825 N.E. Multnomah St.
Portland, OR 97232

PACIFICORP
PACIFIC POWER UTAH POWER

March 6, 2006

PAC-E-04-07

Idaho Public Utilities Commission
472 W Washington
Boise, ID 83270

Attention: Jean Jewell
Commission Secretary

Re: Compliance Filing
Revisions to the Company's Customer Guarantee Rule 25 and Schedule 300[1]

PacifiCorp (d.b.a. Utah Power & Light Company) hereby submits for filing an original and seven copies of the Company's filing in compliance with Staff Comments regarding PacifiCorp's Revisions to the Company's Customer Guarantee Rule 25 and Schedule 300, #3 in Case No. PAC-E-04-7, Order No. 29698, which stated:

> "That the Company provide a specific proposal to continue monitoring momentary events as soon as possible."

In accordance with this provision, the Company and the Commission Staff have reviewed a plan to ensure momentary outage events be evaluated on a state-wide basis to review system performance in Idaho. A copy of the plan is attached and incorporated as part of this filing.

Background

The Company filed on December 2, 2004 to extend its Service Standards Program which comprises the Customer Guarantees and Network Performance Standards. At that time, the Company proposed that both programs be modified slightly to reflect experiences gained during the prior 5 year period. Within the Network Performance Standards, the Company proposed removal of a MAIFI (Momentary Average Interruption Frequency Index) commitment. The Company has limited substation SCADA (System Control and Data Acquisition) equipment that is capable of detecting interruptions to support an accurate MAIFI metric. The Company had previously developed a surrogate method of

[1] In Case No. PAC-E-05-8, the Company committed in Commitment ID 10) to develop a plan for measuring short interruptions that it would present to and review with Commission Staff. It committed to filing this plan within 60 days after the meeting with Staff. On January 12, 2006, the Company and Commission Staff reviewed this plan; modifications reflecting Staff input were made and incorporated in the Short Interruption Measurement Plan, which is attached. In Order No. 29973 issued on February 13, 2006, the Commission accepted and adopted the commitments included in the Consolidated List of Commitments, including Commitment ID 10).

measurement for the short interruptions that MAIFI is designed to capture for substations that do not have SCADA. This surrogate method is not accurately transformed into a MAIFI metric. Recognizing this, the Company and Commission Staff have concurred that reporting two different short-interruption measures, dependent upon the type of equipment at the substation, would provide the Company and the Commission Staff awareness of areas within the system that may be experiencing unusual short-interruption performance.

Summary

In compliance with PAC-E-04-7[2] the Company provides the attached Short Interruption Measurement Plan, which will be used to measure short duration outages for both SCADA and non-SCADA substations. Using the method outlined, these results will be provided annually with its regular report of Idaho reliability to Commission Staff.

It is respectfully requested that all formal correspondence and Staff requests regarding this filing be addressed to the following:

By E-mail (preferred): datarequest@pacificorp.com

By regular mail:
Data Request Response Center
PacifiCorp
825 NE Multnomah, Suite 800
Portland, OR 97232

Please direct any informal questions to Heide Caswell at 503-813-6216.

Sincerely,

D. Douglas Larson

D. Douglas Larson
Vice President, Regulation

Enclosures

[2] This filing also pertains to PAC-E-05-8, Commitment ID (10), as noted previously in footnote 1.

PACIFICORP

POWER DELIVERY ASSET MANAGEMENT
SHORT-INTERRUPTION/MAIFI REPORTING
MEASUREMENT REPORT
February 21, 2006

CONTENTS

1.0 EXECUTIVE SUMMARY (IDAHO ONLY)

At the approval of the merger between ScottishPower and PacifiCorp, the Company instituted the Service Standards Program, which identified Performance Standards and Customer Guarantees that it would implement during the five-year period after the merger's approval. The Customer Guarantees were those customer-specific commitments, such as responsiveness to a request for an estimate. The Performance Standards were state-wide system commitments, and addressed sustained outage reliability improvements in addition to momentary outage frequency improvements. During the five-year period the Company successfully completed each of these commitments. On December 2, 2004 the Company filed to extend the program with some modifications. Fundamentally, this modification removed a specific improvement target for momentary outage frequencies, recognizing the historic surrogate used to calculate momentary interruptions was inaccurate; the Company previously used breaker operations counts as a method to infer a momentary outage event. In PAC-E-04-7 Staff accepted the modified Service Standards Program, with the provision that the Company propose its future planned MAIFI measurement methodology. This plan describes the process proposed.

The merger between PacifiCorp and ScottishPower and the introduction of CADOPS (Computer Aided Distribution Operations System, an automated outage management system), and Prosper/US (which is a company-developed system for archiving and reporting outage information), throughout PacifiCorp have been shown to significantly increase the accuracy and consistency of sustained outage reporting. With CADOPS implementation, (in March, 2002) the legacy systems which captured momentary information, however incorrectly, were disabled from automatically generating these statistics. In the interim, a limited amount of SCADA-outfitted substations have been reporting momentary outage information into the CADOPS system. These outage events have been archived into Prosper/US. Momentary indices have been the result of this small subset of momentary outages divided by the total customers for each state, which has resulted in substantial under-reporting of momentary metrics. This report describes the going-forward data collection methodology, utilizing PacifiCorp's SCADA system, where currently in place, beginning at April 1, 2005, to be reported at fiscal year-end. Additionally, it describes the method to calculate MAIFI and $MAIFI_{E,}$ in addition to identifying the method for determining breaker operations for non-SCADA circuits.

2.0 BACKGROUND

Upon the completion of the merger, the Company immediately instigated plans to simultaneously improve and monitor network reliability performance. This was accomplished through a series of improvement programs such as the deployment of the Network Initiatives Program, as well as implementation of outage management software.

The effect of the Network Initiatives Program, as well as other delivery system improvements, can be evidenced by evaluating performance up to the point that CADOPS was implemented, and has been previously demonstrated in each state's reported momentary outage metrics. The system improvements that delivered the reduction in historic MAIFI included the continued expansion of the underground network, improved vegetation management programs, continued fuse coordination techniques, optimization of reclosers and greater usage of reclosers and SmartLinks.

The Company used substation breaker operations counts to infer a momentary interruption. It calculated that for every time a substation breaker operated when not associated with a switching or maintenance operation, a momentary interruption had occurred. Every customer served from that substation breaker was considered to have experienced a momentary customer interruption. The total number of momentary customer interruptions was divided by all customers to arrive at MAIFI. This was divided by 3 to arrive at a MAIFIe result. The factor of 3 was selected because the Company's convention was to have 3 operations prior to lockout. This method did not account for breaker operations that resulted in lockout, for those operations that successfully cleared a fault prior to the third reclose operation, nor for short-duration loss of supply events. Regardless, using the breaker-operation method consistently from 1995 through 2002 demonstrated that the Company had achieved its merger commitment 5% improvement goal (in Performance Standard 3).

However, after CADOPS, the reported MAIFI indices in each state have substantially declined, in large part due to the methods used to infer a MAIFI metric. Upon implementation of CADOPS, a substantial number of momentary events were not transmitted into Prosper/US, which led to an understatement of the Company's momentary indices.

Commencing on April 1, 2006 the Company proposes that it will use its existing SCADA system in concert with its Dispatch Log Application to calculate momentary indices to explicitly report MAIFI and $MAIFI_E$ metrics. These results will be reported for fiscal year-end 2006, after March 31, 2006. After deployment of its EMS/SCADA project the same fundamental calculations will be performed within the PI historian, the database into which the EMS/SCADA system will feed, and again will derive momentary metrics, consistent with IEEE standards. Additionally, due to the relatively small percentage of circuits that are outfitted with SCADA, the Company will continue to collect and analyze mechanically-counted breaker operations for circuits that do not have SCADA.

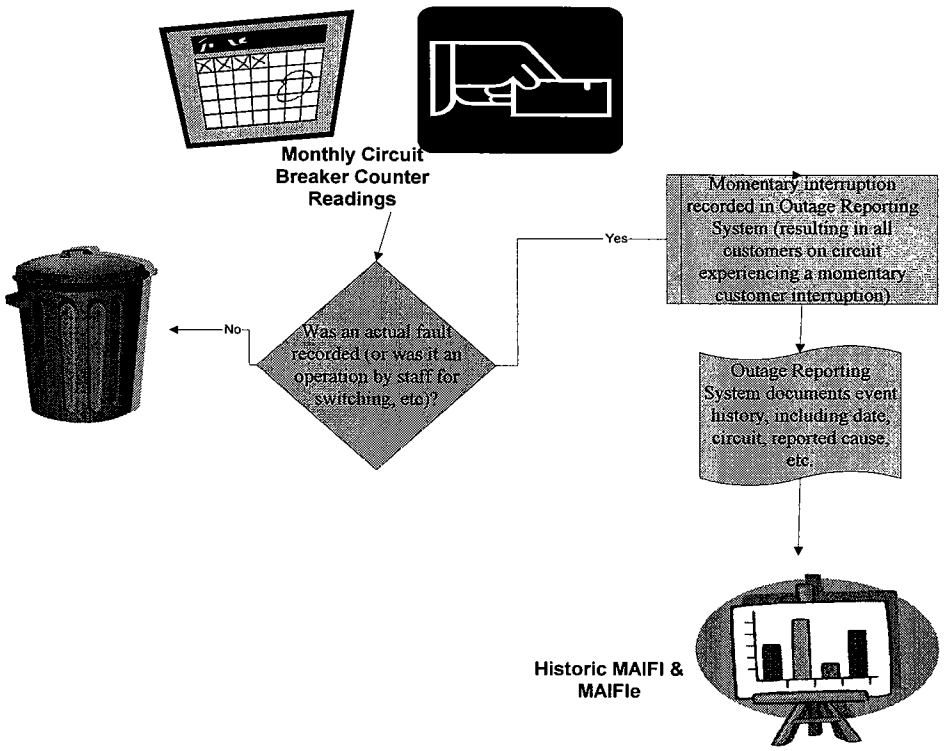
3.0 PROCESSES

3.1 PRE-CADOPS ENVIRONMENT:

Prior to CADOPS, PacifiCorp measured momentary events based upon circuit breaker operations, measured by mechanical counters located at substations. It assumed that every time a breaker operated, except when associated to routine maintenance or with a temporary switching operation, a momentary interruption occurred. This data was collected by monthly capture of these breaker counter readings, performed concurrent with substation inspections. These readings were entered into the outage reporting system via an assumption that for each of these events during the period, each customer connected to the circuit experienced a momentary customer interruption. The momentary average interruption frequency index, or MAIFI, was calculated by dividing the sum of momentary customer interruptions by all customers served within the given area (i.e. the number of customers served within a state). To calculate a momentary event index, it divided the MAIFI index by a factor of 3 (based upon the Company's conventional settings for reclosures prior to lock-out). These interruptions were stored as ORS (Outage Reporting System) entries within the outage management system.

The effect of this approach was to overstate momentary interruptions since many of them result in a sustained interruption (and these can not be differentiated). Potentially, also momentary events may be incorrect since in many cases only one operation of a breaker may be required to clear a fault.

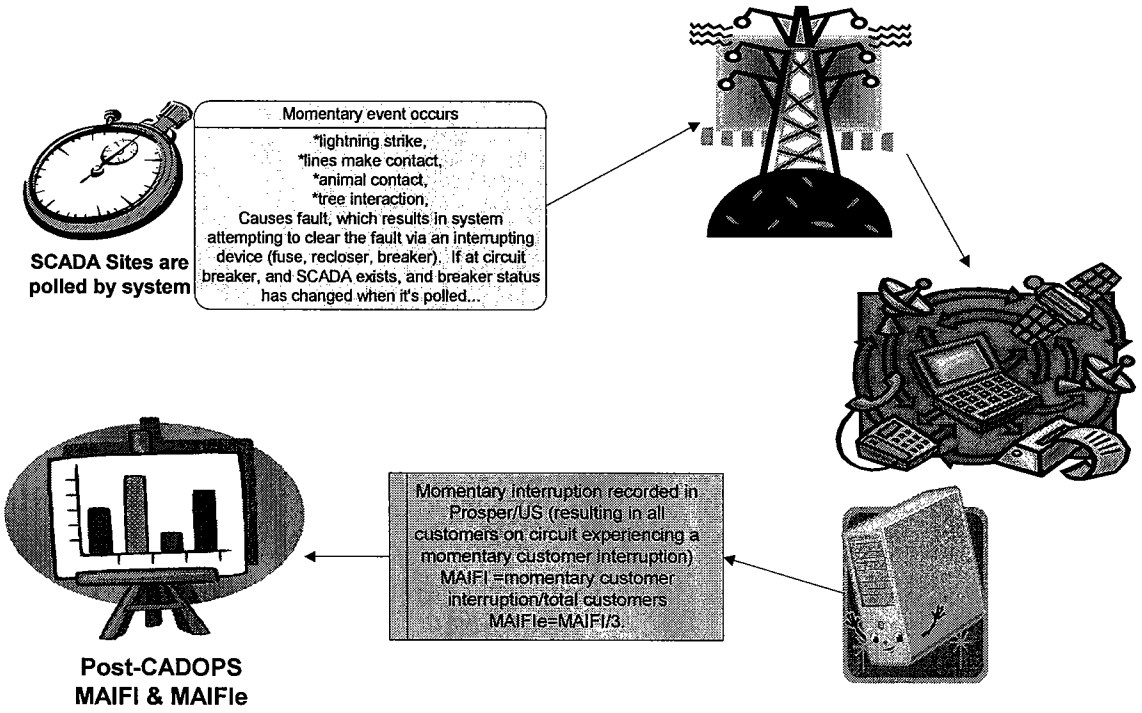
Figure 1: Pre-CADOPS Method for Calculating MAIFI & MAIFIe



3.2 POST-CADOPS IMPLEMENTATION, PRIOR TO APRIL 1, 2006:

At the time of CADOPS implementation, and in preparation for a more long-range momentary outage management data capture strategy, the Company severed the ties that fed breaker-initiated momentary events into the Outage Reporting System. Instead, it determined that utilizing information initiated by SCADA-collected data would be a more accurate measure of momentary interruptions. As such, these outages were reported into Prosper/US, but resulted in understated momentary indices since the system reports were dividing the interruptions (of which only a small percentage were being reported) by all customers served by the Company.

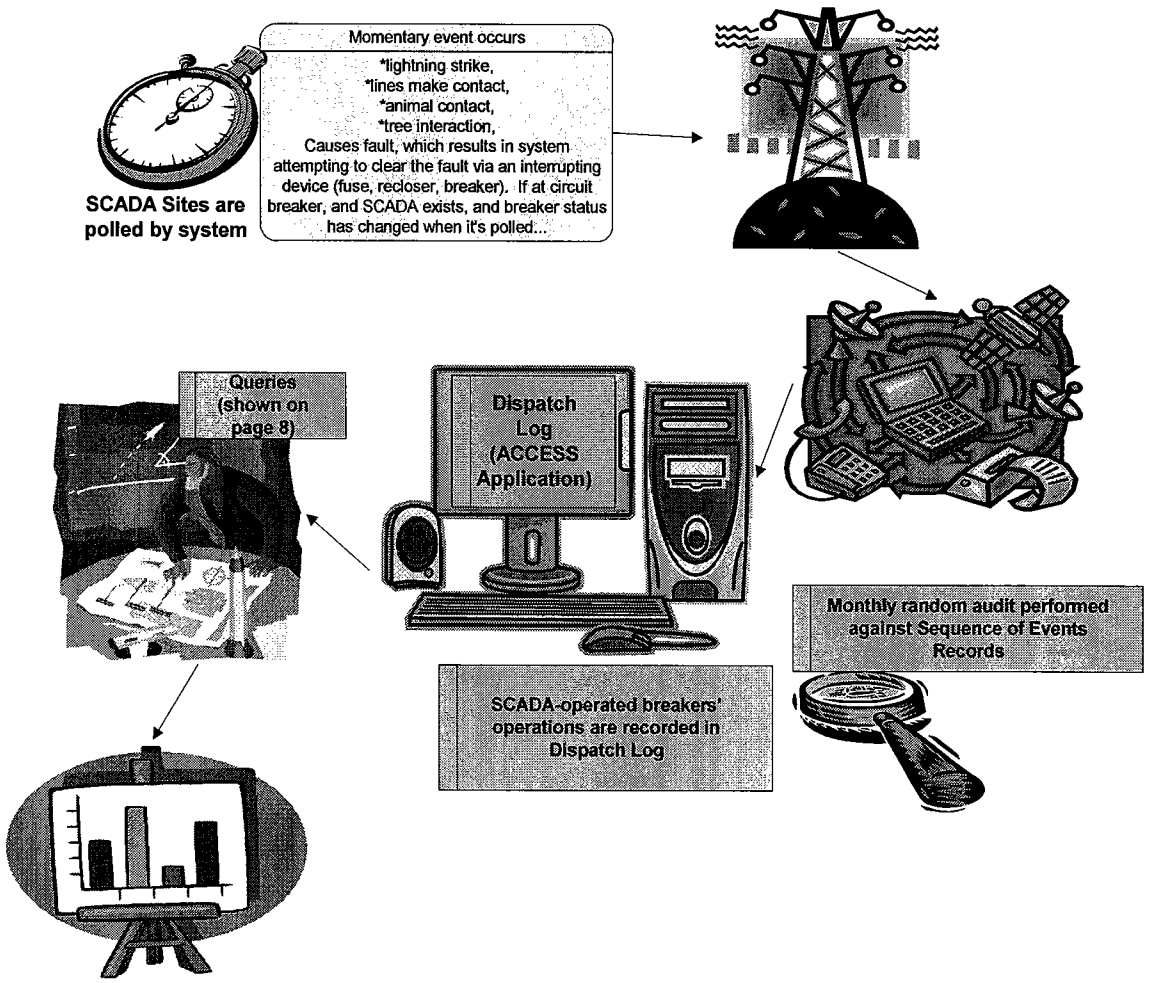
Figure 2: Post CADOPS, Prior to April 1, 2005 Method for Calculating MAIFI & MAIFIe



3.3 POST-CADOPS IMPLEMENTATION, AFTER APRIL 1, 2006:

As stated previously, at the time of CADOPS implementation much in regard to momentary outage data collection changed. One system that was implemented prior to that time is called the Dispatcher Log. This system is an ACCESS database application, and is used to record breaker operations that occur on SCADA operated devices. The data collected within this ACCESS application is all actions that occurred on them, such as tagged-out status, operated (and time, date, number of operations, lock-out status and cause of operation and includes loss of upstream supply). On a monthly basis, a random audit will be prepared, comparing Dispatch Log entries against Sequence of Events Records for SCADA-operated breakers. This dataset will serve as the interim data source until the EMS/SCADA Project is released[1]. Upon implementation of this methodology, the Company will deliver momentary indices consistent with IEEE P1366 standards, where SCADA breakers are present.

Figure 3: Post CADOPS, Post-April 1, 2006 Method for Calculating MAIFI and MAIFIe

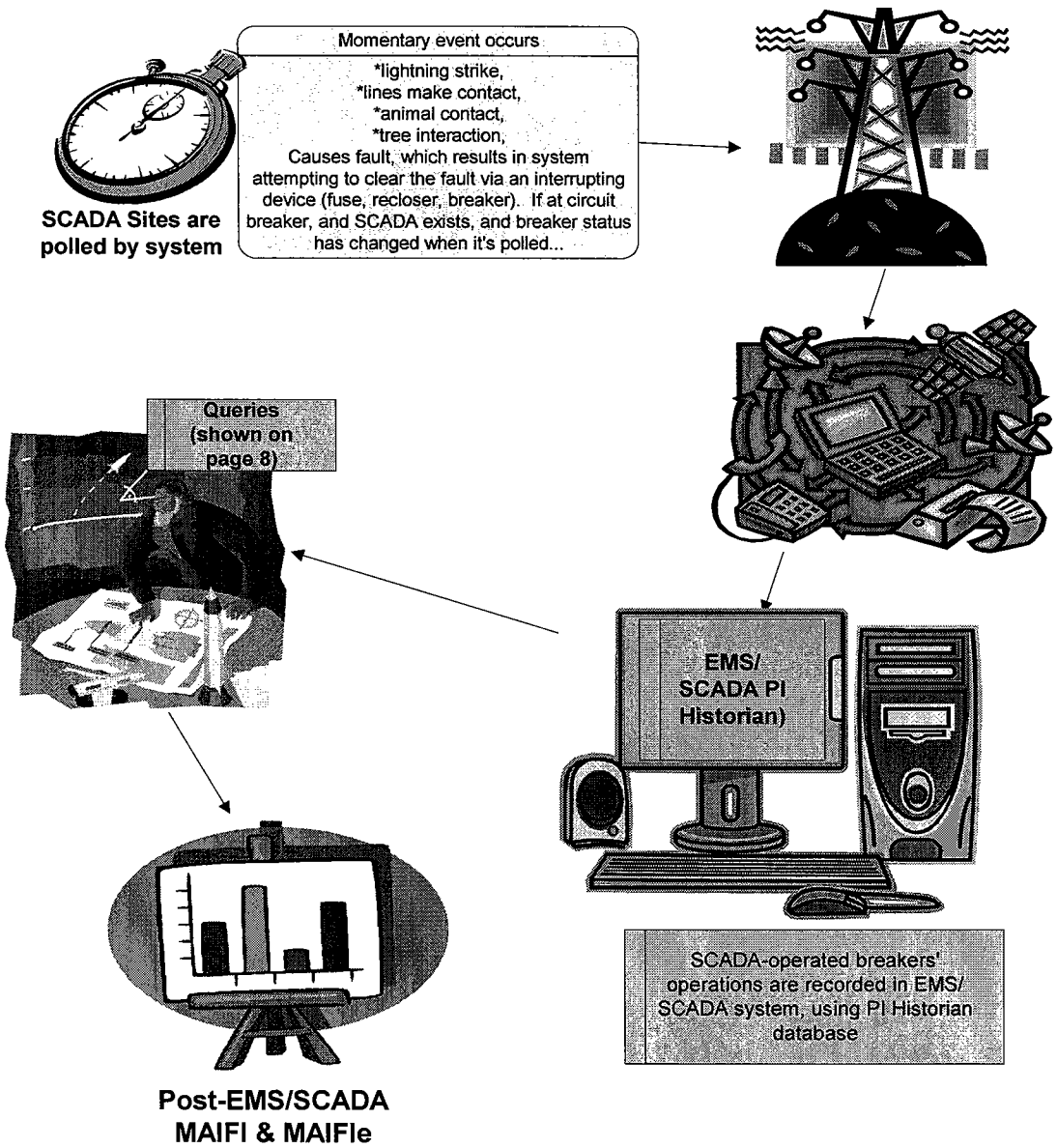


[1] EMS/SCADA was targeted for late 2005 deployment.

3.4 POST-CADOPS /POST-EMS/SCADA ENVIRONMENT:

Upon completion of the EMS/SCADA Project the Company will have a single, comprehensive data source for evaluation of all types of momentary outage operations which requires no human intervention for collecting momentary incidents. After EMS/SCADA deployment, rather than querying the Dispatch Log ACCESS database, queries within EMS/SCADA's PI historian database will be conducted which is fed directly from EMS/SCADA. As previously identified, this method will derive momentary indices consistent with IEEE P1366 standards.

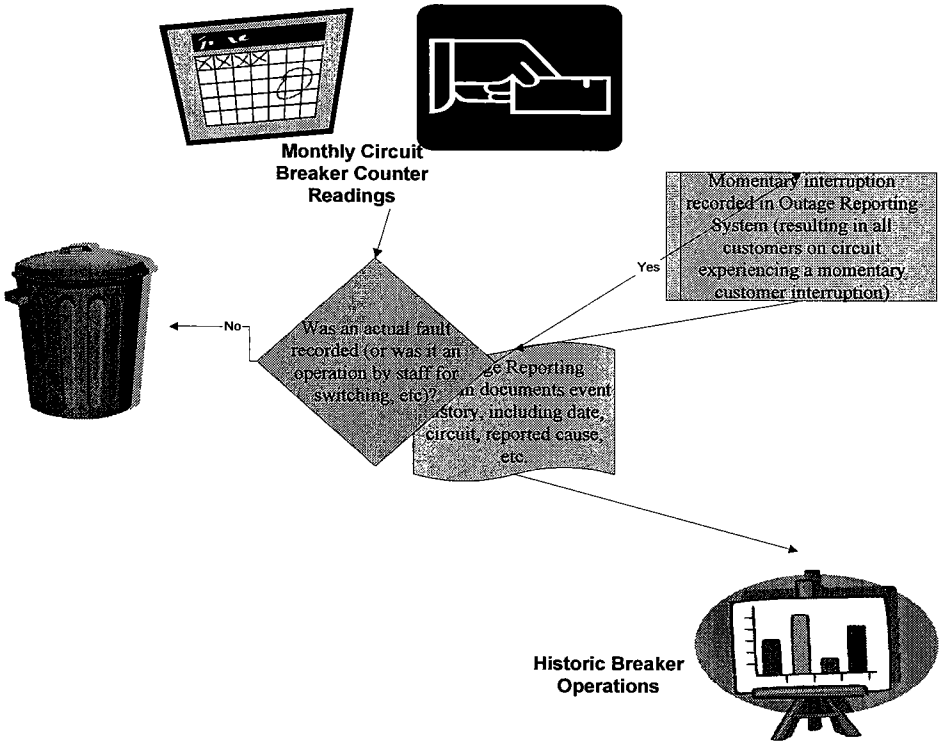
Figure 4: Post-CADOPS, Post EMS/SCADA Method Calculating MAIFI and MAIFIe



3.5 POST-CADOPS BREAKER OPERATIONS RECORD ENVIRONMENT:

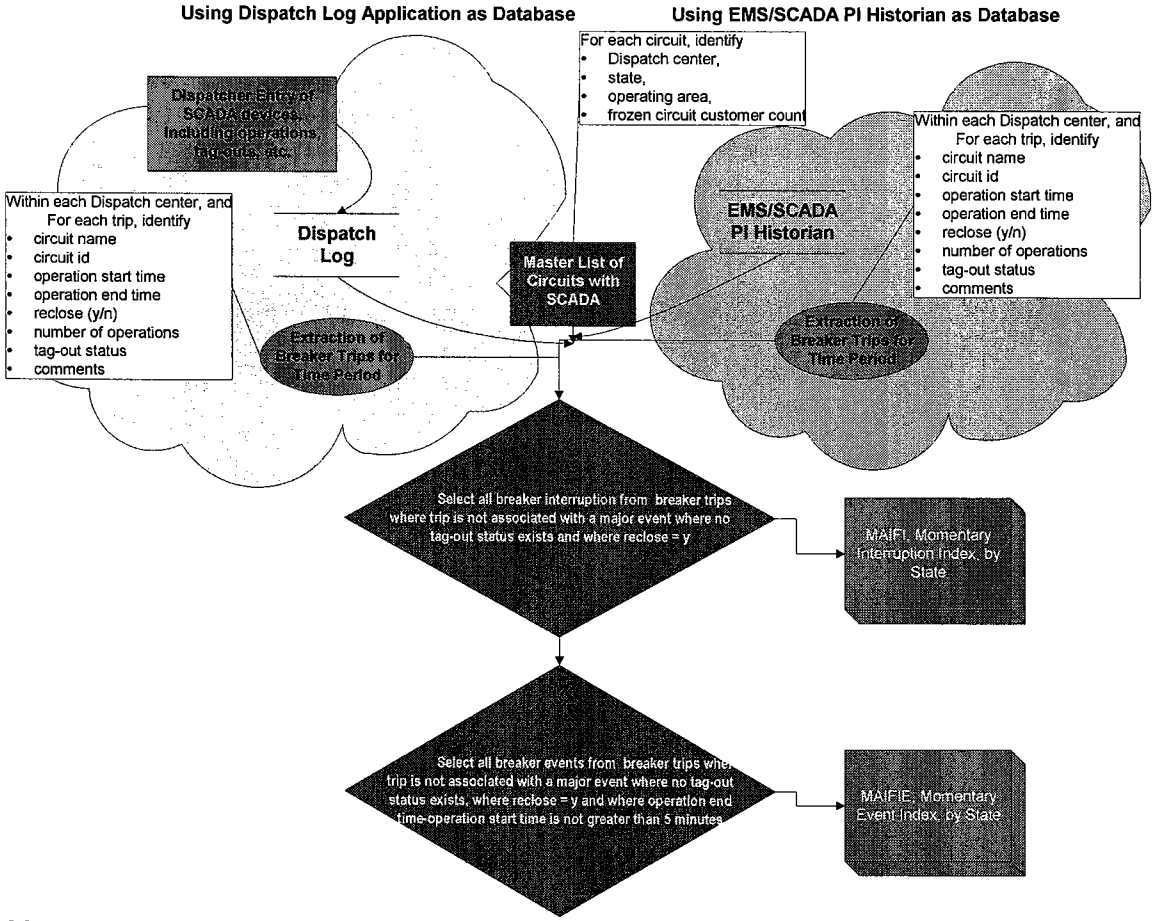
For those circuits without SCADA monitoring equipment, PacifiCorp will measure circuit breaker operations as recorded by mechanical counters located at substations. These mechanical counters are read monthly during substation inspections and are entered into the Company's equipment database, contained in its SAP system. On a routine basis these counts will be downloaded into spreadsheets and reviewed to determine system performance issues. There will be no attempt to infer any form of MAIFI measurement; however this data will be important to evaluate breaker operation performance for potential substation or downline problem facilities. The summarized data will be provided annually in the Company's Service Quality Review Report.

Figure 5: Post-CADOPS Method for Calculating Non-SCADA Breaker Operations



4.0 MAIFI CALCULATIONS

Figure 5: Calculation Flow Process using Dispatch Log & PI Historian



Momentary Interruptions and Events will be calculated as follows:
Definitions

- ✓ SCADA breaker *interruption* is the individual operation of a breaker that does not result in a lockout event, and is not associated with a pre-arranged tagging-out event.
- ✓ SCADA breaker *event* is the individual sequence of a breaker operation that does not result in a lockout event, and for which the next operation in the sequence must be within 5 minutes of the end of the prior operation. It also is not associated with a pre-arranged tagging-out event.

Calculation

- ✓ For each state,
  Momentary Interruption = ($\sum$ (SCADA breaker operation)*(SCADA breaker customer count))/($\sum$(SCADA breaker customer count)
  Momentary Event = ($\sum$ (SCADA breaker event)*(SCADA breaker customer count))/($\sum$(SCADA breaker customer count)

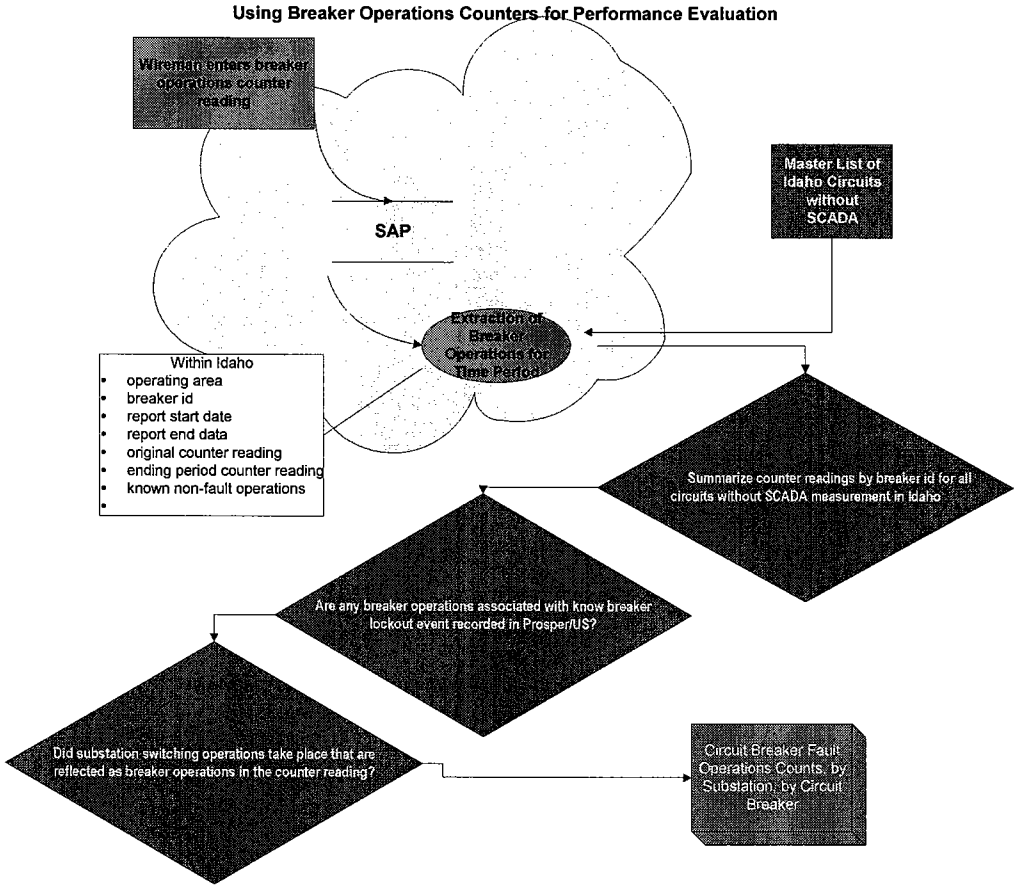
Assumptions

- ✓ Fundamentally, momentary outages are promulgated via vegetation[2], lightning[3] or animals within the vicinity of the overhead distribution system.
- ✓ Downline reclosers[4] have a negligible effect on momentary events experienced by customers either upstream or downstream of the recloser.

[2] Vegetation panels are shown in Appendix B to demonstrate the relative predictability of this type of exposure to the overhead system.
[3] Lightning flash densiities are depicted on Appendix A across PacifiCorp's service territory.
[4] Hydraulic and electronic reclosers are delineated in Appendix C.

5.0 BREAKER OPERATIONS CALCULATIONS

Figure 6: Calculation Flow Process using Breaker Counter Readings, Prosper/US and



Non-SCADA breaker operations will be calculated as follows:
Definitions

- ✓ Non-SCADA breaker *operation* is the individual operation of a breaker that results in a recorded breaker operation on the mechanical counters.
- ✓ Breaker lockout *event* is an event which results in an assumed three operations prior to lockout; a circuit breaker lockout operation will be determined to have occurred when a sustained event is recorded in Prosper/US that has an auto-isolation point of the breaker.
- ✓ Switching *operation* is an event that was recorded in on-site substation records that indicate that Company actions resulted in breaker counter records.

Calculation

- ✓ For each circuit breaker,
  Breaker Operation = (Non-SCADA breaker operation)-(4* (Prosper/US full circuit $\text{outage}_{\text{autoisolation point =circuit breaker)}}$))-switching operation counts

Assumptions

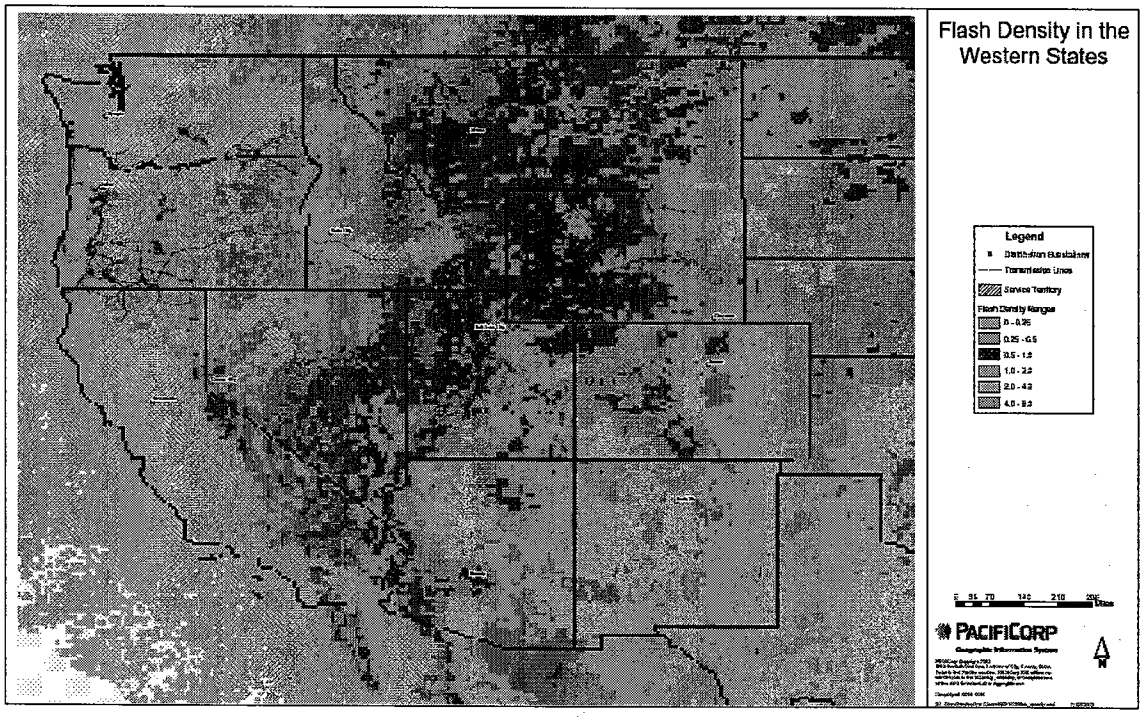
- ✓ Each breaker is set operate three times prior to lockout.
- ✓ Any event that results in a full-circuit outage resulted in the entire breaker operations sequence being performed.

6.0 RECOMMENDATIONS

It is recommended that PacifiCorp migrate its momentary outage measurement to leverage its currently in-place SCADA system and derive IEEE standard-compliant momentary indices, for those areas with SCADA deployed. For those areas not served by SCADA, it is recommended that the historic method of measuring breaker operations be modified slightly to reflect full-circuit outages and employee switching actions, but that the resulting data is used to evaluate the circuit's performance and make appropriate system adjustments. Further, it is proposed that the methodology described previously for using the Dispatch Log ACCESS application for calculating momentary interruption and event indices be employed until the implementation of EMS/SCADA. Thereafter, similar queries and calculations will be used within EMS/SCADA's PI historian database.

PACIFICORP

APPENDIX A: LIGHTNING FLASH DENSITY MAP FOR PACIFICORP SERVICE TERRITORY

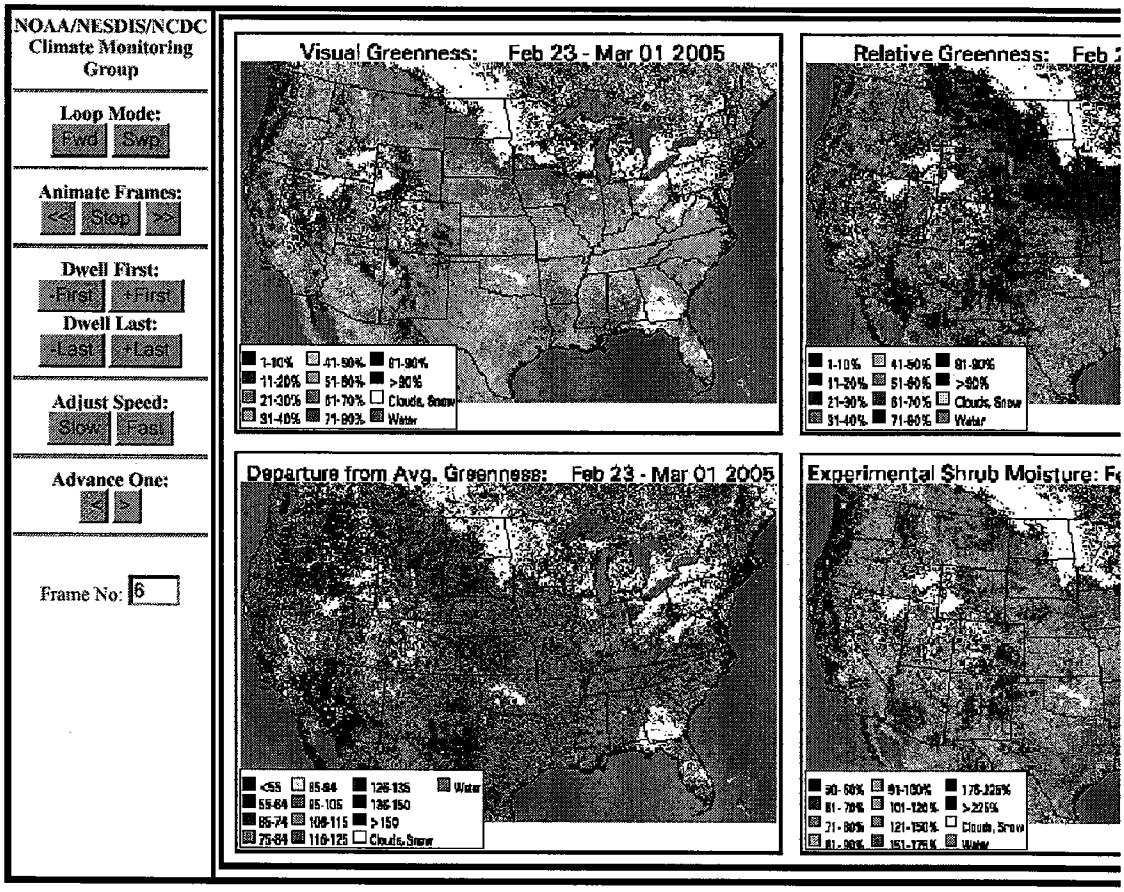


PACIFICORP

APPENDIX B: VEGETATION GREENNESS MAP OF THE UNITED STATES

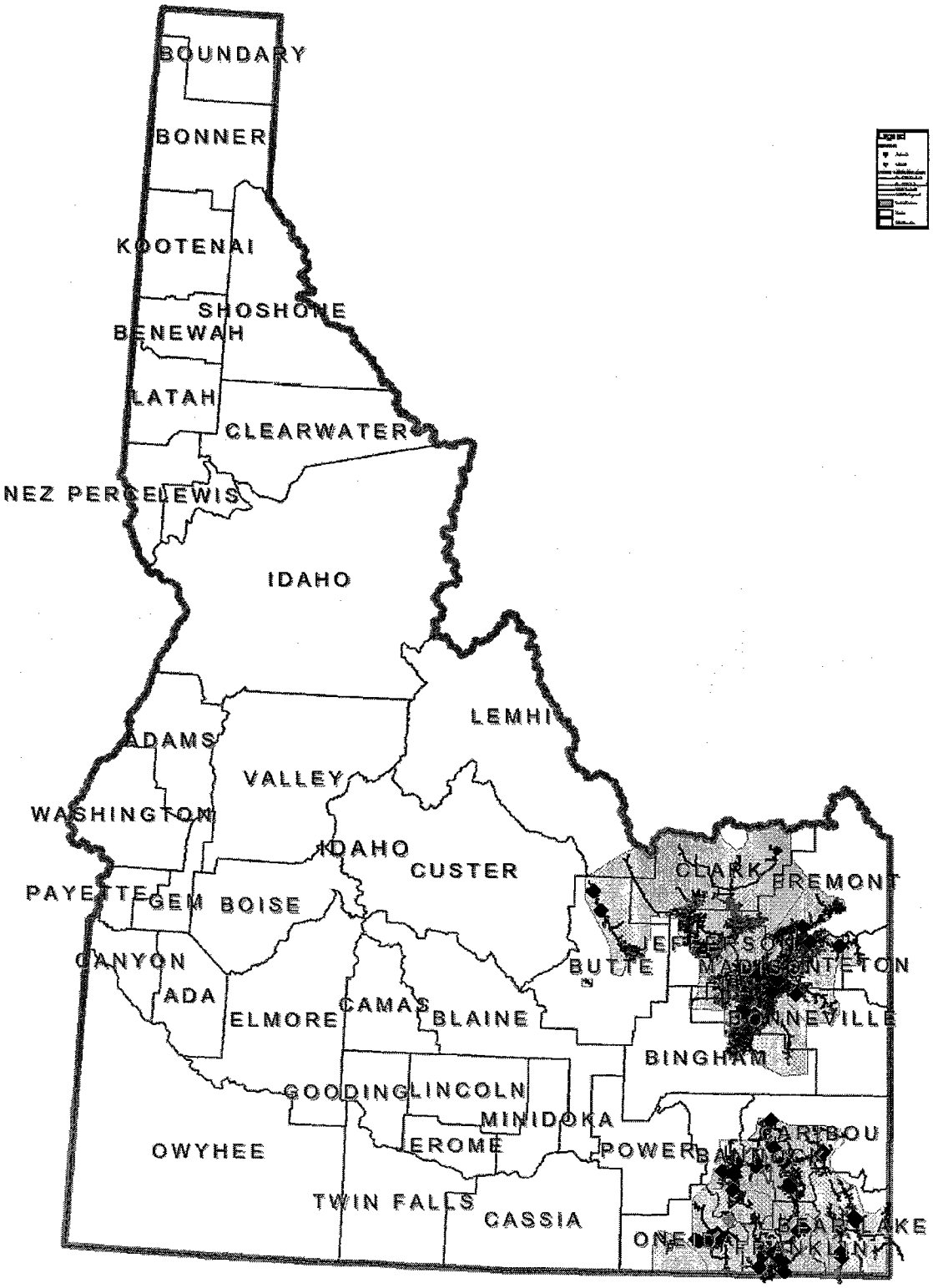
NCDC / Monitor / Greenness / Search / Help

USFS/NIFC Vegetation Greenness Maps

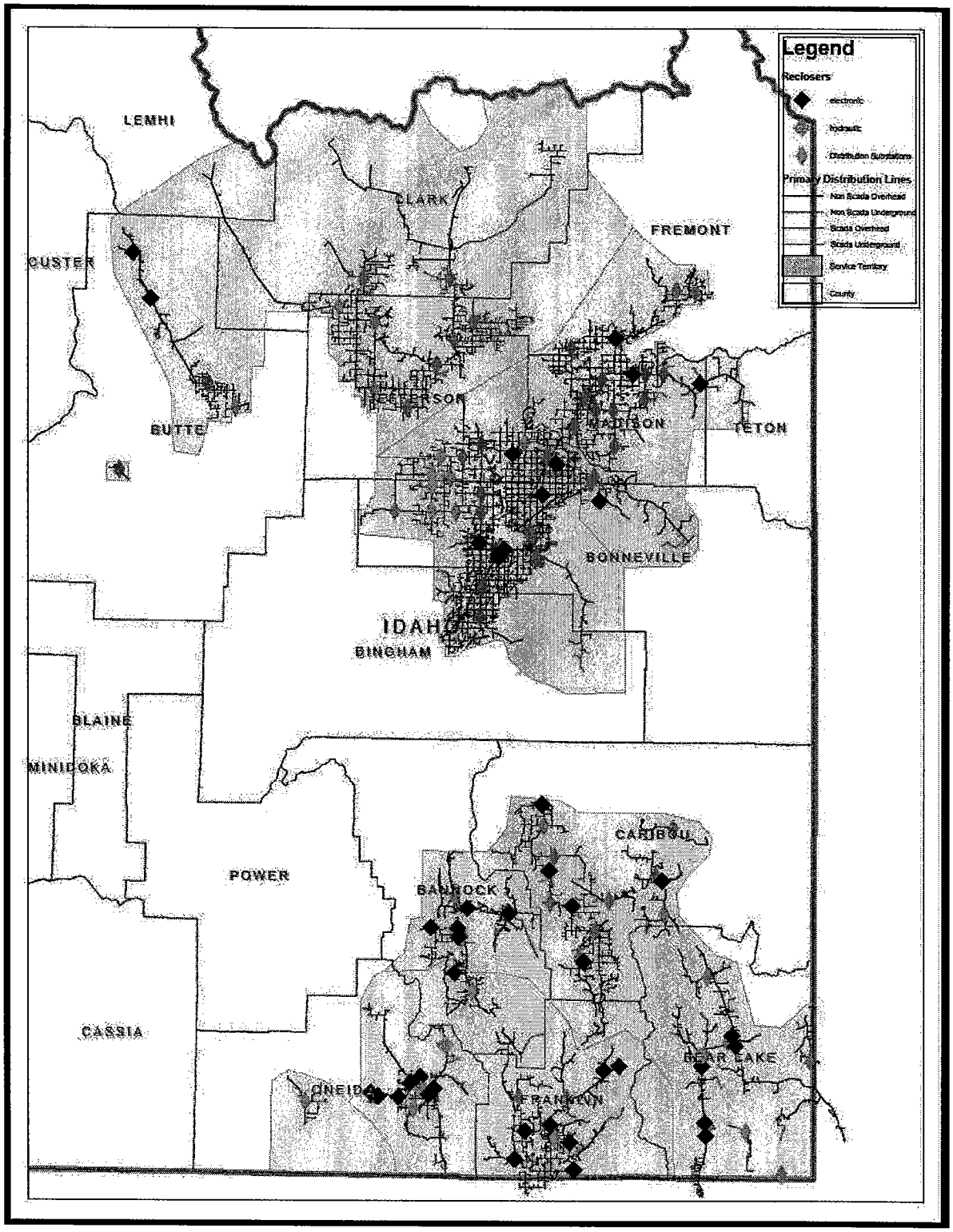


PACIFICORP

APPENDIX C: PACIFICORP SCADA BY STATE, GEOGRAPHICAL DEPICTIONS
Idaho State SCADA Distribution Lines with Line Reclosers

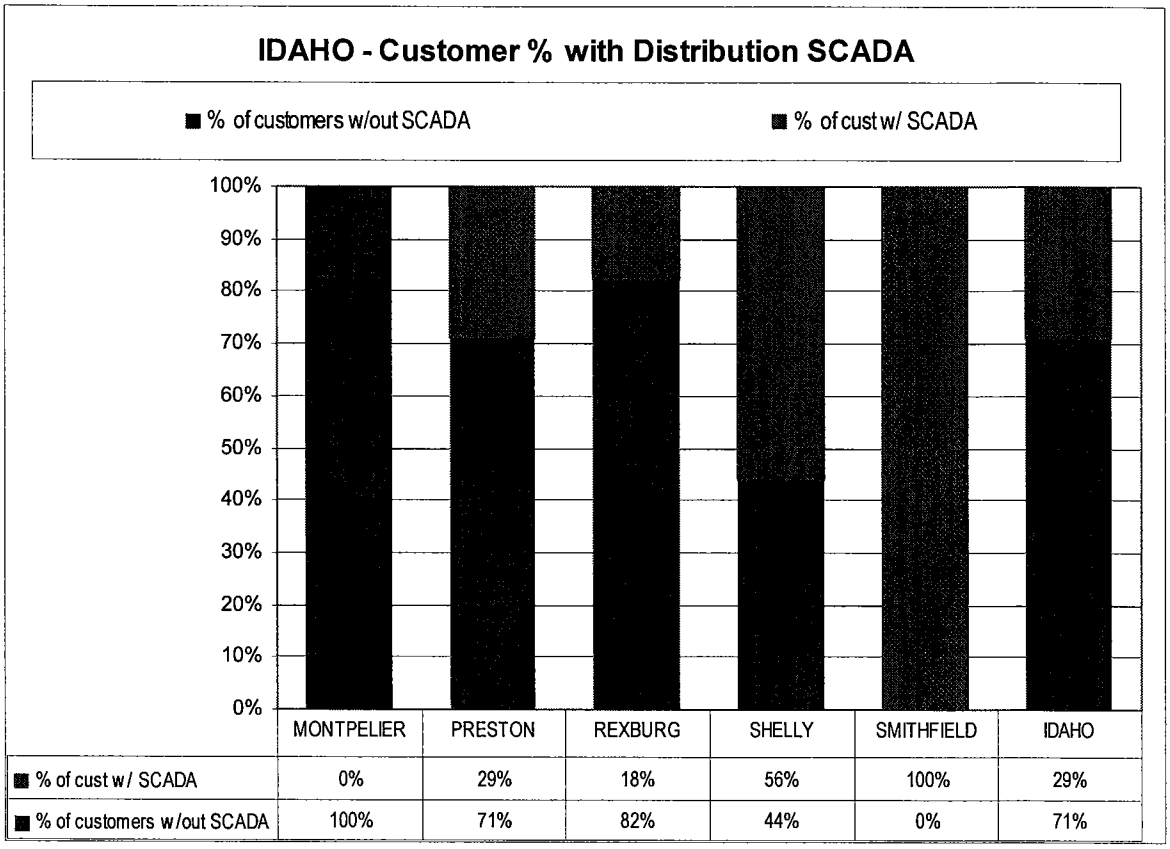


PACIFICORP


Legend
Reclosers
electronic
hydraulic
Distribution Substations
Primary Distribution Lines
Non Scada Overhead
Non Scada Underground
Scada Overhead
Scada Underground
Service Territory
County
LEMHI
CLARK
FREMONT
CUSTER
BUTTE
JEFFERSON
MADISON
TETON
BONNEVILLE
IDAHO
BINGHAM
BLAINE
MINIDOKA
POWER
CARIBOU
BANNOCK
CASSIA
BEAR LAKE
ONEIDA
FRANKLIN

PACIFICORP

APPENDIX D: TABULAR SCADA BY OPERATING AREA W/ CIRCUIT DETAILS



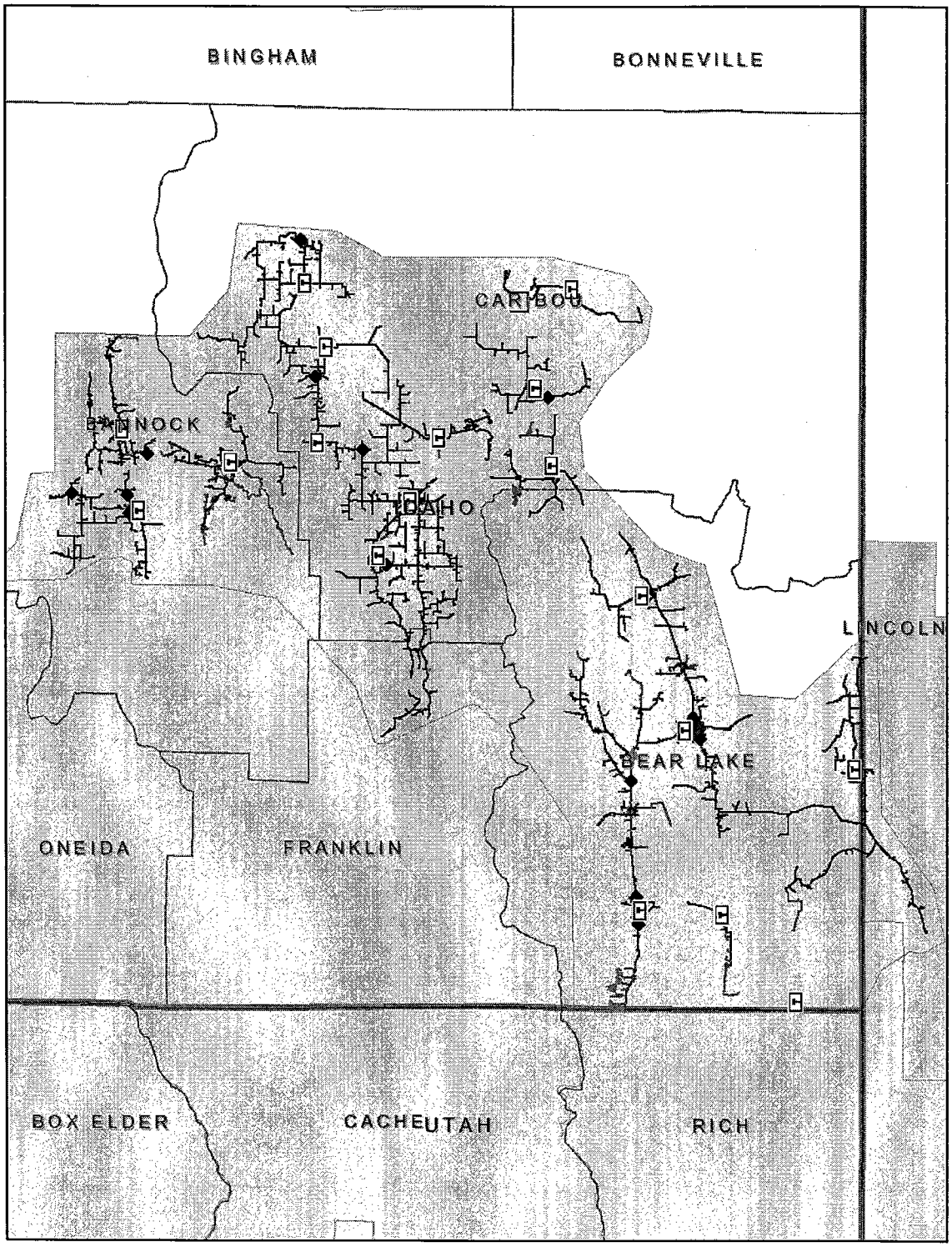
	MONTPELIER	PRESTON	REXBURG	SHELLY	SMITHFIELD	IDAHO
% of cust w/ SCADA	0%	29%	18%	56%	100%	29%
% of customers w/out SCADA	100%	71%	82%	44%	0%	71%

PACIFICORP

Substation Name	Circuit ID	Circuit Name	OP AREA	Customers without SCADA	Customers with SCADA
ALEXANDER	ALX11	ALEXANDER #11	MONTPELIER	196	0
ARIMO	ARM12	ARIMO #12	MONTPELIER	292	0
BANCROFT	BAN12	BANCROFT #12	MONTPELIER	230	0
CHESTERFIELD	CHS12	CHESTERFIELD #12 HATCH	MONTPELIER	84	0
COVE	COV12	COVE #12	MONTPELIER	493	0
HORSLEY	HRS11	HORSLEY #11	MONTPELIER	101	0
LAVA	LVA11	LAVA #11	MONTPELIER	898	0
LUND	LND11	LUND #11	MONTPELIER	148	0
MONTPELIER	MNT11	MONTPELIER #11	MONTPELIER	1004	0
MONTPELIER	MNT13	MONTPELIER #13	MONTPELIER	776	0
MONTPELIER	MNT14	MONTPELIER #14	MONTPELIER	295	0
RAYMOND	RAY12	RAYMOND #12 SOUTH TO PEGRAM	MONTPELIER	100	0
ST. CHARLES	STC11	ST CHARLES #11	MONTPELIER	1354	0
DOWNEY	DWN11	DOWNEY #11	PRESTON	332	0
MALAD	MLD12	MALAD #12	PRESTON	0	236
MALAD	MLD13	MALAD #13	PRESTON	0	1244
PRESTON	PRS12	PRESTON #12	PRESTON	1125	0
PRESTON	PRS13	PRESTON #13	PRESTON	661	0
TANNER	TNR11	TANNER #11 MINK CREEK	PRESTON	311	0
WESTON	WST11	WESTON#11 SOUTH - WESTON/FAIRVEW	PRESTON	313	0
WESTON	WST12	WESTON #12 NORTH TO DAYTON	PRESTON	317	0
BERENICE	BRN22	BERENICE #22	REXBURG	113	0
CANYON CREEK	CNY21	CANYON CREEK #21	REXBURG	0	160
MENAN	MNN11	MENAN #11	REXBURG	288	0
NEWDALE	NWD12	NEWDALE #12	REXBURG	643	0
RIGBY	RGB13	RIGBY #13	REXBURG	0	1172
RIRIE	RIR12	RIRIE #12	REXBURG	785	0
SOUTH FORK	SFK13	SOUTH FORK #13 ANTELOPE FLATS	REXBURG	365	0
ST. ANTHONY	STA12	ST ANTHONY #12	REXBURG	527	0
SUGAR CITY	SGR14	SUGAR CITY #14	REXBURG	328	0
THORNTON	THR11	THORNTON #11	REXBURG	1148	0
GOSHEN	GSH11	GOSHEN #11	SHELLY	0	898
GOSHEN	GSH13	GOSHEN #13	SHELLY	0	446
IDAHO FALLS	I35	IDAHO FALLS-IDAHO FALLS CITY-46KV	SHELLY	1	0
IDAHO FALLS	IDF11	IDAHO FALLS #11	SHELLY	0	709
IDAHO FALLS	IDF12	IDAHO FALLS #12	SHELLY	0	445
IDAHO FALLS	IDF14	IDAHO FALLS #14	SHELLY	0	376
OSGOOD	OSG14	OSGOOD #14	SHELLY	568	0
SHELLEY	SHL14	SHELLEY #14	SHELLY	439	0
UCON	UCN11	UCON #11	SHELLY	1419	0

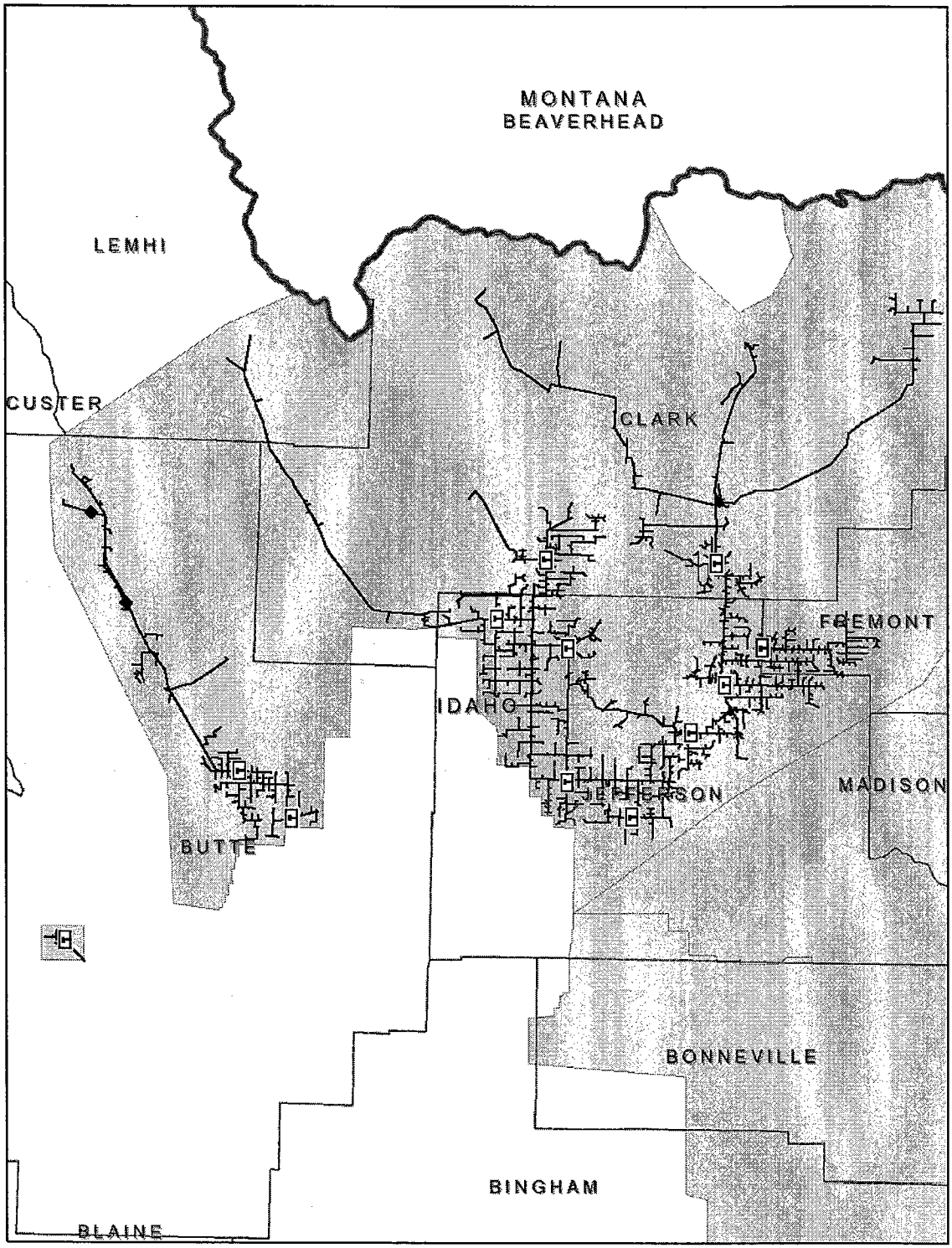
PACIFICORP

APPENDIX E –IDAHO CIRCUIT CHARACTERISTICS MAPS
Montpelier



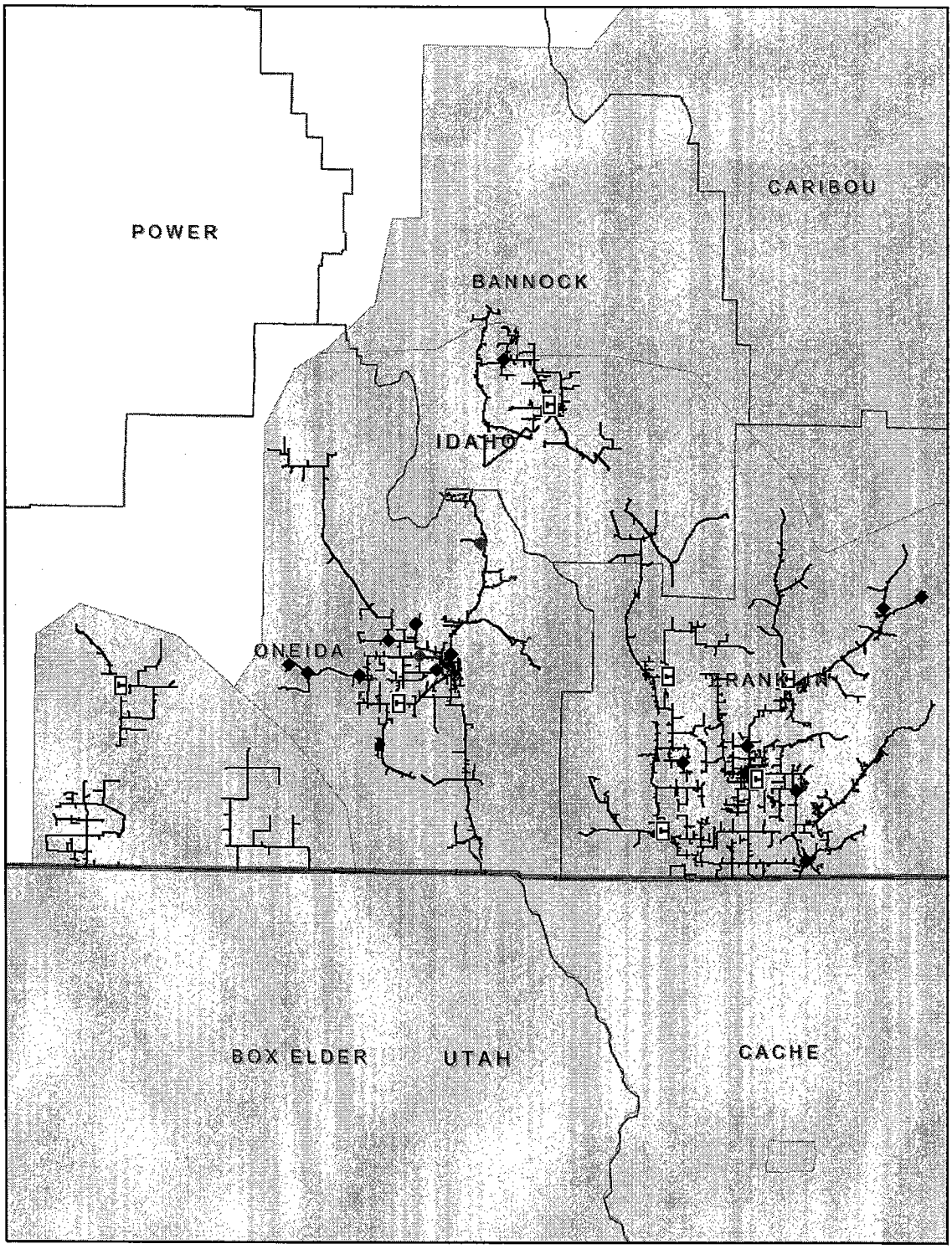
PACIFICORP

Mud Lake



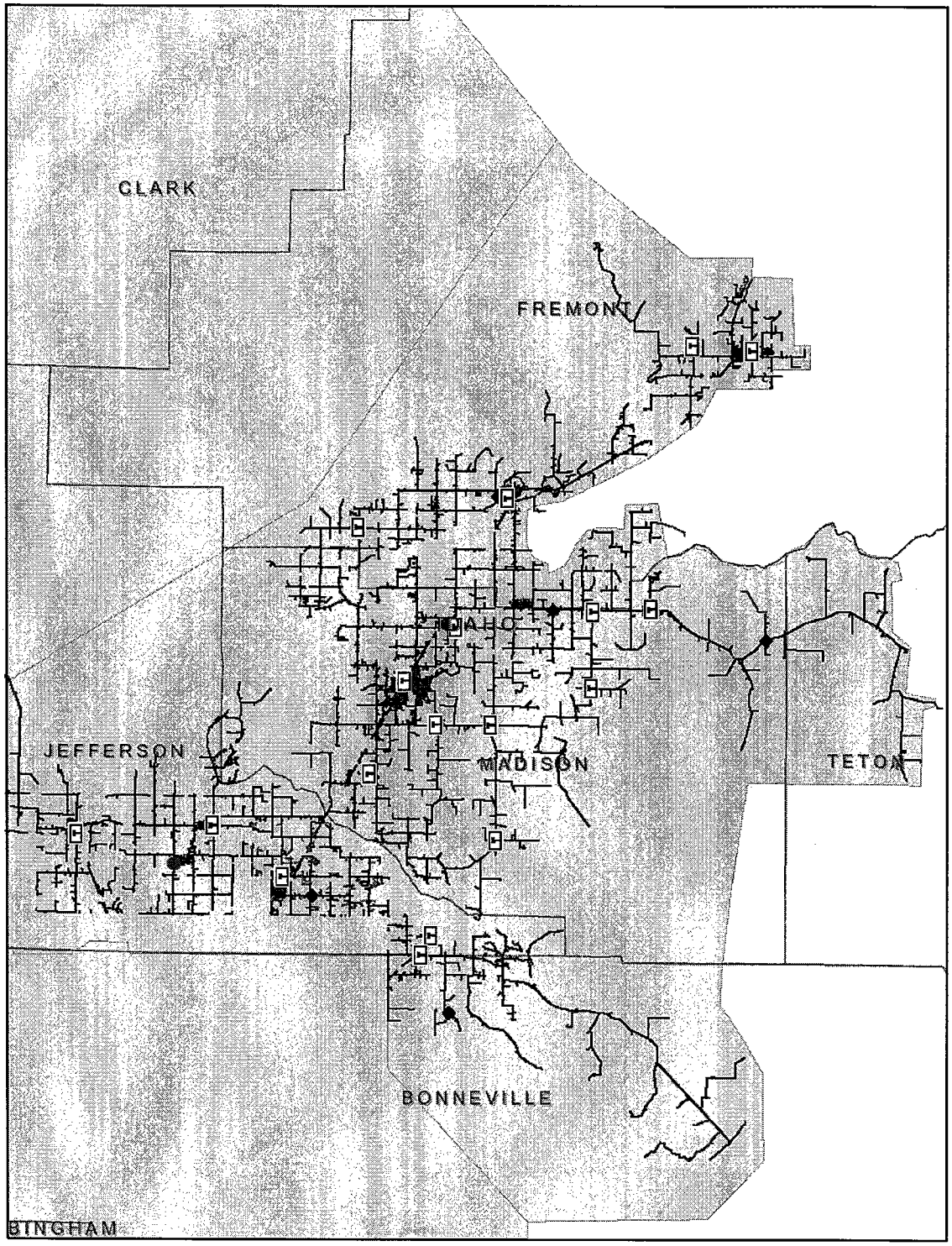
PACIFICORP

Preston



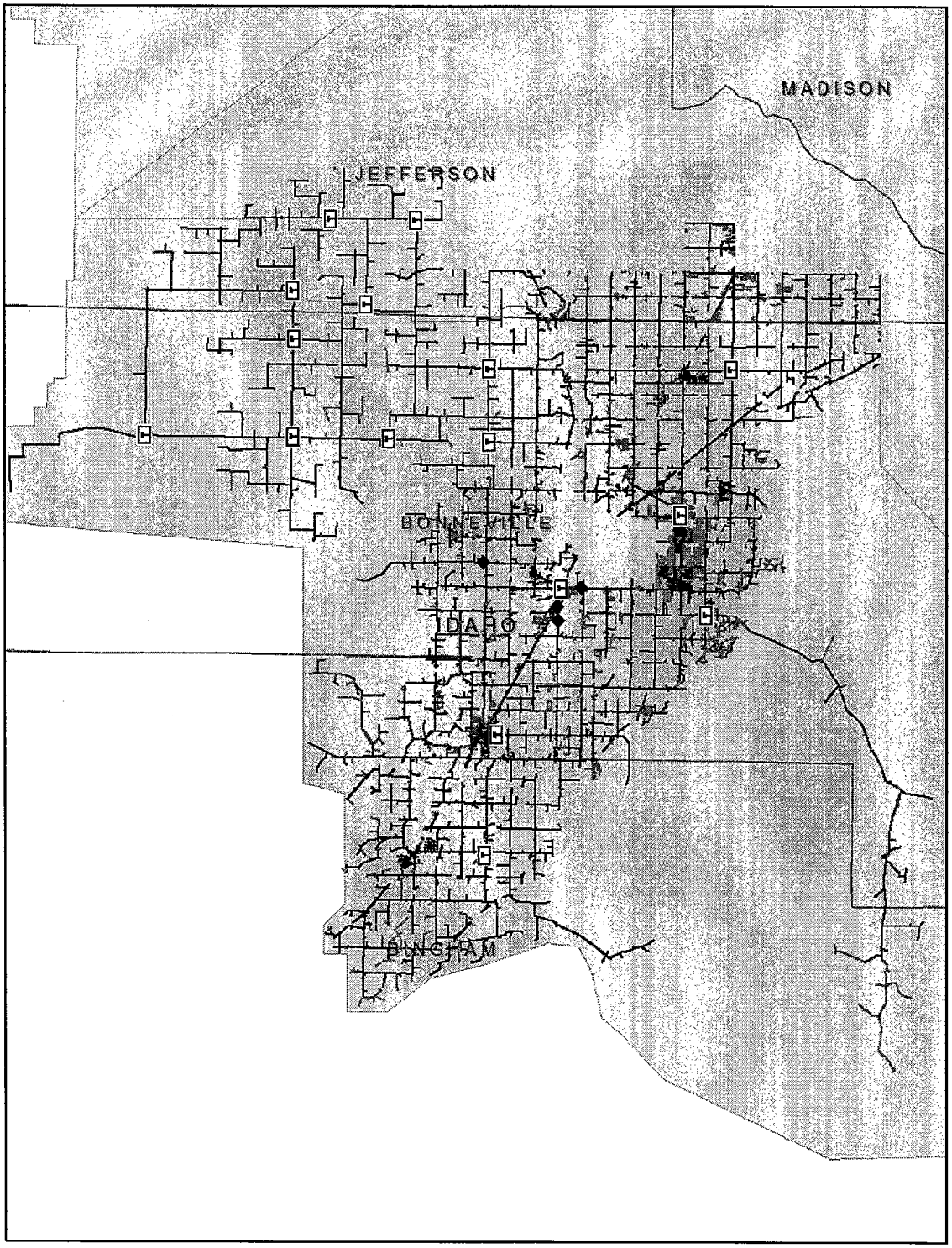
PACIFICORP

Rexburg



PACIFICORP

Shelley



PACIFICORP

APPENDIX F – IEEE P1366-2003 DEFINITIONS

3. Definitions

Definitions are given here to aid the user in understanding the factors that affect index calculation. Many of these definitions were taken directly from *The Authoritative Dictionary of IEEE Standards Terms*, 7th Edition [B8][2]. If there is a conflict between the definitions in this document and the dictionary, the definitions in this document take precedence. Others are given because they have a new interpretation within this document or have not been previously defined.

3.1 connected load: Connected transformer kVA, peak load, or metered demand (to be clearly specified when reporting) on the circuit or portion of circuit that is interrupted. When reporting, the report should state whether it is based on an annual peak or on a reporting period peak.

3.2 customer: A metered electrical service point for which an active bill account is established at a specific location (e.g., premise).

3.3 customer count: The number of customers either served or interrupted, depending on usage.

3.4 distribution system: That portion of an electric system that delivers electric energy from transformation points on the transmission system to the customer.

NOTE—The distribution system is generally considered to be anything from the distribution substation fence to the customer meter. Often the initial overcurrent protection and voltage regulators are within the substation fences and are considered to be part of the distribution system.

3.5 forced outage: The state of a component when it is not available to perform its intended function due to an unplanned event directly associated with that component.

3.6 interrupting device: An interrupting device is a device whose purpose is to interrupt the flow of power, usually in response to a fault. Restoration of service or disconnection of loads can be accomplished by manual, automatic, or motor-operated methods. Examples include transmission circuit breakers, feeder circuit breakers, line reclosers, line fuses, sectionalizers, motor-operated switches or others.

3.7 interruption: The loss of service to one or more customers connected to the distribution portion of the system. It is the result of one or more component outages, depending on system configuration. *See also:* outage.

3.8 interruption duration: The time period from the initiation of an interruption to a customer until service has been restored to that customer. The process of restoration may require restoring service to small sections of the system (see 5.3.2) until service has been restored to all customers. Each of these individual steps should be tracked collecting the start time, end time and number of customers interrupted for each step.

3.9 interruptions caused by events outside of the distribution system: Outages that occur on generation, transmission, substations, or customer facilities that result in the interruption of service to one or more customers. While generally a small portion of the number of interruption events, these interruptions can affect a large number of customers and last for an exceedingly long duration.

3.10 lockout: Refers to the final operation of a recloser or circuit breaker in an attempt to isolate a persistent fault, or to the state where all automatic reclosing has stopped. The current-carrying contacts of the overcurrent protecting device are locked open under these conditions.

3.11 loss of service: A complete loss of voltage on at least one normally energized conductor to one or more customers. This does not include any of the power quality issues such as sags, swells, impulses, or harmonics.

[2]The numbers in brackets correspond to those of the bibliography in Annex D.

3.12 major event: Designates an event that exceeds reasonable design and or operational limits of the electric power system. A Major Event includes at least one Major Event Day (MED).

3.13 major event day: A day in which the daily system SAIDI exceeds a threshold value, T_{MED}. For the purposes of calculating daily system SAIDI, any interruption that spans multiple calendar days is accrued to the day on which the interruption began. Statistically, days having a daily system SAIDI greater than T_{MED} are days on which the energy delivery system experienced stresses beyond that normally expected (such as severe weather). Activities that occur on major event days should be separately analyzed and reported. (See 4.5.)

3.14 momentary interruption: A single operation of an interrupting device that results in a voltage zero. For example, two circuit breaker or recloser operations (each operation being an open followed by a close) that momentarily interrupts service to one or more customers is defined as two momentary interruptions.

3.15 momentary interruption event: An interruption of duration limited to the period required to restore service by an interrupting device.

NOTE—Such switching operations must be completed within a specified time of 5 min or less. This definition includes all reclosing operations that occur within five minutes of the first interruption. For example, if a recloser or circuit breaker operates two, three, or four times and then holds (within 5 min of the first operation), those momentary interruptions shall be considered one momentary interruption event.

3.16 outage (electric power systems): The state of a component when it is not available to perform its intended function due to some event directly associated with that component.

NOTE—

(1) An outage may or may not cause an interruption of service to customers, depending on system configuration.

(2) This definition derives from transmission and distribution applications and does not apply to generation outages.

3.17 planned interruption: A loss of electric power that results when a component is deliberately taken out of service at a selected time, usually for the purposes of construction, preventative maintenance, or repair.

NOTE—

(1) This derives from transmission and distribution applications and does not apply to generation interruptions.

(2) The key test to determine if an interruption should be classified as a planned or unplanned interruption is as follows: if it is possible to defer the interruption, the interruption is a planned interruption, otherwise, the interruption is an unplanned interruption.

3.18 planned outage: The state of a component when it is not available to perform its intended function due to a planned event directly associated with that component.

3.19 reporting period: The time period from which interruption data is to be included in reliability index calculations. The beginning and end dates and times should be clearly indicated. All events that begin within the indicated time period should be included. A consistent reporting period should be used when comparing the performance of different distribution systems (typically one calendar year) or when comparing the performance of a single distribution system over an extended period of time. The reporting period is assumed to be one year unless otherwise stated.

3.20 step restoration: A process of restoring interrupted customers downstream from the interrupting device/component in stages over time.

3.21 sustained interruption: Any interruption not classified as a part of a momentary event. That is, any interruption that lasts more than 5 minutes.

3.22 total number of customers served: The average number of customers served during the reporting period. If a different customer total is used, it must be clearly defined within the report.

3.23 unplanned interruption: An interruption caused by an unplanned outage.

4. Reliability indices

4.1 Basic factors

These basic factors specify the data needed to calculate the indices.

i denotes an interruption event

r_i = Restoration Time for each Interruption Event

CI = Customers Interrupted

CMI = Customer Minutes Interrupted

E = Events

T = Total

IM_i = Number of Momentary Interruptions

IM_E = Number of Momentary Interruption Events

N_i = Number of Interrupted Customers for each Sustained Interruption event during the Reporting Period

N_{mi} = Number of Interrupted Customers for each Momentary Interruption event during the Reporting Period

N_T = Total Number of Customers Served for the Areas

L_i = Connected kVA Load Interrupted for each Interruption Event

L_T = Total connected kVA Load Served

CN = Total Number of Customers who have Experienced a Sustained Interruption during the Reporting Period

$CNT_{(k>a)}$ = Total Number of Customers who have Experienced more than a Sustained Interruptions and Momentary Interruption Events during the Reporting Period.

k = Number of Interruptions Experienced by an Individual Customer in the Reporting Period

T_{MED} = Major event day identification threshold value.

4.2 Sustained interruption indices

4.2.1 System average interruption frequency index (SAIFI)

The system average interruption frequency index indicates how often the average customer experiences a sustained interruption over a predefined period of time. Mathematically, this is given in Equation (1).

4.3 Load based indices

4.3.1 Average system interruption frequency index (ASIFI)

The calculation of this index is based on load rather than customers affected. ASIFI is sometimes used to measure distribution performance in areas that serve relatively few customers having relatively large concentrations of load, predominantly industrial/commercial customers. Theoretically, in a system with homogeneous load distribution, ASIFI would be the same as SAIFI. Mathematically, this is given in Equation (15).

$$\text{ASIFI} = \frac{\sum \text{Total Connected kVA of Load Interrupted}}{\text{Total Connected kVA Served}} \tag{15}$$

To calculate the index, use Equation (16).

$$\text{ASIFI} = \frac{\sum L_i}{L_T} \tag{16}$$

4.3.2 Average system interruption duration index (ASIDI)

The calculation of this index is based on load rather than customers affected. Its use, limitations, and philosophy are stated in the ASIFI definition in 4.3.1. Mathematically, this is given in Equation (17).

$$\text{ASIDI} = \frac{\sum \text{Connected kVA Duration of Load Interrupted}}{\text{Total Connected kVA Served}} \tag{17}$$

To calculate the index, use Equation (18).

$$\text{ASIDI} = \frac{\sum r_i L_i}{L_T} \tag{18}$$

4.4 Other indices (momentary)

4.4.1 Momentary average interruption frequency index (MAIFI)

This index indicates the average frequency of momentary interruptions. Mathematically, this is given in Equation (19).

$$\text{MAIFI} = \frac{\sum \text{Total Number of Customer Momentary Interruptions}}{\text{Total Number of Customers Served}} \tag{19}$$

To calculate the index, use Equation (20).

$$\text{MAIFI} = \frac{\sum IM_i N_{mi}}{N_T} \tag{20}$$

4.4.2 Momentary average interruption event frequency index ($MAIFI_E$)

This index indicates the average frequency of momentary interruption events. This index does not include the events immediately preceding a lockout. Mathematically, this is given in Equation (21).

$$MAIFI_E = \frac{\sum \text{Total Number of Customer Momentary Interruption Events}}{\text{Total Number of Customers Served}} \quad (21)$$

To calculate the index, use Equation (22).

$$MAIFI_E = \frac{\sum IM_E \cdot N_{mi}}{N_T} \quad (22)$$

4.4.3 Customers experiencing multiple sustained interruption and momentary interruption events ($CEMSMI_n$)

This index is the ratio of individual customers experiencing more than n of both sustained interruptions and momentary interruption events to the total customers served. Its purpose is to help identify customer issues that cannot be observed by using averages. Mathematically, this is given in Equation (23).

$$CEMSMI_n = \frac{\text{Total Number of Customers Experiencing More Than n Interruptions}}{\text{Total Number of Customers Served}} \quad (23)$$

To calculate the index, use Equation (24).

$$CEMSMI_n = \frac{CNT_{(k>n)}}{N_T} \quad (24)$$

4.5 Major event day classification

The following process ("Beta Method") is used to identify MEDs. Its purpose is to allow major events to be studied separately from daily operation, and in the process, to better reveal trends in daily operation that would be hidden by the large statistical effect of major events. This approach supersedes previous major event definitions (see Annex A for sample definitions). For more technical detail on derivation of the methodology refer to Annex B.

A major event day is a day in which the daily system SAIDI exceeds a threshold value, T_{MED}. The SAIDI index is used as the basis of this definition since it leads to consistent results regardless of utility size and because SAIDI is a good indicator of operational and design stress. Even though SAIDI is used to determine the major event days, all indices should be calculated based on removal of the identified days.

In calculating daily system SAIDI, any interruption that spans multiple days is accrued to the day on which the interruption begins.

The major event day identification threshold value, T_{MED}, is calculated at the end of each reporting period (typically one year) for use during the next reporting period as follows:

$$CTAIDI = \frac{(8.17 \times 200) + (71.3 \times 600) + (30.3 \times 25) + (267.2 \times 80) + (120 \times 300) + (10 \times 1500) + (40 \times 300)}{1800} = 95.68 \text{ min} \quad (32)$$

$$CAIDI = \frac{200 + 600 + 25 + 80 + 300 + 1500 + 300}{1800} = 1.79 \quad (33)$$

$$ASAI = \frac{1800 \times 2000 - (8.17 \times 200 + 600 \times 71.3 + 30.3 \times 25 + 267.2 \times 80 + 120 \times 300 + 10 \times 1500 + 40 \times 300)/60}{1800 \times 2000} = 0.999635 \quad (34)$$

$$ASIDI = \frac{800 + 1500 + 75 + 500 + 3300 + 3000 + 300}{4000} = 2.12 \quad (35)$$

$$ASIDI = \frac{(800 \times 8.17) + (1500 \times 71.3) + (75 \times 30.3) + (500 \times 267.2) + (3300 \times 120) + 3000(10) + 200 \times 40}{4000} = 444.89 \quad (36)$$

$CTAIDI_p$, $CAIFI_i$, $CEMI_n$, and $CEMSMI_n$ require detailed interruption information for each customer. The database should be searched for all customers who have experienced more than n interruptions that last longer than five minutes. Assume n is chosen to be 5. In Table 5, customer Willis, J. experienced seven interruptions in one year and it is plausible that other customers also experienced more than five interruptions, both momentary and sustained.

For this example, assume arbitrary values of 350 for $CN(k > n)$, and 750 for $CNT(k > n)$. The number of interrupting device operations is given in Table 6 and is used to calculate MAIFI and $MAIFI_E$. Assume the number of customers downstream of the recloser equals 750. These numbers would be known in a real system.

$$CEMI_5 = \frac{350}{2000} = 0.175 \quad (37)$$

$$MAIFI = \frac{5 \times 2000 + 12 \times 750}{2000} = 12.5 \quad (38)$$

$$MAIFI_E = \frac{5 \times 2000 + 6 \times 750}{2000} = 7.25 \quad (39)$$

$$CEMSMI_5 = \frac{750}{2000} = 0.375 \quad (40)$$

Using the above sample system should help define the methodology and approach to obtaining data from the information systems and using it to calculate the indices.

5.3 Examples

The following subclause illustrates two concepts: momentary interruptions and step restoration through the use of examples.

5.3.1 Momentary interruption example

To better illustrate the concepts of momentary interruptions and sustained interruptions and the associated indices, consider Figure 1 and Equation 41, Equation 42, and Equation 43. Figure 1 illustrates a circuit composed of a circuit breaker (B), a recloser (R), and a sectionalizer (S).

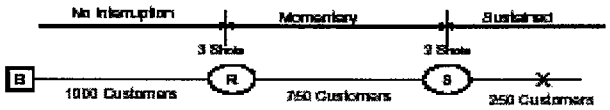


Figure 1—Sample system 2

For this scenario, 750 customers would experience a momentary interruption and 250 customers would experience a sustained interruption. Calculations for SAIFI, MAIFI, and MAIFIE on a feeder basis are shown in Equations 41–43 below. Notice that the numerator of MAIFI is multiplied by 2 because the recloser took two shots, however, MAIFIE is multiplied by 1 because it only counts the fact that a series of momentary events occurred.

$$SAIFI = \frac{250}{1000} = 0.125 \tag{41}$$

$$MAIFI = \frac{2 \times 750}{1000} = 0.75 \tag{42}$$

$$MAIFI_E = \frac{1 \times 750}{1000} = 0.375 \tag{43}$$

5.3.2 Step restoration examples

The following case illustrates the step restoration process. A feeder serving 1000 customers experiences a sustained interruption. Multiple restoration steps are required to restore service to all customers. Table 7 shows the times of each step, a description and associated customers interruptions and minutes they were affected in a time line format.

Table 7—Example 1 for a feeder serving 1000 customers with sustained interruption

Relative Time	Description	Customer Interruptions	Duration (min)	CMI
00:00	1000 customers interrupted.			
00:45	500 customers restored, 500 still out of service.	500	45	22 500
01:00	Additional 300 customers restored, 200 still out of service.	300	60	18 000
01:10	Feeder trips again, 800 previously restored customers are interrupted again. (200 remained out and were not restored at this time.)			
03:30	800 customers restored again.	800	20	16 000
05:00	Final 200 customers restored. Event ends.	200	120	24 000
Totals		1800	N/A	80 500
Example SAIFI = 1800/1000 = 1.8 interruptions Example CAIDI = 80 500/1800 = 44.7 min Example SAIDI = 80 500/1000 = 80.5 min				