8 DAMAGE TO LIFELINES

8.1 Electricity

The Electricity Generation and Transmission Corporation (TEA) of Turkey owns and operates 15 thermal and 30 hydroelectric plants generating the 91% of total electricity of Turkey. The power system consists of 380kV transmission lines and 380/154kV substations which form the backbone of the Turkish power network. Turkish Electricity Distribution Corporation (TEDA) owns and operates regional distribution systems with less than 34.5kV lines.

Although vital power generating facilities such as hydro or thermal power plants did not suffered severe damage, power supply was cut off throughout a wide area including Istanbul. Immediately after the earthquake, TEA and TEDA began to restore the power system by switching properly functioning equipment at disabled substations into systems that were still running. The main cause of the power outage was the damage to the 380/154kV Sakarya substation.

The members of the JSCE team for the investigation into the damage to lifeline systems visited Sakarya substation of TEA on September 7, 1999 (Figures 8.1). The substation which consists of 380/154kV transformers and related switches is one of the key facilities of the power grid in the northwest Turkey. It is located on the hill near the city of Sakarya(Adapazari). While the city is located on Alluvial ground, the substation is located on rather stiff ground. According to the interview to the manager and his technical staffs, we obtained the following information about the damage to the facilities.

Figure 8.1 Sakarya substat on and its administration building

All four transformers slipped about 50cm out of place when their foundation bolts broke off. The weight of each transformer is 200 tons. Five of six major circuit breakers suffered damage leading to oil leakage from the bushings because the bushings slipped out of their positions. Those damaged circuit breakers were made in Sweden while non-damaged one was made in Japan. There was breakage of the support insulators of 15 disconnection switches. Immediately after the earthquake, they began to restore the equipment by two shifts of 100 workers. They successfully restored the function of substation by 2 PM on the same day. Some part of the central city of Sakarya, however, could not receive the electricity because of the damage to houses and distribution poles.

At the time of the visit of the JSCE members, the damaged circuit breakers had been replaced with new ones, and the transformers had been repaired. As for the seismic design code for these equipments, we were told that there was no Turkish original one. It seems that the seismic design is performed according to the codes of the exporting countries.

No severe structural or geotechnical damage within the substation yard was observed. Actually, It was said that that no glass on the tables in the office building was moved. The ground motion of the substation must be almost the same as the motion recorded at Sakarya strong motion observation station (EW 407Gal), which is close to the substation. Although the ground motion must have exceeded the design level, no ground surface rupture occurred in the substation yard. TEA 's important facilities including the Sakarya substation are all located on the stiff ground.

8.2 Water Supply and Sewage Systems

The ground displacement induced by faulting remarkably occurred in the damaged areas. The buried pipelines crossing the fault, suffered damage severely. Figure 8.2 shows the buckling of water supply steel pipe with 28 inches of diameter at Ac su Village. This pipeline crossed the main fault line slantwise. The horizontal displacement of 2.5m was observed in a row of poplar trees close to this site. Figure 8.3 shows the break of pipelines crossing a secondary normal fault with a vertical displacement of more than 2m at Kavakl in Gölcük City. Figure 8.4 shows the breakage of sewage pipe at Arifiye. This pipeline crossed perpendicularly the

main fault and separation of pipe was about 3m. As mentioned above, many pipelines suffered damages due to the permanent ground displacement induced by faulting.

Figure 8.2 Buckling of water supply steel pipe

Figure 8.3 Break of buried pipeline crossing a normal fault with a vertical displacement

Figure 8.4 Breakage of sewage pipe crossing a main foult

Figure 8.5 New pipeline laid in the downtown in Adapazari

The emergency water delivery was conducted by using tank trucks in Gölcük,Adapazari and Izmit where the destructive damages to buildings were occurred. Although the repair works were not almost started in these cities yet as of September 10, 1999, new pipelines were laid in the downtown of Adapazari City as shown in Figure 8.5. Since this area is one of the hardest damaged area of buildings in the city, the pipelines also seems to suffer heavy damages. The pipelines buried here, therefore, abandoned and new pipeline was constructed.

Sapanca Town whose population is about 20 thousands, takes waters from deep well of about 80 m in depth. The water supply pipeline system has approximately 185km of distribution pipelines. About 80% of the total length were made up of asbestos cement pipe, about 20% of polyvinyl chloride pipe and the diameter of main pipeline is 400 mm. The total number of repairs was 300 as of September 7, 1999. The repair ratio, that is defined as the number of

breaks divided by the total pipe length, is 1.62 /km. The total number of repairs seems to become great finally because only about 80% of the total repair works were done at that time. Most of damages occurred at the connection of asbestos cement pipes buried close to Sapanca Lake and rivers. Since ground deformation induced by liquefaction and/or fault movement was remarkably occurred there, it seems to be one of the main causes of the pipe damage. Although the repair works done in two days after the earthquake in Yalova City, the recovery rate of Sapanca Town was only 30% after two days from the earthquake.

8.3. Natural Gas Distribution System

Gölcük and Adapazar , where the destructive damage to buildings occurred, have not gas pipeline network. Izmit City seems to suffer severe damage to gas pipeline but the repair works were not almost started yet as of September 10, 1999. The gas leakage was only reported in Yalova City at the locations where structures were heavily damaged or collapsed.

The gas distribution company GDA supplies gas to 1,300,000 households in Istanbul City. Gas is imported from Russia. The steel pipes with 28 to 30 inches in diameter were used from the gas production company to IGDAS. The pressure of gas is 70 to 20bar. The six inches steel pipes were used from regulators to transfittings. All of the distribution pipelines with a pressure of 4 bar from the transfittings to each house were made up of polyethylene pipe with 125 to 32mm in diameter. In the buildings, steel pipes are used and the pressure is 300 to 21mbar. One fell down collapsed due to the collapse of building during the earthquake. Therefore 1,590 customers were not able to get gas supply due to the collapse of the regulator for three weeks after the earthquake. There was no damage to the buried gas pipelines even in the area where the buildings were severely damaged.

8.4 Lifeline Support in Post-Disaster Management

According to the statistics by the Turkish government, over 15,000 people were killed and about 24000 people were injured by the earthquake. For building damage, over 60000 buildings were collapsed and about 58,000 buildings were seriously damaged (As of 9/22/99). Because of the collapse of their houses and/or fear of staying in house regardless of its safety

condition, over 100,000 people are evacuated from their home. The disaster victims set up their tents on many places such as open yards, streets and parks.

The Red Crescent (K z lay) camps were set up in many places (Figures 8.6 & 8.7) to provide basic needs such as water, food, tent, medical care as well as the disaster relief information. The lifeline support management in the camps is one of the most important issues for the emergency management. According to an official working for the disaster application center for victims in a camp at Gölcük, currently, the substitutes for lifeline systems are functioning without major troubles, so that the fundamental needs of people are satisfied in the camp.

Figure 8.6 Emergency water delivery

Figure 8.7 Tents in a park

(1) Water Supply and Sewage

As of September 9, the water supply network has not been restored yet in Gölcük. Hence, the water is delivered by water wagons and stored in the water tanks located in the camps (Figures 8.8 and 8.9). The refugees could get water from the tanks.

Figure 8.8 Water wagon

Figure 8.9 Water tank

DS (The state Water Works) bored several new wells or re-operated the wells bored previously by DS to provide fresh water for the people who are leaving in temporary pre-fabrique houses and tents complexes. Four new wells and one existing well equipped with pumps provide fresh water to 5 new temporary housing complexes in Adapazar City. Two new wells at Yalova and two new wells at Gölcük were bored and equipped with pumps for the fresh water needs of these cities. No water shortages exist in the cities, towns and villages of the earthquake stricken region as of September 28, 1999.

As for the sewage system, portable toilet units are set up on streets and in camps (Figure 8.10). The toilet unit has a water tank for flushing so that water has to be supplied to this tank as well.

Figure 8.10 Portable toilet unit

Figure 8.11 Portable food supply unit

(2) Food Supply

Food supply stations were set up in the camps. The menu of a meal that we observed is bread, meal and fruit. The number of the supply stations is not enough. Therefore, the people has to be wait in line to get foods at each meal time (Figure 8.11).

(3) Telecommunication

Telephone units free of charge are set up in the camps (Figure 8.12). In addition mobile phones are quite popular as the communication situation is quite good.

Figure 8.12 A telecommunication Tent

(4) Housing

Since the disaster victims are afraid of the safety condition of their houses due to the aftershocks, many people sleep in tents. The building safety inspection are proceeding, but it has not covered the whole disaster area yet. The tent is provided by Red Crescent, international relief agencies, and military forces. According to the government, about 50,000 temporally housing units are planned to be constructed by the end of November.

Since it is the summer, people could stay outside. However, as the winter is approaching, some refugees staying in tents should go back their home. The quick dissolution of the camps is a key issue for restoration of the community. The government has to construct enough number of the temporally houses as quickly as possible.