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An emergency energy supplying center project in urban area (I)

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ABSTRACT: Our life rely more and more on energy. It is important to make reliability of energy supply system in urban area higher. This paper is one of the series of basic study on the emergency energy supplying center project. In this paper, we describe the result of survey of a power failure in a big city named Hiroshima in western Japan. The power failure was caused by a typhoon and lasted 6 days at longest. We made survey of every infra-structure, many kinds of building and factories. With the result, we consider measures for this kind of disaster.

1. PURPOSE OF THIS STUDY

Our life rely more and more on energy. Once the energy supply, especially the electricity supply is stopped in the city, infra-structure systems will have much difficulty in maintaining the functions and our life will be in much trouble. We have many earthquakes and other natural disasters that cause big power failure. So it is important for us to know what kind of trouble will appear in case of power failure and what kind of measures are effective for the problems.
Last autumn, we have big power failure in Hiroshima that last 6 days at longest and many weak points have appeared. We suveyed every infra-structure, many kinds of building and factories. With the result, we consider measures for this kind of disasters.

2. OUTLINE OF THE POWER FAILURE

The power failure happened in many prefectures of western part of Japan caused by a big typhoon No.19. One of the worst case was in Hiroshima. Hiroshima city has population of 104.4 million and located at the coast. The typhoon hit Hiroshima in the evening of 1991. 9.27. By the strong wind (the maximum is 58.9 m/s), power supply system got phisical damages. Most customers (99.7%) lost their power. It was almost recovered in 2 days. But the third day, they had slight rain, that caused the second big power failure (61.9%) as salt on the insulators melted by the rainfall. It took 3 more days to recover the system.

3. SURVEY OF INFRA-STRUCTURES

We made suvey of every infra-structure. They are electricity supply, telecommunication system, broadcasting system, railway, airport, traffic signals, water supply and treatment and gas supply system. The method is that we send question form to the operating company or organization previously, and go to ask later. The period of the survey is 1991.11.1 - 11.25. The result is shown in Table 1.

4. SURVEY OF BUILDINGS

We made survey of many kinds of building. Kinds and number are shown in Table 2. The method and period of the survey are the same as that of infra-structures. The result is shown in Table 3.

Table 2. Kinds and number of surveyed buildings

No	Kind	Number
①	Office	9
②	Finance	10
③	Department store	8
④	Convenience store	3
⑤	Hotel	8
⑥	Hospital	7
⑦	Gas station	3

Table 1. Result of the survey of infra-structures

	Electricity	Telecommunication	Broadcasting
Outline of systems	·Number of customers : 394,000 ·Suppled in 1990 : 4,284 mil.kwh ·Number of converter : 22	·Number of customers : 689,000 ·Number of service in 1990 : 904 mil. ·Number of exchange station : 82 ·Number of exchange station with generator : 18	·Number of televison station : 94 ·Number of radio station : 7
Power failure period of central office or facility	·The 1st failure 9/27 19:56 - 9/28 08:28 9/29 02:15 - 9/29 04:01 ·The 2nd failure No	·The 1st failure 9/27 20:07 - 9/29 03:19 ·The 2nd failure 9/30 04:06 - 9/30 04:53	·The 1st failure 9/27 20:07 - 9/27 22:07 ·The 2nd failure 9/30 03:30 - 9/30 03:35
Troubles of the systems	·The automatic switches on the electricity transport poles were out of order because of the salt. The control center could not control the system. Moreover they could not know whether the switches are on or off. ·They couln't predict large scale power failure caused by salt.	·The service demand increased but no trouble. ·One of the batteries of exchanger over-discharged. They charged the battery with potable generator.	·The generators operated without any trouble. ·Noise of generators caused the mis-operation of CVCF. ·To supply oil at the station on the top of the hill was very hard. It caused 1 hour stop of the broadcasting.
Responce	·They called for help of the other electric companies. ·They made P.R. activity by mass-communication, cars and telephone. ·They have plan to change insulators to salt resist ones.	·The damages are not so bad, as most cables are set in the ground.	·Special news program for typhoon was broadcast.
Troubles of the customer	·Number of maximum power failured customers -the 1st failure : 390,000 -the 2nd failure : 244,000	·Out of service caused by salt : 9613 lines ·Public phones for pre-paid card, extension phones and multi-function phones that need power couln't operate.	·Broadcast stopped for 50 seconds. ·Television broadcast stopped at the north-western part of area for about 1 hour.
	Railway	**Airport**	**Traffic signals**
Outline of systems	·Length of railway : 34.9 km ·Number of stops : 76 ·Number of transported people in 1990 : 82.01 mil. ·There is no generator at all	·Number of landed plane in 1990 : 11374 - Number of passangers : 1,937,378 - Baggages : 12,904 t - Post : 4,476 t ·There is enough capacity of generator	·Number of signals : 3,075 ·Police of Hiroshima Prefecture has the control center of the signals. ·The control center has only batteries and no generator.
Power failure period of central office or facility	·The 1st failure 9/27 19:00 - 9/27 23:45 ·The 2nd failure 9/30 05:00 - 9/30 07:30	·The 1st failure 9/27 19:15 - 9/28 17:00 ·The 2nd failure 9/30 02:30 - 10/1 11:20	·The 1st failure 9/27 20:00 - 9/27 22:00 ·The 2nd failure No
Troubles of the systems	·When the wind velocity became over 20 m/s, they began to put the cars in the car shed, but some cars were not in time for the power cut-off and they were left on the railway. ·Wireless communication transfer station has battery, but the capacity was not enough for this long power failure. ·The crossing gates and signals could't operate. ·Electric supply wire could't operate because of the salt.	·They had no trouble because the airport was closed and the generator operated well. ·The airport was closed on the 27th because of the strong wind and because of the submergence. on the 28th.	·The signals have no back-up systems, so they went out of order when the power failure began. ·The control center's battery kept only 30 minutes and after that the control center went out of order. ·Even though the center was working, in case the signal has no power, they couldn't control. ·2,000 signals of 3,075 went out of order.
Response	·7 cars were subserged. After the power recovery, they were put in the car shed. ·The cars have no way to have contact with the control center but each stop has emergency telephone. ·Radio helped the people to get information about the situation of the train. ·They have plan to set generators and U.P.S.for communication system.	·Submergence was not so bad, as there is time lag between the peak of typhoon and the high tide.	·Many policemen stood in the crossing to sign. ·Traffic information were broadcast by television, radio, and on-site information systems. ·They are examining that they set battery at main signals.

Troubles of the customer	·Number of troubled people -9/27 14,000 -9/28 75,000 -9/30 99,000 -10/1 40,000	·Closed period 9/27 19:00 - 9/28 15:00	·Traffic accidents were less than usual.
	Water supply	Discharged water treatment	Gas
Outline of systems	·Number of customers : 435,947 ·Number of supply water storage : 130 ·Number of pumping station : 110 ·Number of treatment plant : 4 ·There are many hills and water is supplied by way of maximum 5 puming stations. ·There is no generator in the pomping stations at all.	·Service area : 5,280 ha ·Number of served population : 579,000 ·Number of pumping station : 17 ·Number of treatment plant : 4 ·Not all the pumping stations have generators.	·Number of customers : 380,248 -Hiroshima city area : 292,578 ·The 6th - 8th biggest gas company of 240 in Japan. ·Number of plant : 5 ·Gas plants have generators, but the capacity is not enough for the normal operation. ·23 gas transfer station are monitored at a control center by wireless system.
Power failure period of central office or facility	·The 1st failure 9/27 20:00 - 9/27 22:00 ·The 2nd failure No	Not clear	·The 1st failure 9/27 19:11 - 9/28 10:30 ·The 2nd failure 9/29 02:30 - 10/1 10:00
	·All the pumping stations stopped (the worst case was for 40 hours) and the supplied area were suspended.	·Emergency generator worked well and there was no trouble. ·Discharged water becase less than usual because of the water suspension. ·Short period power cut-off caused trouble of electronic pump control. ·To know the situation of unstaffed pumping station was difficult.	·They counld not access customer's information in the computer. It caused much trouble in treating the customers. ·Emergency generator operated for 116 hours as the recovered power had less reliabilty and the quality was bad.
Response	·Water was supplied by water wagons in suspended area. ·The capacity of supply water storage will be increased from 8 hours to 14 hours. ·The regulation is changed so that more than 4 story building should have both system of roof tank system and direct supply system.		·To keep fuel for the generator was very hard.
Troubles of the customer	·Number of suspended customers -9/28 : (21 pumping st.) 13,520 -9/29 : (6) 3,750 -9/30 : (7) 18,930 -10/1 : (13) 26,065 -10/2 : (12) 25,465 ·Water suspension was caused by two cases. One is by the stop of pumping station. The other is by the stop of water pump in the buildings.	·Many people counld not use their toilet.	·Some of modern houses have central gas heating and hot water system that uses electricity for control. So many people couldn't operate the system even though they have gas. ·Over-electric-current caused by the salt burnt controller of gas central heating and hot water systems.

Table 3. Result of the survey of buildings

	Troubles	Response
①	·Multi-function telephone, extension telephone and Fax didn't operate. ·They have no electricity for lighting. ·Security system had such trouble without electricity. ·Water suspension occured. ·Most buildings have no emergency generator. Batteries didn't have enough capacity.	→They used candles or electric torches for lighting. →They increased the guards.
②	·Fortunately, 9/28,29 was weekend and the 1st failure caused no trouble. ·The shutter of cash dispenser had no electricity to open. ·In many blanches, the computer on-line system stopped. ·They have much trouble in setting the portable generator. -It took long time for the engineers to get to the site because of the bad traffic.	→They opened manually. →They lease portable generator or shifted the customers to the other blanches.

②	-There was not enough space in front of the building for the generator and the noise suffered the surrounding people. -No one knew the necessary capacity of the generator. ·Security system had much trouble without electricity.	→They increased the guards. Some employee stayed all at night.
③	·They ran elevator by the electricity generated by generator. It caused bad fluctuation of voltage for computer. ·Refrigerator had no electricity and much food went bad. ·The shutter of cash dispenser had no electricity to open.	→They stopped elevators. →They put much dry ice in the refregerator, but it was not effective. →They opened manually. It took more than 1 hour.
④	·The trouble was serious as they are open for 24 hours. ·P.O.S. system couldn't operate and they had much trouble in stocking the goods. ·Foods in refrigerator went bad and threw them away. ·People bought many rice-balls and much confectionary. ·No one predict the 2nd power failure, so they stocked foods after the 1st failure. That caused more damages.	→They stocked goods according to the previous week needs. But the needs in case of power failure are much different from that of normal case.
⑤	·There was much trouble in services like lighting, water & hotwater supplying and cooking. ·They couldn't access information of customers in computers.	→Some hotels were closed and shifted the customers to another hotels.
⑥	·Hospitals have emergency generator. But this time, the period was so long that there was much trouble. ·The power cut-off happened so often that a starter of a generator driven by compressed air could not operate. ·In a hospital, water shortage was serious. ·They didn't use computer as the reliability of the power supply is very low. ·The services for the inpatients such as bathing, lighting, air-conditioning, cooking, washing clothes and dishes, bell for emergency and so on had much trouble. ·Many operations were postponed. ·There was much trouble in preparing and keeping medicine. ·Artificial respiration instrument stopped in a hospital.	→A fire engine transported water and supplied. →After the complete recovery, they calculate the charges and patients paid. →They use candles or electric torches. Medicine that needs cooling were prepared just before taking. →Nurses operated it manually for all day long.
⑦	·Pump of the gas stopped. ·Washing service stopped. ·Demand of the gas was less than usual as the traffic was bad and many people didn't use their cars.	→They used manual pump. It was a very hard work.

5. SURVEY OF FACTORIES

We surveyed one large automoble factory and 10 smaller ones. The method and period of the survey are the same as that of infra-structures. Most factories have no emergency generator. We show the result of the large factory in Table 4.

Table 4. Result of the survey of a large factory

Outline of factory	·Kind of factory : Automobile ·Site area : 55 ha ·Contracted electric capacity : 94,200 kw ·Ordinary generator : 55,600 kw ·Emergency generator : 3,800 kw
Power failure period	·The 1st failure 9/27 20:00 ~ 9/29 13:00 ·The 2nd failure 9/30 04:00 ~ 9/30 06:00
Troubles	·Capacity of the generators was not enough for minimum operation. ·Operation is controlled by computers. Every time the power is cut-off, operation return to the beginning automatically. Intermittent power failure interrupted the progress of the operation. ·They couldn't get parts because of the power failure at its factories.
Response	·The operation consists of 20 sections. They operated 5 sections in expectation of electricity recovery. But in 2 hours, they must give up the partial operation as the operation of the section came to an end. ·They are examining the emergncy operation.

6. CONCLUSION

In this survey, it has become clear that much part of our life is supported by electricity and there are many points of discontinuity to carry out many services.
To prevent the disaster of power failure, we should think of measures from the following 3 view points.

1)Systems and functions of our life should be independent of power supply.
2)Systems should have so much storage as to endure long period of power failure.
3)To have generator with enough capacity and high reliabilty.

As for 3), it is difficult for each system and building to have enough generators. It is easier to have common generator in a district that supplies minimum necessary power. By using this generator for the usual use, the reliability and economy of the system become better. To realize this idea, some problems should be solved. They are ①to make the minimum necessary of the power clear, ②who operate the system and revision of the regulation of the electrical enterprise, ③air-pollution and safty.

REFERENCES

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