COMPANY HAZARD REDUCTION/COMPUTER SYSTEMS PROTECTION: COST EFFECTIVENESS OF HAZARDS REDUCTION PROGRAMS

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ABSTRACT

The payoff from Hazards Reduction Programs cannot be measured until a disaster occurs. At that time, the value of the program is directly proportional to the savings in life, equipment and inventory that the program has affected.

Trying to determine the cost effectiveness of Hazards Reduction Programs is very difficult and can probably only be done, if it can be done at all, after an earthquake or other catastrophic event, and the costs associated with the program can be compared with the estimated damage that might have occurred without it. At IBM San Jose, for example, we undertook a very extensive (and very costly) Hazards Reduction Program involving:

1. Strengthening buildings After extensive seismic and geological studies of the plant site, thorough structural analysis of all the site buildings, and development of comprehensive plans to strengthen each building (most of them built between 1957 and 1975) to the level of a site specific earthquake resistant design criteria developed jointly by IBM, independent-consulting structural engineers and consultants from Stanford and Cal Tech, installation of internal shear walls or construction of external braced frames began. The resulting building designs were considerably stronger than required by the current Uniform Building Code. While construction was underway, we kept all of our activities – manufacturing, development, and research – in full operation.

2. Extensive review of building interiors to identify items that could become hazardous in an earthquake. This involved such things as tying air diffusers and light fixtures to the structural ceiling above, bolting storage cabinets back-to-back through demountable partitioned walls, and installing seismically activated shut-off valves in natural gas and oxygen lines. It also involved the much more extensive measure of reviewing each individual piece of manufacturing or laboratory equipment and engineering unique designs to eliminate or mitigate their hazard potential during a strong earthquake.

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3. Training of all personnel. This was initially begun with a very small group of key executives which became known as the Disaster Management Team (DMT). Consisting of the site general manager, security manager, and plant engineer, we began a series of disaster exercises in which a basic scenario was described ("... a major earthquake struck the area at 9:30 a.m., on Wednesday, a scheduled workday ..."). A series of previously prepared, prescripted messages were sent in to the DMT at rapid intervals describing realistic events ("... a fire is raging out of control in building 004 ..."), and the DMT reacted to them as it would react to an actual emergency. After each exercise, a debriefing was held to analyze its effectiveness, determine what tools and materials the DMT needed to be more effective, and what additional management and staff should be added for the next exercise. A similar debriefing, involving all the participants, was held following each exercise which included a larger and larger circle of people until, eventually, all employees were involved via building evacuation drills.
   While our management teams were involved in the disaster exercises just described, we were also training employee sweep teams, first aid teams, structural assessment teams, and chemical spill response teams.
   Simultaneous with the team training activities described above, a program of employee awareness was undertaken in an attempt to focus attention on hazards that might exist in individual offices, labs, or workstations. We asked each employee to take immediate action with anything they could correct themselves, such as removal of heavy objects from shelves above their desks. We provided a form upon which they could note hazards requiring the involvement of maintenance or plant engineering so that we could follow up with corrective action. An example of this would be a request to bolt a heavy bookcase to the wall. Finally, we asked for any suggestions, no matter how impractical or costly they thought it might be, in an attempt to be certain we had not overlooked anything. We were able to incorporate some of these ideas.

This program, which is so briefly described above, actually occurred over about a five-year period. There was no legal requirement to do all of this. Our buildings met the codes that were in effect at the time of their construction and were probably as strong as most other buildings built in Santa Clara Valley during the same time span. It was a costly and, in some cases, disruptive program. We did not analyze return on investment. It was never really a consideration since our motivation was to create the safest possible environment for our employees. However, in so doing, it quickly became apparent that we were also ensuring our ability to get back into business with a minimum of delay following a strong earthquake.

What then have I to say regarding the cost effectiveness of Hazards Reduction Programs – my assigned subject for this conference? Quite simply, the cost effectiveness of these programs must be evaluated on an individual basis. Moral considerations aside, one can easily spend more than the net worth of a small- or even medium-sized business. On the other hand, the ability to continue to function, produce, and deliver goods and services to the marketplace certainly has value – perhaps a great deal of value. No matter what the size of your business, it costs very little to analyze your particular situation, develop a strategy to deal with it, and assign estimated costs and prioritization to the various elements of the program. It still has not cost anything up to this point.

The next step, however, is to carefully review the cost and priority lists, determine what you can afford to spend, and begin to implement your hazard reduction program in the areas that will give you the most safety for your money.

The three-element IBM San Jose program, described above, is presented in order of descending cost. That is, the building construction was by far the most expensive item, designing and implementing individual equipment and machinery tie downs was next in the expense order, and employee awareness and training was the least expensive. Our plant site buildings were mostly constructed of reinforced concrete. Steel-framed structures would be likely to require far less, if any, additional bracing. Depending on the nature of one's business, tying down large equipment and machinery may not be a problem. Probably the greatest payoff for the least expense is to be realized by the employee awareness and training programs. Simply, helping people to tune into their own work environment and getting them to correct individually hazardous conditions, such as removal of heavy objects from shelves and bookcases, can be beneficial. Clearly defining emergency exit routes from the building and familiarizing individuals with their respective employee assembly areas so that managers can quickly determine if all their employees are accounted for is of great value. Assigning individuals to be responsible for helping handicapped employees out of the building is very important. Organizing teams that are CPR and first aid trained, as well as special teams to sweep the building after evacuation to be sure no one is injured and teams or individuals to deal with any situations or hazards that might be unique to your business, are all relatively inexpensive measures. I personally believe that businesses in highly competitive industries should have a fairly extensive seismic preparedness program, not only to protect their own markets, but because recovery from a widespread disaster may create additional demands for their products. Municipal, State, and Federal governments, as well as the military, certainly need the ability to continue uninterrupted following a disaster, as do hospitals, police, and fire agencies. Their ability to provide continuous services is certainly necessary and, therefore, cost effective, no matter what the expense involved. Small businesses should develop a program on paper, analyze the costs of each step of its implementation, and proceed with the portions they can afford that provide the greatest protection within the limits of their budget. A comprehensive program can be pursued simultaneously, as we did at IBM, or it can be budgeted to occur over a longer period of time. Remember that once your hazard reduction program is in place and the major expenditures are behind you, it is relatively inexpensive to maintain. Hazard reduction in the private sector. Is it cost effective? I firmly believe the most expensive action a business can take is to do nothing.

Earthquake Loss Mitigation for Computer Rooms

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ABSTRACT

The first step in disaster recovery planning is to identify the various critical functions that have to continue during the disaster or at least be back on-line shortly after the event. There are several major categories of these functions one of which is Facility Recovery/Reconstruction. Next it is necessary to identify the various supporting systems within the facility and brake them out into manageable elements. Some of the systems would be electrical power distribution, air conditioning, tape library, computer equipment and others. One or more elements make up each of the systems and each has to be addressed individually.

INTRODUCTION

Although there is still much to learn about earthquakes, we do understand their effects and the danger they represent. The information is available to mitigate the potential losses. Structural engineers have the necessary know-how to build structures that are earthquake resistant. They can apply some of these principals to non-structural elements within the building, specifically to those functions that support a computer center operation.

The business interruption risk due to earthquake is very high because what has been learned and applied to new buildings has infrequently been applied to the computer center and its supporting systems. Therefore the computer center which is usually the most vital operation within a company is the most vulnerable. It is susceptible to being shut down due to loss of electric power and cooling or the computer center and its contents may be heavily damaged requiring months to put it back into operation. Business interruption of such length may be fatal to the company. To avoid such a catastrophe each company should review their earthquake response capability. Disaster recovery planning is a cheap insurance policy that every business can afford.

IDENTIFY THE RISK

Disaster recovery planning for a computer center is made up of several categories. Each category usually is defined as a function that the computer center performs to provide the service that is the reason for its existence. Then each function has to be analyzed so that its components can be identified and the risk assessed. In some cases the components such as a payroll application may be transferable to another site. In the case of the computer center's physical plant, it can not be transferred, it must be hardened.

Detailed Analysis

The various systems that need to be identified are the power distribution system which includes everything from the building entrance to the power distribution unit in the computer room. The substation, near the building service entrance, needs to be inspected to see if the transformer is securely fastened to its supports. The switch gear such as the main and branch circuit breakers and other devices need to have their cabinet inspected for sturdiness and its attachment to the floor. The conduit feeds from the substation to the computer room must be securely fastened so that long stretches do not start swinging due improper support. A conduit could break causing its sharp edges to cut through the insulation on the feeders cables creating a short circuit and possibly a fire. The next logical location to check is the power distribution unit that these feeders are connected to. These power distribution units must be secured so they could not move around and break off any of the branch circuits that connect it to the computer equipment. Again a possible fire hazard and certainly a business interruption. If a backup generator is on site, it must be securely fastened to its mountings with both vibration isolators and snubbers. A good example of this kind of failure was found in the Olive View Hospital after the 1971 San Fernando earthquake [1].

The air conditioning system needs to be thoroughly examined for structural soundness. Its source of power which could be from a different substation should be examined. As in the power distribution units case, the substation including its transformer and cabinetry should be securely fasten to the floor. The electrical feeds from it to the various motor control centers and the electrical line to the chillers, pumps and tower fans need to be braced so that undue swaying will not occur. The connection to the equipment should be flexible enough to handle any off-setting movement.

The tower usually located on a roof or on a cement pad adjacent to the building must be securely fastened to its footings and mounting devices. The strength of the footing should be inspected to be sure it is capable of handling the load of the tower full of water if an earthquake was to shake it back and forth. It is important to note that the higher the building the larger the displacement could be, in effect amplifying the motion the tower would be subjected to.

The pipes from the chiller to the tower are usually quite large and very heavy. Special attention should be given to just how securely they are supported. Check their routing to see if any of the lines are suspended over high voltage equipment such as the substations within the building. Check the type of pipe couplings being used since some are known not to be able to withstanding torquing which could be induced by strong ground motion. The pumps that pump the water to the tower and back should be secured to their mountings with strong hold down braces and bolts. The connection of the water lines must be capable of handling the movement that can be expected between the water lines and the pumps.

The chillers or compressors can be quite large and extremely heavy. Because of their size and weight they require special attention when evaluating their hold down mounts or snubbers. These units will tend to either tip over or slide about breaking their connecting piping resulting in flooding and of course the loss of the cooling system [1].

The water lines and their associated pumps that move the water from the chiller to the computer room air conditioners need to be closely inspected. The same principals apply to these lines except that these are usually much smaller pipes never-the-less a critical element in the cooling of the computer room. Next would be the air conditioners mounted on the floor in the computer room. Are they mounted on appropriate seismic stands and are the connections of the chilled water lines flexible enough to absorb the differential movements that might occur between the air conditioners and their connecting pipes?

Within the room the raised floor system is a crucial element since all of the computer equipment rests on top of it. If the floor is not strong enough in both the vertical and horizontal directions the equipment loads can not be secured because that would increase the loading on the already in adequate floor. Pedestals are frequently glued to the floor instead of being bolted in place. Is the pedestal assembly capable of supporting the lateral load that might be expected in an earthquake if it was bolted down? Generally the pedestals are not designed to handle these loads since they are typically designed to meet the UBC load which is about half the anticipated lateral load caused by a moderate to major earthquake. If stringers are needed they should be securely bolted in place.

The equipment sitting on the raised floor needs to be examined. In some cases this equipment should be fastened to the subfloor, through the raised access floor, in other cases it should be allowed to slide or roll around. Each piece needs to be classified as to if it would tip over or can it be allowed to move about tethered by its power and interface cables.

Probably the most vital assets in a computer are the tapes containing data that maybe difficult if not impossible to reproduce. A tape library could be useless if the racks have fallen over and crushed the reels of tape and perhaps inflicted harm upon an employee. The racks should be examined to verify if they are designed and constructed to take being shaken by an earthquake. Most are made up of flimsy sheet metal spot welded in enough places to keep it upright under normal usage. If they are not, over head bracing by itself is not the answer [2].

For a more detailed treatment of mitigating the losses in a computer room, see the FIMSC publication [3].

PLANS AND IMPLEMENTATION

Once the identification phase has been completed and the level of risk assessed then designs need to be drawn. These designs would be the various brackets and fixtures that will secure the equipment.

Documentation

Fully detailed drawings should be made of every piece. These drawings should bear the stamp of the design engineer so that there is no doubt to the authenticity of the information.

Once the drawings are finished including dimensions and material to be use then a source needs to be located to fabricate the braces, trusses, brackets, etc. No compromising should be allowed since each piece has been calculated and dimensioned for a specific load. If inferior material is used or a dimension changed with out the approval of the design engineer then a failure may occur causing the collapse or movement of the piece of equipment that was being secured.

Implementation

The implementation phase is as critical as the designs themselves. Every fixture, bolt or weld must be installed as the design engineer expects. The bolts must be the proper size and in the case of concrete slab floor, long enough to be embedded to the proper depth per the manufactures specifications. Typically this requires on site inspections during the installation period. In some cases it is necessary to test by a third party the strength of some of the installed pieces. Cinch anchor bolts need to be tested under tension to ensure the workmen have properly installed them. A random sampling can be made and if any failures are found then more need to be tested. Sometimes a trend will be obvious such as failures occurring only on those installed by a specific workman. This could be due to improper training or a faulty tool.

COST

The cost for risk assessment, design and installation of seismic bracing has to be addressed with management. Often the on going costs and upgrades to the physical plant are not included in the budgeting process and therefor never get done. Since the need is not visible to management, it should be presented in a timely and professional manner so that it can gain a place in the budget. Not until this is done will there be monies set aside for the work.

Disruption

Management needs to know the risk they are facing. With recovery time after a moderate or major earthquake being estimated at 72 hours before help can arrive and perhaps weeks to months before replacement machinery can arrive and a labor force being available to install the equipment, it becomes very clear that the computer operation and the company could sustain a major disruption.

Loss of Market Share

What are the costs of this disruption? The obvious ones are the cost to remove debris, buy and install new equipment. The cost of recovering the data due to damaged tape reels can be significant. More importantly is the disruption to the business. The cost of lost production, not being able to ship products. Most of the country has not been impacted by the earthquake. If the business can not ship the product, the customer will go to someone else who can. This presents a scenario that is meaningful to management, "loss of market share." It will take several orders of magnitude longer to regain that share if it can be done at all. The expense of the additional effort on the part of the sales force will be above and beyond the normal had the earthquake not occurred.

CONCLUSION

Disaster recovery planning is an important part of business and when compared to the alternatives it is affordable. It is as vital as the security of the premises, fire protection and insurance. An important part of the plan is the pre-event strengthening of the structure and the contents. The post-event plan is the Recovery/Reconstruction phase which if the pre-event plan has been performed carefully, will be minimal.

Some of the details of the "hardening" of the site have been covered above. Each site will have its own peculiar systems and equipment that need to be analyzed. There may be some unusual situations that have not been addressed by others. If so then design and if applicable, laboratory test them.

Other issues are the building site, the type of soil, the potential slope or ground failures, all are important factors to consider when working on earthquake hazard mitigation. Location of the computer room within the building has a large affect upon the amount of shaking it will experience. Engineering Geologist and Structural Engineers are needed to estimate the amount of potential shaking that is possible at the site and what external threats might be present such as ground failure. They can suggest alternatives to mitigate the various threats. This is money well spent.

During construction on site inspections are needed to ensure that the plan is being executed properly. Poor workmanship in this area can lead to business disruption obviating the well intentioned efforts up to this point not to mention the costs. When new construction is planned, this is the opportunity to install the seismic braces and designs at a substantial savings.

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