Exhibit No.:	
Issues:	**Lake Road T-G#4 Accident**
Witness:	**Dwight V. Svuba**
Type of Exhibit:	**Direct Testimony**
Sponsoring Party:	**St. Joseph Light & Power Company**
Case No.:	**EO-2000-845**

ST. JOSEPH LIGHT & POWER COMPANY

CASE NO. EO-2000-845

DIRECT TESTIMONY

OF

DWIGHT V. SVUBA

ST. JOSEPH, MISSOURI

September 2000

Exhibit No. 5
Date 10-26-00 Case No. Eo 2000-845
Reporter M

DIRECT TESTIMONY

OF

DWIGHT V. SVUBA

ST. JOSEPH LIGHT & POWER COMPANY

CASE NO. EO-2000-845

Q. Please state your name and address.

A. My name is Dwight V. Svuba. My business address is 1413 Lower Lake Road, St. Joseph, Missouri.

Q. By whom are you employed and in what capacity?

A. I am employed by the St. Joseph Light & Power Company ("SJLP") or ("Company") in the position of Vice President - Energy Supply.

Q. Please briefly describe your educational background and professional registration status.

A. I received a Bachelor of Science degree in Electrical Engineering from Iowa State University in 1965. In 1973, I received a Master of Science degree in Electrical Engineering from the University of Missouri at Columbia. I am a registered Professional Engineer in the State of Missouri.

Q. What is the nature of your work experience and current responsibilities?

A. I was employed by SJLP as an Electrical Engineer upon my graduation from Iowa State University. I have worked in the capacity of both an engineer and a manager on varied engineering assignments such as distribution and transmission line engineering, substation design, relaying and communications engineering as well as transmission and

distribution system planning. As Vice President - Energy Supply, I am responsible for bulk power supply including power production, system operations and planning, and fuel procurement. In addition to direct management of the Lake Road Power Plant including environmental compliance, my departments are responsible for economic scheduling of our generating units, wholesale power purchases and sales, fuel and interchange budgeting and planning, electric system planning and fuel supply. I am a member of the National and Missouri Society of Professional Engineers, and a member of the Institute of Electrical and Electronic Engineers. I have been active in the coordinated operation and planning of the interconnected electric system. I am SJLP's Executive Committee representative on the Cooper-Fairport - St. Joseph - 345 kV Interconnection ("CFSI" or "MINT"), Western Systems Power Pool ("WSPP"), and the Mid-Continent Area Power Pool ("MAPP").

Q. Have you previously testified before this Commission?

A. Yes.

Purpose of this Testimony

Q. What is the purpose of your direct testimony?

A. The purpose of this testimony is to provide background information on the Lake Road Plant, Turbine-Generator No. 4 (T-G #4), the control modifications completed in the spring of 2000, a description of the accident that occurred on June 7, 2000, the repairs and modifications made as a result of the accident, and the current status of the unit.

Q. Are you sponsoring any schedules?

A. No.

Lake Road Plant

Q. Please provide a brief description of the Lake Road Power Plant facilities.

A. The Lake Road plant is located in south St. Joseph, Missouri, on the east bank of the Missouri River. The plant consists of four steam turbine-generators, three combustion turbines, and six fuel-fired steam boilers. The plant's generating units have a net electric generating capability of 257 megawatts ("MW"). The plant also supplies industrial steam for sale to six nearby industries. The plant can be considered as a separate 900 pound steam system, an 1800 pound steam system, and a combustion turbine system. When I refer to "pound", as in 1800 pound system, I mean pounds per square inch ("PSI") of steam pressure.

Q. Please describe what is included in the 1800 pound system.

A. This is a single generating unit located at the Lake Road Plant and it consists of Turbine-Generator Number 4 (T-G #4), manufactured by General Electric (GE), and Boiler Number 6; together they are referred to as "Unit 4/6". The steam produced by this unit has a nominal operating pressure of 1800 PSI. Coal is the normal primary fuel for Boiler Number 6. Natural gas is used as a start-up fuel and may be used as an alternative fuel.

Q. Please explain the Lake Road 900 pound system.

A. The 900 pound system operates at a nominal steam pressure of 900 PSI and is fed by five boilers (Boilers #1, #2, #3, #4 and #5) which have varying fuel sources including coal, gas and No. 2 fuel oil. Boiler #5 is the only 900 pound system boiler capable of burning coal. The 900 pound steam system supplies three turbine-generators (Generators #1, #2,

and #3) and the industrial steam sales customers.

Q. Please describe the three combustion turbines.

A. The combustion turbines consist of combustion turbine ("CT") No. 5, which can operate on natural gas or No. 2 fuel oil, and two aircraft derivative jet turbines ("Jets"), No. 6 and No. 7, which only burn No. 2 fuel oil.

June 7, 2000 Accident

Q. What was the status of Unit 4/6 on June 7, 2000, prior to the incident?

A. The unit had returned to service on June 2, 2000, after its annual spring outage, which started on May 2. The unit was on-line with full capability.

Q. What work had been completed during the spring outage?

A. In addition to routine boiler and plant maintenance, several capital projects were completed. Two of these projects were the replacement of the turbine-generator control system (with the Mark V control system) and the installation of a new static generator excitation system (EX-2000), both by General Electric.

Q. Please describe what happened to Lake Road T-G#4 on the afternoon of June 7, 2000.

A. The unit was operating at near full capacity when it tripped off at 2:06 p.m. Immediately after the trip, the supply of oil to the unit's bearings and the generator hydrogen seals was interrupted. Without this oil supply, the five bearings quickly overheated and suffered mechanical damage. The loss of seal oil allowed hydrogen to escape from the generator, resulting in explosions and fires. The high temperature and high vibrations caused by the bearing damage resulted in further fires and equipment damage to the unit.

Q. How was this situation handled by plant personnel?

A. The primary concern in this situation was the safety of employees. Emergency services were contacted via the 911 system and non-essential personnel were evacuated from the plant. Meanwhile, operating personnel took steps to limit damage and protect equipment. The generator hydrogen supply was immediately closed and vents were opened to prevent hydrogen from fueling the fires. When lubricating oil was restored to the bearings (a few minutes after the unit trip), it provided an additional source of fuel for the fires. Therefore, operators shut the lubricating oil back off to control fire damage. Plant operators then put out the fires with fire extinguishers. Unaffected equipment was monitored, controlled and/or shut down as required. All fires were extinguished and equipment was secured by the time fire department personnel arrived on site.

Q. Were there any injuries resulting from the incident?

A. No. There were no injuries.

Q. Did the fire cause significant damage?

A. No, the fires were fueled by hydrogen and lube oil, and the damage was limited to the immediate vicinity of the bearings.

Q. Was anybody working on the unit at the time of the trip?

A. Yes. A GE field service engineer and a SJLP instrument technician were troubleshooting a problem with the T-G vibration instruments that were supplied with the new Mark V control system.

Q. What caused the unit to trip?

A. The Mark V turbine-generator control system tripped the unit due to high vibration

indications from the new vibration equipment. However, vibration readings immediately prior to the trip, inspection of the unit and subsequent investigation lead us to believe that the unit did not actually experience high vibration prior to the trip.

Q. What do you believe caused the trip?

A. The most likely cause of the trip was the troubleshooting work on the vibration sensors being performed by GE and SJLP personnel. This work resulted in false indications of high vibration, which in turn resulted in a unit trip.

Q. Would you expect the T-G controls to trip the unit if it had high vibration?

A. Yes. The controls are set to trip the turbine to protect it from being damaged by high vibration.

Q. What happens when the turbine trips in this situation that would affect the bearing and seal oil supply?

A. Immediately following a turbine trip, a generator lock-out relay operates to disconnect the generator from the electrical system. When this relay operates, one of the devices it opens is the main auxiliary power breaker that supplies AC power to the unit's auxiliary electrical equipment (motor-driven pumps, fans, and other equipment), including two AC-powered bearing and seal oil pumps. When these two pumps lose power, low oil pressure results. The unit's DC emergency bearing and seal oil pump (powered by station batteries) normally starts automatically in response to the low oil pressure, thereby maintaining the oil supply.

Q. Why was the bearing and seal oil supply interrupted on this occasion?

A. On this occasion, the DC pump failed to start when power was lost to the AC lube oil

pumps.

Q. Do you know why the DC pump failed to start?

A. An investigation of the incident is still in progress. We currently believe that the pump control was not in the automatic operating mode. The pump control must be in automatic mode to start automatically on loss of oil pressure.

Q. Why was the pump not in automatic?

A. During the normal start-up procedure, the DC oil pump is tested. After running for this test, it must be stopped by the operator. The control would then revert to "local" mode, not to automatic. Due to control changes that were completed during the GE turbine control replacement project, the operators failed to realize that the pump control did not return to the automatic mode after a stop command. We believe that the pump control was in the "local" mode at the time of the incident, i.e. the pump would not automatically start.

Q. Please describe these control changes.

A. Prior to May 2000, the primary control interface for the DC lube oil pump was a pistol grip control switch with indicating lights, located on the north wall of the control room. The position of this switch and the status of the lights provided a clear indication of the pump's status to the operator. The secondary control interface was an electronic control station on the unit's distributed control system (DCS), i.e on a computer screen. This electronic control station was only visible to the operator when that particular screen was displayed on one of the operating consoles. During the control replacement project, the wall switch (along with several others) was removed to allow installation of the new

Mark V turbine control system cabinet. After the switch was removed, the operators had to use the DCS console display to control the pump and to determine its status.

Q. Were the plant operating personnel aware of this change?

A. Yes, it was obvious to the operators that the physical control switches had been removed and that their sole interface for controlling this equipment after the outage was via the DCS control consoles.

Q. Besides the control interface changes, were there any other DCS-related factors that you believe contributed to the incident?

A. Yes. It was generally believed by plant personnel (not only operators, but also engineers and supervisors) that the DC oil pump control in the DCS returned to the automatic mode after the pump was stopped by the operator. It was not discovered that the pump did not "return-to-auto" until the investigation after the June 7th incident. Since the pump control did not return-to-auto (as the manual switch had done), it was necessary for the operator to make a second control action to place the pump in automatic mode after stopping it.

Q. Why would plant personnel believe that the DC oil pump control returned to auto?

A. The manual control switch (that was removed) returned to the automatic control position after a stop command. Similarly, the DCS controls for the two AC lube oil pumps each had a return-to-auto feature. Since the operators operate the AC oil pumps much more often than the DC pump, they became accustomed to this feature with the oil pumps. Finally, the return-to-auto feature is more "fail-safe" than simple on-off-auto control. It was assumed that the most "fail-safe" logic would be used for the DC oil pump control.

These factors combined to give the SJLP operators the perception that the DC oil pump control mode returned to automatic after the pump was stopped.

Q. If the DCS controls lacked this feature, why was it not discovered previously?

A. Prior to May 2000, the operators normally used the manual control switch to operate the DC oil pump. Since the DCS control station and the manual control switch operated in parallel, the return-to-auto feature of the manual switch effectively concealed the problem in the DCS control logic.

Q. Why was the Turbine 4 control replaced during May 2000?

A. The previous turbine control system was the original GE system that was installed with the unit in 1966. It was no longer the current design and parts were no longer readily available. By updating the control system, SJLP expected to maintain unit reliability and improve operation.

Q. Who was responsible for replacing the control system?

A. GE was hired by SJLP to design and oversee the installation of the new Mark V turbine-generator control system.

Q. What was the scope of GE's engineering responsibilities?

A. General Electric had responsibility for all of the design and engineering for the project. This responsibility included (1) system engineering, which is the design of the control system equipment itself, the control logic that is used, and how this logic is implemented by the system software; (2) construction engineering, which included preparation of the drawings and other instructions used to remove the replaced equipment, install the new system, and integrate the new system with existing plant controls; and (3) field

engineering, which included check-out and start-up of the completed system.

Q. Was GE responsible for engineering the removal of the manual control switch for the DC bearing and seal oil pump?

A. Yes.

Q. Did GE engineers review the DCS control logic prior to the removal of the manual switch for the DC bearing and seal oil pump?

A. No, not to my knowledge.

Q. Was GE responsible for the check-out and successful start-up of the new control system?

A. Yes.

Damage, Repairs, Repair Costs and Schedule

Q. Please summarize the equipment damage due to the incident.

A. Damage to the unit included damage to all five bearings and the turbine-generator shafts at the bearing locations (journals), damage to all steam seal packing, oil seals and oil deflectors, minor damage to the turbine rotating and stationary blades, damage to the collector ring assembly, and varying degrees of damage to instrumentation, insulation, and other components.

Q. Please summarize the repairs made.

A. The turbine-generator was completely disassembled, inspected and cleaned. The three rotor sections were sent to repair shops where the badly damaged No. 3 bearing journal was weld repaired and re-machined, other journals were machined to remove damaged areas and all five bearings were rebuilt and repaired. All steam seal packing, oil seals and

oil deflectors were replaced. Minor repairs were completed on rotating and stationary blades. The generator rotor was disassembled, cleaned and tested. After failing an electrical test, one rotor coil was re-insulated (the rotor will require a complete rewind in the near future). The collector rings were repaired and the wiring to the exciter was replaced. All vibration and turbine supervisory instrument probes were replaced. The unit was aligned and reassembled.

Q. What is the total cost to perform the repairs?

A. The total cost of repairs, maintenance and betterment is estimated to be $2.5 million. Company witness Larry J. Stoll addresses the financial impact of the repair costs in his direct testimony.

Q. What was the Company's original time estimate to repair the unit and get it back in service?

A. We initially estimated that the unit would return to service about September 1, 2000.

Q. When was the unit actually returned to service?

A. On August 8, 2000.

Q. Why were you able to get the unit back in service sooner?

A. There were several reasons. General Electric provided timely delivery of parts and quick turn-around on repairs. In some cases, it was necessary to pay premiums to expedite parts or repairs. Rotor repairs were limited; it was not necessary to replace turbine blades or rewind the generator rotor. The SJLP project manager performed an exceptional job in coordinating the repairs and expediting the project. The millwright repair crews worked 20 hours a day (10 hours each shift), seven days per week throughout the repair project.

Finally, an established working relationship between SJLP and GE resulted in good cooperation and a greater effort on GE's part to get the unit back on line as quickly as possible.

Q. Was this incident something that normally occurs at Lake Road and other power plants?

A. No. Although there are forced outages of generating units from time to time due to equipment failures, this was particularly significant in terms of the damage incurred, the amount of time it took to make the repairs, and the financial impact on SJLP.

Q. Has an event of this particular nature ever occurred at SJLP or any other power plant before such that SJLP should have been aware of the problem?

A. Not that I am aware of.

Turbine Generator Protection Modifications

Q. Were any modifications made due to the incident?

A. Yes. After the incident, overall T-G protection was reviewed by plant personnel and outside consultants. Based on these reviews the bearing and seal oil pump controls were modified and a new generator protective relay was installed.

Q. How were the oil pump controls modified?

A. The DC oil pump manual control switch and lights were reinstalled and the parallel control in the DCS was removed. The control logic was modified to start the standby AC or DC pump automatically upon loss of power to the other pump(s), in addition to starting on loss of oil pressure. One of the AC oil pumps (#1) now has a second power source that is supplied from the 900 pound plant, which is not normally interrupted on a

Unit 4/6 trip. This alternate source is now the normal power supply for this pump, which effectively moves the DC pump from being the first (and only) backup in the case of a unit trip, to a secondary backup role. Multiple alarms were added to alert the operator to abnormal conditions for either the AC or DC oil pumps. Finally, control logic has been added to prevent the turbine-generator from being started without the DC oil pump in a ready state and automatic mode.

Q. What protective relay changes were made?

A. A new state-of-the-art, generator multi-function protective relay and associated devices were installed to provide enhanced relay protection for Generator #4. This new relay provides redundant protection to the existing generator relays. In addition, this relay now provides the following protection that was not previously available: back-up phase fault, volts per hertz over-excitation, reverse power, out-of-step, two-zone loss of field, and additional under-frequency.

Q. Would you expect an incident such as the one on June 7th to be something that will recur frequently at SJLP?

A. No. We do everything we can reasonably do to keep generating units such as Unit 4/6 operating properly. As I have indicated, we have reconfigured the controls in an effort to prevent this type of situation from ever happening again.

Current Unit Status

Q. What is the current status of the unit?

A. The unit is back in service and providing low-cost electricity for our customers. Through

the exceptional efforts of Company personnel and many of its suppliers and contractors, the unit was back to full capability for the peak power demands placed on SJLP's system during the week of August 28th. The unit has successfully completed its annual MAPP (Power Pool) accreditation test, maintaining its accredited capacity of 97 MW. The turbine has slightly high vibration on two bearings. We will continue to monitor this situation and may attempt to reduce the vibration by adding balance weights to the rotor during a short scheduled outage this fall.

Q. Does this conclude your direct testimony at this time?

A. Yes.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of St. Joseph Light & Power Company for the issuance of an accounting order relating to its electrical operations.	))))	Case No. EO-2000-845

County of Buchanan)
)
State of Missouri)

AFFIDAVIT OF Dwight V. Svuba

Dwight V. Svuba, **being first duly sworn,** deposes and says that he is the witness who sponsors the accompanying testimony entitled "Lake Road T-G#4 Accident"; that said testimony was prepared by him and/or under his direction and supervision; that if inquiries were made as to the facts in said testimony and schedules, he would respond as therein set forth; and that the aforesaid testimony and schedules are true and correct to the best of his knowledge, information, and belief.

D. V. Svuba

Subscribed and sworn before me this 11th day of September, 2000.

Rita Sandstrom
Notary Public

My Commission expires:

June 29, 2002

RITA SANDSTROM
Buchanan County
My Commission Expires
June 29, 2002