2000 AEIC Load Research Conference

Validation, Editing and Expansion in a Deregulated Environment

by Joseph S. Lopes
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Introduction

- **Joseph S. Lopes**
  - **Math & Computer Science Degree - Manhattan**
  - **Applied Energy Group, Inc. Co-founder (1982)**
    - **Senior VP, Treasurer 1982 - Present**
  - **American Electric Power 1977-1980**
    - **Load Research Group (Bill Mekolites)**
    - **Preceded Jeff Laine (AEIC Chairman)**
  - **Stone & Webster Management Cons. (1980-82)**
  - **Developed PC-IDEAS LR System for NYPA 1985-90 (1st PC LR System)**

Background: Validation & Editing

- Applications of Interval Load Data
  - 1960's/70's: Rates and Planning
  - 1978: PURPA, Cost-of-Service
  - 1980's: DSM Evaluation
  - 1990's: Technology Assessment
  - 2000's: Load Profiling
- Quality of Data Always an Issue
  - Garbage in - garbage out

Background: Validation & Editing

- Implications of Bad Interval Data
  - Small sample sizes expanded by multiples of 1,000 - 100,000
  - Rate and regulatory scrutiny leads to disqualification of cost recovery and lower rate of return
- Causes of Bad and Lost Data
  - Equipment Failure, Mis-communications, human error, weather, human error, computer failures, and bad luck

History of Load Data

- **Prehistoric Days**
  - **7,000 - 10,000 days BC (Before Competition)**
  - **Magnetic Tape Recorders (1960's, 1970's)**
    - **better than strip charts**
    - **tapes are bulky**
    - **tapes jam, stretch, break**
    - **time splice mismatches**
    - **outage timing uncertain**

» **Load Research Man-->**

History of Load Data

- **App. 7000 (days) B.C. (Before Competition)**
  - **Load Research Man discovers Batteries!**
    - **Continuous time pulse**
    - **Easier to identify outages**
- **App. 3,000 B.C.**
  - **LR Man discovers electronics!**
    - **No more mechanical errors**
    - **Infant mortality worst problem**
- **Since then…**
  - **optical ports, modems, wireless**

Load Data Today

- Not all Load Research Programs survived the Dark Ages
  - Mergers, cost-cutting, preparing for deregulation, staff "retirements"
- Today, 2000 A.D. (After Deregulation)
  - Digging out the old data
  - Polishing off old techniques
  - Revitalizing samples

Why Validate and Edit?

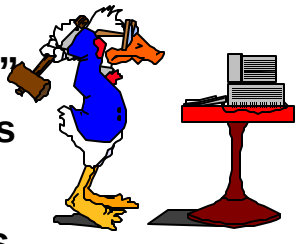
- High costs and customer intrusion make each data point valuable
- Limited budgets, manpower, priorities, other resources in "leaner" utility mean smaller samples
- Small margin for error, less time to fix
- Each data point lost could be 1% of typical small samples of 100 per class
- Must recover all data possible

Load Data Validation

- **Has new technology eliminated bad data?** ***No, it has reduced problems and changed the types of problems***
- **Objectives of Validation**
  - **identify data that is inaccurate, missing or not representative**
    - **holes in the data: missing because data lost**
    - **outages: accurate but not representative!**
    - **Spikes and troughs: Outage followed by payback**

To Edit or Not to Edit?

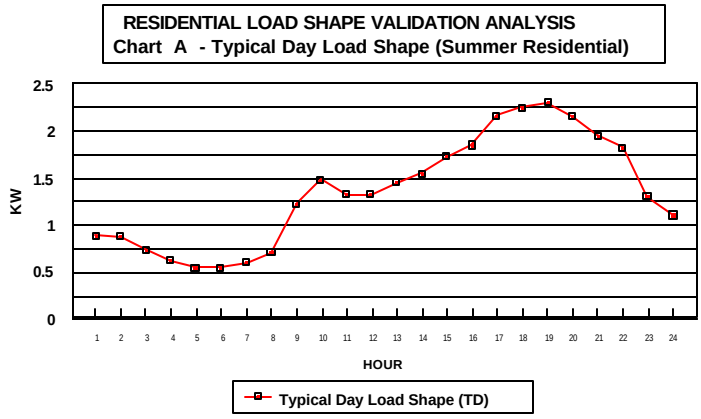
- **"Edit by Exclusion" is often the easiest "edit"**
  - **risk too much data loss**
  - **could bias the results**
- **Edit Patch Techniques**
  - **Judicious use of patching**
  - **Consistent criteria essential**
  - **Maintain natural variability of data**



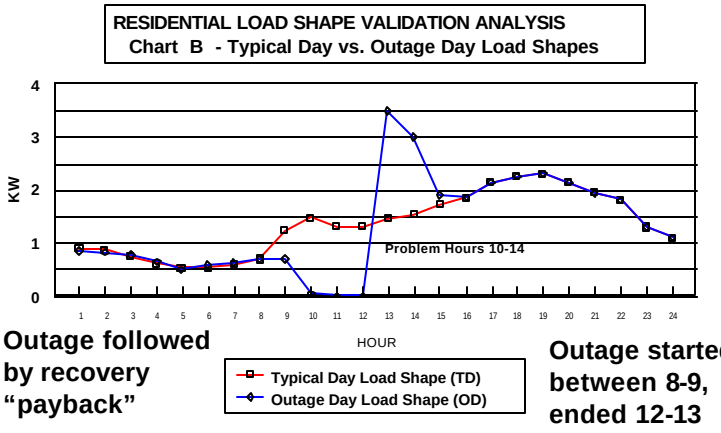
Keys to Effective Validation

- **Validation should:**
  - **Identify problem data automatically**
  - **Only flag a small percentage**
  - **Have consistent criteria**
  - **Minimize Errors:**
    - **Type I Error - Reject good data**
    - **Type II Error - Accept bad data**
  - **Type II Error is more serious**

Validation - Typical Day



Validation - Problem Data



Outage followed by recovery "payback"

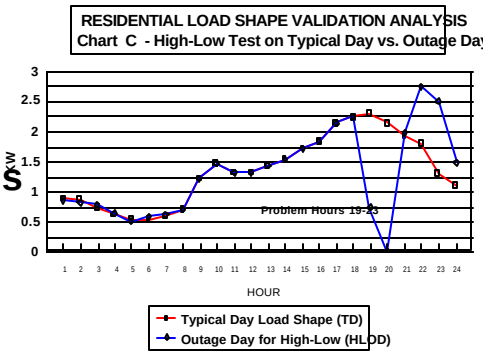
Outage started between 8-9, ended 12-13

Validation Tests

- **Basic Tests and Issues**
  - **Missing Data**
  - **Zero use intervals (unless end uses)**
  - **Zero use for days/weeks (data communications?)**
  - **Unusual Inconsistency (may be usual)**
  - **mismatches against billing (may not be available)**
  - **Best to compare against prior period**

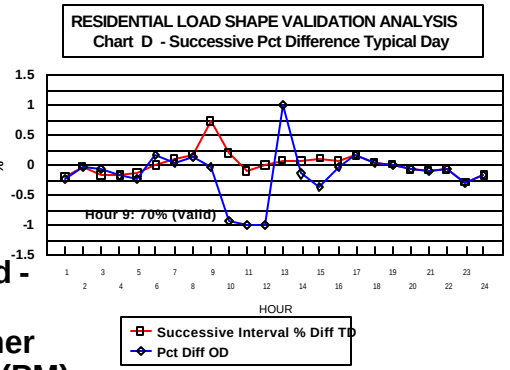
Validation - High/Low Tests

- Typically used for Billing
- Not as effective for interval loads
- need all hours accurate, not just peak
- Cannot account properly for natural variability of data



Validation - Successive % Difference

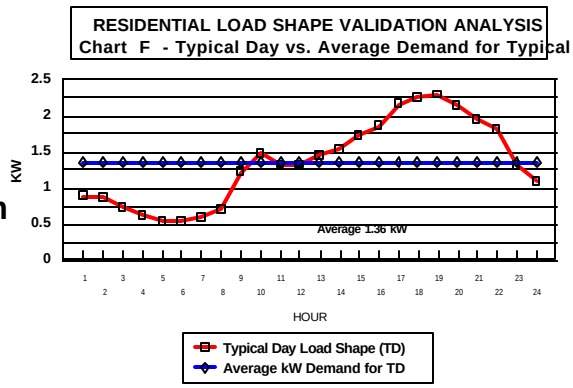
- Used for interval data tests
- Not effective for variable loads
- Cannot handle normal variability
- Inherently biased - some intervals are naturally much higher (early AM) or lower (PM) than previous



Missed Hour 14 problem on Outage Day

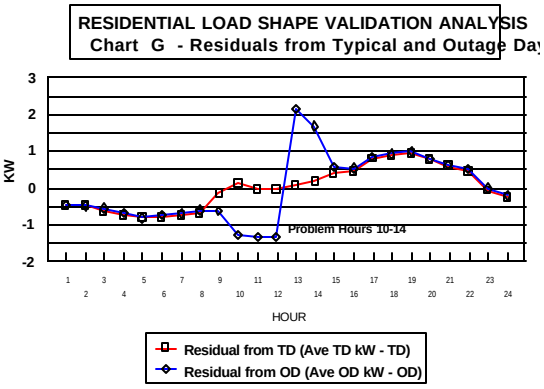
Validation Test - Pattern Recognition

- A good concept, but how to do it
- Option 1: Create a residual from the average daily interval load



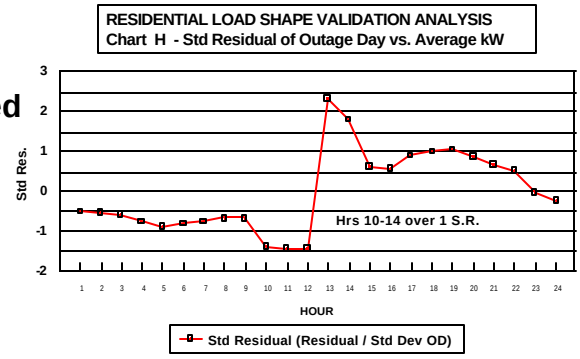
Validation Test - Pattern Recognition

- Compare residual from typical and outage days
- Set a criterion that will consistently distinguish good from bad intervals



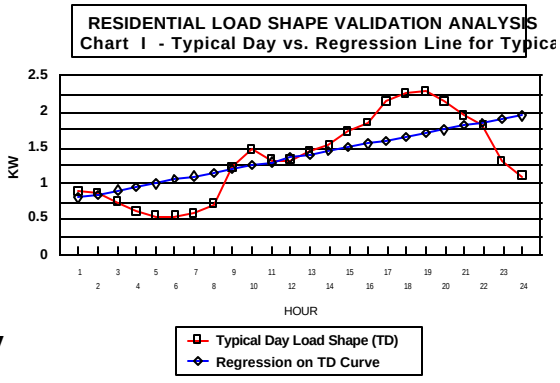
Validation Test - Pattern Recognition

- **Option 2: Create standardized residual by dividing residual by standard deviation**
- **Identify Outage Day bad intervals**



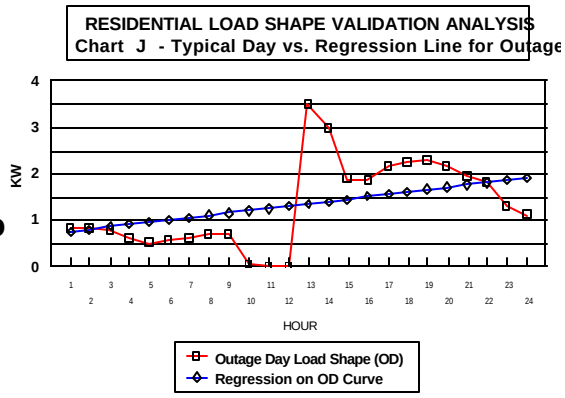
Validation Test - Pattern Recognition

- **Option 3: Use regression vs. time as the baseline for residuals**
- **Better reflects changes in use levels during the day**



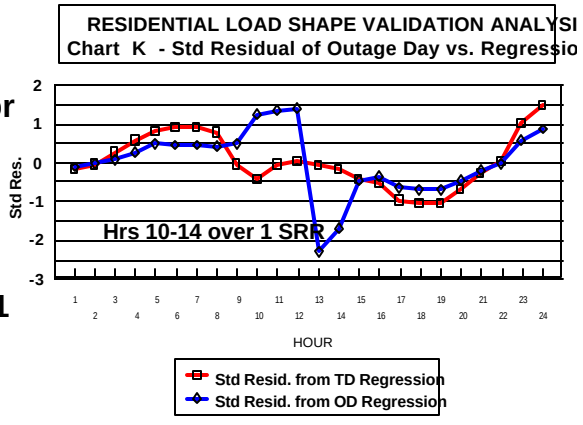
Validation Test - Pattern Recognition

- **Option 3: Regression line for Outage Day should be very similar to typical day**



Validation Test - Pattern Recognition

- **Option 3: Standard Residuals for Typical Day vs. Outage Day**
- **Standard residuals > 1 indicate problems**



Validation Test - Pattern Recognition

- **Advantages of Pattern Recognition:**
  - **Unbiased Test**
  - **Standardizing residuals accounts for different load levels - can develop base residual pattern from previous month's average load shape**
  - **Can be made computational and automated**
- **Constraints of Pattern Recognition**
  - **Useful only for short outages up to ~8 hours**
  - **Need additional test to validate use levels**

Editing Techniques

- **Smoothing**
  - **Short-term outages (1-4 hours), use average value on either side for missing/invalid data**
- **Shaping**
  - **Short-medium periods, use typical shapes from previous period, with scaling option**
- **Borrowing**
  - **Medium to long periods, including whole days: "borrow" data from a previous period, similar in day of week, day type, weather**

Editing Techniques

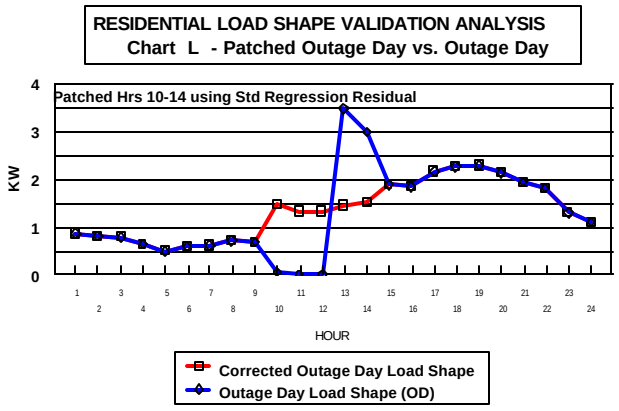
- **Patterning**
  - **Similar to Shaping, use standardized residual from prior period, scaled automatically from problem day use level**
  - **Appropriate for up to 8 to 10 hours within a day**
  - **Most valuable for outage days, where both outage and payback must be identified**

Editing Criteria

- **"Rules" need to be consistent**
- **Typical Rules:**
  - **Smooth up to 4 missing/invalid intervals, including payback after outage**
  - **Shape or Pattern patch only up to 1/2 day**
  - **Borrow data to patch missing days, using same day type and similar weather day**
  - **Pattern data to patch missing days with external estimate of load level**
  - **Need an audit trail to document/undo**

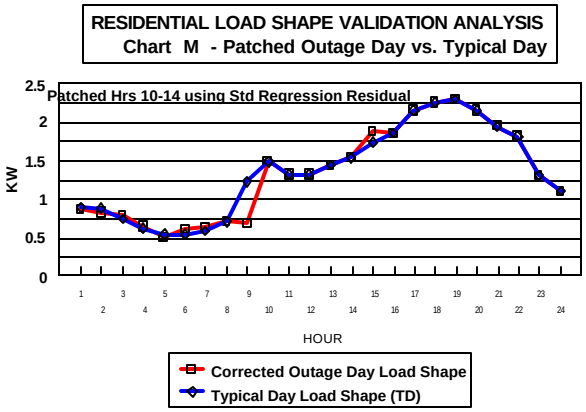
Typical Edit Transaction

- **Pattern Patch of Outage and Payback Period**



Typical Edit Transaction

- **Pattern Patch of Outage vs. Comparable Typical Day**
- **Hours on either side of problems are still slightly off**



Validation & Editing Today

- Deregulated industry will increase the need for accurate, QUALITY-CONTROLLED Data
- Load Profiling and Market Settlement Process will require more automation as data must be processed daily and/or "on-the-fly" and expanded to supplier or system levels
- Many users for load data, including regulated utility, suppliers, energy service providers
- Applications: Load Profiling, rates, technology assessment and other traditional ones

SUMMARY

- SO MUCH DATA, SO LITTLE TIME!
- Deregulation will require automated data quality control: Validation and Editing
- Risk of expanding data with unseen problems is great - and avoidable!

BEFORE

Load Research Man says: "Don't be a caveman like me!"

AFTER