

DO COMMERCIAL BUILDINGS HAVE POWER PROBLEMS? THE ANSWER IS - THEY CERTAINLY DO.

By Patrick J. Lynch, P.Eng.

*PROBLEMS CAN BE GENERATED BY THE ACTUAL BUILDING LOCATION, OTHERS BY EQUIPMENT WITHIN THE BUILDING AND SOME THROUGH INCORRECT OVERALL BUILDING DESIGN PROCEDURES. **LESS THAN 10%** OF THE PROBLEMS ORIGINATE FROM THE HYDRO UTILITY, YET WHEN THE EXASPERATED CLIENTS CONTACT US INITIALLY, THEY "PERCEIVE" THE UTILITY TO BE 100%, TO BLAME FOR THEIR PROBLEMS.*

Through our work to-date in the United States, Canada and overseas, we have investigated and uncovered over 22 different problems that can occur within a commercial building (within a manufacturing environment this number can be increased by a factor of 5).

We will present four different case studies today. All the case studies selected we feel are typical of what could be expected to occur now, and in the future in a typical modern office complex.

It should be noted because of the severity of some of the problems (lost dollars \$) and our electrical engineering investigation report findings, as to the cause, several cases are now within the legal system seeking compensation and we cannot divulge the names of the designers, manufacturers or building owners. Therefore, we will call this building, for the purpose of these case studies:

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- EMI / RFI Engineering Investigations
 - Forensic Electrical Engineering Failure Analysis
 - Power Quality & Energy Audits
 - Project Management

**THE LAST CANADIAN PLACE
BEER CAN TOWER BUILDING**

Owned by:

**THE CANADIAN MACKENZIE BROS.
THE GREAT CANADIAN WHITE NORTH**

CASE STUDIES:

The phone rang at Power Line Systems Engineering Inc. The famous MacKenzie Bros. Beer Can Tower building was in trouble once again. It was another electrical power problem!

For you, that have just joined us maybe we should go back and recap the problems, as they have happened to date at this building. It should be noted, none of these problems were generated by the hydro utility.

CASE STUDY #1:

The building was being constructed beside a major Canadian airport. The MacKenzie Bros. invited the neighbours over for a sandwich and beer. The neighbours told them they recently had to install computer room shielding. The construction on the Bros. building had already started! Did they have problems as well? The MacKenzie Bros.' sensitive major financial data processing centre was going to occupy the first two floors of this building. Therefore, they immediately commissioned us to perform a R.F. evaluation study up to 12 GHz. The study revealed the computer equipment would be subjected to electro-magnetic fields forty (40) times greater than was deemed acceptable by the computer equipment suppliers. These fields would

radiate into any sensitive electronic device and associated power cabling within the building. All construction immediately stopped on those two floors and tenders were called to supply all necessary equipment to properly shield these computer rooms. In addition, it also involved modifications to the heating and ventilating, sprinklers, power line feeds, lighting, entry and exit door layouts, etc. The total additional cost per floor for these modifications was close to **1/2 billion dollars!!**

CASE STUDY #2:

This building is approximately ten years old now. But ever since the beginning they have had problems with an abnormal number of failures in the induction motors of the motor generation sets supplying the elevators hoist power in one part of the building. Each motor rewind was costing between \$5,000.00 to \$10,000.00. The elevator manufacturer was being forced each time to pay for the rewinds. The MacKenzie Bros. argued the motors should have been properly designed for the job in the first place. The elevator manufacturer claimed identical motors and loads were in other building complexes and had never failed.

We were called in to investigate. After a quick examination of the facts it was found the MacKenzie Bros. electrical staff were testing their entire elevator system on emergency bypass diesel generator power every month (as part of the routine elevator testing program).

The automatic in-phase monitor for this group of elevators was transferring from emergency to utility power **180 degrees out of phase each time**. This put excessive stresses on the motor windings each time and caused the eventual motor failures. The MacKenzie Bros. had taken out a preventative maintenance contract directly with the in-phase monitor manufacturer to have the automatic transfer switch system checked out yearly. It was found this manufacturer

never checks the phase relationships on their units when they do their yearly checks. **They claimed, if it wasn't working properly it would trip out the upstream breaker.** The elevator manufacturer has had to absorb approximately **\$300,000.00** in repairs and associated costs to these motors since the building was constructed. This last item is currently being renegotiated now with all the concerned parties.

CASE STUDY #3:

The MacKenzie Bros. were concerned with lighting efficiency. New state of the art, high efficiency (high power factor) fluorescent lighting ballast system was installed on each floor. The lighting zones on each floor were controlled by a master computer located in the property management's maintenance area. In this way each floor or partial zones on the floor could be remotely controlled. It was found the 600 Volt contactors for each zone were overheating and the contacts were fusing together. The contactor was rated for 20 Amps and most of lighting load current in each zone did not exceed 12 Amps. Interestingly, it also appeared the overheating was on a random loading basis. Some contactors carrying as little as 7 Amps were failing but some 12 Amp circuits were not. In addition, only certain random floors of this thirty (30+) plus floor building were being affected.

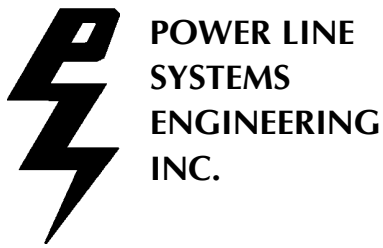
The MacKenzie Bros. called their other beer tower divisions across Canada and the United States and found they also had similar problems in their high rise buildings. All had used the same very reputable lighting system manufacturer. The manufacturer was persuaded by the Bros., to call us in to investigate. We surveyed the Brothers' other buildings across North America, as well as their corporate head offices and found they all exhibited the same problem.

Harmonic resonance was being set-up by the lighting ballasts. The lighting neutral currents in some areas exceeded the phase currents by 20%. The 3rd harmonic (180 Hz.) was found to be the harmonic contributing to the high neutral current. This in turn caused the contactor upon opening to generate severe arcing (re-striking) and welding. Total incurred cost to date for all the buildings, \$200,000.00. Short Term Solution: Installation of anti-harmonic circuits.

CASE STUDY #4:

In another wing of their building, they had installed a very sophisticated light sensitive fluorescent ballast system. The ballasts would be electronically gated to provide a constant light exposure over the work areas. As more sunlight entered the building, the ballast would be controlled for minimum fluorescent light, etc. The Brothers' main U.P.S. (450 KVA), located in the basement on a **separate transformer and feeder dropped off-line** each time this lighting system was working. We found this lighting system was severely distorting the supply waveform and caused the U.P.S. to malfunction. This same lighting system, tripped out G.F.I. units and blew capacitors off the wall. Note: When the emergency diesel generator was turned on for long term back-up for the computer, the power factor capacitors blew up. Total lighting system cost **1.6 million dollars**. Solution: complete system re-design.

These examples are but a few of the problems that are plaguing commercial high-rise buildings today. With the increasing use of non-linear loads (harmonic producing) and sophisticated electronic devices for measurement, control and data processing; these problems are guaranteed to worsen.



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The MacKenzie Bros. are not alone with their power problems. They have drained many a bottle trying to negotiate settlements with upset tenants, suppliers and building designers. A complete electrical engineering diagnostic survey must be done first and foremost, otherwise you will find yourself continually treating the symptoms rather than eliminating the cause.

There are many businesses that are suffering with this new technology. Through the co-operation of all the concerned parties, and organizations such as I.E.E.E., C.S.A., U.L., and the utilities; standards and operating safeguards can be created, to avoid many of these pitfalls.

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