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Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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1.0 INTRODUCTION

On Sunday, May 8, 1988 a fire swept through Illinois Bell's telecommunication switching facility located in Hinsdale, Illinois. This station, located 20 miles west of downtown Chicago, is the major gateway through which local and long-distance calls are routed for 30 other central stations (1). The Hinsdale hub's normal traffic is 3.5 million calls a day (2). The resulting fire disabled 42,000 local circuits, over 118,000 long distance lines and severed 195,000 data circuits (3).

This left 38,000 people, including over 3,500 businesses, without telephone and data communication links and 475,000 more customers with limited service (4,5). The results of the disabled hub, one of five serving the Chicago area, caused lost revenues, increased costs, inconvenience and lost confidence in a service hitherto largely taken for granted. Restoring service to full capacity took over a month.

Because earthquake and other natural hazards could have caused the fire and the resulting losses just as easily as the proximate cause in this case, the earthquake research section of the Critical Engineering Systems Division at the National Science Foundation thought it important to study this loss and its higher order economic consequences. With this information, a more complete appreciation of the severe secondary and higher order economic consequences that can ensue from a major earthquake can be gained.

Earthquakes caused fires that burned San Francisco in 1906 and Tokyo in 1923 and caused 38 ignitions in the more recent Whittier Narrows earthquake of October 1, 1987. However, economic losses from a major earthquake in a heavily populated area such as Los Angeles, California have only been estimated for the primary damage caused to structures. Secondary and higher order economic losses have been estimated only on a sporadic basis so that the total consequence of a major earthquake have never been fully evaluated. This study is intended to bring a part of the economic loss puzzle to light.

2.0 CAUSE OF THE FIRE AND PREPAREDNESS PLANNING

2.1 SEQUENCE OF INITIAL EVENTS

The switching station building in Hinsdale contained 41,455 local telephone lines (38,000 users), 165,000 T-1 (computer and data) circuits, 30,000 special data circuits and 118,000 long distance circuits connecting Chicago to western and southwestern Illinois (3). On Sunday May 8, 1988, Mother's Day afternoon at 3:50 pm and again at 3:59 pm, sporadic fire alarm signals from the Hinsdale station were received by Illinois Bell's off-site maintenance facility in Springfield, Illinois, 197 miles away. The Hinsdale station was unmanned. The monitoring Illinois Bell employee assumed the alarms were triggered by power outages caused by strong winds that are common to the area. The fire alarm normally accompanied the power outage alarm. It would clear itself if there were no fire. After both the 3:50 pm and 3:59 pm alarms were sounded, they cleared. At 4:20 pm, only the fire alarm rang.

The monitoring employee called the Duty Supervisor in Wheaton, which is near Hinsdale. The supervisor's call to the local fire department was unsuccessful due to the burned telephone lines. The supervisor was successful, however, in calling a nearby Hinsdale telephone company employee, who in turn reportedly flagged down a passing motorist at approximately 4:55 p.m., who alerted the fire department at 4:58 pm. The fire department arrived on the scene at 5:02 pm, 38 minutes after an unambiguous alarm, and one hour and twelve minutes after the first alarm was detected (3).

The fire proved difficult to extinguish, due to the electrical power continuously fueling the fire. Disconnecting the power proved to be complex and time-consuming. When the power was finally cut off, approximately two hours after the arrival of fire fighters, the fire was immediately extinguished. The burned out area comprised an area of only 30 feet by 40 feet. The corrosion damage from smoke was extensive (5).

2.2 CAUSE OF FIRE

According to the Forensic Technologies International (FTI) report (5), the fire was ignited by earlier caused damage to a DC power cable. Approximately two months prior to the fire, Illinois Bell retained the services of Garrett and West (G & W), an electrical contracting company, to remove various equipment and wiring. During the course of wiring removal, referred to as "mining", a G & W employee allegedly damaged a power cable, which caused arcing, sparks to fly, and an isolated loss of service. The G & W employee reportedly repaired the damaged cable with electrical tape.

Subsequent movement of the damaged cable within the overhead cable tray caused it to come into contact with an armored cable sheath. The armored cable acted as a ground, resulting in shorting, arcing and overheating. Tests performed during the accident investigation by FTI verified this as a reliable ignition source possibility. An earthquake, even a very small one, could have caused the motion which set all of the subsequently described costly events into motion.

Since the fire occurred over a month after the cable was allegedly damaged, movement of the cables relative to each other within the cable tray had to occur. The commercial power interruption which occurred the day of the fire, added to normal vibrations from temperature changes and low level building vibrations, may have caused enough movement to bring the damaged cable into contact with the armored cable (5).

2.3 ILLINOIS BELL'S PREPAREDNESS

The Hinsdale switching station was built in 1962 and had been internally upgraded to incorporate fiber optic technology approximately two years earlier. The station had only 25% redundancy, or the ability to bypass circuits, whereas Chicago hubs typically have 50% redundancy (2).

There were no fire suppression systems installed at the facility. Illinois Bell believed sprinklers would damage the electrical equipment (6). Halon gas, the most common computer room fire suppression system, was never seriously considered because it was thought unnecessary, according to James Eibel, Illinois Bell's Vice President of Operations (2). Also, since much of Hinsdale's equipment was near the ceiling, Illinois Bell thought a Halon automatic dispensing system would not be effective, due to the gas' tendency to settle to the ground (3).

The Hinsdale hub's fire alarm system intentionally bypassed the local fire department and instead was routed to an off-site maintenance facility in Springfield, Illinois. Illinois Bell's reasoning for not routing the alarm to local officials was a fear that without Illinois Bell personnel on hand to provide guidance, local fire fighters could inflict unnecessary water damage to the switches (2). Nevertheless, the Hinsdale Fire Department performed routine fire inspections at the Hinsdale facility, with the last one on March 2, 1988. Finally, the Hinsdale facility was unmanned during off-hours.

2.4 ANALYSIS OF PREPAREDNESS

Illinois Bell's prevailing standards of fire safety had been in effect since 1947 - the time of the last major Illinois Bell fire (2).

The following discussion addresses pros and cons of various fire mitigation techniques expressed in the previous section.

- 1) Added Redundancy - adding redundancy to a switching station would provide additional protection against lost service, but adding redundancy is costly.
- 2) Fire Suppression System - Illinois Bell's reservations concerning sprinklers is well founded due to the fact that unnecessary water damage to electrical equipment can result. However, Halon or CO₂ gas fire suppression systems are well proven in equipment-sensitive applications such as computer rooms. The fact that automatically dispersed Halon settles would appear to be a minor obstacle. Halon 1301 is approximately two and one-half (2 1/2) times more effective than carbon dioxide (7). The low toxicity of Halon 1301 allows it to be discharged safely as a total flooding system into occupied spaces, unlike other gaseous extinguishing agents. On the other hand, carbon monoxide, when discharged into a total system flooding arrangement will not support life. Consequently, it is unacceptable by many authorities in various jurisdictions.

Automatic sprinkler systems prove to be an effective back-up to a Halon automatic fire extinguishing system. The sprinklers work only after a significant period of heat rise, which would occur if either the Halon system fails or is overcome by fire.

2.5 ANALYSIS OF FIRE PROTECTION OPTIONS

Alarm Bypassing Local Officials - Illinois Bell feared that without company technicians guiding fire fighters, electrical equipment could be unnecessarily damaged. Illinois Bell used a remote facility to monitor 280 unattended facilities including Hinsdale.

For this type of detection system to be successful, the following should apply:

- a) Technicians at the remote monitoring facility should have a reasonable workload in order to effectively deal with emergencies. The technician in charge of monitoring Hinsdale had 40 additional facilities to watch (5).
- b) The fire alarm should ring only when fire is detected. The existing fire alarm system would ring whenever there was a loss of power, along with the "loss of power" alarm. The combination of number of alarms and superfluous alarms contributed to the slow response time (5).
- c) The mode of communication alerting local Illinois Bell technicians to fire situations should not be via telephone. Instead, an airwaves system should be used. During the Hinsdale fire, the Duty Supervisor could not get through to the local fire department due to burned out lines at the Hinsdale station (3).
- d) There should be a direct alarm to the fire department in order to ensure that the fire is attended to immediately. This would eliminate the chance for human error, which indeed occurred, when the monitoring technician failed to contact the local fire department, as required by company procedures. Any special provisions required of the local fire department could be worked out with the utility beforehand.
- e) Illinois Bell's reason for having the switching station unmanned was to cut costs(6). It has become standard industry practice to remotely monitor central offices during non-working hours. The Hinsdale central office was staffed by employees during regular working hours. The advantage to having a manned station would be to provide for quicker response and permit fire suppression with hand held extinguishers.
- f) There should be a reasonably straightforward method for cutting power to the facility. Due to the complexity of de-energizing the Hinsdale office, it took over 2 hours to shut off all AC and DC power. This would have greatly reduced both smoke and water damage (5).
- g) The optimum suggested automatic fire detection and suppression system would consist of a Halon primary system and a back-up automatic sprinkler system. In order to make a Halon system effective, though, it would be necessary to specially modify the building. Specifically, there

would have to be compartmentalization in order to achieve the necessary Halon concentration levels. This would be a formidable task, however. According to Pat Corso, a Chicago area operations manager at Pyrotronics, a halon distributor, it would cost from \$250,000 - \$350,000 to equip a station the size of Hinsdale (8). The Halon extinguishing system would function automatically upon detection of products of combustion and automatically activate a total flooding of the subject fire compartment within ten (10) seconds. It is further suggested that the detection devices consist of ionized product of combustion units and be connected in a cross zone arrangement to reduce the possibility of false alarms and inappropriate extinguishing agent dumping. The automatic sprinkler system would not function unless the Halon system failed. The resulting water damage from the automatic sprinkler system would be far less than fire damage to the equipment and/or building, than if the backup sprinkler system were not installed.

3.0 LOSSES

Approximately 3,500 businesses or 10% of the local customers were cut off for up to one month (4). An Illinois state legislator put losses to businesses at \$150 million as of May 23, 1988, fifteen days later (9).

There were several types of losses which occurred due to the sudden cessation of telephone and linked data services. Loss of revenue from lost sales was the most pervasive and the most damaging, while costs incurred by undertaking remedial measures in order to minimize revenue loss was the other major type of loss.

To estimate the dollar loss to businesses affected by the outage, three different approaches were used. Approaching a problem (in which the quantity and quality of the information is limited) from different perspectives and comparing the results, gives a higher degree of confidence to the losses computed. In this way the true loss can be bounded if not accurately estimated.

3.1 EXAMPLES OF SECONDARY LOSSES

The primary loss incurred was the damage to the switching station caused by the fire. While this was a considerable loss, it is the secondary and higher order losses which result from the fire that are of interest in this study. The most direct losses were lost revenues from unavailable telephone and data links. The largest specific victims from this type of loss were Illinois Bell, AT&T, MCI and U.S. Sprint. Illinois Bell says it lost one million dollars per day in business from local calls (3). Illinois Bell and AT&T incurred additional expenses in repair costs to the damaged lines and in providing emergency services. Illinois Bell also lost money due to rebates given and defense from lawsuits.

Less direct, but nevertheless categorized as secondary losses, were lost revenues due to anticipated orders typically accomplished by telephone. Examples would include commodity and stock brokers, florists, catalogue sales companies (e.g. Sears & Roebuck), pizza takeout restaurants, airline reservations, local lodging enterprises (e.g. Holiday Inn), travel agencies, telephone solicitation companies and their employees, the state (e.g. lottery terminals), answering services and many miscellaneous businesses which transact business directly by telephone.

A particularly hard hit business was the Florists Transworld Delivery Association (FTD), which connects 12,500 of the association's 23,000 nationwide florists. All computer and phone traffic was halted on Mother's Day, rendering it unable to send flowers by wire or process credit card transactions for two weeks. Half-capacity voice service was restored after 11 days, via an AT&T installed microwave dish. Illinois Bell regular service was restored June 3, 26 days after the fire, but with a 30% average failure rate for calls (3).

The lodging industry also lost revenue because potential patrons could not call through for reservations and because of the inconvenience posed by a lack of telephone service. The Drake Oakbrook Hotel estimated losses of \$15,000 to \$20,000 (225 rooms) during eight days of no service and limited service for the following two weeks. Other individual hotels estimated losses of up to \$30,000. The May 1988 issue of "Trends in the Hotel Industry Chicago" reported a decline of seven percent (7%) in suburban hotel occupancy for May 1988 (4). One hotel reported in the BBB survey that it did not receive any reservations during a two week period.

The telephone solicitation industry and answering services were predictably hard hit and at least eight telemarketing firms comprised of approximately 200 workers were forced to lay off employees (a tertiary loss) until service was restored (14,15). Sears-Roebuck temporarily laid off 250 workers in its telemarketing group. Approximately 700 state lottery agents lost the use of their machines, resulting in loss of revenue.

Airlines lost revenues from both cancelled flights on Monday May 9 and from unanswered reservation requests. United Airlines reported that approximately 7,000 calls were missed because the airline's computers receive calls through the Hinsdale switching station (16). It also was forced to cancel 40 incoming and outgoing flights (17).

Other losers were credit card companies which lost revenue due to the lack of credit check services and retailers whose customers use only credit cards as a means of payment (18).

There were approximately 100 financial institutions hit by the outage. Banks could not process checks. Over 300 auto-teller machines were out of order for up to two weeks. Brokers could not process the normal volume of orders nor execute orders at the normal speed (3,16,19).

There was a plethora of businesses which normally perform many transactions via telephone, facsimile, telex and/or computer link which lost substantial revenue and incurred extra costs due to the Hinsdale fire. United Stationers, Inc., Sears & Roebuck, Boise Cascade, Spiegel, Van Kampen Merritt, Mutual Life, Motorola, Walgreen Co. and Prudential Life are a few of the larger companies incurring losses.

3.2 EXAMPLES OF TERTIARY LOSSES

Tertiary losses are losses twice removed from the direct impact of telephone service failure. A few personnel were laid off temporarily, principally in the telemarketing and answering service areas. However the most noteworthy examples of a tertiary loss were the slowdowns caused at O'Hare International and Midway Airports. The fire cut off a communications link consisting of over 28 data circuits from a west suburban Federal Aviation Administration tracking station to O'Hare's air traffic control computers (20). The result was a general slowdown on May 9 and 10, whereby the separation of planes was increased from 3 miles to 20 miles (18,20). This caused 20% of O'Hare's 2,300 daily flights to be cancelled on May 9, and sparked a ripple effect of delays and cancellations across the country (16). It is estimated that a minimum of about \$11 million was lost due just to cost of cancellations.

Additional tertiary losses were incurred by real estate agents, who could not call in new listings and therefore decreased their chances of selling property (9,18). Businesses and residences with remote burglar alarms which went through the switching station were rendered useless (21). Subscribers who became burglary victims would be categorized as a tertiary loss. Potential auto-teller machine users had to either stand in long teller lines, costing them time, or forego the cash altogether if their request was not made during regular banking hours. The latter case could also deprive businesses of their customers' patronage. Local Governments lost potential revenue when 700 lottery sales outlets were put out of commission (22).

An immense amount of productivity was lost due to businesses and individuals being forced to adapt, improvise, substitute and forego. (A detailed discussion of particular loss mitigation methods employed ad hoc is contained in Section 4.0.)

3.3 EXAMPLES OF HIGHER ORDER LOSSES

An example of a higher order loss would be students who were truant when they realized school officials could not call their parents (18). Other sources of loss would be the services and products which would have been bought with the otherwise lost funds in the normal velocity of money throughout the local economy. The Internal Revenue Service lost revenue as a consequence of business' lost sales.

State and local governments incurred additional costs by providing "permanent" police outposts in centralized locations because they could not be contacted by telephone (18). Forced with the possibility of increased crime due to the unavailability of

telephones, police put extra patrols on duty. Hinsdale increased its normal patrol more than fivefold due to the outage (22).

3.4 LOSS ESTIMATE NUMBER ONE

The first estimate of revenue and mitigation losses uses the following information:

- 1) The estimate of \$150 million loss as of May 23, 1988 (9).
- 2) Knowledge that the first stage of the new phone switch came on line May 26, 1988, which restored approximately half of the local customers (10).
- 3) Knowledge that the second stage of the new switch came on line June 5, 1988, which effectively restored service to the remaining users (10).
- 4) The results of the Better Business Bureau (BBB) survey of 124 businesses (11). (see typical questionnaire reproduced in Appendix A)
- 5) Knowledge that over 3,500 businesses were affected (4,5).

The daily loss is:

$$\$150 \text{ M} \div 10 \text{ working days (WD)} = \$15 \text{ M/WD}$$

The loss up to the time the first stage new switch was started up is:

$$\$15 \text{ M/WD} \times 14 \text{ WD} = \$210 \text{ M}$$

The additional loss until the second switch was operational is:

$$20 \text{ WD} - 14 \text{ WD} = 6 \text{ WD} \times 1/2 \times \$15 \text{ M/WD} = \$45 \text{ M}$$

The total revenue loss is : $\$210 \text{ M} + \$45 \text{ M} = \$255 \text{ M}$

The additional losses businesses incurred due to mitigation efforts were extrapolated from the Better Business Bureau's survey referenced above. Of the 124 companies which responded to the questionnaire, 112 answered the question regarding costs expended to mitigate losses.

The total loss for those 112 businesses was \$958,000 or \$8,553.57 per business. Extrapolating this figure to 3,500 companies gave a total of \$29,937,500 or roughly \$30 million.

Therefore, the combined revenue and mitigation loss for method one is $\$255\text{M} + \$30\text{M} = \$285\text{M}$.

3.5 LOSS ESTIMATE NUMBER TWO

The second estimate is based upon the following information and assumptions:

- 1) Demographic and economic information from the 1988 edition of the Statistical Abstract of the United States, published by the Department of Commerce (12).
- 2) The number of Chicago switching station hubs in the Chicago area is five of which Hinsdale is one.
- 3) The *equivalent* total outage was 15 days.
- 4) Industries dependent upon day to day telephone service are a) Wholesale/Retail Trade, b) Finance/Insurance/Real Estate, and c) Services.

The following statistics were derived from the 1988 Statistical Abstract of the United States, along with the above mentioned information:

<u>ITEM</u>	<u>UNITS</u>	<u>YEAR</u>	<u>AMOUNT</u>
Population, Chicago	(p)	1986	6,188,000 Persons
Population, USA	(p)	1986	241,078,000 Persons
Business Receipts, USA	(\$ per yr)	1984	7,783 billion
Number of Hubs, Chicago	(#)	1988	5
Growth Rate	(\$ per yr)	1984-1988	7.5%
Total to Partial Outage	(days)	1988	30
Equivalent Total Outage	(days)	1988	15
Businesses Dependent on Day to Day Telephone	(\$ per yr)	1984	3,731 billion

The following breaks down the \$3,731 billion estimated to be dependent upon day to day telephone.

Wholesale/Retail Trade	\$2,519 Billion
Finance/Insurance/Real Estate	517
Services	<u>695</u>
TOTAL	\$3,731 Billion

The business sectors omitted from the count were: manufacturing; agriculture; forestry; fishing; mining; construction; transportation; public utilities.

The growth rate of business is on the order of 7.5% per year in current dollars (12). The amount of business done in 1988 as compared to 1984 is then 33.5% greater in 1988 than it was in 1984. Consequently, the loss can be calculated in the following manner, assuming the amount of business dependent upon telecommunications in the wholesale/retail trade, finance, insurance, real estate and service industries is 22.5% (see Appendix B).

$$\text{Revenue Loss} = \$3,731 \text{ Billion} \times 1.335 \times \frac{6,188}{241} \times \frac{1 \text{ Hub}}{5 \text{ Hubs}} \times \frac{15 \text{ days}}{365 \text{ days}} \times 0.225$$

$$= \$236 \text{ million}$$

Using the mitigation loss results derived in the first estimate, the total loss is:

$$\$236 \text{ M} + \$30 \text{ M} = \$266 \text{ M}$$

3.6 LOSS ESTIMATE NUMBER THREE

The third estimate utilizes additional information from the BBB survey (11), and results from a Crisis Management Corporation (CMC) survey (13). In the latter survey, only five (5) of the 57 businesses surveyed responded (see Appendix C for a typical survey form).

The analysis for this estimate consists of tabulating the ratios of revenue losses to mitigation losses. The CMC survey asked for both types of losses. While the BBB survey did not include revenue loss as a question, there were four companies which volunteered the information.

The following lists the results:

<u>COMPANY</u> <u>OR</u> <u>INDUSTRY</u>	<u>SURVEY</u>	<u>REVENUE</u> <u>LOSS</u> <u>(IN \$)</u>	<u>MITIGATION</u> <u>LOSS</u> <u>(IN \$)</u>	<u>TOTAL</u>
Warning Lights of Illinois	CMC	250,000	3,250	
Bart's Auto Body	CMC	0	0	
Nalco Chemical	CMC	0	25,250	
Frain Industries	CMC	150,000	36,500	
George's Tree Service	CMC	7,750	0	
Unknown	BBB	150,000	3,000	
Graphics	BBB	9,300	3,000	
Catalogue sales	BBB	27,500	500	
Restaurant	BBB	<u>9,450</u>	<u>0</u>	
TOTALS		604,000	71,500	\$675,000

Thus, the mitigation loss is $71,500 \div 604,000 = 11.87\%$ of the revenue loss. The total mitigation costs for the 112 companies which responded in the BBB survey is \$958,000 (11).

Extrapolating and converting to revenue gives:

$$\$958,000 \div 11.8\% \times 3,500 \text{ affected business} \div 112 \text{ BBB survey businesses} = \$253,708,000.$$

Adding the mitigation costs derived earlier brings the third estimate total to:

$$\$253.7 \text{ M} + \$30 \text{ M} = \$284 \text{ M}.$$

3.7 SUMMARY OF LOSSES FROM THREE METHODS OF COMPUTATION

Summarizing the total losses from the three estimates:

		Business Losses (in \$ million)
estimate 1	=	285
estimate 2	=	266
estimate 3	=	<u>284</u>
average loss		278

The estimated loss of about \$300 million represents losses to businesses in the affected area. Not represented are companies which are located outside the affected area, but who suffered an impact of long distance service.

Another factor which may not have been accounted for is the fact that some businesses may have experienced stronger than average sales following restoration of telephone service. Potential customers had four choices when faced with an inability to contact an affected business by phone: 1) contact them using an alternate method (mail, in-person, etc.), 2) delay the order until contact can be made by telephone, 3) contact an alternate business not affected by the outage, or 4) forego the order.

The first two alternatives in the above list amount only to small losses due to time delay. The third alternative results in a loss for that particular company but not to the industry. The customer, on the other hand, might have to pay a higher price and/or settle for lower quality due to the fact it is using the second best supplier. The fourth alternative results in an industry-wide dead loss.

Examples of industries which incurred a high proportion of dead losses are restaurants (especially take-out), telemarketing, answering services, messenger services and job placement firms.

In addition to revenue loss and mitigation expense, some businesses were also impacted in the areas of recruiting, scheduling applicants and security (11).

4.0 EMERGENCY MITIGATION EFFORTS

Many individuals and businesses were compelled to incur costs in order to mitigate the loss of revenue, productivity and added inconvenience. The reason local and state governments as well as Illinois Bell and AT&T incurred costs for remediation was out of duty to the public.

The Hinsdale fire's impact on businesses went beyond the use of the telephone. Computer links, facsimile and telex machines were also rendered useless. In addition to this, many businesses did not have an adequate backup system. A major reason cited for the lack of a backup system resulted from a misplaced confidence in modern technology. It was believed that calls encountering a temporary breakdown in the system could either be rapidly rerouted or at the least, quickly repaired. The telephone system "could not" suffer a catastrophic failure. The telephone system was something most businesses increasingly took for granted (3,9,19,21).

The most common methods used to circumvent the severed telephone lines were the use of portable microwave dishes, cellular telephones and portable earth stations. There were two problems with cellular telephones: 1) Only some worked, because many were linked to land-based switching equipment through the Hinsdale station; and 2) only voice transmission could be used (16). The biggest drawback of microwave dishes and portable earth stations was cost. Installed emergency dishes cost about \$60,000 and a permanent dish as much as \$1,000,000, according to MCI and AT&T (23). This points out the second major reason why many businesses did not have an installed backup system before the disaster: the known cost of back-up systems combined with unknown or low values of expected losses.

Nevertheless, AT&T reported connecting 25 companies and MCI six companies directly to their respective long distance networks via microwave dishes (23). Among those businesses opting for emergency microwave dish service were Dun & Bradstreet Corporation, Prime Computer, Inc., the Hartford Insurance Group, Bekins Van Lines Co., Nalco Chemical Co. and FTD (23,24).

Another expensive alternative was incurred by those companies using disaster recovery hot sites. Comdisco Inc., a hot site supplier, filled its three Chicago hot sites, and even utilized its Carlstadt, New Jersey hot site to support United Stationers, Inc. The costs for doing business at these recovery sites were approximately \$50,000 to enter the site, \$10,000 per month and a daily usage fee of between \$5,000 - \$25,000 (25).

For smaller businesses and individuals, the foregoing efforts were impractical with the exception of cellular telephones. Additional methods of alternative communication employed by this group were CB radios, walkie-talkies, messengers, mail and face to face communication.

Argonne National Laboratories, a government research center, used a radio setup inside a Winnebago van to communicate with Washington D.C. (14). A pizza delivery company parked 12 delivery trucks in the busiest areas and radioed in their orders (1). Hinsdale Hospital used walkie-talkies to communicate between floors (21). It also arranged for Connie's Pizza to dispatch a pizza truck every hour to pick up birth announcements along with its pizza orders (9). Similarly, Arcade Travel Service transformed its delivery drivers into order takers as they covered the travel agency's regular accounts (9). In order for some 100 financial institutions to deposit and transfer funds with the Federal Reserve Bank of Chicago, the latter dispatched an unmarked car to undisclosed locations (19,21). Doctors, dentists, accountants, travel agents, real estate agents and beauticians sent letters telling customers to come in without appointments (21).

A handful of companies were adequately prepared for a major disaster such as the Hinsdale fire. General Electric Information Services Co. had purchased a satellite communications system as a backup, due to eight AT&T fiber-optic failures in two years caused by cables cut by backhoes and mudslides (6). Unocal was able to switch to the company's national private network powered by microwave links (20).

Spiegel, a giant mail-order house, utilized a microwave hookup installed two years previously. Although it restored only one-third of normal data services, it kept Spiegel in business. By May 16, the company added an AT&T microwave dish to its own, thereby increasing service to 90% of capacity (3).

American Airlines' backup procedures were threefold: Dial backup modems, alternate routing (some circuits did not run through Hinsdale) and an array of internal switching capabilities (3). These crisis management plans minimized losses by allowing partial business activities to continue.

In the public sector the local police departments dispatched eight police cars with two-way radios to permanent locations around town to help residents report emergencies (18). Illinois Bell set up 125 free telephones (for local calls) at various locations, with a five minute time limit and up to an hour wait (18,21). Also, Illinois Bell set up four temporary work centers with 200 total telephones for telephone-dependent businesses. The telephone company also provided regularly scheduled shuttle service to these facilities (9).

5.0 GAIN FROM THE EVENT

With every disaster there are always businesses or individuals who benefit from it. The most notable beneficiaries were AT&T, MCI, the cellular phone industry, mail services, hospital emergency rooms and "hot site" suppliers.

AT&T and MCI arrived on the scene within hours of the disaster and provided microwave dish hookups to bypass the severed lines to over 30 companies (23). In addition, AT&T earned kudos from the business community for dedicating hundreds of employees to the repair of the Hinsdale switching station. AT&T also provided customer service during the outage which consisted of taking trouble reports, preparing priority lists and setting up an emergency calling center at a local hotel (3). MCI offered free long distance emergency calls to people without telephone service (26). These gains in public appreciation, though, were tempered by lost revenue from the outage.

A spokesperson for Ameritech Mobile Communications reported the average weekly cellular phone sales in the Chicago area were up by 40% in the weeks after the outage, making it "...the largest sales week in company history." Approximately half of the sales were from portable units and half from car units (9). Leader Communications, Incorporated, reported cellular phone sales of 10 times its normal volume (27). According to the BBB survey, one company purchased 30 cellular phones.

Express mail delivery volume more than tripled during the first two weeks of the outage, from a daily average of 2,500 to almost 10,000. Other overnight services probably experienced similar volume increases (28). One financial services business, according to the BBB survey, mailed out 32,000 letters during the outage. Gas stations may have sold more gasoline due the increase in need for personal contact.

Local hospital emergency rooms reported an increase in volume during the outage. This has been attributed to the fact that patients could not call doctors for appointments, so they went instead to the emergency rooms (18). This, of course, resulted in private physicians losing income.

Restaurants which were close to the Hinsdale facility attributed an increase in business due to the hundreds of workers repairing the equipment as well as onlookers (27). Some accounting firms which deal in loss management suddenly experienced an increase in clientele. They reviewed business insurance policies and provided advice about claims (27).

One unidentified company's comment in the BBB survey was, "The positive side to the crisis was our responsiveness to our customers. We demonstrated our ability to continue service and manage a crisis" (11).

6.0 RESTORATION OF SERVICE AND EMERGENCY MEASURES

Illinois Bell, AT&T and Ameritech put together a team of roughly 200 workers, who worked around the clock from May 11, 1988 to approximately June 4, 1988, restoring the Hinsdale station (24). Illinois Bell's first concern was to prioritize the repairs. Restoring emergency service lines was most important, with high volume, highly telephone-dependent private businesses having the next highest priority. Illinois Bell generally treated voice communications as a higher priority than data lines (24).

Illinois Bell's effort at prioritization was not a complete success however. The telephone company canvassed businesses asking for their own priorities. A spokesman for J.I. Case,

a Tenneco subsidiary that manufactures farming vehicles, reported that its number one priority was to restore its data links (T-1 lines). But the data lines ended up being the last items restored (24). An Illinois Bell representative gave an overly optimistic prediction to Boise Cascade Office Products and FTD. A spokesman from the latter organization summed up the general frustration by saying, "If I had a dollar for the number of times we were told we would have service, I would be a rich man" (3,29). The utility's efforts to disseminate information to customers regarding the status and magnitude of the problem were primarily secondhand via mass media. According to the BBB poll, only 14% of affected businesses cited Illinois Bell as a primary source of information concerning the outage. Newspapers and television accounted for 66% of companies' primary information, according to the BBB survey. The accuracy of this primary information, regardless of the medium, was judged "not very accurate" or worse by 61% of the polled businesses (11).

Some comments extracted from the BBB survey concerning Illinois Bell's lack of information follows. A public relations firm wrote, "because of the lack of good information, we had to continually change our way of dealing with the crisis. Had we known at the very start how bad it was, we could have immediately relocated the staff..." A consultant wrote, "I felt not enough information was given by Illinois Bell to the public. If the facts are known, you can usually deal with them. I found most people guessing about the time (of restoration) and passing rumors. An unidentified company wrote, "What surprised me was how little the phone company helped" (11).

Illinois Bell opted not to salvage the 1970's-vintage analog local phone switch, but instead to replace it with a fully digital switch. It was installed in two stages: the first stage was operational May 26, 1988 and the second stage came on-line June 5, 1988 (5). Workers were able to replace about 7,000 lines a day (20,24). The 38,000 local users affected by the outage did not have any local service from six days to two weeks. Half of these customers were without reliable local service for 19 days. For the remaining subscribers, it was 28 days before full service was restored. The return of long distance service was sporadic while the new equipment was being installed (10).

As was mentioned previously, Illinois Bell provided 125 free telephones at various locations and set up four temporary work centers with a total of 200 telephones. It also provided shuttle service to these facilities. It also double-credited all subscribers' bills during the outage and reported that it will not seek a rate increase to cover the \$1 to \$2 million a day in lost revenues, the \$2 million deductible on its insurance, nor any other ancillary repair expenses of more than \$300,000 (10,30,31).

For the first 2 1/2 weeks of the outage, the hardest hit towns had to use municipal employees on 12-hour shifts to patrol the area and to staff about 50- emergency centers. Illinois Bell employees began staffing them after that time. John Marquart, Darien Village administrator, said "overtime cost alone for our village could run around \$30,000 not including equipment and vehicle costs"(32). Illinois Bell said it will distribute \$500,000 in "community and economic development grants" to 12 local government units affected by the fire (33). The utility may also compensate the local communities for expenses incurred by the fire, such as extra police patrols (10).

7.0 LEGAL AND INSURANCE ASPECTS

Illinois Bell underwent a formal investigation as a result of the fire. The investigation was headed by a joint task force consisting of the Office of the State Fire Marshall, the Illinois Commerce Commission and the Emergency Services and Disaster Agency. Additional investigation and analysis was provided by Forensic Technologies International, Bellcore, Illinois Bell and Factory Mutual Insurance Company, among others. Attorney-General Neil Hartigan filed a petition with the ICC demanding compensation of telephone customers affected by the loss of service, but the commission lacks the authority to force Illinois Bell to compensate victims (9,18). In addition to demanding that the utility create a special fund to compensate victims, Attorney-General Hartigan also asked the ICC to hold a formal inquiry on the outage and order the utility to submit a disaster plan for ICC approval (10).

As of July 3, 1988, eight lawsuits had been filed against Illinois Bell. The undisclosed amount of damages sought by the plaintiffs are for lost business revenues and remediation expenses. The allegations against the utility are that it "violated the Public Utilities Act and/or common law statutes by committing negligent and willful actions, including the failure to provide adequate fire detection and suppression systems," according to Business Insurance (10).

Five of the eight plaintiffs are: Lee and Eddie's Catering (\$100,000); a Naperville Travel Agency (\$250,000); H.A. Gorden & Co., an accounting firm; James D. Fiala Paving Co.; and Orvin Wilkin, a commodities trader. Prosecuting attorneys have asked that the lawsuits be certified as class actions (10).

Illinois Bell is seeking immunity from the lawsuits based on a provision in a tariff it filed with the ICC. The provision states, "The liability of the company for damages arising out of mistakes, omissions, interruptions, delays, errors or defects in transmission occurring in the course of furnishing service or other facilities, and not caused by the negligence of the customer, shall in no event exceed an amount equivalent to the proportionate charge to the customer for the period of service during which such mistake, omission, interruption, delay, error or defect in transmission occurs. No other liability shall in any case attach to the company"(10). An ICC spokesman said that it has typically allowed the tariff provision in an effort to keep phone rates down. Since the phone company must supply everyone who requests phone service, it is usually granted immunity from such lawsuits (10).

A similar but less devastating telephone outage occurred in part of New York City in 1987, in which telephone service was unavailable for up to two weeks. Courts ruled that the local telephone company was not liable for any business interruption damages. Yet with the growing importance of telecommunications, providers of these services will face increasing scrutiny (5).

The litigation against Illinois Bell concerning business interruption will be dependent on the answer to two questions: 1) Did the utility act prudently in its operation of the switching facility? 2) How will the courts interpret the circumstances surrounding the 72 minute delay in the arrival of the fire department?

Illinois Bell does not carry insurance to cover lost business incurred by customers, even though its parent company, American Information Technologies Corp., purchases excess liability coverage in the London market. The utility's damaged property is covered by a policy written by Arkwright Mutual Insurance Co., in which the deductible is \$2 million (10,19).

Many affected businesses carried business interruption insurance, but did not contain the off-premises endorsement pertaining to communication services (10,34). While this coverage was available, the endorsement would have had to specifically describe the lack of telephone service and list Illinois Bell's Hinsdale switching station in order for the coverage to apply, according to Robert Lindemann, a commercial property underwriting officer (10).

8.0 ISSUES DEVELOPED BY THE EVENT

The Hinsdale switching station fire was possibly the worst telephone outage in the history of the industry in terms of costs to affected users. This is attributed to the number of severed lines (347,000 fiber optic circuits), the duration of the outage (up to one month) and the rapidly growing business-computer network. Hinsdale carried an average of 3.5 million calls a day and linked between 16-50 additional stations.

The current trend in telephone circuitry is to fewer networks and bigger switches. This evolution is a product of technology and deregulation in the industry. Fiber-optics, in which hair-thin strands of glass can carry at least 8,000 calls versus 24 on a pair of copper wires, is the new technology. Deregulation has forced telephone utilities to be more competitive and therefore more cost-conscious. Thinner networks, utilizing more expensive but superior fiber-optics, and larger switches bring economies-of-scale. The nation's commerce is becoming more dependent upon computer communication carried by telephone lines, whereby orders are placed, money is transferred and data consulted.

The Defense Department has become concerned about the problem of sabotage of the nation's telephone system due to the increasing concentration of potential crisis nodes and everyday importance in commerce and defense (6). Therefore, a disaster at a switching station is more devastating than in the past due to: 1) more customers being affected; 2) society's increasing dependance on telephone lines; and 3) higher costs of repair (6). There are more than 11,500 central offices such as Hinsdale in the United States (5).

Illinois Bell's fire preparedness was not adequate. Remote monitoring, an unmanned station, no automatic alerting of local officials, an inattentive employee and most important, no fire suppression system or crisis management plan are the most compelling reasons for the lack of adequacy. Since deregulation of the telephone industry, there has been no national organizational authority over telephone security. This has led to non-uniform practices amongst regional companies. There is no compiled information on how many other "Hinsdales" exist throughout the country, but there is a general consensus that Hinsdale was not an anomaly (3,19).

Businesses and individuals in Chicago learned firsthand how dependent they were on the telephone system. This has led many of the larger companies to look into more expensive backup systems than were previously thought warranted. Some of the most common are alternate routing, using more than one carrier and bypassing the local telephone company completely via microwave dish, either permanently or for emergencies only. Even though 99% of all telephone traffic presently passes through local telephone company circuits, local telephone companies are concerned about being bypassed by carriers such as AT&T and MCI. Currently, the federal government imposes restrictions on telephone companies, whereby they cannot compete with long distance carriers on remote hookups (23).

For smaller businesses and individuals, in which cost is a much larger constraint, the most practical backup system is a cellular telephone. This assumes that the cellular network does not encounter the severed area, as many did in the Hinsdale accident. Many people dependent on the telephone are beginning to reclassify the cellular telephone as a necessity rather than a luxury (9).

There were many small companies which feel that they are at the mercy of the telephone company. Cellular telephones are not the solution for these firms, and, when coupled with the fact that an outage of this magnitude is a rare event, they believe it is the utility's sole responsibility to avert a like disaster (11).

The insurance industry will probably feel the effects of the Hinsdale fire, even though the payout is very little in the form of time element coverages. Time element coverages (business interruption, contingent business interruption and extra expense) are not readily available for the identified peril of lost communications. Property insurance coverages generally only respond when the named insured has incurred physical damage to the policy covered property. Presently, the insurance industry has a pervasive tendency not to consolidate its contingent coverages, leading to unpaid losses and frustrated policyholders. The Hinsdale incident certainly generated bad feelings toward insurance companies, however, it is highly unlikely that the situation will have any effect on the insurance industry's time element underwriting practices or procedures. Non-insurance industry sources hope that with more disasters, comprehensive time element communication may be automatically included under general business interruption coverage (34).

As a result of the disaster, Illinois Bell will install an \$80 million safety system to reduce the probability of another major outage. Under the new system, each local switching station will connect to two other stations, whereby a disabled facility could be largely bypassed. The utility also plans to build three new alarm centers, install sprinklers and use flame resistant cables. It plans to pass these costs on to customers (35).

The results of pending lawsuits may have a sweeping effect on the telephone industry, if Illinois Bell is held liable for customers' business interruption. This particular problem can not now be included in the overall loss picture, however, it is mentioned here for the sake of completeness.

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APPENDIX A

BETTER BUSINESS BUREAU
SURVEY OF IMPACT
IMPACT BELL HINSDALE SWITCH FIRE

This survey is designed to assess how the fire at Illinois Bell's Hinsdale switching office affected your business. If it did affect your business, what steps did you take during this period and what steps are you now taking to prepare for the future? By gathering this information and eventually sharing it, we hope to minimize the impact of any possible similar incident.

Please answer each question as completely as possible, by putting an "X" next to the appropriate response. Use the last question on the survey to make additional comments.

Return the survey to:

Better Business Bureau of Chicago and Northern Illinois
Attn: M. Dohrs, Telecommunications Trade Practices
Committee
211 W. Wacker Drive
Chicago, Illinois 60606

The Problem

1. For how long was your business telephone service interrupted as a result of the fire? (Check one.)

- | | |
|---------------------------------|--------------------------------|
| a. Not at all _____ | d. For 15 to 21 days _____ |
| b. For less than one week _____ | e. For 22 to 28 days _____ |
| c. For 7 to 14 days _____ | f. For more than 28 days _____ |

2. From what source did you receive the majority of accurate information about the problem during the period of interruption? (Check one primary and one secondary source.)

- | | <u>Primary</u> | <u>Secondary</u> |
|---|----------------|------------------|
| a. From Illinois Bell | _____ | _____ |
| b. Newspapers | _____ | _____ |
| c. Television | _____ | _____ |
| d. Second hand, through business associates, etc. | _____ | _____ |
| e. From my long distance carrier | _____ | _____ |
| f. Other (specify) | _____ | _____ |

3. How accurately was this estimate of the length of time your business telephone service would be interrupted?

- a. Very accurate _____
- b. Reasonably accurate _____
- c. Not very accurate _____
- d. Very inaccurate _____

4. What areas of your business were negatively affected/interrupted by the absence of telephone service? (Check all that apply.)

- a. No major interruption, just minor inconvenience _____
- b. Marketing _____
- c. Sales _____
- d. Customer relations _____
- e. Accounting _____
- f. Data processing _____
- g. Distribution _____

Other (specify) _____

5. What strategies did you implement to protect your business from the impact of the telephone problem or to substitute for normal services/functions that could not be performed? (Check all that apply.)

- a. None required _____
- b. Relocated functions to alternate sites with phone service _____
- c. Employed temporary staffing or paid overtime so tasks usually automated could be performed manually _____
- d. Installed dedicated back-up system with another carrier _____
- e. Implemented alternative marketing programs to substitute for telemarketing _____
- f. Made use of "disaster" data processing center _____

Other (specify) _____

6. If you adjusted your marketing program to accommodate the loss of any telemarketing functions, what did you do?

- a. No adjustment required _____
- b. More broadcast advertising _____
- c. More newspaper advertising _____
- d. More direct mail _____
- e. Crisis communications (letters, etc.) to customers _____

Other (specify) _____

7. How much do you estimate the cost of these strategies to be?

- a. No cost _____
- b. Under \$1000 _____
- c. \$1,001 to \$5000 _____
- d. \$5001 to \$10,000 _____
- e. \$10,001 to \$25,000 _____
- f. \$25,001 to \$100,000 _____
- g. Over \$100,000 _____

Planning for the Future

8. What preparations have you made to address the impact should a similar incident occur in the future? (Check all that apply.)

- a. None required _____
- b. Reduced our firm's dependence on telecommunications _____
- c. Retained a dedicated back-up system installed during this crisis _____
- d. Made plans to install a dedicated back-up system with an alternate carrier _____
- e. Identified a site to which your business can be relocated in the event of problem _____
- f. Cross-trained employees to perform automated functions manually in the event of disaster _____
- g. Developed a disaster recovery plan _____
- h. Secured new insurance coverage/adapted existing coverage to include special provisions addressing this situation _____
- i. Adapted supplier or customer contracts/agreements to protect company from liability in the event of utility interruption that prevents you from meeting obligations _____

Other (specify): _____

9. If you have developed a formal or informal disaster recovery plan, please indicate which of the following components are included in the plan: (Check all that apply.)

- a. Identification of the primary functional areas a telecommunications disaster would affect: _____
- b. Identification of automated functions that could be performed manually in the event of a telecommunications problem: _____
- c. Cost projections of dollar losses per day of lost service _____
- d. Customer communications program to inform/advise re crisis _____
- e. Alternative marketing plans to substitute for telemarketing: _____
- f. Standards and planning checklist to manage recovery in a precise and controlled manner: _____
- g. Relocation plans to shift functions to alternate sites: _____

Other (specify) _____

10. What additional comments would you like to make about the steps you took to respond to the fire or the plans you've made for the future?

11. (OPTIONAL)

Your name: _____

Title: _____

Company: _____

Street Address: _____

City: _____ State _____ ZIP _____

Telephone number: _____

APPENDIX B

In order to determine the amount of lost telecommunications-only sales to previously identified industries, a subjective rating scheme was assigned to certain comments taken from the BBB survey. Comments identifying, in words, a loss were subjectively rated on the following scale:

<u>General Description of Loss</u>	<u>Percent Loss Of Daily Business</u>
Small	15%
Medium	25%
Heavy	50%
Severe	75%
Total	100%

Twenty-one (21) businesses volunteered comments which were able to be quantified in this manner. The remaining companies did not volunteer comments for several reasons, including:

- 1) proprietary information
- 2) losses were not as high

Using a log-normal distribution yields a mean of 38.9% loss for the 21 businesses, with a standard deviation of 19.7%. Assuming the remaining 103 businesses in the survey suffered one standard deviation lower losses than the 21 businesses, or 19.2%, the following total percentage can be calculated:

21 businesses ÷ 124 total BBB survey businesses x 38.9
plus
103 remaining businesses ÷ 124 total BBB survey businesses x 19.2

$$\begin{array}{rcl} 21/124 \times 38.9 & = & 6.6 \\ 103/124 \times 19.2 & = & \underline{15.9} \end{array}$$

Total estimated
telecommunication loss 22.5%

APPENDIX C

ILLINOIS BELL TELEPHONE FIRE BUSINESS LOSS AND COSTS INCURRED QUESTIONNAIRE

This questionnaire is part of a study conducted by Crisis Management Corporation for the Critical Engineering Systems Division, National Science Foundation (NSF) under Grant No. CES 88-20941. The purpose of this questionnaire is to compile losses from this disaster. Ultimately, the purpose is to propose changes in order to mitigate future losses.

NSF is an agency of the United States government and is not affiliated with Illinois Bell. We will appreciate all the information you can supply us so that we might be able to prevent this type of disaster to occur again in the future.

A. General Information

Company Name _____

Division (if applicable) _____

Address _____

B. COMPANY LOSS ESTIMATES

- 1) Number of days with no telephone service _____
- 2) Number of days with Sporadic telephone service _____
- 3) Number of days with no computer data service _____
- 4) Number of days with sporadic computer data service _____
- 5) Estimated cost in dollars for outside services to repair/replace/substitute phone and computer links.
(Please include items such as microwave dishes, cellular phone, walkie talkies, "hot site" service, etc) _____
- 6) Estimated number of hours spent by company personnel in repairing and restoration of service _____
- 7) Estimated cost of #6 [\$ rate x hours] _____
- 8) Estimated loss in dollars of lost revenue _____
- 9) Estimated savings in dollars from laid off workers (if applicable) _____
- 10) Estimated rebate in dollars from Illinois Bell or insurance during outage _____

11) Please describe other direct or indirect losses not requested above

C. PERSONNEL LOSS ESTIMATES

12) Were any employees temporarily laid off? Yes___ No___

13) If yes, please answer the following questions.

a) How many workers were laid off _____

b) Average number of days lost/worker _____

c) Average wage per worker _____

d) With or without pay? with___ without___

e) If with pay, indicate percent of normal wage
(eg. 100% = full wage) _____