COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

BIG RIVERS ELECTRIC CORPORATION	)	
	)	
_____	)	CASE NO. 91-444
	)	
ALLEGED FAILURE TO COMPLY WITH COMMISSION REGULATIONS	)	

SHOW CAUSE ORDER

Big Rivers Electric Corporation ("Big Rivers"), a Kentucky corporation engaged in the generation, production, and transmission of electricity to or for the public, for compensation, for lights, heat, power, or other uses, is a utility under the jurisdiction of the Commission pursuant to KRS 278.010(3)(a) and 279.210(1).

KRS 278.040(3) authorizes the Commission to promulgate reasonable regulations to implement the provisions of KRS Chapter 278 and to investigate the methods and practices of utilities. Pursuant to this authority, the Commission promulgated 807 KAR 5:006, Section 22, which requires each utility to adopt and execute a safety program which, at a minimum, requires employees to use suitable tools and equipment and to be instructed in safe methods of performing their work. In addition, the Commission has promulgated 807 KAR 5:041, Section 3, which requires an electric utility to construct and maintain its plant and facilities in accordance with good, accepted engineering practices.

Commission Staff prepared a September 23, 1991 Electrical Utility Accident Investigation report ("Accident Report"), attached hereto as Attachment A, which alleges that:

1. On August 12, 1991, an explosion occurred in the basement of Big Rivers' Coleman Generating Plant, Hawesville, Kentucky. As a result of the explosion, one employee of Big Rivers was fatally injured and one was seriously injured.

2. Prior to the explosion, the two employees were assigned to perform welding duties on two 6-inch condensate pipelines located a few feet above a sulfuric acid storage tank. The tank had a capacity of 5,000 gallons but contained only 2,000 gallons at the time of the explosion.

3. The acid storage tank had an original metal thickness of 0.375 inch when installed in 1967. After developing a leak in 1985, the metal thickness of the bottom half of the tank was measured to range from 0-inch to 0.262 inch. The tank was then rotated 180 degrees and placed back in service.

4. Big Rivers provided the Commission with technical information on handling the sulfuric acid tank. The information indicates that: a) storage should be in a well-ventilated area away from flammable materials and sources of heat or flame due to the formation of highly flammable hydrogen gas when sulfuric acid is stored in a steel tank; b) the tank must be vented; and c) there should be no smoking, cutting, or welding in the immediate vicinity of the tank.

5. The acid tank was not properly vented.

6. Big Rivers' employees were not provided appropriate protective equipment for performing welding work in a hazardous area.

7. The acid tank was neither isolated nor shielded from the welding work. The tank was not purged to remove the flammable gas and the welding area was not adequately ventilated.

Based on a review of the Accident Report, and being advised, the Commission finds that a prima facie case has been made that Big Rivers violated 807 KAR 5:006, Section 22, by not providing appropriate tools and equipment, not shielding or isolating the acid tank during welding, and not instructing employees about the hazardous location and the safety procedure to be followed when cutting in the vicinity of the acid tank; and violated 807 KAR 5:041, Section 3, by not appropriately venting the acid tank and allowing the tank wall thickness to be less than the recommended minimum.

The Commission, on its own motion, HEREBY ORDERS that:

1. Big Rivers shall appear at a hearing on January 14, 1992, at 10:00 a.m., Eastern Standard Time, in Hearing Room 1 of the Commission's office at 730 Schenkel Lane, Frankfort, Kentucky, to show cause why it should not be subject to the penalties prescribed in KRS 278.990 for the probable violations of 807 KAR 5:006, Section 22, and 807 KAR 5:041, Section 3.

2. Big Rivers shall file within 14 days of the date of this Order a written response to the probable violations noted herein.

3. The Accident Report, attached hereto as Attachment A, shall be made a part of the record in this case.

Done at Frankfort, Kentucky, this 6th day of December, 1991.

PUBLIC SERVICE COMMISSION

Chairman

Vice Chairman

Commissioner

ATTEST:

Executive Director

ATTACHMENT A

ELECTRICAL UTILITY ACCIDENT INVESTIGATION

DATE OF THIS REPORT 9/23/91 SUBMITTED BY Elie El-Rouaiheb and Fuad Sharifi.

NAME OF UTILITY Big Rivers Electric Corporation.

ACCIDENT REPORTED BY Haydon Timmons

DATE AND TIME ACCIDENT OCCURRED 10:34 A.M. CST - 8/12/91

DATE & TIME UTILITY LEARNED OF ACCIDENT 10:34 A.M - 8/12/91

DATE & TIME ACCIDENT REPORTED 12:35 P.M. - 8/12/91

DATE OF ACCIDENT INVESTIGATION 8/13/91

DATE SUMMARY WRITTEN REPORT WAS RECEIVED FROM UTILITY 8/19/91

PERSONS ASSISTING IN THE INVESTIGATION Bruce Shelton and Richard Greenwell.

NAME OF VICTIM(S) 1. James Boarman SEX M AGE 40

FATAL No NAME OF EMPLOYER:

INJURIES First and second degree burns to 50% of his body.

2. Melvin Hagar SEX M AGE 35

FATAL Yes NAME OF EMPLOYER:

INJURIES

3. SEX AGE

FATAL NAME OF EMPLOYER:

INJURIES

ELECTRICAL UTILITY ACCIDENT INVESTIGATION (Continued)

LOCATION OF ACCIDENT SITE Coleman Power Plant

DESCRIPTION OF ACCIDENT See Attachment 1.

SOURCE OF INFORMATION Bruce Shelton, Rich Greenwell of Big Rivers Electric Corporation, Big Rivers' report, and an onsite investigation.

PROBABLE VIOLATIONS OF COMMISSION REGULATIONS

Big Rivers is in probable violation of 807 KAR 5:041, Section 3,due to the following: 1)Sulfuric acid tank was not appropriately vented; 2) the tank wall thickness is less than the minimum thickness recommended. Also, Big Rivers is in probable violation of 807 KAR 5:006, Section 22 due to following: 1) employees weren't using suitable tools and equipment; 2) the tank was not shielded or isolated from the flame; 3) employees were not instructed about the hazardous location and the safety procedure that was needed for implementing the cutting.

RECOMMENDATIONS Due to Big Rivers' probable violation of 807 KAR 5:041, Section 3 and 807 KAR 5:006,Section 22, it is recommended that the Commission consider action in accordance with KRS 278.990.

INVESTIGATION OF AN ACCIDENT IN
BIG RIVERS ELECTRIC CORPORATION, COLEMAN PLANT

On Monday morning, August 12, 1991, a 5,000-gallon acid storage tank exploded in Coleman Plant, Big Rivers Electric Corporation ("Big Rivers"). Melvin Hagar and James Boarman, (welders employed by Big Rivers) were assigned to remove about a 2-foot section from each of two 6-inch condensate pipelines located on a pipe rack a few feet above the acid storage tank and close to the ceiling of the basement. As a result of the explosion, sulfuric acid splashed on the welders and resulted in the death of Melvin Hagar on August 12, 1991 and burned James Boarman,[1] who was hospitalized in Humana Hospital, Louisville, Kentucky.

Commission Staff ("Staff") Elie El-Rouaiheb and Fuad Sharifi investigated the accident on August 13, 1991. They met Rich Greenwell, Vice General Manager of Production; and Bruce Shelton, Plant Superintendent. Staff visited the area of the accident and took photographs.

The sulfuric acid is used for the regeneration of the Cation Softener which is used in the demineralization of boiler feed water. The water treatment units, including the sulfuric acid tanks, were located in the basement of the building of Big Rivers. There are two acid tanks in the Big Rivers water treatment plant: one 5,000 gallon acid tank installed in 1967 for Units 1

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[1] Employer's First Report, Item 1 of Big Rivers' filing on August 19, 1991.

and 2; and a second sulfuric acid tank, 5,000 gallon capacity, installed in 1987 for Unit 3. The sulfuric acid tank that exploded on August 12, 1991 was the one used for Units 1 and 2, and in this report it will be referred to as Tank 1.

Tank 1 was installed at Big Rivers in August 1967. It was manufactured by Hungerford and Terry, Inc., Clayton, New Jersey. The tank is 8 feet in diameter; 14 feet, 7 inches long; 3/8 inch thick, and is made of carbon steel. The tank was tested pneumatically at 5 psi in 1967. The tank stores concentrated sulfuric acid which is loaded by trucks via a 2-inch pipe, and the acid is pumped out to the Cation exchanger tank intermittently during the regeneration process. Concentrated sulfuric acid is less corrosive to carbon steel than diluted sulfuric acid, but the limited reaction of concentrated sulfuric acid with the steel (tank's wall), produces hydrogen gas which diffuses into the vapor phase and when mixed with air produces a hydrogen-air explosive mixture. This explosive mixture occurs at a wide range of hydrogen/air ratio (4 to 74.2 volume percent hydrogen).

The tank was constructed with a vent. The purpose of the vent connection is to release the vapor mixture from the top of the tank. An overflow line is used to drain the excess acid in case of overloading the tank. The overflow line and the vent line may jointly be connected to the vent nozzle as shown in Figure 1, page 6.

During the field investigation, Staff requested to meet with Safety Department personnel or the Safety Superintendent regarding the safety procedures followed by Big Rivers in its operation and

maintenance of the acid tanks. Big Rivers recognized one person responsible for safety in the plant, but he was not available then. Big Rivers was requested to file with the Commission all the information regarding its safety guidelines in operating, handling, and maintaining the acid tanks, and to provide the design and the engineering of acid Tank 1.

On August 19, 1991, Big Rivers filed with the Commission some of the information requested in the meeting between Staff and Big Rivers on August 13, 1991. The filing consisted of 14 items referred to in the footnotes in this report.

On August 22, 1991, Staff requested additional information, and Big Rivers filed its response to the questions on August 29, 1991. On September 9, 1991, Staff requested information regarding the insurance report and accident investigation of the injured welder. Apparently there will be no insurance report for this accident, and it will be limited to a Workers' Compensation statement. Big Rivers is presently working with Mr. Boarman's attorney in an effort to obtain an eye witness account of what happened. This investigation is still underway and is likely to continue for awhile.

Big Rivers' accident investigation report[2] concludes that: 1) The acid Tank 1 sustained an internal explosion which resulted in its rupture; 2) The explosion was the result of an ignition of hydrogen that was in acid Tank 1; 3) The exact cause of the accident could not be determined, but one possibility is that the

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[2] A report filed on August 19,1991, Item 14.

overflow line was broken by outside means due to a very thin connection.

Big Rivers filed with the Commission technical information for the handling of sulfuric acid.[3] This information included a set of safety instructions concerning the following topics:

1. Unloading sulfuric acid from tank cars and the possibility of the Hydrogen-Air explosive mixture formation in the vapor space of the tank car.

2. Design and handling tank trucks.

3. Cleaning of sulfuric acid storage tanks, with reference to Stauffer Chemical Company's[4] publications in handling sulfuric acid.

4. Properties of sulfuric acid and instructions on handling.

5. Uses of sulfuric acid.

In this safety information, it is stated that sulfuric acid should be stored in a cool, dry, well-ventilated area away from flammable materials and sources of heat or flame.

On July 9, 1985, a leak was observed in the bottom of the tank,[5] and the tank was subjected to an Ultrasonic Thickness test ("UT"). Severe corrosion was noticed, and the metal thickness of the bottom half of the tank ranged from 0-inch (leak) to 0.262

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3 Item (13) of Big Rivers' filing on August 19, 1991.

4 Stauffer Chemical Company has been out of business since 1987. ICI took over the company. Stauffer Chemical used to supply sulfuric acid to Big Rivers.

5 Item (3) of Big Rivers' filing on August 19, 1991.

inch while the original metal thickness was 3/8 inch (0.375"). In 1985 Tank 1 was rotated 180 degrees presumably because its bottom section was very thin.

On May 19, 1989, the wall thickness of Tank 1 was measured again by UT. Metal thickness was in the range of 0.200 to 0.300 inches.[6]

On August 13, 1991, Staff was told that the acid tank located in Unit No. 3 (5,000-gallon tank installed in 1987) is commonly used in the operation while Tank 1 (which is located in the Unit No. 1 and No. 2) is barely used. Prior to the explosion, Tank 1 contained about 2,000 gallons of commercial sulfuric acid.

Big Rivers filed with the Commission Stauffer Technical Information on handling the sulfuric acid tanks that it considers a general guideline to Big Rivers[7] which provides the following information:

1. Association of hydrogen or explosive atmospheres in vapor spaces of sulfuric acid tanks.

2. Minimum wall thickness is 3/8 inch, including 1/8 inch corrosion allowance.

3. An external inspection is suggested every 2 years and an internal inspection every 4 years. The life of the small unlined tanks is expected to be 15 to 20 years or longer.

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6 Reference to footnote 5, item 3, of Big Rivers filing on August 19, 1991.

7 Reference to the telephone conversation between Fuad Sharifi and Bruce Shelton on September 18, 1991.

4. A vent and overflow is shown in a typical tank's drawing as shown in Figure 1.

5. The storage should be a well-ventilated area away from flammable materials and sources of heat or flame.

6. Highly flammable hydrogen gas is formed when sulfuric acid is stored in steel storage tanks or drums. Therefore, smoking, cutting, or welding must not be allowed in the immediate vicinity of the tank.

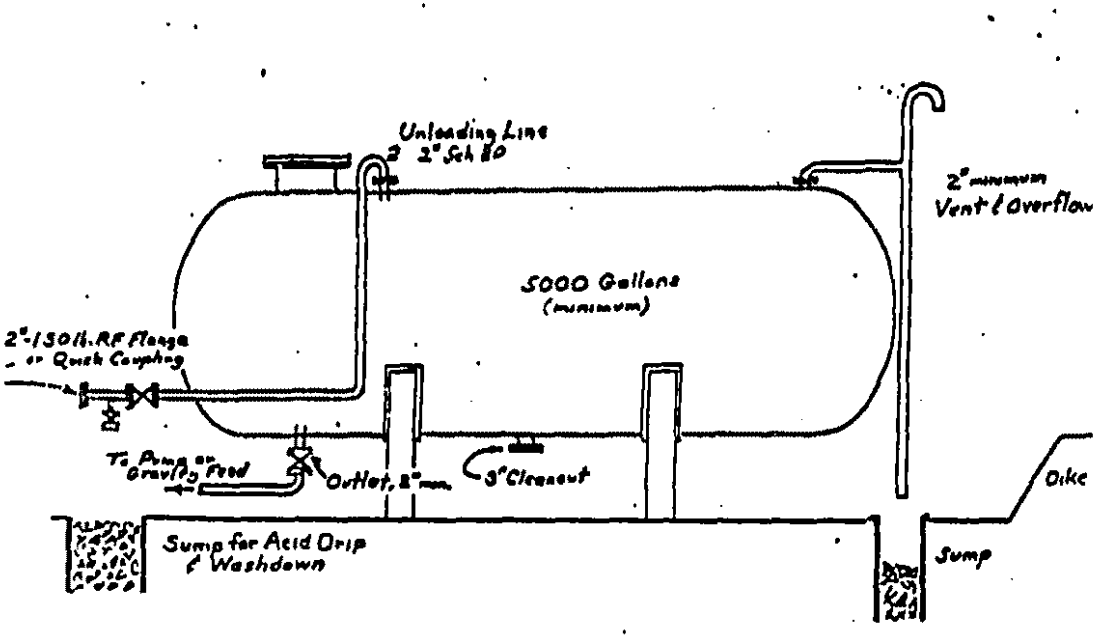

Figure 1

Typical Sulfuric Acid Storage Tank Arrangement

Big Rivers filed with the Commission a memo[8] which was addressed to Big Rivers' employees giving them safety instructions about cutting and welding clearance procedures in hazardous areas. The acid tank area is considered by Big Rivers to be included in the hazardous area, and this safety instruction applied to the acid tank's area.[9]

Following are some of the instructions:

1. When work is to be done around a generator or hydrogen manifold, appropriate measures must be taken to ensure that no explosive gases are present. Whatever the action taken, it must be specified in the clearance.

2. The person accepting a clearance (Normally the maintenance people sign the clearance, permit, and accept it after it has been issued by the operators.) will continually observe the condition of the area and, if any change in conditions occur that would make the area hazardous, the clearance should be released . . . .

Reference to Big Rivers' filing with the Commission its Manual for Accident Prevention,[10] Section I-2(B), Welding and Cutting Operations:

> B-1(3) "Ensure that combustible material which cannot be removed is kept wet or PROTECTED by a fire-resistant

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8 Item (8) of Big Rivers' filing on August 19, 1991 is a memo dated September 27, 1988 from Bruce Shelton and Jim Burris to Big Rivers' employees.

9 Big Rivers' response dated August 29, 1991 to Question 3 of the Staff information request of August 22, 1991.

10 Big Rivers' filing on August 19, 1991, Item No. 6.

shield," i.e., the hydrogen in vapor phase in the tank should be shielded or isolated from the field of work.

B-1(4) "Purge, wash, decontaminate and VENT a closed container to atmosphere to REMOVE FLAMMABLE, COMBUSTIBLE OR TOXIC material. Examples: barrel, drum, tank, pipe and a portable container," i.e., the tank should have been purged from hydrogen as an alternative to being shielded from flame.

B-2(1) "Ensure adequate ventilation." An adequate ventilation of the cutting area will remove the explosive mixture from the vicinity of the tank.

FINDINGS

Acid Tank 1 was subjected to severe corrosion as was shown by the UT test in 1985. The wall thickness of the tank was reduced to less than 30 percent of its original thickness.

The recommendations given by Stauffer Chemical Company (which provided Big Rivers with guidelines in handling sulfuric acid) show that the acid tank wall thickness should be no less than 0.375 inches. This wall thickness is the sum of 0.250 inch as minimum mechanical wall thickness plus 0.125 inch for corrosion allowance. The UT test in 1985 showed that the corrosion allowance (0.125 inch) in the wall thickness was exhausted for most parts of the bottom half of Tank 1. Big Rivers chose to rotate Tank 1 180 degrees. The connections, nozzles, and other appurtenances were replaced by new ones. The tank was tested for leaks by filling it with water instead of the 5 psi pneumatic testing that was used in the original installation. The tank was considered a nonpressure vessel which does not require an inspection certificate.

Tank 1 was not appropriately vented. There was no vent line connected to the outside of the tank's vicinity. The 2-inch overflow line, which was found broken, was inappropriately considered a vent line. The overflow line is used in case acid Tank 1 is overfilled during loading. A vent is recommended for a sulfuric acid tank because of formation of hydrogen gas in the vapor phase. Since hydrogen and air make an explosive mixture (4 to 74.2 volume percent hydrogen), it is essential to connect a tank vent to a point outside the basement and preferably with a flame trap and/or a desiccant dryer. If the tank was idle for most of the days, the condition would be even more hazardous.

The flame trap prevents a backfire of a flame from an outside source through the vent line into the tank when the vent line is releasing explosive mixture, especially when the tank is not a pressurized one. A desiccant dryer prevents water condensation forming in the tank in humid situations. The water condensation will dilute the acid which makes it more corrosive to the tank's wall.

Staff is of the opinion that Big Rivers should have applied the safety handling procedures in cutting the condensate lines which were located in the vicinity of a hazardous area even though the condensate lines were not connected directly to Tank 1

Staff believes that since Tank 1 was open to the atmosphere, the area was hazardous and that Big Rivers should have considered cutting and welding in the vicinity of the acid tank as hazardous as working on connecting lines of the tank itself; and therefore, the same safety handling procedures had to be applied.

An explosimeter was used (sniffer test) to test the area for explosive mixture by Gene Burlingame at 8:47 a.m. on top of Tank 1 only[11] while the only relief of the tank was the overflow line which was open at grade level. The explosion occurred nearly 2 hours after testing for explosive mixture without rechecking or supervision of the area for any change in the environmental conditions. Ironically, there was a No Smoking sign on Tank 1; and by cutting the condensate line, Big Rivers permitted an open flame in the No Smoking area without shielding the source of ignition from that area, i.e., without isolating the tank which is the source of producing the explosive gas which could be ignited by smoking or open flame.

During Staff's visit to the location of the accident, the 6-inch condensate line was already cut, and the piece that was cut was on the floor. The welders used a stepladder for cutting the elevated condensate pipe which was close to the roof of the building. There is a possibility that the welder needed a support to handle the heavy piece of condensate pipe and used the 2-inch overflow line that was connected to the top of Tank 1 and bent in a U shape down to the grade to the side of the ladder.

Staff's assumption is based on the broken overflow line from the connection of the pipe to the tank which was badly corroded. Staff is of the opinion that the break seemed to occur due to an outside shear force rather than the resulting explosion. If the overflow line broke before the explosion, hydrogen could have

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[11] Item 14 of the report filed by Big Rivers on August 19, 1991.

released from Tank 1 and ignited, creating a backfire to the tank which contained nearly 3,000 gallons of explosive hydrogen-air mixture which splashed the sulfuric acid all over the area.

RECOMMENDATIONS

Big Rivers' accident resulted from a failure to recognize a hazard, poor maintenance on the acid tank, poor planning, and unsafe work practices.

The explosion underscores the need for effective implementation of good safety management systems in Big Rivers' plants.

Safety management requires a written analysis of the hazards involved, communication of the information to employees, procedures for changing plant equipment, safety operating procedures, a preventive maintenance program, a hot work permit system, and an action plan for emergencies.

Big Rivers should develop strict safety procedures in the operation and maintenance of the sulfuric acid system which include, but are not limited to, the following:

1. The tank wall thickness should be tested periodically by UT; and if corrosion is observed and material thickness becomes below the recommended level, the tank should be repaired promptly or replaced.

2. A proper vent should be installed on the tank to release the hydrogen into a safe area outside the vicinity of the tank.

3. Any cutting or welding in the tank's area should be forbidden unless the tank is blinded and completely isolated and the area is tested to be explosive free. Proper safety instructions should be displayed on the permit and on the tank.

4. The tank area should be well illuminated and well ventilated during operation or maintenance.

5. Personal protective equipment should be used for maintenance employees in the hazardous areas.

Respectfully submitted,

Elie El-Rouaiheb

Fuad Sharifi

FS/mll