. We are looking for earthquakes on this system, not explosions. If anyone feels we should switch to a continuous recording mode to ensure we get data, please let me know before 8 am Wednesday the 25th. That's the latest time I can change anything.

Concerns. I have one old concern. The noise at U1A/G. In quieter areas we set GS-13 channels to a gain of 32. I had to drop that to a gain of 1 for this study, as a gain of 32 sent the noise floor completely off the scale of my small test unit. The noise may be a greater factor than we originally considered.

_____
Name

Subject Code:

cc: Correspondence Control, M/S NLV008

Interoffice Memorandum
ADVANCE \d17 To: Karl Hahn Date:
DATE \@ "MMMM d, yyyy" May 29, 1998

From: R. L. White No.: RW-98-006
Scientific Specialist, BN

Subject: Status of U1A Seismic Study

On May 27, 1998 we again dumped the data from the datalogger in trailer B-72. There were 365 events logged, generating a file of about 106MB. I used a quick-look program to examine the event files and found only five or six that appear to be of a seismic nature. All the rest look to be caused by transient noises. I checked the University of Nevada Reno Earthquake Information database, but could find no correlation to any events recorded by our system. The recent quarter was very quiet again, seismically speaking. There was only one event over magnitude 4, and two over magnitude 3. As per Larry Hutchings request I have placed the data file on our ftp server so he can download it for further analysis. Also with Larry's concurrence I have modified the parameters for the data logger to see if we can catch some of the smaller earthquakes that we have detected with the Area 14 array. We will run the system for another 4 weeks.

_____
Name

Subject Code:

8.2 Appendix B

Seismic Evaluation Events

January 5,1998

A Position Paper was prepared which summarized the seismic hazard level for NTS and provided suggestions on "How to Proceed".

January 20 and 26,1998

Review Team met and discussed U1a Complex and philosophy for the review. The basic approach was adopted that assumed loss of commercial power and to focus on life safety rather than experimental equipment survival.

February 4,1998

LLNL presented an orientation seminar on seismic topics including DOE Natural Phenomena Policy and the DOE Seismic Evaluation Procedure which establishes an approach for system and component walkdown.

February 5,1998

Walkdown inspection of surface facilities by the team was conducted.

February ,1998

Additional walkdown of surface facilities by BN was conducted to gather additional data.

February 11,1998

Results of surface walkdown discussed and reviewed by team.

February 17-18,1998

Bechtel Corporate staff made a site visit to start their evaluations of the shaft and tunnel integrity and to estimate the ground motion at the -950 foot elevation.

February 18,1998

Walkdown inspection of subsurface facilities to develop a list of SSCs and place them into appropriate Performance Categories (PC).

February 20,1998

Met with BN and Sandia staff to define seismic instrumentation requirements and instrumentation locations at the surface and subsurface.

April 23,1998

Walkdown inspection of subsurface facilities to define actions needed.

April 24,1998

Review of walkdown results of subsurface facilities. Planning project documentation.

8.3 Appendix C

LLNL POSITION ON SEISMIC ISSUES AT THE U1A COMPLEX

ROBERT C. MURRAY
ANTHONY M. DAVITO

JANUARY 5, 1998

Available Guidance

Several documents exist that provide guidance in the seismic area for NTS. These are:

1997 Uniform Building Code (UBC)

This model code is prepared by the International Conference of Building Officials (ICBO), is formally updated and issued every three years, and is adopted by many communities as the Building Code to be enforced by their Building Department. NTS is in UBC Zone 3. Zone 4 provides a larger peak ground acceleration (PGA) which could be used for higher hazard facilities. The UBC values for Zone 3 and 4 are listed below:

Zone 3	0.3g PGA
Zone 4	0.4g PGA

The Uniform Building Code is a model code that is used mainly in the western United States. The seismic criteria portion of the code is prepared by the Structural Engineers Association of California (SEAOC) and is generally adopted completely by the ICBO. Other model Building Codes include the National Building Code used mostly in the northeast and the Standard Building Code used in the south. The National Earthquake Hazard Reduction Program (NEHRP), which has been established by congress in 1977, is working to unify the building code process in the seismic area. National hazard maps, prepared by the USGS, are available for definition of ground motion. Provisions have been prepared for design of facilities. The plan is for all the model Building Codes and the NEHRP Provisions to come together and one model Building Code is to be issues. They plan to issue the International Building Code in the year 2000 in the United States.

LLNL Mechanical Engineering Safety Manual

This manual is prepared by staff from the LLNL Mechanical Engineering Department . It provides design criteria for Livermore, Site-300, and NTS. There is a chapter which addresses wind and earthquake design criteria. The requirements for NTS are:

General Purpose Facility	0.30g PGA
Moderate or Low Hazard Facility	0.30g PGA
High Hazard Facility	0.46g PGA

Safety professionals would be asked to assist in selecting the category for each structure, system, or component (SSC) located at the U1A complex.

DOE Natural Phenomena Hazards (NPH)Policy

This policy consists of DOE Order 420.1 Facility Safety, its implementing guide, and DOE Standards on design/evaluation criteria, categorization, and determining the hazard level for the site. This policy was developed over many years with major input from LLNL. All DOE elements were asked for review comments. The question and comments were resolved and the policy issued. The same process was followed with presentations and resolution of comments from the DNFSB.

DOE-STD-1021 Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components

Provides guidance for placing each SSC into one of five performance categories (PCs), where:

PC 0 No Criteria
PC 1 Standard Building Code Criteria
PC 2 Building Code Criteria for Essential Facilities
PC 3 Intermediate Criteria above Building Codes and below Commercial Nuclear Power Plant Criteria
PC 4 Approaching Criteria used for Commercial Nuclear Power Plants.

DOE-STD-1020 Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities

Provides guidance on definition of the Design Basis Earthquake (DBE) and use of the DBE for design or evaluation of PC 1 through PC 4 SSCs. The criteria incorporates good practice and lessons learned from past earthquakes that have occurred world wide. For NTS (410 Area) this would require the following PGAs:

PC 1	0.30g PGA
PC 2	0.30g PGA
PC 3	0.34g PGA
PC 4	0.46g PGA.

A special study was also conducted for the DAF site by Geomatrix Consultants, Inc. in 1995. This was a simplified study, and generated a full hazard curve. The recommended value for PC 3 was 0.3g PGA. The corresponding values for NTS are:

PC 1	0.18g PGA
PC 2	0.20g PGA
PC 3	0.30g PGA
PC 4	0.50g PGA

The American Society of Civil Engineers have produced two Standards applicable to DOE facilities in the seismic area. They are:

ASCE 4-98, ASCE Standard for Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety Related Nuclear Structures

ASCE 7-95, ASCE Standard for Minimum Design Loads for Buildings and Other Structures.

DOE NPH Policy is consistent with these Standards and references them. There is an ongoing effort to convert DOE NPH Standards into ASCE and American Nuclear Society (ANS) Standards.

As can be seen above, there is available guidance in the area of seismic input for NTS from many sources.

Suggestions for U1A Complex

1. Provide orientation training on DOE NPH Policy and national trends in seismic policy to NTO, BN, LANL an LLNL staff involved in this process. LLNL has provided this training throughout the DOE complex from 1989 to 1995. In addition. LLNL has developed the DOE Seismic Evaluation Procedure, which lays out a cost effective approach, based on walkdowns and behavior of systems and components during past earthquakes, for reviewing systems and equipment.

   Product: Trained staff, knowledgeable in seismic criteria and its applications.

2. Categorize each of the structures, systems, and components into the five DOE established Performance Categories. The Performance Categories range from PC 0 (no criteria) to PC 4 (approaching nuclear power plant criteria). Enlist the assistance of safety and operations personal and any available safety or accident analyses. Get LANL and LLNL agreement on the Performance Category of each SSC.

   Product: Consensus list of each structure, system, and component at U1A with an assigned Performance Category.

3. Reach a consensus on the Design Basis Earthquake for the complex. Use available guidance from UBC, ME Safety Manual, DOE NPH Policy, and the USGS Hazard Mapping Project. Incorporate information that may be available from DAF and YMP. Establish ground motion for surface and underground structures for Performance Categories which cover the SSCs at U1A. Have the ground motion peer reviewed by a panel of experts.

   Product: Defensible surface and below grade ground motion (PGA and Response Spectra) for the SSCs at U1A.

4. Conduct a walkdown review of the SSCs for the established criteria and document the results.

   Product: List of SSCs with identified vulnerabilities (if any).

5. Upgrade SSCs as appropriate

   Product: Upgraded facility with upgrading process documented. Facility capable of meeting the seismic threat.

8.4 Appendix D

Interdepartmental letterhead
Mail Station L-126
Ext: 2-0314

Feb 24, 1998
SM98-11

To: **Tony Davito/Bob Murray**

From: **Dorothy S. Ng**

Subject: **Seismic Evaluation for the U1a Site**

Ref. 1. **R.L. White, Proposal for Seismic Studies at U1a/U1g, memorandum to Karl Hahn, 2/9/98.**

Ref. 2. **K.J. Coppersmith, Simplified Seismic Hazard Analysis for Device Assembly Facility (DAF) Revised Report (2879), memorandum to Dorothy Ng, 3/13/95.**

Ref. 3. **Norm Burkhart, S- and P-Wave Velocity Profile (Figure 13B), plot to Bob Murray, Received 2/13/98.**

Ref. 4. **Civilian Radioactive Waste Management System, LV, NV, Seismic Design Inputs for the Exploratory Studies Facility at Yucca Mountain, Technical Report, Figure C-4, P- and S-Wave Velocity Profiles for the ESF (after Subramanian et al., 1990 and Rogers et al., 1987).**

Ref. 5. **Bechtel Nevada, U1a Ground Support Task Plan, received on 2/20/98.**

Ref. 6. **Fenix and Scisson, Inc., U1a Steel Shaft Sets, U1a Steel Shaft Sets Details, U1a Guide & Pipe Brackets Details, U1a Shaft Elevation, Shaft Steel Lagging Sections, & Details, Shaft Collar Plan Section, & Details, October 1968.**

This memorandum documents the seismic walkdown for the U1a downhole and the following meetings:

Date	Time	Location	Subject	Participants
2/18/98	1:00 pm	U1a	Walkdown postmortem	Schechter, Sahni, Ng
2/18/98	3:30 pm	B600	Seismic motion measurement	White, Hahn, Ng
2/19/98	2:00 pm	U1a	Seismic evaluation	Gurbuz, Arango, McCamant, Ng
2/20/98	10:00 am	U1a	Seismic motion measurement	Shear, White, Hutchings, Ng
2/20/98	2:15 pm	B3/LV	Seismic evaluation	Gurbuz, Arango, Hutchings, Schechter, Ng
2/20/98	3:00 pm	B3/LV	Walkdown report review	Schechter, Sahni, Hutchings, Ng

The seismic walkdown for the U1A downhole

The seismic walkdown team was composed of the following six members:

Name	Organization
Davito, Tony	LLNL
Hahn, Karl	LANL
Livingston, Rex	BN
Ng, Dorothy	LLNL
Sahni, Vinod	BN
Schechter, Ken	BN

The walkdown started from inspecting the shaft. The cage traveled slowly with occasional stops so that we could visually inspect the structure of the shaft and identify the utilities that ran along side the wall of the shaft. The shaft was built in 6-foot sections of steel frame consisted of steel channel columns and wideflange beams. The first 2 sections of the shaft from the ground are lined with concrete panels which edges are encased in steel wideflange beams behind the channel columns.

Below the concrete sections are wood laggings. The wood laggings are situated in wideflange beams with wood gage block shimmed in the exterior flange. Uneven gaps could be seen between the wood laggings. The large gaps were covered with narrow-thin boards to keep the silt from leaking into the shaft. Some sections were steel laggings made of woven wire meshes.

For alignment purpose, several sections were made of concrete. Steel bearing channels were also added below the wideflange beams horizontally and penetrated the soil at both ends by about 3 feet. These bearing channels are supposed to be at 48 feet spacing. However, I have counted more than 8 sections bearing channel spacing at the elevation closed to the downhole.

The utilities include emergency power, communication, air quality monitoring system, air vent, and fire suppression system. Most of the systems are in 1"-diameter cables except the 4"-diameter air pipe, 20" diameter vent, and the 2"-diameter water line. All cables and pipes were bracketed to the wideflange beams.

Next to the cage are the steel evacuation ladders with landings spaced at 18 feet vertically (a span of 3 sections). This is an emergency evacuation route in case of the cage being out of service. The landings is #5 extended metal being tack welded to the wideflange beams. The ladder is welded on the extended metal. The connectivity of the evacuation ladder and landing appeared to be adequate. The miner's record speed of climbing the entire length of the ladder is 22 minutes.

In the downhole, the focus was to identify the equipment and systems in various areas and to assign their classification. The walkdown report documents the equipment and systems grouped for the individual areas. The following is my observation:

A lot of cables are strapped in the plastic lined U-shaped metal straps in bundles along the wall of the main and side drifts. The U-shape metal straps have hooks at the ends which are hooked on the tunnel wall covering mesh. The anchorage of the cables are at irregular spacing. Most of them are for experiment and are classified as PC0.

The air duct is a 48" diameter tube in the main drift. As it branched off to the side tunnels the cross-sections are smaller, some of which is circular while other is oval. The air inlet duct is mostly 15" diameter tube in the alcoves. The support of these ducts varies from 4/1" guard wires to small gage wires and at irregular spacing. Some air inlet ducts are rested on top of the instrumentation cabinets, such as in the 04 Detection Alcove. The anchorage of the entire air duct may need further field inspection.

The regular lighting are provided at even spacing. When the normal power supply failure occurs, every fourth light becomes the emergency light powered by the emergency power system. The power cable for the lights are strapped onto unistruts which are tied to the tunnel wall reinforcing rods.

Along the 02 drift, there are 2-6" conduits for fire arming cables. They are strapped to the unistruts which are tied to the tunnel wall reinforcing rods. Again, the anchorage spacing is irregular and need further field inspection.

Along the main drift between the 02 and vent drifts, there are two rectangular box conduits. They are reinforced by two unistrut along their length on the back face. These unistruts are tied to vertical unistruts which are braced to the tunnel wall reinforcing rods by two metal strips. The spacing of the tied rods are not measured and need further inspection.

In the 04 Detection Alcove and U-shape Vent Drift Alcove, the instrumentation cabinets are bolted to the base angles, two bolts per cabinet. The base angles are rested on 6" x 8" wood blocks. There is no tiedown on the top of the cabinets. The cabinets are about 15" x 30" and over six feet tall. They are placed side-by-side with doors on both narrow ends of the cabinets for easy access. These cabinets contain diagnostics equipment and control panels. Some of them are cooled by chilled water system. They are classified as PC1 equipment. At low g-level the base tiedown appeared to be adequate because the cabinet foot print is large, over 30" by 6 to 8 feet.

In the heavily equipped areas, such as, the 04 Detection Alcove and U-shape Vent Drift Alcove, the cables are supported by double-deck trays. The upper deck has a pair of trays rested on horizontal unistruts. The unistruts are supported by a single rod welded to the tunnel wall reinforcing rod. The support spacing is irregular. There is no lateral supports. The lower deck has one tray rested on unistruts. The unistruts are tied to the unistrut of the upper deck by two metal strips. The lower cable tray puts an eccentricity load in the single rods, vertical supports. The spacing of the lower deck support is not clear. It appears to me that some part of the lower cable tray sits on the top of the cabinets. Therefore, further inspection is needed.

In the 06 drift, the heavy equipment, such as water chiller, freon drum, and the yellow generator are placed on the ground or inside a basin on the ground. Their anchorage appeared to be adequate. The tiedown for the 10" pipe for gas (?) was not obvious and need to be investigated further.

In U1g area, the Transformer Alcove, the equipment racks contain heavy tools. The racks do not have doors or chains to secure the tools from falling off the racks. The racks also need tiedown.

Along the drift, there are many cabinets for the emergency supply, such as, stretcher. They are not tied down to the wall. The cabinets in the refuge centers are also not tied down. The tiedown of the house hold cabinets will be addressed in the walkdown report in the general notes.

The downhole walkdown was a difficult task. Most of the systems are common to all areas yet the anchorage of the systems are mostly irregular. Most of the anchorage is too high to be visible to me. Although the ground motion in the downhole is not known, it is safe to claim that the ground motion will be less than 0.3g. At low ground acceleration some of the anchorage may be sufficient regardless that the spacing is irregular.

Meeting Minutes

Date	Time	Location	Subject	Participants
2/18/98	1:00 pm	U1a	Walkdown postmortem	Schechter, Sahni, Ng

Walkdown postmortem meeting was held to compare notes. According to Schechter, it is determined that all the PC1 and PC2 systems are subjected to evaluation. The matrix will have evaluation for all PC1 and PC2 systems. I believe some of the systems are adequately supported while the others do need further field inspection. Ken was eager to submit the matrices to Martin by the end of February; therefore, the additional walkdown had to be performed after the matrices were submitted.

I believe declaring that all downhole PC1 and PC2 systems are needed to be evaluated will discredit our service. The word "evaluation" was used in the anchorage for the above ground equipment or trailers because we have identified the need for them. When the same word "evaluation" is used in the PC1 and PC2 systems the readers will interpret the same way. It would be more appropriate to replace the word "evaluate" to further field inspection. We should schedule a second walkdown as soon as the matrix for downhole is ready. The matrix may be helpful in recording the conditions of the anchorage during the inspection. I am not sure that Schechter and Sahni were convinced.

Vinod believed that the matrix should be ready for faxing on Tuesday, 2/24/98. I have received three sets of the above ground walkdown matrix with drawings for our review (Davito, Murray, Ng).

Date	Time	Location	Subject	Participants
2/18/98	3:30 pm	B600	Seismic motion measurement	White, Hahn, Ng

We discussed the locations for the seismic motion recorder. I received a proposal (Ref. 1) prepared by White. We all believe that the best location in downhole is in the small room at the end of the main drift (Transformer Alcove). White also suggested to locate the recorder at the location directly above the downhole recorder. However, they found that directly above the downhole recorder there is a sump surrounded by earth embankment. The recorder has to be placed about 50 feet off the downhole recorder, to clear the embankment.

I requested that White to meet with Hutchings on Friday morning, 2/20/98, to further discuss the detail of the recording. Since Hutchings will analyze the recorded data to obtain the ground motions for the site above ground and downhole, it is important for him to study the geometric configuration of the site and to review the locations of the recording instruments.

A meeting was set for 10:00 am, Friday morning, and Rod Shear will join us. Shear is from Sandia responsible for the short term seismic studies at the NTS. Both Shear and White were willing to meet us on their day off.

Date	Time	Location	Subject	Participants
2/19/98	2:00 pm	U1a	Seismic evaluation	Gurbuz, Arango, McCamant, Ng

The purpose of this meeting is to discuss the Bechtel and LLNL seismic evaluation plans. The seismic instrumentation was discussed. I showed them the locations for instrumentation on the site drawing. The ground motions from Hutchings' analysis will be provided to Gurbuz for structural analysis of the downhole.

The ground characteristics was discussed. The memo documenting the probability seismic hazard assessment (PSHA) for the Device Assembly Facility (DAF) (Ref. 2) were discussed. The DAF is about 10 miles from U1a. It is believed the soil conditions for both DAF and U1a to be similar, alluvium.

The seismic characteristics in the U1A site was discussed. Based on the DAF memo, both DAF and U1a are close to the same faults; namely, Cane Spring, Mine Mountains, and Yucca Fault. Based on the earthquake (EQ) distribution map, the EQs in the area are magnitude of 5 or smaller. Their rupture lengths and slip rates are small in comparison with the other faults in NTS. The DAF hazard curve is affected by the background seismic data not by the local faults. We agreed that the seismic data used in the PSHA for the DAF and its resulting hazard curve is applicable to U1a. A copy of the memo was distributed to Gurbuz and Arango.

The shear-wave velocity was also discussed. A copy of shear-wave velocity (Ref. 3) used in the PSHA for the Yucca Mountain (YM) Project was provided to Gurbuz and Arango for their information. This velocity plot was compared with the shear-wave velocity plot (Ref. 4) provided by Norm Burkhart. A shear-wave velocity of about 2 km/sec at 1000 feet below ground was calculated by Arango by hand which is consistent with the YM profile. However, the YM site is located on rock. Its shear-wave velocity profile is quite different from that shows in Burkhart's profile which will be applied to the site analysis by Chen (LLNL).

Gurbuz and Arango felt that they need more time to plan their seismic evaluation for U1a. They were aware of Hutchings' visit on Friday and expressed interest to meet with Hutchings. A meeting was scheduled for Friday, 2:00 pm, at B3 in Las Vegas, to further discuss the Bechtel seismic evaluation.

Date	Time	Location	Subject	Participants
2/20/98	10:00 am	U1a	Seismic motion measurement	Shear, White, Hutchings, Ng

The meeting was held in the Superintendent Trailer at U1a. The tasks have be identified as below:

- Sandia provides the instrumentation.
- U1a provides the cables.
- Sandia collect the data and filter the background noise.
- LLNL analyzes the data.

We showed the locations for the seismic motion recorder to Hutchings on the site drawing. The available instrumentation can only take the vertical velocity component. Hutchings needs the velocity time history in three orthogonal directions. According to White, a datalogger is in the shop for refurbishment and it may be ready in two weeks. With that datalogger, they can record three velocity components.

Sandia will filter the machinery background noise from the measured data. They had good results from a magnitude of 3 to 4 EQ event. In the U1a area, there is one 3 or 4 EQ event every 4 to 6 weeks. Sandia plans to record the ground motions for 6 to 8 weeks. We may have some good data for Hutchings by mid April if Mother Nature cooperates. The recorded EQ event will be confirmed by the records taken at the University of Reno Seismological Laboratory. Shear mentioned that if we need the recording for longer period they might be able to extend the recording period.

After the discussion, we went downhole. The recording location in the downhole is in the small room at the end of the main drift (Transformer Alcove). The room was isolated from the rest of the downhole in order to collect stagnant air for sampling. The physical isolation is perfect for measuring ground motion. Besides, the floor is concrete, adequate for motion transmission.

Shear showed us the instrumentation cabinet in the U-shape Alcove. He also showed us the cable route which goes through the Emergency evacuation shaft cable hole. He is sure that the signal will maintain its quality.

After downhole, we went above ground to the U1G area. A large sump is located directly above the downhole recorder location surrounded by earth embankment. The suggested location is too close to the 100-HP fan used of the air ventilation. Hutchings suggested to move it to the base of embankment on the right hand corner of the sump which is closer to the instrumentation trailer farther from the fan.

Date	Time	Location	Subject	Participants
2/20/98	2:15 pm	B3/LV	Seismic evaluation	Gurbuz, Arango, Hutchings, Schechter, Ng

Hutchings presented his plan for data analysis. Gurbuz pushed for the ground motion to be released by the end of March. The reason is that Gurbuz and Arango committed to provide a report addressing a list of seismic questions (seismic evaluation objectives, Ref. 5) raised by McCamant. Downhole ground motion is what they need to evaluation those questions. They provided us the list of seismic questions.

We could not commit to that date. The reason is that as mentioned in the previous meeting, the instrumentation will be in mid March. We might get the data around mid April. Gurbuz suggested to guesstimate a ground acceleration value of about 0.2g. The rest of us preferred to wait for the data analysis.

As we discussed the seismic evaluation, I reminded Gurbuz and Arango that the decision was made to comply with the Uniform Building Code, applying a magnitude of 0.3g to the evaluation of the PC1 and PC2 systems and equipment. Decision has not be made on what response spectra will be used. Ref. 2 provides a response spectra generated from the PSHA. Hutchings can also generates response spectra from the ground motion measurement. The choice of response spectra may be made by comparing the spectra from both sources.

We discussed the ground motion. I provided a copy of PGA versus depth profile generated for the YM Project for 500-year return. The profile shows sharp reduction in acceleration through 80 meters below ground. The acceleration reduces a little more from 80 to 200 meters below ground. YM is on rock site while U1a is on alluvium site. Alluvium has higher damping than rock. According to Hutchings, the reduction of ground acceleration at the U1a site will be significant than those showed in the YM profile. He predicted a value of about 0.1g at 1,000 feet below ground.

Gurbuz would like to discuss with Murray in the future on the list of objectives raised by McCamant.

Date	Time	Location	Subject	Participants
2/20/98	3:00 pm	B3/LV	Walkdown report review	Schechter, Sahni, Hutchings, Ng

We went over the matrix which was in a draft form. Sahni preferred to complete the matrix before any review. He believed that the matrix should be ready for faxing to me on 2/24/98.

I mentioned that I had counted more than 8 sections between the bearing channels in the shaft. Sahni provided me a set drawings of the shaft design (Ref. 6). The drawing shows bearing set spacing of 8 sections. However, that might not be the as built drawings. we can check the spacing in out next walkdown.

No walkdown was scheduled because Schechter preferred to complete the matrix for Martin. I suggest to schedule a walkdown early next week.

Distribution: (w/o attachment)

Arango, Ignacio	BN
Gurbuz, Orhan	BN
Hahn, Karl	LANL
Hutchings, Larry	LLNL
McCamant, Randy	BN
Schechter, Ken	BN
Shear, Rod	Sandia
Sahni, Vinod	BN
White, Bob	BN

8.5 Appendix E

U1a Seismic Evaluation - Surface Facility Matrix (See Figure 2 for locations.) Revision No. 1 Date: September 8,1998.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
1	Substation # 102	0	N	No action required.
2	P-Division Trailer	1	N	No action required.
3	DX-Division LANL Trailer	1	Y	Evaluate trailer lateral restraint requirements, AC mounted on side and duct on top of trailer.
4	JTO Conference Room # 502762	1	Y	Evaluate for trailer lateral restraint, and AC/Duct on trailer top.
5	JTO Backboard	0	N	No action required.
6	LLNL 986 Trailer	1	Y	Install lateral restraint at south end in 2-directions.
7	Butler Arms LLNL Trailer	1	N	No action required.
8	LLNL Trailer joined w/ Butler Arms LLNL Trailer	1	N	No action required.
9	Air Conditioning unit 103	0	N	No action required.
10	High Voltage Unit No. 3541-3	0	N	No action required.
11	Air Conditioning unit	0	N	No action required.
12	JTO Field Office & Workshop (Office & Storage) J-7-1	1	Y	Evaluate lateral/vertical restraint.
13	DX-5 Workshop, J-7	0	N	No action required.
14	Substation # 13	0	N	No action required.
15	RAD Safe Base Station	0	N	No action required.
16	UPS 01	0	N	No action required.
17	LANL Field Offices (2)	0	N	No action required.
18	Field Supr. Office	0	N	No action required.
19	Railroad Car	0	N	No action required.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
20	Assembly Bldg. (Air Bldg.)	1	Y	Keep the exits clear of all obstructions (Keep good house-keeping). Evaluate tie-downs requirements for all cabinets including chemical cabinets. Evaluate air filter plenum for tie-down.
21	Air Conditioning unit	0	N	No action required.
22	Electricity Panel	0	N	No action required.
23	Storage	0	N	No action required.
24	Mine Rescue	1	Y	Evaluate lateral restraint for trailer and mounted equipment. Evaluate any adjacent items that could fall over on this equipment. Keep good house-keeping in the vicinity of this equipment.
25	Electricity Panel	0	N	No action required.
26	Engine Generator/Conc. Pad	1	Y	Install generator on new already designed concrete pad with containment curb. Anchor unit to pad. For further evaluation refer to item no. 27.
27	Hoist Commercial Power	0	Y	Install missing anchor bolts, and additional bolts as required (1 - AB at each corner of equipment). Open the cabinet and inspect for anchorage. Evaluate the effect of the transformer failure on all adjacent items including items no. 26 & 29.
28	Electricity Panel	0	N	No action required.
29	Emergency Backup	1	Y	For evaluation refer to items no. 27 & 32.
30	Electricity Panel	0	Y	Evaluate for anchorage.
31	Communication Panel	0	Y	Evaluate for anchorage.
32	Hoist House	1	Y	Evaluate existing bolt anchorage for the cabinets. Anchorage required for air compressor. Evaluate the metal structure (Kelly Klosure Systems) for wind resistance. Evaluate the effect of the structure failure on item no. 29.
33	4160 DBL Switch	0	Y	Evaluate for anchorage.
34	Head Frame	2	N	No action required.
35	HSE-1-3, Weather Station	0	N	No action required.
36	Emergency Backup Hoist	1	Y	Evaluate lateral restraint for trailer and items installed on it.
37	Access Control Bldg. (Metal Shed)	1	Y	Evaluate lateral restraint requirements for Air Quality Monitoring & Scanning Monitor equipment. Evaluate building for wind resistance.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
38	Shaft Spray Tanks #1 & #2	0	Y	Evaluate tie-down anchorage, cracked weld at tank support (north-east corner of Tank #2). Evaluate flexible connections for pipes attached to tanks.
39	MCC	0	Y	Evaluate anchorage.
40	MCC	0	Y	Evaluate anchorage.
41	Ventilation Fans	0	Y	Evaluate anchorage.
42	Ventilation Exhaust	0	N	No action required.
43	Equipment Trailer	0	N	No action required.
44	Gas Bottles Storage	0	Y	Evaluate lateral restraint requirements for storage shed and chains for the bottles.
45	Lube Oil Shed 38201	0	Y	Evaluate equipment tie-downs.
46	Storage Bldg. #1	0	N	No action required.
47	Mechanics/Minors Shop	1	Y	Evaluate tie-downs for tall cabinets, cabinets containing flammable liquids, equipment including drill-press. Add loops around light fixtures to prevent fixtures falling out during interaction.
48	1000 Gallons Water Tank	1	Y	Evaluate tank structure including eccentric column anchorage at the concrete pad.
49	Mechanics Storage (2)	0	N	No action required.
50	Miners Storage (2)	0	N	No action required.
51	Water Tank	0	Y	Evaluate lateral restraint requirements for the trailer and flexible connection for the pipe attached to the tank.
52	Electricity Workshop	0	N	No action required.
53	Electricity/Pipe Fitters Storage (2)	0	N	No action required.
54	Phone Skid	1	Y	Evaluate lateral restraint requirements.
55	LANL Offices	1	N	No action required.
56	LANL Offices	1	N	No action required.
57	BN Field Office	1	N	No action required.
58	CCTV Trailer (MWV #5)	1	N	No action required.
59	Safety Storage Equipment	1	N	No action required.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
60	3541-7	0	N	No action required.
61	Construction J. Box	0	N	No action required.
62	Electricity Supr/Wiremen	1	N	No action required.
63	BNC Inspection	1	N	No action required.
64	Carpenters/Ironworkers	1	N	No action required.
65	Laborers/Teamsters	1	N	No action required.
66	Pipe Fitters	1	N	No action required.
67	Air Line (10" Dia) on Timber Supports on Ground	2	Y	Evaluate lateral restraint requirements to prevent pipe derailing from wood supports and lateral restraint at the dielectric insulator. Evaluate the entire system including items from 67 thru 71.
68	Compressor Pads - Diesel Tank	2	N	No action required.
69	Compressor Pads - Diesel Generators on Wheels	2	Y	Evaluate need for wheel chocks.
70	Compressor Pads - NNWSI Electric Driven Compressors	0	N	This equipment is not connected to the system. Evaluation will be required if utilized in future.
71	Compressor Pads - Air Cooler/Dryer	2	Y	Evaluate lateral restraint requirements.
72	Emergency Generator	2	Y	Evaluate lateral restraint requirements for trailer and supported equipment.
73	Utility Water Tank	1	Y	Evaluate lateral restraint requirements for the trailer and flexible connection to the pipe attached to the tank.
74	Air Line	2	Y	Evaluate the line including the attached cantilevered valve for lateral restraint requirements.
75	Emergency Evacuation Hoist	2	Y	Evaluate lateral restraint requirements and plate under columns for vertical support.
76	Jib Crane	1	Y	Evaluate the crane. Check for current certification including any NDT and load testing.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
77	Vent	0	Y	Evaluation interaction effects on items 75 and 76 for wind effect.
78	Air Monitoring Downhole - UPS-B2	1	Y	Evaluate batteries, electrical cabinets inside and AC unit on top of structure.
79	Air Monitoring Downhole - UPS-B1	1	Y	Evaluate batteries, electrical cabinets inside and AC unit on top of structure.
80	Air Monitoring Downhole - PSU-2	1	Y	Evaluate the item for seismic capability.
81	Air Monitoring Downhole - PSU-1	1	Y	Evaluate the item for seismic capability.
82	Air Monitoring Downhole - MG-21	1	Y	Evaluate the item for seismic capability.
83	Air Monitoring Downhole - MG-22	1	Y	Evaluate the item for seismic capability.
84	A/C (3)	0	N	No action required.
85	LLNL Trailer # 9187	1	Y	Evaluate lateral restraint requirements.
86	LLNL Trailer # 997	1	Y	Evaluate lateral restraint requirements.
87	Power Synthesizers	0	N	No action required.
88	MWV #9	0	N	No action required.
89	LS-12	0	N	No action required.
90	MWV #3	0	N	No action required.
91	LLNL Trailer #9116	1	Y	Evaluate lateral restraint requirements.
92	LLNL Motorhome	0	N	No action required.
93	LS-13	0	N	No action required.
94	MG-15	0	N	No action required.
95	JT-02 (P15-140) A/C	1	N	No action required.
96	MG-25	0	N	No action required.
97	JT-01 (P14-101) A/C	1	N	No action required.
98	P-14-GZ	0	N	No action required.
99	Diesel Generators	0	N	No action required.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
100	IT - 20, IT - 21, IT - 22 & IT - 23	0	N	No action required.
101	Eng. Gen. # 78711	0	N	No action required.
102	Sandia B-72 Trailer	1	Y	Evaluate lateral restraint requirements.
103	A/C (2)	0	N	No action required.
104	MTR J-8-006	1	N	No action required.
105	Substation #152758	0	N	No action required.
106	HSE-1-4 Bldg.	0	N	No action required.
107	Hardened Guard Shack	0	N	No action required.
108	F. O. HUB (J-8-12) A/C	1	N	No action required.
109	Tel Van #108	1	Y	Evaluate the system. Phone bank system at CP also must work. Contact Wiltel for alignment.
110	Sandia Trailer	0	N	No action required.
111	Sandia PK-7 Trailer	0	N	No action required.
112	LLNL Motor Home	0	N	No action required.
113	PT-101	0	N	No action required.
114	Air Conditioning unit	0	N	No action required.
115	Diesel Gen.	0	N	No action required.
116	Diesel -1, Substation	0	N	No action required.
117	Mobile Cranes	1	Y	Maintain the crane in accordance with manufacturer's specifications. Outriggers out, boom at maximum 45-degree to horizontal, fueled, and maintained ready to use.
118	Storage Sheds (2)	0	N	No action required.

NOTES: Assumption:

1. Lose experiment/equipment in trailers and air building.
2. Commercial power is out
3. Life Safety.
4. Check inside of all trailers. Evaluate cabinets, equipment, etc. for stability
5. Chock wheels of all trailers.
6. Prevent vertical drops for trailers with no windows

8.6 Appendix F

A list of the U1a surface PC-1 structures, sysyems, and components that require action.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
1/3	DX-Division LANL Trailer	1	Y	Evaluate trailer lateral restraint requirements, AC mounted on side and duct on top of trailer.
2/4	JTO Conference Room # 502762	1	Y	Evaluate for trailer lateral restraint, and AC/Duct on trailer top.
3/6	LLNL 986 Trailer	1	Y	Install lateral restraint at south end in 2-directions.
4/12	JTO Field Office & Workshop (Office & Storage) J-7-1	1	Y	Evaluate lateral/vertical restraint.
5/20	Assembly Bldg. (Air Bldg.)	1	Y	Keep the exits clear of all obstructions (Keep good house-keeping). Evaluate tie-downs requirements for all cabinets including chemical cabinets. Evaluate air filter plenum for tie-down.
6/24	Mine Rescue	1	Y	Evaluate lateral restraint for trailer and mounted equipment. Evaluate any adjacent items that could fall over on this equipment. Keep good house-keeping in the vicinity of this equipment.
7/26	Engine Generator/Conc. Pad	1	Y	Install generator on new already designed concrete pad with containment curb. Anchor unit to pad. For further evaluation refer to item no. 27.
8/29	Emergency Backup	1	Y	For evaluation refer to items no. 27 & 32.
9/32	Hoist House	1	Y	Evaluate existing bolt anchorage for the cabinets. Anchorage required for air compressor. Evaluate the metal structure (Kelly Klosure Systems) for wind resistance. Evaluate the effect of the structure failure on item no. 29.
10/36	Emergency Backup Hoist	1	Y	Evaluate lateral restraint for trailer and items installed on it.
11/37	Access Control Bldg. (Metal Shed)	1	Y	Evaluate lateral restraint requirements for Air Quality Monitoring & Scanning Monitor equipment. Evaluate building for wind resistance.

ITEM NO.	ITEM NAME	PC CATEG'Y	EVAL. REQD. Y/N ?	COMMENTS
12/47	Mechanics/Minors Shop	1	Y	Evaluate tie-downs for tall cabinets, cabinets containing flammable liquids, equipment including drill-press. Add loops around light fixtures to prevent fixtures falling out during interaction.
13/48	1000 Gallons Water Tank	1	Y	Evaluate tank structure including eccentric column anchorage at the concrete pad.
14/54	Phone Skid	1	Y	Evaluate lateral restraint requirements.
15/73	Utility Water Tank	1	Y	Evaluate lateral restraint requirements for the trailer and flexible connection to the pipe attached to the tank.
16/76	Jib Crane	1	Y	Evaluate the crane. Check for current certification including any NDT and load testing.
17/78	Air Monitoring Downhole - UPS-B2	1	Y	Evaluate batteries, electrical cabinets inside and AC unit on top of structure.
18/79	Air Monitoring Downhole - UPS-B1	1	Y	Evaluate batteries, electrical cabinets inside and AC unit on top of structure.
19/80	Air Monitoring Downhole - PSU-2	1	Y	Evaluate the item for seismic capability.
20/81	Air Monitoring Downhole - PSU-1	1	Y	Evaluate the item for seismic capability.
21/82	Air Monitoring Downhole - MG-21	1	Y	Evaluate the item for seismic capability.
22/83	Air Monitoring Downhole - MG-22	1	Y	Evaluate the item for seismic capability.
23/85	LLNL Trailer # 9187	1	Y	Evaluate lateral restraint requirements.
24/86	LLNL Trailer # 997	1	Y	Evaluate lateral restraint requirements.
25/91	LLNL Trailer #9116	1	Y	Evaluate lateral restraint requirements.
26/102	Sandia B-72 Trailer	1	Y	Evaluate lateral restraint requirements.
27/109	Tel Van #108	1	Y	Evaluate the system. Phone bank system at CP also must work. Contact Wiltel for alignment.
28/117	Mobile Cranes	1	Y	Maintain the crane in accordance with manufacturer's specifications. Outriggers out, boom at maximum 45-degree to horizontal, fueled, and maintained ready to use.

8.7 Appendix G

U1a Seismic Evaluation - Subsurface Facility Matrix (See Figure 3 for locations.) Revision No. 1 Date: September 8, 1998

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	U1a SHAFT			
SHF-1	Emergency Power	1	N	No action required.
SHF-2	Lights	1	N	No action required.
SHF-3	Communications	1	N	No action required.
SHF-4	AQMS (Air Quality Monitoring System)	1	N	No action required.
SHF-5	Shaft Spray System	1	N	No action required.
SHF-6	Steel Sets, R/C & Crib	2	Y	Evaluation being conducted by Bechtel Headquarters.
SHF-7	Emergency Egress (ladders)	2	N	No action required.
SHF-8	Hoist Cage	1	Y	Require evaluation.
SHF-9	Vent Lines	1	N	No action required.
SHF-10	Slikline (6" dia)	1	N	No action required.
SHF-11	Compressed Air Line (4" dia)	2	N	No action required.
SHF-12	Water Line (2" dia)	1	N	No action required.
SHF-13	Shaft (steel set)	2	Y	Require evaluation.
	U1a REFUGE			
REF-1	AQMS	1	N	No action required.
REF-2	Communications - Intercom	1	N	No action required.
REF-3	Communications - Telephone	1	N	No action required.
REF-4	Vent Line	1	N	No action required.
REF-5	Compressed Air Line	2	Y	Add strap to filter at end of line.
REF-6	Supply Cabinet	1	Y	Tie-down cabinet.
REF-7	Lights	1	N	No action required.
REF-8	Heaters	1	N	No action required.
REF-9	Lockout / Tagout Box	1	N	No action required.
REF-10	Refuge Chamber	2	Y	Add egress, clear obstruction.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	LANDING			
LAN-1	Water Line	1	Y	Add lateral supports to wall.
LAN-2	Air Lines	2	Y	Add lateral supports to wall.
	U1a SHOP			
SHP-1	Vent Line	1	Y	Install consistent cables/wire ropes at regular spaces.
SHP-2	Lights	1	N	No action required.
SHP-3	AQMS	1	N	No action required.
SHP-4	208 Volts Electricity Distributor - Back Board (temp. power)	1	Y	Add vertical and lateral supports when construction is complete.
SHP-5	Monorail/Crane	1	N	No action required.
SHP-6	Air Lines	2	Y	Add vertical and lateral supports when construction is complete.
SHP-7	Water Line	1	Y	Add vertical and lateral supports when construction is complete.
SHP-8	480 Flex Power Lines (temporary)	1	Y	Add vertical and lateral supports when construction is complete.
SHP-9	Fire Extinguisher	1	Y	Support from column.
SHP-10	Flammable Material Storage Cabinet	1	Y	Install anchors.
SHP-11	Diesel Fuel Cabinets	1	Y	Install anchors.
SHP-12	File Cabinet	1	Y	Install anchors.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	IH OFFICE			
IHO-1	AQMS	1	N	No action required.
IHO-2	Cabinets	1	Y	Tie-down cabinet.
IHO-3	AQMS (Fiber Link)	1	Y	Add straps.
	U1a ELECTRICAL ALCOVE			
ELA-1	4160 Switches	1	Y	Install anchors.
ELA-2	Emergency Power (Panel)	1	N	No action required.
ELA-3	Backboard	1	N	No action required.
	DX-12 ALCOVE (Fiberoptic Hub)			
DX12-1	Fiber Optic Equipment	0	N	No action required.
DX12-2	Diagnostic Racks on wood supports	1	Y	Install tie-downs.
DX12-3	Vent Line	1	Y	Tie-down end.
DX12-4	Lights	1	N	No action required.
DX12-5	Power	1	N	No action required.
DX12-6	Cable Tray	1	N	No action required.
DX12-7	Cabinets	1	Y	Tie-down cabinet.
	01 DRIFT			
01D-1	Lights	1	N	No action required.
01D-2	Vent Line	1	Y	Install consistent wire ropes at regular spaces.
01D-3	Water Line	1	Y	Install consistent wire ropes at regular spaces.
01D-4	Power	1	N	No action required.
01D-5	AQMS	1	N	No action required.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
01D-6	Emergency Power	1	N	No action required.
01D-7	Communications including PA System	1	N	No action required.
01D-8	Compressed Air	2	N	No action required.
01D-9	A/C Unit outside DX-12 (on wheels)	1	Y	Add restraint.
01D-10	Emergency Lights	1	N	No action required.
01D-11	Fire Extinguishers	1	N	No action required.
01D-12	Communication Box (overhead) by Plug # 2	1	N	No action required.
01D-13	Evacuation System	1	N	No action required.
01D-14	Gas Sampling System	1	N	No action required.
01D-15	Elect Transformer Alcove 7+50 - Switch	1	Y	Install blocking for restraint in 2-directions.
01D-16	Elect/Tray Cable Support	1	N	No action required.
	02 DRIFT			
02D-1	T & F Cables in conduit	1	N	No action required.
02D-2	Diagnostic Cables	1	N	No action required.
02D-3	480 V Cables supported on hog wire	1	Y	Provide adequate cable support system.
02D-4	Flammable - Cabinet	1	Y	Tie-down cabinet.
	06 ALCOVE			
06A-1	Flammable Cabinets	1	Y	Tie-down cabinet.
06A-2	Chiller System	0	Y	Provide blocking.
06A-3	Tall Cabinet	1	Y	Tie-down cabinet.
06A-4	Gas Bottles	1	N	Good housekeeping required.
06A-5	File Cabinets	1	Y	Tie-down cabinet.
06A-6	Freon Lines - welded rebar	1	N	No action required.
06A-7	Backboards	1	N	No action required.
06A-8	Telephone	1	Y	Improve the existing support.
06A-9	Chilled Water	1	N	No action required.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	04 DETECTION ALCOVE			
04A-1	Vent Lines	1	Y	Install consistent cables/wire ropes at regular spaces.
04A-2	Air Lines	1	Y	Install consistent cables/wire ropes at regular spaces.
04A-3	Freon Lines	1	N	No action required.
04A-4	Water Lines	1	N	No action required.
04A-5	Diagnostic Racks	1	Y	Provide blocking/tie-down.
04A-6	Laser Table w/ rotating camera	0	N	No action required.
04A-7	File Cabinets	1	Y	Tie-down cabinet.
04A-8	Monitor on Pad.	0	N	No action required.
04A-9	HVAC System	1	N	No action required.
04A-10	HVAC Ducts	1	N	No action required.
04A-11	Backboard	1	N	No action required.
04A-12	Compressed Air	1	Y	Need bottom support, and frame support from wall.
04A-13	Backroom - Rotating Mirrors	1	N	No action required.
04A-14	Backroom - Black Lights	1	N	No action required.
04A-15	Sheet Metal Hood	1	N	No action required.
04A-16	Cable Trays	1	N	No action required.
04A-17	Telephone	1	N	No action required.
04A-18	AQMS	1	N	No action required.
04A-19	Lights	1	N	No action required.
	ENTRANCE TO KISMET			
ETK-1	AQMS on wheels	1	Y	Install straps.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	03 DRIFT			
03D-1	Bulkhead	1	N	No action required.
03D-2	Vent Line	1	N	No action required.
03D-3	Air Line	2	N	No action required.
03D-4	Water Line	1	N	No action required.
03D-5	Junction Boxes	1	N	No action required.
03D-6	Stretcher Cabinet	1	Y	Install tie-off .
03D-7	Cable Racks	1	N	No action required.
03D-8	Temporary Cable Bundles	1	N	No action required.
	DX-5 AREA			
DX5-1	AQMS	1	N	No action required.
DX5-2	Lights	1	N	No action required.
DX5-3	Vent Line	1	N	No action required.
DX5-4	Power Cables	1	N	No action required.
DX5-5	Communication System	1	N	No action required.
DX5-6	Evacuation Alarm	1	Y	Leaning against wall. Install tie-off.
DX5-7	Cabinets	1	Y	Tie-down cabinet.
DX5-8	Cable Trays	1	N	No action required.
DX5-9	Energy Measurement Equipment	1	N	No action required.
	U1a 100 & U1a 101			
LLL-1	Compressed Air Line	2	N	No action required.
LLL-2	Water Line	1	N	No action required.
LLL-3	Lights	1	N	No action required.
LLL-4	Power	1	N	No action required.
LLL-5	AQMS	1	Y	Leaning against wall. Install tie-off.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
LLL-6	Emergency Lights	1	N	No action required.
LLL-7	Fire Extinguishers	1	Y	Install after construction.
LLL-8	Plywood Panel for cable protection	1	N	No action required.
LLL-9	Power Distribution System	1	N	No action required.
LLL-10	Backboard	1	N	No action required.
LLL-11	Temporary Power	1	N	No action required.
LLL-12	Unistrut Supports for Lights	1	N	No action required.
LLL-13	Instrument Control Panel Cabinet	1	Y	Install anchors.
	U1g USERS ALCOVE			
U1G-1	Refuge Chamber	2	Y	Evaluate nest of cables at entrance - egress problem.
U1G-2	Cable Trays	1	N	No action required.
U1G-3	Vent Line	1	N	No action required.
U1G-4	Emergency Power	1	N	No action required.
U1G-5	AQMS	1	Y	Secure monitor to tray.
U1G-6	Communications - Phones	1	N	No action required.
U1G-7	Communications - Two Intercoms	1	N	No action required.
U1G-8	Communications - Radio System	1	N	No action required.
U1G-9	U1G Shaft Emergency Egress including cage	2	N	No action required.
U1G-10	Diagnostics Racks	1	Y	Install anchors/blocks.
U1G-11	Compressed Air	2	N	No action required.
U1G-12	HVAC System - Racks & A/C Unit	1	Y	Install straps to wall.
U1G-13	Refuge Supply Station	1	N	No action required.
U1G-14	Water Lines	1	Y	Add vertical supports to line at valve locations.
U1G-15	Instrumentation Cabinets	1	Y	Install anchors.
U1G-16	Evacuation System	1	N	No action required.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	01 NORTH SHOP			
01N-1	Storage racks	1	Y	Block heavy objects from falling. Move heavy objects down. Good housekeeping required.
01N-2	Vent Line	1	Y	Need straps.
01N-3	Lights	1	N	No action required.
01N-4	Power	1	N	No action required.
01N-5	AQMS	1	Y	Install tie-off.
01N-6	Intercom	1	N	No action required.
01N-7	Telephone	1	N	No action required.
01N-8	Emergency Lights	1	N	No action required.
01N-9	Backboard	1	N	No action required.
01N-10	4160 w/o Switches	1	N	No action required.
01N-11	Chilled Water Tank (Temporary Storage)	1	N	No action required.
01N-12	5000 to 480 Volts Transformer on wood blocks	1	Y	Remove blocks and install anchors.

8.8 Appendix H

A list of U1a Subsurface PC-1 Structures, systems, and components that require action.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	U1a REFUGE			
1/REF-6	Supply Cabinet	1	Y	Tie-down cabinet.
	LANDING			
2/LAN-1	Water Line	1	Y	Add lateral supports to wall.
	U1a SHOP			
3/SHP-1	Vent Line	1	Y	Install consistent cables/wire ropes at regular spaces.
4/SHP-4	208 Volts Electricity Distributor - Back Board (temp. power)	1	Y	Add vertical and lateral supports when construction is complete.
5/SHP-7	Water Line	1	Y	Add vertical and lateral supports when construction is complete.
6/SHP-8	480 Flex Power Lines (temporary)	1	Y	Add vertical and lateral supports when construction is complete.
7/SHP-9	Fire Extinguisher	1	Y	Support from column.
8/SHP-10	Flammable Material Storage Cabinet	1	Y	Install anchors.
9/SHP-11	Diesel Fuel Cabinets	1	Y	Install anchors.
10/SHP-12	File Cabinet	1	Y	Install anchors.
	IH OFFICE			
11/IHO-2	Cabinets	1	Y	Tie-down cabinet.
12/IHO-4	AQMS (Fiber Link)	1	Y	Add straps.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	U1a ELECTRICAL ALCOVE			
13/ELA-1	4160 Switches	1	Y	Install anchors.
	DX-12 ALCOVE (Fiberoptic Hub)			
14/DX12-2	Diagnostic Racks on wood supports	1	Y	Install tie-downs.
15/DX12-3	Vent Line	1	Y	Tie-down end.
16/DX12-7	Cabinets	1	Y	Tie-down cabinet.
	01 DRIFT			
17/01D-2	Vent Line	1	Y	Install consistent wire ropes at regular spaces.
18/01D-3	Water Line	1	Y	Install consistent wire ropes at regular spaces.
19/01D-9	A/C Unit outside DX-12 (on wheels)	1	Y	Add restraint.
20/01D-15	Elect Transformer Alcove 7+50 - Switch	1	Y	Install blocking for restraint in 2-directions.
	02 DRIFT			
21/02D-3	480 V Cables supported on hog wire	1	Y	Provide adequate cable support system.
22/02D-4	Flammable - Cabinet	1	Y	Tie-down cabinet.
	06 ALCOVE			
23/06A-1	Flammable Cabinets	1	Y	Tie-down cabinet.
24/06A-3	Tall Cabinet	1	Y	Tie-down cabinet.
25/06A-5	File Cabinets	1	Y	Tie-down cabinet.
26/06A-8	Telephone	1	Y	Improve the existing support.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	04 DETECTION ALCOVE			
27/04A-1	Vent Lines	1	Y	Install consistent cables/wire ropes at regular spaces.
28/04A-2	Air Lines	1	Y	Install consistent cables/wire ropes at regular spaces.
29/04A-5	Diagnostic Racks	1	Y	Provide blocking/tie-down.
30/04A-7	File Cabinets	1	Y	Tie-down cabinet.
31/04A-12	Compressed Air	1	Y	Need bottom support, and frame support from wall.
	ENTRANCE TO KISMET			
32/ETK-1	AQMS on wheels	1	Y	Install straps.
	03 DRIFT			
33/03D-6	Stretcher Cabinet	1	Y	Install tie-off .
	DX-5 AREA			
34/DX5-6	Evacuation Alarm	1	Y	Leaning against wall. Install tie-off.
35/DX5-7	Cabinets	1	Y	Tie-down cabinet.
	U1a 100 & U1a 101			
36/LLL-5	AQMS	1	Y	Leaning against wall. Install tie-off.
37/LLL-7	Fire Extinguishers	1	Y	Install after construction.
38/LLL-13	Instrument Control Panel Cabinet	1	Y	Install anchors.

ITEM No.	ITEM NAME	PC CATEGORY	EVAL. REQD. Y/N ?	COMMENTS
	U1g USERS ALCOVE			
39/U1G-5	AQMS	1	Y	Secure monitor to tray.
40/U1G-10	Diagnostics Racks	1	Y	Install anchors/blocks.
41/U1G-12	HVAC System - Racks & A/C Unit	1	Y	Install straps to wall.
42/U1G-14	Water Lines	1	Y	Add vertical supports to line at valve locations.
43/U1G-15	Instrumentation Cabinets	1	Y	Install anchors.
	01 NORTH SHOP			
44/01N-1	Storage racks	1	Y	Block heavy objects from falling. Move heavy objects down. Good housekeeping required.
45/01N-2	Vent Line	1	Y	Need straps.
46/01N-5	AQMS	1	Y	Install tie-off.
47/01N-12	5000 to 480 Volts Transformer on wood blocks	1	Y	Remove blocks and install anchors.

8.9 Appendix I

U1A Head Frame Analysis