EXHIBIT C

CAPACITY EXPANSION ALTERNATIVES FOR
THE TRUMBULL/SHELTON AREA,

prepared by

EPRI SOLUTIONS

Capacity Expansion Alternatives For the Trumbull / Shelton Area

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Background

The United Illuminating Company (UI) is planning for additional load growth in the Trumbull/Shelton area. The Old Town Substation supplies electric power to approximately one half of the Town of Trumbull and the northernmost section of the City of Bridgeport. The Trap Falls Substation supplies electric power to the easternmost section of the Town of Trumbull, the southern half of the Town of Shelton, and the northernmost section of the Town of Stratford. UI analysis shows that a single contingency that results in the unavailability of a substation transformer, at either substation, could require load shedding by the summer of 2005 unless corrective action is taken. UI has prepared a need statement and has conducted preliminary engineering and economic evaluation for four alternatives:

1. Build a new 115 kV/13.8 kV substation in the Town of Trumbull, Connecticut. The new substation will consist of two 13.8 kV buses fed by two 24/32/40 MVA transformers, with a firm capacity of approximately 58 MVA. The new substation will be designed and operated with the bus-tie breaker in the normally open position. It will initially be configured with four 13.8 kV feeder breaker positions.
2. Transfer load from Trap Falls and Old Town to other substations through distribution load transfers (new feeders and distribution duct lines required).
3. Install a single 40 MVA Power Delivery System (PDS) at proposed Trumbull substation site
4. Build a new substation at a different location

Engineering and economic analysis, performed by UI, showed that building a new substation is the preferred solution. UI retained EPRI Solutions, Inc. to assist in the review of solutions identified by UI and to assist UI in the identification and evaluation of other possible alternatives. This report presents the results of that effort.

Executive Summary

EPRI Solutions, Inc reviewed the expected load growth for the Trap Falls and Old Town substation area and then evaluated different solutions for dealing with the growth. EPRI Solutions, Inc. evaluated the economics of the different solutions as well as their impact on system reliability and quality. The following is a summary of the findings:

1. With all equipment in service, UI has adequate capacity to meet anticipated maximum demand over the next five years, even under extreme summer conditions. However, an outage of critical equipment serving the Trumbull/Shelton area during extreme summer temperatures will result in overloads requiring load shedding. Such actions would negatively affect UI system reliability performance.

2. Weather normalization of the loads indicates that if the temperatures in the summer of 2004 had been like those in 2001, the failure of a single 115 kV to 13.8 kV substation transformer at either Old Town or Trap Falls, would have resulted in overloads in the remaining transformer. That would have required some temporary load shedding. It is estimated that a transformer failure and subsequent load shedding operation could add approximately 1.7 minutes to the System Average Interruption Duration Index (SAIDI) (1500 customers * 6 hours of load shedding / 315,000 customers). UI is required by law to maintain SAIDI and the System Average Interruption Frequency Index (SAIFI) at 1998 levels.

3. The summer peak loading on the Old Town substation is currently significantly above the value that can cause voltage collapse. In order to avoid this voltage collapse issue the Old Town bus-tie-breaker is operated in the open position any time the substation load exceeds 65 MVA (20 MVA below substation firm rating). A transformer failure could impact SAIDI and SAIFI since at this loading level it will take more than 5 minutes for systematically moving the customers fed from the affected transformer to the other transformer.

4. A transmission line outage while operating with the open bus-tie breaker will result in lower power quality because nearly all load equipment without Uninterrupted Power Supply (UPS) backup will trip offline during the resulting interruption that could be as much as 20 seconds. However, the bus-tie open configuration will result in higher power quality for the more common type of events (voltage sags due to individual 13.8 kV feeder faults) because approximately half of the customers supplied from that substation are more isolated from the distribution faults.

5. The Trap Falls substation has a transient voltage stability loading limit equal to the substation firm rating so there is currently no inherent need to open the bus-tie breaker. In any event, the bus tie-breaker at Trap Falls must remain closed because of the dual feeds to Sikorsky (opening the bus-tie may cause circulating currents within the Sikorsky facility).

6. There were initially four alternatives proposed by UI to deal with the load growth and increased risk of load shedding. EPRI Solutions, Inc. expanded this list and evaluated the following ten different alternatives (first 4 provided by UI):
    a. Build Trumbull Substation
    b. Transfer load from Old Town and Trap Falls to other substations
    c. Install 40 MVA modular substation (PDS)
    d. Build substation at alternate site
    e. Replace transformers at Old Town and Trap Falls with larger units
    f. Feeder enhancement / distribution automation
    g. Distributed Generation
    h. Conservation and Load Management
    i. Complementary combinations of above listed options

   j. Do nothing (shed required amount of load if simultaneous occurrence of extreme summer temperatures and unexpected equipment outages occur).

7. UI is operating under certain constraints and has established reliability planning criteria (N-1) that influence the optimum solution selection process. The key constraints are:
   a. The UI service territory currently has a large number of unoccupied commercial properties that could cause unusually rapid increases in system loads. It is estimated that in the Trumbull/Shelton area about 25% of the existing commercial property is vacant. (Appendix C contains a partial listing of load additions that could materialize up through 2009.)
   b. UI is required to provide the reliability of service that is the same or better than the reliability levels that existed during 1998. This has been interpreted as the current four-year average reliability should be the same or better than the four-year average ending in 1998.
   c. The loading on the 1710/1730 transmission lines has significantly impacted the maintenance and operability of these lines and any additional loading on these lines would exacerbate the problem. A major 345 kV transmission line project (Middletown-Norwalk) is expected to be added to the UI service territory in southwestern Connecticut by the year 2009 and would not provide the needed relief of these lines until this time frame.
   d. UI has historically designed distribution substations with two identical transformers (typically feeding two buses with the bus tie closed). The total loading on the substation has been limited to the "firm rating" of the substation which is generally the maximum amount of load that one of the transformers could carry for approximately 24 hours (one load cycle). This arrangement eliminates the need to drop load in the event of a transformer failure (i.e. mobile substation brought in within 24 hours).
   e. Existing area substation and distribution infrastructure configuration excludes application of Distributed Generation as an immediately available substation capacity solution in the affected area.
   f. UI's recent substation designs have tended toward smaller transformers due to voltage support, fault duty, transportability and contingency plan concerns (e.g., Allings Crossing, Indian Well, Mill River, Broadway, and Congress). This new design philosophy allows for possibly more DG to be interconnected to at these new substations' distribution system.
   g. UI has not yet started any pilot projects utilizing "distribution automation" and lacks infrastructure for such systems.
   h. UI only owns a portion of the transmission lines in its service territory, which results in UI paying "transmission line usage charges." (Reference Figure 3)

8. The Trumbull substation option will immediately improve power quality (reduce the number of voltage sags) for customers fed from the Old Town and Trap Falls substations because fewer customers will be fed from those substations (i.e. fewer feeders or shorter feeder lengths). Any immediate improvement in the reliability indices SAIDI (System Average Interruption Duration Index) or SAIFI (System Average Interruption Frequency Index) will be limited to the previously mentioned values if one of the Old Town or Trap Falls transformers failed during high loading conditions and/or to the extent that some feeder shortening can be accomplished with the initial four feeder configuration. However, once the new substation is fully developed (10 feeder positions) distribution circuits can be reconfigured and improvements in SAIDI and SAIFI can be expected along with a reduction in feeder losses as well as improved voltage performance.

9. The Trumbull substation option has the following salient features:
   a. Consistent with UI's historical approach for maintaining N-1 reliability planning criteria.

b. Provides capacity margin for the Trumbull/Shelton area until sometime after the year 2015.
c. Provides capacity margin for both Old Town and Trap Falls substations until sometime after the year 2015
d. Reduces the risk of voltage collapse at Old Town by reducing the amount of time that the bus-tie breaker is operated in the open position.
e. Is in line with UI's philosophy of smaller substation transformers.
f. Reduces "transmission line usage charges" that UI must pay by $220,000 per year (with the initial amount of load transfer to Trumbull substation).
g. Physical location is advantageous from a transmission interconnection point of view, allowing for the least initial cost for distribution infrastructure to provide load reliably for both Old Town and Trap Falls substations.
h. Provides needed capacity at the lowest infrastructure cost.
i. Capital Intensive (approximately $13.4 Million).
j. The earliest a new Trumbull substation could become operational is prior to the summer peak of 2007.
k. By design, will provide connectivity for future Distributed Generation capacity.

Conclusions and Recommendations

1. From the initial list of ten alternatives, building the Trumbull substation is the best long-term solution consistent with the constraints and circumstances mentioned above.

2. The weather normalized load forecast indicates that the Old Town and Trap Falls substations are both presently at risk of overload should summer temperatures approach those experienced in 1999 and 2001. The potential for 5-10% more load if now-vacant office space becomes occupied exacerbates this risk. Therefore, a prudent response would be to proceed with construction of the Trumbull substation on the earliest practical schedule. Based on the constraints described above, the goal would be to have the substation operational before the summer peak of 2007.

Geographical Overview and Observations

Figure 1 shows the basic geographical area of interest. The distance between Old Town and Trap Falls substations is approximately six miles. The planned location for the Trumbull substation is also indicated (circled). UI plans to energize all or part of the four 13.8 kV feeders shown in Figure 1 from the new substation. The feeders scheduled to be transferred to the new substation are Old Town 2627 and 2620 and Trap Falls 3545 and 3547.

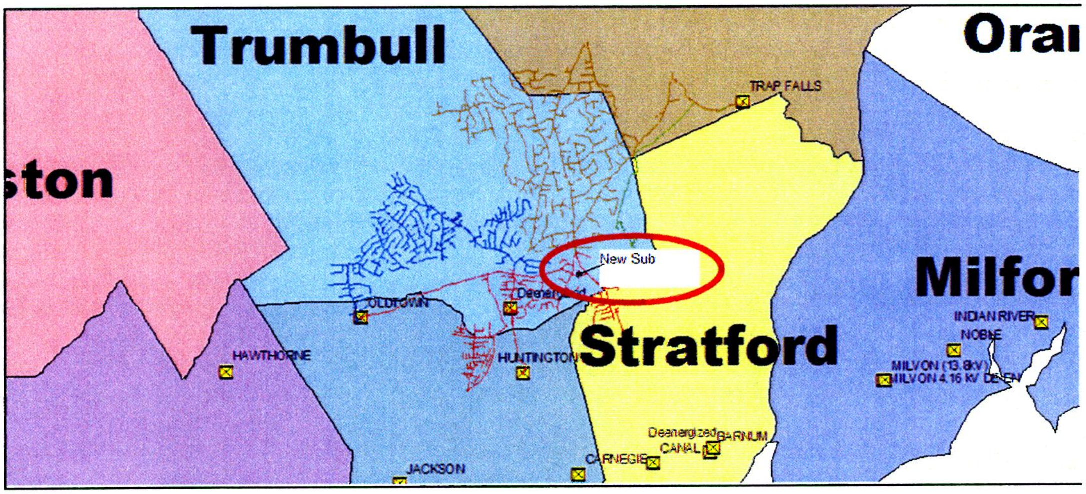

Figure 1 - Trumbull Junction Geographical Location – Selected Feeders Shown

The non-coincident peak loading for these four feeders is summarized in the following table.

Table 1- Non-Coincident Peak Loading for Four Selected Feeders

	UI - Peak Feeder Loading					Base kV (L-L)=		14.20
			Amps			Base kV (L-N) =		8.20
sub	Feeder	Date	Phase A	Phase B	Phase C	% Current Imbalance	Power Factor	Total KVA at (14.2 kV)
Old Town	2620	Jun-02	284	322	299	7	0.99	7,420
Old Town	2627	Sep-01	418	453	406	6	0.99	10,469
Trap Falls	3545	Jul-02	276	286	285	2	0.99	6,944
Trap Falls	3547	Jun-03	388	405	343	9	0.99	9,313
							Total=	34,146

Figure 2 shows all of the existing feeders out of both Old Town and Trap Falls. The locations for Old Town, Trap Falls and the new substation are circled. Typically, a distribution substation should be located near the geographic center of the distribution planning area it serves to maintain a short average feeder length. Visually, it would appear that a site located about 2.5 to 3 miles north or northwest of the selected site might have inherently better distribution feeder characteristics.

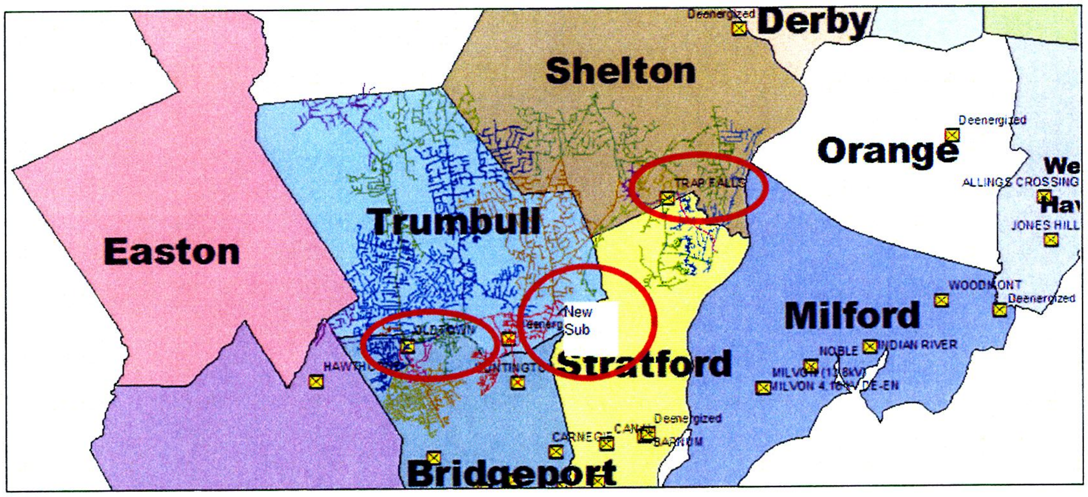

Figure 2 - Old Town and Trap Falls Geography - All Feeders

Substation location is always a compromise between transmission and distribution considerations. While the selected location for the new substation may not be ideal from a distribution point of view, it is very well located with respect to the location of the existing transmission system (Figure 3).

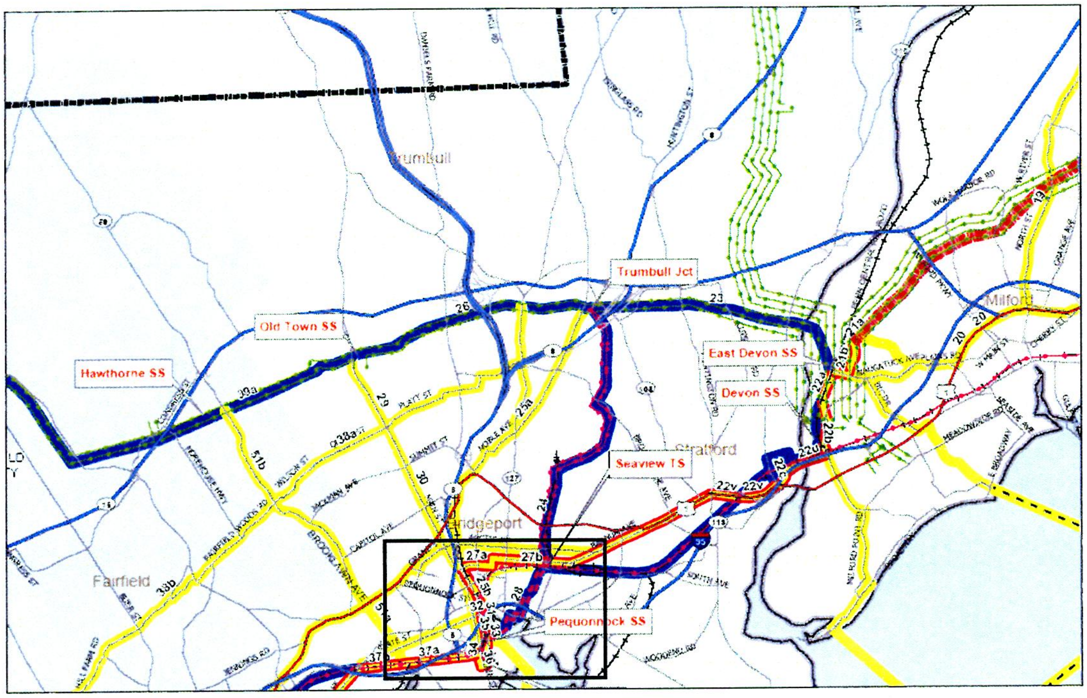

Figure 3 - Trumbull Junction Geography -Transmission Lines and Highways

LEGEND

- Limited Access Highway
- Highway
- Roads
- Railroad
- Pipeline
- UI 115-kV Transmission Lines
- UI 115-kV Underground Transmission Lines
- CL&P 115-kV Transmission Lines
- CL&P Underground 115-kV Transmission Lines
- CL&P 345-kV Transmission Lines
- Undersea Transmission Lines

Figure 3 shows that Trumbull Junction is the termination point for the "UI owned" 115 kV transmission lines (Lines 1710 and 1730). See Reference 6. Both Old Town and Trap Falls (not shown) are fed from Connecticut Light & Power (CL&P) 115 kV transmission lines. Relocating 35 MW of load such that it is directly fed from "UI owned" transmission lines at Trumbull Junction will result in an estimated savings to UI of $220K per year ($63K for every 10 MW) due to a reduction in CL&P transmission line usage charges. Relocating 35 MW of load from Old Town and Trap Falls is not expected to have a significant impact on UI transmission line losses.

Reference 10 suggests that the 115 kV tap line to the proposed Trumbull substation site is going to be "direct" (i.e. no appreciable length). The costs associated with building 115 kV tap lines to some of the nine potential locations is estimated to be between 3 and 4 million dollars per mile. This high cost structure for building 115 kV tap lines severely limits substation site location options.

The substation single lines for Old Town and Trap Falls substations are shown in Appendix A as are the pertinent parts of the 115 kV transmission system.

Substation Design Criteria

With regard to major distribution substations, UI has historically followed what is known as an "N-1" design criterion. This means that UI customers would not experience an outage (other than perhaps a momentary outage) for serious single contingency events such as the failure of a 115 kV-13.8 kV transformer. This design criterion requires that the total load being fed from the substation not exceed the "firm rating" of the substation. Additionally, the requirement that acceptable voltage be maintained at the secondary bus at the firm rating of the substation has tended UI toward installing smaller size transformers.

The UI "firm rating" of multiple transformer substations with interconnected secondaries is equal to the peak of the maximum daily load cycle which can be carried by this substation upon the first contingency loss of one substation transformer. The emergency loading capability of substation transformers is commonly the determinant of the firm capacity of these substations.

The loading levels on the Old Town and Trap Falls substations have risen to the point that the substations firm ratings are either currently exceeded or will be exceeded by the Summer of 2005. Allowing the load to go beyond the substations firm rating is a violation of the basic design guide because it could require load to be shed during a contingency event (depending upon loading at the time of the contingency).

In general, violations of historical design criteria should not be allowed because UI is required by law not to reduce system reliability below the July 1, 1998 values. The impact of any allowed violations on SAIDI and SAIFI would have to be quantified and quantifiable offsetting improvements would have to be made in order not to risk violating the 1998 values.

In addition to not violating the firm rating, the total system load should, in general, not exceed that which can cause "voltage collapse" upon loss of one of the transformers. Voltage collapse can sometimes occur during the loss of one transformer because the remaining transformer immediately picks up the entire substation load. This does not allow time for the load tap changers to adjust to the new loading requirements. The voltage collapse issue can be avoided by operating the substation with the bus-tie open and then picking up any dropped load in a manner that gives the load tap changer a chance to re-adjust.

The following table, Table 2, summarizes both the firm rating and voltage collapse (stability) ratings in MVA for the Old Town and Trap Falls substations as well as some of the other substations in the general vicinity (Reference 3 and 4)

Table 2 – Substation Firm Ratings (MVA) and Voltage Collapse Limits

	Old Town	Trap Falls	Hawthorne	Barnum	Indian Wells
Substation Firm Rating	85.5	76.6	99.6	54.1 (switchgear limitation)	74.5
Voltage Stability	65.0	76.0 (ref 3)	65.0	NA	NA
Transformer Nameplate Rating	36/48/60	30/40/50	42/56/70	42/56/70	24/32/40

The "firm" substation ratings shown above were developed by UI utilizing the PT Load software program. These results look reasonable and are consistent with accepting a small amount of loss of life, up to 5% per event.

The voltage collapse limits shown above were obtained from Reference 3 and Reference 11. They were derived based on a post-transient voltage criteria of 12.42 kV (90% of 13.8 kV). The large difference between the Old Town firm rating and the voltage stability limit, as compared to the differential at Trap Falls, suggests that today's basic operation of the Old Town substation is probably not consistent with a "bus-tie" closed philosophy. The impedance of the Old Town substation transformers is about 14% which is about 2% higher than the transformers at Trap Falls.

Substation Loading

Existing Substation Loading

The hourly loading data (total) on the Old Town substation for the years 1998 through 2004 is graphically displayed in Figures 4 – 9. It should be noted that the hourly loading levels are the net substation peak load with all conservation and load management programs in place at the time.

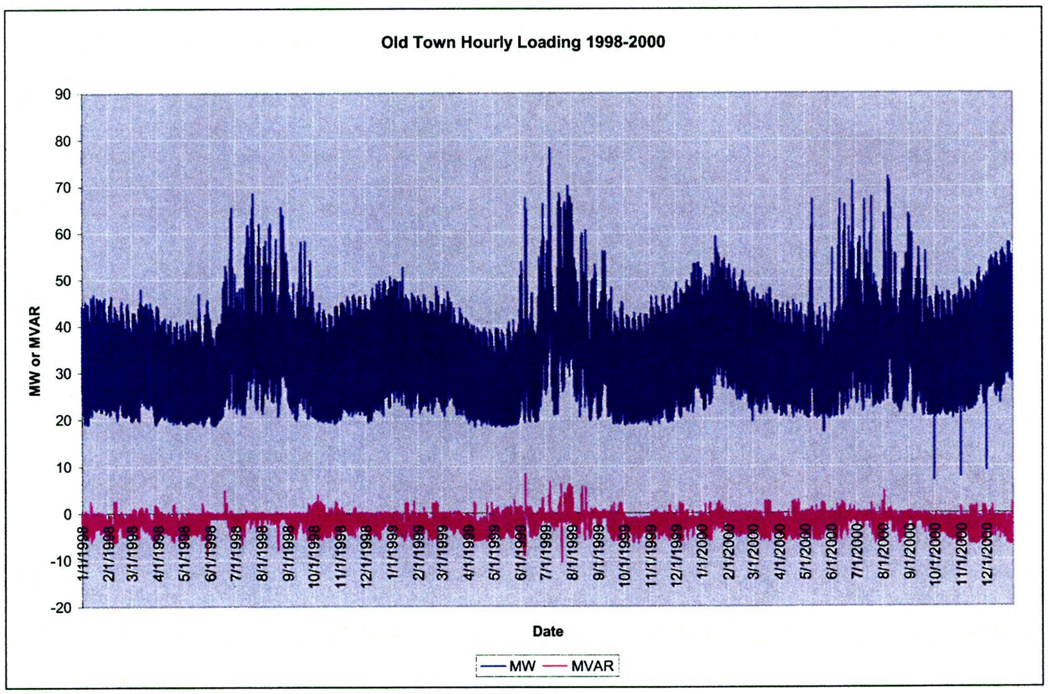

Figure 4 - Old Town Substation Hourly MW and MVAR Loading (1998-2000)

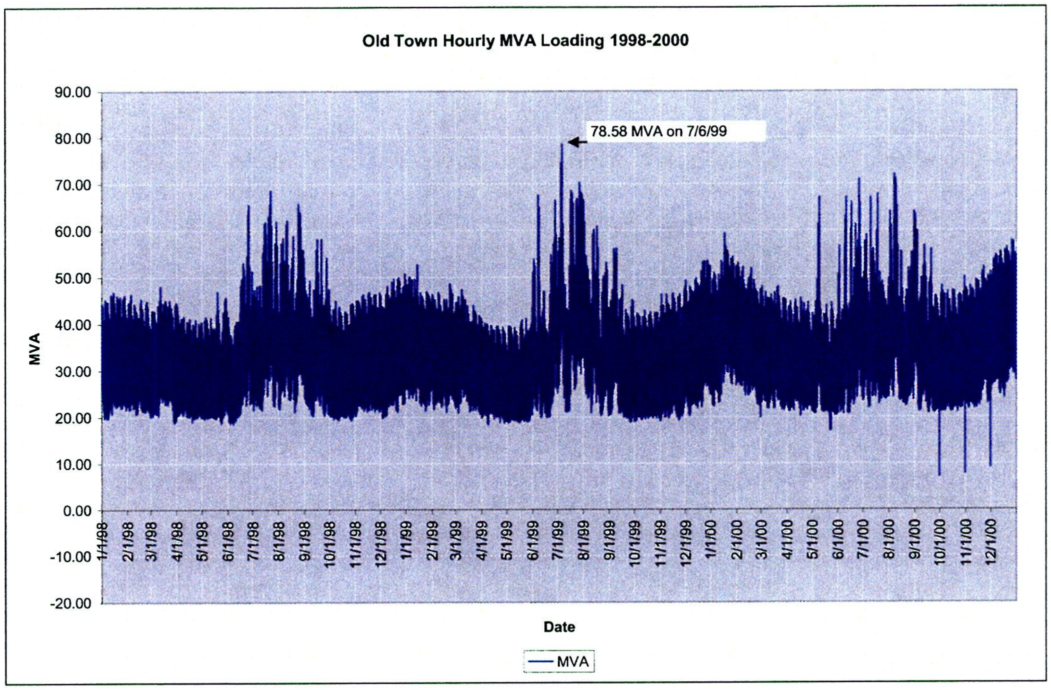

Figure 5 - Old Town Substation Hourly MVA Loading (1998-2000)

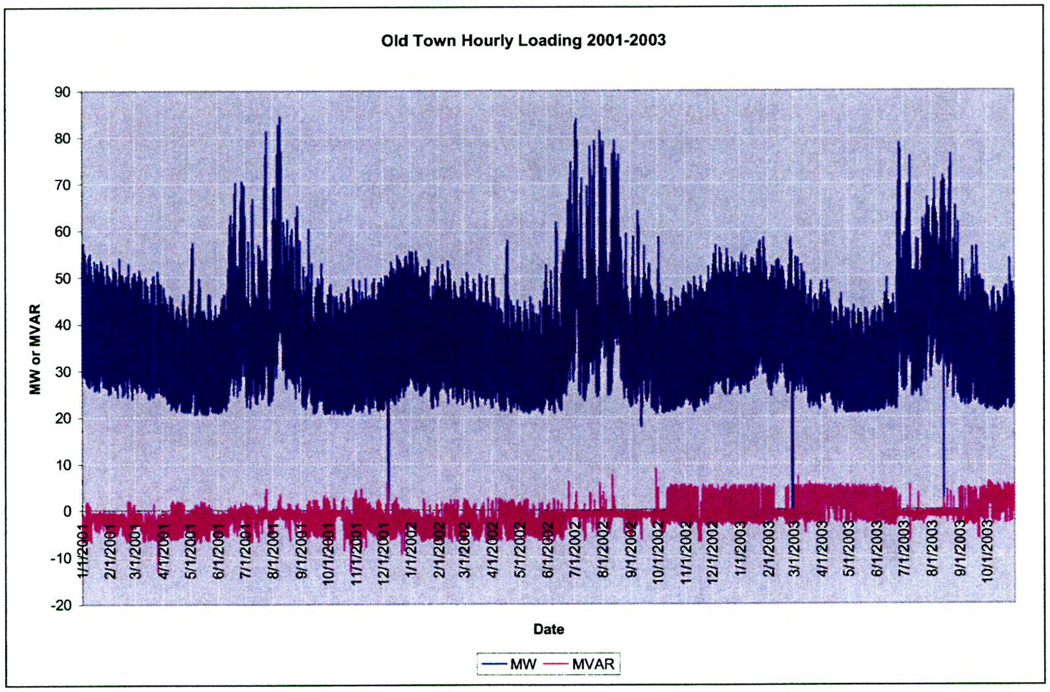

Figure 6 - Old Town Substation Hourly MW and MVAR Loading (2001-2003)

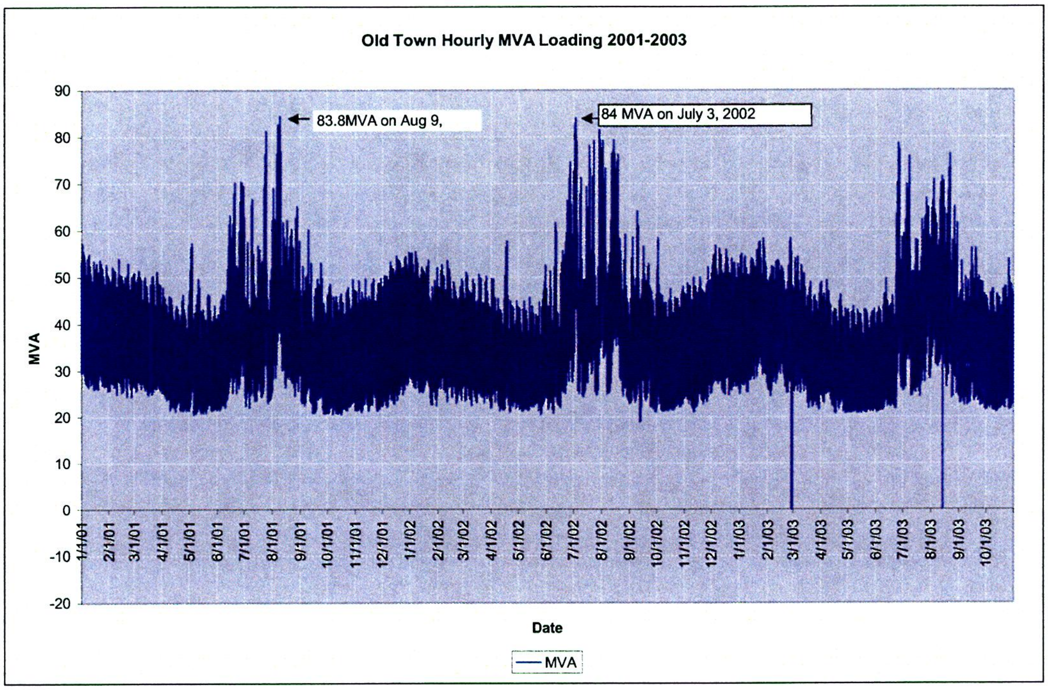

Figure 7 - Old Town Substation Hourly MVA Loading (2001-2003)

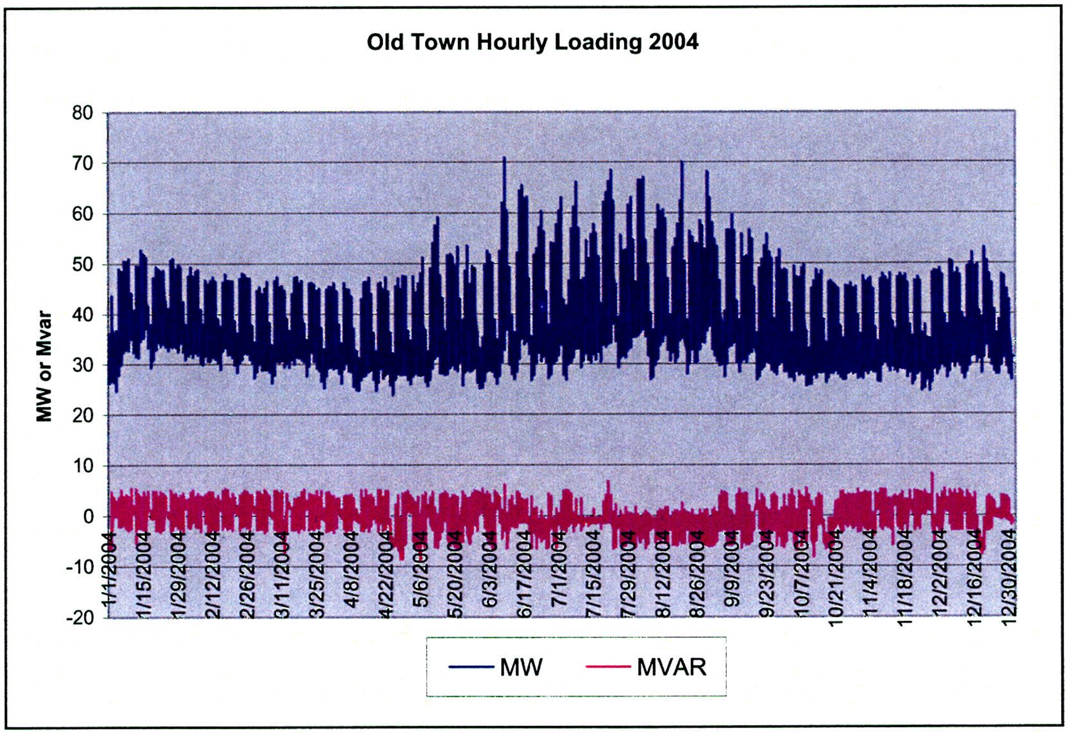

Figure 8. Old Town Substation Hourly MW and MVAR Loading (2004)

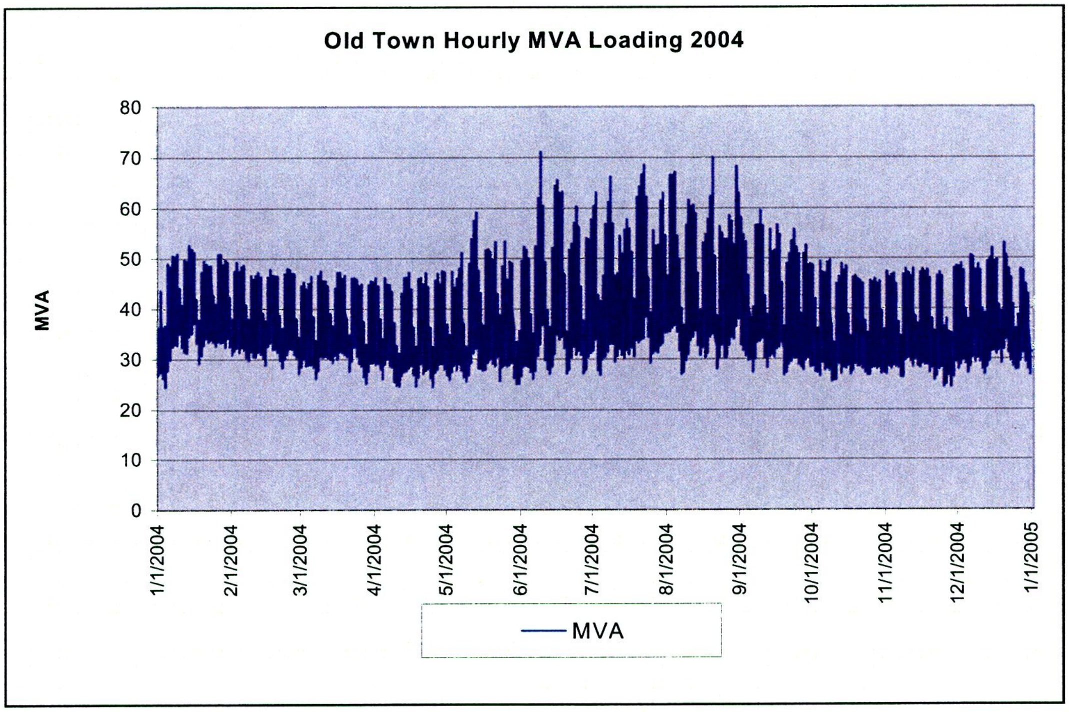

Figure 9. Old Town Substation Hourly MVA Loading (2004)

The preceding figures clearly demonstrate the summer peaking nature of the Old Town substation and they also indicate that the peak load may vary as much as 10 - 20 MVA from one summer day to the next. The above figures also demonstrate that the firm rating of 85.5 MVA has not yet been violated, although the loading in 1999 and 2001 came quite close. There are typically three days each summer in which the load reaches a distinct peak.

The peak loading day that occurred at the Old Town substation for the years 1998 to 2004 occurred on July 3, 2002. The daily MVA load cycle for that day (and +/- 12 hours) is shown in the following figure.

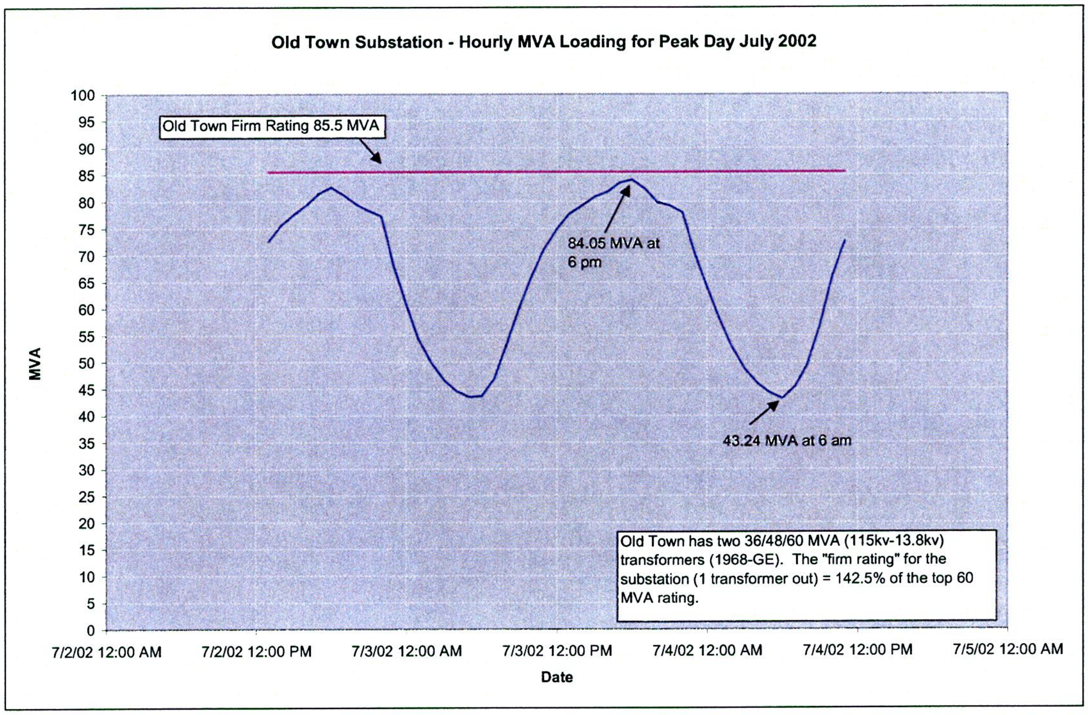

Figure 10 - Old Town Hourly MVA Loading - Peak day July 2002

Figure 10 demonstrates that the load on the substation will naturally drop to about of its peak value within 12 hours of reaching its peak value. If one of the two Old Town transformers became unavailable, the remaining transformer would only have to support high values of load for a duration of less than 12 hours. The time to get the mobile substation installed may exceed 12 hours. The firm thermal rating of UI substation transformers is the highest loading values that may be reached in a 24-hour load cycle. This includes the cooling effects from the lower transformer loading on either side of the daily load peak.

The hourly loading data (total) on the Trap Falls substation for the years 1998 through 2004 is graphically displayed below in Figures 11-16. It should be noted that the hourly loading levels are the net substation peak load with all conservation and load management programs in place at the time.

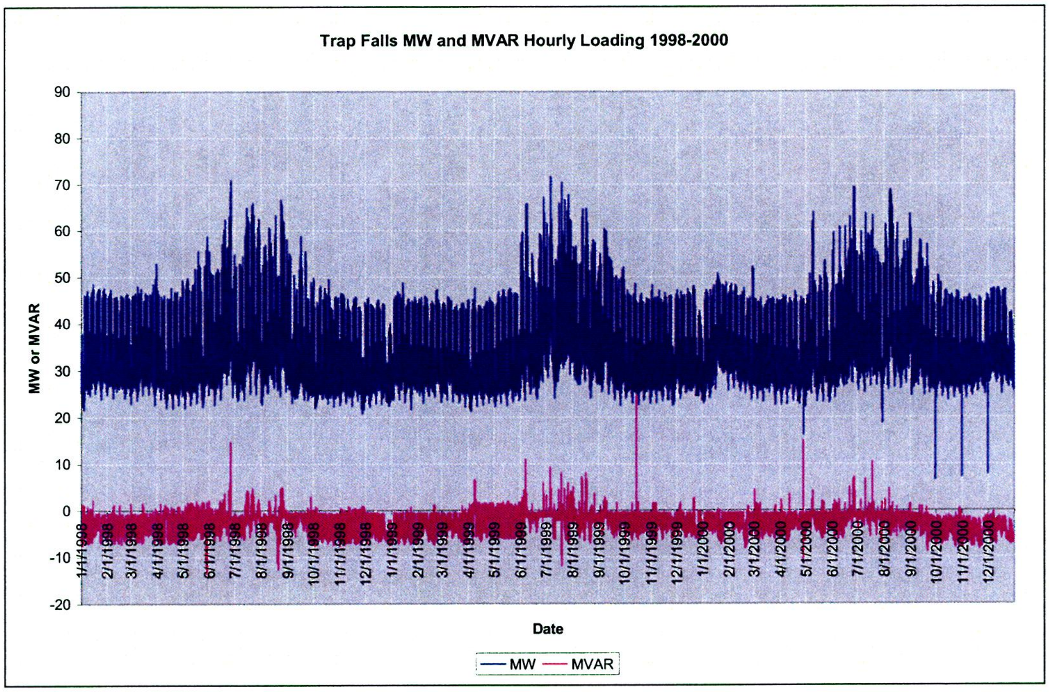

Figure 11 - Trap Falls MW and MVAR hourly Loading 1998-2000

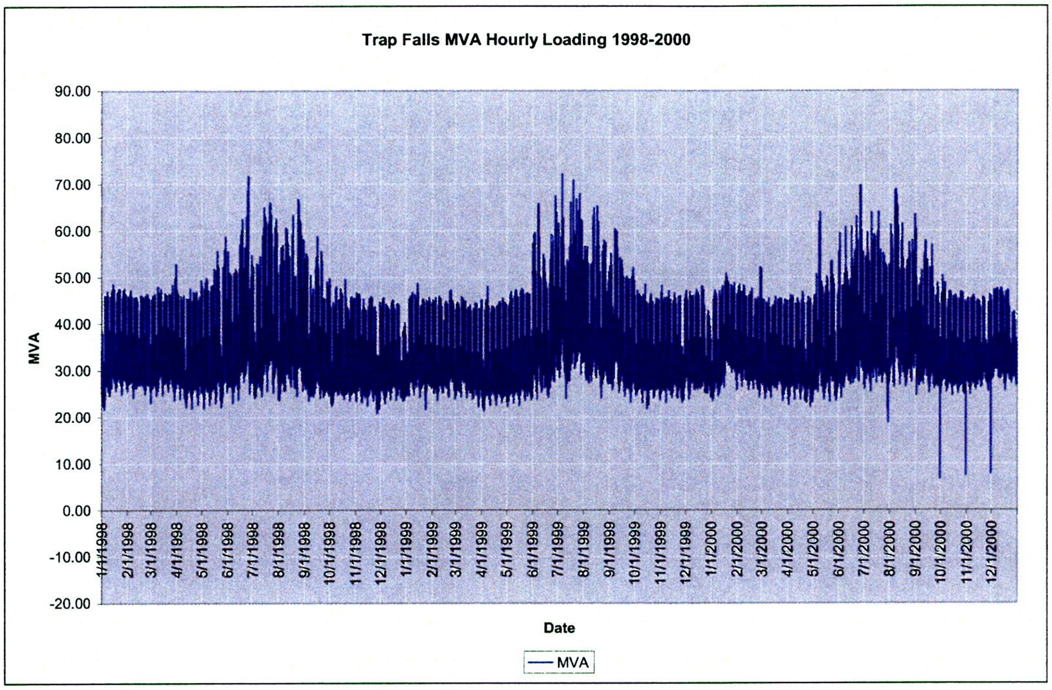

Figure 12 - Trap Falls MVA Hourly Loading 1998-2000

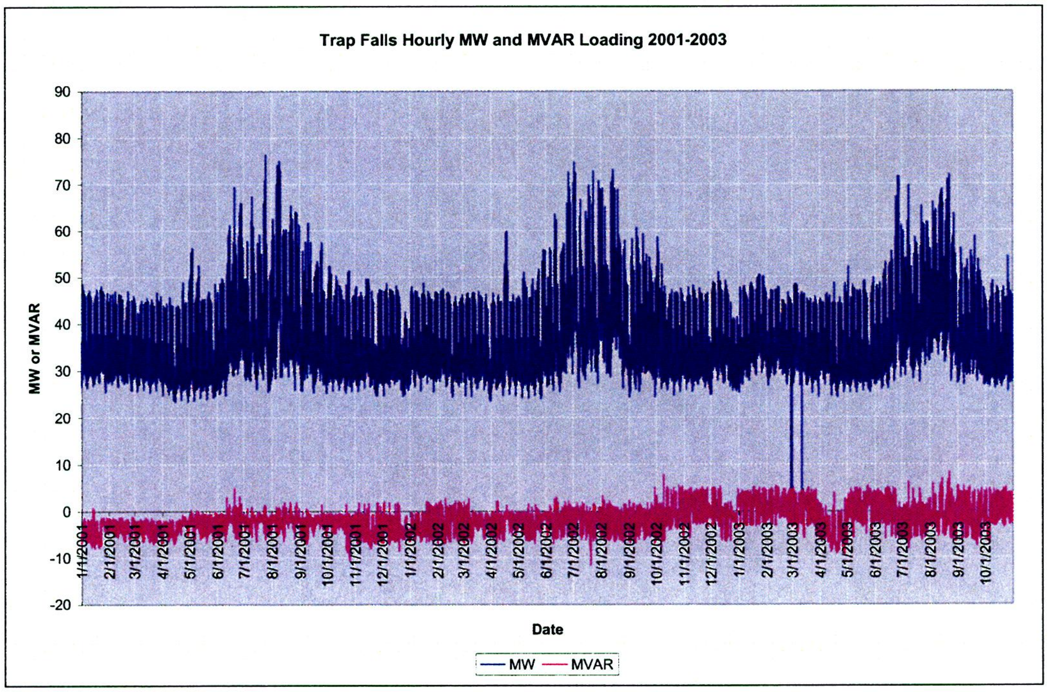

Figure 13 - Trap Falls Hourly MW and MVAR Loading 2001-2003

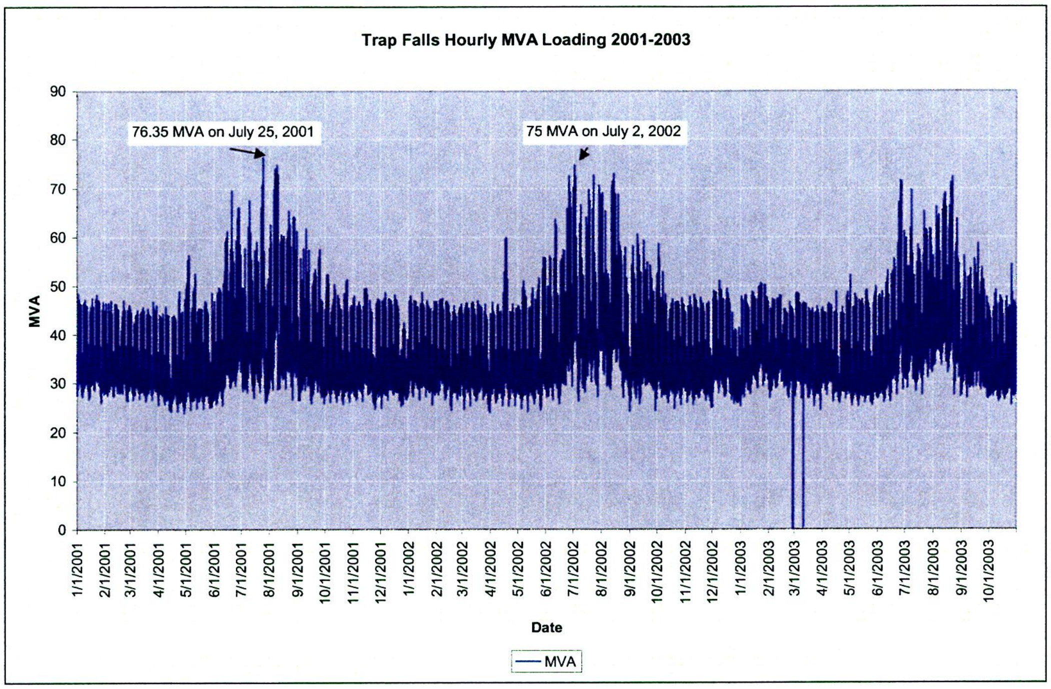

Figure 14 - Trap Falls Hourly MVA Loading 2001-2003

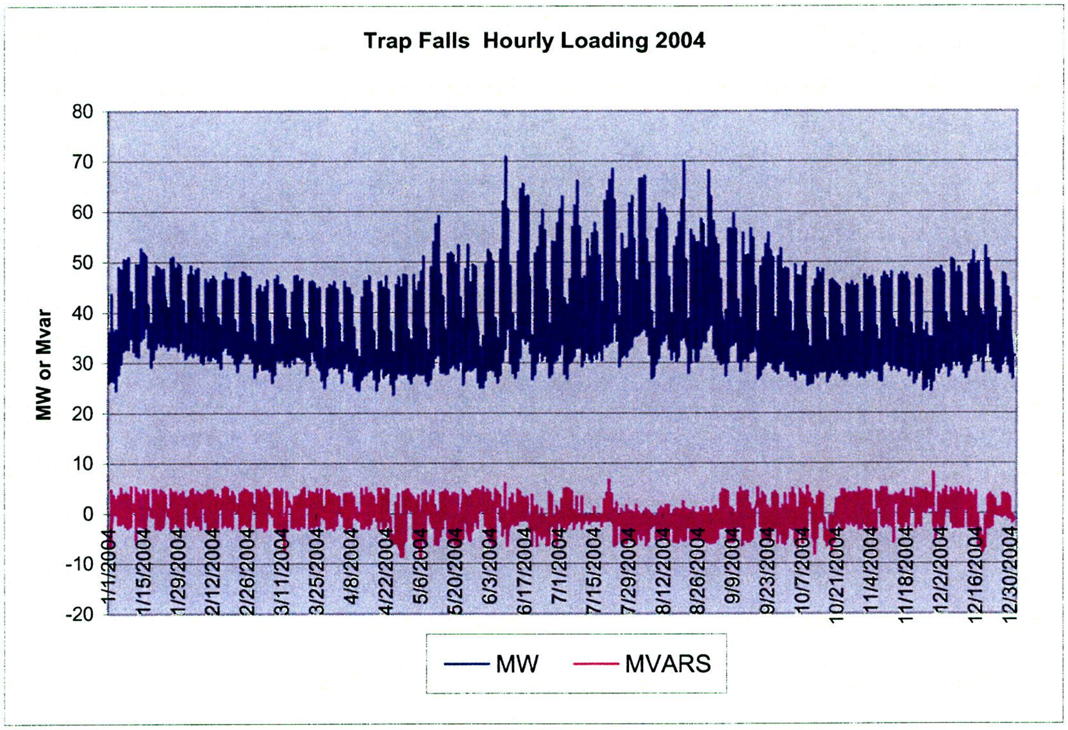

Figure 15. Trap Falls Hourly Loading (2004)

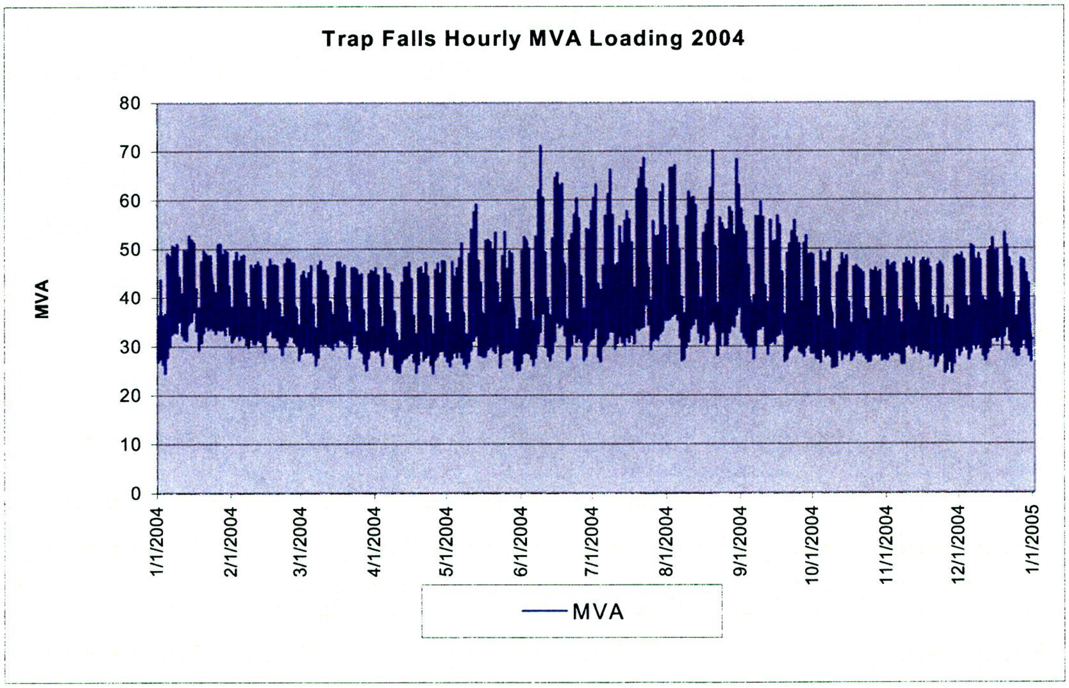

Figure 16. Trap Falls Hourly MVA Loading (2004)

The Trap Falls load shape characteristics are very similar to that previously described for Old Town. The firm rating of 76.6 MVA was nearly reached on July 25, 2001 but subsequent years have resulted in slightly lower peaks. The reduced peak is a combination of milder weather and/or some feeder load transfer to adjacent substations.

The daily MVA load cycle for July 2, 2002 is shown below in Figure 17. The reduction in load as the loading cycle proceeds after the peak is similar to the Old Town loading cycle, although the percentage reduction is not as great. The comments made for Figure 10 apply here as well.

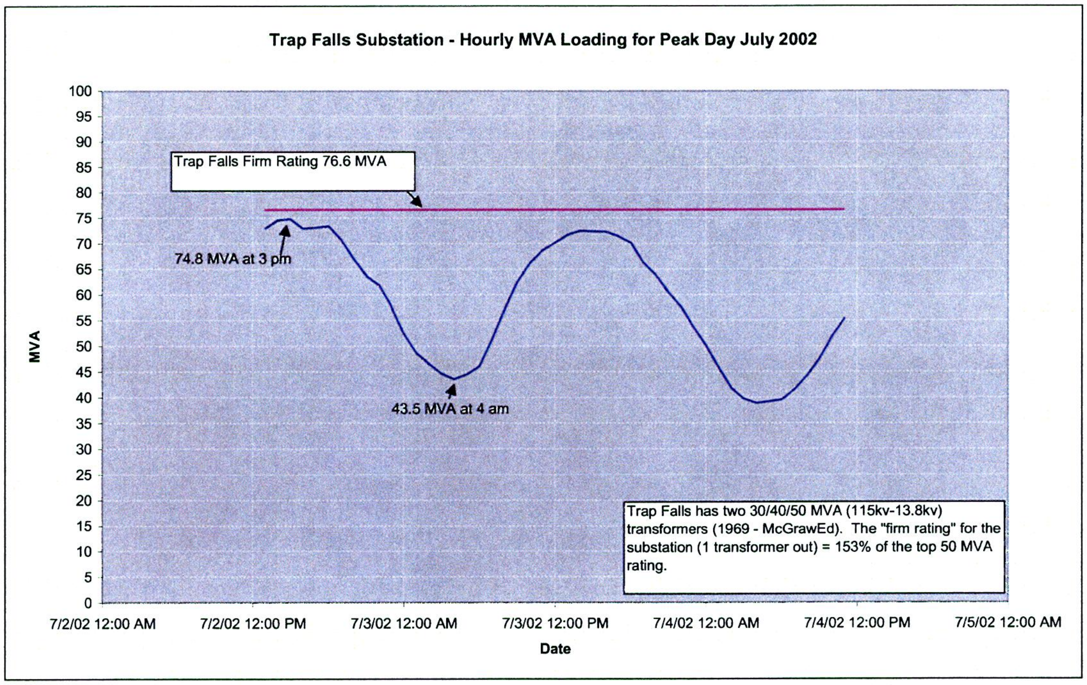

Figure 17 - Trap Falls Hourly MVA Loading - Peak day July 2002

Future Substation Loading

UI provided their estimate of future substation loading (Reference 12) and this estimate has been shown as the dashed blue lines in Figure 18 and Figure 19 below. It should be noted that the UI load projections were originally developed assuming that the Trumbull substation was operational in 2004 and that the four feeders shown in Table 1 had been relocated. This assumption was "backed" out of the UI projections prior to plotting the results on the following two figures.

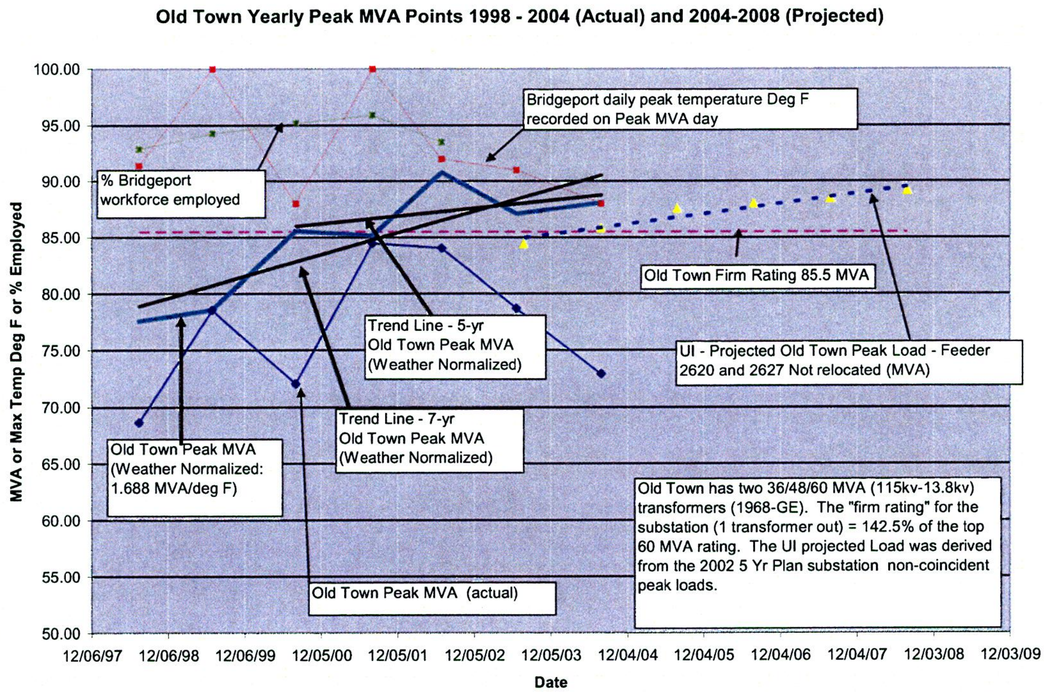

Figure 18 - Old Town Substation Loading (Actual and Projected)

The weather normalized load forecast is also shown on each plot. The actual load was normalized to a 3-day weighted temperature-humidity index (WTHI) that was computed based on an ISO New England method. Refer to Appendix B for details. The normalization was done to a WTHI that has occurred approximately once per decade since 1948. This WTHI was reached in 1999 and 2001, but the summer peaks in subsequent years have been more mild.

For the Old Town substation (Figure 18), the 5-year trend line of the weather normalized load has a slope similar to the UI projection. However, it is some 3 MVA higher than the UI forecast. The 7-year trend line shows even a higher slope, but is likely too conservative. The load growth rate would appear to have slowed somewhat the last few years and the 5-year trend line more closely agrees with the UI estimate growth rate based on other criteria.

The weather normalization assumed 1.688 MVA per degree WTHI. This is the correlation of the load to WTHI from 2002 – 2004. The load nearly reached the firm rating of the substation in the extreme temperature year of 2001. If there had been similar extreme temperatures in 2004, the loading would have exceeded the firm rating by 3 MVA.
The weather adjustments for the Trap Falls loading pattern for the last 7 years yield a trend line that very closely matches the UI peak load projections for this substation (see Figure 19).

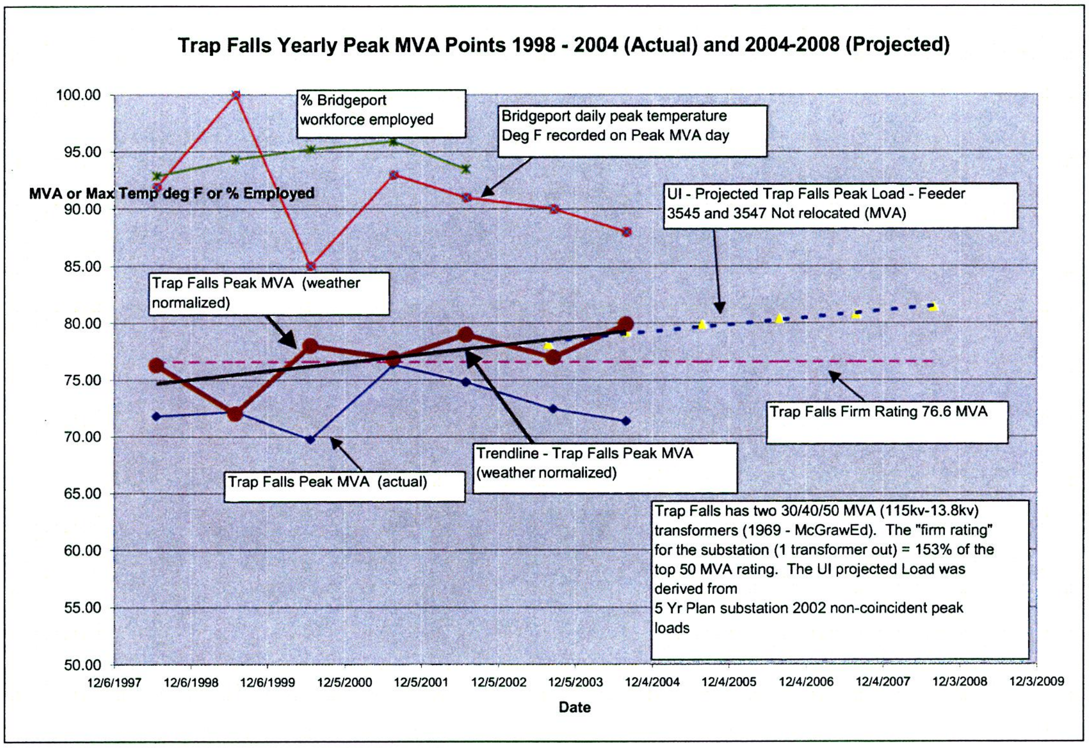

Figure 19 - Trap Falls Substation Loading (Actual and Projected)

Summarizing the two figures showing the loading projections, the weather normalized loading trends indicate that the future loading on these stations will be at least as high as the UI projections and could be as much as 2-3 MVA higher.

The UI peak load projections were derived in part from the non-coincident substation peak loads in 2002, the highest substation peaks to date (as a result of the milder summers in 2003 and 2004) and the projection for future years was based on the following three elements:

1. Identified customer load increases
2. UI Economic Development Major Project Forecast
3. System sales growth projection

The UI peak load projections do in general factor in the effect of weather and demand side conservation and load management programs. However weather is not included in the Economic Development Major Project element. The overall reasonableness of the UI load projections can however be evaluated in part by reviewing the historical peak load points and their corresponding linear trend lines that are also shown in Figure 18 and Figure 19.

The strong correlation between the daily peak temperature at Bridgeport and the peak MVA loadings is also apparent in Figure 18 and Figure 19. A more detailed look at the temperature dependence may be found in Appendix B.

The effect that temperature, local economics and demographics can have on these load growth estimates are presented below along with a summary of the overall expectations for the load growth.

Weather / Temperature Considerations

The following temperature profile for Bridgeport shows the historical data for the past 40 Years.

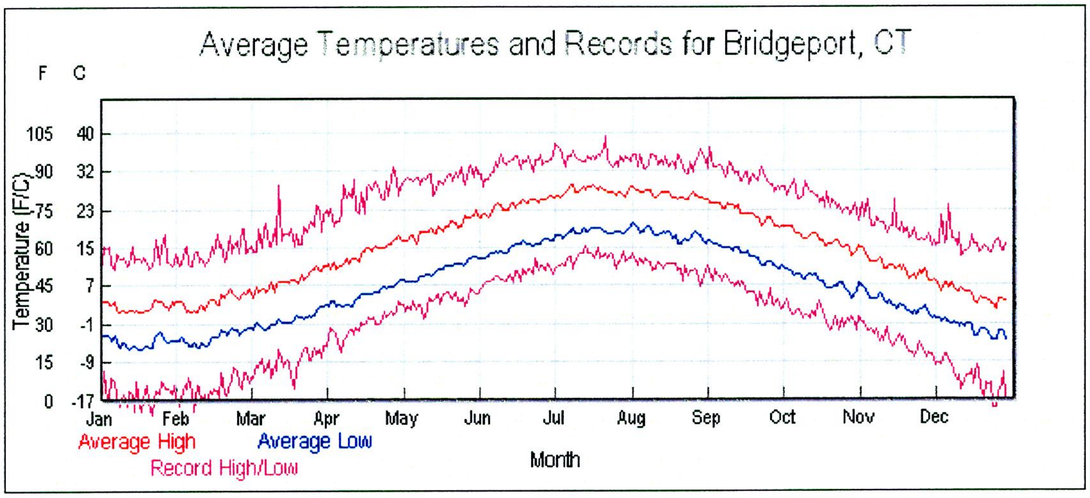

Figure 20 - Historical Temperature Profile for Bridgeport, CT

Temperature is only part of the story. Relative humidity also plays a role as does the number of consecutive days of high temperature. The common procedure in this region is to consider three days and compute a weighted temperature-humidity index (WTHI) that can be correlated to power consumption.

Figure 34 (Appendix B) shows an estimate of historical WTHI from 1948 to 2004. WTHI was computed based on ISO New England formulae.

When the days with the highest WTHI are considered, the correlation of load to WTHI is 1.05 MW/deg for Trap Falls and 1.688 MW/deg for Old Town. When a WTHI of 37 is chosen as a design value, the 71 MW peak for the relatively cool 2004 summer translates to a projected load of 80 MW if extreme temperatures had been achieved.

Economic Considerations

From 1998 to 2002 the Bridgeport employment rate varied between 93 and 96%. The effect of the 1% rise in employment between 1999 and 2000 on the load appears to have been negligible in comparison to the reduction in peak temperature.

The high vacancy rate of commercial property in the Trumbull/Shelton area (estimated to be 25%) could however have a "step-change" type impact on the load growth estimate. This fact may not be completely reflected in the current UI peak load projections however it may be partially included and may in fact explain part of the load reductions in the last several years. It should be noted that there is already a "step change" differential between the 2003 and 2004 projected and actual load in Figure 18 and Figure 19. Most of this differential is thought to be due to a temperature correction since these years were not extreme temperature years. However, part of it may be due to load reductions associated with increased vacancies. The high vacancy rate will however factor into the overall uncertainty guidance given below in the load growth summary.