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EARTHQUAKE HAZARD MITIGATION FOR DATA PROCESSING FACILITIES

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SUMMARY

Evidence from earthquakes over the past two decades clearly shows that data processing facilities (DPF) and systems are vulnerable to earthquake motions. DPF are essential to almost all aspects of our daily lives. Significant damage and loss of function of DPF after an earthquake would have serious economic impact on a region. There is a definite need for standards or guidelines for seismic resistant design of DPF. FIMS, Inc., a non-profit corporation, sponsored development of "Data Processing Facilities - Guidelines for Earthquake Hazard Mitigation" which was published in June 1987. A summary of the major elements in the Guidelines is presented.

INTRODUCTION

FIMS, Inc., a non-profit corporation, was formed by twenty nine organizations concerned about hazard mitigation for DPF. FIMS, Inc. retained VSP Associates, Inc. to assemble a group of consultants to research the problem and develop guidelines for seismic hazard mitigation. Robert A. Olson was Project Manager, Roland L. Sharpe was Technical Manager and Editor, and Neville C. Donovan, William E. Gates, William T. Holmes and Terence P. Haney were authors of several of the chapters in the Guidelines. A Technical Advisory Committee reviewed drafts and provided general guidance. In addition, a draft was sent for review and comment to selected state and federal agencies, building departments, and engineering associations.

The Guidelines provide owners and users of DPF with the best current earthquake hazard mitigation information. If implemented properly, damage should be limited to that which would be repairable within a specified time period after an earthquake, asuuming repair parts and personnel are available. The Guidelines are directed to designing for short term, medium term, and long term levels of outage.

Summary discussions of pertinent factors are presented, including:

- o Risk variability and analysis of probable motions at a site,
- o Building performance and evaluation of existing facilities,
- o Support utilities systems and their reliability,
- o Techniques for mitigating losses to heating, ventilation - air conditioning systems, electrical systems, and elevators,
- o Design of new and existing computer floors,

- o Guidelines for protection of tape and disk storage, and
- o Planning for and responding to earthquakes.

Techniques for computer equipment are discussed by W.E. Gates in a separate paper.

GROUND MOTION

A discussion is presented of earthquakes and their cause, zoning maps and equivalent risk concepts, applicability of zoning maps for DP facilities, and general guidelines for determining site specific ground motions.

Variables to be considered when estimating the amount of damage a facility might expect are the probable location of future earthquakes, their expected occurrence frequency, site soil profile, and building geometry. The need for site specific seismic criteria is determined to a large extent by the specified performance criteria for the building and its contents.

BUILDING SEISMIC DESIGN CONSIDERATIONS

The performance of buildings during earthquakes, types of structural framing-the advantages and disadvantages, response of buildings to earthquake motions, and analysis and design methods for buildings and equipment are reviewed. General guidelines to consider in the design of new DP facilities, or for evaluation and strengthening of existing facilities are presented. The advantages and disadvantages of using simplified and detailed analytical methods for buildings and equipment are discussed.

The primary purpose of U.S. seismic codes has been to protect life and safety of building occupants and those immediately outside the building. In recent years however, other considerations have become important, such as keeping exits open and essential facilities, like hospitals and communication centers, functional during and after earthquakes. As costs for repairs have risen, non-structural elements have also received attention.

The performance of buildings in earthquakes is influenced by a number of factors. They include the structural system, the types of construction materials, flexibility of the building framing, whether or not many brittle-type components such as glass or ceramic tile finishes are used, age, and location. Earthquake motions generally amplify with height in a building. As a result, equipment and building components are subjected to increasing inertial and displacement effects with increasing height in the facility.

SUPPORT UTILITIES

The functioning of a DP facility is dependent on support utilities, including electrical power, water supply, sanitary and storm sewers, natural gas and communications. The DPF owner or his architect-engineer should meet with the utility companies to determine probable reliabilities of the various systems and whether on-site back-up is required.

Consideration should be given to providing back-up systems for power and water supply when DP outage must be limited to a few hours. Back-up should also be considered for longer outage times, unless a high reliability rating can be given to the utility supply systems.

The electrical power system includes storage batteries for uninterupted power supply (UPS), the main power supply, and a back-up generator system for critical support systems. All systems should be designed with adequate seismic resistance.

The need for a back-up water supply system is dependent on the type of cooling ststem: cooling tower or chiller. A supply of potable water should be provided for personnel so the DP center can continue to function.

NONSTRUCTURAL ELEMENTS

There are many nonstructural elements involved in aDP facility that are important to its proper functioning. These include the many electrical power equipment items and distribution system, heating, ventilation and air conditioning systems and equipment, environmental enclosures such as partitions and ceilings, and cooling water. A tabulation showing the relative vulnerability and importance of each element is given. A table is included for each of thirteen generic types of elements with analysis and design criteria, and techniques for the three levels of protection: minimum, intermediate, and maximum. The users of the Guidelines must select the appropriate level of protection.

General guidelines to be considered in design of nonstructural components - either new or existing - are presented. The requirements to be followed to ensure occupancy and functioning after an earthquake are discussed. How to identify high importance-high risk elements in new and existing buildings is described.

RAISED ACCESS FLOORS

Raised computer floors are a critical element in the DP center. They provide the basic support for the equipment and a shield for subfloor utilities needed to operate the equipment. The collapse of such floors during an earthquake means extensive damage to equipment and utilities. Recovery could take months.

Real data on floor performance under extreme conditions are lacking. However, cyclic tests have shown that the typical raised floor system may behave in a brittle fashion, exhibiting little reserve capacity beyong initial yielding. Tests have shown that corrective design can modify their behavior into an energy absorbing form capable of resisting large seismic loads. Consideration should be given in the design to both lateral and vertical seismic motions. Each of the four commonly used floor systems: cantilever pedestals, braced pedestals, braced panels, and pedestal-stringer frames can be designed to be seismic resistant.

Procedures for testing new and existing installations are included and guidelines for specifying and testing new and existing floor systems are given.

TAPE AND DISK STORAGE

Most magnetic storage media used in electrinic data processing systems are susceptible to damage from earthquake motions. Many data libraries have offsite back-up locations to prevent loss of stored data at the main site. This is generally adequate for fire, theft, or sabotage, but may not be for earthquakes. Thus, tape and disk storage areas should have special design for earthquakes.

A common form of seismic design for tape storage racks is connective bracing between racks with ties to the adjacent structural framing. Often there is no provision to prevent tapes from shaking free and falling to the floor with subsequent loss of data. It is critical that a qualified and experienced structural engineer design or review the bracing and or restraint systems.

CONTINGENCY PLANNING

It is estimated that only one out of twenty organizations with extensive data processing facilities have good up-to-date emergency plans. The Guidelines provide a detailed basis and format for developing a Plan. Careful observance of the steps listed in the contingency planning guide will reduce dollar and productivity loss, shorten recovery time, and create less demend for outside support, which may not be available following a amjor earthquake.

The detailed checklists and recommended action items are organized around pre-earthquake mitigation procedures, immediate response actions, and interim recovery period actions.

Contingency planning should not be limited to the earthquake threat, the following points are important to overall emergency planning:

- To achieve its objective a contingency plan must have management support, and even though it has specific applications to the DPF, it must be integrated with the Company's comprehensive emergency plan.

- The DP contingency plan must be written by those in charge of the DP facilities and operations.

- The DP contingency plan should take into account all local hazards, and attention should be given to both primary and secondary effects.

- Response actions must be based on the location, size and type of operations, extent of networking (internal and external), access considerations, security, local building official's safety - access requirements, and other matters known only to those who operate within a specific environment.

- The contingency planner must also look at all possible areas of dependency, ranging from availability of personnel to facility access.

In addition to having a plan, it is essential that personnel receive proper training in their emergency response roles, and that the plan be tested periodically through some form of drills. Such tests or drills must be carefully planned and presented for maximum benefit.

Where data processing is a unit within an organization, its plan must be compatible with and supportive to the rest of the Company's response planning.

RELATED SYSTEMS

In addition to developing data for the above items, a study was made of related systems. Representaives of the financial community - banks, insurance companies, security exchanges and stock brokers, and savings and loan firms were contacted. All of these organizationa are dependent on DP facilities, but in addition need dependable communications systems: in-house, local area, and long distance.

Insurance companies often have extensive paper documents in files, in addition to computer data bases. These could be vulnerable during and after a seismic event. The various companies are currently studying possible changes in operation and mitigating measures.

SUMMARY

The Guidelines are a first attempt at compiling and developing mitigation guidelines for all of the elements involved in the design and operation of a DPF. Revisions and updating will be needed when more information and research results become available. Meanwhile, the document should be of considerable value to the owner, designer and equipment manufacturer.

ACKNOWLEDGEMENTS

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REFERENCES

1. "Data Processing Facilities - Guidelines For Earthquake Hazard Mitigation", FIMS, Inc., June 1987. Available from VSP Associates, Inc., 455 University Avenue, Suite 340, Sacramento, CA, 95825, U.S.A.