EQUIPMENT SYSTEMS IN THE SEISMIC ENVIRONMENT

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Modern urban societies rely on extensive and complex equipment systems to supply energy and critical services, maintain economic productivity, and provide comfort and life-safety within structures. These equipment systems, which may be classified as either utility systems, industrial systems, or building systems, represent a major resource allocation or financial investment. When these equipment systems are subjected to the dynamic environment generated by earthquake ground motion or the dynamic response of structures which support or house the equipment, they must (1) damage resistant and (2) continue to function to maintain critical system requirements. The vulnerability of equipment to earthquake damage noted in past major earthquakes has focused attention on the earthquake resistance of equipment systems. The design and evaluation of individual equipment components (non-nuclear) exposed to earthquake dynamic environments is an area of earthquake engineering which has been neglected in the past but is, at present, being pursued by investigators in several countries. Equipment has the added dimension of functional or operating requirements which must be maintained during or after the seismic environment in addition to resisting the stresses induced in the equipment structure. The functional configurations and materials utilized (ceramic, cellulose, plastic, rubber, etc.) create difficulties in the formulation of mathematical models which represent the dynamic behavior of equipment. The importance of considering nonlinear dynamic response in equipment evaluation must be emphasized. Full scale dynamic testing of equipment is often the only means of verifying functional capability and accounting for nonlinear dynamic behavior. The procedures and criteria utilized for dynamic testing of equipment must be carefully established to insure that excessive or "over-testing" does not result. For large, massive equipment or non-critical equipment, an analytical model with natural frequencies and damping verified by low-level testing (forced or free vibration) is recommended.

EQUIPMENT SYSTEMS

UTILITY SYSTEMS (LIFELINES)	INDUSTRIAL SYSTEMS	BUILDING SYSTEMS
WATER:	OIL REFINERIES &	RESIDENTIAL
storage, treatment	CHEMICAL PLANTS	COMMERCIAL OFFICES:
distribution, fire	HEAVY INDUSTRIAL	high-rise,
fighting	PLANTS	low-rise
SEWAGE:	MANUFACTURING	MERCANTILE STRUCTURES
collection, treatment	PLANTS	PUBLIC STRUCTURES:
TRANSPORTATION:	COMPUTER DATA	offices, schools
air, rail, harbor,	PROCESSING	HOSPITALS
transit, pipelines	FACILITIES	
COMMUNICATION:	STORAGE AND WARE-	
telephone, microwave,	HOUSE FACILITIES	
radio, TV		
ENERGY:		
gas, liquid fuel,		
electric power;		
generation or storage,		
transmission, distribution		

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