

NUCLEAR DESIGN LOADS

1. GENERAL

1.01 This section discusses and provides standards for nuclear design loads. These standards are provided for use in the design of new buildings or building additions that are intended to house telephone equipment that meets the requirements of Section 800-610-164, "New Equipment-Building System (NEBS), General Equipment Requirements."

1.02 This section supersedes Section 5.4 of Specification X-74300, "NEBS Building Engineering Standards (BES)." Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 Planning for the survival of critical transmission facilities involves several combinations of three primary techniques:

- (a) Alternate routing flexibility by distributing communications services throughout a web of physical facilities
- (b) Locating installations away from such possible target areas as cities and military installations
- (c) When facilities must be within "danger" areas, constructing them in such a way as to "harden" them against the effects of a nuclear attack.

1.04 Since the network already includes such measures as diversified routing and alternate route selection, which help to assure continuity of service, each new facility of the Long Lines Radio and Cable Network must be studied to arrive at the best combination of separation distance and hardened construction that will satisfy survival objectives.

2. NUCLEAR EFFECTS

2.01 To appreciate the possible consequences of nuclear attack, it is necessary to know and understand the effects of nuclear explosions and how the elements of the communication system respond to them. A 20-megaton nuclear explosion, as indicated in Fig. 1, would scoop out a crater

about a mile wide and hundreds of feet deep and would cause earthquake-like shock tremors for many miles around. The fireball would be about three miles in diameter and would contain highly luminous gases hot enough to ignite flammable material and melt steel.

2.02 The pressure at the source of the explosion would be several million pounds per square inch. The pressure at the front of the expanding shock wave, however, would diminish with distance from the source of the explosion.

2.03 As outlined in Table A, microseconds after the explosion, long before the arrival of blast pressures, intense nuclear radiation and large fluctuating electric and magnetic fields would reach miles away from the burst point. In addition to being a hazard to people, nuclear radiation can permanently alter the electrical characteristics of electronic components. The electric and magnetic fields can generate large currents in cables and create high voltages that may damage switching and transmission equipment.

2.04 Material lofted from the explosion crater or picked up by the air blast as it sweeps across the ground surface would form debris that might hit buildings and antennas. "Hot" radioactive fallout would cover land areas for many miles around the burst point, depending on wind patterns.

2.05 Effects that must be considered for installations designed to withstand nearby nuclear explosions are: air blast, ground shock, nuclear radiation (initial and fallout), thermal radiation, electromagnetic effects, and debris. While some of these effects pose more serious problems than others, each must be treated with equal importance, since hardened installations are only as strong as their weakest critical component.

BLAST OVERPRESSURE

2.06 In general, the level of peak overpressure, in pounds per square inch, is used to define the amount of protection provided for a facility in a given situation. Overpressure varies with the size of the weapon and distance from the point of

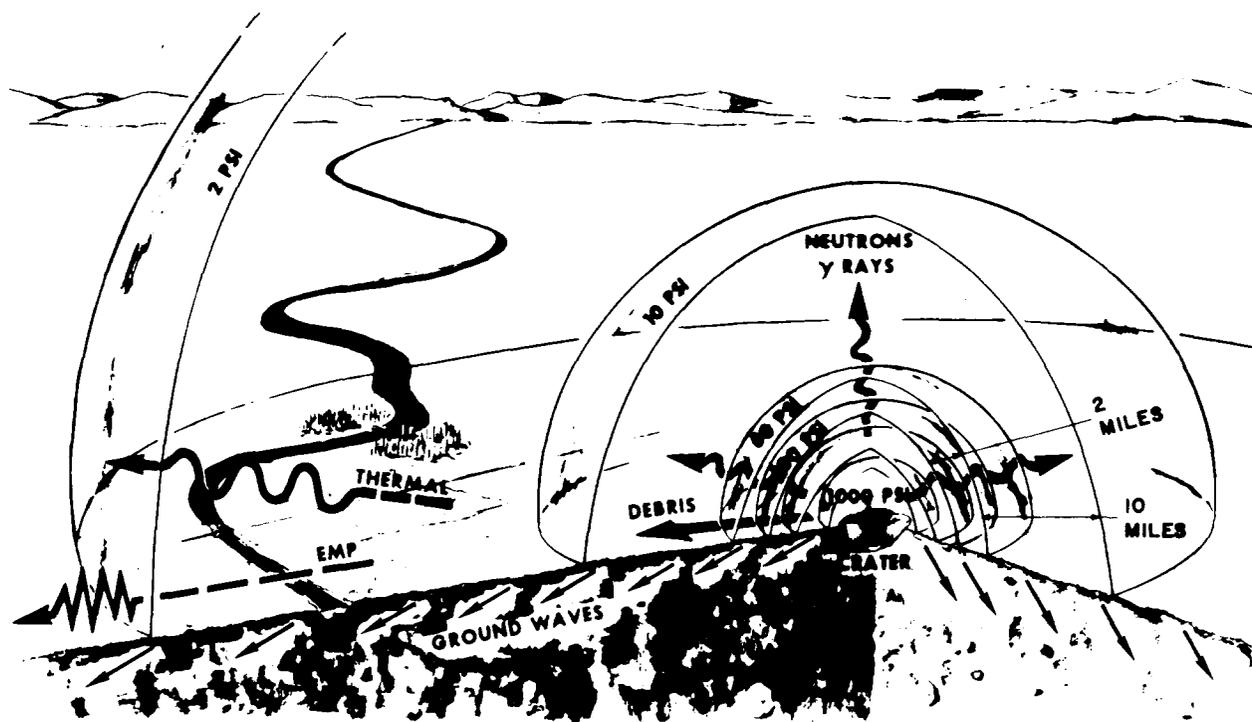


Fig. 1—Scope of 20-Megaton Surface Blast

TABLE A

CHRONOLOGICAL SEQUENCE OF EVENTS AFTER 20-MT SURFACE BURST (50 PSI)

TIME AFTER EXPLOSION	WEAPON EFFECT
Microseconds	Prompt gamma radiation, neutron radiation, EMP, low-energy thermal pulse
1 second	Air-blast-wave front, major thermal pulse, high winds, ground shock
2.3 seconds	End of positive blast pressure
3.7 seconds	Debris and radioactive fallout; winds reverse direction
1 hour	Greatest percentage of fallout has been deposited

detonation. For example, facilities located 2.5 miles from the point of detonation (ground zero) of a 20-megaton weapon must be hardened to withstand an overpressure of 50 psi. A structure located more than 13 miles from a 20-megaton explosion would be adequately protected if built to withstand an overpressure of 2 psi. Buildings that must resist overpressures of 10 psi or more are usually installed below ground, where many of the effects of a nuclear explosion are either eliminated or greatly attenuated.

SHOCK PROTECTION

2.07 Shock isolation is necessary in stations rated at 50 psi to protect equipment against damage by ground-shock motion. Accordingly, shock mountings similar in principle to the suspension system on a car are used to limit accelerations to 3 g's, a tolerable level for most communication equipment. Shock levels at sites built to withstand 10-psi overpressures are low enough that shock isolation is not required. Special attention is

required for isolation systems located in earthquake regions to limit low-frequency response.

ELECTROMAGNETIC PULSE (EMP)

2.08 The electronic equipment in radio and carrier buildings must be protected from the effects of EMP. Devices for limiting both voltage and current are used in individual circuits, but reliability and economic considerations generally dictate that structural shielding also be considered. Interconnected reinforcement steel or a metal shield completely enveloping the building provides this protection. Doors, air shafts, pipes, and cables that penetrate the building must be given special consideration, however, to ensure the integrity of the EMP shielding. Pipes and cable entrances must be reinforced to allow for possible movement of the building relative to the earth surrounding it. In addition, metal flashing surrounds each metallic line entering the building and is bonded to both the metallic line and the EMP shield. Design standards for shielding against EMP are given in Section 760-200-222.

3. FALLOUT PROTECTION

3.01 Telephone buildings generally provide a high degree of fallout protection because of their heavy construction needed to accommodate equipment. Equipment floors are generally designed to support 150 pounds per square foot; walls are generally of strong construction with a minimum number of windows. Telephone equipment in the buildings provides additional shielding from fallout. Basements and interior areas of multistory buildings will often provide very good shelter space without the need for modification.

3.02 The term "protection factor" is used to express the relative reduction in the amount of radiation that would be received by a person in a protected location compared with the amount that would be received if the person were unprotected. For example, if a shelter has a protection factor of 100, an unprotected person would be exposed to 100 times more radiation than someone inside the shelter.

4. NEW BUILDINGS AND MAJOR BUILDING ADDITIONS

4.01 When planning new buildings and major building additions, consideration should be given to shelter areas and shielding for fallout

protection. With judicious planning, it should be possible to provide this protection at a minimum cost. In all new buildings, quite apart from the need to protect essential government services, protection of work areas and the provision of adequate space suitable for use as a shelter for the employee population is desirable, particularly in important toll buildings.

4.02 A main objective for major new construction or building additions for important switching centers is to design this type of critical building to be structurally superior to other buildings in its vicinity to reasonably assure the building's operation as long as other buildings in its vicinity function. Fallout protection advantages accrue automatically from this approach.

5. RADIO RELAY STATIONS

5.01 Certain above-ground facilities located at some distance from potential target areas, such as microwave radio relay stations, are only designed to survive overpressures of 2 psi. Although initial nuclear radiation, ground shock, blast, wind, and debris are not serious problems at this distance, EMP, heat, and fallout must be considered. In cases where facilities are not manned, fallout protection may be ignored. Since the buildings are above ground, however, they are designed to withstand moderate heat.

6. CARRIER MAIN STATION

6.01 Selective routing of cable and waveguide systems makes it possible to design the junction and power feed stations to withstand overpressures of 2, 10, or 50 psi. The critical nuclear effects for the 10-psi level of overpressure are debris, ground shock, blast, and EMP. These are shown specifically in Fig. 2 along with critical nuclear blast environments for other overpressures. The usual earth cover employed for structures rated 10 psi and above causes the effects from thermal and nuclear radiation to be considered noncritical, although special life-support facilities must be provided at manned stations. Of the critical effects, ground shocks and blast require the provision of special building elements such as protective valves for the air intake and exhaust system, blast doors, and mounts for equipment survival. Shielding for electromagnetic effects is attained by the use of solid sheets or by steel reinforcing bars in the structure.

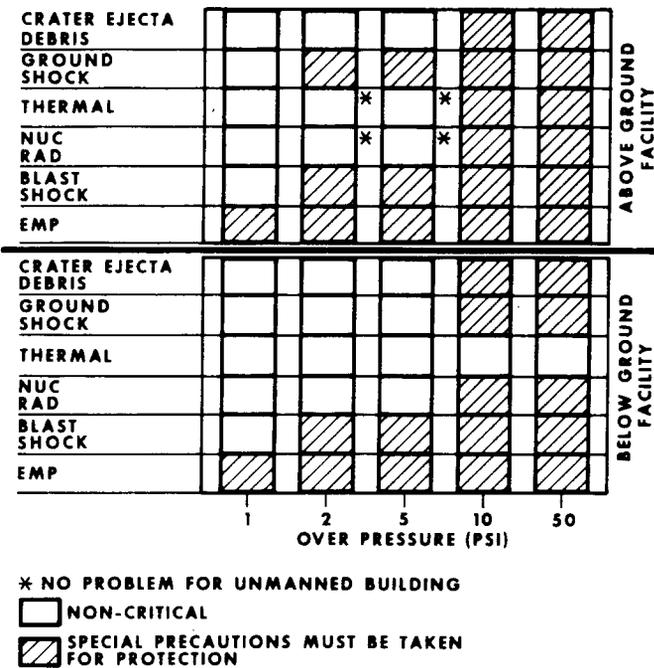


Fig. 2—Critical Nuclear Blast Environments

6.02 Close cooperation between the Bell System and government agencies during the planning stages of these blast-resistant transmission facilities has produced a highly reliable communications system. The Bell System's hardened communications network should provide the United States with communications through any natural disaster and even during a nuclear attack. The degree of protection and the plan for survival is continuously under study by the Bell System. The future philosophy will be strongly influenced by the estimated destructiveness of future weapon systems and the desired degree of resistance of telephone plants to the effects of these weapons.

7. REFERENCES

1. Section 800-610-155—Earthquake and Disaster Bracing for Central Office and PBX Equipment

2. Section 001-780-201 LL—Plans for Survivable Communications
3. Section 800-610-157—Hardening of Central Office and Main Station Equipment Installed in 50-psi Buildings
4. Section 800-610-163—Hardening of Central Office and Main Station Equipment Installed in 10-psi Buildings
5. Specification X-76090—Design Criteria for 1/2-psi Hardened Buildings—Bell Laboratories
6. Specification X-76084—Design Criteria for 2-psi Hardened Buildings—Bell Laboratories
7. Specification X-76071—Design Criteria for 10-psi Hardened Buildings—Bell Laboratories
8. Specification X-76091—Design Criteria for 50-psi Hardened Buildings—Bell Laboratories
9. Design and Construction of Hardened Telephone Plant—AT&T—September 1966
10. AT&T Letter—Protection of Service Against Major Disasters—March 23, 1960
11. Design of Structures to Resist Nuclear Weapons Effects—ASCE—Manuals of Engineering Practice, No. 42, 1961
12. S. Gladstone—Effects of Nuclear Weapons—U.S. Atomic Energy Commission (available from Superintendent of Documents, Government Printing Office), revised April 1962
13. N. M. Newmark, et al., Air Force Design Manual—Principles and Practices for Design of Hardened Structures—APSN-C-TOR-62-138—December 1962; also SD-295-408
14. Building Data Sheet R-3a—Radioactive Fallout Protection—System Policy—March 1, 1965

8. NUCLEAR EFFECTS STANDARDS

- 8.01** Provide a minimum fallout protection factor of 100 for work areas and shelter space for the employee population in new toll buildings and major building additions.
- 8.02** Locate survivable radio and cable facilities to achieve the appropriate degree of construction hardness relative to distance from target areas.
- 8.03** Construct hardened buildings in accordance with criteria contained in Bell Telephone Laboratories X specifications for 1/2-, 2-, 10-, or 50-psi rated buildings.
- 8.04** Employ underground or bermed construction for 50- and 10-psi rated buildings.
- 8.05** Mount equipment in 50-psi rated structures on floor-fastened or ceiling-suspended shock isolators of all-metal construction.
- 8.06** In Earthquake Zone 4, add low-frequency response limiters to shock isolation systems.
- 8.07** Brace (hard mount) all equipment in 10- and 2-psi rated buildings directly to the interior building wall, columns, or floors.
- 8.08** Adhere to the standards for EMP contained in Section 760-220-110.