OFFICIAL EXHIBITS

REBUTTAL TESTIMONY

OF

JEFFREY W. CUMMINGS

SENIOR VICE PRESIDENT UMS GROUP, INC.

ON BEHALF OF

INDIANAPOLIS POWER AND LIGHT COMPANY

IURC CAUSE NOS. 44576 / 44602

INCLUDING IPL WITNESS JWC ATTACHMENTS 1-R THROUGH 5-R

IURC
PETITIONER'S
EXHIBIT NO. 28-R
9-30-15
DATE REPORTER

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INTRODUCTION

Q1. Please state your name and business address.

A1. My name is Jeffrey W. Cummings. My business address is 1543 Abbotsford Drive, Naperville, IL 60563.

Q2. By whom are you employed and in what capacity?

A2. I am employed by UMS Group Inc. ("UMS") of Morris Corporate Center, 300 Interpace Parkway, Suite C380, Parsippany, New Jersey, 07054. I am a Senior Vice President of UMS, a consultancy that specializes in asset and performance management and business transformation for electric, gas and water utilities.

Q3. Please generally describe the qualifications of UMS.

A3. UMS Group is an International Management Consulting firm founded in 1989 to serve the global utility industry. We specialize in enterprise-level value creation, performance management solutions and utility asset management; applying insights gleaned from a myriad comparative performance assessments across all major functions of our Clients (numbering in excess of 300 electric, gas and water utilities across 6 continents) and a number of Global Learning and Benchmarking Consortia. In so doing, we have earned our position as an industry leader in Asset Management, as evidenced by (1) our designation as an endorsed assessor by the Institute of Asset Management, the professional body of those involved in the acquisition, operation and care of physical assets – particularly critical infrastructure, and (2) our delivery of projects ranging from initial assessments to full-scale Asset Management transformations. Using PAS 55, the precursor to the recently implemented ISO 55000 standard, against which organizations can be measured for compliance with basic asset management policies and practices, we have assisted our Clients in ensuring they have the programmatic elements in place to manage their assets, and most importantly, manage all known and implied risks, thus creating superior lifecycle value from their owned and/or operating asset base. And, in providing this assistance, we have effectively crossed the threshold from theoretical knowledge to practical application.

Q4. What is your professional and educational background?

A4. A summary of my professional and educational background is attached to my testimony as IPL Witness JWC Attachment 1-R (Appendix A).

Q5. Are you sponsoring any attachments in support of your testimony?

A5. Yes. In addition to the above referenced IPL Witness JWC Attachment 1-R (Appendix A), my testimony includes IPL Witness JWC Attachment 2-R (Appendix B). Together with Company Witness Feldman, I co-sponsor IPL Witness JWC Attachment 3-R (Asset Lifecycle Plan for the CBD Underground Network),[1] IPL Witness JWC Attachment 4-R (Asset Management Strategy), and IPL Witness JWC Attachment 5-R (Monthly Asset Management KPI Report) which are more specifically identified below.

Q6. Were these attachment prepared or assembled by you or under your direction or supervision?

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[1] A Public and confidential version of this attachment has been provided.

A6. IPL Witness JWC Attachment 1-R (Appendix A) and IPL Witness JWC Attachment 2-R (Appendix B) were prepared by me or assembled under my direction or supervision. IPL Witness JWC Attachments 3-R, 4-R and 5-R were prepared by IPL, but are entered under my testimony to substantiate their existence and further illustrate points made in this testimony.

Q7. Have you previously testified in proceedings before the Indiana Utility Regulatory Commission ("IURC")?

A7. No, I have never previously testified in IURC proceedings. However, I have testified before other regulatory commissions, including the New Jersey Board of Public Electric Utilities, the Kansas Corporation Commission, and the Alberta Utilities Commission; and have performed audits and assessments on behalf of the staffs of the Pennsylvania and Ohio Regulatory Commissions.

Q8. What is the purpose of your rebuttal testimony?

A8. I was engaged to provide a third-party review of certain recommendations emanating from the recent Investigation of IPL's Network – Cause Number 44602 – Report of Independent Consultant dated June 22, 2015 by O'Neill Management Consulting, LLC ("ONC") (hereinafter referred to as "the O'Neill investigation" or "the O'Neill Report") and related testimony from the IURC Staff (specifically Dan O'Neill and Morgan Robert Pauley) and Office of Utility Consumer Counselor ("OUCC") (specifically Ray L. Snyder, Barbara A. Smith, Leon A. Golden, Edward T. Rutter, and Anthony A. Alvarez). More specifically, my rebuttal testimony disputes the need for an audit of IPL's Asset Management process (a recommendation included in the IURC and OUCC testimonies).

I identify a more reasonable means to address the desire for transparency set forth in the O'Neill Report. My testimony also responds to the recommendation offered by Staff Witnesses O'Neill and Pauley regarding a regulatory reporting process and performance metrics. Finally, I respond to the OUCC testimony related to these recommendations.

Q9. Should we imply from your stated purpose that you take exception to the O'Neill Report itself?

A9. While I explain below my disagreement with certain recommendations in the O'Neill Report, the report is a fair representation of the current design of IPL's CBD Underground Network and of the events leading up to the investigation.

Q10. Could you be more specific regarding your disagreement with certain recommendations?

A10. As stated above, I rebut the need for an independent audit of IPL's Asset Management process. I explain later in my testimony that the basis for the level of transparency called for in the O'Neill Report is already established. Given this, an "audit", which in my experience means an assessment to establish the baseline, is not necessary. I discuss below how a reporting and periodic self-assessment process which includes independent verification might better achieve the transparency Mr. O'Neill recommends. Notably, the term "asset management audit" is not defined in the Report. It may be that the assessment process that I recommend below is analogous to what Mr. O'Neill had in mind.

I do not read the Report as claiming that IPL is lagging or deficient with regard to asset management, nor to indicate that some kind of punitive action is warranted. Yet, the tone of the OUCC testimony appears to indicate otherwise. I explain below why that perception of IPL is not accurate and otherwise respond to the OUCC testimony.

Further, though I am in agreement with the desire stated in the Report to design a set of performance metrics to avoid the opening of a new investigation with every incident that occurs in the Downtown Network, I do take exception to the scope and process envisioned by the Staff and OUCC testimony. This too, is explained further in the testimony.

ASSET MANAGEMENT

Q11. Mr. O'Neill's Report discusses the term "Asset Management". Please define that term?

A11. Asset Management defines an approach, methodology and practices that optimize the inherent trade-offs between risk, operational effectiveness and economics in operating, maintaining and replacing critical assets. "Asset Management," in its current form, is relatively new and should not be confused with the management of assets in which the electric utility industry has engaged for over a 100 years. With clear distinction between those that define the work related to assets (Asset Managers) and those that perform the work on the assets (Service Providers), analyses of asset condition and performance data and information, and an assessment of each asset's relative importance (criticality) to the system, Asset Management allows a company to drive proactive decisions in areas such as the repair versus replacement of assets, the maintenance regimen to be assigned to a specific asset (*e.g.;* interval, condition or risk-based), and how best to allocate capital across the portfolio of a utility's assets

Q12. What makes a discussion of Asset Management as a seemingly new initiative relevant?

A12. Though electric utilities have been managing assets for over 100 years, the advent of new technologies and IT platforms to collect, display, analyze and make decisions on asset-related data has facilitated Asset Management and the associated standards I discuss below – namely PAS 55 and ISO 55000. We are now able to apply more sophisticated approaches to manage the lifecycle of critical assets from procurement through retirement, and determine the most effective use of capital as it relates to the trade-offs between asset repair and replacement. Further, the industry is evolving to more of a risk-based decision making model, necessitating a separation in roles, between those that make decisions on what actions to take for specific assets and those that are charged with executing the maintenance and operation of those same assets. Formal standards for such an evolution have been in place for only 10 years, and only a few electric utilities (IPL being one) have truly committed to a plan to meet these standards.

Q13. Please explain what the terms PAS 55 and ISO 55000 mean.

A13. These are the standards referred to in the previous discussion. PAS 55, the Publicly Available Specification created by the Institute of Asset Management, provides guidance and a requirements checklist of good practices (refer to Figure B-1 in <u>IPL Witness JWC Attachment 2-R</u> (Appendix B)). Its intent has been to drive decisions that assure the proper operation and care of physical assets – particularly critical infrastructure. Originating in the UK, PAS 55 has been successfully deployed in electric utilities around the world, providing a "common language" and framework to assist these companies in achieving system performance objectives at optimal cost on a sustainable basis. In 2014

PAS 55 was supplanted by the International Organization for Standardization ("ISO") 55000 standard, applying a similar requirements checklist (refer to Figure B-2 in Appendix B) to provide all stakeholders with a high level of assurance that risks and costs associated with the management of assets are fully and properly optimized.

Q14. In the 2011 Report (p. 44), Mr. O'Neill wrote:

> **In our experience one of the pitfalls of committing a company to asset management can be an excessive concentration on the philosophy of asset management, including such heavily philosophical approaches as the British PAS 55 standards, or an intensive effort at building extensive databases. We have opined elsewhere that a more effective approach to adopting asset management can be to identify the key decisions to be made, using existing data resources, and to then build a plan to acquire only that data that is critical to making good decisions.**

Do you agree?

A14. I do not agree with the relatively narrow perspective offered by Mr. O'Neill. Though data and information based decision-making on critical assets is a cornerstone to effective Asset Management, there are other equally important aspects to consider, such as:

- Alignment of asset – related decisions with corporate strategy regarding operational effectiveness, risk tolerance thresholds, and finance,
- Work prioritization and assignment based on asset requirements as opposed to the composition and competencies of the current work force, and
- Enabling all critical Asset Management functions and processes with the skills and competencies required to perform these functions.

The framework offered by PAS 55 (and now by ISO 55000) includes the tactics presented by Mr. O'Neill, but expands the approach to include a more holistic and balanced view (as opposed to Mr. O'Neill's term, "philosophical approach"). Successful implementations at a number of electric utilities worldwide (*e.g.;* PowerStream, Hydro One, Toronto Hydro, National Grid – UK, CenterPoint, Puget Sound Energy, and Public Service Electric and Gas – New Jersey), where PAS 55 was used as the framework, attest to this fact.

Mr. O'Neill may be referring to some failed implementations where PAS 55 or ISO 55000 was the adopted framework for assessing current state, identifying gaps, and establishing an Asset Management Transformation Plan. If that be the case, one must be careful to discern between a poor strategy and ineffective operating model versus poor implementation of an otherwise sound idea. My view is that PAS 55 and ISO 50000 are not ineffective operating models.

Q15. What is the relevance of a discussion on PAS 55 and ISO 55000 to this testimony?

A15. IPL has adopted the AES Global Asset Management Standards to shape its Asset Management Program (refer to the third column of Figures B-1 and Figures B-2 in Appendix B for a listing and definition); and has conducted self-assessments in 2013 and 2015 to identify programmatic gaps against these Standards (the 2013 self-assessment), and ascertained progress since then in closing said gaps (the 2015 self-assessment).

These self-assessments provide a basis for the transparency that underlies Mr. O'Neill's recommendation for an audit. But, a key step in accepting this point involves validating that the AES's Global Asset Management Standards are consistent with industry accepted practices, i.e. those emanating from the standard (*i.e.*; ISO 55000 and its predecessor, PAS 55) and now used worldwide by acknowledged best performers in Asset Management.

Q16. Are the AES Global Asset Management Standards which IPL is using aligned with these industry accepted standard you describe?

A16. Yes. To the extent that IPL meets the standards specified in AES' program, one can be assured that IPL's Asset Management process is aligned with the industry accepted PAS 55 and ISO 55000 Standards.

Q17. What is the significance of this alignment?

A17. The O'Neill Report explains (pp. 5, 25-26, 34, 51, 53-55) that the desire for greater transparency is intended to provide a higher level of confidence in IPL's execution of Asset Management, and this desire is the primary driver for the recommended asset management audit. As the self-assessments performed in 2013 and 2015 were based on sound criteria, it is my view that they form a relevant and effective baseline against which to report progress. Furthermore, through periodic reporting against this baseline, the IURC will be provided the transparency that underlies Mr. O'Neill's recommendation for an asset management audit.

Q18. Did UMS validate these latest (2015) self-assessments?

A18. Yes we did. UMS, an endorsed assessor by the Institute of Asset Management, reviewed IPL's Asset Management process across six domains:

1) Asset Strategy (*e.g.;* Asset Management System, Risk Management, Asset Lifecycle Management and Root Cause),
2) Processes (*e.g.;* Capital and Operations Expenditures Management and Asset Performance Monitoring),

3) Delivery (*e.g.;* Operations and Maintenance Management and Training, Awareness and Communications),

4) Support Services (*e.g.;* Asset Supply Chain Management and Business Information Management), and

5) Performance Management (Management of Change, Recovery Plan, Continuous Improvement and Business Continuity Management)

6) Audit and Control (Peer Review)

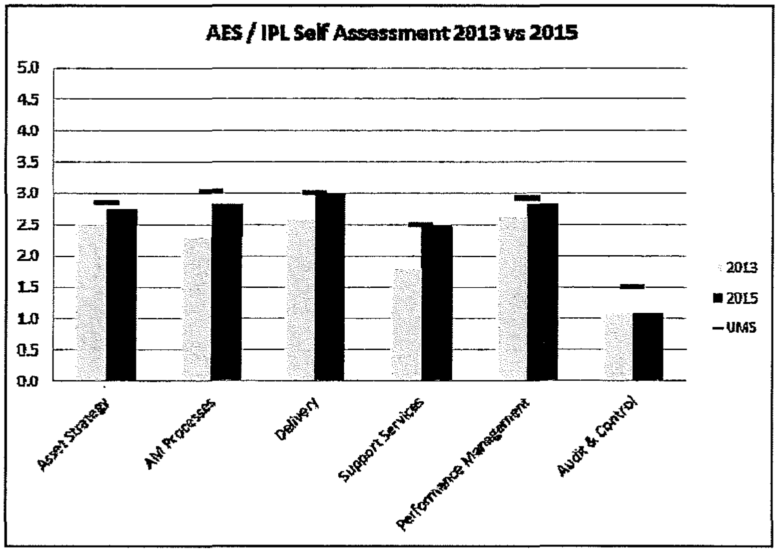
Based on interviews and a review of applicable reports and documentation, we applied a maturity scale, ranging from "0.0" ("Innocence": The organization has not recognized the need for the requirement or there is no evidence of commitment to put in place) to "5.0" ("Excellence": The organization can demonstrate that it employs the leading practices, and it achieves maximum value within this domain) to each of the six domains listed above.

It should be noted that an "across the board" rating of "3.0" ("Competence": The organization can demonstrate that it systematically and consistently achieves relevant requirements set out in the standard) would represent top quartile performance among the U.S. electric utilities.

This rating was done for each of the three assessments (*i.e.;* that recently performed by UMS and those performed by IPL in 2013 and 2015). Based on the comparisons of the two 2015 assessments (UMS and IPL's self-assessment) it is clear that IPL's self-assessment is well grounded in reality; and by inference the same can be assumed about the 2013 self-assessment. In fact, IPL's scoring was, in some of the domains, less favorable than the UMS scoring, indicating that IPL may have applied a higher standard of excellence than that in effect across the industry.

Figure 1 below illustrates the results of this validation effort, where the UMS assessment (marked by the orange bar) either matches or exceeds the "value" assigned by IPL.

Figure 1: Comparisons of UMS and IPL Self-Assessments



Q19. What conclusions do you draw from the UMS validation and, in particular the results portrayed in Figure 1?

A19. First, and foremost, there has been improvement across all but one of the domains that define an effective asset management program. By our assessment IPL is at or nearing the "competence level" (rating of "3.0") in four of the six domains. This reflects a significant amount of progress over a 2-year time span. All of their Asset Management processes are functional and continuing to improve. And, this rate of improvement compares favorably to other asset management transformation efforts which we have seen in the U.S. electric utility industry. With respect to the one domain where IPL is scoring well-below the "competence level," (*i.e.;* Audit and Control), this rating is indicative of IPL's pragmatic approach to asset management. IPL focused first on the more substantive and higher priority activities that will provide immediate return for their efforts (*e.g.;* Asset Lifecycle Plans, Health Indexing and Improved IT Enablement), and is now formulating and issuing documentation that address governance and overall asset management process integration, two of the main areas of focus for Audit and Control. This prioritization framework is consistent with most successful transformations where the capture of immediate benefits is essential for creating momentum in the change management process.

Second, as previously stated, the IPL self-assessment reflects a higher standard than that reflected across the industry. This characteristic of holding oneself to a higher standard than the norm is a leading indicator of any organization committed to continuous improvement and is, in particular, consistent with IPL's drive to establish itself as an industry leader in asset management.

Third, though not reflected in Figure 1, but germane to the discussion, is that in comparison to other U.S. electric utilities, IPL is on a par, if not slightly better across each of these domains. And fourth, the assessment methodology used by IPL, and by UMS as a verifier of the efficacy of IPL's self-assessment, lends itself well to providing the transparency desired in the O'Neill Report.

Before moving onto the next question, it should be pointed out that achieving a maturity level of 3.0 ("Competence") across all of the domains is the industry standard for certification. Decisions to strive for "Excellence" in any of these domains (and for that matter, any of the 15 standards that comprise these domains) should only be made after a business case with attendant cost-benefit analyses is presented and deemed prudent.

Q20. In the 2015 Report, Mr. O'Neill states that:

> **"For both the network transformers and the network protectors, we would expect to see, as part of the asset management process, a document that lays out the replacement strategy based on condition, cost, and risk." (pp. 38-39); and**

> **"We look forward to seeing the asset management strategy that determines the rate of secondary cable replacement based on failure, cost, and risk." (p. 40)**

And OUCC Witness Golden (p. 3), in his testimony states that:

> **"IPL's AMP evaluates transformers, breakers, network manholes, network vaults, network transformers, and network protectors. It is notable that underground cables in the downtown network are not evaluated in the AMP."**

How do these statements reconcile with the assertion that IPL has a viable and continually improving asset management process?

A20. IPL has recently completed its Asset Lifecycle Plan for the CBD Underground Network. The Asset Lifecycle Plan is consistent with the recommendations from Mr. O'Neill. This document (included herewith at IPL Witness JWC Attachment 3-R) provides a comprehensive view of IPL's approach for improving the reliability and safety of IPL's CBD Underground Network.

Mr. O'Neill's expectations regarding network transformers, network protectors and replacement of secondary cable, and OUCC Witness Golden's concerns regarding underground cables in the downtown network are addressed in this Plan. The document demonstrates the viability of IPL's asset management process and their commitment to continuous improvement. And, with respect to the desire for transparency, this document defines the plan for addressing the asset-related challenges in a manner that can be tracked, reported on and verified.

Q21. In the 2015 Report, Mr. O'Neill states that:

> **"We requested (DR 6.4) a copy of the document for the downtown network, which the response in the above table indicates was completed in February, 2015. We received a draft dated March 23, 2015 which was obviously incomplete, although it had 66 pages of content (as a combined DP&L and IPL document, with separate discussion of each." (p.39)**

Does this apparent discrepancy infer any doubt regarding the validity of this Asset Lifecycle Plan for CBD Underground Network?

A21. No. The Asset Lifecycle Plan for the CBD Underground Network will always be a "work in progress," and was even more so during its initial development. The entry for the Downtown Network in Table 8 of the O'Neill Report: Status of Life Cycle Asset Plans correctly stated "Draft Completed – 2/26/2015," as that was the first version of the report to be issued for comment. However, the draft report provided in response to DR 6.4 was an updated version, reflecting a trend of continual revisions and refinements that occurred through to the issuance of the completed document, which incidentally was ultimately issued as an IPL-specific plan (attached hereto as <u>IPL Witness JWC Attachment 3-R</u>) .

Q22. In OUCC Witness Smith's testimony, she states that:

> **"Although IPL claims to have adopted the AES Asset Management Standard, IPL's strategy is not documented, but in IPL's words, is just a 'philosophy.' Without a transparent, written asset management strategy, it is virtually impossible for the Commission and other interested stakeholders to evaluate IPL's asset management system's effectiveness or lack thereof." (p.5)**

And OUCC Witness Golden asserts in his testimony:

> **"Finally, in contradiction with AES' AMS, IPL does not currently have a written asset management strategy. In the AES Asset Management Global Standard adopted by IPL in 2013, STD0001**

states 'the business shall establish, document, implement and maintain a long-term AM Strategy.' However, IPL stated that its 'Asset Management Strategy' is a philosophy and not a written document."

Do these statements alter your view regarding the state of IPL's Asset Management Program or the need for an audit?

A22. No. First, a review of the documents upon which the OUCC relies, reveals that IPL's language is being taken out of context. The word "philosophy" was used to describe the Company's response to an IURC question wherein the Company explained that its strategy (or philosophy) is to inspect the downtown vaults on a two year cycle and the manholes on a three year cycle. See OUCC Witness Golden Attachment LAG-8 and the Company's Response to Question 5 in the IURC Docket Entry in Cause No. 44602 dated March 24, 2015. The OUCC does not challenge the reasonableness of this inspection frequency. It is unreasonable to characterize IPL's achievement in formalizing its Asset Management strategy as merely "philosophical".

Further, the O'Neill Report at page 33 states that "none of the recent incidents can be traced to a failure of asset management." This refutes the idea presented by Ms. Smith that it is "virtually impossible" to evaluate the effectiveness of IPL's Asset Management system.

The written Asset Management Strategy is included with my testimony as <u>IPL Witness JWC Attachment 4-R</u>. More importantly, even in the absence of a written document, the criteria specified in the AES' Global Asset Management Standards (demonstrated to be aligned with the ISO 55000 and its predecessor PAS 55 Industry Standards) which IPL has adopted provide the evaluation framework and assessment methodology necessary to report progress towards and transparency into the effectiveness of IPL's development of its Asset Management Program.

Q23. In the 2015 Report, Mr. O'Neill states that:

> **"With the progress since 2011, much more of the process is now operational, although IPL admits that there are still some aspects that are conceptually envisioned but not yet fully developed, i.e.; what we call aspirational." (p.5)**

And OUCC Witness Golden refers to this point in his testimony:

> **"The OUCC agrees with O'Neill's observation that 'some aspects of IPL's AMP are conceptually envisioned but not yet fully developed, i.e.; what we call aspirational.' An audit of…" (p.6)**

Please respond.

A23. As I understand Mr. O'Neill's and OUCC Witness Golden's intent in using the term "aspirational," it would appear to differentiate between (1) a well-developed set of initiatives and actions to accomplish a goal or objective, or completion thereof, and (2) a goal or objective that requires more vetting or research before such a plan can be defined, scheduled and monitored to completion. This mix of definitive actions and conceptual ideas typifies any improvement program or process implementation effort, particularly one as transformational and complex as Asset Management. The fact that Mr. O'Neill points to much progress in operationalizing IPL's Asset Management process with correspondingly less reliance on aspiration over a 4-year period, illustrates a natural course of events of any implementation effort. In fact, it is an indicator that real progress is being made, rendering an audit unnecessary. An audit to address the balance between "operational" and "aspirational" would only serve a purpose if the progress Mr. O'Neill noted (and UMS has confirmed) had not occurred.

Adding to the point that IPL's Asset Management process is substantive (*i.e.;* far from merely "aspirational") is the existence of a comprehensive monthly asset management KPI report included with my testimony as <u>IPL Witness JWC Attachment 5-R</u>. This report, designed to track and provide evidence of the effectiveness of IPL's asset management process, is relatively unique. Even among the leading asset management organizations around the world, few routinely document the effectiveness of its asset management process in accomplishing the various dimensions of its mission. And even fewer commit to do so on a routine monthly basis, demonstrating IPL's commitment to complete transparency and accountability in the effectiveness of its asset management function.

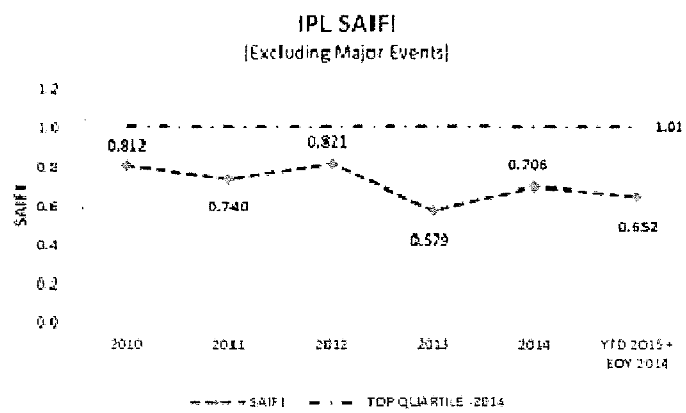
Q24. Does the need for further development of an "Asset Management" program mean that IPL has not been managing its facilities and service?

A24. Not at all. At its very core, Asset Management is about creating superior lifecycle value from owning and operating an asset base for all stakeholders served by the assets, and supporting a data / information – driven decision making process that is based upon the risks associated with the normal operation of these assets. The fact that IPL is on a journey to improve its systems, processes and competencies can only be construed to mean they strive to be even more effective. In fact, there is ample evidence that confirms that, from an overall system perspective, IPL has managed its assets very effectively.

Q25. What evidence can you provide?

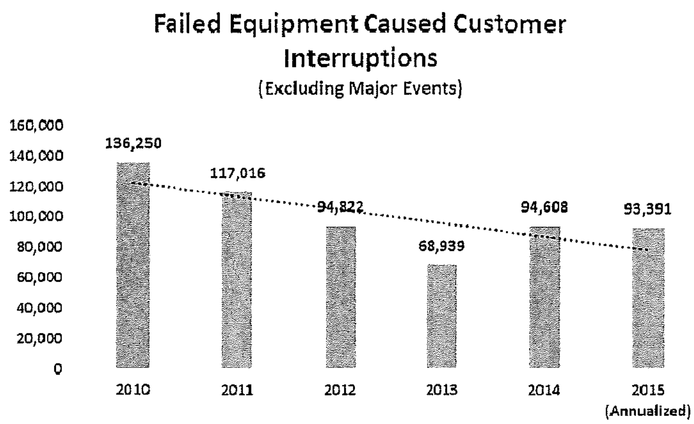
A25. With respect to overall system reliability, IPL has consistently been positioned in the top quartile of all U.S. investor-owned electric utilities. Figure 2 below presents a comparison of SAIFI ("System Average Interruption Frequency Index"), calculated as the ratio of number of sustained customer interruptions per reporting period to the total number of customers served per reporting period. SAIFI is selected for this comparison because effective Asset Management is more about reducing the frequency and size of unplanned outages, and plays only a minor role in addressing the duration of these unplanned events; and in addition to IPL's strong comparative position each year, overall performance in terms of unplanned customer interruptions has improved by 20 percent.

Figure 2: IPL SAIFI Performance Trends and Comparisons (2010 – 2015)



Delving further into IPL's Outage Performance Data, the trend related to Failed Equipment Caused Outages, most directly linked to an electric utility's ability to properly operate, maintain, and replace assets, is also favorable (Figure 3 below). Typically, I am seeing opposite trends in the industry with 2 to 3 percent annual increases in customer interruptions attributed to failed equipment. This industry trend is widely assumed to be driven by aging assets. In the case of IPL, I note the opposite trend, where the number of customer interruptions attributed to failed equipment has decreased by 30 percent since 2010. This trend, one that is counter to industry norms, speaks to IPL's knowledge of the system, and its ability to effect timely interventions, two hallmarks of effective asset management. I might also point out that even the starting point of 136,250 customer interruptions in 2010 attributed to failed equipment compares favorably (*i.e.,* lower on a per customer basis) to those electric utilities we have benchmarked over the past 5 years.

Figure 3: Failed Equipment Caused Customer Interruptions (2010 – 2015)



Q26. Returning to the issue at hand, the CBD Underground Network, statements have been made regarding funding levels that would cast doubt on IPL's Asset Management process. OUCC Witness Smith summarized her concerns as follows:

> **"There is no evidence that IPL has expended any funds above the level it typically has spent in routine maintenance in order to mitigate remaining safety and reliability concerns. In fact, according to OUCC Witness Edward Rutter, IPL's spending on the operation and maintenance ("O&M") of its underground system has remained relatively constant for the past twenty years, although one can reasonably assume the dollars required to perform the same types of O&M tasks have increased over this time period."(p.4)**

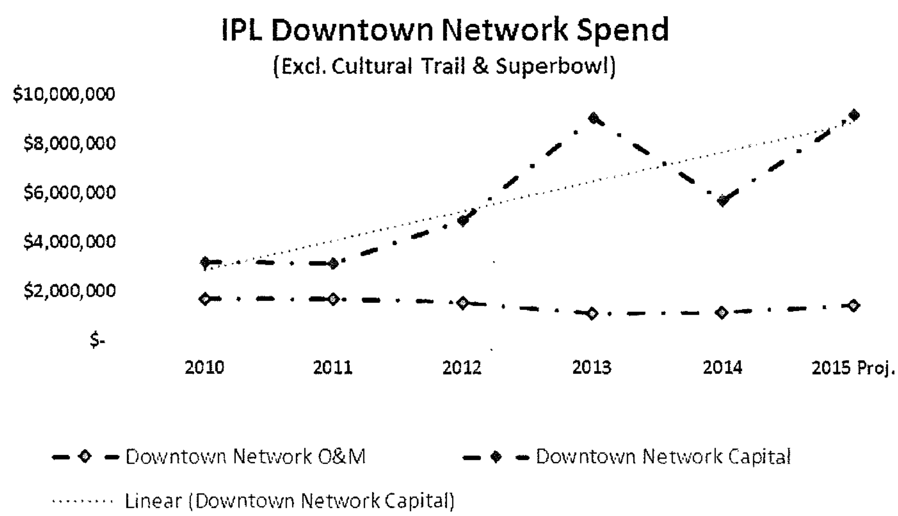
And, including OUCC Witness Rutter's recommendation (p. 22) that the IURC:

> **"Require IPL to document how and why the 1.6% increase in maintenance cost per mile (over twenty (20) years) is sufficient to maintain IPL's underground network."**

How do you reconcile these statements with the notion that IPL has been managing its assets effectively?

A26. The O'Neill Report indicates that this issue was assessed and Mr. O'Neill concluded (p. 35) that there has not been "any 'starving' of the spending on the downtown network". Further, the OUCC statements do not adequately consider the increase in capital invested in the CBD Underground Network (even after excluding the Cultural Trail and Super Bowl Initiatives), over the past six years (refer to Figure 4 below).

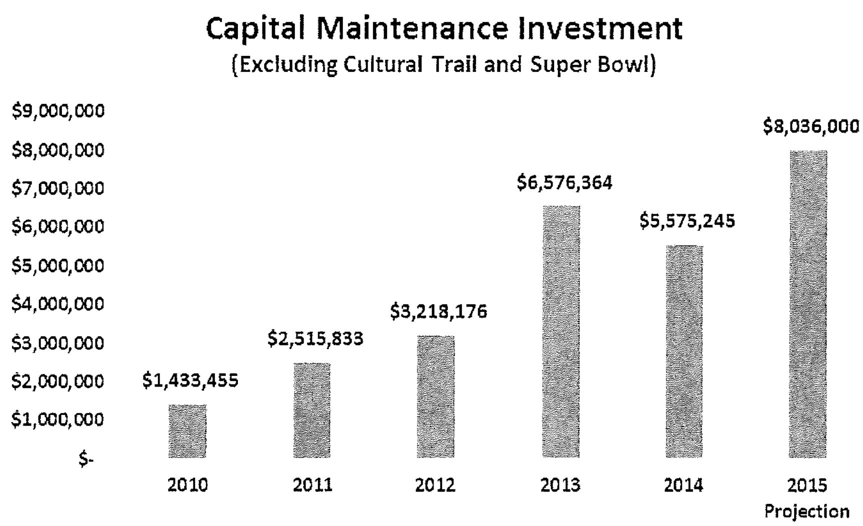
Figure 4: IPL Downtown Network Spend (2010 – 2014)



Category	2010	2011	2012	2013	2014	2015 Proj.	CAGR
Downtown Network O&M	$ 1,723,903	$ 1,723,903	$ 1,548,649	$ 1,095,078	$ 1,171,276	$ 1,464,618	-13.1%
Downtown Network Capital	$ 3,229,638	$ 3,155,215	$ 4,913,426	$ 9,074,075	$ 5,687,242	$ 9,236,000	21.7%
Total Downtown Network Spend	**$ 4,953,540**	**$ 4,879,118**	**$ 6,462,075**	**$ 10,169,153**	**$ 6,858,517**	**$ 10,700,618**	**21.5%**

O&M spending on the CBD Underground Network is largely focused on test and inspection activities. Any remediation actions are funded by capital investment. Further, in response to the concerns raised by OUCC Witness Rutter regarding O&M spending comparisons with other utilities, it is important to note that accounting practices for what constitutes a capital investment versus an O&M cost can vary across states. In fact, even within IPL, there have been changes in differentiating between capital investment and O&M costs as recently as 2013 (*e.g.;* splices and network relays). Therefore, in reviewing spending patterns as an indicator of commitment to addressing the CBD Underground Network issues, in the case of IPL, the analysis should include total spending (*i.e.;* both O&M and Capital), where the amount of dollars invested are significant. Figure 5 below further substantiates this and refutes OUCC Witness' Smith's and Rutter's concerns by profiling the amount of Maintenance Capital that was spent during the time frame in question.

Figure 5: Capital Maintenance Investment (2010 – 2015)



Q27. On somewhat of a related matter, OUCC Witness Smith (p. 4) states in her testimony:

> **"Rather than take a more proactive approach to these problems, IPL paid IPACLO Enterprises, Inc. ("IPALCO") $507M in dividends between 2010 and 2014. This is part of IPL's 20-year practice of paying large dividends to IPALCO, an amount that grew to $2.6B between 1994 and 2014. These decisions demonstrate that IPL has not appropriately prioritized its critical downtown infrastructure needs, especially given its intent to pay IPALCO a high percentage of its net income each of the next 3 years."**

Please respond.

A27. This rather inflammatory statement suggests that the two decisions are coupled, when in fact, the decision to invest / not invest in the CBD Downtown Network is based on a prudent risk assessment methodology; as evidenced by the ongoing capital maintenance investments. It is my view that the decisions made during the time frame referenced in OUCC Witnesses statements were prudent (*i.e.;* the actions taken were reasonable and appropriate given the information known or that should have been known at the time the funding decisions were made), and not indicative of a shortcoming in Asset Management, keeping in mind (going back to the beginning of this testimony) that Asset Management as it is practiced by IPL today was in its infancy during the events leading up to the CBD Downtown Network events.

Q28. OUCC Witness Golden raises a concern regarding the technologies used to enable Asset Management:

> **"IPL's AMP consists of disjointed software programs. IPL personnel must navigate through several systems that provide maintenance, criticality, engineering design, and historical asset data. The quality of data gathered by these numerous systems could be compromised due to human error, software glitches, or program redundancies…" (p.4)**

Please respond.

A28. It is true that IPL, like most other electric utilities, has a number of separate IT platforms and systems with individual data repositories. Any system can be prone to human error or other glitches/redundancies and I would point out that while he raises a general concern as to what potentially "could be", Mr. Golden does not contend nor provide any evidence that an unreasonable situation exists today. Furthermore, IPL has implemented a very reasonable solution, one that is undergoing continued refinement, to safeguard against the specific systems interface issues raised in OUCC Witness Golden's testimony.

Termed the "Asset Management Website," IPL's "solution" acts as a portal to collect the data and analytic results of the myriad systems that define IPL's current Asset Management technology platform (*e.g.;* EMPAC, IVARA and WMIS). This website addresses the issue of what is the proper source for each specific data element, and provides IPL Management with real-time data and information from which to make decisions. This incremental approach reflects a prudent strategy with respect to IT enablement, while IPL completes its Asset Management implementation from the organization, competencies, and process perspectives. Furthermore, it assures that the decision to maintain this approach or switch to a more robust (and very likely more expensive), "one-stop" IT solution is well-informed and the role of IT is to facilitate or enable well-tested processes and practices, rather than to prescribe any theoretical technology solution.

Q29. How does this point relate to your position that IPL does not require an audit of its Asset Management process?

A29. It speaks to IPL's approach to seek prudent courses of action that invoke continuous improvement in its approach to asset management. IPL has demonstrated a systematic process to IT enablement, by focusing first, on its processes and maximizing the use of its current system in support of these processes. Any decision to invest in more robust IT solutions should be made, based on a sound business case that puts at the forefront the need to improve the effectiveness and increase the efficiencies of pre-established process and practices.

Q30. Mr. O'Neill and each of the OUCC and IURC Staff testimonies call for further investigation (audit) to provide greater transparency of IPL's progress in its drive to be an industry leader in Asset Management; and thereby lead to the IURC's being able to have confidence in IPL's execution of its Asset Management process. Before moving on to the Performance Metrics portion off your testimony, how would you summarize your views regarding the necessity for this audit?

A30. There are two situations that might warrant the initiation of an audit of IPL's asset management process:

(1) If it were the only way to address Mr. O'Neill's stated call for more transparency and to increase the IURC's confidence in IPL's execution of its asset management process, or

(2) If there were a noted lack of progress in or perceived lack of commitment to implementing the asset management process.

It is my view that neither applies in this proceeding. As explained above, the 2013 self-assessment provides a baseline against which to assess IPL's efforts to formalize its asset management processes, a baseline that is based on sound Asset Management principles and philosophy, and on well-established and accepted industry standards. An updated self-assessment, completed in 2015 and verified by UMS as an accurate representation of current state, demonstrates significant progress has been made in a relatively short period of time. I have presented evidence that further supports this view, ranging from superlative system performance to demonstrated financial commitment to the CBD Underground Network.

Further, OUCC Witness Smith's testimony makes reference to "the history of explosions or other events that have occurred in IPL's downtown underground network" as constituting an "emergency." In light of Mr. O'Neill's assessment that IPL's CBD Underground Network is well-designed and the risk is low, and the noted reduction in number of major and total events since 2012, it is my view that a more deliberate process than that connoted by the term "emergency" is called for.

Therefore, it would seem appropriate to advance the discussion past the purported need for an "audit" (which as noted above, I assume refers to an assessment to establish a baseline of IPL's current state with respect to Asset Management) and onto the level of transparency that may be desired to instill and maintain IURC confidence in IPL's execution of its asset management process.

Q31. Do you have a specific proposal as to how best to proceed should the Commission determine further action is warranted to increase its confidence in IPL's asset management process?

A31. As stated or alluded to above, it is my view that a baseline already exists for monitoring and reporting IPL's progress in continuing its implementation of an Asset Management process, and its CBD Underground Network Lifecycle Plan. Further, a starting point for periodic progress updates exists in the form of the aforementioned comprehensive monthly asset management KPI report. Therefore, I recommend that IPL and IURC Staff (and additional parties as deemed appropriate) meet to collaborate on a path moving forward within 6 weeks of IPL receiving the Order to do so. The objective of these meetings would be to determine how best to track, report and verify IPL's progress in further improving its Asset Management process and executing the CBD Underground

Network Lifecycle Plan. I suggest that the most recent self-assessment of IPL's Asset Management process and the CBD Underground Network Lifecycle Plan be used as baselines against which to measure progress. Furthermore, I suggest that the follow on activities include IPL self-assessments of both initiatives every 6 months for an initial 2-year period, augmented by an objective third party review. This objective third party review could involve Mr. O'Neill, but should also include a consultancy endorsed by the Institute of Asset Management. We would recommend that these 2 entities work in concert and issue a single report, summarizing either concurrence with or exception to IPL's self-assessments. After this initial 2-year period, I recommend that all parties meet to determine the necessity (or lack thereof) of continuing this process. It is my contention that such a process as described above would accomplish Mr. O'Neill's stated objective of greater transparency to increase the Commission's confidence in IPL's Asset Management process; and more specifically, its application in improving the performance of IPL's CBD Underground Network.

Q32. Does this conclude your rebuttal testimony on the points raised around the need for an audit of IPL's Asset Management process?

A32. Yes. I would now like to shift my focus to the portions of the O'Neill Report and testimony regarding performance management.

PERFORMANCE MANAGEMENT

Q33. In reviewing the O'Neill Report and related IURC Staff and OUCC testimony a number of terms, "performance metrics," "performance benchmarking," and "performance benchmarking program," are seemingly used interchangeably. Are they, in fact, different ways of saying the same thing?

A33. Though certainly related, they are not at all interchangeable, varying significantly with respect to ease and cost of implementation and benefits to be derived; and in their specific application, implications and consequences.

Q34. Could you enlighten us as to these differences, starting with "performance metrics?"

A34. Certainly. Performance metrics are simply performance measures that indicate progress towards a desired outcome or target performance level. Implemented correctly, they will provide an objective way of showing that a specific strategy is working, offer comparisons to gauge the change of performance over time, focus attention on that which is considered important with an emphasis on accomplishments over well-intended effort, and reduce ambiguity as to what constitutes success and can be easily verified. SAIFI and SAIDI are examples of performance metrics.

Q35. How is "performance benchmarking" different, yet related to "performance metrics?"

A35. Performance benchmarking is the process of comparing one organization's service and cost level performance against a pre-selected group of peer organizations. Peer organizations are generally selected based on their similarities in terms of customer demographics, system design, and geographic factors (*e.g.;* urban / rural, forestry and weather patterns). The goal is to (1) determine an organization's comparative position, in terms of quartiles, across a number of performance domains (*e.g.;* reliability, capital re-investment levels, customer satisfaction and O&M spending, to name a few), and identify those practices that drive top performance (*i.e.;* those employed by top quartile performers – those that out-perform at least 75 percent of peer group in a specific performance domain). Performance metrics form a subset of these comparisons, as oftentimes a greater level of granularity is required to target the practices that drive strong performance. For example, SAIFI is a performance metric that is often benchmarked. The number of customer interruptions per outage event, typically not a performance metric, could provide insight as to effectiveness of circuit protection.

Another, albeit narrow application of performance benchmarking, would be a one-shot exercise around a specific set of performance metrics to determine what constitutes a valid performance target. In this application, benchmarking is less about performance improvement through identification and incorporation of best practices, and more about establishing performance targets.

Q36. What then is the distinction between "performance benchmarking" and a "performance benchmarking program?"

A36. A benchmarking program includes all the activities related to "performance benchmarking," but replaces the pre-selected peer group for a single comparison effort, with a consortium of organizations, committed to a cyclic (typically every 2 years) and ongoing routine of submitting data, receiving "masked reports" (*i.e.;* reports that protect the confidentiality of each participant), and sharing best practices in a facilitated off-site workshop. There is usually a governance structure (*e.g.;* steering group made up of a subset of the participants) to set the direction of the program, including the topics to be covered and the performance metrics (and other measures) to be benchmarked.

Q37. How does this all relate to what Mr. O'Neill (p. 54) terms "an explicit incentive mechanism?"

A37. The explicit incentive mechanism that Mr. O'Neill refers to is commonly referred to as Performance Based Regulation ("PBR"), an approach to utility regulation designed to strengthen utility performance incentives. The form of PBR being referred to in Mr. O'Neill's report targets specific areas for performance monitoring and designs an award-penalty mechanism indexed to a specific performance target (typically in the form of a performance metric).

Q38. How is all of this related to your rebuttal testimony?

A38. In the introduction to my testimony, I stated my exception to the scope and process of performance management, as envisioned by the IURC Staff and OUCC testimony and, I would add portions of the O'Neill Report. An understanding of the concepts presented above sheds light on my exception.

The first part of Mr. O'Neill's recommendation on page 55 seems to be specifically focused on establishing a set of performance metrics for the CBD Underground Network to "avoid the process of opening a new investigation with every incident of perceived poor performance." But then he includes in his recommendation on page 55 a transition to a PBR construct (after a certain amount of reporting and revision of the metrics). IURC Staff Witness Pauley's recommendation (p. 4) expands the O'Neill report recommendation to include a collaborative process to develop a reasonably comprehensive set of benchmarks and performance measures, which might ultimately be used for PBR, *i.e.* a "formal benchmarking processes, including possible incentives and disincentives" (pp. 20-21). OUCC Witness Smith also jumps beyond Mr. O'Neill's Report and recommends (p. 6) the Commission "initiate and maintain a performance benchmarking program".

Given that in the overall scheme, IPL consistently maintains its position as a low cost provider of reliable retail electric service, as demonstrated by IPL's reliability scores and low rates compared to other utilities in the State, my view is that the expansions described in the O'Neill Report and the related IURC and OUCC testimonies are unnecessary, and in some instances, not in line with established industry performance management standards. The balance of this testimony will address the specifics that substantiate this view.

Q39. In the 2015 Report, Mr. O'Neill states that:

> **"The IURC should order that IPL enter into discussions with the IURC concerning the design of a set of performance metrics which could be used to avoid the process of opening new investigations with every incident of perceived poor performance." (p.55).**

Do you concur with this statement?

A39. The idea that the utility and the regulator should have discussions seems, in my view, innocuous. My testimony does not oppose discussions, information sharing, and education. Rather, my testimony 1) explains that the subject matter and scope of what the other parties appear to propose is quite broad depending on the language used to describe the endeavor; and 2) shows why the purpose of any collaborative effort should be reasonably stated.

Assuming that Mr. O'Neill's recommendation regarding the establishment of performance metrics is tied solely to the CBD Underground Network, I do not take issue with that portion of his recommendation. However, if the intent is to broaden the discussion to a system-wide review of all performance metrics, I do not see the necessity nor merit of such an undertaking. IPL continues to excel in system reliability, maintains comparatively low rates, and compares favorably to the other Indiana utilities in customer satisfaction.

It would appear that the other parties in this proceeding are using the events that occurred in a relatively small portion of IPL's service territory to dramatically expand the entire performance management regulatory framework and operating model (*i.e.;* the expansion of regulatory oversight from the current reporting against a pre-defined set of reliability metrics, to a full-fledged benchmarking program).

Q40. In IURC Staff Witness Pauley's testimony, he states that:

> **"I am making the recommendation that performance metrics be developed only for IPL."**

Please comment.

A.40 I question what can and should be achieved through discussions with IPL only, with the exclusion of the other Indiana utilities (unless the focus of the discussion would be solely on IPL's CBD Underground Network). I particularly have this concern if such a process could eventually lead to a form of performance based regulation (which is inferred on page 4, lines 12 and 13 of Mr. Pauley's testimony). It runs counter to the notion of state-wide vetting and one is left to wonder the basis for singling out IPL, and not including the other Indiana utilities whose performance and rates do not compare favorably to IPL's standards.

Q41. In IURC Staff Witness Pauley's testimony, he states that:

> **"It should be recognized that most existing metrics are used to evaluate normal performance rather than exemplary performance." (p.8)**
>
> **"The Collaborative should develop quantifiable benchmarks as well as qualitative benchmarks where quantification is not reasonably feasible." (p.19)**

Please respond.

A41. These statements underscore the challenge in establishing a common language with respect to performance management (*i.e.;* the primary reason for my brief tutorial on these terms on pages 22-24 of this testimony). That said, the first statement should be reworded to more appropriately read, "Metrics are used to evaluate utility performance, and their comparative positon, either against a pre-established standard or the industry (*i.e.;* benchmark) and to determine the extent to which performance is exemplary.

The second statement recognizes the distinction between the underlying precept of benchmarks, which by their very nature are quantifiable, and the broader concept of Performance Management. This broader concept recognizes that not every business function can be expressed in terms of a metric. In some instances, a plan akin to the Asset Lifecycle Plan for CBD Underground Network may be tracked, but typically such tracking and reporting is not accomplished via a performance metric.

Q42. In the 2015 Report, Mr. O'Neill completes his recommendation, vis-A-vis Performance Management, stating:

> **"Such metrics could ultimately be part of an explicit incentive mechanism, although we suspect that a certain amount of reporting and revision may be necessary before the metrics would be stable enough to become part of such a mechanism, and in any event the mechanism itself should be open to modification and revision over time as experience is gained with it."**

And, IURC Staff Witness Pauley states in his testimony:

> **"After setting benchmarks and gaining experience with how the utility is meeting its performance expectations, the stakeholders may be in a position to recommend jointly or separately formal performance benchmarking processes, including possible incentives and disincentives."**

Would you care to comment on these statements?

A42. Certainly. Both of these statements infer a recommendation to transition into a Performance Based Regulation construct, a framework currently in place in approximately one-third of the States today. This involves a rather significant effort and cost which, applying logic, should include all Indiana regulated utilities. Further, a recent survey of the Commission Staffs in 10 of the States that have invoked some form of PBR regulation reveals mixed reviews. I question the prudence of embarking on such an effort in response to a situation that can be managed via an Asset Lifecycle Plan (with appropriate milestones) and a well-orchestrated set of performance metrics geared strictly to the CBD Underground Network; particularly given IPL's overall status as arguably the best performing Indiana utility, delivering relatively low cost and reliable electric service for many years.

Q43. With respect to the "well-orchestrated set of performance metrics geared strictly to the CBD Underground Network" the 2015 Report and IURC Staff Witness Pauley state:

> **"We continue to feel that an average rate of less than 2.0 [major events] per year is an appropriate goal." (2015 Report, p.19)**

> **"I support the one performance standard suggested by O'Neill Management Consultants of no greater than two (2) significant incidents on average in the Downtown Network in any given year." (IURC Staff Witness Pauley Testimony, p.20)**

Please respond.

A43. Besides the more basic issues of ensuring a clear definition of what constitutes a "major event" and establishing the calculus for determining how to report an "average number of major events," I question the bases for the recommended target of "less than 2.0 per year." In the process of negotiating a performance target, I would suggest a comparison with similar Underground Networks be conducted as one primary input to the discussion.

Q44. On pages 15 through 18 of his testimony, IURC Staff Witness Pauley outlines his general list of considerations for the collaborative he proposes. Do you have any comments on this?

A44. In addition to my comments above, I offer the following points regarding this general list:

- *Reliability and Resiliency*: IURC Staff Witness Pauley suggests that it might be "appropriate to assess a measure of average equipment age for various categories of equipment to be considered in performance metrics." (p.16) Sound Asset Lifecycle Management acknowledges age as one dimension for monitoring resiliency, but actual asset failure data, quantitative measures of asset condition, operating history and maintenance regimen are all stronger indicators of asset health and the risk of impending failures.

- *Customer Satisfaction*: In reviewing this description the majority of items listed are what I would best term, "performance domains" which could have objectives assigned, but would not easily convert to a performance metric linked to customer satisfaction.
- *Asset Management*: The statement that "companies that have successfully transitioned to an asset management business model have reported annual savings in capital and O&M combined of around 15 percent" (p.17) can easily be misinterpreted. That figure includes utilities that were notoriously high in O&M costs during a time when the industry as a whole was at much higher cost structures than are in place today. IPL has an established record as a low-cost provider of electricity and any expectation of savings in the range quoted by Mr. Scott Sydney should be viewed skeptically.
- *Staffing*: There are no real metrics to be had with respect to staffing, other than a well-documented plan to address the realities of an aging workforce and attrition or vacancies of any empty "mission-critical" job positions.
- *New Technologies and Innovations*: Consistent with my previous statement regarding a number of recommendations in Customer Satisfaction, this area is more aptly categorized as a performance domain or area of focus, and does not render itself to a set of meaningful performance metrics.

Q45. Do you have any additional comments on IURC Testimonial Staff Witness Pauley's suggested framework for the collaborative effort?

A45. The decision to embark on such an undertaking will necessarily need to weigh the costs and benefits to be incurred and absorbed. In reviewing my comments, it should be apparent that many of these items, though important factors to the business, cannot easily be condensed to a set of meaningful performance metrics. Any performance metric that is not objective, easily quantifiable, and able to be verified will lose its effectiveness over time; and is likely to render any PBR process confusing and ineffective.

Q46. How would you summarize your rebuttal of the Performance Management portion of the 2015 Report and related testimony?

A46. For all the reasons stated above, I am concerned about the lack of precision in the language used by the other parties to describe this recommendation. If the parties have different views on what activities they are advocating, what outcomes they desire, or if the scope of the undertaking is unrealistically broad, the collaborative effort is likely to fail. I concur with Mr. O'Neill's notion of working collaboratively to establish a set of meaningful performance metrics for the CBD Underground Network, with targets that reflect the realities of current state moving over time towards continuous improvement. I do not subscribe to the notion that the issues that prompted the IURC to initiate the formal Investigation are cause to (1) totally revamp IPL's Performance Management framework, nor (2) adopt Performance Based Regulation as a new regulatory construct. I am concerned that the broad language discussed above, if incorporated into a Commission order will create a project that is not manageable or efficient. Finally, if the IURC deems it appropriate to order such restructuring, I strongly caution that an IPL-specific approach will not produce the desired result from a state-wide perspective.

Q47. What do you recommend?

A47. I recommend that IPL agree to meet with Staff and the OUCC (and other parties as appropriate) to collaborate on a set of metrics to monitor and trend the performance of IPL's CBD Underground Network. Similar to the process outlined in Q31 above, the initial meeting should occur within 6 weeks of IPL receiving the Order to do so. In establishing this set of CBD Underground Network-centric metrics and defining the format and frequency of periodic reporting (a process which should be completed within 3 months of the initial meeting), all parties should take heed of IURC Staff Witness Pauley's point that this process expand upon, and not shift IPL's focus on the performance of its entire system. Further, I would recommend that an initial 2-year time period be established, after which all parties should convene to assess the need for continuing this level of reporting.

In the event that counter to my objection, a broader scope of performance management is ordered (*i.e.;* to include revamping the current Performance Management framework or establishing a new regulatory construct), then I recommend that this effort be undertaken after completing the above CBD Underground Network-centric performance management process. This "second phase" though, should include all Indiana electric utilities; and therefore, will likely require significantly more time to reach concurrence regarding the list of performance metrics, establishment of performance targets, as well as the content and frequency of reporting.

Q48. Does that complete your rebuttal testimony?

A48. Yes.

VERIFICATION

I, Jeffrey W. Cummings, Senior Vice President of UMS Group Inc., affirm under penalties of perjury that the foregoing representations are true and correct to the best of my knowledge, information and belief.

Jeffrey W. Cummings

Dated: August 31, 2015

APPENDIX A

JEFFREY W. CUMMINGS

SUMMARY AND BACKGROUND

Mr. Cummings is a Senior Vice President and Managing Director for the Americas of UMS Group. He has 35 years of professional consulting experience, with an extensive background in both engineering and strategic and operational planning for the large investor-owned utilities and municipalities in North America and Australia; most recently FirstEnergy (Ohio, West Virginia, Maryland, New Jersey and Pennsylvania), Westar Energy, ATCO Electric, Lansing Board of Water and Light, Saskatchewan Power, BC Hydro, Ameren (Illinois and Missouri), Ergon Energy and Public Service Electric and Gas Company. He supports these clients in addressing key strategic and operational challenges and has most recently focused on T&D network modernization, distribution reliability, energy efficiency, and fleet optimization, capital investment planning and prioritization, asset strategy and plan development, organizational transformation, and regulatory strategy; and when called upon, has offered expert testimony, most recently to one Canadian Provincial Utility Commission (PBR Rate Filing) and two U.S. State Regulators (Reliability Performance Assessments).

Prior to joining UMS Group, Mr. Cummings operated an independent consulting practice for nearly a decade where he supported utilities in the areas of strategic and operational planning, organizational development, technical and commercial management, and merger and acquisition assessment and implementation. Earlier in his career he held a series of engineering leadership positions at Vectra Technologies (formerly Pacific Nuclear and a publicly traded nuclear services company) and ultimately became Vice President of Nuclear Engineering. In that capacity, he served as the profit/loss manager for over 425 professional engineers across 5 regional offices in the U.S. In performing this role, he actively engaged in formulating strategies for customer development, product/service expansion, business consolidation, and oversaw the management of over 500 projects annually for approximately 75 percent of the U.S. nuclear utilities. And, prior to his tenure with Vectra Technologies, Mr. Cummings was employed by Stone and Webster Engineering Corporation where he assumed increasing levels of responsibility in the management of large Lignite and Nuclear Power engineering and construction projects.

Mr. Cummings holds an M.S. degree in Operations Research from the U.S. Naval Postgraduate School and a B.S. degree from the U.S. Naval Academy at Annapolis, Maryland

HIGHLIGHTS OF EXPERIENCE

Spearheaded efforts to provide third party assessments of a mid-Atlantic electric utility's capital investment, O&M spending levels and service level performance in support of a base rate filing; and later assessed the prudence of decisions made in the events leading up and during three extraordinary storm events during the 2011 - 2012 time frame. In both instances, written direct testimony was provided and Mr. Cummings was called upon to provide oral testimony during cross-examination.

Assisted a mid-western electric utility in developing a Grid Revitalization Program for submittal to its Board of Directors and State Regulator. The proposed plan provided profiles of projected capital and O&M cash flows, the capture of utility and customer benefits, and an industry context around which to justify such a program.

Assisted a Canadian electric utility in offering an independent third party assessment of a recent PBR filing performing high-level comparative analyses of proposed growth and infrastructure renewal capital investments over a 5-year period; and assessing the risk of returning to previously established lower capital investment plans. This effort included providing testimony as part of a formal hearing with the Provincial Utility Commission.

Served as Project Director for a full-scale business renewal effort, establishing a plan to improve the efficiency of capital investments, and decrease O&M spending by as much as $50 million a year without any noted decrease in system performance. Conducted across Power Production, Transmission and Distribution and Customer Service, this effort launched a series of initiatives that over 10 years will decrease spending levels by a cumulative $500 million, and set the stage for adopting the relevant aspects of PAS55. Areas of focus included comparative cost and service level analyses, work planning and execution, performance dashboards, transmission and distribution reliability, capital portfolio optimization, and business value/risk tolerance frameworks.

Served as Project Director of four comprehensive assessments for separate Transmission and Distribution operating companies of a large US-based electric holding company. Three involved a review of practices and processes related to electric system reliability as measured by SAIFI, CAIDI and SAIDI with a thorough review of historical results (as reported in their outage management systems) and supporting reliability programs. Specifically, these assessments analyzed service interruptions, service restoration, organization and staffing, and capital/operating spending patterns with the objective immediately and sustainably improving performance; and included formal presentations to Commission staff across 2 regulatory jurisdictions. The fourth assessment involved a thorough review of the electric distribution infrastructure from both an asset health and condition and energy efficiency viewpoint, resulting in a long term strategy and plan to transform the network to 21st century standard. This involved identification of key technical and financial legacy issues, incorporation of a number of constraints and factors (e.g. financial, technology and social equity), and a holistic portrayal of costs and benefits from both a portfolio and individual circuit/substations perspectives; and the articulation of the plan tailored for each external stakeholder (e.g. commission staff/regulator, legislators, environmentalists, shareholders and customers).

Assisted a large Northeastern utility in identifying over $80 million of O&M cost reduction initiatives without impacting service level (e.g. customer service, system reliability or safety). Areas of focus included electric transmission and distribution, customer operations, gas distribution and asset management. The final outcome has been incorporated into a long range plan to improve earnings despite an unfavorable outcome is a recent rate case filing.

Performed a capital and O&M spending diagnostic for a mid-level Midwest utility in support of an overall business case to infuse more capital into its transmission and distribution infrastructure. The case was compelling enough to present to the Board of Directors and the Commission State and will be a cornerstone for subsequent strategic planning and future rate filings.

Supported a mid-level Midwest utility in its energy efficiency/demand response filing with the state regulatory and governing entities. Applied industry comparative analyses in demonstrating value capture for all stakeholders (investors, customers and utility), and validated that the proposed program met the intent and letter of the legislative mandate.

Conducted an enterprise-wide capital efficiency assessment for a Canadian Utility spanning electric transmission and distribution and power generation. In reviewing their planned capital expenditures over a 10-year period, Mr. Cummings developed a plan to (1) reduce the current plan by 25 percent and (2) optimize the allocation of capital over the 10-year capital planning horizon.

Strategic advisor for a major transformation effort within a U.S. Midwest municipality, that included conducting performance diagnostics of its engineering and production divisions, development of a work planning and outage management program (and support processes), and a number of initiatives focused on achieving organizational alignment.

Assisted a large Australian electricity distribution utility in optimizing the size and mix of its fleet of vehicles and attached equipment, factoring in financial constraints, environmental requirements, and the aligning of work level, staffing and specific task descriptions. The process of arriving at a plan to reduce capital investments by as much as $20.0 million and operating expenses by $1.2 to $2.0 million involved the active participation of the company's internal customers (i.e. users of the fleet assets), resulting in organizational acceptance of the outcome. Mr. Cummings extended this effort to a large Western U.S. electric municipality, developing a strategy and plan to achieve comparative results.

Led the implementation of a process (and supporting software) to optimize the capital spending profile across three operating companies within a large US-based electric and gas company (electric transmission and distribution, gas transmission, distribution and storage, fleet, and electric generation); as well as one of the largest gas utilities in the US Midwest. In performing these projects, Mr. Cummings facilitated the linkage of a proposed investment's value and its contribution to overall corporate strategy as well as the risk should a specific investment be deferred; and equally important, implemented the process in a manner that garnered organizational support for change.

Oversaw the implementation of an industry forum to identify trends and perform causal analyses on the failure of critical transmission equipment and components. In pooling industry equipment/component performance data, the goal was to apply statistically relevant data to accurately predict failure patterns establish optimum replacement vs. refurbishment criteria. In parallel with the initial formation of this forum, Mr. Cummings also performed the following:

- Comprehensive performance diagnostic across all functions of one of the largest electric municipalities within the US Southwest. In so doing, he provided a plan of action to maintain service levels yet reduce operating costs by as much as 25 percent. The recommendations were adopted and integrated with the municipality's five-year operating plan.

- Development of a preventive and corrective fleet (vehicle and attached equipment) maintenance program, adopting may of the best practices from the petroleum and U.S. Naval programs, and tailoring them to application in a gas municipality environment. The project team, led by Mr. Cummings, provided a detailed process manual (with supporting process maps), an implementation plan (i.e. process/procedure changes and additions, technology enhancements and organization adjustments), and a series of key measures to assist the utility in adopting the recommendations. The program was embraced by both the municipality and city government officials.

Participated in a task force and subsequently joined the implementation team in developing and executing a five-year plan to revamp the electric transmission and distribution infrastructure for the Chicago business district. This effort involved the translation of highly technical specifications and detailed budgeting information into terms easily understood by commission staff, city government, and the utility's customers. The resulting plan was adopted by the Board of Directors, accepted by the City of Chicago, and supported by the commission staff and state regulator.

While supporting implementation, Mr. Cummings developed the strategies and plans for initially routing, certifying, designing, and installing 135kV and 345kV transmission to meet projected load growth and system reliability requirements. He played a key role in shortening the certification period by as much as 50 percent. This required effective liaison and communication with the Illinois Commerce Commission and Army Corps of Engineers as well as coordination of Commonwealth Edison's engineering and construction organizations and their assigned "contractors of choice."

Provided consulting services to a number of technology based enterprises including gas and electric utilities, engineering and architectural firms and manufacturers of electric components. The projects included:

- Strategic and Operational Planning and Integration (Linkage of Business Vision, Core Values, Financial Goals and Core Business Processes, maintaining a balance between long-range sustainability of the business and short range stakeholder expectations).

- Organizational Development (Competency-based Performance Management System Development and Implementation, Business Culture Assessments, Employee 360-degree Evaluations, Leadership Development, Recruiting and Employee Selection).

- Marketing and Sales Support (Branding Strategy Development, Customer Satisfaction Surveys, Product/Service Positioning and Pricing Strategies, and Sales Training).

- Technical and Commercial Management (Ensuring a proper balance between achieving profit/loss targets and meeting the quality standards as specified by the customer)
- Merger and Acquisition Assessment and Implementation

Worked in a variety of capacities for a nuclear engineering consulting company, serving initially as a Project Manager and ultimately as the Vice President of Nuclear Engineering. Over this 11-year period he played a major role in growing annual revenues from $5.0 million to $50.0 million while increasing market penetration to approximately 75 percent of the US nuclear utilities. Many of the skills and competencies used by Mr. Cummings in his roles as management consultant (summarized above) were developed through hands-on experience in managing over 425 engineering professionals and overseeing the management of over 500 projects annually.

Worked in a variety of capacities for Stone and Webster Corporation, primarily assigned to major nuclear power plant design and construction projects. Specific assignments included:

- Assignment to the Beaver Valley Power Station project, establishing a projects control process and system within the Duquesne Light Company to manage the installation of Three Mile Island modifications in support the second refueling outage, improving actual performance in terms of work performed and schedule duration from the initial refueling outage by a factor of three. Following this effort, Mr. Cummings shifted his focus to the unit under construction (unit no. 2) where he installed a process to facilitate the final turnover of the systems (and accompanying documentation) to plant operations over an 18-months period.
- Assignment to Clinton Power Station, where he acted as Project Controls Manager for the contractor, facilitating the lifting of 12 Nuclear Regulatory Commission (NRC) imposed stop work orders and subsequent construction and turnover of the plant to the Illinois Power Company (IPC). Key activities over a two-year period included a successful Fuel Load Caseload presentation to the NRC, support to IPC in preparing and presenting rate cases to the Illinois Commerce Commission (ICC) for cost recovery, installing an information system to track the turnover of all systems, and instituting an integrated cost and schedule process and system to support weekly and monthly reporting to project and IPC executive management. His role in integrating the construction and system turnover schedules (and subsequent development of computerized detailed system turnover punch lists) served as a primary catalyst for successful completion of the Clinton Power Station project.

Served in the U.S. Navy in increasingly responsible roles culminating as a Weapons Officer on a destroyer, USS Robert E. Peary (FF-1073). In this capacity, he managed and led three divisions totaling 100 sailors, responsible for the maintenance and operation of all weapon and detection systems, the major equipment necessary to support basic seamanship evolutions, and daily consumables for the entire ship's force. He left the U.S. Navy in 1980, having earned the Navy Achievement Medal for his efforts during two extended deployments and extraordinary performance in the areas of Anti-submarine Warfare and Naval Gunfire Support.

RECENT ARTICLES AND SPEECHES

- "*Driving Reliability Improvements-Regulatory Oversight*", presentation given to the EEI Transmission, Distribution and Metering Conference, New Orleans, LA, April 7, 2009.
- *"A Paradox of Thrift: Economic Barriers to T&D Network Modernization",* an article written in January 2009.
- *"Grid Modernization: A Roadmap to Tomorrow's Infrastructure...Don't Get Lost on the Way to AMI,"* a white paper written in April 2009.

APPENDIX B

The following tables illustrate the mapping of the three assessment frameworks addressed in this testimony; namely:

- AES' Global Assessment Management Standards (the basis for IPL's self-assessment;
- Publicly Available Specification 55 ("PAS 55"); and
- ISO 55000 Standard (emanating from PAS 55 and recently established as the Standard for Asset Management across all industries).

As the following tables and charts illustrate, the domains and elements that comprise AES' Global Assessment Management Standards are consistent with those established in PAS 55 and ISO 55000.

NOTE: The numbers in the first columns of these tables relate to the numbering convention used in each respective standard and/or specification.

Figure B1: PAS 55 / AES Asset Management Standards Comparison

	PAS55 Domain	AES Asset Management Standard(s)	Count
4.1	General requirements	STD0001 Asset Management System	1
4.1.1	Asset management system	1.1 Introduction ; 1.3 Process	2
4.1.2	Review against PAS 55-1		
4.2	Asset management policy	1.3.03 Asset Management Policy	1
4.3	Asset management strategy, objectives and plans	1.3.04 Asset Management Strategy ; 1.3.06 Asset Management Objectives	2
4.3.1	Asset management strategy	1.1 Introduction ; 1.3 Process (1.03.01 - 1.03.10) ; 3.1 Introduction ; 7.3 Process (7.03.01 - 7.03.04)	4
4.3.2	Asset management objectives	10.3.02 Selecting Performance Targets	1
4.3.3	Asset management plans	2.1 Introduction ; 2.3.02 CapEx Process ; 2.3.01 OpEx Process ; 5.3.01.01 Operation Plans ; 5.3.01.02 Maintenance Plans	5
4.3.4	Optimization of asset management strategy and plans	7.3 Process ; 7.3.01 Identifying the Need	2
4.4	Asset management enablers and other requirements	STD0005 Asset Operation and Maintenance	1
4.4.1	Asset information management system(s)	12.3 Process	1
4.4.2	Risk identification, assessment and control	2.3.02.06 Prioritization Methodology ; 2.3.01 OpEx Process (Risk Analysis) ; 4.3 Process ; 4.3.03.01 Identification ; 4.3.03.02 Risk Analysis ; 4.3.03.03 Evaluating Risk ; 4.4 Monitor and Review ; 4.5 Uses of Risk Information	8
4.4.3	Emergency preparedness, response and business continuity planning	11.1 Introduction ; 11.2.01 Leadership Teams ; 11.2.02 Recovery Plan Team ; 11.3 Process (Management of Change) ; 14.7.03 Awareness Education ; 14.7 Phase 5: Ongoing BCM Activities	6
4.4.3.1	General	6.3.04 Supply Chain Contingency Plan ; 11.3.01 Minimum Requirements (Business Level Strategies) ; 14.5 Phase 3: Define Business Level Strategies	3
4.4.3.2	Emergency plan(s)	11.3.06 Recovery Plan Status Reporting	1
4.4.3.3	Emergency equipment and resources	14.4 Phase 2: Gather Basic Information	1
4.4.4	Legal, regulatory, statutory and other asset management requirements		
4.4.5	Structure, authority and responsibilities for asset management	2.2 Roles and Responsibilities ; 3.2 Roles and Responsibilities ; 4.2 Roles and Responsibilities; 5.2 Roles and Responsibilities ; 6.2 Roles and Responsibilities ; 7.2 Roles and Responsibilities ; 9.2 Roles and Responsibilities ; 10.2 Roles and Responsibilities ; 11.2 Roles and Responsibilities ; 14.3 Phase 1: Form Business Continuity Management Team	10
4.4.6	Outsourcing		
4.4.7	Training, awareness and competence	3.3.03.03 Training ; 5.2 Roles and Responsibilities (Communication and Training - STD 0008) ; 8.2 Roles and Responsibilities ; 8.3.02 Competence Requirements ; 8.3.02.01 Reviewing Competence and Identifying Gaps ; 8.3.02.02 Closing Competence Gaps ; 8.3.05 Evaluate the Program ; 9.2 Roles and Responsibilities (Training)	8
4.4.8	Consultation, participation and communication	3.3 MoC Process ; 4.3.02 Communication	2
4.4.8.1	Communication		
4.4.8.2	Participation and consultation		
4.4.9	Asset management system documentation	1.1 Introduction ; 1.3 Process	2

	PAS55 Domain	AES Asset Management Standard(s)	Count
4.5	Implementation of asset management plans	2.3.02.04 Close Project ; 2.3.02.05 Evaluate Results ; 5.3.01.01 Operation Plans ; 5.3.01.02 Maintenance Plans ; 5.3.04 Work Control for Operations and Maintenance (Operations Work Controls) ; 5.3.04 Work Control for Operations and Maintenence (Maintenance Work Controls) ; 6.3.01 Asset Sourcing Planning ; 6.3.03 Asset Sourcing Execution ; 6.3.05 Inventory Optimization ; 6.3.06 Asset Life Cycle Procurement ; 7.3.02 Asset Creation / Acquisition ; 7.3.03.01 Routine Operations and Maintenance ; 7.3.03.02 Renewal / Rehabilitation ; 7.3.04 Disposal	14
4.6	Checking and corrective action		
4.6.1	Performance and condition measurement and monitoring	2.3.02.05 Evaluate Results ; 5.3.07 Operations and Maintenance Key Performance Indicators (KPIs) ; 10.3.01 Selecting Performance Measurements ; 11.3.03 Performance Framework	4
4.6.2	Evaluation of compliance		
4.6.3	Asset-related failure, incident investigation, nonconformity, corrective action and preventive action		
4.6.3.1	Asset-related failure and incident investigation	5.3.07 Recognizing the Need (Triggers) ; 11.3.03 Initiation of Recovery Plan (RCA) ; 13.3.06 Root Cause Analysis	3
4.6.3.2	General		
4.6.3.3	Procedures		
4.6.3.3.1	General		
4.6.3.3.2	Immediate action	5.3.03 Form the RCA Team	1
4.6.3.3.3	Recording	5.3.02 Preserve Evidence	1
4.6.3.3.4	Investigation	5.3.04 Execute the RCA	1
4.6.3.4	Nonconformity, corrective action and preventive action		
4.6.3.4.1	Corrective action		
4.6.3.4.2	Preventive action	5.3.03.03 Preventative Maintenance	1
4.6.3.4.3	Follow up	5.3.05 Take Corrective Action and Monitor the System	1
4.6.3.5	Non-conformance, and incident analysis	5.3.04 Execute the RCA	1
4.6.3.6	Monitoring and communicating results	5.3.05 Report RCA Findings ; 3.2 Roles and Responsibilities (Communication and Training)	2
4.6.4	Control of records	12.3.03 Control	1
4.6.5	Audit	15.3.05.07 Conducting Peer Review Follow-up	1
4.7	Management review and continual improvement	13.3.01 Activities ; 13.3.02 Areas of Focus	2

Number of AES AM Standards that Apply to PAS 55

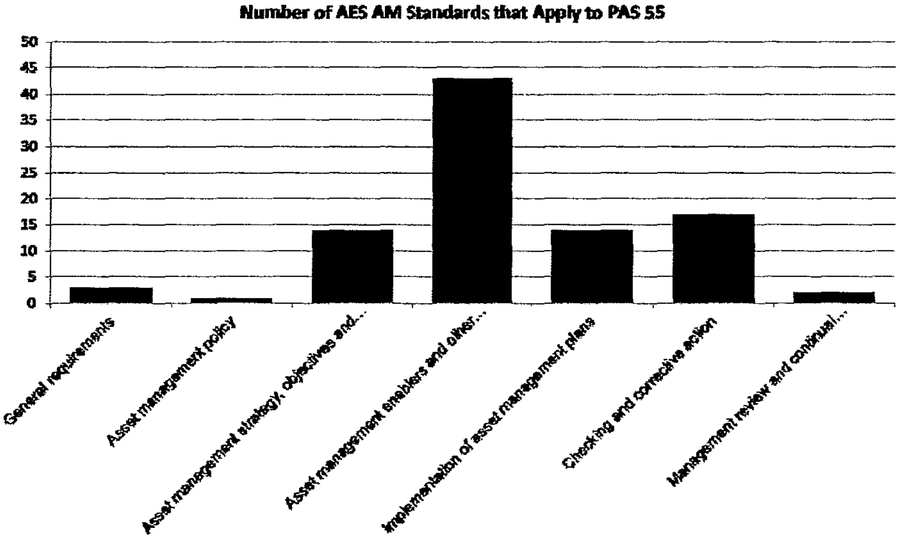
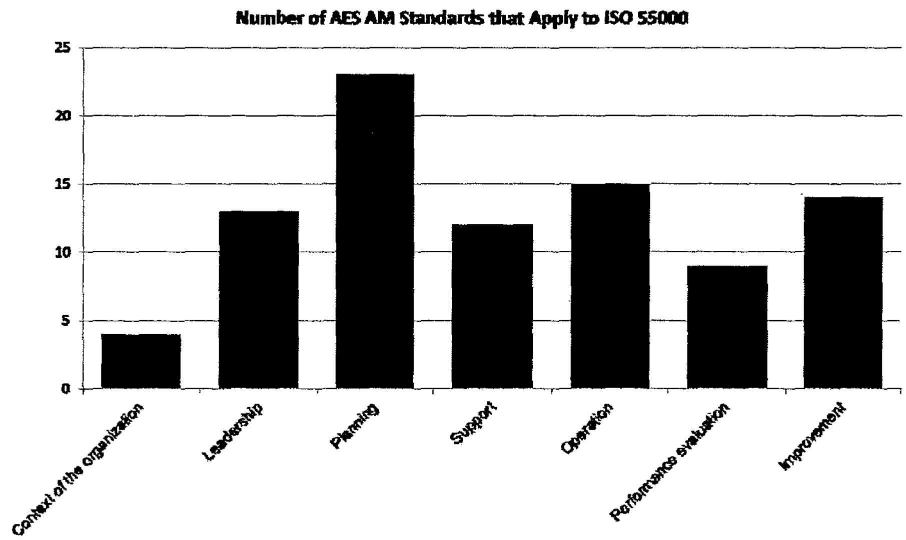


Figure B-2: ISO 55000 / AES Asset Management Standards Comparison

	ISO 55000 Domain	AES Asset Management Standard(s)	Count
4	Context of the organization		
4.1	Understanding the organization and its context	1.2 Roles and Responsibilities	1
4.2	Understanding the needs and expectations of stakeholders	1.1 Introduction	1
4.3	Determining the scope of the asset management system	1.3 Process	1
4.4	Asset management system	1.3 Process	1
5	Leadership		
5.1	Leadership and commitment	1.2 Roles and Responsibilities	1
5.2	Policy	1.3 Process	1
5.3	Organizational roles, responsibilities and authorities	2.2 Roles and Responsibilities ; 3.2 Roles and Responsibilities ; 4.2 Roles and Responsibilities ; 5.2 Roles and Responsibilities ; 6.2 Roles and Responsibilities ; 7.2 Roles and Responsibilities ; 8.2 Roles and Responsibilities ; 9.2 Roles and Responsibilities ; 10.2 Roles and Responsibilities ; 11.2 Roles and Responsibilities ; 14.3 Phase 1: Form Business Continuity Management Team	11
6	Planning		
6.1	Actions to address risks and opportunities for the asset management system	2.3.02.06 Prioritization Methodology ; OPEX Risk Analysis ; 4.3 Process ; 4.3.03.01 Identification ; 4.3.03.02 Risk Analysis ; 4.3.03.03 Evaluating Risk ; 4.4 Monitor and Review ; 4.5 Uses of Risk Information ; 6.3.04 Supply Chain Contingency Plan ; 11.1 Introduction ; 11.2.01 Leadership Teams ; 11.2.02 Recovery Plan Team ; 14.2 Framework Overview	13
6.2	Asset management objectives and planning to achieve them	1.3 Process ; CAPEX Description ; 2.3.02 CapEx Process ; 2.3.01 OpEx Process ; 7.3.01.01 Requirement Definition ; 7.3.01 Identifying the Need ; 7.3.02 Asset Creation / Acquisition ; 7.3.03 Asset Operations and Maintenance ; 7.3.03.02 Renewal / Rehabilitation ; 7.3.04 Disposal	10
7	Support		
7.1	Resources		
7.2	Competence	8.3.02 Competence Requirements ; 8.3.02.01 Reviewing Competence and Identifying Gaps ; 8.3.02.02 Closing Competence Gaps ; 8.3.04 Evaluate the Training ; 8.3.05 Evaluate the Program ; 9.2 Roles and Responsibilities (Training)	6
7.3	Awareness	3.3.03.03 Training ; 14.7.03 Awareness Education	2
7.4	Communication	4.3.02 Communication ; 5.2 Roles and Responsibilities (Communication and Training)	2
7.5	Information Requirements	5.3.02 Foundations for Operation and Maintenance Plans	1
7.6	Documented information	12.3 Process	1
8	Operation		
8.1	Operational planning and control	2.3.02 CapEx Process ; 2.3.02.04 Close Project ; 2.3.02.02 Evaluate Proposal ; 5.3.01.01 Operation Plans ; 5.3.01.02 Maintenance Plans ; 5.3.04 Work Control for Operations and Maintenance Operations Work Controls) ; 5.3.04 Work Control for Operations and Maintenance (Maintenance Work Controls) ; 6.3.01 Asset Sourcing Planning ; 6.3.03 Asset Sourcing Execution ; 6.3.05 Inventory Optimization ; 6.3.06 Asset Life Cycle Procurement	11
8.2	Management of change	3.3.03.03 Training ; 3.3 MoC Process ; 3.3.01 Categories of Changes ; 11.3 Process	4
8.3	Outsourcing		
9	Performance evaluation		
9.1	Monitoring, measurement, analysis and evaluation		
9.1.1	General	2.3.02.05 Evaluate Results (CAPEX Results Evaluation) ; 2.3.02.05 Evaluate Results (OPEX Performance Monitoring) ; 5.3.05 Operations and Maintenance Key Performance Indicators (KPIs) ; 10.3.01 Selecting Performance Measurements ; 10.3.02 Selecting Performance Targets ; 10.3.03 Performance Framework	6
9.1.2	Evaluation of the performance of the asset portfolio and asset management processes	10.3.04 Variance Analysis and Action plan	1
9.2	Internal audit	15.3.05.03 Verifying Information	1
9.3	Management Review	15.3.05.07 Conducting Peer Review Follow-up	1
10	Improvement		
10.1	Nonconformity and corrective action	13.3.07 Improvement Actions	1
10.1.1	General		
10.1.2	Processes for the investigation of asset-related nonconformities and incidents	Event Triggers ; 9.3.02 Preserve Evidence ; 9.3.03 Form the RCA Team ; 9.3.04 Execute the RCA ; 11.3.03 Initiation of Recovery Plan (RCA) ; 13.3.06 Root Cause Analysis	6
10.1.3	Processes for implementing corrective actions	9.3.06 Take Corrective Action and Monitor the System ; 9.3.05 Report RCA Findings	2
10.2	Preventive action	5.3.03.03 Preventative Maintenance	1
10.3	Continual improvement	13.3.01 Activities ; 13.3.02 Areas of Focus ; 13.3.07 Improvement Actions ; 13.3.08 Results and Benefits	4



All assessments require a pre-established maturity scale, against which to mark progress towards achieving competence across all critical dimensions of Asset Management. Though somewhat different, the scale used by AES (and subsequently IPL) is sufficient to monitor progress towards effective Asset Management.

Figure B-3: Comparison of Maturity Scales

AES Maturity Scale		PAS 55 Maturity Scale		ISO 55000 Maturity Scale		Comparison
		0 Innocence	Learning - Developing Understanding of Required Capability	0 Innocent	The organisation has not recognised the need for this requirement and/or there is no evidence of commitment to put it in place	AES standards combine the first 2 levels of ISO 55000 "Innocent" and "Aware" into "Firefighting"
1 Fire Fighting	No Objective Evidence of Existence	1 Awareness	Applying - Basic Knowledge of Required Capabilities	1 Aware	The organisation has identified the need for this requirement and there is evidence of intent to progress it.	
2 Stabilizing	Opportunities for Improvement Exist	2 Development	Embedding Good Understanding Of Requirements And Progressing On Implementation	2 Developing	The organisation has identified the means of systematically and consistently achieving the requirements, and can demonstrate that these are being progressed with credible and resourced plans in place	
3 Preventing	Meets Minimum Requirements	3 Competence	Optimizing & Integrating - All Required Capabilities In Place, With Integration Underway	3 Competent	The organisation can demonstrate that it systematically and consistently achieves relevant requirements set out in ISO 55001.	
4 Optimizing	Easily Exceeds Boundary Conditions	4 Excellence	Mastery & Innovation - Recognized Leader In Required Capabilities, Pushing the Boundaries of Asset Management	4 Optimizing	The organisation can demonstrate that it is systematically and consistently optimising its asset management practice, in line with the organisation's objectives and operating context.	AES Standards map to ISO 55000, splitting the PAS 55 standard of "Excellence" into 2 standards - "Optimizing" and "Excellence"
5 Excellence	Exhibits world-class attributes			5 Excellent	The organisation can demonstrate that it employs the leading practices, and achieves maximum value from the management of its assets, in line with the organisation's objectives and operating context.	

Standard for *"Compliance"*

Downtown Underground Network Asset Life Cycle Plan

August 31, 2015

AES
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Figure Index

Table Index

I. Executive Summary

A. Overview of the CBD Underground Network Asset Life Cycle Plan Strategies

The Asset Management Strategy is built upon systematic data-driven decisions for all dimensions of asset maintenance, operation, risk, and investment. This strategy drives a range of initiatives that ensure consistent collection, organization, analysis and communication of asset data. The data is used to measure and monitor the performance and health of each asset, which is in turn used to systematically identify and prioritize system and asset risks and make optimum investment decisions. Core to this asset management strategy is development of Asset Life Cycle Plans (ALCP's).

ALCP's have been or are in the process of being developed, executed, and updated for each asset type. These plans provide an essential road map for the lifecycle care of each asset type, defining what the assets are, profiling their key attributes and characteristics, tracking their performance and failure rates over time, prescribing how they will be maintained, operated, and monitored, and defining how and when it will be determined that they should be replaced.

Each plan includes: A review of the current asset base, a summary of past asset performance and maintenance history, discussion of current asset condition and risks, a review of current maintenance and operation practices vs. industry best practices, identification of replacement needs and spares strategy, asset expenditure requirements (O&M and Capital), and a discussion of innovations related to the type of asset.

Development efforts / completion of comprehensive asset life cycle plans for critical assets is prioritized based on risk and potential impact on ratepayer costs and reliability. Comprehensive plans have been developed for wood poles, substation breakers, large power transformers, relay protection, and the Central Business District (CBD) downtown network. Initiatives to develop draft plans for other major asset classes have been scheduled for completion over the next 6 to 24 months (e.g., UG direct buried cable (URD), overhead conductors, transmission structures, Distribution OH and UG transformers, Substation CTs and PTs, Disconnect Switches, Reclosers and Sectionalizers, Pole top hardware (insulators, cutout switches, lightning arrestors, etc.), Reactive devices, etc.).

These plans have been prioritized based on the view in the Figure 1 Asset Life Cycle Plan Development (ALCP).

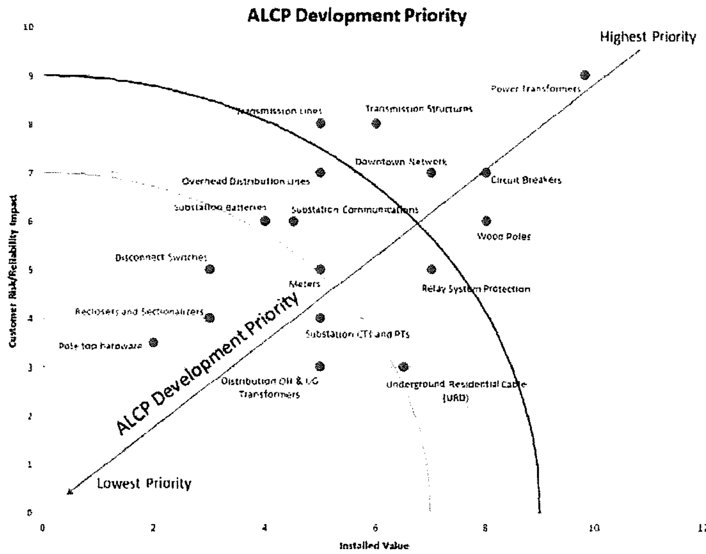

Figure 1 Asset Life Cycle Plan Development (ALCP)

This provided a high level view of our priorities and informed our schedule for development of the remaining asset life cycle plans.

Asset Class Lifecycle Plan Development Strategy		
Wood Poles	Complete	12/4/2014
Relay System Protection	Version 3 completed	11/25/2014
Circuit Breakers	Version 3 completed	12/15/2014
Power Transformers	Version 2 completed	8/15/2015
Downtown Network	Complete	8/31/2015
Underground Residential Cable (URD)	Data gathering, draft under development	2015 Q4
Overhead Distribution Lines	Data gathering, draft under development	2015 Q3
Transmission Structures	Data gathering, draft under development	2016 Q1
Meters		2016 Q3
Substation Batteries		2016 Q3
Transmission Lines		2016 Q4
Substation Communications		2016 Q4
Distribution Transformers		2017 Q1
System Control and Data		2017 Q2
Substation CTs and PTs		2017 Q3
Disconnect Switches		2017 Q4
Reclosers & Sectionalizers		2017 Q4
Pole Top Hardware		2017 Q4

Figure 2 Asset Life Cycle Plan Schedule (ALCP)

B. Scope of Downtown Network ALCP

The Downtown Underground Electrical Distribution Network System for Indianapolis provides extremely reliable electrical power to customers in an esthetically pleasing manner. Network systems are typically required where large quantities of power are needed, but space is limited. The downtown underground networks consist of network transformers, network protectors, network relays, vaults, manholes, duct systems, primary and secondary cables. These combine to provide downtown customers with their power requirements. Network systems are designed to be redundant, such that failure of any one piece of equipment (e.g., cable section, transformer, etc.) does not result in a customer outage.

The scope of this Asset Life Cycle Plan (ALCP) is focused on the network system assets serving downtown Indianapolis. This document will continue to track the network system assets during their lifespan. Reviews and adjustments to the ALCP will be made on an annual basis or as often as needed.

C. Summary of Initiatives

1. Network Protectors

Sections VI.A.3 and IX.B document an initiative to phase out routine test/calibration of network protector relays at IPL. It is recommended that instead a "feeder drop / breaker test" be used instead of the existing network protector relay testing practices. This is a similar philosophy to a condition based maintenance practice for transmission relays that is acceptable to NERC. However, a visual inspection of the protector will still be required to look for abnormal conditions (oil seeping, water ingress, rust, etc.).

2. Secondary Network Cable

IPL will begin a pilot program to change the existing PILC lead jacketed standard for secondary cables in the downtown network from 350 MCM EPR to a [redacted]

3. Secondary Connections and Limiters

[redacted] another initiative for IPL is to begin a pilot program of using cable limiters on all new IPL secondary cable installations. Additionally, a crab/mole installation will also be piloted to facilitate connections of secondary cables. Additional supporting information is in Sections II.E.4 and II.E.5.

4. Steam Temperature Monitoring

Section IV.F describes the challenges that exist with the co-existence of the downtown electrical network and steam system. Citizens Thermal and IPL continue to work closely to address any issues and are working on long term solutions. IPL plans to begin a pilot program to monitor duct line temperatures. This data can be brought back through the downtown network SCADA system. This will allow IPL to rapidly identify possible high temperature issues and inform Citizens in a much quicker time frame.

5. Primary Cable

As pointed out in the Root Cause Analysis for the North Street Network Event, steam temperatures in the duct line appeared to have caused significant thermal damage to the outside jacket of the EPR primary cable. This was the first time this had been observed. [redacted]

6. Low Side Transformer and Protector Protection

An existing risk for clearing low side transformer and protector 277/480V locations at IPL is identified in Section IV.D.1. IPL is in the process of replacing the existing electromechanical relays on the [redacted] Gardner Lane and Edison feeders serving the secondary 120/208V and 277/480V grids. The new relays should be capable of singe phase VAR measurements. These single phase VAR analog points will be monitored for levels and rate of change measurements. These points will alarm in the Transmission Operations Office for abnormal conditions. This initiative should be complete by 12/31/2016.

7. System Modeling and Load/Fault Studies

Contingency planning by running system load flow and fault studies has been emphasized by various references in this document as an important tool. Section IX.E details existing programs. IPL has modelled the network system in GTECH but plans to expand the use of this modeling for additional on-going load and fault studies, which will help in secondary limiter placement and identifying whether inserting ground impedance in the substation transformer connection to ground to limit the primary failure energy level will cause any adverse effects to the secondary network. Section IX.G explains a method planned to limit the primary fault current.

8. Network Standards

Section II.D reviews existing standards and specifications. IPL is making progress but does not yet have a complete updated set of network Standards. The Asset Management Standards group is leading the effort to create downtown network standard documents for reference on preferred practices and to create some additional standards and revisions for IPL, such as a ring bus standard and network protector specifications.

II. Asset Base

A. Network System Description

1. Introduction

Network systems are known for ensuring high reliability and are designed for areas with high electricity use and high customer density. Several transformers are connected together underground so that electricity can be supplied to a customer by more than one transformer. This is a different set-up from the radial distribution system where there is typically one transformer used to supply electricity to a group of customers.

The first low-voltage AC network system is reported to have been installed in Memphis, Tennessee around 1907. The network transformers were supplied by primary feeders through distribution cutouts and were connected to a solid grid of low-voltage cables that were protected with fuses. Early installations, as the Memphis system, were unsatisfactory due to the inability of the fuses between the transformers and the secondary mains to clear faults on primary cables and transformers. This shortcoming showed that a means of detecting power-flow direction was required to prevent a primary fault causing a complete loss of the network.[1]

In 1922, the first AC network system, in which network protectors were automatically tripped and closed by relays, was placed in service in New York City by the United Electric Light and Power Company. This was the birth of the secondary network system, as it is known today. This cable grid was a three-phase, four-wire system and it operated at a nominal voltage of 120/208 V and soon, this type of system became an accepted method of supplying combined power and lighting load.

By 1974, 315 companies in the United States used a low-voltage network system. Today's 120/208 V network grid systems are very similar in configuration and basic operation to the first

[1] A History of Underground Secondary AC Networks, Robert J. Landman, H&L Instruments, L.L.C., IEEE PES, Life Senior Member

systems. Reliability of service is a paramount requirement of an electric distribution system, especially in the central business districts of large cities. The low-voltage network system is the method most commonly used to obtain this reliability. The underlying principle of all network systems is an interconnected grid of secondary mains operating at utilization voltage and energized from a number of primary feeders through step-down transformers. Today, there are over 350 cities, throughout the world, operating low voltage network systems.[2]

In the early 1950s, the loads, primarily from the increase in air conditioning, were reaching the level where it was very difficult to supply the customer's need at 120/208 V. This drove the practice of using 277/480-volt secondary spot networks for larger buildings. The spot is a network of two or more transformers and protectors, banked on the secondary side with a single "collector" bus.

Part of the evolution of urban underground electric systems has been, for Indianapolis as well as other cities, that load has been gradually taken off of the secondary network grids and converted to spot networks or primary selective loads, especially as blocks are redeveloped into larger buildings or campuses.

The decision to not interconnect the secondary on spot networks was driven by both technical and economic reasoning. Because the 277/480-volt vaults were widely dispersed within a network area, engineers felt the small increase in reliability did not justify long secondary cable runs between vaults. Additionally, and more importantly, was the difficulty of extinguishing any arcing faults on the secondary system. Faults occurring at voltages of 277/480 V do not self-extinguish most of the time.

Network transformers are generally located in sub surface vault structures that are most often located in public right-of-way. The network transformer secondaries are connected in parallel through secondary network protectors, generally mounted on each network transformer. These network protectors trip to isolate transformer and primary cable faults from back-feeding from the energized secondary grid. Secondary voltage connections may be made between vaults using low voltage cables. Most customer loads are usually served from the secondary system.

As mentioned previously, network systems are extremely reliable. However network systems are very expensive to construct, maintain and operate, and for this reason, most utilities have not significantly expanded network service outside of traditional network areas.

2. Definitions

Consistent definitions are critical to understanding the design and operation of secondary network distribution systems. Alternate definitions for some of the terms may be found in different regions. The definitions below represent the most common usage.[3]

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[2] A History of Underground Secondary AC Networks, Robert J. Landman, H&L Instruments, L.L.C., IEEE PES, Life Senior Member

[3] A History of Underground Secondary AC Networks, Robert J. Landman, H&L Instruments, L.L.C., IEEE PES, Life Senior Member

Cable Limiter: This is an enclosed fuse for disconnecting a faulted cable from a secondary network distribution system and protecting the unfaulted portion of that cable from serious thermal damage.

Protector Cycling: The undesirable cyclical opening and closing of a network protector because of load conditions. This is also sometimes called "protector pumping".

Secondary Grid Network: A secondary network system with geographically separated network units and the network-side terminals of the network protectors interconnected by low-voltage cables that span the distance between sites.

Network Relay(s): A relay (or for older models 2 relays - master and phasing) that provides two purposes. The first is to trip the network protector when power flow is from the low-voltage side to the high-voltage side of the network transformer. This is set to be sensitive enough to trip on transformer magnetizing current. The second function is to close the network protector when transformer side voltage is higher than network voltage and leads the network in phase angle ensuring power flow into the network.

Arc Flash Reduction Mode Setting (ARMS): The Eaton CM-52 protector has a sensitive forward looking maintenance setting that can be used to reduce the severity of arc flash energy exposure.

Network Protector: An assembly composed of a circuit breaker and its complete control equipment (network relay, current transformers, and may include potential transformers).

Network Transformer: A transformer designed for use in a vault. A network transformer may be submersible or dry vault. It usually, but not always, has a provision for attaching a network protector.

Primary Network Feeder: Dedicated primary network feeders are feeders that supply only network transformers for the grid network, the spot network, or both. Non-dedicated primary network feeders, sometimes called combination feeders, are feeders that supply both network transformers and non-network load.

Secondary Network: The low-voltage circuits (cables) 120/208V or 277/480V supplied by the network units (the network transformer and its associated network protector).

Spot Network: A secondary network distribution system that consists of two or more network units at a single site. The secondary network-side terminals of these network units are connected together with bus or cable. In spot networks, the paralleling bus does not usually have low-voltage ties to adjacent or nearby networks.

3. IPL Network System Boundaries

Indianapolis Power and Light's Downtown Network is approximately contained within the area known as the Central Business District or Mile Square, bounded by East, West, North and South

Streets. The territory is approximately 9 blocks by 9 blocks, or a mile long on each side. The IPL network serves approximately 1,834 customers, with a peak demand of 133 MW.

The advantage IPL has over many of their counterparts is how dry the vaults and manholes are and how well they drain. The big negative IPL has is that Indianapolis has the second largest steam system in the United States. Thus, the IPL underground facilities can be adversely affected by a leak or poor/failing thermal insulation in the steam system.

[redacted]

Figure 3 IPL Network Boundaries

4. Network Substations

IPL has two substations feeding the downtown network, Edison and Gardner Lane. Each substation has three transformers with a top rating of 40 MVA. The 138 kV high side winding is connected ungrounded wye and the 13 kV low side is connected solidly grounded wye. There is a third tertiary which provides phase to ground fault current on the 13 KV primary system.

5. Primary Feeders, Switches and Switchgear

Primary feeders are conductors, usually in the 12 to 13.8kV range, that are connected from the substation transformers and that transfer power to the distribution network transformers feeding customers. For most downtown networks these are insulated and run underground through a duct system.

a) IPL

IPL has approximately 367,131 feet (69.5 miles) of network primary cable (36 circuits, each averaging 2.1 miles). With the retirement of 13kV feeders from Sub #3 in 2014, IPL eliminated nine feeders serving the downtown network. Thus, IPL has 36 remaining 13.2kV primary feeders serving the downtown network. Of these feeders, 28 feed the spot and secondary networks. The remaining eight feeders are direct primary voltage feeds to some of the largest customers downtown.

[redacted]

Figure 4 IPL Network Feeders

The estimated percentage types of primary cable used in the Indianapolis network for the above feeders are:

Type of Cable	Percentage	Miles
• EPR (750 MCM)	10%	6.95
• EPR (350 MCM)	20%	13.9
• EPR (4/0 MCM)	5%	3.5
• PILC (750 MCM)	20%	13.9
• PILC (350 MCM)	15%	10.4
• PILC (4/0 MCM)	28%	19.5
• PILC (1/0 MCM)	2%	1.4

All of this cable is copper, and EPR is used for all new construction.

IPL also has two 4kV feeders serving air conditioning and chiller load for six customers. Presently these feeders are served from [redacted] with a project scheduled to move the source for these feeders to [redacted] circuits in 2015.

6. Network Transformers

Network transformers are submersible and are made to be used below ground level in a vault (to be discussed later) structure. The network transformers are designed to meet IEEE Standard C57.12.40 for this type of operation.

The role of a network transformer is to convert the distribution voltage (i.e., 13.2 kV for IPL) to the typical customer utilization voltage of 120/208 volts for small commercial customers and 277/480 volts for larger commercial facilities.

277/480 volt network transformers are usually placed in a segregated vault cluster to feed a large single customer/building load.

120/208 volt network transformers are also placed in vault clusters, but the clusters are connected together by a system of ducts and manholes (to be discussed later) that electrically tie several clusters. The customer's being served from the 120/208 Volt network have smaller loads and their services can come from the vault or from a manhole. In this way, the clusters of vault transformers share the load.

IPL has had a history of excellent performance from the network transformers. Our subject matter experts cannot remember any electrical failures of network transformers.

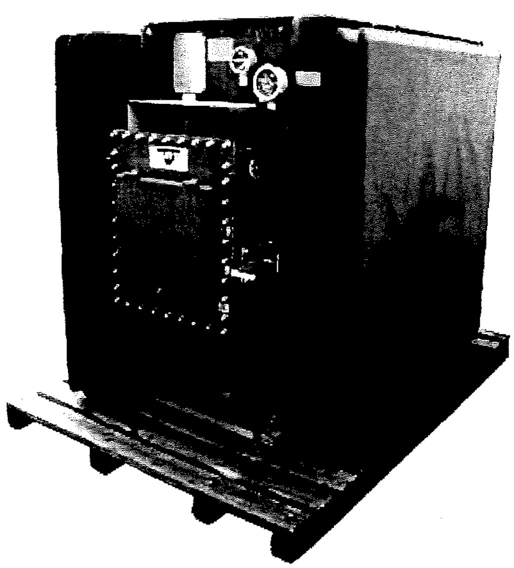

Figure 5 Network Transformer

Following extensive research into the practices of other companies, and advice from Network practices experts, IPL has decided to adopt the emerging industry best practice and convert to a higher flash point fluid such as FR3 (Envirotemp) for transformer insulation. Additionally, the industry is moving away from oil filled termination chambers to elbow fittings.

a) IPL

Indianapolis Power & Light uses 1000 kVA, 1500 kVA and 2000 kVA network transformer sizes for the 277/480 V system and 300kVA, 500 kVA, 750 kVA and 1000 kVA transformers for the120/208 V system.

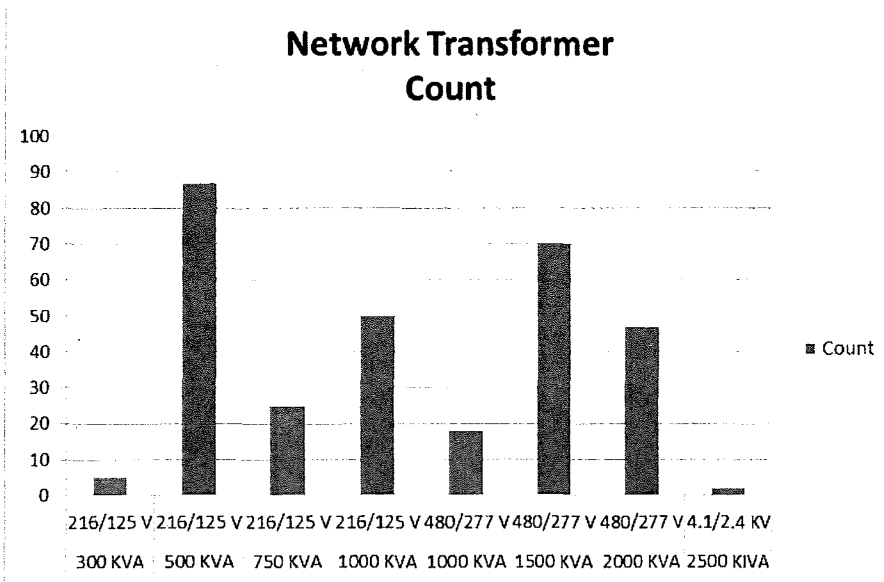

Figure 6 IPL Transformer Sizes

Experience has shown on the IPL system most of the transformer rust occurs on the top of the transformer and not the bottom, unlike most utilities with wet vaults where rust typically occurs at the bottom of transformers. IPL has installed transformer deflector shields under the open grating areas where the network transformer is exposed to corrosion causing materials. This should aid the transformer tank lifespan.

IPL also has the practice of using bottom rails, purchased with the transformer and then adding additional rails garnered from salvage when installing the transformer. These rails lift the bottom of the transformer several inches above the floor of the vault, and thereby facilitate transformer cooling and avoid rust on bottom of the transformer.

7. Network Protectors

The purpose of the protector is to be a circuit breaker with automatic open and close capabilities based on various algorithms programmed into network relays. Network relays are located inside the protector. The two basic roles of the relay settings are:

1. To disconnect the transformer from the secondary grid in the event the primary feeder is faulted or de-energized;

2. To close the protector (depending on voltage and phase quantity criteria) and load requirements on the secondary grid.

However, recently Eaton Corporation has introduced the CM-52 protectors with an Arc Flash Reduction Mode Setting that allows the protector to be put in a sensitive forward looking protection scheme to reduce arc flash energy.

The network protector may be mounted on the secondary side of the network transformer or remotely mounted, such as to the vault wall.

Also, as discussed in the "IEEE Guide for the Protection of Network Transformers" (IEEE Standard C37.108-2011), most network protectors in service have not been designed or tested to operate as switching or isolation devices for operating electric generators. These concerns currently prevent many utilities from allowing installation of net energy generators within areas served by secondary networks.

Figure 7 Network Protector

In the industry one issue with Westinghouse protectors manufactured from 1949-1957 was the use of aluminum that was often substituted for copper on the bus. This design is known to be susceptible to deterioration from exposure of the bus to salt water. The corrosion can lead to the development of hydrogen gas and can lead to an explosion in environments that are wet and salt-prone. The copper/aluminum can be distinguished by measuring the thickness of the bus.

The good news is that this has not been a problem for IPL.

Another issue discovered with Westinghouse protectors in the early 1990's was an issue of some protectors accumulating toluene gassing. This resulted in two protectors failing at IPL during routine switching events. These protectors have since been sampled periodically and explosive levels are no longer detected.

a) IPL

IPL has 303 network protectors in service. Of these, there were 58 pre-1985 Westinghouse 480 Volt CM-22 Network Protectors identified after the August 13, 2014 incident in Downtown Indianapolis. These 58, plus the other 79 - 480 Volt Network Protectors will be replaced to comply with the latest Arc Flash requirements. The existing units will be replaced with Eaton CM-52 protectors with Arc-Flash Reduction Module (ARM).

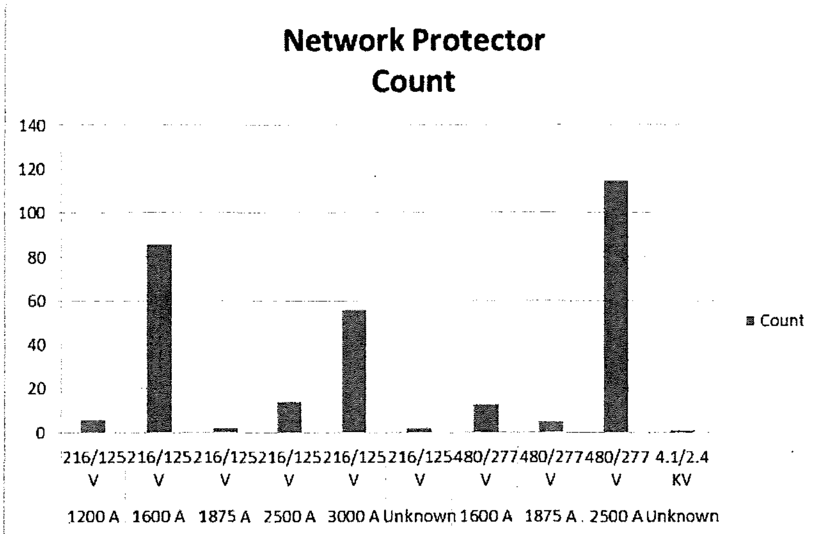

Figure 8 IPL Network Protector Sizes

IPL does not fuse the leads to the collector bus. The older IPL 277/480V protectors only have links and are not fused within the protector. All newer 277/480V protectors will have fuses within the protector.

8. Vault Structures

These structures house the underground network transformers, protectors, and the collector bus. Typically a vault consists of one to four compartments also referred to as bays. The size of the bay is typically 10 feet by 20 feet. Each bay generally contains one network transformer and protector combination. A grating in the vault roof provides ventilation, and an access door allows personnel entry into the vault. Most vaults contain openings between the bays that allow a worker to move from one bay to another. There is a collector bus comprised of individual copper or aluminum bars to which cables connect that runs the length of the vault through each bay. The bus is supported from the ceiling of the vault by insulators or insulating boards. The output of the network transformer connects to this collector bus. Service cables to customers and network secondary cables between vaults also connect to the collector bus. The vault is a confined space and requires additional safety precautions to be followed for entry.

9. Manholes and Duct System

Manholes are used as junction/splicing points for the underground cables. Workers physically enter these structures, which vary in size but are approximately 5 feet wide by 10 feet long. As with vaults, manholes are considered a confined space and require additional safety precautions to be followed for entry.

a) IPL

The IPL system contains approximately 433 miles of concrete-encased conduits and 1,210 manholes in the network.

The vaults, manholes, and ducts that house the Indianapolis secondary networks are typical of those in other cities, except that the size of the older IPL manholes is believed to be smaller than at other utilities. As mentioned previously, the IPL manholes are drier than those in many other cities. Many other cities have large rivers running through them or are in coastal areas and see flooding of manholes fairly consistently.

As mentioned before, the IPL system is at a disadvantage compared to many other network systems because of the extensive (second largest in the US) steam system. This causes some manholes to be too hot to enter, and some ducts to occasionally get so hot that it exceeds the cable's temperature rating.

The standard for new manhole construction is to use pre-cast concrete if there are no obstructions. If there are barriers or insufficient room to install a pre-cast manhole, concrete block manholes will be installed. Estimated manhole construction percentages among existing structures are:

- Pre-cast Concrete ~25%
- Brick ~55%
- Concrete Block ~20 Minimal

The standard for new duct line construction is to use PVC. It is estimated the existing duct line construction percentages are:

	Type of Duct	Percentage	Miles
•	5" Fiber	~ 5%	~ 22
•	4" Fiber	~30%	~130
•	5" PVC	~ 5%	~ 22
•	4" PVC	~20%	~ 87
•	1 Way Clay 3 1/2"	~20%	~ 87
•	4" Sewer Tile	~18%	~ 78
•	3" Sewer Tile	~ 2%	~ 9

10. Spot Networks

Spot network systems are typically used in the urban centers where two or more distribution primary lines (e.g. 12 or 13kV) are supplied to network transformers. Most often, the secondary voltage is 277/480 volts that supply a single large customer/building. It is called a spot network because it uses network-type transformers whose secondary network side terminals are interconnected by cables or a bus. It is very reliable because the secondary connections are from multiple primary sources. Nevertheless, a failure at the common customer collector bus will result in a customer outage.

Spot networks are most often used for customers too large to be fed from the 120/208V secondary grid.

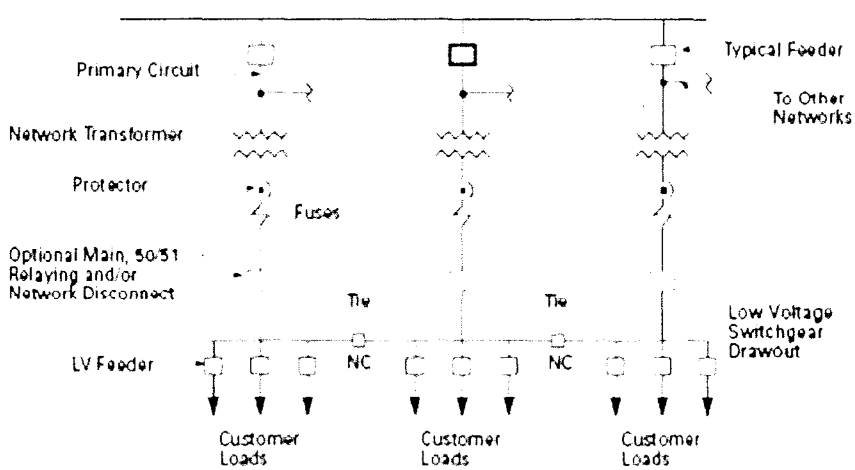

Figure 9 Typical Spot Network Electrical Schematic

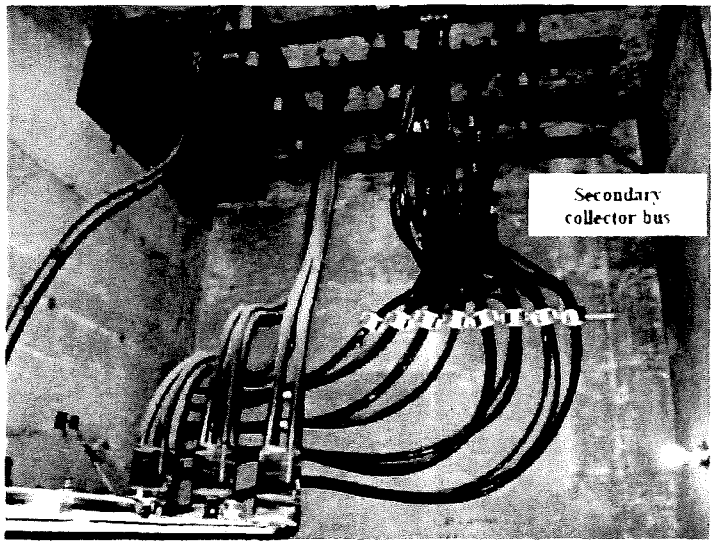

Figure 10 Vault Secondary Collector Bus in Good Condition

11. Secondary Grid Networks

Secondary networks are designed to meet the higher reliability needs and limited space commonly encountered in urban areas.

In a secondary network, electricity is delivered through a system of multiple transformers and underground cables that are connected and operate in parallel. Power can flow in either direction on the lower voltage service delivery lines, commonly called secondary mains. The loss of a single line or transformer in a secondary network does not cause an interruption of power, unlike radial systems that serve most customers outside the downtown areas. If a radial line experiences an outage, service is interrupted to customers until repairs are completed; this is less likely to be the case in a secondary network distribution system.

Most secondary grid networks are operated at 120/208 volts. A primary reason for this is that when you have 277/480 volt networks, the voltage is often high enough to prevent the arc from self-extinguishing.

A schematic of the sources to a secondary network is shown on the next page.

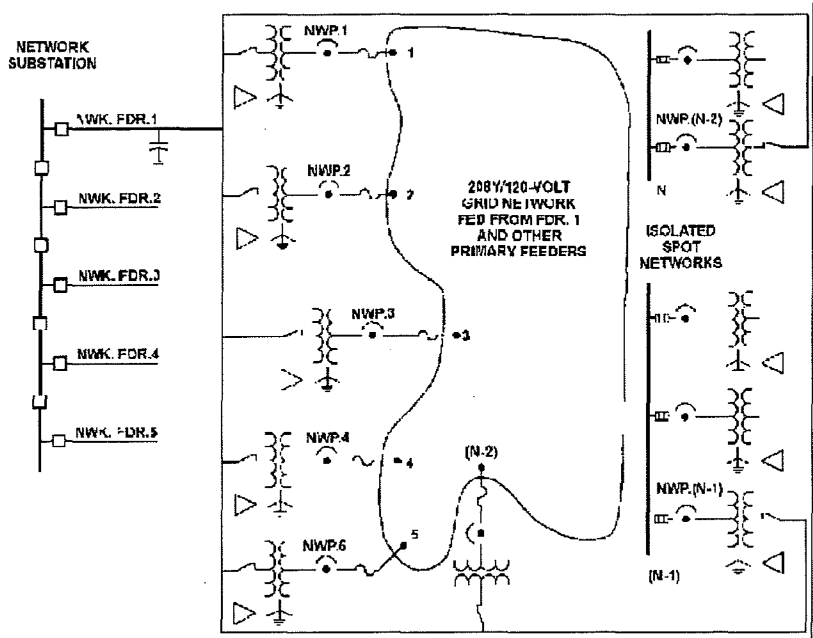

Figure 11 Schematic of Secondary Grid Network Feeds

a) IPL

IPL has approximately 198,000 feet (37.5 miles) of network secondary cable. This cable is in four secondary network areas fed from two separate Substations: Gardner-Lane and Edison. The map (previously presented) of the area served by the four secondary networks (Edison East and Edison West, Gardner Lane North and Gardner Lane South) is shown on the next page.

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[redacted]

Figure 12 IPL Secondary Network Overview

The secondary cable is predominantly PILC, with an estimated 80% of the existing installed cable in service today. All new secondary cable installations are EPR with the vast majority of the new and existing cable being 350 MCM.

The estimated percentages of secondary cable types used in the Indianapolis networks are:

Type of Cable	Percentage	Miles
• PILC (500 MCM)	~ 5%	~2
• PILC (350 MCM)	~ 75%	~28
• EPR (500 MCM)	~ 5%	~2
• EPR (350 MCM)	~ 15%	~ 6

All of the secondary cable is copper.

IPL has designed the secondary grid to have the secondary burn in the clear in the event of a fault. The mains (secondary ties between transformers) are most often 350 MCM, and do not have cable limiters installed.

12. Services

IPL installs cable limiters on both sides of service cables of 3/0 or larger when there are more than two runs of cable. For two runs or less, IPL installs limiters only on the source side. This practice is in line with majority of other utility practices.[4]

a) IPL

The estimated percentage of service cable types used in the Indianapolis network is:

Type of Cable	Percentage	Miles
• PILC (500 MCM)	~ 10%	~ 12
• PILC (350 MCM)	~ 10%	~ 12
• EPR (500 MCM)	~ 55%	~ 68
• EPR (350 MCM)	~ 25%	~ 31

All of the secondary cable is copper and IPL uses limiters on both the customer and utility sides for the larger sizes and multiple runs of service cables.

B. Age Profile

Overall, most network systems across the United States are on the "older" side compared to radial distribution systems. This is often the case because they were initially built long before the surrounding service areas were built out. The following charts show age graphs of IPL network transformers and protectors.

Because of the network protector replacement program to comply with OSHA and NFPA arc flash guidelines, the 277/480 V network fleet is getting much younger at a very fast rate. This program will be complete in 2018. The remaining 120/208 V protectors will continue to be inspected every two years to ensure they continue to perform as designed. The conditioned-based replacement program will continue for these lower voltage network protectors.

[4] EPRI 2012 Urban Network Practices Inventory

1. IPL

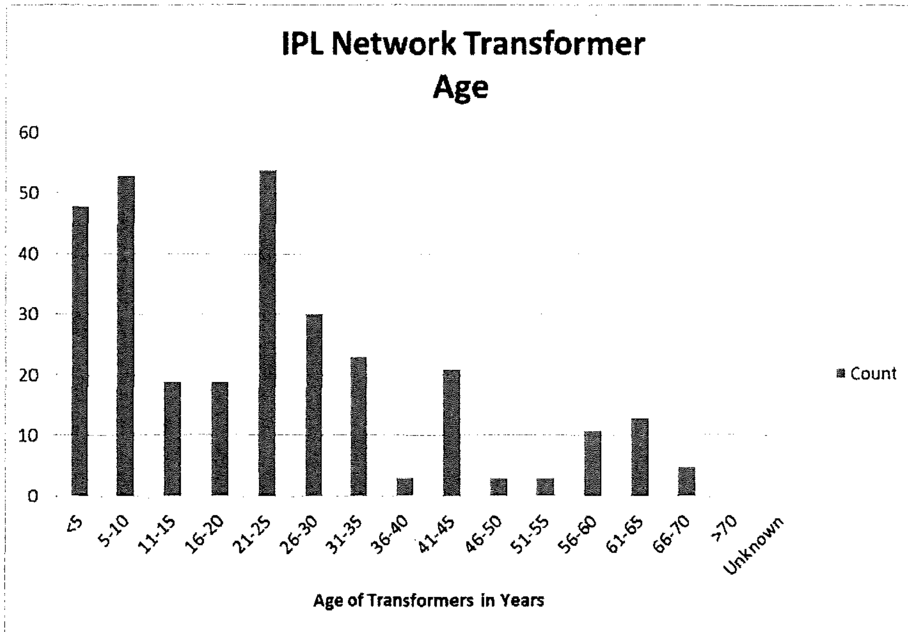

Figure 13 IPL Transformer Ages

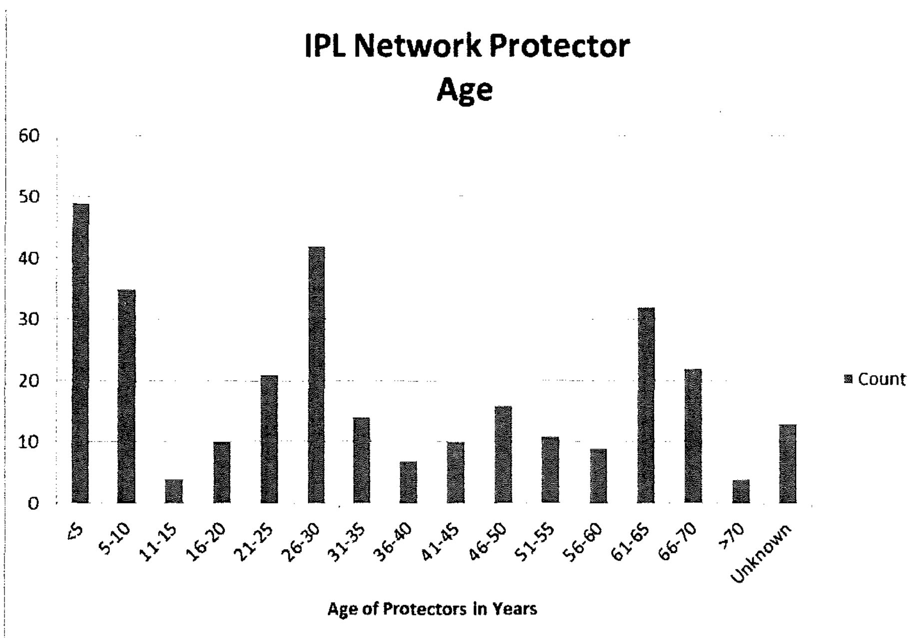

Figure 14 IPL Protector Ages

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C. Annual Growth and Replacement Programs

1. Industry

An EPRI survey of 29 utilities that operate urban networks found that 69% of the respondents were focusing on keeping the geographical area served by network systems the same size. A small percentage (13.8%) was increasing the size and 17.2% were decreasing the geographic area.[5]

From a Best Practices survey commissioned by PPL & LGE in 2013, almost all utilities have some form of a PILC cable replacement program. Those utilities that do not have much PILC have a multi-year program for replacement. Utilities with a significant amount of existing PILC tend to focus more on a performance-based replacement program. This performance-based program is predominantly the primary cable replacement driver for most companies.[6]

Additionally, this survey showed there are also programs for replacing transformers and protectors that are at or near their end of life. This is typically in the range of protector replacements averaging at least 1% of the asset population a year, mostly due to failures rather than load growth. Some utilities were more aggressive and replaced as much as 3 to 4% per year.

Transformer replacements were comparable with the protector replacements, at about 1 to 2% of total asset population.

2. IPL

IPL also has been working on reducing the size of its downtown network. All new services on the fringes of the downtown network are served radially with padmount transformers. Most of these padmount transformers are fed from non-network substation transformers and feeders.

D. Design/Construction/Engineering Standards

1. Preferred Practices

Most utility network systems are designed for n-1 contingencies. [7] An EPRI study found that 79% of utilities designed for n-1 conditions at peak load and 21% designed for n-2 contingencies at peak load.

IPL designs their network for n-1 conditions and has enough redundancy that they can withstand n-2 and greater contingencies for most scenarios.

[5] EPRI 2012 Urban Network Practices Inventory
[6] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013
[7] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013

2. IPL

IPL has a set of underground standards that address common downtown network construction practices. Interviews with subject matter experts noted the following standards need attention, and these will be addressed by the Asset Management group before the next annual update of this ALCP:

- No formal ring bus standard
- Cable specifications need updating
- No specification exists for network protectors

E. Equipment Specifications

1. Network Transformer and Protector Specifications

The IPL specifications for network equipment refer to the ANSI and IEEE standards. The following is a list of the latest network publications:

- IEEE C57.12.00-2010, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- IEEE C57.12.40-2011, IEEE Standard Requirements for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed).
- IEEE C57.12.70-2011, Terminal Markings and Connections for Distribution and Power Transformers.
- IEEE C57.12.90-2010, IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
- IEEE 386-2006 INT 1 – 2011, Separable Insulated Connector Systems Power Distribution Systems above 600 V.
- NEMA TR1-2013, Transformers, Step Voltage Regulators and Reactors.

The above standards pertain to a typical network transformer and protector schematic as shown below.

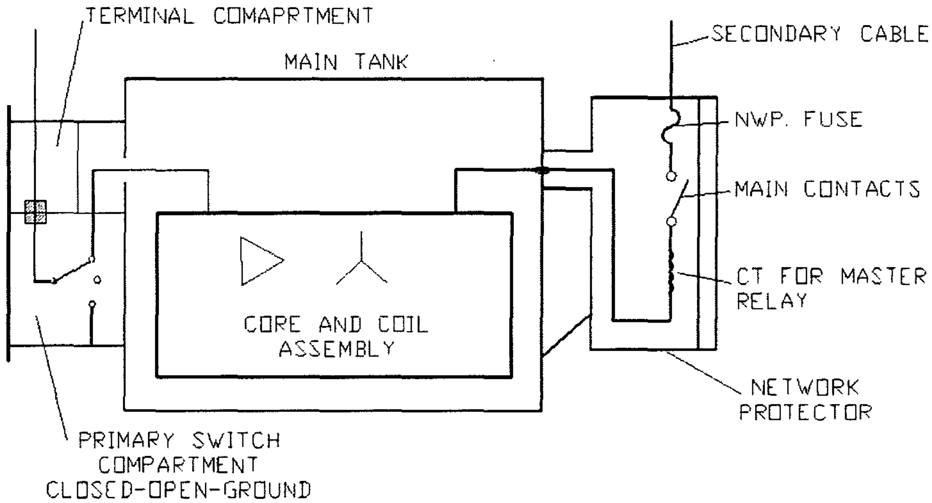

Figure 15 Typical Transformer/Protector Schematic

IPL has standardized on network transformers containing FR3 and bolted primary termination chambers for all future purchases. Additionally, given recent experience and history, IPL will continue to utilize the Eaton protectors.

2. Primary Cable Specifications

Presently, IPL uses EPR cable for new and replacement primary network cable installations. Recently, during the North Street Network Event Root Cause Analysis[8] IPL found that the existing polyethylene jacket on one primary cable had thermal damage from an outside heat source. The source was likely from a previous steam leak. Since this RCA, IPL has found another location where cable that was manufactured in 2013 had similar damage. (See Section V.A Citizens Thermal Coordination for a detailed description and view of the cable damage.)

Based on information from Okonite, the manufacturer of the IPL EPR Primary Cable, the polyethylene jacket is rated at 90° C if it's UL or 105° C if UL is not required. The melting point of polyethylene is 115 C. Its jacket will become soft at temperatures near 115° C. This 115° C is equivalent to 239° F.

Given this latest information IPL has conducted expanded research and worked with Okonite to find a cable with an outside jacket that has a higher temperature rating. [redacted] that is the best suited for the IPL environment.

[8] Root Cause Analysis for North Street Network Event on March 19, 2015, Prepared by James Sadtler Director, Transmission Field Operations Input From Dr. Steven Boggs of Nonlinear Systems Inc., Issued on June 1, 2015.

3. Secondary Cable Specifications

Today IPL uses EPR cable for new secondary network cable installations. This choice has been working well for IPL. However, as mentioned in the Primary Cable Specification Section, IPL recently discovered that polyethylene outer jacket can be damaged by excess heat from a temperature anomaly in the neighboring steam network that co-exists with the IPL network.

After significant research and a factory visit, IPL has an initiative to pilot a [redacted] secondary cable called [redacted] See Section IV.D.2 Protection Gap #2 - Secondary Grid Fault Protection Alternative Strategy #2 for additional explanation. This cable has been selected as the standard by utilities with large urban networks. [redacted] It is believed the pilot trial will be successful and this will become the cable of choice for all new or replacement network secondary installations.

[redacted]

4. Secondary Connection Specifications

IPL uses a combination of ring busses and wyes for secondary connections. The majority of utilities[9] use a mole/crab connection for secondary cables. IPL plans to pilot using moles and crabs for secondary connections. This gives the advantage of a cleaner connection and will create a good location for limiter installations. If the pilot performs well, IPL plans to use this installation for all future secondary manhole connections.

[9] EPRI 2012 Urban Network Practices Inventory

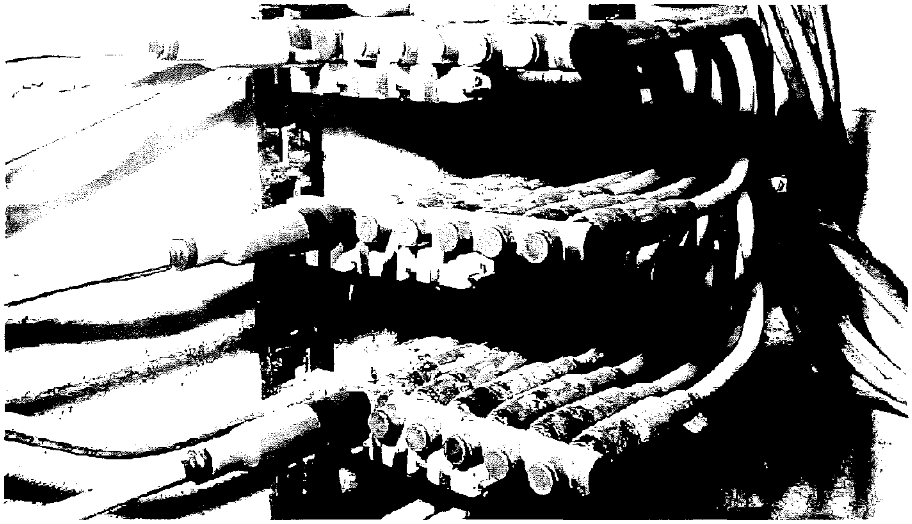

Figure 17 Mole/Crab Connections

By making connections with moles/crabs in each manhole the overall fault duty will increase for the secondary network because the increased number of secondary interconnections will provide more parallel paths and less impedance for fault currents. This is a good result and will help minimize secondary faults that do not burn themselves clear.

5. Secondary Limiter in Main Secondary Cable Runs

IPL has not used limiters in secondary mains in the past. Since the vast majority of utilities are no longer installing PILC secondary cables, the fault currents required to burn secondary faults clear will be increasing. This fault current concern and the fact that most utilities surveyed are already using limiters on service cables and secondary mains, has led IPL to conclude that it should also begin installing secondary limiters in all of our new and replacement secondary cable installations. There is a smart or visible limiter available on the market that allows for the inspector to visibly see if the limiter is blown without having to clamp the cable with an ammeter. A picture of one is shown below. We plan to pilot use of this device as we deploy mole/crabs throughout the network.

Figure 18 Smart Visual Indication Limiter

F. Sources of Network System Information

IPL participates in a number of organizations to share and gain insights into downtown network practices. A few of these organizations worth noting are:

- American National Standards Institute (ANSI)
- Institute of Electrical and Electronics Engineers (IEEE)
- Electrical Network Systems Conference (ENSC) – this is once per year and put on by Eaton
- Network Forum – hosted by Bob Lanham of H&L Instruments
- Electric Power Research Institute (EPRI)
- Northeast Underground Committee (NEUG)
- North American Dense Urban Utility Working Group (NADUUWG)

We utilize such participation as channels for acquisition of information and for exploring potential strategies with other industry experts. Maintaining these valuable relationships takes effort, but distributing ownership across the Asset Management team, makes the workload more manageable, and provides an excellent learning and development opportunity for junior staff.

III. Asset Performance

A. Performance Objectives and Measures

The performance of electric distribution systems is typically measured by a combination of system outages and worst-performing specific locations. Almost all utilities use the **SAIFI** (System Average Interruption Frequency Index), **CAIDI** (Customer Average Interruption Duration Index), and the product **SAIDI** (System Average Interruption Duration Index) to measure their performance. Comparisons between similar utilities are used to measure, "How well are we doing?" The indices work well for typical radial distribution systems. However, they do not work well for networked systems.

Most utilities have not developed any reliability metrics for assessing the performance of the network system. Some that have metrics track major component failures (transformer, protector, primary chamber, ground switch), primary and secondary cable failures.[10]

However, most utilities do track the number of feeder failures. In a Best Practices study commissioned by PPL and LGE in 2013, the utilities that responded using five years of history, the average feeder failure rate of 0.125 per year or about one failure every 8 years. While the average in the survey was once every 8 years, individual company averages ranged from 2 years between failures to 12 years between failures.[11]

It is also noted that equipment loading and environment (steam, salt, water, etc.) are significant variables that can drive failure rates.

Many of the incidents in downtown networks are visible and receive significant publicity. There are a number of publicly available sources documenting Commission investigations, such as:

- The Assessment of Underground Distribution System of the Potomac Electric Power Company Final Report", dated December 7, 2001 and referenced in May 2007 Filing No. 991-E-218
- Independent Assessment of Dislodged Manhole Covers Prepared for The Commonwealth of Massachusetts Department of Telecommunications & Energy Massachusetts Report", dated December 9, 2005

While individual manhole incidents gather a lot of attention, it has been difficult to quantify some incidents with actual publicly available numbers. The next two figures show a couple of tables that have been published.[12]

Utility	Number of Network Manholes	Number of Manhole Incidents per Year	Manhole Incidents per 1000 Manholes per Year
Alabama Power	250	5	20
Florida Power and Light	220	3	14
Texas Utilities	3500	24	7
GPU Energy (PA)	286	2	7
Boston Edison	3000	12	4

[10] EPRI 2012 Urban Network Practices Inventory
[11] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013
[12] The Assessment of Underground Distribution System of the Potomac Electric Power Company Final Report", dated December 7, 2001 and referenced in May 2007 Filing No. 991-E-218

Con Edison	275,000	1219	4
NYSEG	250	1	4
Tampa Electric	500	1	2
Jacksonville Electric Authority	1400	2	1.5
Pepco	57,000	38	0.7
Duquesne Light	1800	1	0.6
Virginia Power	2400	1	0.4
Southern Company	2937	1	0.3

Figure 19 Selected Utility Manhole Incident Counts

Summary of Other Utility Manhole Events

State	Companies	Date Range	Manhole Events	# of Manholes	# of Vaults	# yrs of data
DC[1]	Pepco	Jan 2000- Dec 2000	48	n/a	n/a	1
		Jan 2001- July 2001	46	n/a	n/a	0.58
MA[2]	NSTAR	July 2004 - Dec 2005	44	38000	800	1.5
	National Grid	Aug 2004 - Dec 2005	20	20735	1675	1.4
	WMECO	June 1999- Dec 2005	30	3750	250	5.5
	Unitil	1998- Dec 2005	0	192	30	8

Figure 20 IPL 7/7/2011 Report to IURC

B. IPL

IPL tracks network incidents in a MS Access database. This database is located on an IPL network drive. The link is [redacted]

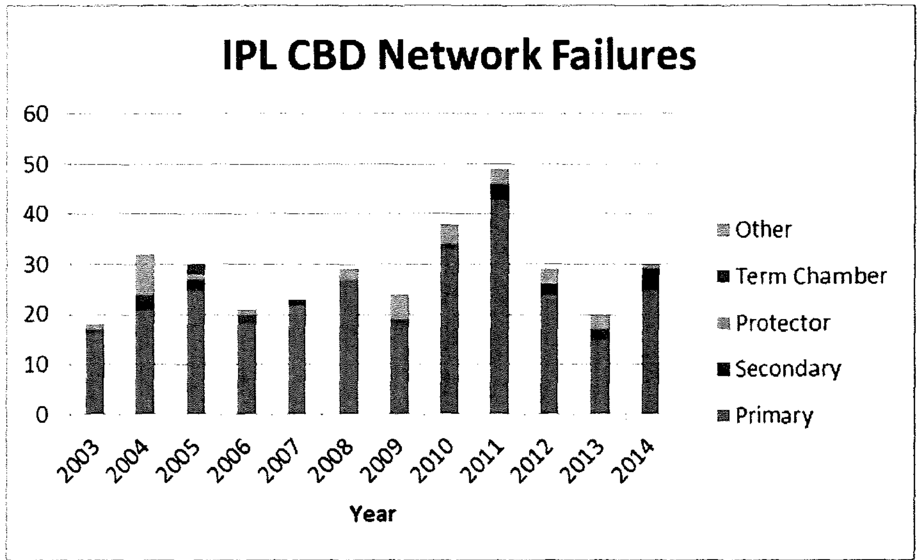

Figure 21 IPL CBD Network Equipment Failures

This figure combines various types of equipment failures (primary cable, network transformers, network protectors, and secondary incidents) to yield an overall view of the network performance. Most of these failures caused no interruption to customers because of the redundancy of the design. The level and trend of these failures, however, can be used as an approximate gauge of the potential for incidents that would interrupt customers or cause a network incident.

One obvious difference for the IPL data is the large number of primary faults that IPL experiences compared to the industry averages. This has been primarily attributed to the presence of a large steam system in Indianapolis. To help address any steam issues that may affect the IPL electric system, Citizens Thermal and IPL have established a joint Task Force and monthly coordination meetings. (See section V.D for more details.)

Additionally, there has been an e-mail notification blast message group created. As of August this group consists of 62 e-mail addresses. This has been a very successful method to communicate with all critical players from both IPL and Citizens Thermal.

C. O'Neill Consulting Recommendations

After some IPL downtown network events, in 2011 O'Neill Management Consulting, at the request of the Indiana Utility Regulatory Commission was hired to review IPL's downtown network performance.[13] All ten recommendations from the report to improve the performance of the IPL network were implemented by IPL. The following table lists these recommendations.

[13] Independent Assessment of Indianapolis Power & Light's Downtown Underground Network Final version December 13, 2011, O'Neill Management Consulting, LLC

Item	Tier 1 Recommendations	IPL Status	IPL Action
1	Improve Citizens Thermal coordination and address and have a process to address hot manholes	Completed	Monthly coordination meetings with IPL and Citizens. Additionally, implemented e-mail alert notification to address hot facilities. Additionally, IPL and Citizens have formed a Task Force to look at the long term strategy of co-existance of both systems.
2	Improve the program of inspection and repair of manholes and vaults	Completed	Manholes, vaults, transformers, and protector inspection data is captured with tablet computer with business logic built into the inspections. This data is analyzed by the Ivara algorithm developed with SMEs to get consistent priorities for follow up work. All data is transparent and viewable with through a web page.
3	Begin a program of retrofitting termination chambers and protecting the tops of network transformers with deflector shields	Completed	IPL retrofitted all termination chambers with FR3 fluid and all tranformers requiring deflector shields.
4	Begin a program of replacement of certain failure-prone network protectors	Completed	IPL has examined all aluminum bus protectors and all CM-22 480V protectors. Additionally, IPL is replacing all 277/480V protectors for arc flash mitigation (employee safety and improved reliability).
5	Improve the process of asset management by dedicating additional resources to development of equipment databases and processes	Completed	Significant additional resources have been added with a full-time staff of 12 people and use of outside consultants and contractors.
	Tier 2 Recommendations		
6	Evaluate technology for electronic capture of field inspection findings through the use of handheld devices, such as tablets, smart phones, or other means	Completed	Manholes, vaults, transformers, and protector inspection data is captured with tablet computer with business logic built into the inspections.
7	Re-examine the SCADA project, re-focusing on the data that such equipment will capture, and managing the stages of implementation	Completed	CBD SCADA project is complete. Data is available to all users via easy to use web site, PI Process Book and MS Excel. Additionally, an e-mail is automatically sent to stakeholders on any abnormal values.
8	Continue to deploy small-scale technological advances such as thermal imaging, fault direction indicators, and lift/locking manhole covers in selected locations	Completed	Infrared is used during inspections. Fault indicators are used to improve fault locating. By the end of 2015 all downtown network manholes will have Swiveloc manhole covers installed.
9	Continue to develop automated mapping/GIS data and applications for the downtown underground network	Completed	The downtown network in in the GIS Gtech mapping system. Load flow and fault study work continues.
10	Re-evaluate Dissolved Gas Analysis on network transformers, and explore the possibilities for fire retardant dielectric in vaults.	Completed	All transformer main tanks, switching compartments, and termination chambers had DGAs completed. All new transformers have FR3 fluid and bolted connections for the primary termination.

Table 1 – 2011 O'Neill Consulting Recommendations

It is important to note is that IPL not only completed all ten of these recommendations, but in many instances have exceeded the recommendations and gone much further to improve the downtown network performance.

IV. Asset Condition and Risk

A. Impact of Failure and/or Risk Exposure

Similar to public reaction to utility storm response, the perceived performance of a downtown network and network events tends to garner significant local regulatory and media attention. This can be seen by monitoring media reports.

One way to monitor these media reports is with Google Gmail account alerts that monitor the web for new content and are configured to send an e-mail to you. So if you want to receive recent postings about topics such as manholes, downtown network fires, etc., you can have this alert automatically send an e-mail to your Gmail account. The Gmail account can automatically forward these alerts to another e-mail account that you use for work. The link to set this feature up is at:

https://www.google.com/alerts

At IPL in Asset Management we have such alerts tracking the following terms:

- manhole,
- downtown network fire
- downtown power outage

As stated previously, network events such as secondary outages and network fires tend to get significant negative attention. So the strategy question is, "How best can we minimize this risk?"

B. Network Response to Incidents

In the PPL / LGE commissioned Best Practices survey in 2013, most utilities did not have a formal written network emergency restoration plan, nor did they have any type of load management plan to follow during feeder outages at peak load periods. Most follow an ad hoc process of load monitoring, field inspections, and internal discussions.[14] Additionally, at the Indiana Commission hearing on November 3, 2014 regarding IPL's downtown network issues, Commission experts strongly urged IPL to have a written Network Response Plan for these abnormal events.

[14] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013

In another survey on network event responses, a 2012 EPRI Survey showed 57% percent of respondents believed they had an up-to-date, documented procedure for responding to network emergencies, with 18% going to the effort to conduct periodic drills for events such as network outages or fires.[15]

The documentation of a network plan is a good way to help transfer knowledge of subject matter experts and also allows time to study and consider alternatives to different event scenarios.

The IPL Network Emergency Plan was completed and issued on February 21, 2015.

C. Network Failure Root Cause Analysis

IPL has conducted thorough Root Cause Analyses over the past few years for each significant downtown network event. The results of these RCAs have provided opportunities to further improve understanding of the failure mechanisms. A list of these RCA's is shown below:

- 150 East Market Street Network Event on March 14, 2014.
- 26 S. Meridian Street Network Event on August 13, 2014.
- 327 East New Your Street Network Event on November 24, 2014
- 428 Massachusetts Avenue Network Event on March 16, 2015
- North Street Network Event on March 19, 2015

D. Protection of Network Elements (Risk Profile)

One of the ways to minimize risk to the network is to ensure that for the highest risk items, a plan exists to minimize the consequences (this usually means fires and/or outages).

Historically in the industry the items that have created the most attention are:

- Network Transformer or Protector Failures Resulting in a Fire
- Network Customer Outages
- Dislodgement of Manhole Covers

These are usually the result of incidents that are at the boundary of relay/fuse protection devices, secondary faults, or in some cases where there is very limited fault clearing capabilities or intermittent arcing faults. In these instances, a utility cannot rely on the fault to "burn" itself clear or even have limiters, if present, clear the fault.

[15] EPRI 2012 Urban Network Practices Inventory

This section presents IPL's strategy for dealing with two of the most visible risk scenarios (Protection Gaps) - transformer low side winding and network protector and secondary grid fault protection, which have been identified as having higher "risk potential" than other areas of the network.

1. Protection Gap #1 - Transformer Low Side Winding and Network Protector Protection

The majority of utilities surveyed via EPRI, Midwest Electrical Distribution Exchange (MEDE), Indiana Energy Association (IEA), and phone interviews, do not have a sure-fire method to de-energize faults on the low side of the transformer winding and/or within the network protector. Below is a typical schematic showing the primary feeder, network transformer, protector and secondary grid.

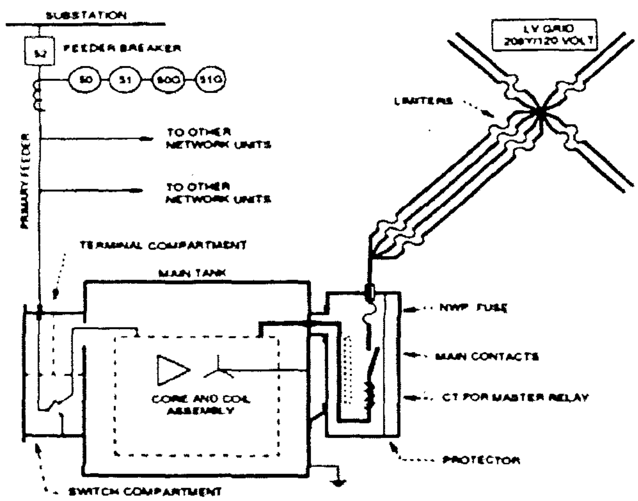

Figure 22 - Standard Feeder, Transformer, Protector, Grid Schematic

In many instances, if a failure occurs in the low side transformer winding or on the source side of the network protector fuses, the substation relays are not sensitive enough to trip for fault currents.

In the 2013 PPLL / LGE commissioned survey of best practices, the survey respondents noted that some utilities are looking at, or have installed as a pilot, a vacuum interrupting device in front of the network transformer to allow the transformer to self-clear during a fault (not the

009261

feeder breaker), and also to take the transformer out of service without switching out the feeder.[16]

We have reviewed the extent of this problem across the IPL network and present possible solutions to this transformer low side fault scenario in the next few sub sections.

a) IPL Practices 277/480 V Locations

Currently, IPL specifies and purchases 277/480 V protectors with fuses. The older IPL protectors were bought without fuses and use links similar to the DP&L protectors. The fact that IPL does not fuse the 277/480 V leads from the protector to the collector bus broadens the range of limited fault clearing exposure.

Historically, IPL has not had a good way to de-energize this type of failure. However, IPL subject matter experts can only recall one event, which was the IPL 26 S. Meridian event in August 2014, that resulted in this type of fault scenario.

b) 120/208 V Locations

This low side fault situation is an issue for IPL on 120/208 V systems. However, the risk of a fault that is not self-extinguishing on the 120/208 V system is significantly less than that of a 277/480 V system. So the need to find a more sensitive fault clearing/fire protection solution is not warranted based on a thorough benefit-to-cost comparison.

c) Alternative Strategy #1

The predominant practice to protect this area has been to use something similar to the Fenwal® system that is being used at DP&L or other heat/infrared detection systems to de-energize the source of fault current entering the substation.

The cost of a Fenwal® installation is approximately $[redacted] per bay. This includes the Fenwal wire, network protector heat sensing element, and the purchase, installation and control of a high side disconnecting device to the transformer. Although the switches do not provide overcurrent protection, they are connected to the Fenwal® System which should open the switches in the event of a vault fire.

DP&L is successfully using the Fenwal® Fire Detection System in their 480V Spot Network Vaults. The control unit, operating directly from the power source, impresses a small voltage on the sensing elements. When an overheat condition occurs at any point along the element length; the resistance of the wire drops sharply; causing current to flow between the outer sheath and the center conductor.

This current flow is sensed by the control unit, which produces a signal to actuate the output relay and trip a lockout relay in the vault. This lockout relay trips all of the high side switches in front of the transformer. This system is not used in the 120/208 V vaults.

[16] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013

When the fire has been extinguished or the critical temperature lowered, the Fenwal® System automatically returns to standby alert, ready to detect any subsequent fire or overheating condition.

A review of 20 years of experience with the Fenwal® system shows five false trips during this time, or one every four years. It has not been needed to operate correctly.

There has also been some question as to whether this system will be sensitive enough to operate for an internal low side transformer fault.

d) Alternative Strategy #2

Another possible alternative is to adjust the substation feeder relay settings to sense a fault on the low side of the network transformers. This would cover the 120/208 V and 277/480 V secondary systems.

To study this alternative the IPL network system was used. It is modelled in GIS and CYME and an older model in ASPEN. For this ALCP review, faults were simulated on the low side of the transformer terminals for dozens of different vault transformers using the ASPEN tool. Single phase to ground fault scenarios were used since this resulted in the least amount of primary feeder current. The fault values seen at the feeder breakers ranged from a high of 789 to a low of 94 amps. The low 94 A scenario was for a single line to ground fault on the UG [redacted] network protector at [redacted] West New York Street.

These fault current values are too low to trigger any type of automatic relay tripping of the substation breaker. There are many other fault scenarios that are behind a network protector fuse or limiter that can draw more than the minimum current of 94 Amps seen in this low fault scenario. Additionally, during most days the feeder load current will be more than 94 Amps.

Consequently, it will be necessary to monitor VAR values in the SCADA system rather than monitoring solely fault current values. To get the differentiation needed, these VAR values need to be single phase values. Below is a sample phasor diagram at the substation breaker with the lowest fault current of all the scenarios run (one phase-to-ground 120/208 V fault).

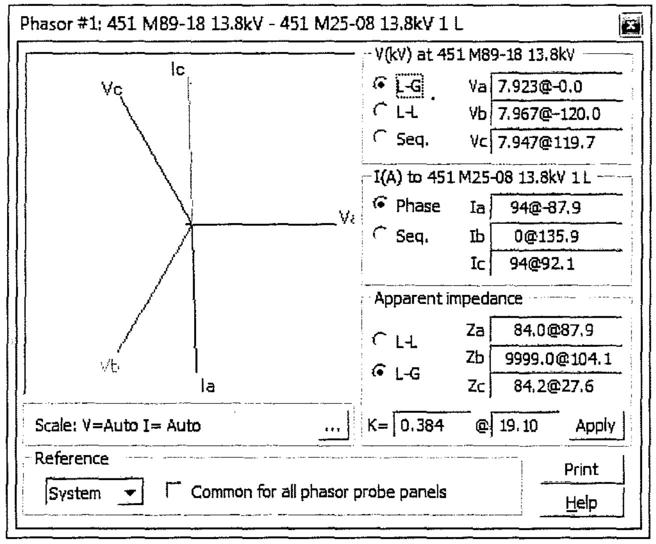

Figure 23 - Phasor Diagram of Fault Current for Low Side Protector Failure

The Schweitzer Engineering Labs (SEL) 351 relay has the capabilities to monitor single phase VARs. The drawback to this solution is it should not be set it to automatically de-energize the feeder. It will require operator intervention. So the ECS system will be set to alarm on these points when the values above a threshold of approximately 500 kVAR.

Using microprocessor relays for both the network protector and feeder protection opens the possibility of detecting an arcing fault signature. IPL has observed voltage and VAR bursts during fault incidents. Below is a screenshot from IPL's PI Historian from the 13kV feeders for arcing faults on the 120/208 V network.

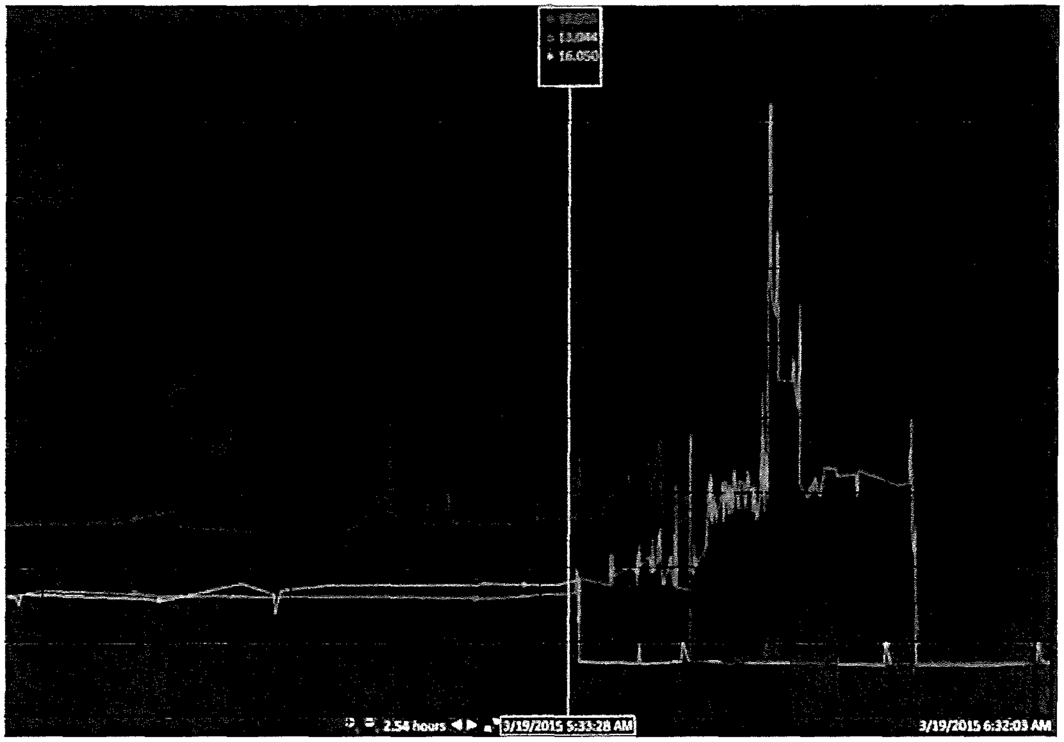

Figure 24 – 13kV Current for Low Voltage Arcing Fault

IPL presently does not monitor VAR values at the feeder level for the circuits feeding the downtown networks. As part of the CBD SCADA, IPL does monitor the individual network protector VAR readings. The chart below shows KVAR, KW, and KVA values from PI Historian data recorded for a recent 120/208 V fault at North Street and Capital Avenue. As expected, the KVAR and KW values have a similar signature as the feeder currents.

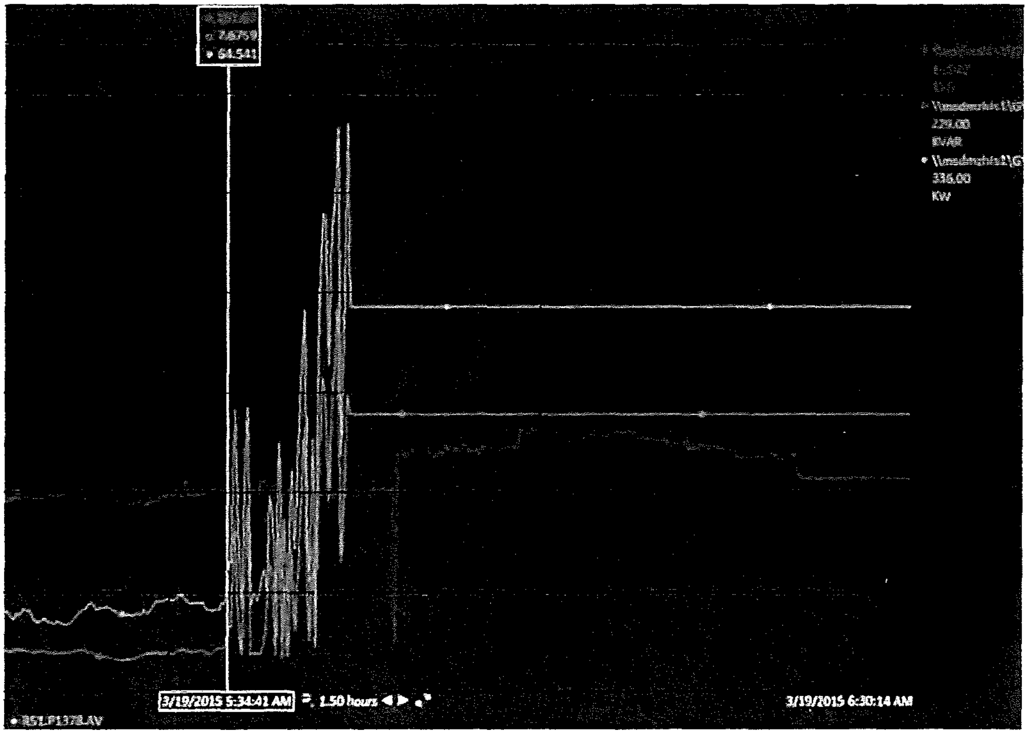

Figure 25 – 210 W New York 411 Unit KVA, KVAR, & KW for Low Voltage Arcing Fault

Our understanding is that Eaton is developing software for their network protector relay to possibly identify these arcing faults as part of a relay firmware upgrade. IPL uses the Eaton MPCR network relay and has completed its upgrade of all network protector relays in 2013 as part of IPL's $50 million Smart Energy Project.

e) *Alternative Strategy #3*

A third possible solution has also been investigated. There is likely sufficient room in most 277/480 V vaults for a primary switch/overcurrent device to be installed. The [redacted] Switch would accomplish this, giving overcurrent protection to help guard against incidents. This switch has a microprocessor relay and can be set to coordinate with the network protector fuses and substation relays.

The cost of the basic model switch is $[redacted]. If we assume a similar cost to install the switches the total IPL cost would be in the ballpark of $[redacted] dollars for doing all of the 277/480V transformers.

f) Decisions

(1) 277/480 V Locations

As mentioned before, DP&L has an existing system (Fenwal®) for the 480V protection that has worked well. While it does result in occasional false operations (historically one every four years), it is recommended DP&L continue this practice for 277/480 V vault locations.

At a very high level the estimated costs for implementing these alternatives at IPL are:

- Alternative #1: $ 8.4 M
- Alternative #2: $ 0.6 M
- Alternative #3: $ 7.0 M

The plan is for IPL to implement alternative #2. While the disadvantage is that this alternative requires operator intervention, given the small probability of occurrence based on DP&L and IPL history, along with present industry practices for most utilities, the additional costs of the other alternatives in this instance have minimal justification.

(2) 120/208 V Locations

As mentioned before, Alternative #1 (Fenwal®) is used at DP&L and addresses the 277/480 V systems. However, this has not been implemented at the 120/208 V locations.

For IPL it is believed the cost/benefit of implementing this solution for the lower voltage systems is not warranted because of the very low probability of occurrences.

2. Protection Gap #2 - Secondary Grid Fault Protection

The second and more likely protection gap scenario is a network secondary fault that results in dislodged manhole covers, network fires and outages. The following table shows a summary of a Survey of Underground Network Secondary Limiter use by Charles Fijnvandraat.[17]

Utility	Network Size	Use Limiters within 120/208 grid?
Alabama Power	~450 units	No
IPL	~320 units	No
LGE	~ 425 units	No
MGE	~ 200 units	No
Nashville Electric	~400 units	No
PPL - 5 network cities	~ 280 units	No
Con Edison	~26,500 units	Yes
EPCOR	~175 units	Yes
HECo	~ 140 units	Yes
NSTAR	~1,350 units	Yes
Pepco	~4,150 units	Yes

[17] Secondary Limiter use Survey of Underground Network by Charles Fijnvandraat, July 24, 2014.

PGE	~1,360 units	Yes
PPL - 1 network city	~ 50 units	Yes
Seattle City Light	~1,250 units	Yes
SMUD	~450 units	Yes
UI	~160 units	Yes
Georgia Power - Savanna	~80 units	Yes

Table 2 – Secondary Limiter Use in Secondary Mains

Some of the key highlights from this survey are:

- Most utilities have experienced burning manholes and non-extinguishing arcing faults regardless of whether or not they use limiters
- Limiters are installed with the intention to reduce the extent of equipment damage
- Utilities without secondary grid limiters are designed to clear faults by the secondary cable burning clear
- Coordination issues can exist with limiter use
- It is not unusual to experience faults where no limiters were blown
- Most faults on the secondary grid are high impedance, arcing types
- Almost all utilities have practices to allow the secondary at first to burn clear and/or limiters to open, then if necessary, cut the secondaries around the faulted area
- Piecemeal replacement or gradual installation of limiters can lead to coordination issues
- Inspection programs are important, in particular looking for open limiters after a fault incident
- None of the survey participants have plans to change the present design and operation of their secondary system

Additionally, a 2012 EPRI survey showed 24 out of 27 respondents use limiters in their secondary mains.[18] DP&L installs limiters on all of the secondary main conductors from crab to crab. During discussions with DP&L field subject matter experts, it was learned that limiters can be found blown and no abnormal issues found and vice versa, similar to the results referred to in the previous survey.

IPL does not install limiters on secondary main conductors. From the above data it shows IPL's practice of not using limiters in the secondary mains is in the minority of utilities responding.

One of the issues at IPL is the lack of routine fault studies looking at limiter coordination or whether sufficient fault current exists on the outskirts of the network to ensure faults can burn clear.

[18] EPRI 2012 Urban Network Practices Inventory

Previously, IPL has considered the feasibility of installing cable limiters at certain locations on the secondary network system to provide an additional level of protection. These cable limiters could help to isolate faulted secondary cables and reduce the risk of secondary network events for some fault scenarios. The determination of the possible locations for placement of these cable limiters requires detailed models of the secondary network system, as well as performance of both power flow and fault current studies.

For very low currents, the limiter may not protect the cable insulation for intermittent arcing faults. This is not unusual, and is why today there are still cable fires in utility systems that have limiters.[19]

a) Alternative Strategy #1

Presently IPL uses a condition based replacement program for secondary cables. During manhole inspections, cables are evaluated based on the apparent condition of the cable end protruding from the duct, and damaged cables are scheduled for replacement. While this approach has worked acceptably in the past, the limitation of this solution is that IPL still has secondary faults. Only about 5% of the secondary cable is visible for inspection. Con Ed in New York had researchers from the University of Connecticut and commissioned a Columbia University Study which found that most serious secondary incidents are usually not in a manhole, but start in the duct line.[20] This is reinforced by the Root Cause Analysis for North Street Event on March 29, 2015.[21] This alternative would suggest continuing down the path IPL has historically used.

b) Alternative Strategy #2

An alternative is to move to a more robust cable design and significantly accelerate the replacement of the secondary cable in the downtown networks. Some of the major utilities [redacted]

While this cable and a replacement program will not prevent secondary incidents over the next several years, it will significantly reduce the likelihood of such events in the near term. However, the cost of this program will be significant. For the IPL system with approximately 37 miles of secondary cable and an average installation cost of $[redacted] per foot, we would expect an increase in capital budget requirements of approximately $ [redacted] million for just the secondary cable installation. However, this work is also very likely to require some new duct line and

[19] The Assessment of Underground Distribution System of the Potomac Electric Power Company Final Report", dated December 7, 2001 and referenced in May 2007 Filing No. 991-E-218

[20] 2011 Contact Voltage Test & Facility Inspection Annual Report, Consolidated Edison Company of New York, Inc. February 15, 2012 http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={0D67AB70-0C8B-4DDB-A458-7EDD2978BB3C}.

[21] Root Cause Analysis for North Street Network Event on March 19, 2015, Prepared by James Sadtler, Director, Transmission Field Operations, Input From Dr. Steven Boggs of Nonlinear Systems Inc., Issued on June 1, 2015

manhole replacements, which will increase the overall cost of the secondary cable replacement program.

It is estimated that approximately [redacted] of the duct line in the areas that will be targeted for secondary cable replacement will need to be replaced with new ducts. With the cost of a new duct line estimated at $[redacted] per foot this significantly increases the cost of replacing secondary cable. We have an estimated [redacted] secondary cable runs (on average) in each duct bank, yielding the following calculation.

- Secondary Cable Replacement = Miles * ft. /mile * $/secondary mile
- Secondary Cable Replacement = [redacted]
- Duct Rebuilding = probability of duct repl. * duct cost *sec. feet / sec. runs per duct
- Duct Rebuilding = [redacted]

There will also be a need to rebuild some of the older manholes. It is estimated approximately [redacted] of the 1210 manholes will need to be expanded or rebuilt. The average cost is approximately $[redacted] per manhole.

- Manhole = # of manholes * probability of replacement * cost
- Manhole = [redacted]

Under these very high level assumptions, the total cost for replacing the entire IPL secondary cable system and necessary duct replacements is approximately $[redacted] million. This does not include any contingency, nor the cost for cable limiters or mole/crab installation.

c) *Alternative Strategy #3*

Another alternative approach is to selectively identify and target replacement of impending secondary cable failures in the duct line (before they actually fail) is to scan the downtown network for stray voltage. During a demonstration, IPL tested the use of [redacted] to identify locations that may have indications of stray voltage. Initial testing was very promising. Data has shown that this technology allows utilities to identify and replace cable at the earliest stage of failure, often before it has a chance to evolve into an incident that impacts safety or reliability.[22] Presently [redacted] has contracted approximately [redacted] employing this technology to identify stray voltage locations on a daily basis.

[22] 2011 Contact Voltage Test & Facility Inspection Annual Report, Consolidated Edison Company of New York, Inc. February 15, 2012 http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={0D67AB70-0C8B-4DDB-A458-7EDD2978BB3C}.

d) SME Identified Risk

Given the recent attention network fires and outages have garnered with the public and local Commissions, IPL feels it is necessary to have an effective replacement program for secondary cables similar to the 1 to 4% replacement programs many utilities have for network transformers and protectors.

A survey of IPL subject matter experts identified key areas that have a heavy volume of secondary cables (higher risk consequence areas) and/or a history of secondary problems (higher risk probability) that need to be reviewed in more detail. These locations are:

[redacted]

e) Decisions

As described above, IPL is currently in the minority among US utilities with urban network systems in not using limiters in secondary mains. With our planned movement to [redacted] cable and away from PILC for secondary mains, IPL will begin a pilot program of using limiters on the IPL secondary system. The optimum areas for this program have been identified from subject matter expert interviews (see Section IV.D.2.d). The planned funding for the IPL secondary cable replacement program in the capital budget is $ [redacted] annually.

<u>Targeting Which Cables to Replace</u> - There is currently no industry accepted practical approach for inspecting the condition of cables within the duct bank conduits between manholes. And our cable assets are generally all well within the acceptable life spans for these assets in service elsewhere across the industry. Therefore simply replacing all our secondary cable (37.5 miles in total) is not economically justified. Nevertheless, we do not support a run-to-failure approach for this strategically important asset. The funding level we have established is sufficient to replace approximately 16,000 feet of secondary cable per year, but the challenge is in identifying where to start and how to prioritize the replacement work as we progress through the system. We are employing 2 targeting strategies for this prioritization:

- Identifying Pending Failures - IPL will implement a pilot program over the next several months using stray voltage detection technology and will determine how successful this is in finding stray voltage and identify secondary cables beginning to fail. If this is successful, we anticipate moving to an annual survey program using this service.

- Targeting areas of identified thermal damage - As described in section V - Interaction with Steam System – a portion of IPL's secondary cable is suspected to have been exposed to excessive operating temperatures from past exposure to steam leaks and insulation break downs. We have discovered evidence of significant damage done to some of these cables and believe this has played a significant part in recent cable failures. As outlined in section V, we have identified more than [redacted] locations in which we have our cable in close proximity to Citizens Thermal Steam Piping. We are defining the criticality ranking of these colocation sites based on:

- Citizens' documented history of past leaks,
- IPL's documented history of cable failures,
- The number of primary and secondary cables in our duct banks, and
- Several sensitivity factors associated with: load in that area, Vault / Manhole construction and congestion, cable location within the duct bank, and cable age and failure history.

Based on the priority of these locations, we will be initiating inspections of selected cable in those duct banks. Depending on the health and cleanliness of the ducts, the inspection methods will range from video inspection of the cable sheathing in the area of the steam system crossing, to extraction of 1 or more sample cables for condition assessment / examination. System wide replacement priorities will then be established based on these condition findings.

E. Asset Health Indexing and Criticality

1. Asset Health Indexing

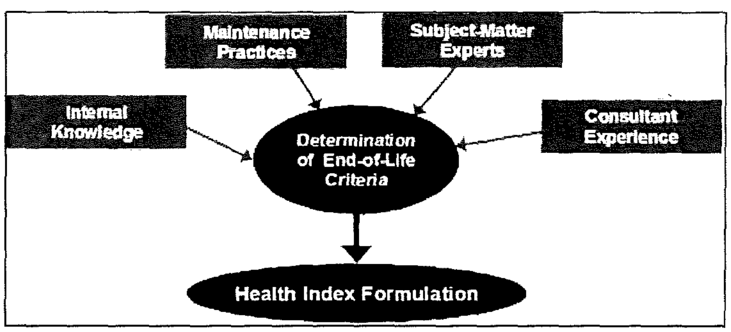

Figure 26 - Standard Asset Health Index Formulation Example

An effective Asset Health Indexing approach allows a utility to systematically identify where an asset is in its life cycle and when it is likely to reach end of life.

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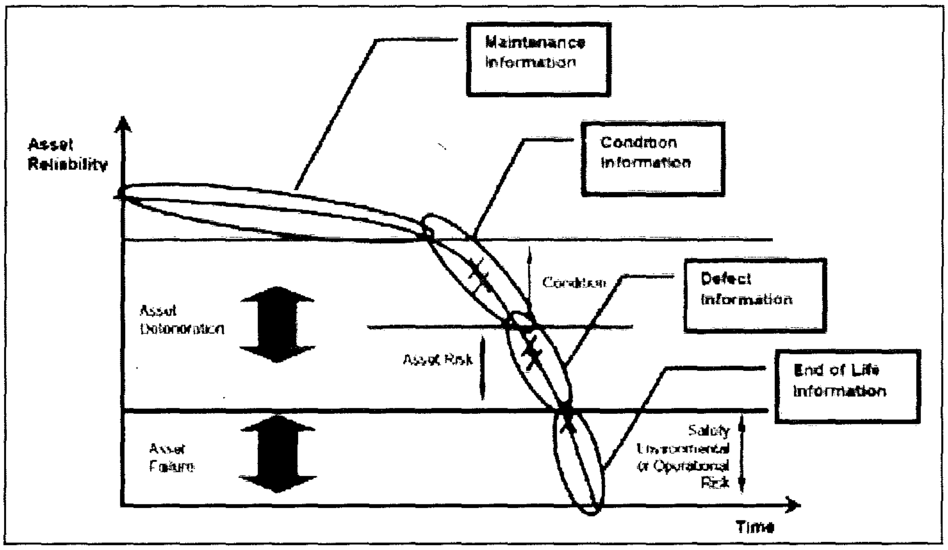

Figure 27 - Asset Lifecycle Diagram

Our Asset Health Index approach uses the findings from preventive maintenance activities and asset condition assessments to develop an overall picture of the health of the asset. It is based on identifying the modes of failure for the asset and its subsystems, and then developing measures for the degradation that can lead to end-of-life for the entire asset. To develop each index, there is a need to understand the functionality of the asset and the manner in which its subsystems work together. Condition ratings of subsystems can then be combined to create a composite score for the asset. The continuum of asset scores can be subdivided into ranges of scores that represent differing degrees of asset health (and therefore risk of failure).

For downtown network systems a useful initial approach for determining the AHI is to aggregate and trend the results of manhole and vault inspections. IPL has developed calculated indicators for manholes, vaults, transformers, and protectors. These are trended to help determine overall network health. The graph below is a running 12 month indication from December 2014.

In the last half of 2014 additional indicators for network protectors were added, looking for protector bushing damage and barrier board tracking. These additions were based on the results of a root cause analysis done on the failed protector at 26 South Meridian in August of 2014. These changes added more indicator values, raising the baseline average scores for network protectors.

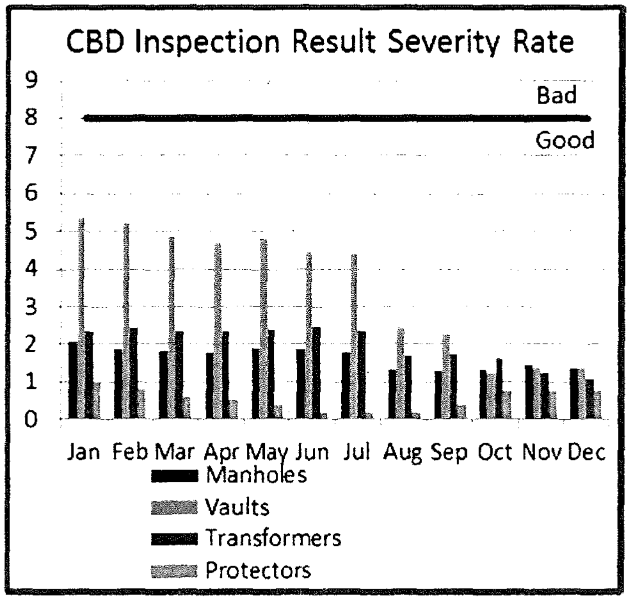

Figure 28 – IPL Calculated Indicators Showing Inspection Follow-up Severity

From the graph to the right, we see the trend of inspection finding severity scores are decreasing. The bars on this chart illustrate a rolling 12 month average of inspections results. This suggests that the overall health of the network assets on December 2014 was much better than on January 2014. We are still evaluating the optimum level for manhole indicator follow up severity scores.

Additionally, a count of IPL inspections and follow up work orders for the downtown network (below) shows some catch up manhole inspections done in 2014, and that we are stable at our planned levels for other inspections.

IVARA CBD Inspection Count

Count of Inspections	**Column Labels** 2012	**2013**	**2014**	**Grand Total**
MANHOLE-PD	368	450	620	1438
NTWK PROTECT-PD	165	26	160	351
NTWK TRNSFRM-PD	141	115	155	411
VAULT-PD	63	74	69	206
Grand Total	**737**	**665**	**1004**	**2406**

Table 3 - IPL Ivara CBD Inspection Count

Results from these inspections are presented in the table below and show that the follow up work that was generated by these inspections was effective in driving a very significant decrease in *"defects"* or *"non-conformances"* over the past three years. Overall condition of the equipment in our vaults and manholes has therefore improved appreciably.

EMPAC CBD Follow Up Work Orders Generated from Ivara Inspections

Count of WORK_ORDER_NO	Column Labels			
Row Labels	**2012**	**2013**	**2014**	**Grand Total**
FEEDERS-PD	8	13	10	31
MANHOLE-PD	160	44	24	228
NTWK PROTECT-PD	3		1	4
NTWK TRNSFRM-PD	58	25	1	84
VAULT-PD	21	32	7	60
Grand Total	**250**	**114**	**43**	**407**

Table 4 - IPL EMPAC CBD Follow Up Work Generated from Inspections

Of course, a substantial portion of our CBD Network assets exist outside the manholes and vaults, in the ducts that connect these areas. These are the primary and secondary cable runs. As indicated earlier, asset condition and health is more challenging to measure for these assets. We have significant experience with these assets and believe that the condition of our cables is generally good, with the obvious exception of cable sections that have been damaged by exposure to steam or extreme heat from neighboring steam mains and services where the insulation has deteriorated over time. Therefore, our focus in this area will be to survey the cable in those ducts known to have experienced such a high temperature exposure, and use any evidence of damage discovered to prioritize our cable replacement investments over the next several years.

The long-term goal is to develop a comprehensive set of measures that will allow us to rate individual elements and the asset system as a whole as *excellent*, *good*, *average* or *poor*. It is also important to monitor the overall trend in asset health. The format used to monitor such trends is illustrated below.

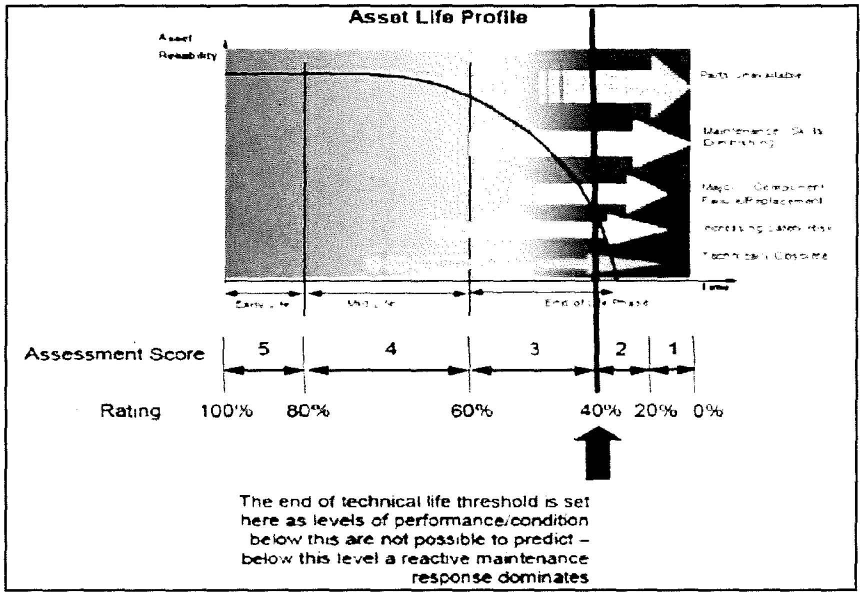

Figure 29 - Asset Life Profile Utilizing an Asset Health Index (Assessment Score)

Industry Best Practice is to use Asset Health Index values to drive Asset Management decisions. The percentage of assets in each index category is managed to achieve the desired asset profile. It is paramount to know whether the number of assets in poor condition (where failure is more likely) is increasing, or if the average condition is trending downward (suggesting a possible under-investment). Interventions are planned based on meeting targets for Asset Health and minimizing overall power system risk.

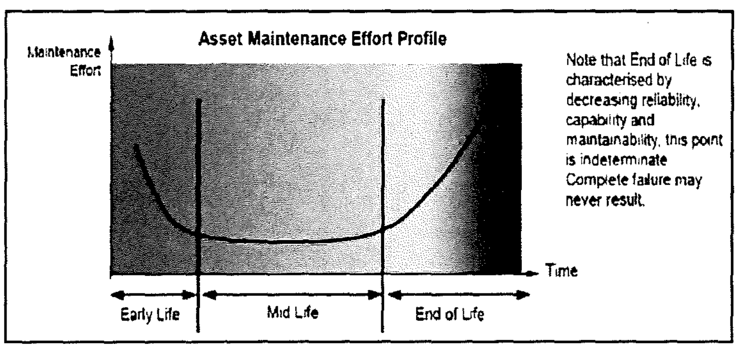

Figure 30 - Asset Maintenance Effort Profile

2. Asset Criticality

Translating Asset Health into Asset Risk requires integration with a model that calculates the criticality of each particular asset.

Asset criticality provides a measure of the consequence of failure and may, for example, be evaluated in terms of the following criticality areas:

- Safety
    - What is the safety risk for our employees?

- What is the safety risk for the general public?
- Network Performance
  - What is the likely impact on customer reliability if a particular component in the network fails?
- Financial
  - What is the cost associated with a failure or an outage?
  - What is the cost associated with an incident such as network fire?
- Company Image/Regulatory
  - What is the risk to the Company's image when an incident occurs?
  - Any regulatory obligations or risks?
- Environmental
  - What is the risk of an environmental impact associated with a failure?
  - Etc.

a) IPL Manhole Criticality Inputs

IPL has developed the following inputs for scoring the criticality of manholes, along with the weights associated with these inputs. This data and the calculated criticality scores are stored for each manhole in the Ivara Asset Performance Management System.

The overall criticality is calculated by summing the total indicator rating values together for each manhole and divided by the maximum sum possible. The result is added to one to get a number from 1 to 2 to use as a multiplicand for overall asset risk.

As an example criticality score we will assume a manhole has a history of steam, an existing vented cover, and more than 3 primary circuits in a manhole. The criticality would be calculated as 1 + (8 + 1 + 3) / 30 = 1.4. This criticality factor is the multiplicand with the asset health value for a sum of overall asset risk.

Manhole Criticality Ratings (06-29-12)	
INDICATOR	Priority Rating (1 to 10) 10 most urgen
MH - Criticality History of Steam	8
MH - Criticality Secondary 500MCM	7
MH - Criticality Secondary Circuits (3 or more)	5
MH - Criticality Previous Fault	4
MH - Criticality Primary Circuits (3 or more)	3
MH - Criticality High Traffic Area	2
MH - Criticality Vented Cover	1

Table 5 - IPL Manhole Criticality Inputs

b) IPL Vault Criticality Inputs

IPL has developed the following inputs for scoring the criticality of vaults along with the weights associated with these inputs. The process is the same as that previously described for manholes. This data and the calculated criticality scores are stored for each vault structure, transformer and protector in the Ivara system.

Vault, Network Transformer, and Network Protector Criticality Inputs and Ratings (07-06-12)	
INDICATOR	Priority Rating (1 to 10) 10 most urgen
Vault - Criticality History of Steam	10
Vault - Criticality Secondary 500MCM	7
Vault - Criticality Transformers Peak Loading > 50% (No outage)	5
Vault - Criticality Important Customer	5
Vault - Criticality Outage for Double Contingency	5
Vault - Criticality Multiple Transformers Without Fire Separation	4
Vault - Criticality Previous Incident	4
Vault - Criticality High Traffic Area	3
Vault - Criticality Unique Construction	2

Table 6 - Vault, Transformer and Protector Criticality Inputs

F. IPL Downtown Network Asset Health and Criticality Indexes

IPL uses the previously mentioned asset criticality and inspection indicators to calculate overall and individual asset risk indices. The following charts illustrate the overall risk index for each class of assets for the IPL downtown network. The asset criticality is based on items such as steam history, number of cables, high traffic areas, etc. These asset health indices are based on the latest inspection data – so it is a worst case presentation because some of the recorded defect items resulting in poor scores have since been corrected. All of this data is stored in Ivara. The following charts show this data as of August 2015 with the manhole risk indexes shown below.

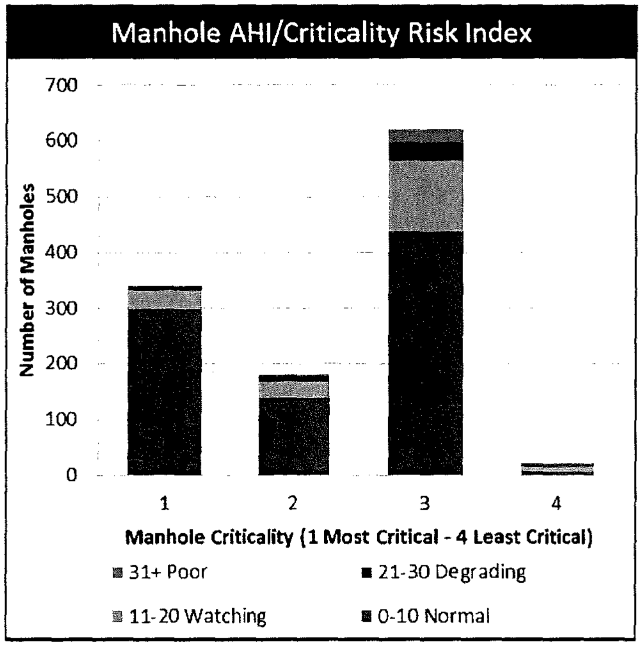

Figure 31 – Manhole AHI/Criticality Risk Index

The figure above shows the vast majority of manholes are in the 'normal risk' category. Any manholes that are in the degrading or poor category have had a follow up work order issued with appropriate priorities assigned based on criticality.

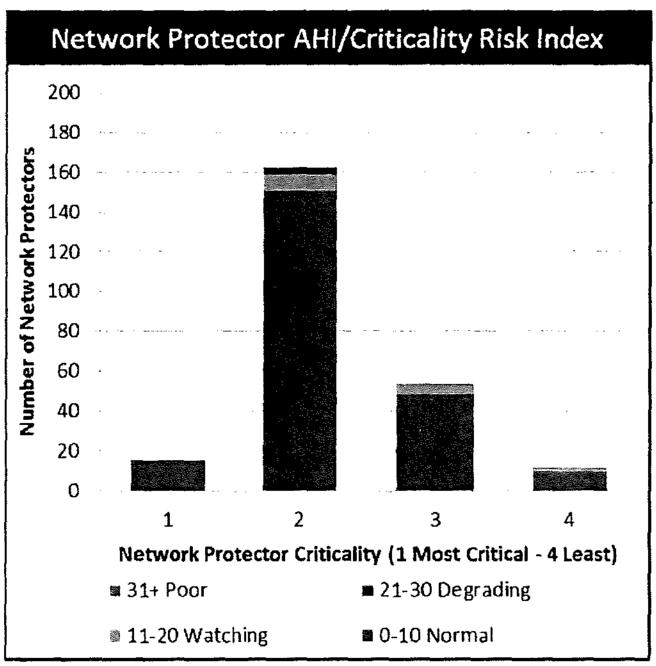

Figure 32 – Network Protector AHI/Criticality Risk Index

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The figure above for network protectors shows the vast majority are in the normal risk category. Any that are in the degrading or poor category have had a follow up work order with an appropriate priority assigned.

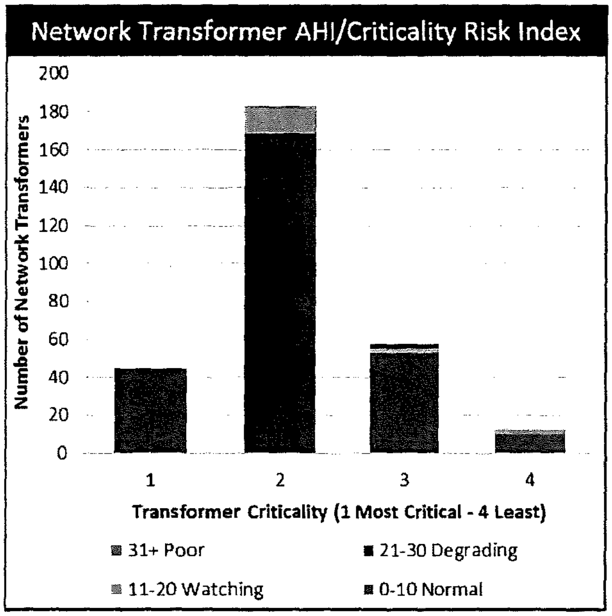

Figure 33 - Network Transformer AHI/Criticality Risk Index

Similar the manhole and network protector charts, the vast majority of Network Transformers are in the normal risk category. Any that are in the degrading or poor category have had a follow up work order with an appropriate priority assigned.

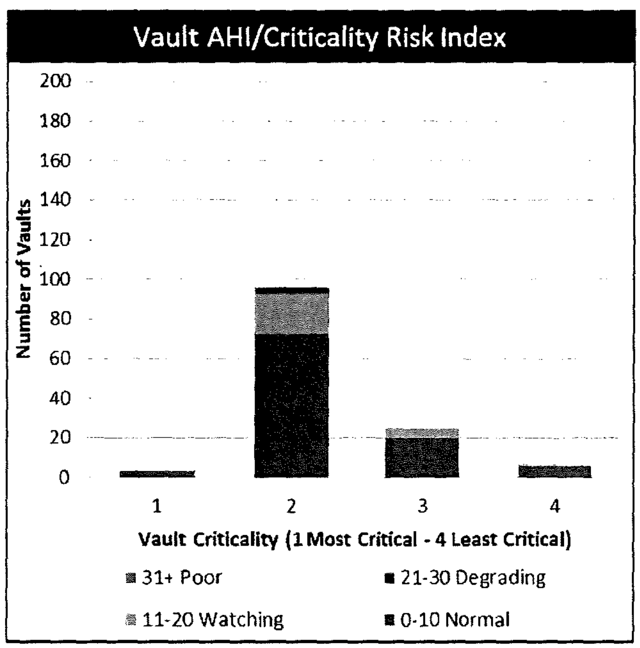

Figure 34 - Vault AHI/Criticality Risk Index

The above figure for vaults shows the vast majority are in the normal risk category. Any structure issue is tracked in the IPL WMIS work management system. These are visited by a civil engineer to have priority ratings assigned from 1 to 10.

V. Interaction with Steam System

As noted in the Asset Performance and Asset Condition sections, IPL has higher cable failure rates than are typical of other utility downtown networks. While industry data is lacking on the effect of a steam system with a power system, anecdotal data from discussions with other utilities makes it clear that there is a significant effect. Interviews with DP&L's most experienced subject matter experts suggest they typically experienced around 2 faults per month on their downtown network when Dayton had an active steam system. In 1981 when the steam system was shut down, the number of faults fell to less than six per year. A survey of selected utility fault data seems to confirm this observation.

A. Citizens Thermal Coordination

Indianapolis has the second largest steam system in the United States (only smaller than New York City). IPL shares the city streets with this network of high temperature steam pipes, and this coexistence has increased the number of cable faults that IPL has compared to our peers.

IPL and Citizens Thermal work very closely with each other to address any steam anomalies found during inspections or the course of normal work. Monthly coordination meetings are conducted and any issues that need to be addressed are discussed during these meetings. Citizens Thermal also shares their steam anomaly system survey each year with IPL. IPL reviews this data and does spot checks of manhole and vault locations.

Additionally, IPL and Citizens Thermal have an email notification system that is used to inform and communicate issues such as a hot manhole that needs to be addressed. A sample of this e-mail is shown in Appendix XI.G.

One of the findings of the Root Cause Analysis for North Street Network Event[23] was that steam is suspected to have caused the secondary cable failure in the duct line. Neither manhole on either side had any recorded history of being hot. In 2015 IPL personnel took the Citizens Thermal Anomaly Report and using a thermocouple, measured the temperature at any crossing that showed higher than normal temperatures on the Anomaly Report. The results of these inspections are included in Appendix O.

A few of the locations showed duct temperatures in excess of 150 degrees Fahrenheit. The highest temperature found was on the north side of Ohio Street where a duct line crosses Meridian Street. The recorded temperature at the highest point in this duct run was 211 degrees Fahrenheit. There were two sections of idle primary cable in this duct line. One cable

[23] Root Cause Analysis for North Street Network Event on March 19, 2015, Prepared by James Sadtler Director, Transmission Field Operations Input From Dr. Steven Boggs of Nonlinear Systems Inc., Issued on June 1, 2015

was PILC and the other EPR. IPL crews pulled both the idle cables out for inspection and to check for thermal damage. The following photos show the damaged cable.

Figure 35 – EPR Cable Damage

The EPR cable shown in the above and below pictures was relatively new, manufactured in 2013. Obviously the cable jacket is showing thermal damage similar to the failed EPR primary cable jacket at North and Capital during the North Street Secondary Event.

Figure 36 – EPR Cable Damage Close Up View

The picture following shows the PILC cable that was removed for inspection and to check for thermal damage. The lead sheath shows significant aging. The polyethylene jacket on the neutral has been completely melted away on a part of the cable. The copper has also turned green, illustrating that it has been exposed to the elements for some time.


Figure 37 - PILC Cable Damage

B. Description of the Citizens Thermal System

Citizens Thermal has low and high pressure steam systems. The system operates at approximately:

[redacted]

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[redacted]

C. Analysis of IPL and Citizens Faculties in Close Proximity

IPL and Citizens Thermal maps were overlaid and locations where facilities are in close proximately were documented. Parallel and locations where IPL and steam lines cross were noted. Some of the results revealed of this initiative include:

[redacted]

D. IPL and Citizens Thermal Strategic Initiative

As noted in the previous section the influence of the steam system up in the duct line was discovered during the North Street RCA and then subsequent duct line temperature measurements confirmed this observation. This data led to a subsequent Task Force being formed to review long term strategic plans to address this duct line temperature issue.

In August of 2015, representatives of Citizens Thermal and IPL along with Dr. Steven Boggs met to discuss the latest information and to brainstorm possible next steps and long term solutions to minimize the impact of the steam system on the power distribution system.

Some of the key points from this initial meeting were:

[redacted]

[redacted]

E. Duct Line Temperature Monitoring

At the request of IPL, Dr. Steven Boggs has done some high level modelling of steam temperatures and the escalation of temperatures through a typical duct system. Some of the key points from his initial modeling include:

- The temperature between ducts in the same duct bank can vary significantly.
- Temperature movement through concrete is very slow. It takes approximately 24 hours for heat transfer through 1 foot of concrete.
- Any temperature monitoring needs to be in the duct closest to the steam line.
- The computations also suggest that air flow in the ducts may be effective in limiting the temperature to which cables are exposed as a result of a nearby steam leak.

IPL has contracted with Dr. Boggs to conduct more detailed Finite Element Analysis computations for duct bank temperature management to get more detailed and a better understanding of the heat transfer process and possible damage mitigation practices which might be taken by IPL and Citizens when leaks are discovered.

F. Strategic Initiatives for Co-Existence

Based on the research and analysis done the following additional initiatives are planned to address power/steam issues.

1. Form an IPL/Citizens Thermal Strategic Initiative Task Force

As mentioned in Section D, this group has been formed and had its initial meeting. A charter and task list has been created. Citizens has agreed to share their steam line elevation maps so that IPL can estimate the separation between IPL duct line and steam line crossings. This data will be used, along with the number of secondary cables in the duct bank, to prioritize locations for real time temperature monitoring and/or routine manual measurements.

2. Duct Line Temperature Monitoring Pilot Program

IPL will begin a pilot program for monitoring duct temperatures in real-time and bring the data (in either an analog or alarm status) back through the IPL SCADA system using the existing VaultGard communication hubs. This pilot program will test various technologies that are available and find the optimum technology and application method.

3. Determine Highest Risk Areas with Power/Steam Proximity

Using IPL and Citizens Thermal maps, manhole data sheets, Citizens' Anomaly Reports, manhole steam history and field inspection data, IPL Asset Management will assemble this data into a database and develop appropriate algorithms to prioritize locations with the highest risk factors. Over time these algorithms will be adjusted and refined as we learn from new data.

VI. Asset Maintenance

A. Maintenance Strategies & Standards

Underground networks present challenges to the utility industry, with aging infrastructure and high costs for construction and maintenance compared to radial distribution systems.

1. Industry Practices

An EPRI survey of 29 utilities operating network systems in 2012 found the vast majority of utilities regularly perform vault (97%) and manhole (83%) inspections. Almost all of these inspections are on time-based cycles. Additionally, 93% of the respondents have documented up to date maintenance guidelines for performing maintenance on network equipment.[24]

2. IPL

IPL inspects all vaults, transformers and protectors on a two year cycle. Manholes are on a three year cycle. Presently these inspections are collected using MobileFrame software and tablet computers. This manhole inspection process is documented at:

[redacted]

During manhole inspections, 20 indicators are recorded using built in business logic to guide the inspector through the inspection process. Table 1 in the Appendix shows these inspection items and condition assessment states. Each state is assigned weight that helps determine the urgency of the follow up work. This data is trended to determine if inspection frequencies should increase, decrease or remain the same.

The vault inspection process is documented at:

[redacted]

Examples showing the indicators collected and their severity scores are shown in the Appendix of this document.

[24] EPRI 2012 Urban Network Practices Inventory

a) MobileFrame Inspection Software

IPL implemented the MobileFrame software late in 2012. This software with built in logic guides the inspector through the inspection process. The tablet computer is shown below.

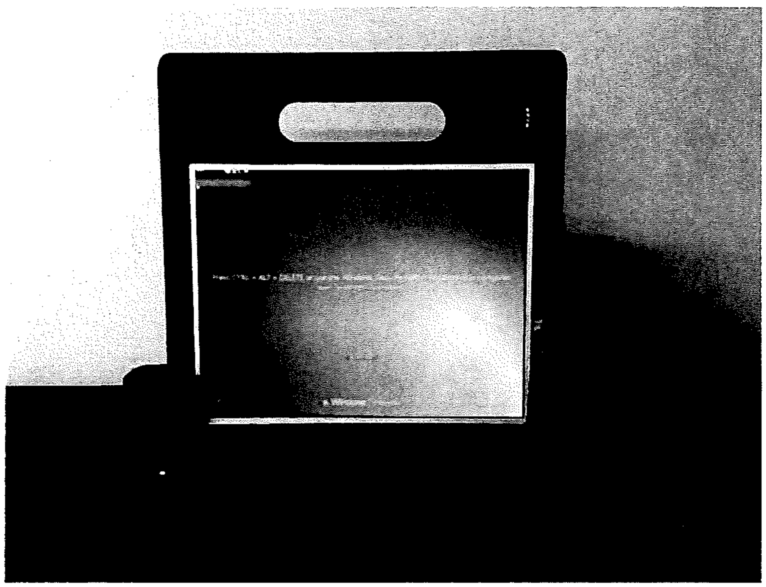
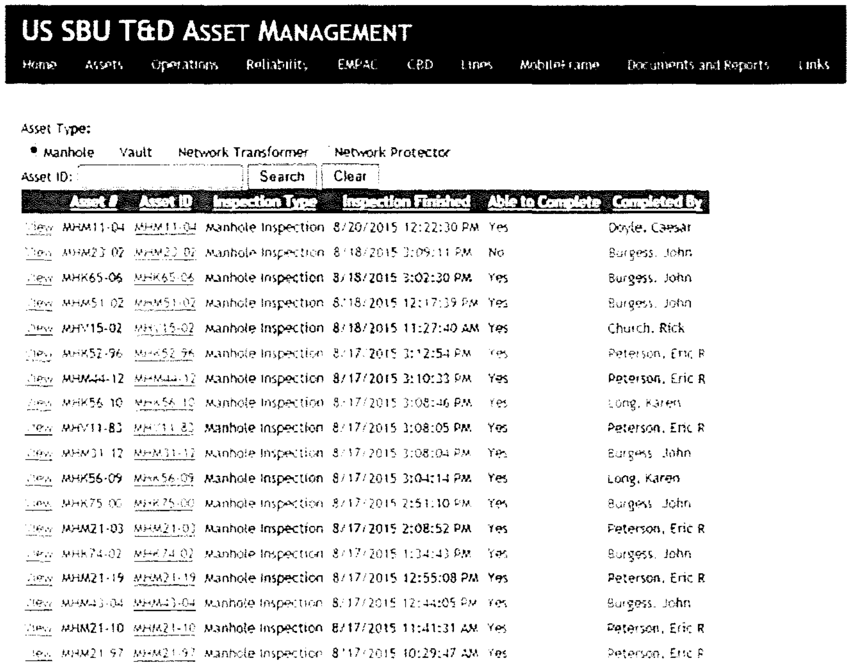


Figure 38 – CBD Inspection Tablet Computer

At the end of the day the inspector docks his tablet computer in a stand like the one shown above. The inspection data is uploaded to the MobileFrame server. All of the inspection data can be viewed on the Asset Management Web Site (see typical webpage view on the next page).



US SBU T&D ASSET MANAGEMENT

Home Assets Operations Reliability EMPAC CBD Lines MobileFrame Documents and Reports Links

Asset Type:

• Manhole Vault Network Transformer Network Protector

Asset ID: Search Clear

	Asset #	Asset ID	Inspection Type	Inspection Finished	Able to Complete	Completed By
View	MHM11-04	MHM11-04	Manhole Inspection	8/20/2015 12:22:30 PM	Yes	Doyle, Caesar
View	MHM23-02	MHM23-02	Manhole Inspection	8/18/2015 3:09:11 PM	No	Burgess, John
View	MHK65-06	MHK65-06	Manhole Inspection	8/18/2015 3:02:30 PM	Yes	Burgess, John
View	MHM51-02	MHM51-02	Manhole Inspection	8/18/2015 12:17:39 PM	Yes	Burgess, John
View	MHV15-02	MHV15-02	Manhole Inspection	8/18/2015 11:27:40 AM	Yes	Church, Rick
View	MHK52-96	MHK52-96	Manhole Inspection	8/17/2015 3:12:54 PM	Yes	Peterson, Eric R
View	MHM44-12	MHM44-12	Manhole Inspection	8/17/2015 3:10:33 PM	Yes	Peterson, Eric R
View	MHK56-10	MHK56-10	Manhole Inspection	8/17/2015 3:08:46 PM	Yes	Long, Karen
View	MHV11-83	MHV11-83	Manhole Inspection	8/17/2015 3:08:05 PM	Yes	Peterson, Eric R
View	MHM31-12	MHM31-12	Manhole Inspection	8/17/2015 3:08:04 PM	Yes	Burgess, John
View	MHK56-09	MHK56-09	Manhole Inspection	8/17/2015 3:04:14 PM	Yes	Long, Karen
View	MHK75-00	MHK75-00	Manhole Inspection	8/17/2015 2:51:10 PM	Yes	Burgess, John
View	MHM21-03	MHM21-03	Manhole Inspection	8/17/2015 2:08:52 PM	Yes	Peterson, Eric R
View	MHK74-02	MHK74-02	Manhole Inspection	8/17/2015 1:34:43 PM	Yes	Burgess, John
View	MHM21-19	MHM21-19	Manhole Inspection	8/17/2015 12:55:08 PM	Yes	Peterson, Eric R
View	MHM43-04	MHM43-04	Manhole Inspection	8/17/2015 12:44:05 PM	Yes	Burgess, John
View	MHM21-10	MHM21-10	Manhole Inspection	8/17/2015 11:41:31 AM	Yes	Peterson, Eric R
View	MHM21-97	MHM21-97	Manhole Inspection	8/17/2015 10:29:47 AM	Yes	Peterson, Eric R

Figure 39 – AM Web MobileFrame Inspection Listing

Additionally, from the previous web page view, the user can select and click on any manhole and get the details from the most current and historical inspections. This is shown in the following figure.

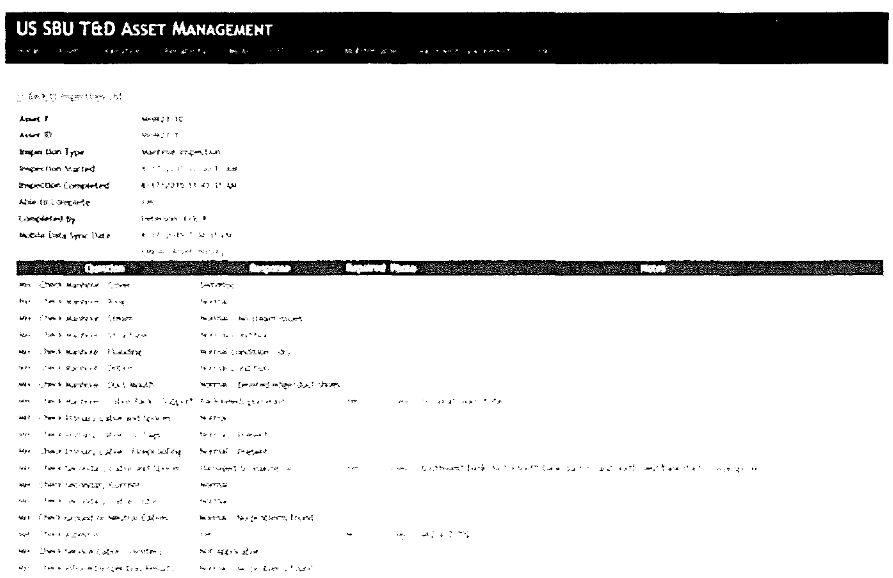


Figure 40 – AM Web MobileFrame Inspection Detail

As shown in these figures pictures are required for certain selections. A click on the "View" button under the Required Photo column reveals the picture that was taken. Following is a picture of the leaking splice from the previous inspections. It should also be noted that in the Repaired column the inspector repaired the splice during the inspection. This is seen in the photo.

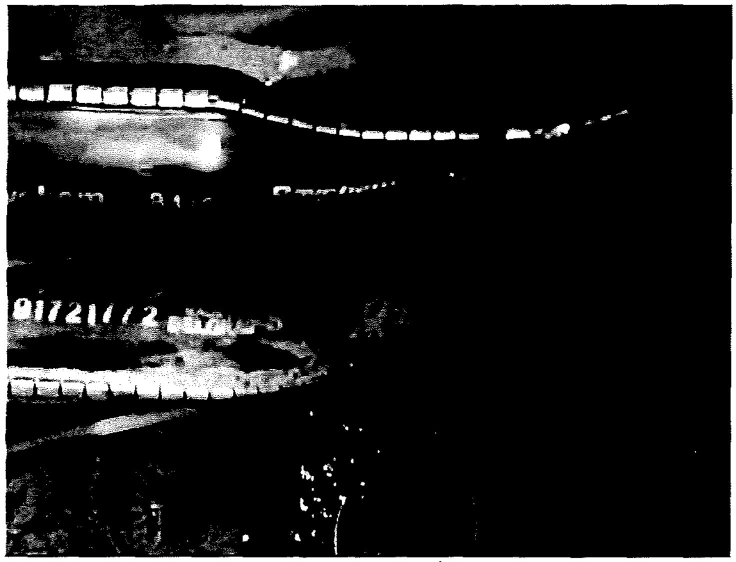


Figure 41 - AM Web MobileFrame Inspection Photo Detail

3. DP&L and IPL Differences in Network Protector Maintenance Practices

During discussions with SMEs it was noted that the maintenance practices during inspections was, as expected, different between the two utilities. DP&L and IPL comparison on network protector maintenance is shown in the following table.

Inspection/Maintenance Practice	DP&L	IPL
Test Relay with Test Set	Checks tripping current and closing voltage	Checks tripping current and closing voltage
Ductor Protector Contacts	No	Yes
Hi-Pot Protector Barrier Board	Yes	No
Feeder Breaker "Drop" Test	Visit vault adjacent units to ensure protectors are closed and will open the feeder breakers and check pilot indicating lights monitoring feeder voltage to insure all protectors came open.	No drop tests

One area of opportunity is to eliminate routine test/calibration of network protector relays at IPL. It is recommended a 'feeder drop / breaker test' be used for testing network protector relays. This provides a real world test that is superior to any field conducted test because it will measure actual system conditions and response, and will test for acceptable open and closing. This is similar philosophy to a condition based maintenance practice for transmission relays that is acceptable to NERC. This is non-invasive and reduces the risk of damage or leaving the

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protector in an inoperable state after a manual test. A direct quote from a NERC guide on testing protective relay systems is, "Experience has shown that keeping human hands away from equipment known to be working correctly (as a drop test does) enhances reliability."[25]

However, a visual inspection of the protector will still be required to look for abnormal conditions (oil seeping, water ingress, rust, proper gasket sealing, etc.).

More industry data is being gathered to determine if ductoring of protector contacts and hi-potting of the barrier board are necessary.

4. Quality Audit Practices

Fifty-four percent (54%) of utilities routinely conduct post construction audits to ascertain / assure the quality of the construction. Most of these audits were review of manhole and duct installation and the quality of workmanship.[26]

VII. Expenditure Requirements

A. Existing Capital Replacement Programs

IPL is spending significant capital dollars replacing older network equipment and rebuilding structures.

1. IPL

The 10 year capital forecast calls for continued replacement of older network infrastructure based on observed conditions. In the 2015 capital budget, IPL has identified the following items:

[redacted]

[25] Protection System Maintenance A Technical Reference September 13, 2007 Prepared by the System Protection and Controls Task Force of the NERC Planning Committee

[26] EPRI 2012 Urban Network Practices Inventory

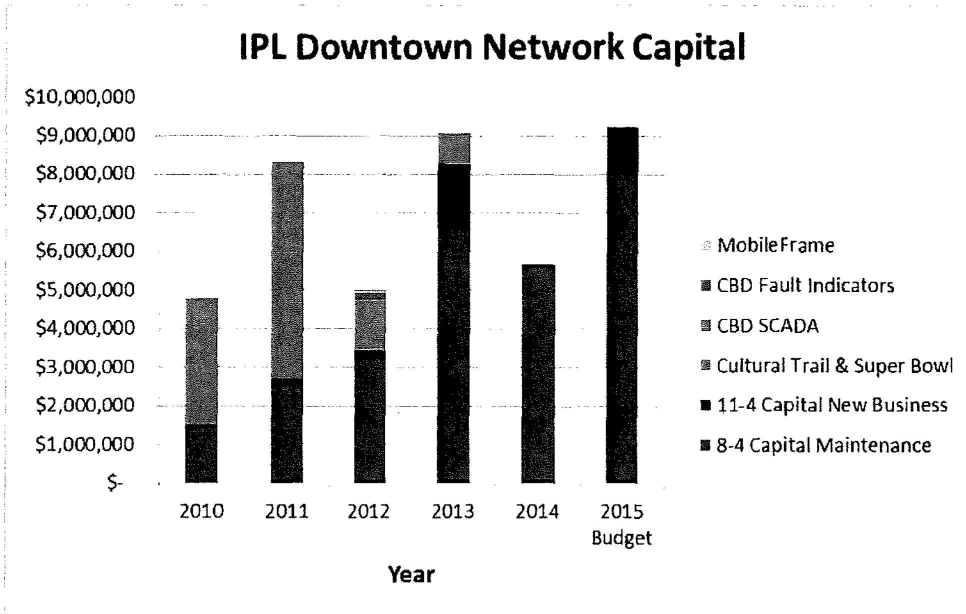

Table 7 – IPL Capital Spending History

The proposed CBD capital budget for the next five years is shown in the next table. The item "8-4 CBD – Network Capital Maintenance" includes the category for Manhole Repair, Vault Repair, Duct-line and Cable Repair, etc.

Proposed T&D CapEx Budget for CBD Network for 2016-2025 (in 000's)

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CBD Network										
8-4 CBD-Network Capital Maint.	3,000	3,000	3,550	6,660	5,220	5,230	5,340	5,350	5,616	5,672
11-4 CBD-New Facilities	1,200	1,200	823	846	869	893	918	944	903	912
IPL T&D CBD 480V Network Protector Repl 2016	3,000									
IPL T&D CBD Secondary Cable Replacement 2016	2,500									
IPL T&D CBD 480V Network Protector Repl 2017		3,000	3,000							
IPL T&D CBD Secondary Cable Replacement 2017		2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
IPL T&D CBD Primary Cable Replacment 2016	750	750	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total CBD Network	**10,450**	**10,450**	**10,873**	**11,006**	**9,589**	**9,623**	**9,758**	**9,794**	**10,019**	**10,084**

Table 8 – IPL Capital Budget

It should be noted this is significantly higher than the capital maintenance budget for the IPL downtown network has been in the past.

B. Proposed Capital Replacement Programs by Asset Class

The sections below propose, subject to IPL's capital budgeting prioritization process, the funding and replacement programs for downtown network facilities by asset class.

1. Network Protectors

In March of 2013 an internal IPL group was formed to study the new arc flash requirements for the downtown network. The Project Charter was to develop a workable Arc Flash mitigation plan to be implemented within the IPL Power Delivery Organization for Voltages Less Than 1,000 Volts. The initiative considered the National Electric Safety Code (NESC) and the Institute of Electrical and Electronics Engineers (IEEE) 1584 & 1584-1 guide for performing Arc Flash calculations of the incident energy exposure to personnel. After initial analysis and calculations it was narrowed to develop a workable Arc Flash mitigation plan for the 480/277 Volt exposure contained within the CBD.

The group completed its recommendation in December of 2013. The recommendation was to replace all existing 277/480 V network protectors with the Eaton CM52 Network Protector with Arc Flash Reduction Module. After management agreement, a five year plan to replace approximately 147 existing 277/480 V protectors was approved.

As of July 2015, IPL had replaced 41 protectors with the Eaton CM52. The plan is to continue the replacement program until completion in 2018. This program is budgeted at $[redacted] per year.

IPL will continue to replace other network protectors on a condition based evaluation. This replacement plan is expected to average approximately three (3) per year at the 120/208 V level, based on the history of past condition based evaluations.

2. Network Transformers

As mentioned earlier network transformers at IPL have been very reliable. We have a condition based replacement program. IPL has been averaging approximately six (6) network transformer replacements per year. This is around a 2% replacement rate and given the relatively light loading these transformers have historically seen, this replacement rate should continue and be adequate for the next few years.

3. Primary Cable

In 2012, an internal IPL report was published to define the priority of IPL primary cable replacements.[27] This has been used to identify which primary cable to be replaced. The table

[27] Proactive UG Primary Cable Replacement Program For Central Business District, Developed by: Michael Holtsclaw, Brian Kaiser, Rick Leffler, Greg Micheel, 6/1/2012

below shows the amount of primary cable IPL has installed the last few years as well as estimated amount in 2015.

Year	2011	2012	2013	2014	2015 Est.
Prmary Cable (feet)	24,229	20,521	24,821	27,491	20,000

Table 9 - IPL Downtown Network Primary Cable Installation

In 2014, IPL identified higher priority primary cable replacement/installations that targeted transferring the Sub #3 network feeders and loads to Edison substation. The very tight clearances at Sub #3 were severely limiting maintenance by requiring significant outages on nearby equipment for normal maintenance. This primary cable work was completed in early 2015. This allowed the retirement of five (5) 34/13 kV transformers with an average age of over 60 years.

In 2015 the 4kV feeders from Sub #3 will be transferred to [redacted] Substation. This will allow the retirement of [redacted].

4. Secondary Cable

As mentioned before, the secondary replacement programs have been condition based. The table below shows the amount of secondary cable IPL has installed the last few years, as well as the estimated amount for 2015.

Year	2011	2012	2013	2014	2015 Est.
Secondary Cable (feet)	20,292	4,364	3,712	4,052	10,000

Table 10 - IPL Downtown Network Secondary Cable Installation

As previously pointed out, the secondary grid presents one of the highest risk items in the downtown network. The acceleration of secondary cable replacement will be increasing in future years. This will be prioritized by:

- Stray Voltage Survey Pilot Program
- Hot duct line measurements and observations of cable thermal degradation
- Historical failure data
- Subject matter expert opinion

The secondary cable replacement program will be funded at $[redacted] million for the next few years. Secondary cable that is replaced should be examined to determine if any degradation has occurred. Locations where there has been degradation needs to be noted.

5. Vaults

Historically the vault replacement and refurbishment program has also been condition based. This program has worked well and should be continued at a similar rate, which has been around $[redacted] per year.

6. Manholes

Historically the manhole replacement and refurbishment program has been condition based. This program has worked well; however, the number of manholes in need of structural improvements appears to be increasing. The historical rate, which had dropped below approximately $[redacted] per year now, needs to be increased. This cost is a combination of manhole roof replacement and other refurbishment to total manhole rebuilds at an estimated average cost of a $[redacted] per manhole.

This program should be increased to $[redacted] per year and monitored using structural priority assessments that are recorded in the WMIS work management system.

7. Duct Lines

Similar to manholes and vaults, duct lines are replaced based on condition. Typically, the driving force has been the amount of new cable installations. It is estimated this averages approximately $[redacted] per year.

C. Network Maintenance Program Expenses

1. IPL

Shown below is the total IPL maintenance spending (both corrective and preventive) for the downtown network system. These values include labor, material, contractors and all overhead costs.

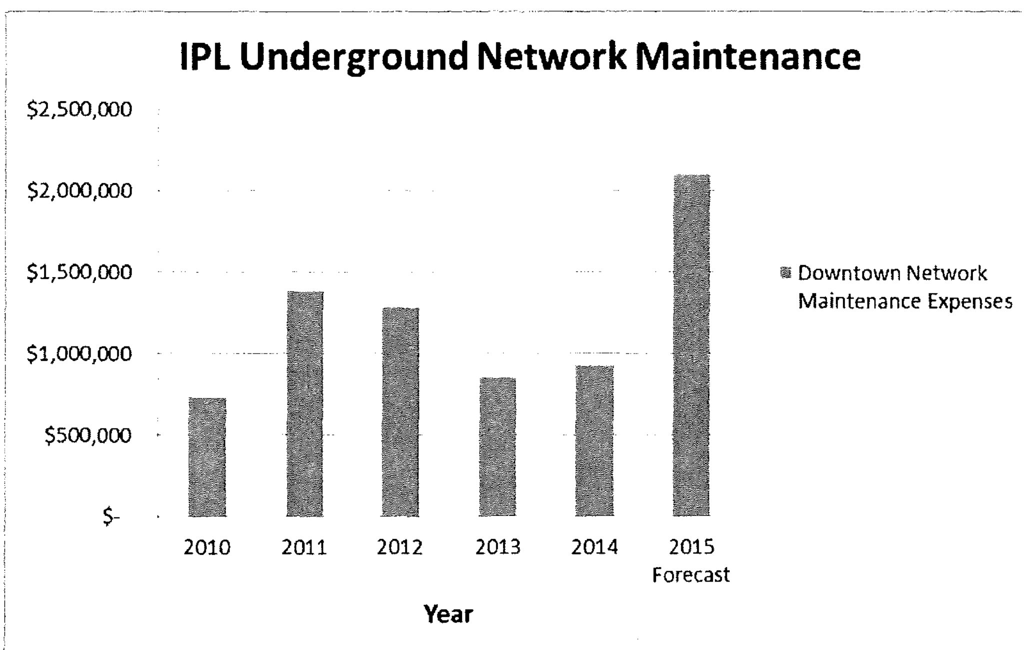

Table 11 - IPL CBD Total Maintenance Expenses

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The 2011 peak was due to a system wide manhole and vault inspection that was conducted as part of the mitigation to an increase in the number of network events. In 2012 many of the items found were addressed and other one-time initiatives such as retro-filling the transformer termination chambers with FR3 fluid were completed.

In 2015 another downtown network sweep was conducted in March. This was done in an accelerated time frame using IPL and outside crews from Chicago, Dayton, and Cincinnati. This is the reason for the significant expected spike in 2015.

The maintenance spending is appearing lumpy because the maintenance work mostly involves inspections and minor repairs. A larger repair from manhole inspection follow up work usually is maintenance capital work and is captured under the capital budget item.

VIII. Asset Information Systems (IT)

A. Information Systems Repository

Historically, most of the asset design information for the IPL network was stored in AutoCAD and on paper prints. In the past, inspection and maintenance data was also done with paper. However as the detail below illustrates, IPL continues to be progressive and move to more electronic data collection and storage in databases.

1. IPL Existing Systems

a) GIS

IPL has modelled the downtown network in their GIS Intergraph system called GTECH. Duct line, vaults, primary and secondary cables are modelled. Maps are being kept up to date in GTECH and AutoCAD today, which leads to a duplication of effort. The primary reason for this is the lack of detail that is not visible for the users in the existing version of GTECH. This will be reviewed in the future, so help determine possible solutions.

b) New Construction

Presently all work orders are done in GTECH with compatible units that feed the WMIS work management system. However, in many situations as mentioned in the previous section, the clarity is lacking so the work orders may also be replicated in AutoCAD and on paper to supplement the detail.

c) Work Management

All construction, maintenance and inspection work for IPL field crews is tracked by individual asset in the EMPAC work management system.

d) Inspection Data

All inspection work is captured in MobileFrame and feeds Ivara, which is the repository for inspection data. For any follow up work that is needed, personnel create a work order in Ivara with the inspection data findings, and an interface creates a work order in the EMPAC work management system. When the EMPAC work order is complete, it is dated complete in EMPAC and the interface between EMPAC and Ivara closes the original order in Ivara.

All manhole and vault structure follow up work is tracked in the lines work management system WMIS.

2. Downtown Network IT System Overview

In Appendix XI.I is a diagram showing how the IT systems work together for the downtown network.

B. Network Incident Database Tracking

The IPL network incident tracking database is on an IPL network drive at:

[redacted]

IPL uses a standard network failure form to capture the necessary data to facilitate tracking and analysis of failure patterns. This form is shown in Appendix.

IX. Innovations

A. Network SCADA

From the Best Practices survey performed by O'Neill Consulting half of the respondents had completed or were in the process of implementing a full scale SCADA program. The Eaton product was the predominant vendor. Those with an operating SCADA system use it to support the load flow programs. It was also noted that as the maturity of the SCADA system improves, the data acquired can be further leveraged. Those that have had SCADA systems installed for 10 plus years are now moving to monitoring secondary grid load points. Those whose implementation was five or less years (or in the progress of installing a system), measure just to the network protector.[28]

IPL completed installation of their SCADA system in 2013 and is using the Eaton system.

1. Description of IPL Downtown Network SCADA System

As mentioned previously, IPL has slightly more than 300 network transformers and protectors. All of the network protectors have MPCV relays which communicate via twisted pair (blue hose) to central hubs, at which "VaultGards", collect the relay information. On average, each VaultGard talks to 23 relays. From the VaultGard the electrical signal is converted into fiber

[28] Best Practices in the Design and Operation Of Underground Secondary Networks, Study commissioned by PPL & LGE November 4, 2013, O'Neill Management Consulting, LLC

optic with and H&L Instrument's converter. These VaultGards communicate with each other and the SCADA RTU's over a self-healing fiber optic ring. This ensures that the loss of a fiber cable will not result in loss of communication.

The relays communicate the following analog, control and status values to the Energy Control System (ECS) delivering real-time insights on system operating status to the Transmission Operations Office to enable better control and monitoring of the downtown network. The following values are available for every network transformer/protector combination and the details are shown in the Appendix.

- Phases Currents, A, B, and C
- Transformer Secondary Voltages, A, B, and C
- Network Voltages ,A, B, and C
- Transformer KVA, KW, and KVAR
- Breaker Failure Status
- Relay Device Status
- Network Protector Relay Breaker Status
- Network Protector Pumping Alarm
- Network Protector Pumping Trip Enabled
- Resent Network Protector Pumping Trip
- Network Protector Relay Temperature
- Network Protector Relay Alarm

2. SCADA Data Available via a Web Browser

IPL has put real-time downtown network SCADA data on an internal web site for easy access. All users can easily click on link to drill down to more data, filter the data to see just a primary feeder, location, or gateway vault area. Every column can also be sorted. As shown in the figure below, abnormal conditions are highlighted by coloring the cell background red, and non-communicating relay have the row highlighted in a light brown color.

[redacted]

Figure 42 - Screen Shot of Asset Management Web Page

3. SCADA Data Available via PI Process Book

The users can also use PI Process Book or a PI-Add-In for Microsoft Excel to query the data. Below is a screenshot of a PI Process Book schematic with real time values of a feeder. This was used for the 277/480 V network protector replacements to determine the best times to schedule replacements.

[redacted]

Figure 43 – PI Process Book Feeder View

4. SCADA Data Sent Via E-mail Alert

In addition to this "pull" technology IPL also uses "push" technology to get SCADA information to users. Every morning at 7:10 AM an e-mail alert is generated of all abnormal conditions in the downtown network SCADA system. This e-mail goes to supervision and other interested parties in engineering, asset management, field maintenance, and operations. The screenshot of the e-mail is shown below.

[redacted]

Figure 44 – Screen Shot of E-Mail Alert of Abnormal Conditions

<u>Key to E-Mail Report in the Preceding Figure</u>

- TE – Telemetry Error, all data from this relay cannot be trusted
- ALARM – Device is in an error state or abnormal state
- OFF LN – Relay is off line, not communicating
- ONLINE – Relay is on line and communicating
- NORMAL – Relay status point is in normal operating range

Numbers in the right hand columns that have a red background are above or below the acceptable operating limit.

5. SCADA Benefits

The benefits brought by IPL's SCADA system are clear. System Operators can now perform protector switching operations remotely, permitting fewer crew entries into the vaults and reducing the risk of the required vault entries. Furthermore, it is expected that future network protector maintenance visits will be less driven by time since protector maintenance will be based on real operating data and conditions. Maintenance effectiveness will continue to be optimized as IPL learns and increases the mining and analysis of the SCADA data. Additionally, as previously stated, IPL now has access to real time, steady-state, and emergency loading conditions in the network for Network risk management and for Asset Management planning purposes.

B. Network Protector Testing - (Primary Drop Test)

The EPRI 2012 Survey asked "Does your network protector maintenance include conducting periodic "drop tests", whereby a primary feeder is opened and measurements are taken for back feed voltage to assure that the network protectors function correctly (automatically open)?" Fifty-nine percent of the respondents answer "No".[29]

Given the fact that this gives a simple and very effective test for the protector and relay, and it is also very inexpensive approach. See the description in Section VI.A.3.

C. Infrared

Infrared or thermal imaging used to involve very expensive equipment which required skilled technicians to properly use. But modern units are smaller, less expensive, and easier to use. There are now hand-held devices about the size of a large flashlight that can be used in confined spaces. As such, the value of such technology is easily worth the cost, and more and more utilities are utilizing this in their inspections.[30]

Sixty-two percent of EPRI respondents perform infrared/heat gun checks as part of their regular maintenance programs.[31] IPL is using the small infrared devices for manhole and vault inspections.

D. Video Camera Technology

A 2012 EPRI survey[32] showed that only 7% of respondents inserted a camera into a manhole and performed a visual inspection using a camera. However, with the cost of these video cameras

[29] EPRI 2012 Urban Network Practices Inventory
[30] Independent Assessment of Indianapolis Power & Light's Downtown Underground Network Final version December 13, 2011, O'Neill Management Consulting, LLC
[31] EPRI 2012 Urban Network Practices Inventory

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such as GoPro and Bublcam being very inexpensive, it makes sense to use this technology to augment data gathering. While this should not replace the actual inspection process, the camera recording can be used to correct data errors and validate some of the manhole inspection results.

A review of the Bublcam shows promise for supplementing manhole inspections. A picture of the camera is shown below. The web site at http://www.bublcam.com/ gives a good overview of the panning capability of the camera.

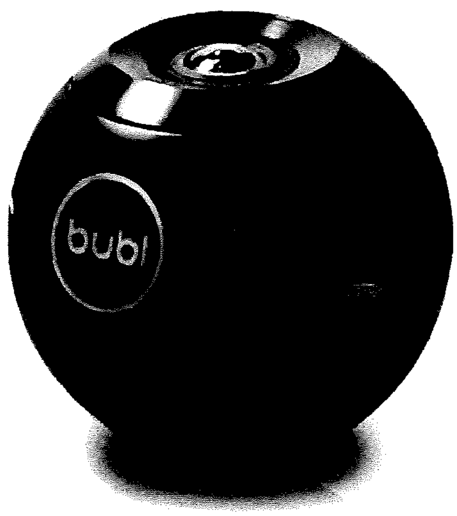

Figure 45 – Bubl camera

From a web site review, *"The Bublcam was originally aiming to produce 360 degree stills, but the company has taken things a lot further and will be incorporating 360-degree video capability at 1080p 30fps or 720p 60fps. Their software has been developed further to be capable of real-time conversion of the multiplex images into a sphere image, enabling live video streaming (through Wi-Fi connectivity). The camera is also equipped with a tri-axial accelerometer for adaptation to movement during shooting."*

IPL is in the process of purchasing one of these cameras or one similar to the Bublcam, and will pilot it during inspections over the remainder of 2015, and/or for checking manhole data sheet and print accuracy. The Bublcam lists for $499. Pending a successful pilot, we expect to roll this technology out to become standard issue equipment for each of our CBD Network crews.

[32] EPRI 2012 Urban Network Practices Inventory

E. Modeling

At this time almost all major companies have begun to put their underground secondary networks on GIS.[33] IPL has their downtown mechanical and electrical systems model in their GIS GTECH system.

Digitizing this data in a GIS database allows transfer of the electrical information into a software system to perform network circuit analysis. This allows load flows, fault studies, voltage drop analysis and various contingencies to be analyzed in greater accuracy than hand calculations. Seventy-six percent of EPRI respondents use software programs to perform circuit analysis, with CYMEDist being utilized by the greatest share (36%) of users for their analysis. Of these utilities that are using a software program, 77% of them are using these tools for both primary and secondary analysis.[34]

F. Fault Location Indicators

The value of this technology is to allow faster location of a primary fault, which facilitates faster restoration. Most IPL fault finding times range from 6 to 24 hours. These fault indicators do not affect the number incidents, only the speed of restoration. This saves money and can reduce the stress on other equipment during peak load conditions from a primary feeder outage.

Another advantage of the fault indicators is that they help in reducing the amount of DC high-potential testing ("thumping") that is normally done to find a fault on a primary feeder, thus reducing strain on the primary cable.[35]

IPL is using the SEL fault indicators and plan on continuing to install additional devices. The location of these fault indicators are targeted at the primary wye locations.

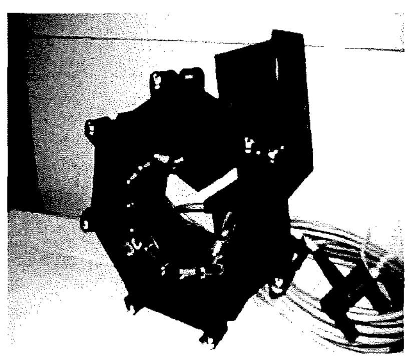

Figure 46 - SEL Fault Sensor

[33] Independent Assessment of Indianapolis Power & Light's Downtown Underground Network Final version December 13, 2011, O'Neill Management Consulting, LLC

[34] EPRI 2012 Urban Network Practices Inventory

[35] Independent Assessment of Indianapolis Power & Light's Downtown Underground Network Final version December 13, 2011, O'Neill Management Consulting, LLC

The fault indication from the sensor is detected with the inspector standing or driving over than manhole location. The detector is shown in the following figure.

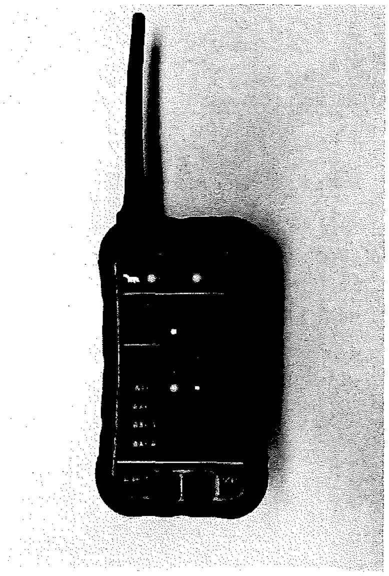

Figure 47 - SEL Fault Sensor

G. Limiting Primary Fault Current

One of the recommendations from the Root Cause Analysis for 428 Massachusetts Avenue Network Event[36] was to investigate limiting the fault current and thus the energy of a primary cable or termination chamber failure. Today, the substation transformers at Edison and Gardner Lane are three winding transformers. The 138 kV primary winding is wye connection and connected ungrounded and the 13 kV secondary winding is wye and connected solidly to the ground bus. The tertiary winding is a delta and provides the phase to ground fault current for primary faults.

IPL is presently running fault and relay coordination studies to analyze and determine the effects of possibly adding secondary impedance in the secondary ground connection to limit this fault current. The concern with this change is to ensure will not adversely impact the clearing of secondary cable faults. This impedance will not appreciably change the secondary fault current if the fault is phase to ground; however, it will limit phase to phase fault currents. Since the vast majority of primary and secondary faults on underground cables are phase to ground, the risk of this proposed change should be minimal, but will be analyzed before a decision is made.

[36] Root Cause Analysis for 428 Massachusetts Avenue Network Event on March 16, 2015, Prepared by James Sadtler, Director, Transmission Field Operations, Issued on May 6, 2015

H. Manhole Cover Restraint Systems

For more than a decade, EPRI conducted research into manhole explosions at the Lenox facility, which consists of several underground structures that faithfully replicate the characteristics of utility underground distribution manholes. Using these replica structures, researchers investigate explosions, their effects, and novel mitigation concepts by injecting known amounts of gas mixture, igniting it, and collecting data on pressures, temperatures, flame-front propagation, manhole cover trajectory, and other parameters.

Building on this research, DTE and EPRI used the facility in 2006 and 2007 to investigate various mitigation strategies to prevent or limit damage by a manhole cover in the event of a manhole over pressurization. Among the approaches the project team investigated was a cover restraint and relief system that restrains the cover to reduce collateral damage and injury.

This is the technology that was patented under the name Swiveloc.

In the Independent Assessment of Indianapolis Power & Light's Downtown Underground Network by O'Neill Management Consulting, they recommended use of this technology for selective manhole covers.[37]

An EPRI 2012 survey of underground network practices showed only 21% of the respondents used some type of manhole restraint system. IPL continues to install approximately 50 Swiveloc manholes covers each year. In 2015 IPL made a commitment to install the Swiveloc manholes covers on the remaining 1,210 manholes associated with the downtown network. As of August 944 Swiveloc manhole covers have already been installed.

X. Conclusion

This Asset Lifecycle Plan is and will continue to be a work in progress and a dynamic reflection of the emerging issues associated with IPL's CBD Network. The issues and analysis presented herein represent our current best knowledge and insights into the optimal strategy for the care and continued development of the overall Network system and each of the assets and components within. Seven initiatives are identified and described in the Executive Summary. This ALCP will be reviewed and update annually, with expanding scope as required in future versions.

[37] Independent Assessment of Indianapolis Power & Light's Downtown Underground Network Final version December 13, 2011, O'Neill Management Consulting, LLC

XI. Appendix

A. IPL Manhole Indicators

Manhole Indicators and Indicator States (11-14-2014)

INDICATORNAM	STATENAME	Trigger E-Mail?	Repaired?	If STATENAME in column "B" is chosen do the following next step.	If STATENAME in column "C" is chosen do the following next st	Priori
Can the Manhole Inspection Be Completed?	Yes					
Can the Manhole Inspection Be Completed?	No			Enter why in comments.	If this is chosen - skip all remaining items	
MH - Check Manhole - Cover	Normal - Solid					0
MH - Check Manhole - Cover	Square Cover			Take Picture		5
MH - Check Manhole - Cover	Swiveloc					0
MH - Check Manhole - Cover	Swiveloc plug damage			Take Picture		1
MH - Check Manhole - Cover	Swiveloc sudden pressure event indicator					5
MH - Check Manhole - Cover	Vented			Does still need vented cover?	Yes/No/Don't Know	2
MH - Check Manhole - Cover	Wrong manhole label			Take Picture		1
MH - Check Manhole - Ring	Broken			Take Picture		5
MH - Check Manhole - Ring	Normal					0
MH - Check Manhole - Steam	Normal - No steam issues					0
MH - Check Manhole - Steam	Steam in manhole			Record temperature in manhole		5
MH - Check Manhole - Steam	Steam in manhole - Too hot to enter	Yes		Record temperature in manhole		10
MH - Check Manhole - Flooding	A few inches of water					1
MH - Check Manhole - Flooding	Approximately one foot of water					2
MH - Check Manhole - Flooding	Greater than two feet of water					3
MH - Check Manhole - Flooding	Normal condition - dry					0
MH - Check Manhole - Flooding	Sewage in manhole	Yes		Did you clean it?	Yes/No	10
MH - Check Manhole - Debris	Bracing and lumber in hole		Yes/No	Take Picture		4
MH - Check Manhole - Debris	Mud 6 inches or more		Yes/No	Take Picture		2
MH - Check Manhole - Debris	Normal condition					3
MH - Check Manhole - Debris	Significant debris		Yes/No	Take Picture		0
MH - Check Manhole - Debris	Some minor debris		Yes/No	Take Picture		1
MH - Check Primary Cable and Splices	Damaged or leaking oil	Yes	Yes/No	Record Primary Feeder	Take Picture	10
MH - Check Primary Cable and Splices	Normal					0
MH - Check Primary Cable and Splices	Not applicable			If this is chosen - gray out and skip all "Primary" items		0
MH - Check Primary Cable and Splices	Needs to be spliced around manhole	Yes	Yes/No	Record Primary Feeder	Take Picture	9
MH - Check Secondary Cable and Splices	Bare conductor	Yes	Yes/No	Record duct direction and number in comments	Take Picture	10
MH - Check Secondary Cable and Splices	Damaged or leaking oil	Yes	Yes/No	Record duct direction and number in comments	Take Picture	10
MH - Check Secondary Cable and Splices	Normal					0
MH - Check Secondary Cable and Splices	Not Applicable			If this is chosen - gray out and skip all "Secondary" items		0
MH - Check Secondary Cable and Splices	Needs to be spliced around manhole	Yes	Yes/No	Record duct direction and number in comments	Take Picture	9
MH - Check Secondary Current	Fluctuating secondary current	Yes	Yes/No	range	Take Picture	10
MH - Check Secondary Current	Between 200 and 350 amps on a conductor	Yes	Yes/No	Record duct direction and number, and current reading	Take Picture	8
MH - Check Secondary Current	Greater than 350 amps on a conductor	Yes	Yes/No	Record duct direction and number, and current reading	Take Picture	9
MH - Check Secondary Current	Normal					0
MH - Check Secondary Current	Zero amps on a conductor		Yes/No	Record duct direction and number in comments	Take Picture	9
MH - Check Ground or Neutral Cables	Bonding needs attention		Yes/No	Take Picture		3
MH - Check Ground or Neutral Cables	Normal - No problems found					0
MH - Check Ground or Neutral Cables	Primary neutral needs attention		Yes/No	Record Primary Feeder	Take Picture	7
MH - Check Ground or Neutral Cables	Secondary neutral needs attention		Yes/No	Record duct direction and numbers in comments	Take Picture	7
MH - Check Manhole - Cable Racks/Support	Normal					0
MH - Check Manhole - Cable Racks/Support	Inadequate support		Yes/No	Enter how many and what wall in comments	Take Picture	7
MH - Check Manhole - Cable Racks/Support	Rack needs porcelain		Yes/No	Enter how many and what wall in comments	Take Picture	6
MH - Check Manhole - Cable Racks/Support	Missing		Yes/No	Enter how many and what wall in comments	Take Picture	7
MH - Check Asbestos	No					0
MH - Check Asbestos	Unsure		Yes/No	Record Primary Feeder	Take Picture	1
MH - Check Asbestos	Yes		Yes/No	Record Primary Feeder	Take Picture	1
MH - Check Primary Cable - ID Tags	Missing or unable to read		Yes/No	Record duct direction and number in comments	Take Picture	4
MH - Check Primary Cable - ID Tags	Normal - Present					0
MH - Check Primary Cable - ID Tags	Not Applicable					0
MH - Check Primary Cable - Fireproofing	Melted or damaged		Yes/No	Record duct direction and number in comments	Take Picture	7
MH - Check Primary Cable - Fireproofing	Missing		Yes/No			3
MH - Check Primary Cable - Fireproofing	Normal - Present					0
MH - Check Primary Cable - Fireproofing	Not Applicable					0
MH - Check Service Cable - Limiters	Limiters missing on some service cables		Yes/No	Record duct direction and number in comments	Take Picture	3
MH - Check Service Cable - Limiters	Normal - Limiters present on all service cables					0
MH - Check Service Cable - Limiters	Not applicable					0

Table XI-1 – Summary of IPL Manhole Indicators (Page 1)

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Manhole Indicators and Indicator States (11-14-2014)						
INDICATORNAM	STATENAME	Trigger E-Mail?	Repaired?	If STATENAME in column "B" is chosen do the following next step.	If STATENAME in column "C" is chosen do the following next st	Priority
MH - Check Service Cable - Duct Seal	Missing		Yes/No	Take Picture		5
MH - Check Service Cable - Duct Seal	Normal - Present					0
MH - Check Service Cable - Duct Seal	Not Applicable					0
MH - Check Manhole - Duct Mouth	Normal - Beveled edge/duct shoes					0
MH - Check Manhole - Duct Mouth	Some rough edges containing cables			Record duct direction and numbers in comments	Take Picture	4
MH - Check Manhole - Duct Mouth	Very rough edges containing cables			Record duct direction and numbers in comments	Take Picture	6
MH - Check Manhole - Structure	Abandoned and empty					0
MH - Check Manhole - Structure	Normal condition					0
MH - Check Manhole - Structure	Roof deterioration			Take Picture		6
MH - Check Manhole - Structure	Wall deterioration			Take Picture		4
MH - Check Manhole - Other	Asphalt covered		Yes/No			7
MH - Check Manhole - Other	Cannot locate					7
MH - Check Manhole - Other	Car parked on					0
MH - Check Manhole - Other	Needs restriction to enter					0
MH - Check Manhole - Other	Normal					0
MH - Check Manhole - Other	Other					0
MH - Check Manhole - Other	Street lighting only					0
MH - Check Infrared Inspection Results	Hot spot - 1 month follow up (30 - 100 F rise)		Yes/No	Enter description in comments	Take Picture	6
MH - Check Infrared Inspection Results	Minor hot spot (10 - 30 F rise)		Yes/No	Enter description in comments	Take Picture	4
MH - Check Infrared Inspection Results	Normal - No problems found					0
MH - Check Infrared Inspection Results	Severe hot spot correct ASAP (>100 F rise)	Yes	Yes/No	Enter description in comments	Take Picture	10
MH - Check Secondary Cable - Idle	Idle cable not capped and sealed		Yes/No	Record duct direction and number in comments	Take Picture	2
MH - Check Secondary Cable - Idle	Idle cable not labeled retired in place		Yes/No	Record duct direction and number in comments	Take Picture	2
MH - Check Secondary Cable - Idle	Normal					0

Table XI-2 – Summary of IPL Manhole Indicators (Page 2)

B. IPL General Vault Inspection Indicators

The following table shows IPL vault inspection indicator and possible states.

Vault General Inspection Indicators and Indicator States (11-17-2014)

INDICATORNAM	STATENAME	Trigger E-Mail?	Repaired?	If STATENAME in column "B" is chosen do the following next step.	If STATENAME in column "C" is chosen do the following next step.	Priority
Can the Vault Inspection Be Completed?	Yes					
Can the Vault Inspection Be Completed?	No			Enter why in comments.	If this is chosen - skip all remaining items	
Vault - Check Fire Doors	Normal - Operable					0
Vault - Check Fire Doors	Not Operable					5
Vault - Check Grating	Normal					0
Vault - Check Grating	Needs attention			Take Picture		5
Vault - Check Vault - Lighting	Normal - Working					0
Vault - Check Vault - Lighting	Maintenance needed		Yes/No			4
Vault - Check Vault - Flooding	Normal condition - dry					0
Vault - Check Vault - Flooding	Approximately one foot of water			Take Picture		4
Vault - Check Vault - Flooding	Greater than two feet of water			Take Picture		8
Vault - Check Steam	Normal - No steam issues					0
Vault - Check Steam	Steam in vault			Record temperature in vault		5
Vault - Check Steam	Steam in vault - Too hot to enter	Yes		Record temperature in vault		10
Vault - Check Debris on Vault Floor	Normal condition					0
Vault - Check Debris on Vault Floor	Minor debris		Yes/No			2
Vault - Check Debris on Vault Floor	Significant debris		Yes/No	Take Picture		3
Vault - Check Vault - Structure	Normal condition					0
Vault - Check Vault - Structure	Abandoned and empty					0
Vault - Check Vault - Structure	Wall deterioration			Take Picture		4
Vault - Check Vault - Structure	Roof deterioration			Take Picture		6
Vault - Check Primary Cable Terminations and Splices	Not applicable			If this is chosen - gray out and skip all "Vault - Check Primary..." items		0
Vault - Check Primary Cable Terminations and Splices	Normal					0
Vault - Check Primary Cable Terminations and Splices	Damaged or leaking oil	Yes	Yes/No	Record Primary Feeder	Take Picture	10
Vault - Check Primary Cable - ID Tags	Normal - Present					0
Vault - Check Primary Cable - ID Tags	Missing or unable to read		Yes/No	Record Primary Feeder		4
Vault - Check Primary Cable Support	Normal - Adequate					0
Vault - Check Primary Cable Support	Inadequate		Yes/No	Record Primary Feeder	Take Picture	0
Vault - Check Secondary Cable	Not Applicable			If this is chosen - gray out and skip all "Vault - Check Secondary..." items		0
Vault - Check Secondary Cable	Normal					0
Vault - Check Secondary Cable	Damaged or leaking oil	Yes	Yes/No	Record duct direction and number in comments	Take Picture	10
Vault - Check Secondary Cable	Bare conductor	Yes	Yes/No	Record duct direction and number in comments	Take Picture	10
Vault - Check Secondary Cable Support	Normal - Adequate					0
Vault - Check Secondary Cable Support	Inadequate		Yes/No	Record description of where in comments	Take Picture	2
Vault - Check Secondary Current	Normal					0
Vault - Check Secondary Current	Zero amps on a conductor		Yes/No	Record duct direction and number in comments	Take Picture	9
Vault - Check Secondary Current	Between 200 and 350 amps on a conductor	Yes	Yes/No	reading	Take Picture	8
Vault - Check Secondary Current	Greater than 350 amps on a conductor	Yes	Yes/No	reading	Take Picture	9
Vault - Check Secondary Current	Fluctuating secondary current	Yes	Yes/No	reading range	Take Picture	10
Vault - Check Secondary Current	Not applicable					0
Vault - Check Secondary Cable - Idle	Normal					0
Vault - Check Secondary Cable - Idle	Idle cable not capped and sealed		Yes/No	Record duct direction and number in comments	Take Picture	2
Vault - Check Secondary Cable - Idle	Idle cable not labeled retired in place		Yes/No	Record duct direction and number in comments	Take Picture	2
Vault - Check Secondary Cable - Idle	Not applicable					0
Vault - Check Service Cable Current	Normal					0
Vault - Check Service Cable Current	Zero amps on a conductor		Yes/No	Record duct direction and number in comments	Take Picture	9
Vault - Check Service Cable Current	Between 200 and 350 amps on a conductor	Yes	Yes/No	reading	Take Picture	8
Vault - Check Service Cable Current	Greater than 350 amps on a conductor	Yes	Yes/No	reading	Take Picture	9
Vault - Check Service Cable Current	Fluctuating secondary current	Yes	Yes/No	reading range	Take Picture	10
Vault - Check Service Cable Current	Not applicable			If this is chosen - gray out and skip all "Vault - Check Service Cable..." items		0
Vault - Check Service Cable - Limiters	Normal - Limiters present on all service cables					0
Vault - Check Service Cable - Limiters	Limiters missing on some or all service cables		Yes/No	Record duct direction and number in comments	Take Picture	3
Vault - Check Service Cable - Limiters	Not Applicable					0
Vault - Check Service Cable - Duct Seal	Normal - Present					0
Vault - Check Service Cable - Duct Seal	Missing		Yes/No	Record duct direction and number in comments	Take Picture	3
Vault - Check Service Cable - Duct Seal	Not Applicable					0
Vault - Check Duct Mouth	Normal - Beveled edge/duct shoes					0
Vault - Check Duct Mouth	Some rough edges containing cables		Yes/No	Record duct direction and number in comments	Take Picture	4
Vault - Check Duct Mouth	Very rough edges containing cables		Yes/No	Record duct direction and number in comments	Take Picture	6
Vault - Check Duct Mouth	Not applicable					0
Vault - Check Infrared Inspection Results	Normal - No problems found					0
Vault - Check Infrared Inspection Results	Minor hot spot (10 - 30 F rise)		Yes/No	Enter description in comments	Take Picture	4
Vault - Check Infrared Inspection Results	Hot spot - 1 month follow up (30 - 100 F rise)		Yes/No	Enter description in comments	Take Picture	6
Vault - Check Infrared Inspection Results	Severe hot spot correct ASAP (>100 F rise)	Yes	Yes/No	Enter description in comments	Take Picture	10

Table XI-3 – Summary of IPL Vault Indicators

C. IPL Network Transformer Inspection Indicators

The next table shows network transformer indicator and states for IPL.

Vault Transformer Inspection Indicators and Indicator States (11-25-2014)

INDICATORNAM	STATENAME	Trigger E-Mail?	Repaired	If STATENAME in column "B" is chosen do the following next step.	If STATENAME in column "C" is chosen do the following next step.	Priority
Can the Transformer Inspection Be Completed?	Yes					
Can the Transformer Inspection Be Completed?	No			Enter why in comments.	If this is chosen - skip all remaining items	
Vault - Check Transformer Deflector Shield Presence	Normal - Shields on all tranformers					0
Vault - Check Transformer Deflector Shield Presence	Shields on some transformers			Are additional shields needed?		0
Vault - Check Transformer Deflector Shield Presence	Shields on no transformers			Are additional shields needed?		0
Vault - Check Debris on Transformer	Normal condition					0
Vault - Check Debris on Transformer	Minor debris		Yes/No			2
Vault - Check Debris on Transformer	Significant debris		Yes/No	Take Picture		4
Vault - Check Equipment Marking or Label Condition	Normal - Marking readable & correct equipment name					0
Vault - Check Equipment Marking or Label Condition	Marking missing, not readable or wrong		Yes/No			8
Vault - Check Network Transformer - Rust	Normal					0
Vault - Check Network Transformer - Rust	Some rust		Yes/No	Take Picture		3
Vault - Check Network Transformer - Rust	Severe rust		Yes/No	Take Picture		5
Vault - Check Network Transformer - Rust	Rust and oil seeping	Yes	Yes/No	Take Picture		8
Vault - Check Network Transformer - Rust	Severe rust and oil seeping	Yes	Yes/No	Take Picture		10
Vault - Check Equipment - Oil Leaks	Normal - No oil leaks					0
Vault - Check Equipment - Oil Leaks	Oil Seeping		Yes/No	Take Picture		7
Vault - Check Equipment - Oil Leaks	Oil dripping or ponding/pooling detected	Yes	Yes/No	Take Picture		10
Vault - Check Equipment Grounding	Normal Grounding secure and in place					0
Vault - Check Equipment Grounding	Grounding not secure or missing		Yes/No	Take Picture		10
Vault - Check Transformer Main Tank - Oil Level	Normal - Gauge reads near 25 degrees C					0
Vault - Check Transformer Main Tank - Oil Level	Oil level low		Yes/No	Take Picture		7
Vault - Check Transformer Main Tank - Oil Level	Oil level high		Yes/No	Take Picture		7
Vault - Check Transformer Main Tank - Oil Level	No oil level detected		Yes/No	Take Picture		10
Vault - Check Transformer Top Oil Temp Gauge - Status	Normal - Gauge in place and working					0
Vault - Check Transformer Top Oil Temp Gauge - Status	Gauge hard to read		Yes/No	Take Picture		2
Vault - Check Transformer Top Oil Temp Gauge - Status	Gauge broken - not working		Yes/No	Take Picture		5
Vault - Main Transformer Oil Temp - Present	Normal < 90 Degrees C					0
Vault - Main Transformer Oil Temp - Present	Warning 90 - 105 Degrees C					5
Vault - Main Transformer Oil Temp - Present	Alarm > 105 Degrees C	Yes	Yes/No	Take Picture		10
Vault - Main Transformer Oil Temp - Max Reading	Normal < 90 Degrees C					0
Vault - Main Transformer Oil Temp - Max Reading	Warning 90 -105 Degrees C					5
Vault - Main Transformer Oil Temp - Max Reading	Alarm > 105 Degrees C		Yes/No	Take Picture		10
Vault - Check Switch Chamber - Oil Level	Normal - Gauge reads near 25 degrees C					0
Vault - Check Switch Chamber - Oil Level	Oil level indication not available					1
Vault - Check Switch Chamber - Oil Level	Oil level low		Yes/No	Take Picture		9
Vault - Check Switch Chamber - Oil Level	Oil level high		Yes/No	Take Picture		9
Vault - Check Switch Chamber - Oil Level	No oil level detected		Yes/No	Take Picture		10
Vault - Check Transformer Infrared Main Tank	Normal < 200 Degrees F					0
Vault - Check Transformer Infrared Main Tank	Warning 200 -250 Degrees F					5
Vault - Check Transformer Infrared Main Tank	Alarm > 250 Degrees F					10
Vault - Check Transformer Infrared Primary Oil Switch	Normal					0
Vault - Check Transformer Infrared Primary Oil Switch	Warning > 10 Degrees F Rise					10
Vault - Check Transformer Infrared Termination Chamber	Normal					0
Vault - Check Transformer Infrared Termination Chamber	Warning > 10 Degrees F Rise					10

Table XI-4 – Summary of IPL Transformer Indicators

D. IPL Network Protector Inspection Indicators

The last IPL inspection table for network protectors is shown below.

Vault Network Protector Inspection Indicators and Indicator States (11-25-2014)

INDICATORNAM	STATENAME	Trigger E-Mail?	Repaired?	If STATENAME in column "B" is chosen do the following next step.	If STATENAME in column "C" is chosen do the followi...	Priority
Can the Protector Inspection Be Completed?	Yes	No				
Can the Protector Inspection Be Completed?	No	No		Enter why in comments.	If this is chosen - skip all remaining items	
Vault - Check Protector Deflector Shield Presence	None	No				0
Vault - Check Protector Deflector Shield Presence	Shield on protector	No				0
Vault - Check Network Protector - Rust	Normal	No				0
Vault - Check Network Protector - Rust	Some rust	No	Yes/No	Take Picture		3
Vault - Check Network Protector - Rust	Severe rust	No	Yes/No	Take Picture		8
Vault - Check Network Protector - Rust	Rust and oil seeping	No	Yes/No	Take Picture		10
Vault - Check Network Protector - Evaluation	Normal	No				0
Vault - Check Network Protector - Evaluation	Gasket Deterioration - Unable to Pressurize	No	Yes/No	Take Picture		5
Vault - Check Network Protector - Evaluation	Indications of water ingress	No	Yes/No	Take Picture		9
Vault - Check Network Protector - Evaluation	Indications of oil	No		Take Picture		10
Vault - Check Network Protector Bus Type	Normal - Copper	No				0
Vault - Check Network Protector Bus Type	Unsure/Not Applicable	No				3
Vault - Check Network Protector Bus Type	Aluminum	No				9
Vault - Check Network Protector Bus	Normal	No				0
Vault - Check Network Protector Bus	Debris	No	Yes/No	Take Picture		7
Vault - Check Network Protector Bus	Tracking	No	Yes/No	Take Picture		10
Vault - Check Network Protector Bus	Debris and Tracking	No	Yes/No	Take Picture		10
Vault - Check Network Protector - Bushing	Normal	No				0
Vault - Check Network Protector - Bushing	Cracked	No	Yes/No	Take Picture		7
Vault - Check Network Protector - Bushing	Tracking	No	Yes/No	Take Picture		10
Vault - Check Network Protector - Bushing	Cracked and Tracking	No	Yes/No	Take Picture		10
Vault - Check Network Protector - Ductor Phase A	Normal - < 900 micro-ohms	No		Record Reading		0
Vault - Check Network Protector - Ductor Phase A	Warning - 900 - 1500 micro-ohms	No	Yes/No	Record Reading		5
Vault - Check Network Protector - Ductor Phase A	Alarm - > 1500 micro-ohms	No	Yes/No	Record Reading		9
Vault - Check Network Protector - Ductor Phase B	Normal - < 900 micro-ohms	No		Record Reading		0
Vault - Check Network Protector - Ductor Phase B	Warning - 900 - 1500 micro-ohms	No	Yes/No	Record Reading		5
Vault - Check Network Protector - Ductor Phase B	Alarm - > 1500 micro-ohms	No	Yes/No	Record Reading		9
Vault - Check Network Protector - Ductor Phase C	Normal - < 900 micro-ohms	No		Record Reading		0
Vault - Check Network Protector - Ductor Phase C	Warning - 900 - 1500 micro-ohms	No	Yes/No	Record Reading		5
Vault - Check Network Protector - Ductor Phase C	Alarm - > 1500 micro-ohms	No	Yes/No	Record Reading		9
Vault - Check Network Protector - Relay Close Volts	Normal < 4 Volts	No		Record Reading		0
Vault - Check Network Protector - Relay Close Volts	Warning > 4 Volts	No	Yes/No	Record Reading		5
Vault - Check Network Protector - Relay Trip Amps	Normal < 10 Amps	No		Record Reading		0
Vault - Check Network Protector - Relay Trip Amps	Warning > 10 Amps	No	Yes/No	Record Reading		9

Table XI-5 – Summary of IPL Network Protector Indicators

009309

E. Downtown Network SCADA Points and Description

Point Name	Use of Network Relay Data Points
A Phase Current	Monitor real time loads and review historical loading. This data will be compared with network load flows and be used to help optimize the downtown network design.
B Phase Current	Monitor real time loads and review historical loading. This data will be compared with network load flows and be used to help optimize the downtown network design.
C Phase Current	Monitor real time loads and review historical loading. This data will be compared with network load flows and be used to help optimize the downtown network design.
A Phase Transformer Secondary Voltage	Monitor real time voltage and review historical voltage anomalies. (e.g. substation load tap changer not operating correctly) This data is used to ensure when a primary feeder is de-energized all of the protectors have opened.
B Phase Transformer Secondary Voltage	Monitor real time voltage and review historical voltage anomalies (e.g. substation load tap changer not operating correctly). This data is used to ensure when a primary feeder is de-energized all of the protectors have opened.
C Phase Transformer Secondary Voltage	Monitor real time voltage and review historical voltage anomalies (e.g. substation load tap changer not operating correctly). This data is used to ensure when a primary feeder is de-energized all of the protectors have opened.
A Phase Network Voltage	Monitor real time voltage and review historical voltage anomalies. If the protector is open this voltage along with the transformer voltage can give an indication of a light load condition.
B Phase Network Voltage	Monitor real time voltage and review historical voltage anomalies. If the protector is open this voltage along with the transformer voltage can give an indication of a light load condition.
C Phase Network Voltage	Monitor real time voltage and review historical voltage anomalies. If the protector is open this voltage along with the transformer voltage can give an indication of a light load condition.
Transformer KVA	Monitor real time transformer loading and review historical loading. This data will be compared with network load flows.
Transformer KW	Monitor real time transformer loading and review historical loading. This data will be compared with network load flows.
Transformer KVAR	Monitor real time reactive power flow. This is used to monitor feeder voltage differences and customers with significant lagging power factors. The KVAR data will be compared with network load flows. Additionally, over time we may learn to spot secondary fault conditions.
Breaker Failure Status	Relay calling for an open/close and protector not responding. This data is queried for historical asset health.
Relay Device Status	This value monitors whether the relay is on-line or off-line. A daily e-mail is sent with off-line relays (and other abnormal conditions).
Network Protector Relay Breaker Status	This point is the open/close status of the protector. This data will be used to ensure protectors are not cycling too often.
Primary Switch Status	This is for the state of the primary oil switch. It is not used at this time.
Network Protector Pumping Alarm	This status is indication of protector cycling excessively. These points are queried for possible load or relay setting issues.
Network Protector Pumping Trip Enabled	When enabled and the protector has cycled - a trip is issued by the relay when the programmed number of cycles is met.
Resent Network Protector Pumping Trip	This resets pumping enabled command.
Network Protector Relay Temperature	This is the relay temperature in Celsius. We monitor the temperature for potential relay and network protector problems?
Network Protector Relay Alarm	The relay is in alarm and needs attention. These points are queried for trends.

Table XI-6 – SCADA Points for Each Network Transformer/Protector

F. IPL Network Failure Input Form

This page and the next three pages show the IPL network failure form that is completed by field personnel for every downtown network fault.

Page 1 of 4

ipl an AES company

INDIANAPOLIS POWER & LIGHT COMPANY

NETWORK FAILURE ANALYSIS DATA FORM

Date of Event: ____________ Time of Event: ____________

Location Address: ____________________________

Feeder Number ____________ Old Sub 3 Feeder Number: ____________
If Edison 412, 422, 432, 442, or 462

Description of Event: ____________________________

____

____

____

Substation:	
	Edison
	Gardner Lane
	Sub 3

Network Area:	
	Edison East
	Edison West
	Gardner Lane North
	Gardner Lane South
	Non-Network

Initial Cause:	
	Fault
	Dig In
	Flooding
	Steam Leak
	Infrastructure
	Other

Edison East Area and it was in Old Sub 3 Cable	

What Failed:	
	Cable
	Splice
	NW Protector
	NW Transformer
	Vault Bus

Fault Location:	
	Manhole
	Duct line
	Vault

IURC Reportable Event:	
	Yes
	No

Note: If the Answer to any of the 3 questions in Pink are Yes, this is an IURC Reportable Event

Were Flames or Smoke Visible Above Vault Grating:	
	Yes
	No

Manhole Number 1: ____________ Manhole Number 2: ____________

Last Inspected: ____________ Last Inspected: ____________

Manhole Temperature: ____________ Manhole Temperature: ____________

Manhole Cover Type:	
	Solid
	Stabiloc
	Vented
	Slotted

Manhole Cover Type:	
	Solid
	Stabiloc
	Vented
	Slotted

Cover Dislodged:	
	Yes
	No
	Unknown

Cover Dislodged:	
	Yes
	No
	Unknown

NW Failure Analysis Report Version 3.1 Dated 2/3/2015

Table XI-7 – Network Failure Input Form (Page 1)

Manhole Event Observations

Reported Prior to Event:		
Manhole #1	Nothing	
	Smoke	
	Fire	
	Smoke & Fire	
	Unknown	

Reported Prior to Event:		
Manhole #2	Nothing	
	Smoke	
	Fire	
	Smoke & Fire	
	Unknown	

Event Observed By:		
	IPL	
	IFD	
	IMPD	
	Media	
	Public	

Personal Injuries:		
	Yes	
	No	

Property Damage:		
	Yes	
	No	

Fault Locating Information

Fault Indicator #1:		
	Not Tripped	
	Tripped	

Fault Indicator #2:		
	Not Tripped	
	Tripped	

F.I. Operated Correctly		
#1	Yes	
	No	

F.I. Operated Correctly		
#2	Yes	
	No	

Recorded Fault Current ____________

Recorded Distance to Fault ____________

Total Time to Locate Fault: ____________

Equipment Involved

Primary Cable:		
	PILC	
	EPR	
	XLPE	
	Other	

Duct Number: ____________

Conductor Size:		
	750	
	350	
	4/0	
	#1	
	Other	

Secondary Cable:		
	PILC	
	EPR	
	XLPE	
	VCLC	
	Other	

Duct Number: ____________

Conductor Size:		
	750	
	500	
	350	
	Other	

Original Splice Type:		
	Straight	
	Single Wye	
	Double Wye	
	Transition	

Original Splice Material:		
	Heat Shrink	
	Cold Shrink	
	Taped	
	Lead Wiped	

Replaced:		
	Splice	
	Cable	
	Ductline	

Number of Splices Rpl.: ____________
Feet of Cable Replaced: ____________
Feet of Ductline Replaced: ____________

Table XI-8 – Network Failure Input Form (Page 2)

Network Transformer:	Pri Termination	
	Pri. Switch	
	Main Tank	

Make: ____________

KVA: ____________

Serial Number: ____________

Transformer Condition:	Good	
	Some Corrosion	
	Heavy Corrosion	

Pri. Termination Type	Under Oil	
	Elbows	

Network Protector:	Failed to Open	
	Failed to Close	
	Relay Issue	
	NWP Fuse Open	
	Gasket Failure	
	Catastrophic Failure	

Inspection Date: ____________

NWP Serial Number: ____________

Network SCADA:	Yes	
	No	

Oil Test Data

Oil Samples Taken:	DGA	
	Oil Quality	
	Other	
	None	

DGA Results:	Pass	
	Fail	

Sample Number: ____________

Test Report Number: ____________

Oil Quality Results:	Pass	
	Fail	

Sample Number: ____________

Test Report Number: ____________

Vault Data

Bay: ____________

Last Inspected: ____________

Vault Bus Fault:	Phase - GND	
	Phase-Phase	
	None	

Hi Cap Fuse:	Okay	
	Open	
	Failed	

Cause:	Tracking	
	Shorted	
	Flooding	
	Other	

Barrier Board:	Okay	
	Deteriorated	
	Failed/Flash Over	

Bus Issue:	Bus Bars	
	Insulator	
	Clamp	

Structure Condition	Excellent	
	Good	
	Poor	

Table XI-9 – Network Failure Input Form (Page 3)

Additional Comments or Information

Submitted By:	____________	Date Submitted:	____________
Reviewed By:	____________	Date Reviewed:	____________
Report Uploaded to Database By:	____________	Date:	____________

Table XI-10 – Network Failure Input Form (Page 4)

G. IPL / Citizens E-Mail Notification Example

[redacted]

Figure 48 – IPL / Citizens E-Mail Notification

H. IPL Duct Line Temperature Measurements

[redacted]

Figure 49 - Duct Line Steam Measurements (Page 1 of 3)

[redacted]

Figure 50 – Duct Line Steam Measurements (Page 2 of 3)

[redacted]

Figure 51 - Duct Line Steam Measurements (Page 3 of 3)

I. Downtown Network IT System Interaction

The following chart shows the interaction between various IT systems used in the downtown network.

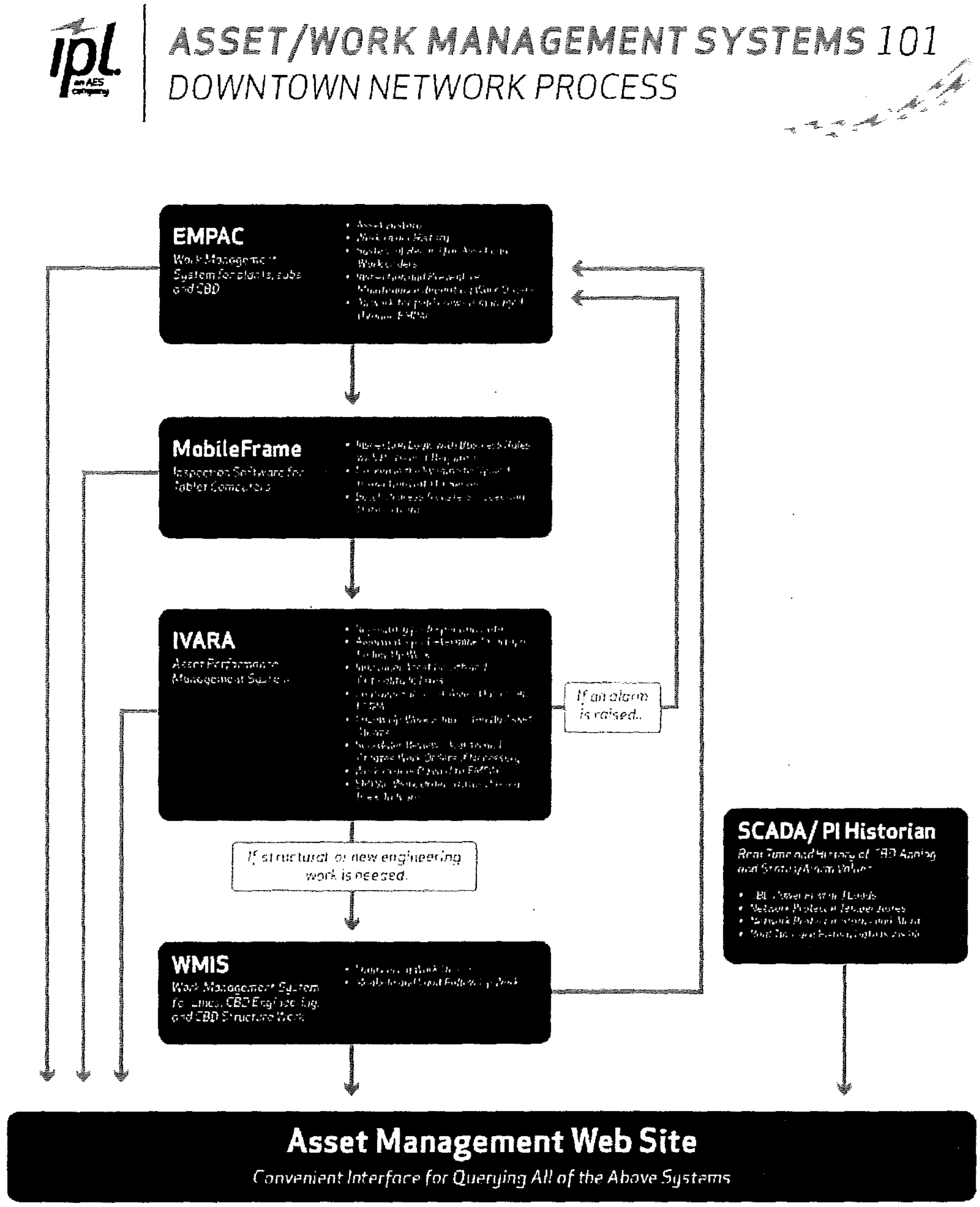


Figure 52 - Asset Management Systems for Downtown Network

AES
we are the energy

Asset Management Strategy

August 31, 2015

AES/IPL

Customer Operations

009320

IPL Customer Operations Asset Management Strategy

1.0 Introduction

As an Electric Transmission & Distribution businesses, IPL is dependent on our physical assets to provide highly reliable service to the Indianapolis area. As such, a well-defined strategy for purchasing, operating, maintaining, and as appropriate retiring assets is necessary to successfully operate the business. The AES Global Asset Management Standards dictate that each business must document an Asset Strategy to execute the business plan within the framework of the business Asset Management Policy.

2.0 Purpose of this Document

This document describes the Asset Management Strategy being used in IPL Customer Operations. This strategy defines how IPL Customer Operations will meet the obligations outlined in the AES US Strategic Business Unit Asset Management Policy, and thereby improve the service we provide to our customers.

The Asset Strategy at IPL will make use of various processes, tools, and programs developed and administered by the US SBU Transmission and Distribution Asset Management team. While many of these tools are developed by the Asset Management team, they should be utilized by individuals throughout the organization in making asset-related decisions.

3.0 Asset Management Policy – US Strategic Business Unit

The AES US Strategic Business Unit (SBU) will manage its physical assets with a focus on providing affordable and sustainable energy solutions to our customers. We will accomplish this goal while always adhering to our Shared Values

We will adopt a comprehensive Asset Management System that is defined by AES Global Asset Management Standards so as to attain operational excellence, sustainable development, and optimization of our resources. Our Asset Management System will support our commitments regarding how we will manage our physical assets. We will:

- Continue to make safety the top priority for our employees, contractors, visitors, and Stakeholders.

- Minimize and/or control our impact to the environment, complying will all legal and regulatory requirements;
- Maintain a systematic and sustainable process that considers the interrelated aspects of commercial, environmental, safety, legal, employee, information, financial, community, regulatory, and any other stakeholder needs that influence or affect the management of our physical assets;
- Optimize the availability and performance of our physical assets during their lifecycle through the implementation of operation, maintenance, risk, and investment processes that are considered to be best practices prevailing in the industry;
- Strive for continuous improvement of our processes through innovation, application of new technologies, and best practices using the APEX (AES Performance Excellence) methodology to establish the appropriate metrics to measure, evaluate , and compare our operating businesses;
- Provide a platform to maintain reliable asset identification and technical information as well as criticality criteria, to be used to mitigate risks and pursue market opportunities ;
- Maximize our gains through better utilization of our physical assets and proactively manage their lifecycle costs;
- Ensure that our people are trained, motivated, responsible, and accountable for the results of our Asset Management System.
- Make asset management decisions at the local business level, supported by advice and processes provided centrally to allow for fleet-wide optimization.

AES US SBU Leaders will be responsible for communicating, implementing, disseminating, and enforcing this Asset Management Policy and ensuring the establishment and achievement of its objectives and obligations.

All AES US SBU employees and contractors are responsible for understanding and committing to this Policy.

4.0 Asset Management Strategy

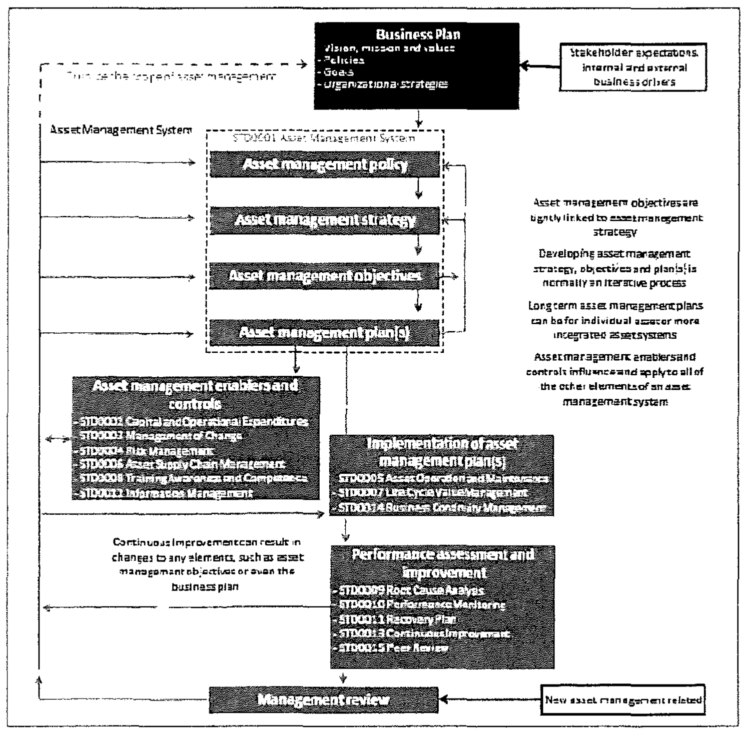
The purpose of our Asset Management Strategy is to summarize IPL's methodology and practices for providing a systematic representation, governance and management framework that will enable IPL to:

- Understand what system capacity and reliability is required, both now and in the future, and what issues drive these requirements;
- Have robust and transparent processes in place for managing all phases of the electric system and asset life cycles;
- Have adequately considered the classes of asset risk IPL's system faces, and ensure that IPL has systematic processes in place to mitigate these identified risks;

- Have an ever-increasing knowledge of our assets (locations, ages, conditions, etc.) and likely future performance;
- Make all decisions within systematic frameworks and guidelines.

The Asset Management Strategy is built upon systematic data-driven decisions for all dimensions of asset maintenance, operation, risk, and investment. This strategy drives a range of initiatives that ensure consistent collection, organization, and communication of asset data. The data is used to measure and monitor the performance and health of each asset, which is in turn used to systematically identify and prioritize system and asset risks and optimize investment decisions.

The process is a dynamic one, recognizing that new information and work delivery challenges may impact on the achievability of the plan and therefore change priorities. This means that there is continuous process of dialogue where the Asset Management team interacts with other internal stakeholders on a regular basis. This occurs regularly through good management practice (e.g. managerial approval, meetings, communications, etc.)



Key internal stakeholders are the T&D delivery organizations (Lines and Substations). They are continuously involved in assessing the profile of future risks and investment levels in the system so to ensure that the plan can be implemented within the existing resource and delivery constraints (e.g. skilled resources, supply chain, contractor availability, etc.).

5.0 Asset Management Objectives

IPL develops each year (as part of the US SBU Business annual planning process) a comprehensive set of Asset Management related objectives. These objectives link the Asset Management Strategy above (section 4.0) and the individual Asset Lifecycle Plans below (section 6.0). These objectives contain a broad scope of activities and achievements planned for the coming year. Specific objectives for 2015 include the following:

Asset Management Maturity:

- Asset Management - Continue asset management maturation process in alignment with the AES Asset Management Standards. Achieve a minimum level 3 status.
- Asset Management – Update the health index on transformers and breakers at IPL and create health indexes for the DP&L breakers and transformers
- Standardization – Continue cross functional initiatives bringing together processes, technologies, and tools in Customer Operations
- Develop ALCP's for key equipment that drives the 10 yrs. capital/maintenance/outage plans

Reliability:

- Reliability - Meet Reliability Operational KPI's & Complete Reliability Business/Tactical Plan Initiatives
- Develop an outage prediction model and utilize it and OMS to develop a common methodology for forecasting ETR
- Implement recommended Best Practices in customer services and reliability
- Support the Indianapolis downtown network formal investigation

Asset Modernization:

- Develop and implement modernization strategies for both IPL and DP&L
- Develop the 2025 CBD plan as well as finalizing network modernization plans at DP&L
- Implement DP&L AC Network Modernization plan to improve safety, reliability and monitoring

Technology Implementation:

- Continue populating the Customer Operations AM Website
- Create a customer service technology roadmap to capture shared savings, operations productivity and enhanced customer satisfaction

Compliance & Innovation:

- Compliance - Complete all 2015 compliance initiatives including the 693 internal mock audit
- Evaluate the use of "Unmanned Aerial Devices" (drones) for inspection and maintenance programs were practical

6.0 Asset Lifecycle Plans (ALCP)

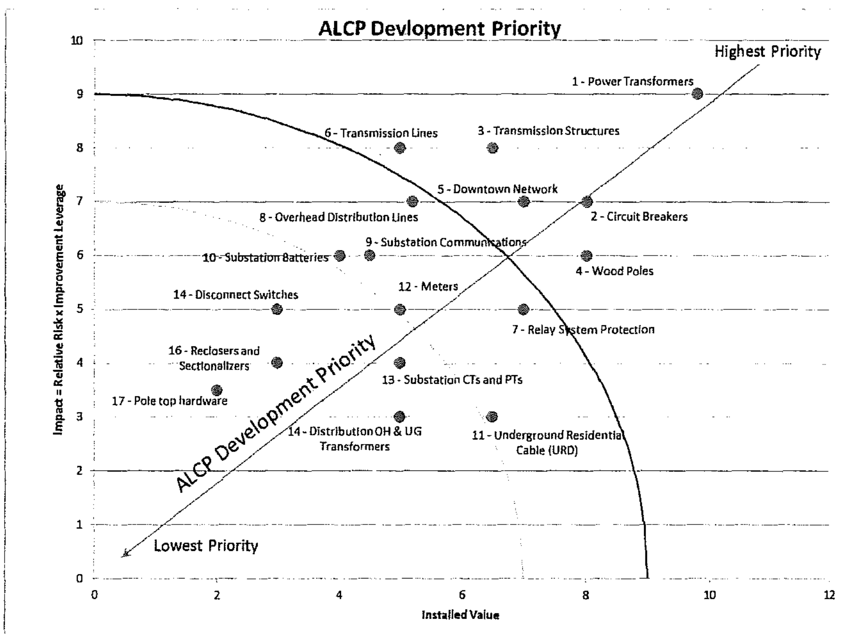
ALCP's will be developed, executed, and updated for each asset type. The ALCP is core to the Asset Management system at IPL. These plans provide an essential road map for the life of each asset type, defining what the assets are, profiling their key attributes and characteristics, tracking their performance and failure rates over time, prescribing how they will be maintained, operated, and monitored, and defining how and when it will be determined that they should be replaced. Each plan includes: A review of the current asset base, a summary of past asset performance and maintenance history, discussion of current asset condition and risks, a review of current maintenance and operation practices vs. industry best practices, identification of replacement needs and sparing strategy, asset expenditure requirements (O&M and Capital), and a discussion of innovations related to the type of asset.

Initial development of Asset Lifecycle Plans (ALCP's) for each major Asset Category requires significant amounts of time and effort to gather and analyze all of the necessary information, assess various options and develop and test robust strategies. Maintaining these plans, once developed, takes significantly less time and cost. Consequently, ALCP development must be prioritized to ensure that the most important plans are developed first, and that the order of development will deliver the greatest improvement in risk reduction and reliability, or improvement in cost, in the shortest time possible.

The priority and sequence of ALCP development has been based on analysis of each asset class in terms of:

- o Relative risk
- o Improvement leverage
- o Availability (and quality) of necessary data
- o Complexity of the problems and solutions needed (time & effort to develop the Plan) The graphic below illustrates the results of our analysis and the relative priority (and sequence) of our Plan development efforts.

The resulting prioritized order to initiate development is depicted in the chart below:



Asset Class Lifecycle Plan Implementation Status		
Asset Type	**Status as of 8/24/2015**	**Projected Completion Date**
Wood Poles	Draft completed	12/4/2014
Relay System Protection	Draft completed	11/25/2014
Circuit Breakers	Draft completed	12/15/2014
Power Transformers	Draft completed	8/17/2015
Downtown Network	Complete	8/31/2015
Underground Residential Cable (URD)	Data gathering, draft under development	2015 Q3
Overhead Distribution Lines	Data gathering, draft under development	2015 Q4
Transmission Structures	Data gathering, draft under development	2016 Q1
Meters		2016 Q3
Substation Batteries		2016 Q3
Transmission Lines		2016 Q4
Substation Communications		2016 Q4
Distribution Transformers		2017 Q1
System Control and Data		2017 Q2
Substation CTs and PTs		2017 Q3
Disconnect Switches		2017 Q4
Reclosers & Sectionalizers		2017 Q4
Pole Top Hardware		2017 Q4

7.0 Strategic Initiatives

7.1 Asset Condition Monitoring

IPL monitors the condition of our assets via various data resources. A combination of regular visual inspection, SCADA infrastructure, testing, and field data collection is utilized to monitor and measure asset health.

Inspection practices are continually evaluated to ensure that the scope and frequency is optimized such that the information collected provides value and prevents avoidable equipment failure.

Industry best practices and emerging technologies are investigated through our active participation in numerous industry forums, and evaluated to ensure their relevance to IPL's unique asset base and operating environment. This supports our commitment to employ all appropriate condition monitoring methods.

7.2 Asset Criticality

IPL is going through a process of ranking its assets for criticality and linking this information to the emerging results from our Asset Condition Assessment efforts. We began this effort with our most critical assets, and have now completed criticality assessments for all the Manholes and Vaults in our CBD Network system, for all Substation circuit breakers, and for all substation transformers. This effort will continue by the Asset Management team over the course of the next 12 to 18 months, in parallel with our efforts to implement asset condition assessment, The sequence with which we will approach different asset classes is expected to mirror the criteria and priorities used in selecting the order for ALCP development. (See 5.1 above)

One of the first asset classes to be completed is the power transformers. The transformers were evaluated based on a prescribed set of questions related to Safety, Environmental, Maintenance, Reliability, and Regulatory or Company Image risk. Each question has a pre-determined maximum potential score aligned with the business risk. For instance, transformers were scored with a maximum of 3000 in Safety, while the maximum Environmental risk was 1000. The sum of all scores were then categorized by numerical ranges, and translated into a criticality score of 1 through 4.

7.3 Asset Health Indexing

Asset Health Indexing is an industry leading methodology that combines condition information with the individual asset's importance or criticality to the system, to determine the relative health of the asset and the priority of interventions that may be required (i.e., changes to monitoring, operating limits, maintenance activities, or replacement strategies) to manage asset related risks in the business. The IPL Asset Management System is in the process of defining a standardized method for measuring and quantifying the health of assets relative to each other. The scoring of this index will incorporate the appropriate inspection and performance monitoring data to ensure that subjectivity is minimized and that asset health is measured consistently within each asset type. The application of these asset health indices will be prioritized in much the same way as are Asset Lifecycle Plans. A comprehensive schedule for completion of these Asset Health Indices is under development and will be completed before year end 2015.

7.4 Root Cause Analysis

IPL will utilize Root Cause Analysis (RCA) to identify and address the underlying causes of why an incident or non-conformance occurred, so that the most effective solutions can be identified and implemented. The RCA is an important component of the Asset Management System, because it prevents re-occurrence of the same issue on a given asset or type of assets, ensuring that performance improvements are sustainable.

The Customer Operations T&D group has defined RCA triggers, and will initiate an RCA for the following events:

1. Any event resulting in lost time or serious injury to an employee or contract employee
2. Loss of Substation Power transformer greater than 30 MVA
3. Complete loss of sources to a substation resulting in 300,000 minutes or more of customer outage
4. Any manhole/vault event on the secondary network system
5. Any Transmission level event resulting in a possible NERC reportable event
6. The Senior Vice-President of Customer Operations may also direct that an RCA be initiated whenever it is felt the situation is warranted.

Upon initiation of an RCA, a cross-functional team is assembled and evidence preserved. The RCA is to be completed within 45 days of an initiating event, unless otherwise approved by the Senior Vice President of Customer Operations. The results of each RCA are appropriately communicated to the organization so that corrective actions can be taken and monitored for effectiveness.

7.5 Asset Failure Forecasting

IPL's high system and customer reliability indicates that the overall system is in relatively good condition. The company has ranked in the top quartile in customer reliability for many years, and is now pushing into the top decile. Nevertheless, we remain committed to continuous improvement and being able to anticipate and avoid potential asset failures is an important enabler of this improvement. The analysis involved in such forecasting can be complex, and requires access to significant volumes of accurate data, which has been a common challenge for utilities across the industry.

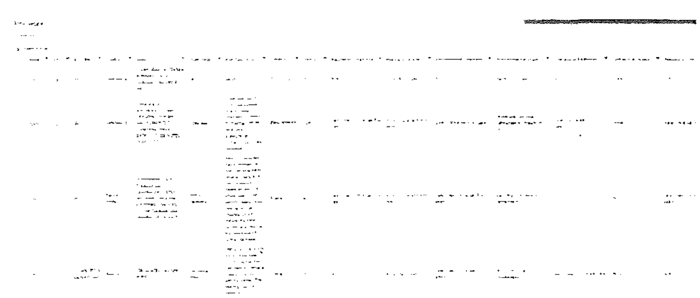
IPL has made some recent commitments and investments in data mining and statistical analysis tools for this purpose. Initial results look promising, with the ability to manage vast amounts of information quickly and to delve into levels of detail not before possible, in analyzing the performance of individual assets, and being able to spot trends within asset classes that were not possible before. We expect to make more investments in this area, both in tools and in the resources to conduct these analyses, and will house these powerful new capabilities as they mature within Asset Management, where they will be best positioned to link their insights and discoveries to our asset risk and failure forecasting, proactive asset strategies and transparent results reporting.

IPL will also continue to move away from reactive maintenance based on lagging indicators toward a more proactive approach based on leading indicators. Monitoring trends in inspection results and calculated indicators such as the Asset Health Index will allow IPL to proactively respond to declines in the condition of any asset.

7.6 Risk Management

The Asset Management System will maintain and utilize an Asset Risk Register. Besides the risks identified and analytic inputs provided by Asset Management, the Asset Risk Register will provide a means for people throughout the organization to document known significant risks related to any asset or part of the system. Along with documentation of each risk, risks are assigned an identification number, and the register documents the risk owner, relative ranking / evaluation of the risk, conclusions of the risk assessment, and whether a mitigation plan is required or has been put in place. If the mitigation plan includes a capital project, then the capital project number is also identified, enabling a user to track a risk to an asset as well as to a capital project designed to mitigate or eliminate the risk.

The risk register will be available via company intranet so that the information will be readily available for people throughout the organization to document new risks, or to make risk informed decisions. This risk register is a current development initiative and will be available through the company intranet by the end of 2015, and should be a valuable tool during the 2016 budgeting process.



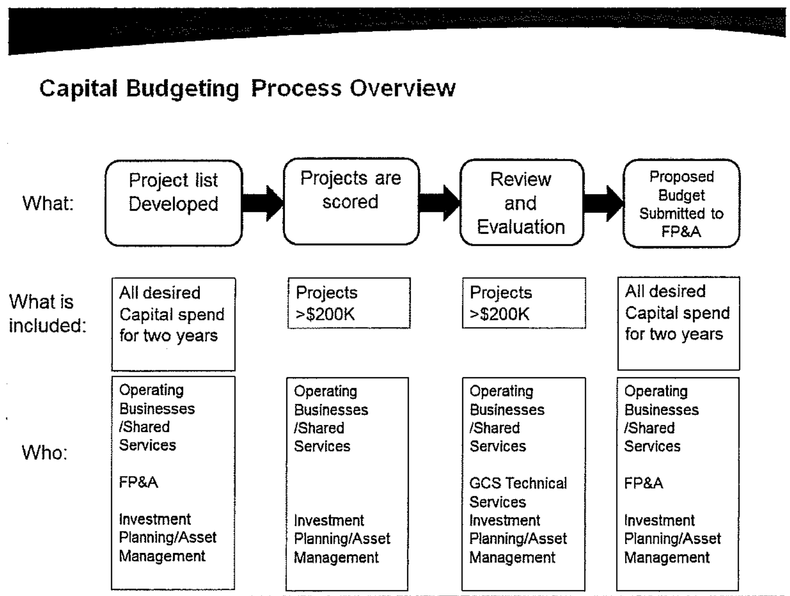
Asset Criticality, Asset Health Indexes, and Asset Failure Forecasting will be utilized identify, mitigate, and prioritize risks.

7.7 Standardized Asset Investment Processes and Analysis

The Asset Management System will use a process-oriented approach to evaluating capital and major operational expenditures, based on AES Global Standard STD0002. The process is intended to ensure that project options, costs, and value to the business have been completely analyzed to maximize benefit and minimize risk from every capital investment made in IPL T&D.

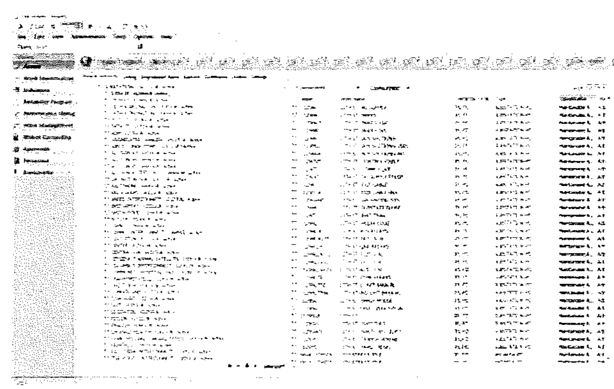
The Project Authorization, Scoring, & Evaluation Tool (PASE Tool) is the foundation of this process, as it is used to evaluate project costs and benefits to the company. PASE has been in place now for the last two budget cycles and is building credibility among internal stakeholder departments as a fair and effective tool for use by the organization in adjudicating competing requirements for capital investment and bringing transparency to the process. The tool assigns monetary costs to non-financial impacts, so that economic benefits, non-financial benefits, and revenue-generating benefits can all be measured on one scale to evaluate a project.

Projects are prioritized each year, and then continually throughout the year, based on quantified risk and impacts on the business. The process is outlined at a high level as follows:

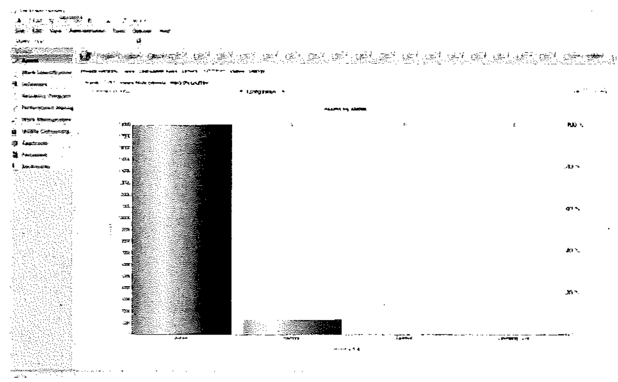


7.8 Asset Performance Management Software

The Asset Management System utilizes Ivara Asset Performance Management Software to manage and monitor asset performance and health. This software provides a repository for all inspection and operational data associated with each asset, and organizes it so that it can be utilized as actionable information, enabling timely and accurate decisions related to the asset.



This software automatically calculates and updates the health of an asset as new inspection and operating information is processed. The program is aligned with the Asset Register, enabling performance and health information to be tied directly to an Asset ID, asset criticality, and other technical information.



IVARA is being utilized for the equipment located in manholes, vaults, and substations. This includes most circuit breakers, power transformers, manholes, vaults, network protectors, and network transformers.

7.9 <u>Asset Management Webpage</u>

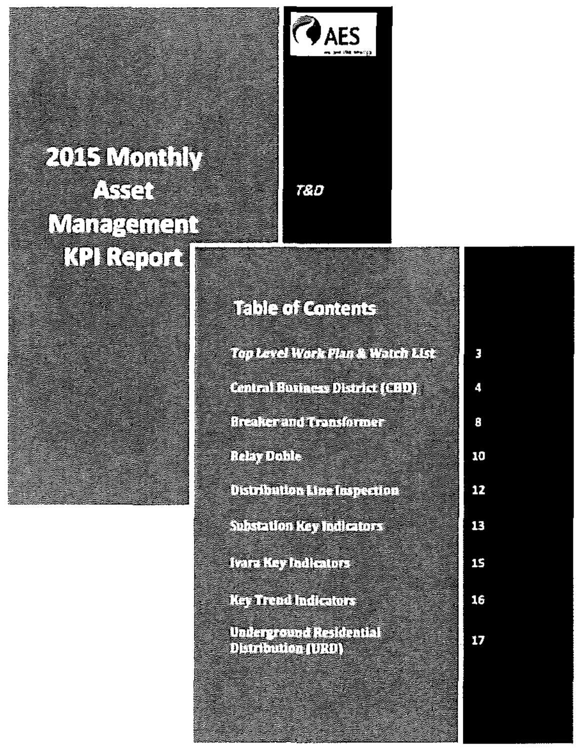
As part of IPL's strategy of making informed, data-driven decisions, it is critical that appropriate information is readily available to the individuals that are making decisions. To ensure that individuals throughout the organization have access to real-time and consistent information, AES T&D Asset Management maintains an Asset Management Webpage on the IPL intranet. This website enables individuals throughout the organization to access a vast amount of information about the company's assets in a single location, without the need for multiple database accounts and passwords. In addition to providing a user-friendly interface to information that is stored in multiple databases, the website also generates various real-time performance and work management reports, as well as serving as a central repository for a multitude of documents related to asset management, including:

- The Asset Register
- Real-time outage and reliability reports
- Real-time work management reports
- Budget Information
- MobileFrame inspection records
- AES AM Standards
- IPL Standards and Engineering Practices
- Asset Health Indices
- Historic outage information
- Real-time CBD work management and system performance reports
- Asset Lifecycle Plans
- Standard Operating Procedures
- Links to other AES, IPL, and DP&L resources

This website was developed by Asset Management as a rapid and low cost solution, with an emphasis on practicality. Each new function was tested to be sure it worked before deployment. The website was designed to manage the issue of defining the proper source for each specific data element.

Before plunging headlong into a major costly and time consuming Enterprise Asset Management system development project, we wanted to assure that our data and decision making processes were sufficiently mature to add short term value. This incremental approach to technology adoption reflects what we believe is a prudent strategy with respect to IT enablement. Furthermore, it will assure that any eventual decision to switch to a more robust (and potentially more expensive), "one-stop" IT solution will be justified based on incremental benefits (and return on the investment) available.

We plan to complete our Asset Management implementation – including ongoing changes to structure, staffing, competencies, and processes - in a similar fashion, *"growing"* into our expanding role, and ensuring that we add significant value at every stage. A good example of this kind of immediate value is our Asset Management KPI Monthly report. It documents the success to-date of our Asset Management group in driving each of the domains we are responsible for. (Preventive Maintenance, Asset Health & Risk, Asset Replacement Progress, Data quality, Compliance, System & Asset Performance, Customer Reliability).



7.10 Management of Change

IPL will employ a formal Management of Change process to evaluate, authorize, and document modifications to equipment, operative parameters, policies and procedures, raw materials, and process conditions. This process ensures that changes are effected in a seamless manner such that the intended benefit is realized without introducing new risk or undesirable consequences to the system.

7.11 Industry Involvement

IPL will continue to be engaged in a variety of industry forums. Participation in these committees and organizations ensures that IPL personnel are aware of issues and innovations that affect the utility industry, and enable IPL to remain at the forefront of implementing best practices.

A partial list of the most prominent industry forums in which we regularly participate includes:

- Substation Best Practices Forum – IPL is one of the founding members.
- Underground Network Forum – IPL is a frequent user and contributor since 2010.
- MEA (Midwest Electric Association)
- MEDE (Midwest Electric Distribution Exchange) – IPL is active in the MEDE annual meeting and knowledge sharing network
- EEI Reliability Surveys – sharing data and best practices for reliability management.
- IEEE Reliability Surveys – sharing data and best practices for reliability management.
- Northeast Underground Committee (NEUC) – IPL provides representation and knowledge sharing data and best practices for UG systems at annual meetings.
- GLMA (Great Lakes Mutual Association) – IPL is an active participant in this association for sharing manpower resources and best practices for storm restoration.
- Doble Group - IPL SME is chairman of the Transformer subcommittee/group

7.12 Future Design Evolution of the Electric System (Utility 2.0)

IPL will continue to embrace the changes that are coming to the utility industry. T&D assets must be managed such that they meet the needs of the customers today, yet still position the company to adapt to the Utility 2.0 business model. IPL has been at the forefront in establishing business relationships that enable distributed generation, electric vehicle deployment, and energy storage to be incorporated into the transmission and distribution system and must continue to embrace these types of initiatives. IPL's strategy will continue to build off of recent "smart-grid" resiliency and reliability projects, and to continue to enhance system performance and the customer experience.

7.13 Integration Into Annual Asset Management Plan

The Asset Management Policy, Asset Management Strategy, and Asset Lifecycle Plans should be utilized as a roadmap during the development of annual Asset Management Plans and budgets. Adherence to these guidelines will ensure that decisions are aligned with the business plan and the organizations strategic initiatives.

7.14 Training & Delivery Resource Challenges

Effective training is necessary to ensure that T&D assets are correctly operated and maintained, and that management and decision processes are correctly executed. As such, it is important that responsibilities and competencies are well-defined, and that tools and diagnostic criteria are available to determine adherence to these requirements. IPL will continue to grow the established training program, and focus on identifying and closing employee competency gaps. A periodic review of training methods and effectiveness will be performed to identify areas for possible improvement.

7.15 Stakeholder Communications

A key factor in the success of the Asset Management System will be the effectiveness of the organization to communicate Asset Management information to all stakeholders. Stakeholders involved in the management of assets at IPL must be able to access, input, update, or dispose of asset-related information at a level appropriate to their job function and responsibility. While the Asset Management webpage is one important information resource, it is critical that other information systems utilized are maintained such that they are consistent and accurate.

7.16 Innovation & Technology Advances

IPL employees shall remain engaged in industry forums, continuing education programs, and continuous improvement programs such as APEX (AES Performance Excellence) to maintain awareness of innovation and technology advances within the industry so that they can be incorporated into relevant processes and plans. Proactive implementation of proven technology and innovative solutions will ensure that IPL customers receive the best reliability and customer experience possible, and position the company to adapt to the future utility business model.

AES
we are the energy

2015 Monthly Asset Management KPI Report

July 2015

IPL T&D

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Preventive Maintenance

The goal of IPL's inspection and preventive maintenance programs is to lessen the likelihood of critical equipment failing or malfunctioning when needed. The ideal inspection and preventive maintenance program would prevent all equipment failure before it occurs. Preventative maintenance (PM) is performed while the equipment is still functioning properly, so that it does not break down unexpectedly. These programs include inspection and testing activities (often called Predictive Maintenance - PdM).

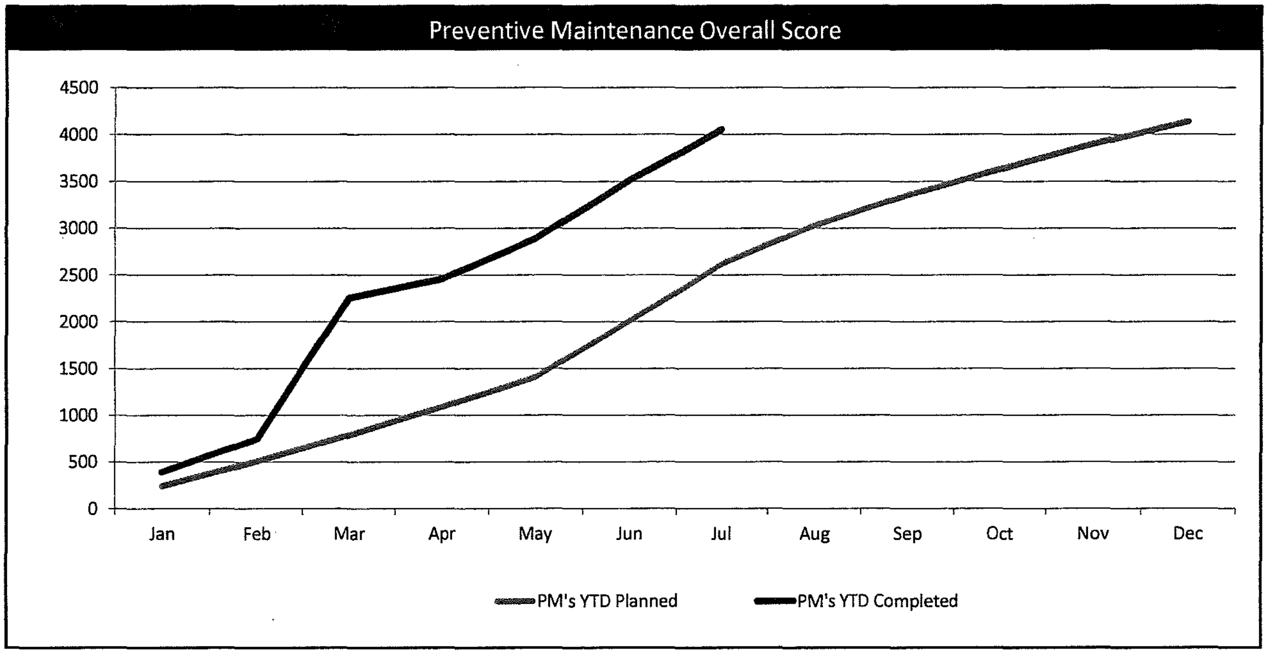
Many of the programs on the following pages are time based, but Asset Management intends to change the triggers for these tasks to condition-based in the future. Within these programs, readings and findings are documented (often through mobile data terminals used by our field workforce), and any follow up work that is required is logged, and work orders created for future repairs before the problems can cause system failure. Such repairs and follow up items are prioritized based on the risk of the associated problem. And for items where risk of failure has minimal impact, we will not have an inspection or maintenance program.

009336

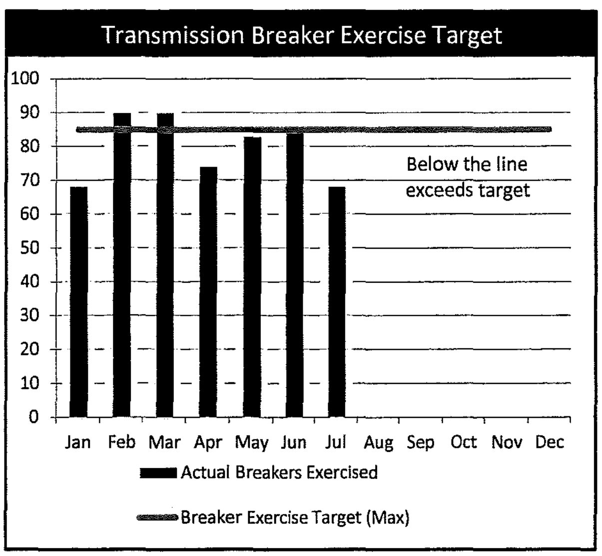
Preventive Maintenance

Preventive Maintenance Top Level Work Plan & Watch List

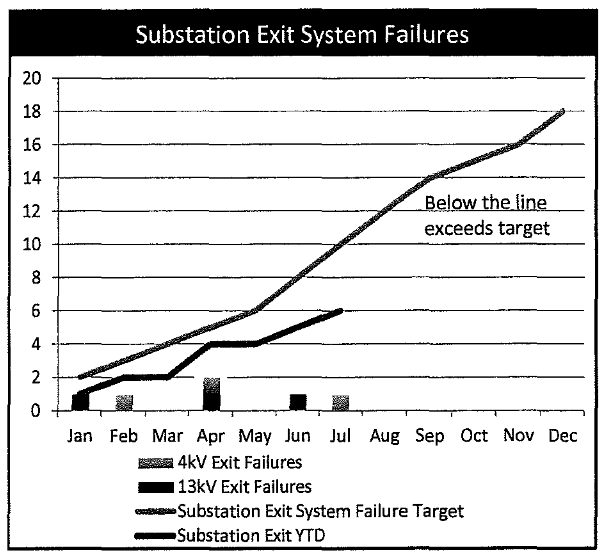
The top chart shows the actual preventive maintenance work is significantly over the planned target. This is primarily attributed to the sweep of the downtown network in March of this year. Transmission Breaker Exercise and Substation Exit Failures metrics have performed well in 2015.



This chart is a summary of the more significant preventive maintenance programs for 2015 and whether IPL is meeting the overall target. Even with acceptable numbers on the chart below some individual programs may still be behind schedule. The total consists of line patrol, substation and downtown network maintenance programs.



A list is provided to Transmission Operations each month to exercise breakers that haven't operated in the last 6 months. This limits the possibility of mechanism "freeze up". We want the number of breakers to be less than the target.

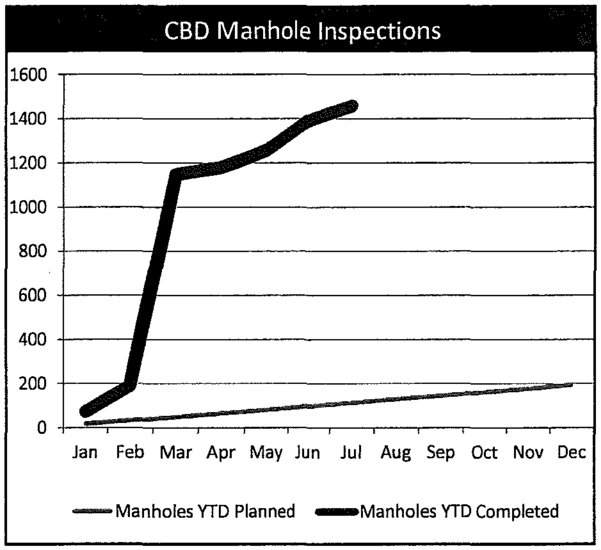


Substation exit cable system failure rates increased dramatically in 2012. In 2013 and 2014 they returned to normal. This metric will track the trend in 2015 with a target of 18 this year.

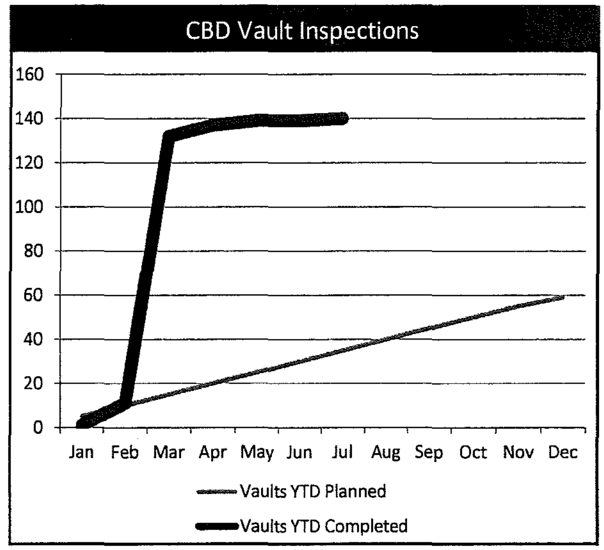
009337

Central Business District (CBD) Inspection Work Plan

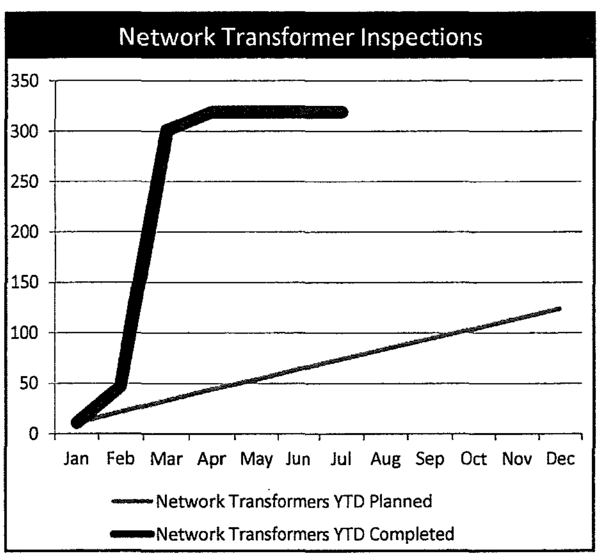
These charts illustrate the inspections that IPL is scheduled to complete for the Central Business District for 2015. The actual numbers far surpass the planned numbers because of the downtown network sweep in March before the NCAA Final Four Tournament.



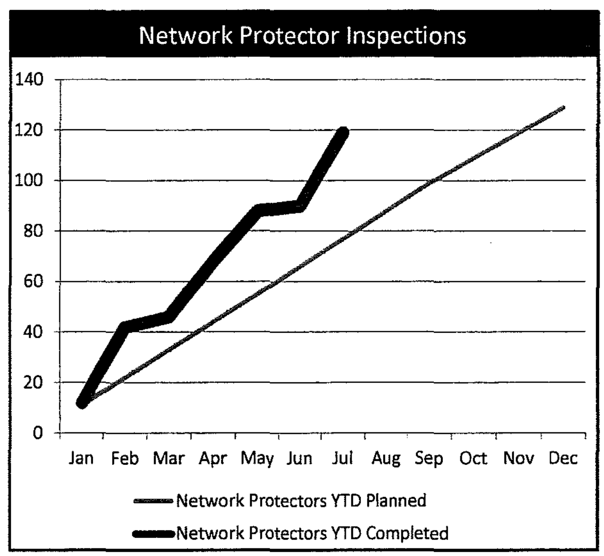
There are 1250+ manholes in the Central Business District. These are inspected on a 3 year cycle. With the system sweep in March the target has been exceeded. This lowered target is due to more than planned inspections in 2013 and 2014. During the network sweep some manholes where inspected a second time.



There are 143 vault structures in the Central Business District. The above remain to be inspected in 2015 for all to be on a 2 year cycle. With the system sweep in March the target has been exceeded. This lowered target is due to more than planned inspections in 2013 and 2014.



There are 304 Network Transformers in the Central Business District. These are inspected on a 2 year cycle. The target line is specific for 2015. With the system sweep in March the target has been exceeded. This lowered target is due to more than planned inspections in 2013 and 2014.

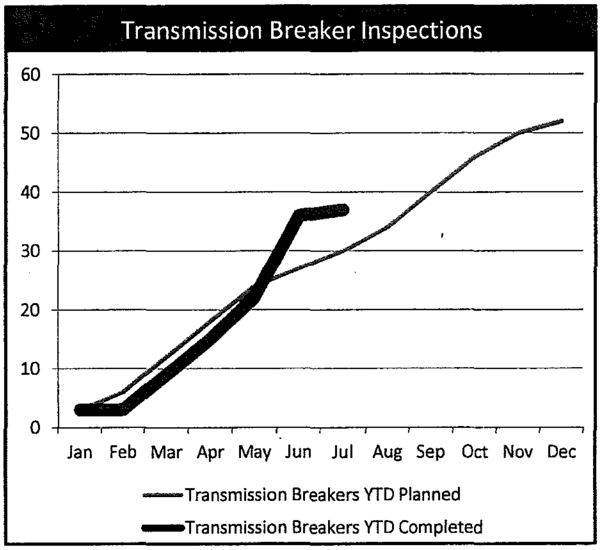


There are 304 Protectors in the Central Business District. These are inspected on a 2 year cycle. The target line is specific to 2015. This lowered target is due to more than planned inspections in 2013 and 2014.

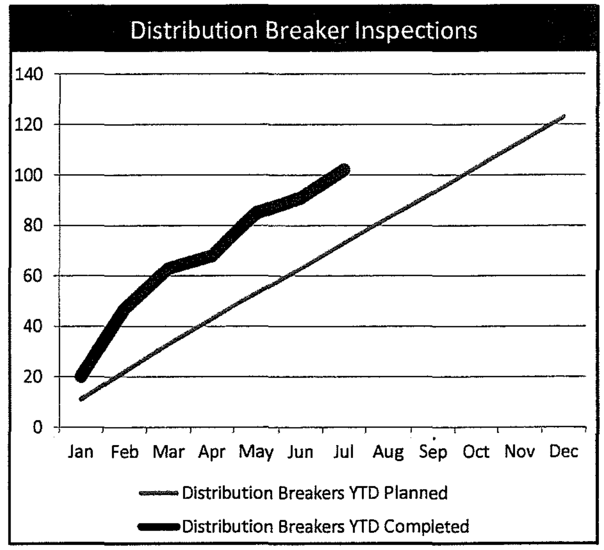
009338

Substation Breaker and Transformer Preventive Maintenance Plans for 2015

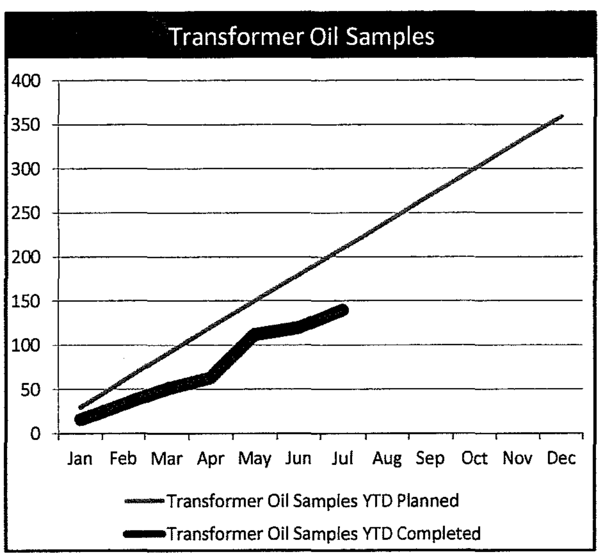
These charts illustrate the substation breaker and transformer preventive maintenance plans for 2015. This data is tracked in the EMPAC work management system. Breaker inspection are ahead of schedule. Transformer oil sampling is behind schedule. This will be addressed by dedicating a resource full time to this activity.



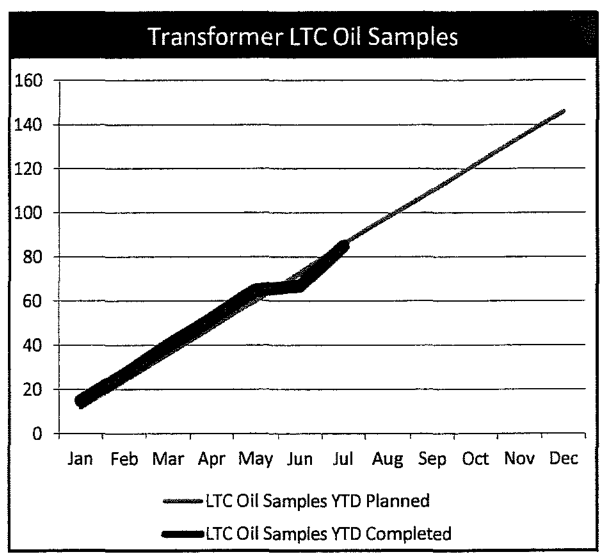
We have eight (8) 345kV and forty-four (44) 138kV breakers due for external maintenance in 2015 for a total of 52 breakers. This lowered target is due to more than planned inspections in 2013 and 2014.



We have thirty-one (31) 34kV, seventy-five (75) 13kV and seventeen (17) 4kV breakers due for maintenance in 2015 for a total of 123 breakers. This lowered target is due to more than planned inspections in 2013 and 2014.



All substation transformers should have at least one Dissolved Gas Analysis (DGA) performed in 2015. An oil sampling resource will be dedicated to this task for the last part of 2015.

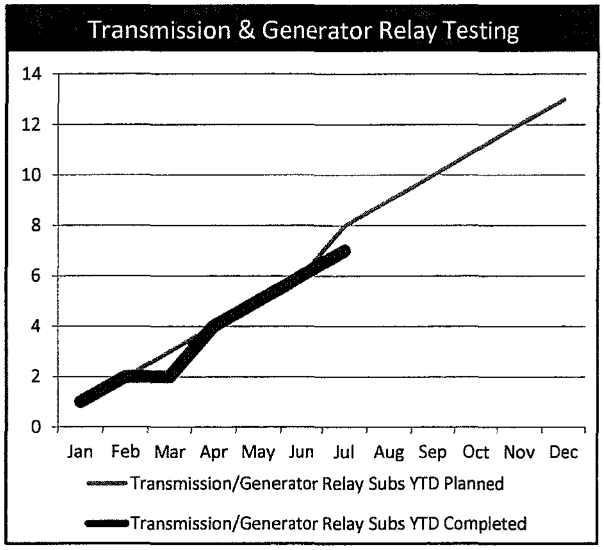


All substation transformers with a load tap changer (LTC) should have at least one Dissolved Gas Analysis (DGA) performed on the LTC in 2015.

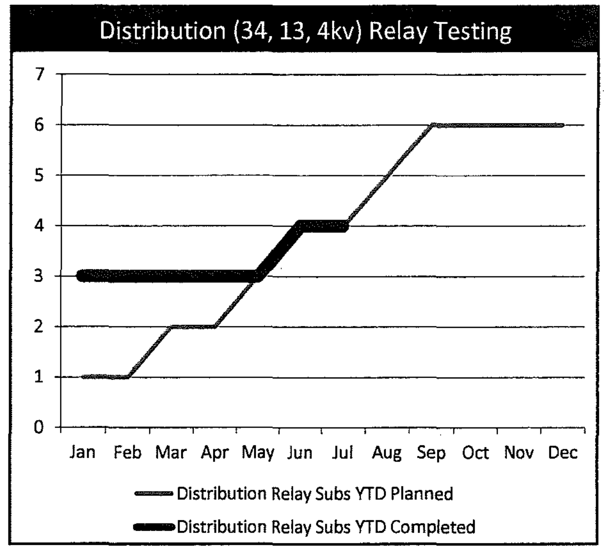
009339

Relay and Doble Preventive Maintenance Work Plan

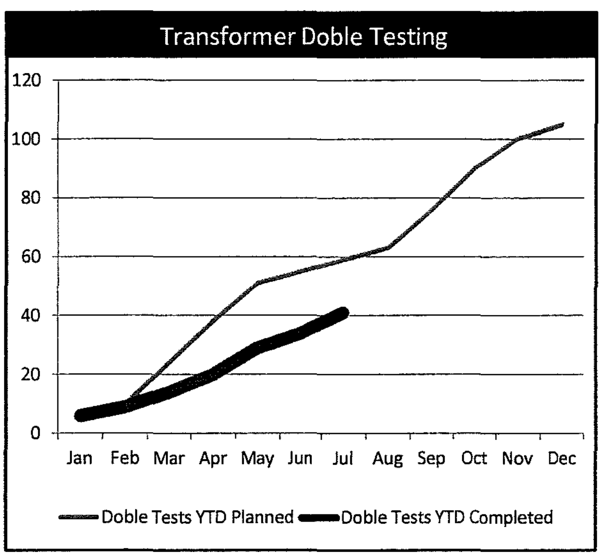
These charts illustrate the inspection work plan for substation relay and Doble (Power Factor Insulation) testing along with infrared inspections in 2015. Transformer Doble Testing is behind schedule. All other programs are within target.



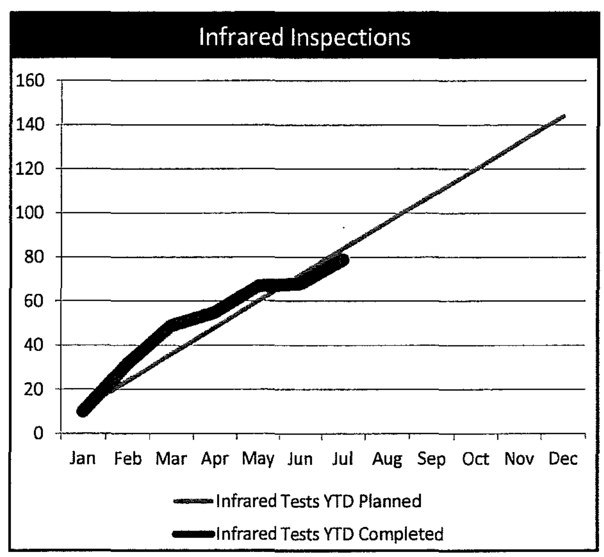
This includes 345/138kV substation relays systems along with generator protection systems greater than 100MVA. We expect to make target by the end of the year.



This includes 34, 13, and 4kV substation relays systems.



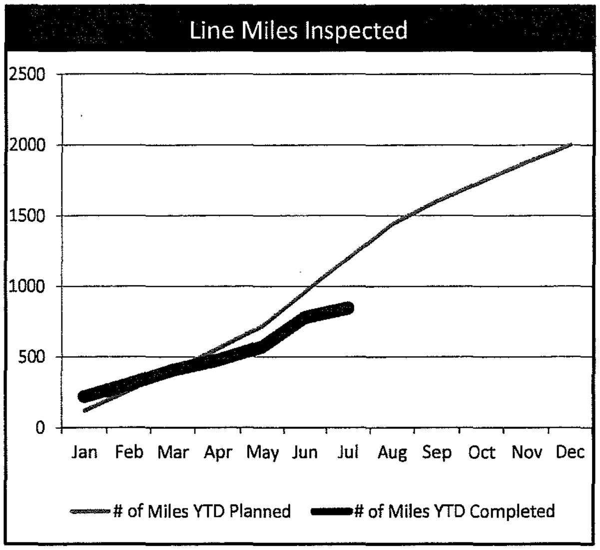
Because of scheduling outages and weather, transformer Doble testing has been behind schedule. The transformers are prioritized based on their criticality index. This is likely to finish behind schedule this year.



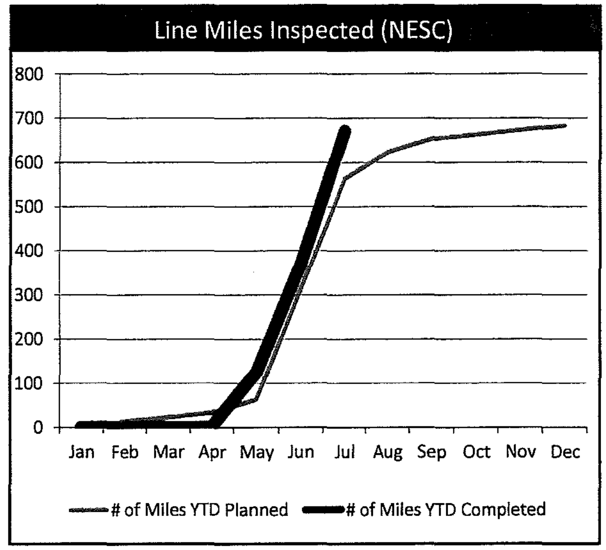
All 143 substations should have at least one infrared scan during 2015.

Distribution Line Inspection Work Plan

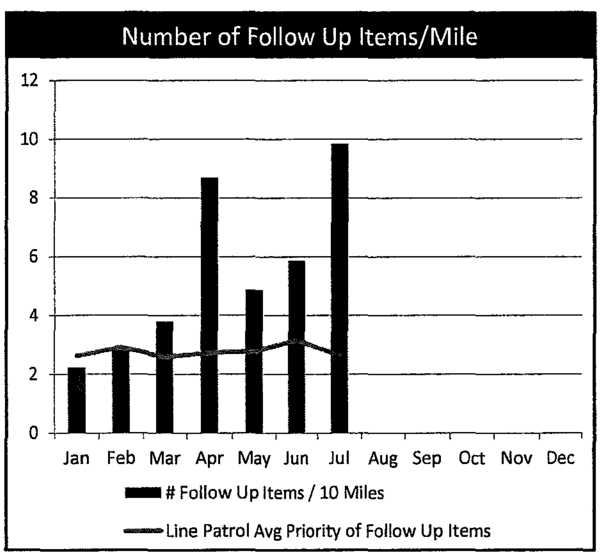
These charts illustrate the inspection work plan for distribution line inspections in 2015. The bottom two charts track the number of follow up items and the severity of these items. The line miles inspected program is behind the plan target. However, the planned illustrated was double the existing preventive maintenance program.



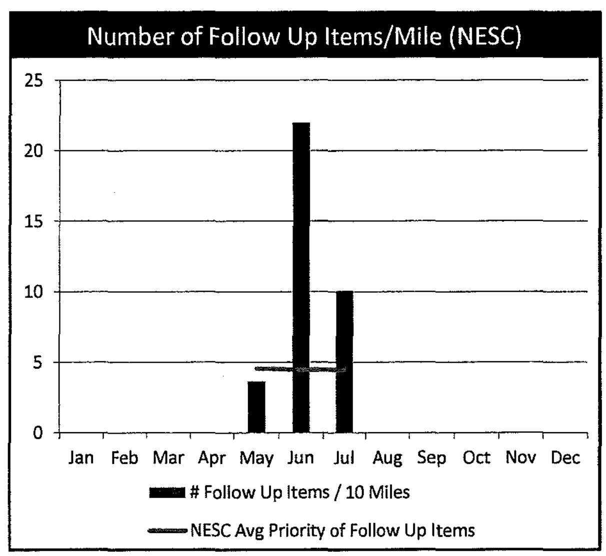
We have 3,958 miles of OH distribution (34, 13, 4kV) lines. These lines are on a 4 year inspection cycle. However the last few years this group has used temporary drivers and been performing on a 2 year cycle pilot program. The increased number of follow up items reduces miles inspected due to time needed to process the work orders.



We have 7,500+ miles of OH & UG distribution (13, 4kV) lines. Targets are set based on resource availability, and circuit length.These lines are on a 10 year NESC inspection cycle.



This statistic is to track the trend of the volume and average priority of follow up work from inspections. If volume or priority increases we may need to inspect more often. If it decreases we may be able to extend cycles. Count and Priority use the same vertical axis."



This statistic is to track the trend of the volume and average priority of follow up work from inspections. If volume or priority increases we may need to inspect more often. If it decreases we may be able to extend cycles. Count and Priority use the same vertical axis."

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Asset Health & Risk

An Asset Health Index (AHI) approach allows IPL to systematically identify where each asset is in its life cycle and when it is likely to reach its end of life. The IPL Asset Health Index approach uses the findings from inspections, preventive maintenance activities, and asset condition assessments to develop an overall picture of the health of the asset. The continuum of asset scores can be subdivided into ranges of scores that represent differing degrees of asset health *(and therefore probability of failure)*. IPL calculates real time asset health scores in the Ivara software application for each of the major asset classes below:

- Substation Transformers
- Substation Breakers
- Downtown Network Vault Structures
- Downtown Network Transformers
- Downtown Network Protectors
- Downtown Network Manholes

Asset health indices are under development for several other asset classes, with the intent that we will have such indices for all major classes by the end of 2017. (See IPL's Asset Management Strategy document for this development schedule.
http://iplassetmgmt/Documents/CustomerOperationsAssetStrategy2013.pdf

Translating AHI into Asset Risk requires integration with a model that calculates the criticality of each particular asset (i.e., individual Asset Importance to the overall system). Asset criticality provides a measure of the consequence of failure. IPL assets are evaluated in terms of their potential impact in the following high level criticality areas:

- Safety
- Network Performance
- Financial
- Company Image/Regulatory
- Environmental

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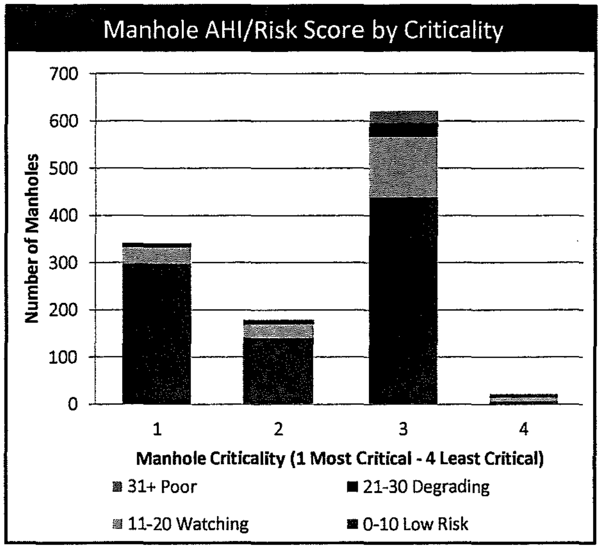
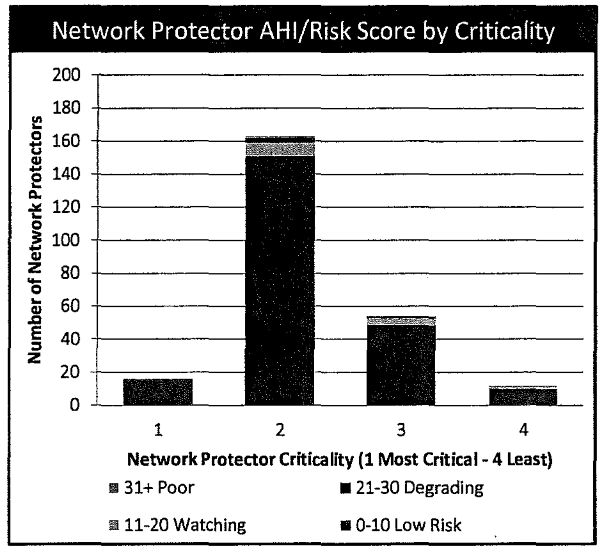
Asset Health & Risk

Central Business District (CBD) Asset Health Indicators By Criticality

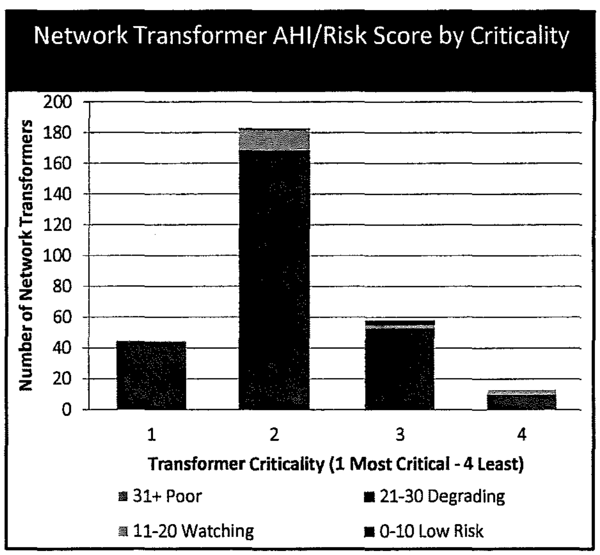
These charts illustrate the overall risk index for each class of assets for the CBD. The asset criticality is based on items such as steam history, number of cables, high traffic areas, etc. The asset health index is based on the latest inspection data. All of this data is stored in Ivara. Work orders exist for risk scores that are degrading or poor.



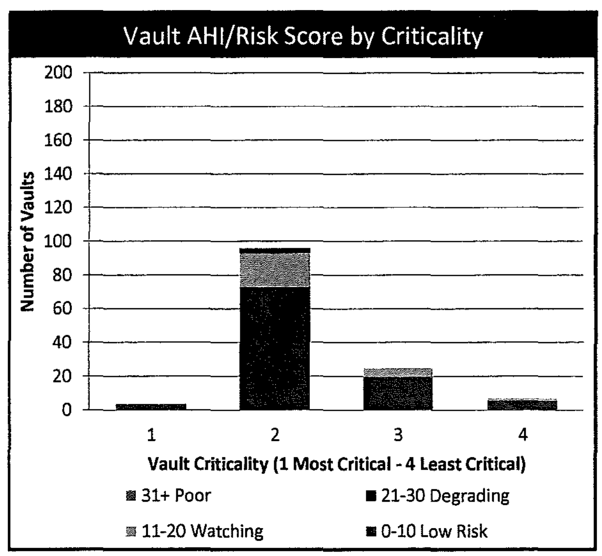
The majority of manhole assets are in the low risk range. Work orders are created for any manhole that is scored more than low risk.



The majority of network protectors assets are in the low risk range. With the planned replacement of all 277/480V protectors over the next few years this chart will continue to show improvement.



The majority of network transformer assets are in the low risk range. Work orders are created for any network transformer that have indexes of degrading or poor.



The majority of network vault assets are in the low risk range. Work orders are created and prioritized for network vaults that have indexes of degrading or poor.

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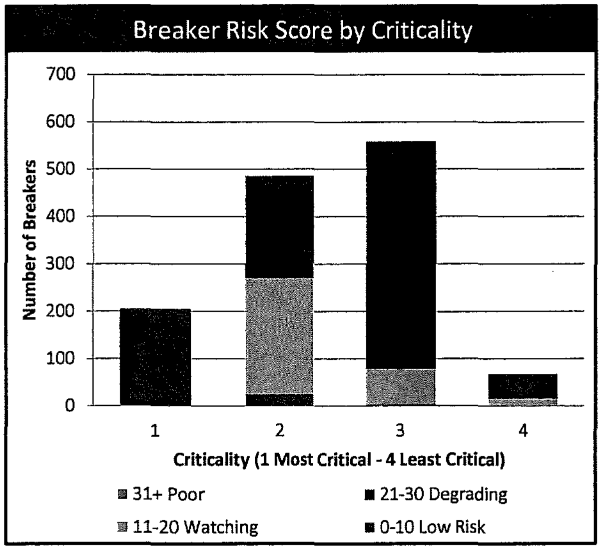
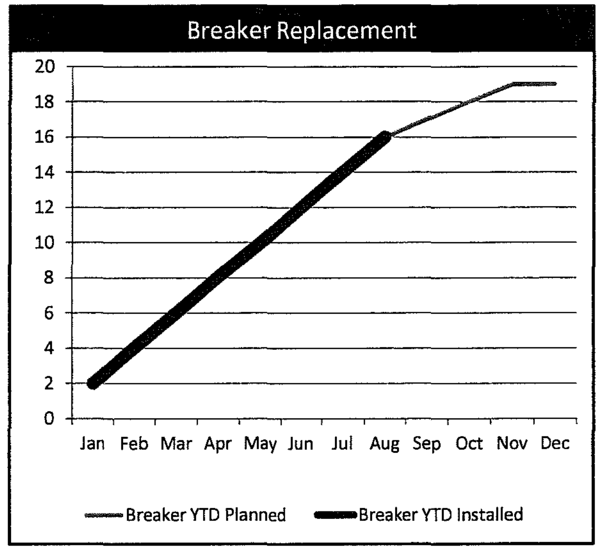
Breaker and Transformer Asset Health Indicators By Criticality & Replacement Plans

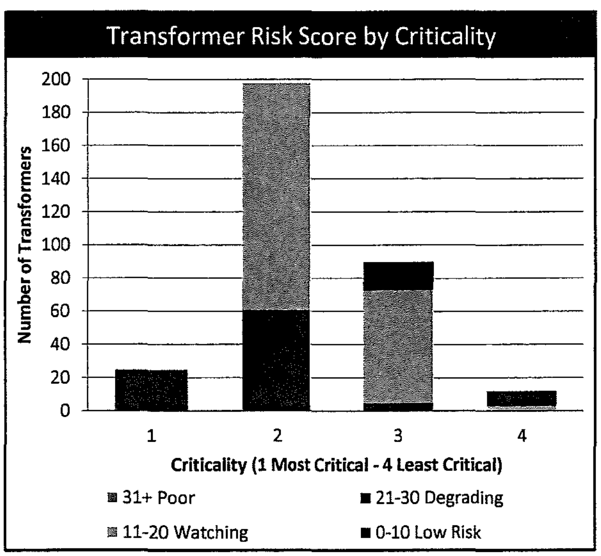
These charts illustrate the overall risk for substation breakers and transformers. The asset criticality is based on items such as cost, redundancy etc. The asset health index is based on the oil tests, power factor readings, age, history, etc. All of this data is stored in Ivara.

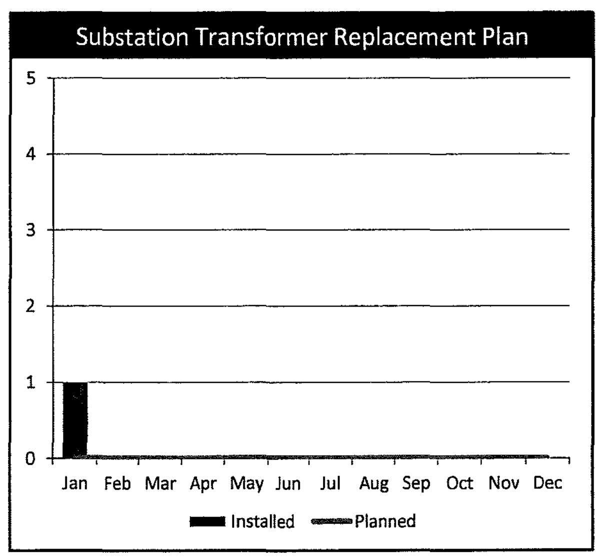




Most of the substation breakers have a health score more than low risk. However, the critical breakers all have a low risk rating. The breaker replacement plans have increase significantly the last few years.

Breaker replacements are on target for 2015. The concentration has been on transmission and subtransmission breaker replacements.





Most of the substation transformers have a health score more than low risk. However, the critical transformers all have a low risk rating.

No transformers were scheduled to be replaced in 2015. The one transformer installed in January was for a failed unit at Sheffield Sub.

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Asset Replacement Progress

Asset replacement decisions are driven by a condition-based approach, using asset criticality and probability of failure to ensure good system reliability and effective risk management. Our replacement programs are dynamic and adjusted each year, as the identified condition of our many asset classes change over time.

Because there is no absolute predictor of asset failure, we work on a probabilistic basis to maintain an acceptable risk profile within each class and for the overall electric system. This means that our plans evolve over time as we discover shifts in the risk profiles of our assets and infrastructure. Some of our oldest assets are in relatively good condition and represent little risk of failure. While some assets less than half as old may have significantly less remaining life and represent higher risks of failure today. This is a well-established phenomenon across the industry, due in part to the fact that our oldest assets were built at a time before manufacturers had the computer design capabilities they do today, and so built into each unit greater safety margins.

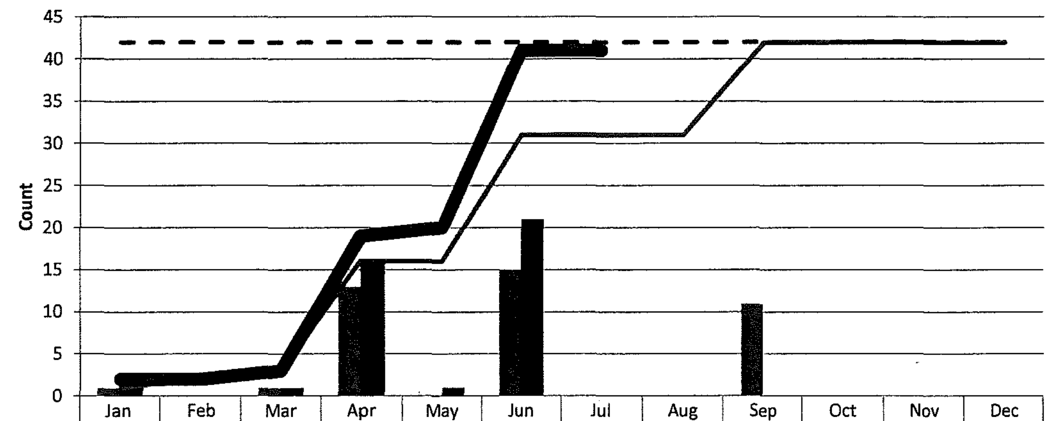
Some of the key asset replacement programs are shown on the following pages.

Asset Replacement Progress

Central Business District (CBD) Replacements

These charts illustrate the replacement plans for assets in the Central Business District for 2015. Network protector replacement is ahead of schedule. Actual primary cable and secondary cable replacements are lagging the planned forecast.

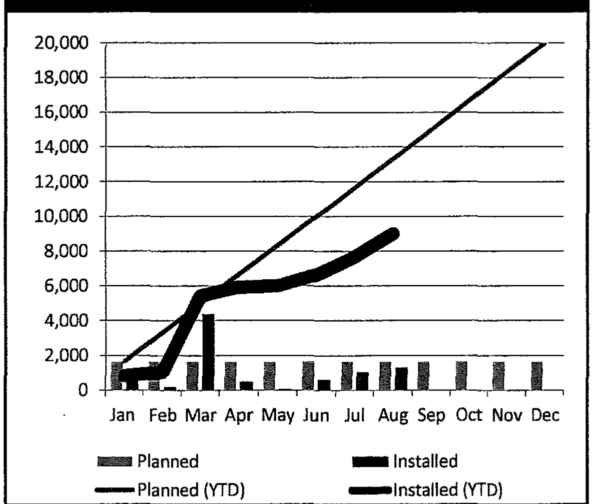
480V Network Protector Replacement 2015 Schedule



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planned	1	0	1	13	0	15	0	0	11	0	0	0
Installed	1	0	1	16	1	21	0					
Planned (YTD)	1	2	3	16	16	31	31	31	42	42	42	42
Installed (YTD)	2	2	3	19	20	41	41					
Target (YTD)	42	42	42	42	42	42	42	42	42	42	42	42

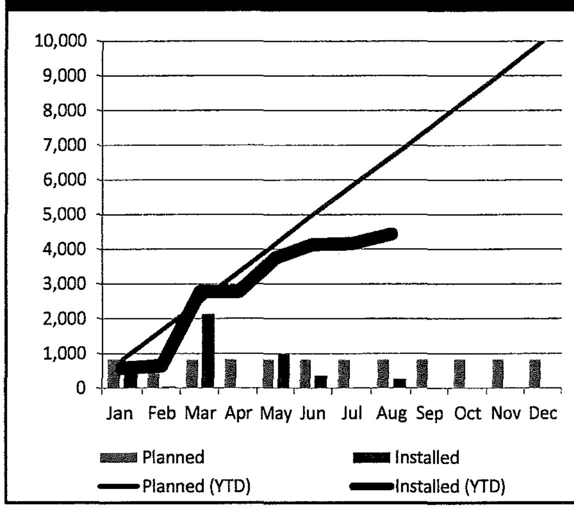
IPL has a 5 year program to replace all of the 277/480 Volt network protectors. This program will be complete in 2018. The above chart shows the schedule for 2015. There is one protector left to do this year to meet the work plan.

PRIMARY CABLE REPLACEMENT



The majority of the primary cable targeted for replacement is XLPE. IPL is pro-actively replacing XLPE primary cable because of poor performance over the years. Pirelli 750 MCM PILC cable out of Gardner Lane is on the watch list. This program has been reduced as IPL changes its primary cable specification.

SECONDARY CABLE REPLACEMENT



IPL has historically replaced secondary cable based on inspection data. New tools have been developed (duct temperature, stray voltage survey) to target additional secondary replacements. This program has been reduced as IPL changes its secondary cable specification.

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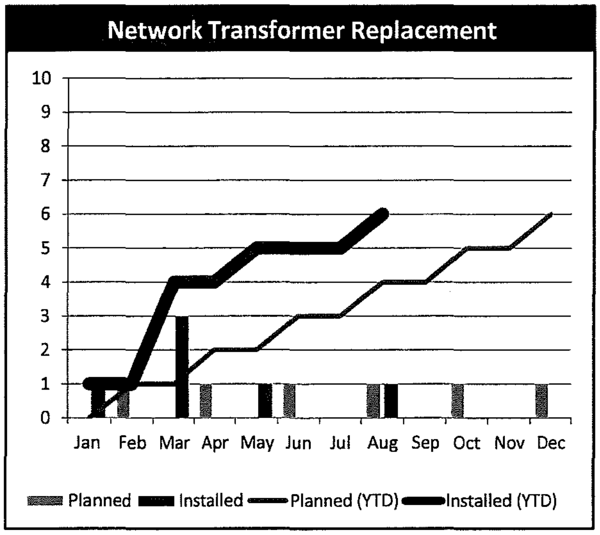
Central Business District (CBD) Replacements *(continued)*

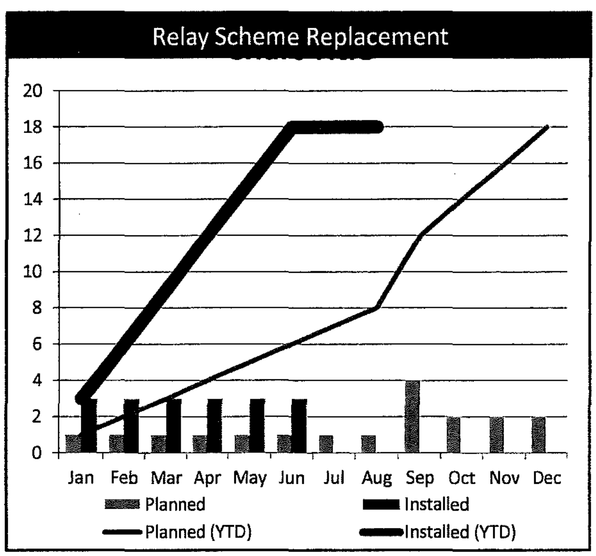
These charts illustrate the replacement plans for the Network Transformers for 2015. This program is ahead of schedule.



IPL has typically replaced 6 to 8 transformers every year. This program is conditioned based and actual replacement may vary slightly.

Relay Scheme Replacement Plan

These charts illustrate the replacement strategy and plan of protective relay systems on the transmission and subtransmission systems. The protective relay system replacement is well ahead of schedule because of planning additional schemes replacements.



This chart shows the relay scheme replacement plans and actuals for 2015. Most of the work during the first half of 2015 was at Hanna Substation and the remote line terminals.

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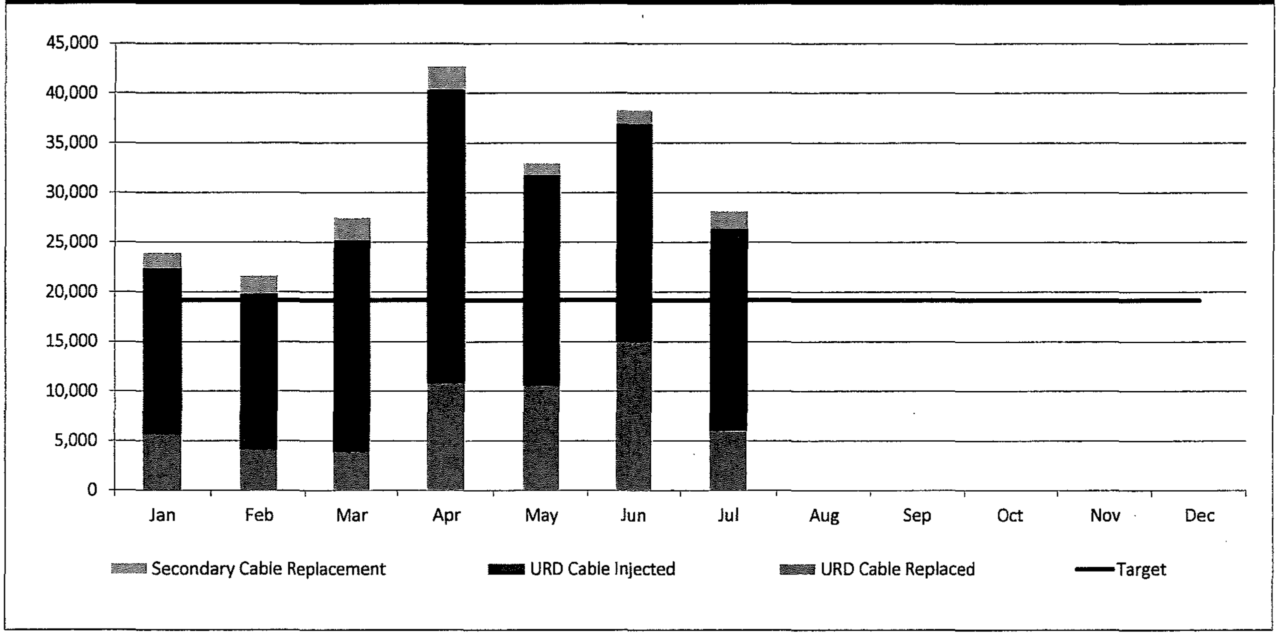
Underground Residential Distribution (URD)

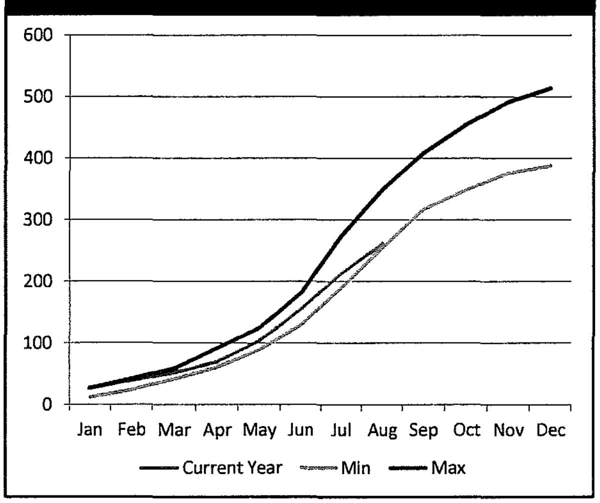
These charts illustrate the replacement strategy and plan of the Underground Residential Distribution (URD) system. This is a combination of primary and secondary replacement along with primary cable injection (refurbishment). All programs are well ahead of schedule.

URD Cable Injection and Replacement



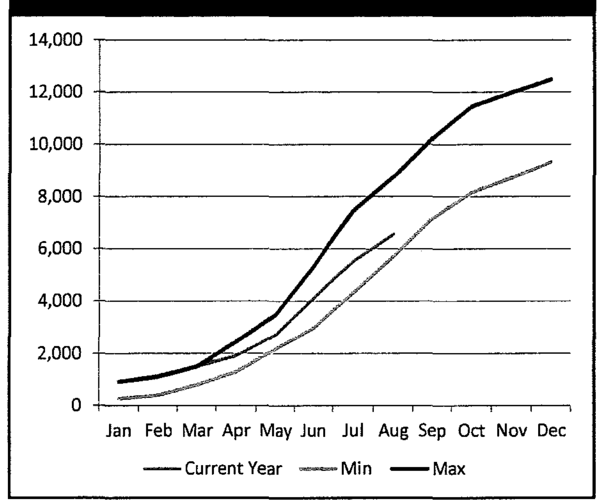
A few years ago IPL begin to see an increasing trend of primary cable faults. This was similar to what others in the industry were seeing. IPL performed some Weibull analysis and determined the most cost effective program was to accelerate primary cable replacements. A few years ago IPL piloted and began using injection to rejuvenate older XLPE cable . At locations where this is practical it saves approximately 55% the cost of replacements.

UG Cable Incidents



Number of underground cable incidents use non-MED data. The history range for min and max use data from 2008-2015.

UG Cable Customers Interrupted



Number of underground cable customers interrupted use non-MED data. The history range for min and max use data from 2008-2015.

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Data Quality

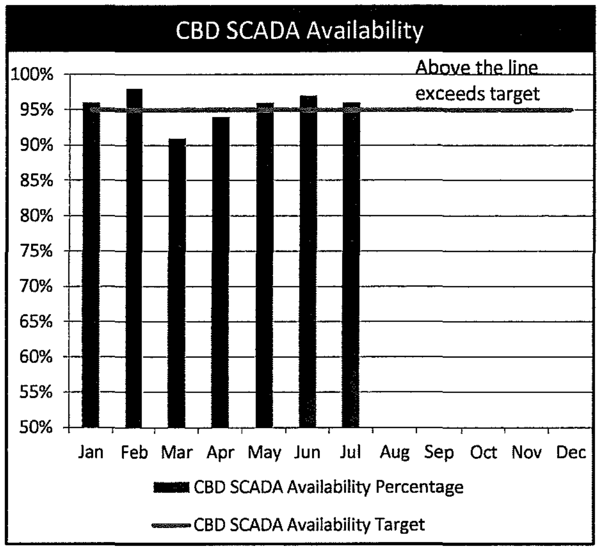
Data quality is managed to ensure that all data required for decision support is consistent, complete, and accurate. In this way, the analysis that utilizes the data can produce repeatable results. Validation is performed to ensure that any errors are identified and corrected. Ensuring high quality data can be expensive, so we must prioritize our efforts in this area, and focus on the data with the greatest value and relevance to the most important decisions. This is an area in which we are still learning through sharing with other best practice Asset Management utilities, and in which we expect to be making improvements each quarter.

Data quality and availability has been a major challenge across the entire utility industry for many years. AES is working to improve data quality by reducing the use of stand-alone spreadsheets and putting mobile devices for data collection in the field. The goal of this dashboard section (and it will continue to evolve / expand in the future) is to track our progress, provide transparency and support accountability for driving change and effectiveness in this important area.

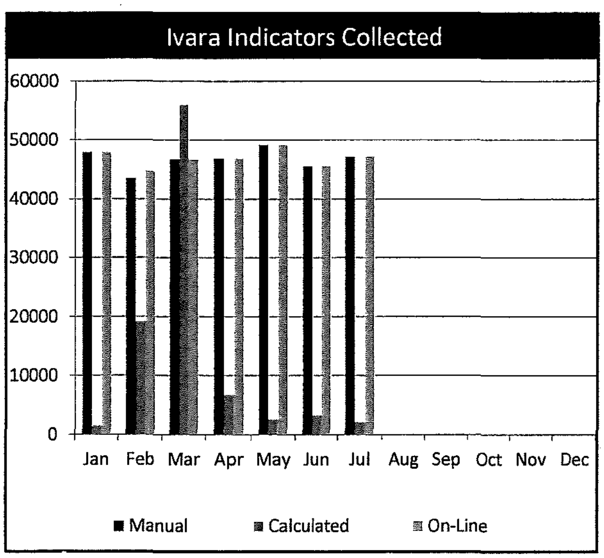
Data Quality

Data Quality Indicators

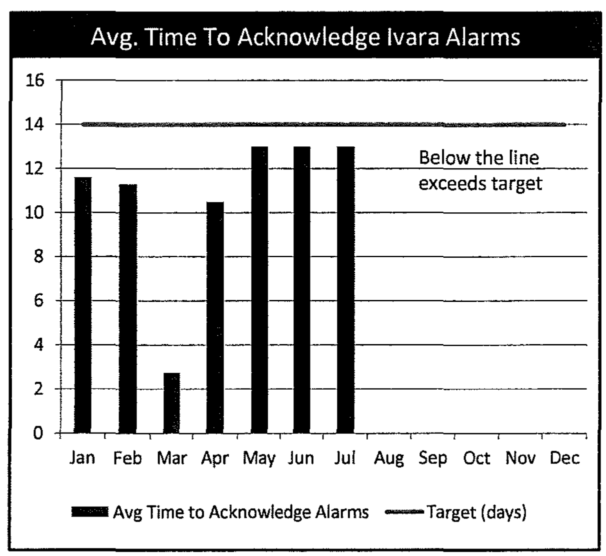
These charts illustrate the overall availability and quality of data collected by IPL to support Asset Management decision making. CBD SCADA availability has been over target every month except March and April. These months were due to the North Street Secondary Cable Event.



This metric monitors the availability of the CBD SCADA. It looks at every tag and calculates on-line versus off-line times.



The more information Ivara has the better. This measures the number of indicators collected each month. The increase in March was due to the increased inspections of the CBD.



Indicator values in Ivara have thresholds that are set. Alarms should be acknowledged in a timely fashion. Lower level alarms have lower priority.

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System & Asset Performance + Monitoring

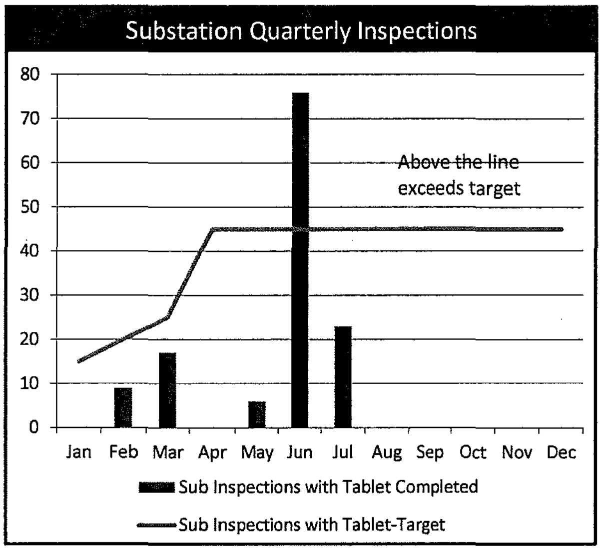
The purpose of this section is to monitor leading and lagging indicators of system and asset performance to understand how assets and programs are performing. Among such lagging indicators of outages are incidents in which equipment failed to operate properly, although this may not have caused a customer or system outage. (i.e., Relay misoperations, Breaker open and close failures to properly operate, etc.) Leading indicators monitored and trended for use in detecting areas of growing concern or equipment risk in the system include: Timeliness of substation inspections, the severity rate of defects noted during UG Vault or Manhole inspections, number of transformers whose condition has placed it on the "watch list", and the number of corrective maintenance jobs on Load Tap Changers that were prompted by inspection results.

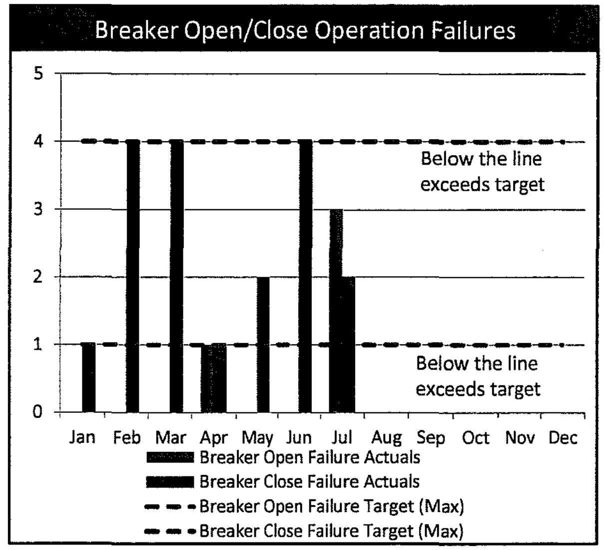
Monitoring these trends will help indicate whether changes should be considered in our inspection, maintenance, and replacement plans.

System & Asset Performance + Monitoring

Substation Key Indicators

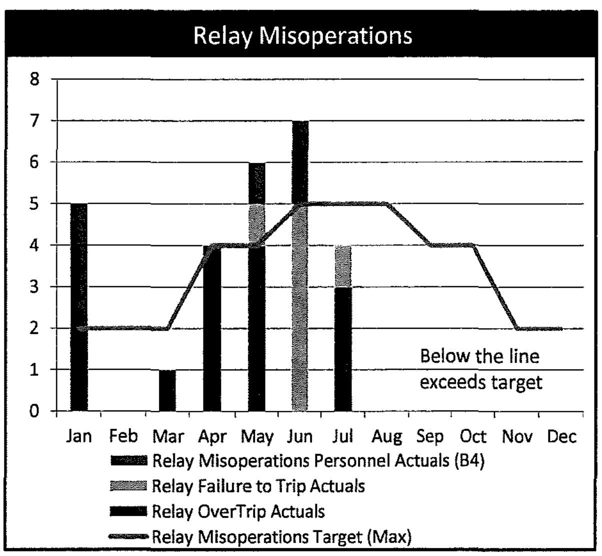
These charts illustrate some key indicators we will monitor to help ensure existing preventive maintenance cycles are appropriate. The Substation Quarterly Inspection chart shows IPL is missing the planned target. The other charts are within acceptable performance.

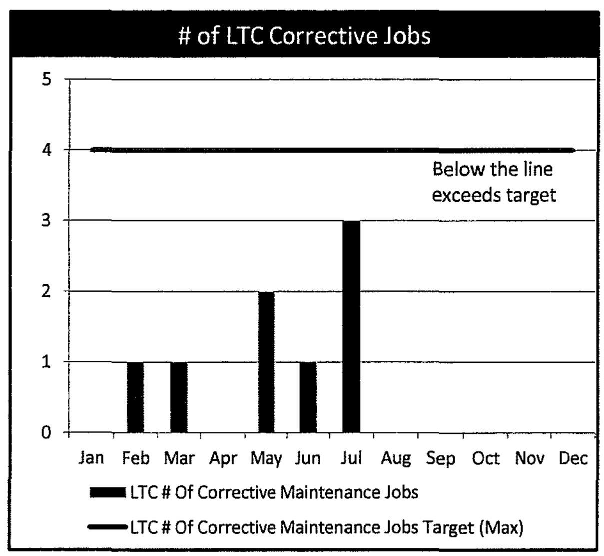




We have 143 substations that are inspected at least once a quarter. This metric tracks these inspections using an Ivara tablet. This program has been put on hold pending implementing a laptop solution and improving the efficiency of data collection.

An indicator for breaker maintenance cycles in the number of breakers that may fail to open or close during normal operations.





An indicator for relay (and the communication system between relays) maintenance cycles in the number of misoperations we experience.

An indicator for transformer load tap changers (LTC) maintenance cycles in the number of LTC's that require corrective maintenance each month.

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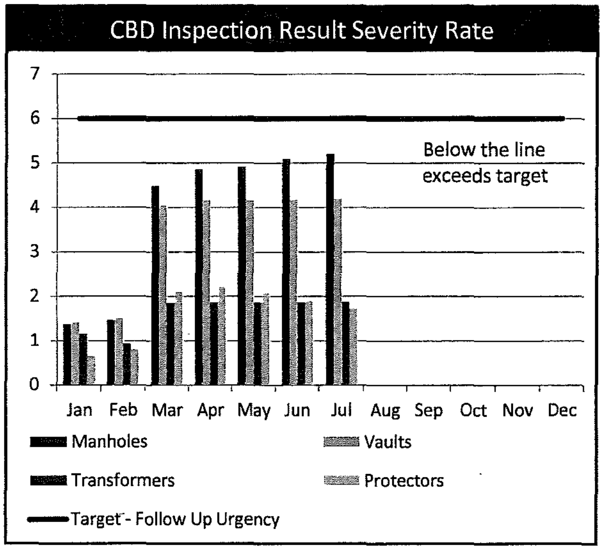
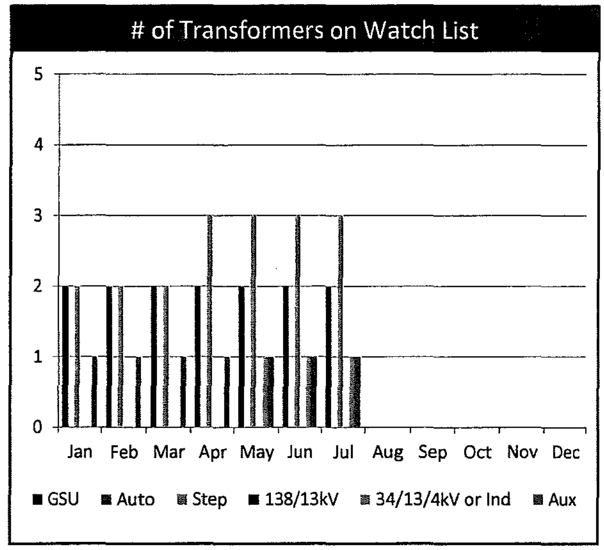
Ivara Key Indicators

These charts illustrate additional key indicators. The CBD Inspection Result Severity Rate is the priority of follow up work from CBD inspections. This had been trending down, but during the March sweep, out of town inspectors made some indicator value assumptions (debris, duct seal, etc.) resulting in higher values than actual. The transformer watch list shows transformers that have indicators that are being monitored closely for further possible action.





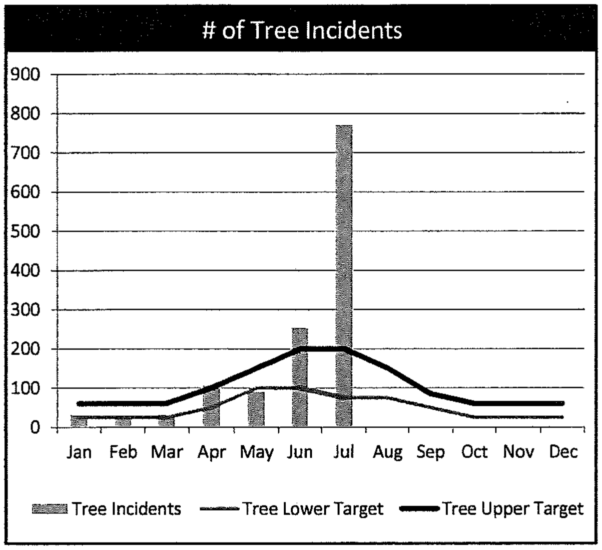
A calculated indicator (made up of inspection indicators will be monitored for severity ratings. The higher the severity the more urgent the follow up work.

The dissolved gas analysis (DGA) for a transformer is its blood test to indicate the overall health. Transformers with a Level 3 or 4 severity will be put on a watch list.

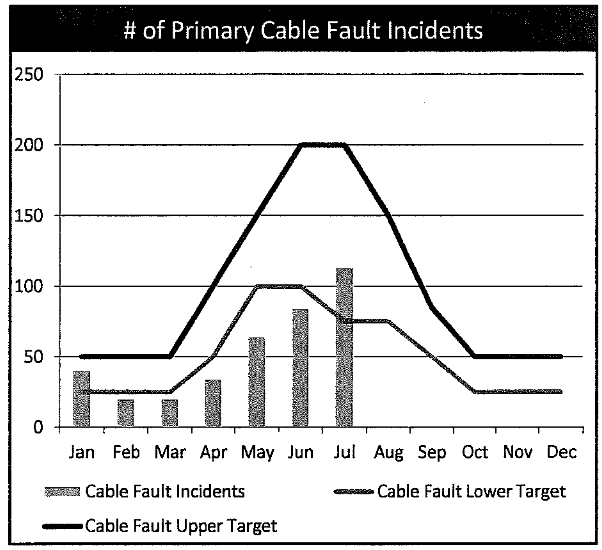
009353

Key Trend Indicators

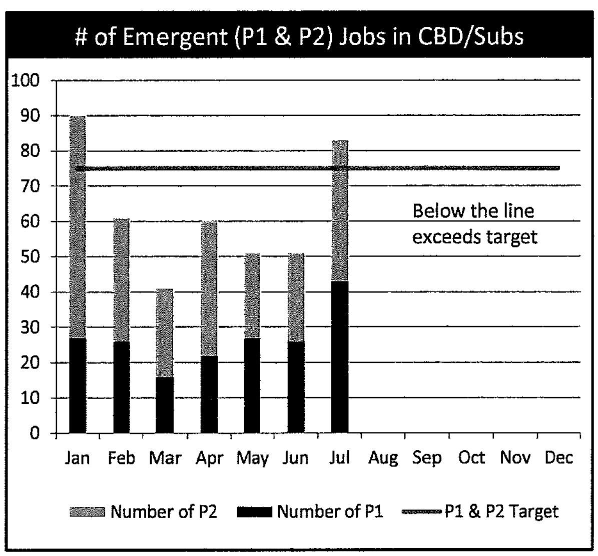
These charts illustrate additional key trend data being monitored in 2015.



This metric monitors the number of tree incidents. Values outside the control window will trigger a review of the line clearing maintenance program. The June and July increase was due to storms. In July we experienced a Level 3 storm.



This metric monitors the number of primary cable incidents. Values outside the control window will trigger a review of the capital replacement program.



P1 are emergency jobs to be worked immediately. P2 are urgent jobs to be work within 2 business days. This metric monitors the number of emergency jobs (P1 & P2) in the CBD and substation area.

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Customer Reliability

The purpose of this section is to monitor the performance of the system and circuit reliability on the service continuity enjoyed by customers. By monitoring the system performance and the trend of outage rates of individual circuits over time, we can better understand the customers' experience and target locations that warrant intervention.

Leading outage causes are measured, reported and analyzed so that trends can be identified. Results of this analysis are presented graphically by the primary causes. Even though our overall level of customer reliability is exemplary (top quartile on both the national and Indiana State levels), we determine the primary drivers of each outage cause, and then target each of those with improvement strategies.

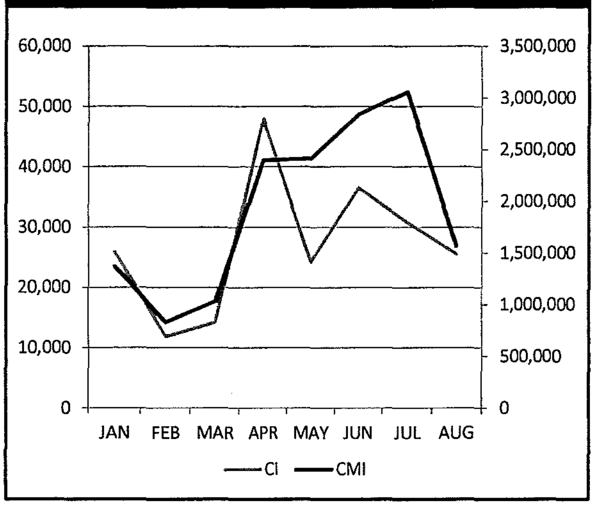
This is another important way that IPL provides transparency into our performance levels and efforts to continuously improve in each driver of customer value or regulatory concern.

Customer Reliability

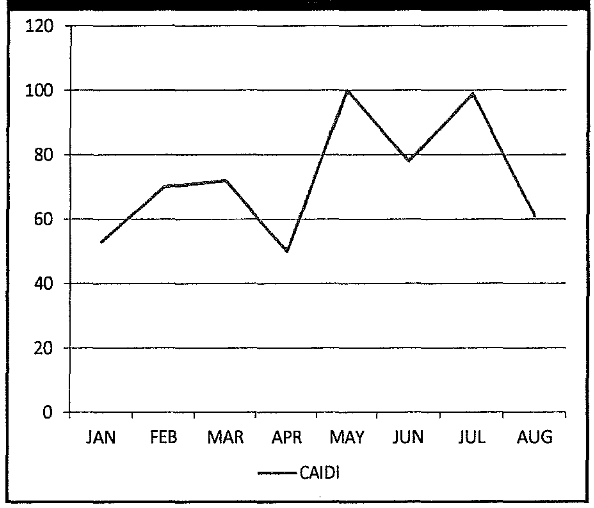
Customer Reliability

These charts describe the system's reliability and its impact on customers. Data does not include major event day (MED).

Interruptions and Minutes of Interruptions

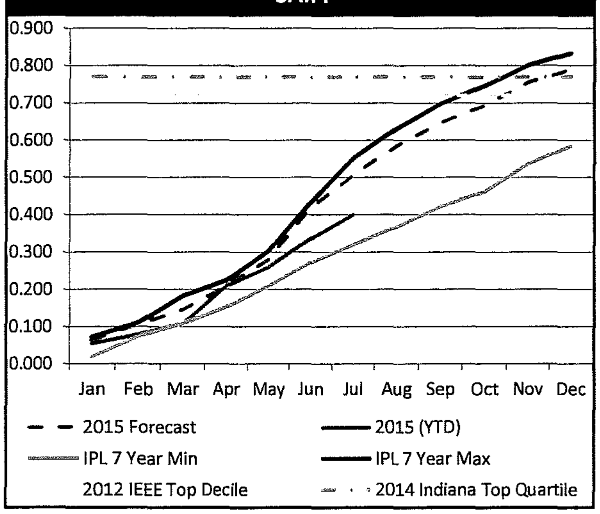


CAIDI

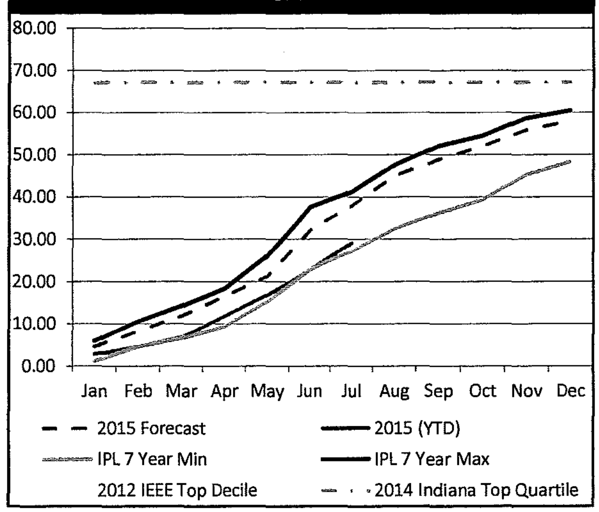


CAIDI measures the responsiveness of the utility in restoring power whenever an outage occurs. It is more indicative of field organization responsiveness, than of Asset Management effectiveness, and so it is included herein primarily for reference and completeness. Customer Interruptions and Customer Minutes of Interruption are shown monthly. The spike in CAIDI in May was due to a large drop in CI while CMI stayed constant. The spike in was July due to a drop in CI and an increase in CMI.

SAIFI



SAIDI



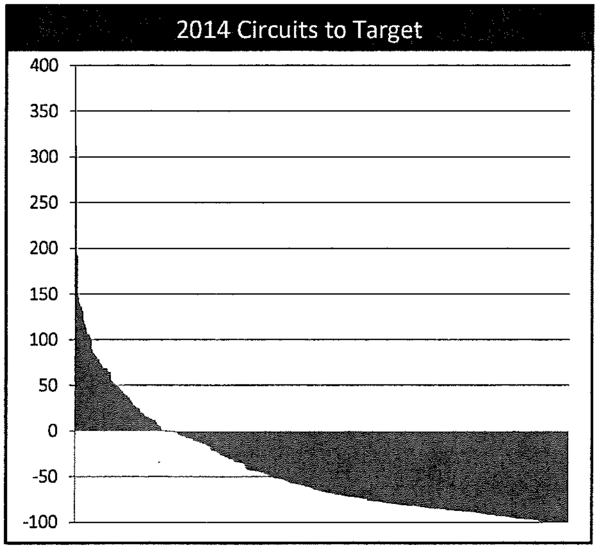
To date our SAIFI has remained below target. April and May neared the forecast due to weather. Min and max include data from 2008 to 2015.

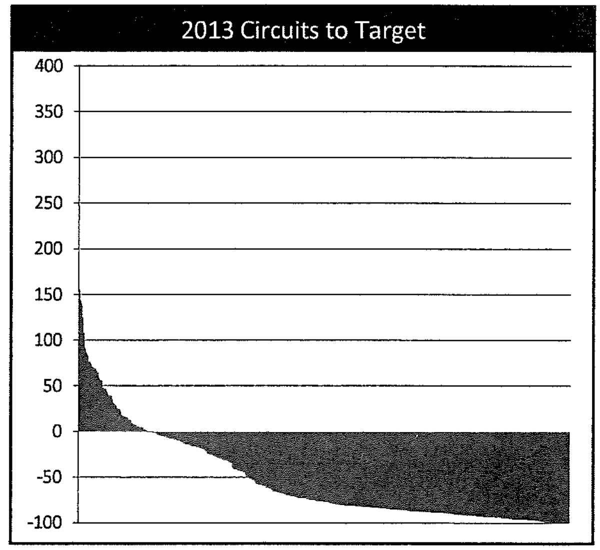
SAIDI has remained very low this year.Min and max include data from 2008 to 2015.

009356

Worst Performing Circuits

To target areas with the worst reliability, the system is examined on a circuit level. Historical performance is compared with current performance to identify the worst 8% of the system. Data does not include major event day (MED).





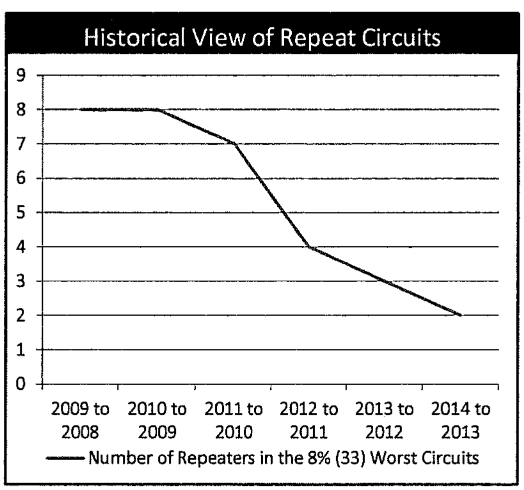
The graphs above show circuit performance for the entire system. A score of zero indicates a circuit met the weighted average of SAIFI and SAIDI. The area above zero in each graph show the circuits that did not meet target. The area below zero met or exceeded target. Circuits Parker No. 5 and Hemlock Tie were twice identified in the top 8% over the past two years. These circuits are being monitored for possible intervention. Below is a list of the leading cause of outages on those circuits.

QRY - Circuit Level Customers by Ckt No MED SUMMARY w Lead Cause

Year	Circuit Name	# of Incidents	Ckt Cust	Ckt CMI	Leading Cause	Leading Cause Incidents	Leading Cause Cust	Leading Cause CMI
2013	PARKER NO. 5	57	2339	278307.68	TREE\TREE ON PRI (INSIDE TRIM ZONE)	9	1021	117931.27
2014	PARKER NO. 5	70	2602	306485.13	TREE\TREE ON PRI (INSIDE TRIM ZONE)	13	2015	225825.48
2015	PARKER NO. 5	28	2561	199104.41	OH EQUIPMENT\OTHER	2	1634	84606.6

QRY - Circuit Level Customers by Ckt No MED SUMMARY w Lead Cause

Year	Circuit Name	# of Incidents	Ckt Cust	Ckt CMI	Leading Cause	Leading Cause Incidents	Leading Cause Cust	Leading Cause CMI
2013	HEMLOCK B TIE	1	557	45349.09	WEATHER/OTHER\LIGHTNING	1	557	45349.09
2013	HEMLOCK TIE	3	570	23050.62	WEATHER/OTHER\LIGHTNING	1	568	22467.47
2014	HEMLOCK TIE	8	794	155077.38	OH EQUIPMENT\BAD X-ARM OR BRACKET	1	562	130860.03
2015	HEMLOCK TIE	7	116	25251.95	TREE\TREE ON PRI (INSIDE TRIM ZONE)	2	55	4747.75

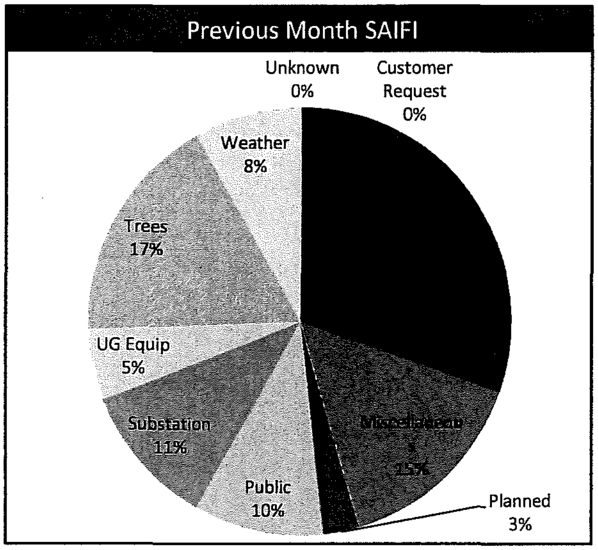


Since 2008, we have seen the number of repeat poorly performing circuits decline. As discussed above the worst 8% are monitored and compared to the previous years. The idea is to target areas that have realized issues so that we can mitigate those risks. This process is optimized by using the historical trends to identify one off events that would not fall under a strategic plan.

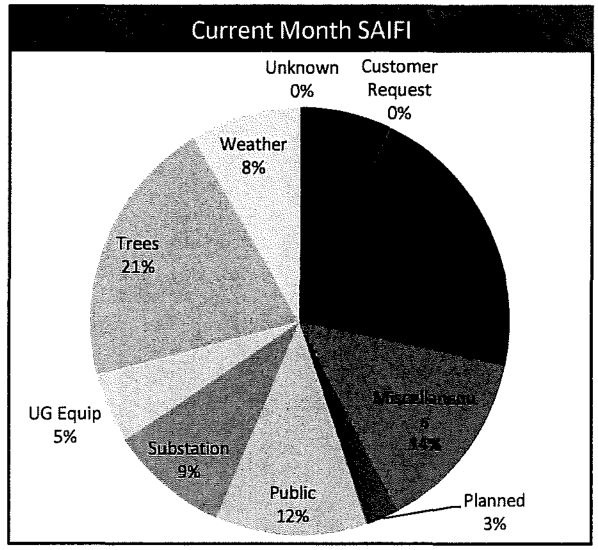
IPL maximizes their resources by strategically targeting circuits rather than making blanket changes to the system. This micro approach allows the company to better understand the customers experience, and what has the highest impact in each customers area. It is the responsibility of the Reliability Team to monitor and make recommendations for the system, and poorly performing circuits.

Outage By Cause

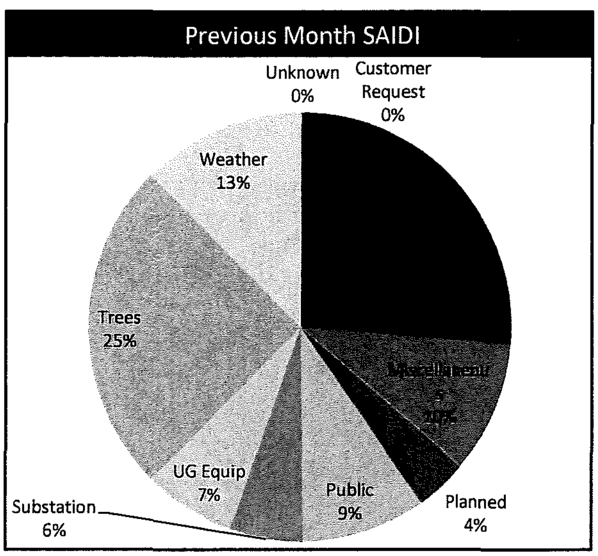
The view of outage data below shows what is the leading cause of interruptions and duration. Data does not include major event day (MED).



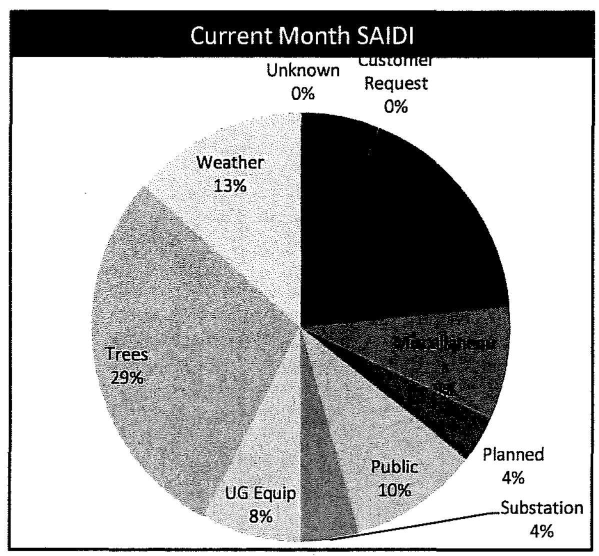
SAIFI in June was at 0.0764 . We are below target due to non-MED storms.



SAIFI in July was at 0.0643. We are below target due to non-MED storms.



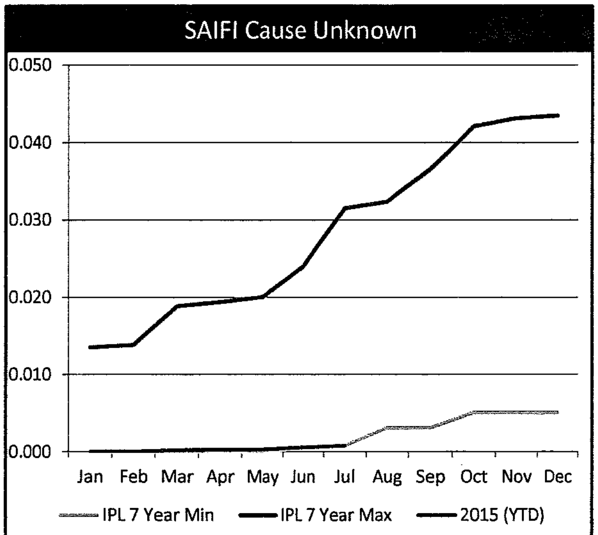
SAIDI in June was at 5.94. We are below target due to non-MED storms.

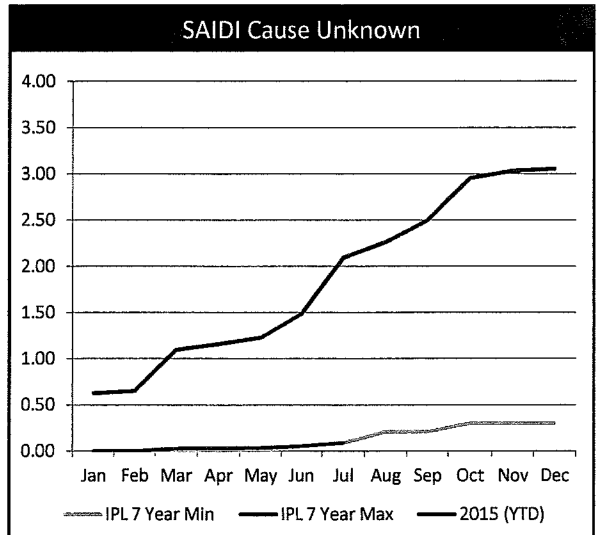


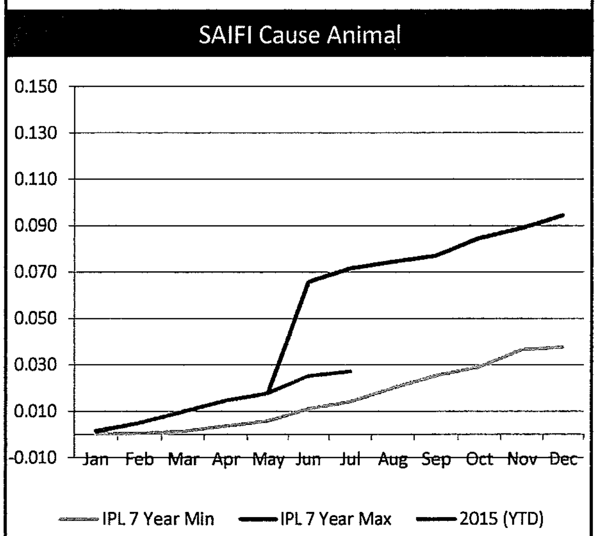
SAIDI in July was at 6.39. We are below target due to non-MED storms.

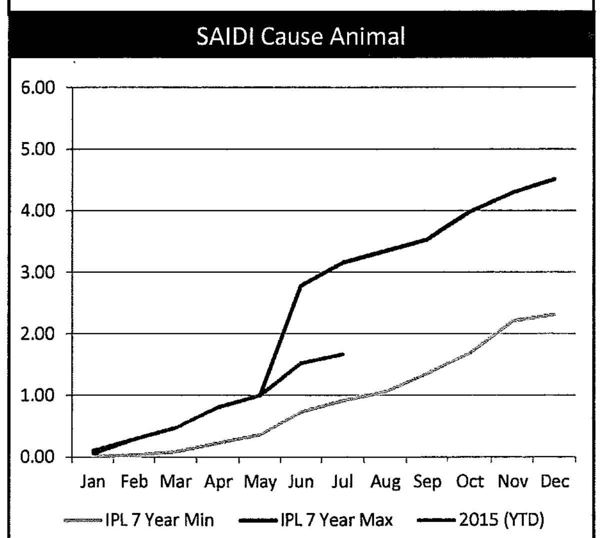
Outage By Cause

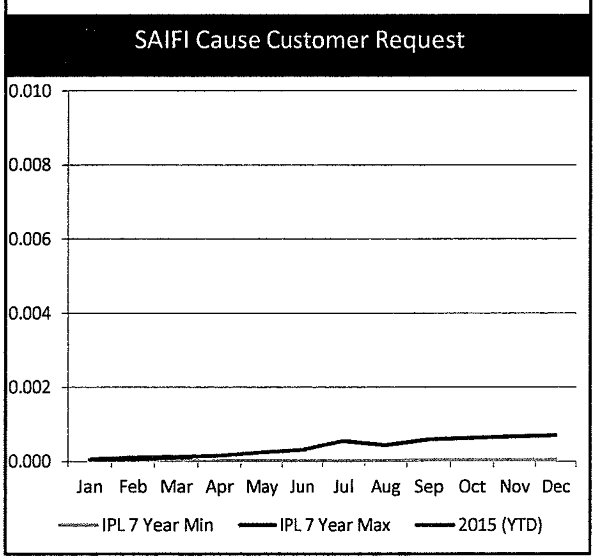
Using historical data it is easier to identify when an outage cause is trending high or low. IPL's outage management system makes it possible to identify what the leading causes are by circuit and which has the highest impact on customers. Data does not include major event day (MED).

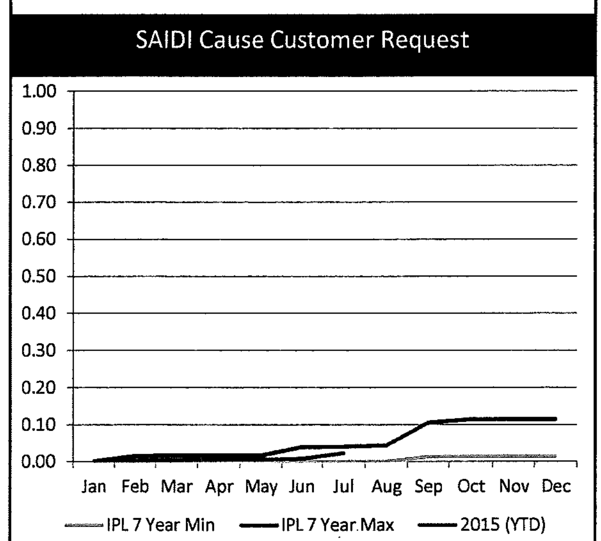












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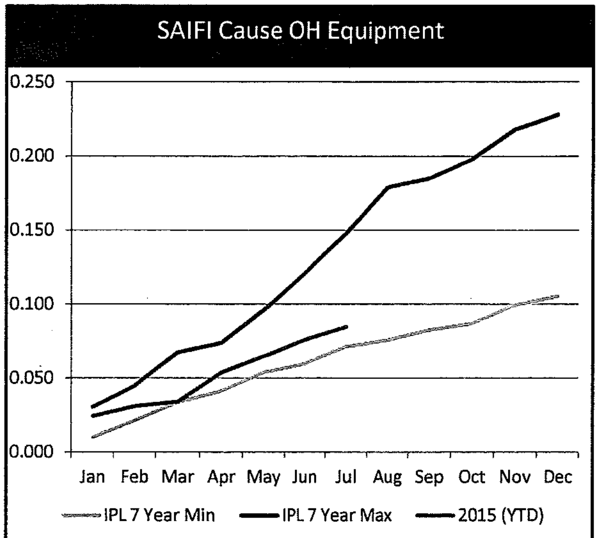
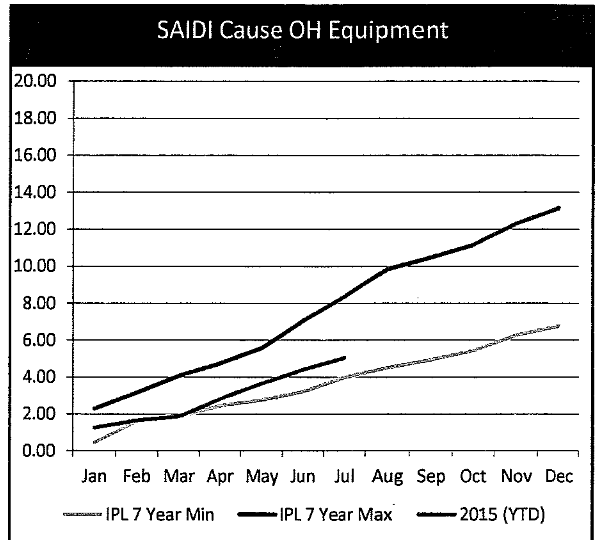
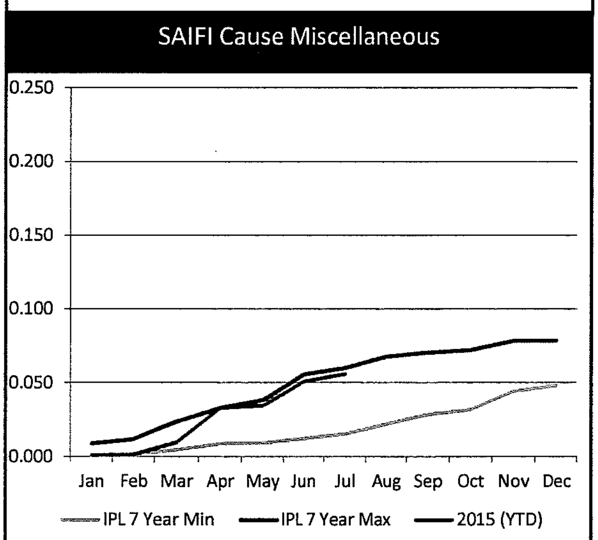
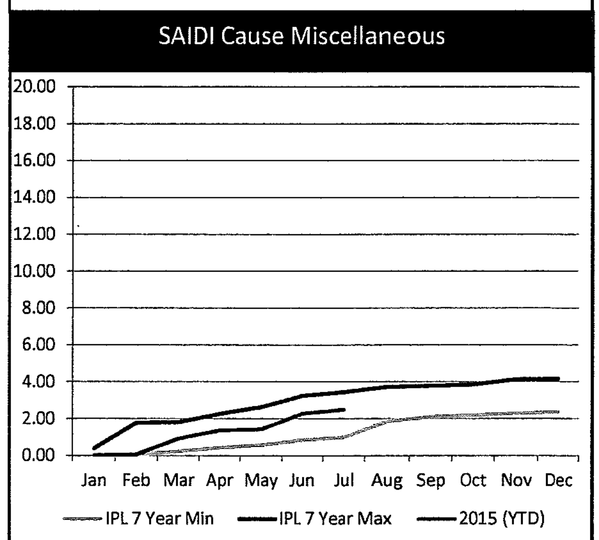
Outage By Cause

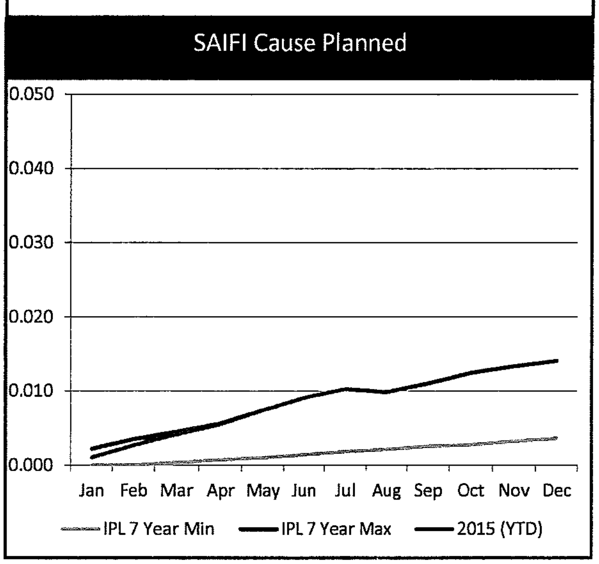
Using historical data it is easier to identify when an outage cause is trending high or low. Data does not include major event day (MED).

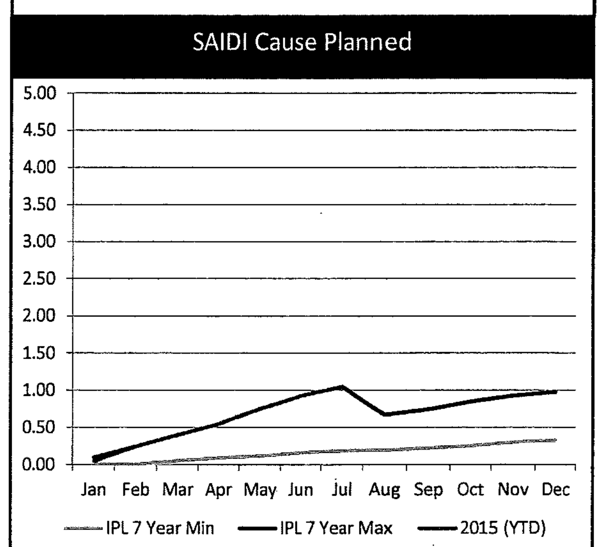












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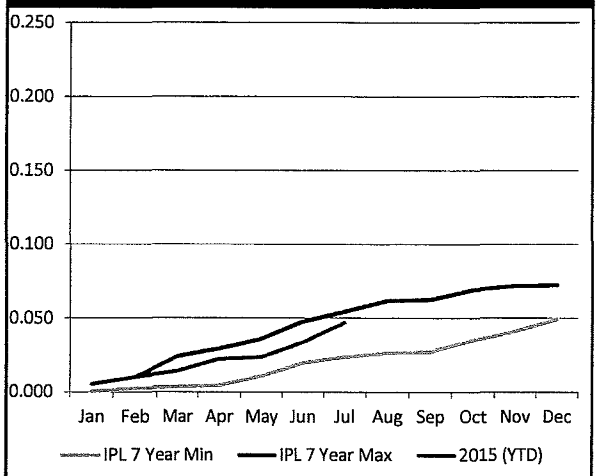
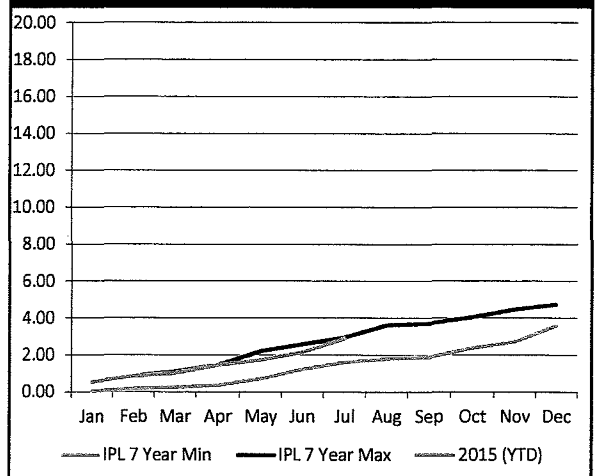
Outage By Cause

Using historical data it is easier to identify when an outage cause is trending high or low. Data does not include major event day (MED).

SAIFI Cause Public



SAIDI Cause Public



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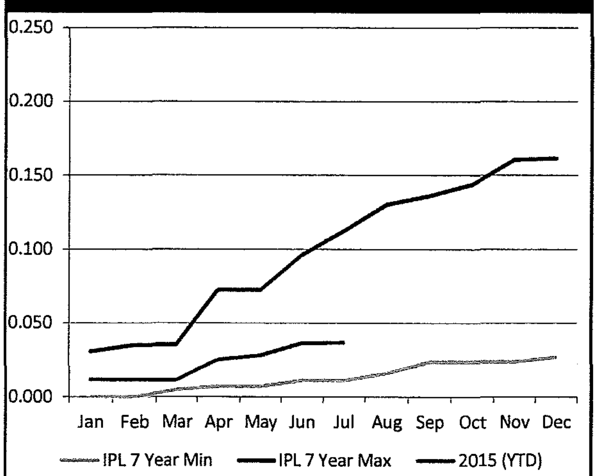

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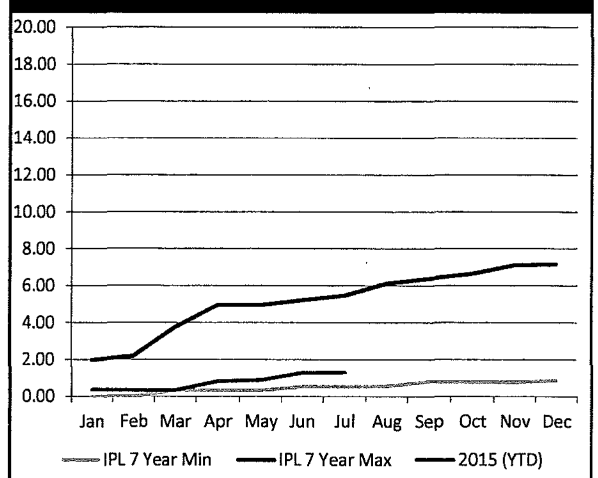

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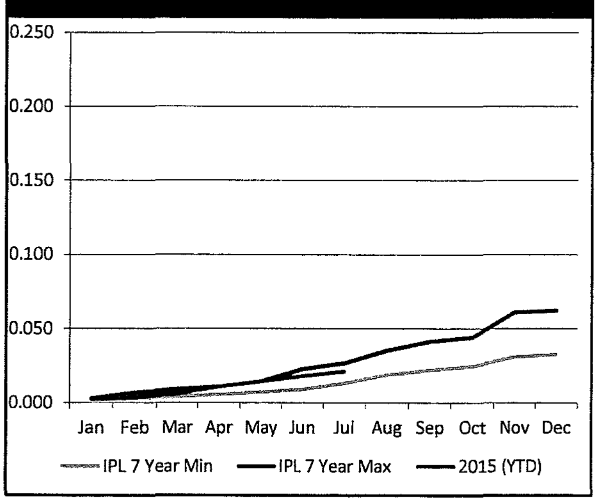

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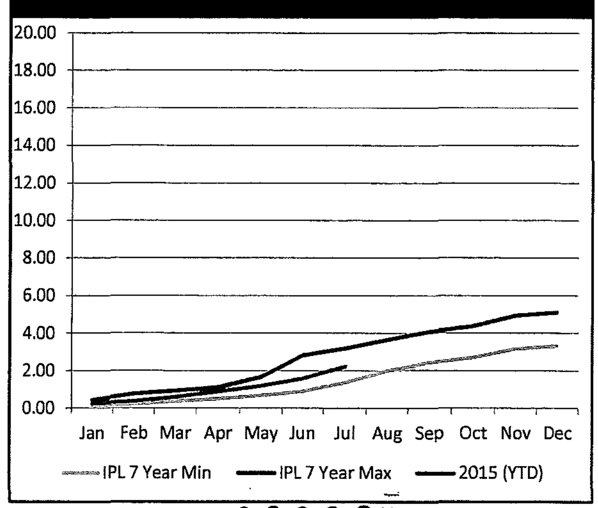
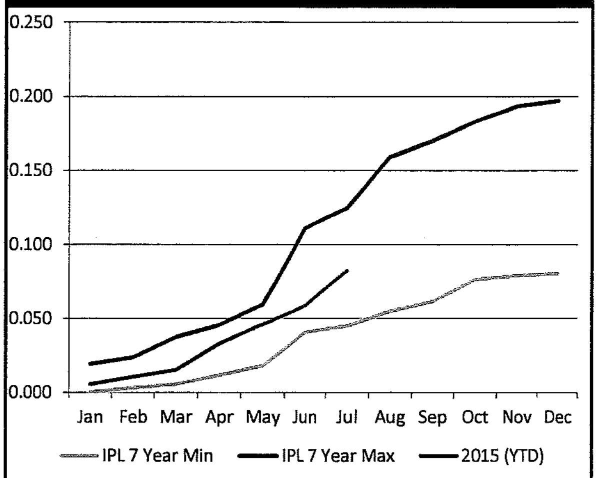


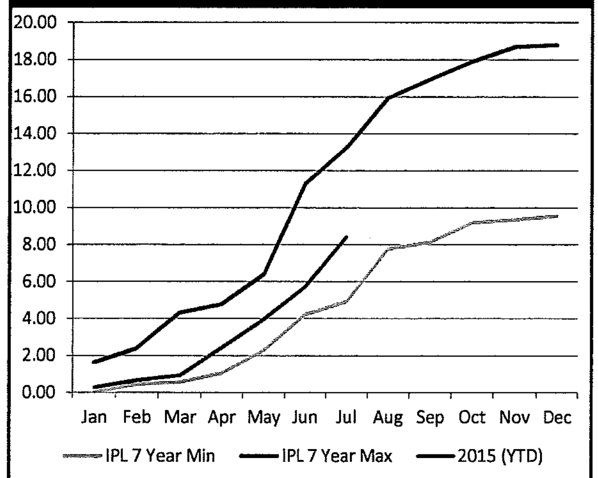
Outage By Cause

Using historical data it is easier to identify when an outage cause is trending high or low. Data does not include major event day (MED).

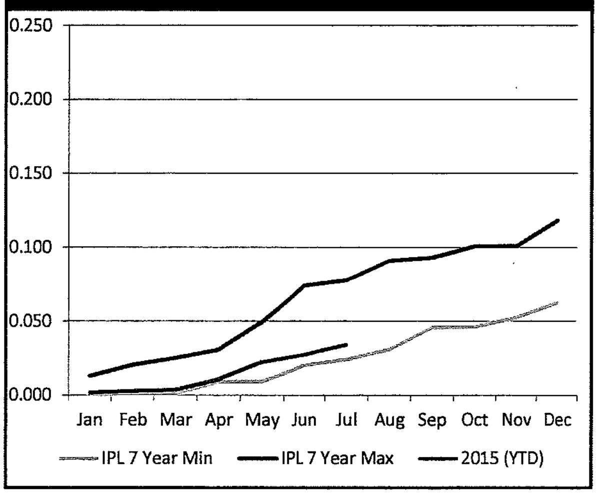
SAIFI Cause Trees



SAIDI Cause Trees



SAIFI Cause Weather



SAIDI Cause Weather