INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 1:

Reference(s): C1/T4/S1/Appendix A

Please provide the following documents that relate to THESL's 2011 rate year:

- The strategic goals and objectives that were approved by THESL's Board of Directors;
- The Business plan including detailed budget for the upcoming year (2011) and long-term projections for the following 4 years;
- The 5-year business plan approved by THESL's Board of Directors;
- All materials presented to HON's Board of Directors when seeking approval of the 2011 rate filing.

RESPONSE:

THC prepares a Consolidated Business Plan, which includes details for THESL and details for THC's unregulated subsidiaries. The 2011 to 2015 Consolidated Business Plan was just approved by the THC Board of Directors on November 26, 2010. THESL intends to request confidential treatment for documents responsive to this request and will provide copies of these documents, redacted as appropriate, to those parties signing non-disclosure agreements.

THESL did not present any materials to the HON Board of Directors.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 2:

Reference(s): C1/T4/S1/Appendix A, p. 6

Please explain the relative roles and responsibilities of the President of THESL and the President and CEO of THC.

RESPONSE:

The role of "President of THESL" no longer exists due to recent organizational changes. In light of the reorganization, the paragraph referenced in this interrogatory should read:

> After completion of the budgeting phase, the CFO reviews the financial and operating plans including discussing the related details with the responsible executives to ensure the business plan as presented is aligned with the strategic goals and objectives. Following this review, the business plan and related assumptions will be presented to the President and Chief Executive Officer of THC for final review. The final business plan is then presented for approval by the Board of Directors.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 3:

Reference(s): C1/T4/S2

Please explain how the economic indicators presented are used to derive the various components of the revenue requirement.

RESPONSE:

The economic indicators provide an overall outlook of economic conditions expected in THESL's operating area. They provide a consistent set of economic environment assumptions that each of the business units can use as a guide in the development of their budgets.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 4:

Reference(s): none

Please explain what efforts THESL has made, or is making, to make electricity more affordable for its customers (productivity initiatives, cost reduction strategies etc.)

RESPONSE:

The amalgamation of the former six GTA utilities into THESL ten years ago provided an opportunity to consolidate functions, systems, collective agreements, organizational structure, and harmonize work methods and job descriptions. Amalgamation has also provided an opportunity to provide strategic alignment to ensure future efforts of the organization followed a path for sustainable, safe and reliable electricity service.

THESL has taken a long-term view of its obligation to provide safe, reliable and affordable electricity service and believes the best way to do that is to install structured and robust management control and reporting systems in every level of the organization coupled with key performance indicators (KPIs) that cascade, and are tied to corporate goals and objectives. In turn, individual performance contracts are set to encourage and reward behaviours that drive performance at every level in a direction that optimizes achievement of goals and objectives. In this way, THESL is able to achieve constant, incremental improvement.

Productivity and cost reduction are two considerations among many that must be properly considered in a long-term view of THESL's obligations. They cannot however be considered in isolation of customer service, asset performance, health and safety of employees and the public, or the financial viability of the organization. THESL

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

considers the proper approach is a balanced scorecard approach. THESL's 2010 Corporate Scorecard is presented in Exhibit C2, Tab 1, Schedule 4 as part of its Compensation Program Guide. Providing a framework and overall support for each of the corporate KPIs, are a number of approaches, systems, and initiatives, many of which are explicitly discussed throughout THESL's evidence in this 2011 EDR.

THESL's structured business planning is described in Exhibit C1, Tab 4 providing an over-arching framework for the evaluation of prior results and control over the development of next cycle budgets; THESL's asset management approach is described in Exhibit C1, Tab 6, Schedule 1, showing how asset investment decisions take into account costs and benefits, resulting in best-value decisions; THESL's facilities strategy is described in Exhibit C2, Tab 2, showing how decisions are made to maximize use and value of building and work center assets; and THESL's supply chain policy is filed at Exhibit C2, Tab 3, Schedule 1, Appendix A, describing the process for achieving the stated objectives including efficient procurement at most favourable prices.

Exhibits F1and F2 describe THESL's O&M and A&G activities, respectively, and the approach taken within each Business Unit to determine what needs to be done, and how to meet objectives in a cost-effective manner.

THESL has presented at Exhibit F1, Tab5, Schedule 1 an operational measure that is considered a clear indication of the year-over-year improvement in productivity and effectiveness of core operations support resources.

In addition to what is described throughout THESL's evidence in this case, filed as Appendix A to this interrogatory is a report titled *An Analysis of Productivity*

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

Improvements at Toronto Hydro-Electric System Limited, prepared by KeyWillow Consulting in July 2009.

Toronto Hydro-Electric System Limited
EB-2010-0142
Exhibit R1
Tab 4
Schedule 4
Appendix A
Filed: 2010 Dec 20
(23 pages)

An Analysis of Productivity Improvements at Toronto Hydro-Electric System Limited

Prepared by **KeyWillow Consulting**
For Toronto Hydro-Electric System Limited

Submitted: July 20, 2009

Introduction

Toronto Hydro-Electric System Limited (THESL) was brought into its current form by the amalgamation of six local distribution companies in 1998. A key argument for the amalgamation was increased productivity.

Productivity, however, is a difficult concept to define or measure in the context of electricity distribution. There is no standard definition or metric enjoying widespread industry acceptance. Even if agreement can be reached on defining the output of a utility, making comparisons between utilities in widely different circumstances, or even with past performance by the same utility in a vastly different context, is full of difficulties. Every attempt to arrive at a number quickly bogs down in disputes over the impact of those differences.

Instead of concentrating on gross year-over-year numbers, a better way to conceptualize ongoing improvements in LDC (Local Distribution Company) productivity, and predict their future trend, is to treat the issue holistically. Has the leadership of the utility implemented improvements that have made operations more efficient? Have they avoided cost increases that would have come with inaction? Have they resisted the impulse to simply harvest the return on earlier investment, and spent what is needed to guarantee future efficiencies? Most importantly, have they institutionalized an approach to continuous productivity improvements? If they have not met the last test, then all their accomplishments might simply be the result of a particular conjunction of management will and opportunity, which could disappear when circumstances change. With a formalized system in place however, improvements will be maintained, and new ones continue to appear.

THESL does pass those tests. It has achieved significant productivity gains through a suite of systemic tools that work together to produce constant, incremental improvements, and by sponsoring focused initiatives which address major opportunities or challenges.

At THESL, productivity improvements derive almost automatically from the utility's use of a robust planning and performance management system – MCRS (Management Control and Reporting System). MCRS is a methodology for organizational planning, execution, control, and reporting that uses constant reviews of key performance indicators (KPIs) to align organizational objectives.

MCRS is also helping to create a culture in which productivity is a key value. Achieving this cultural shift is a long-term program at THESL. It follows a proven methodology for success, which involves initiatives in leadership and the development of appropriate systems, particularly performance systems.

In addition to such broad programs, THESL is undertaking specific initiatives to realize process efficiencies and improve the utilization of resources and assets. Recent and ongoing productivity improvements at THESL include job harmonization, grid response consolidation, and asset management services amalgamation.

Of course, THESL cannot merely focus on gaining greater productivity; such a single-minded focus would result in the harvesting of existing investments, without thought for the future. Instead, the utility is also making focused investments to drive future productivity improvements.

These initiatives do not take place in a vacuum. The technological, regulatory and social environments in which LDCs operate are increasingly complex. THESL consistently shows leadership and innovation as the industry undergoes increasingly rapid change.

Recent Productivity Gains

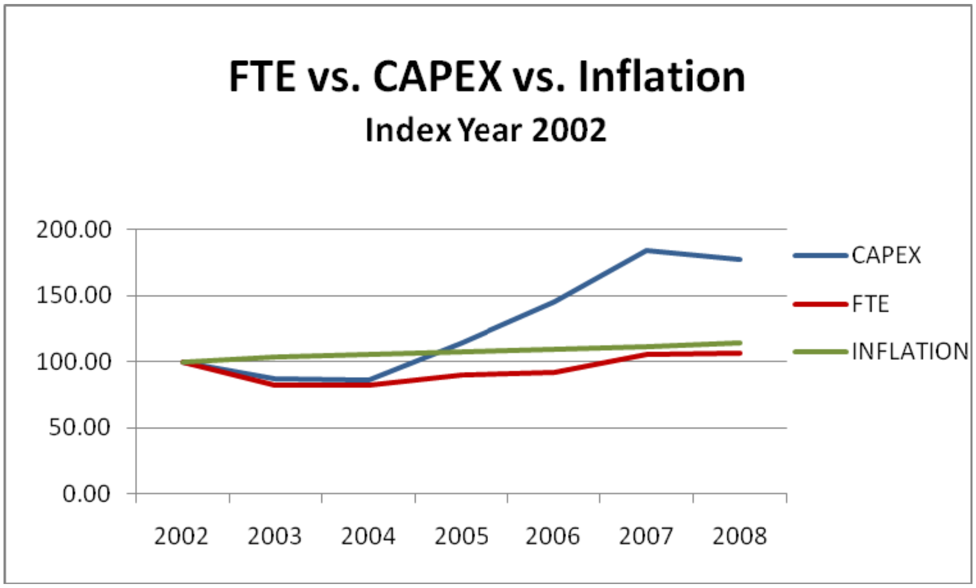
The work performed by THESL over the last seven years has grown substantially. In particular, the distribution infrastructure capital plan has almost doubled, which suggests doubling the requirements for planning, work delivery, and all supporting functions (such as fleet and supply chain). THESL is handling this demand without an equivalent gain in full-time employees (FTEs). In fact, much of the increase in FTEs which has taken place is due to the increased hiring of apprentices under the workforce renewal program (discussed later in this document).

Figure 1 below provides a comparison of the growth rates for capital expenditure and FTEs (indexed to 2002 figures). The graph and table show the clear divergence between the two rates: while plant capital expenditures have been rising steadily, actual FTE count has remained almost flat. (Figure 1 also shows annual inflation in Canada over the same period, as measured by the Consumer Price Index.)[1]

Fig 1. THESL Plant Capital Expenditure, FTE, and Inflation 2002 - 2008

Year	2002	2003	2004	2005	2006	2007	2008
CAPEX ($M)	116	101	100	132	168	213	205
FTE	1462	1201	1207	1316	1343	1543	1562
INFLATION (CPI)	100	103	105	107	109	111	114

[1] Annual CPI figures from http://www.rateinflation.com/consumer-price-index/canada-historical-cpi.php?form=cancpi



MCRS: A Framework for Improvement

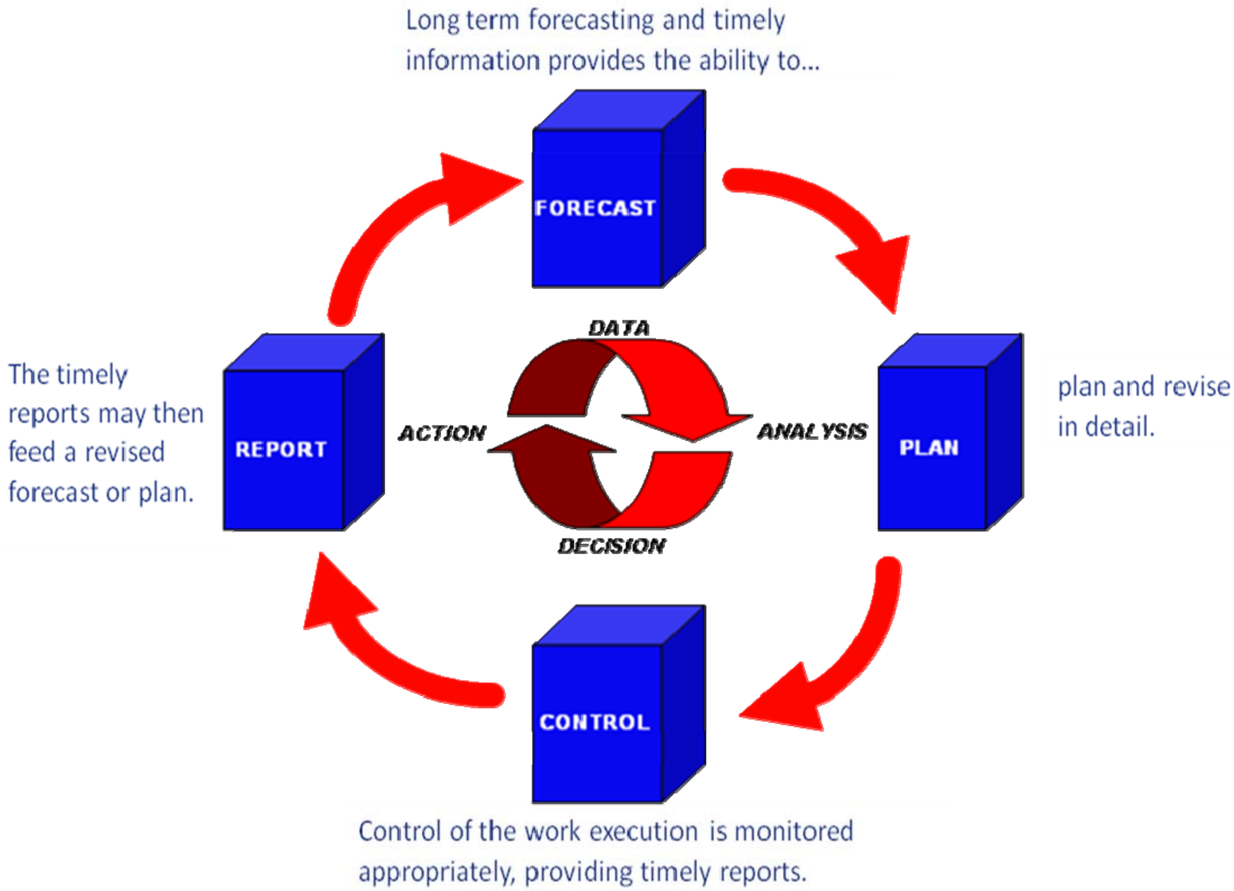
THESL's notable record of managed growth has been facilitated by the introduction of a common set of performance tools and accountability systems, which work together to produce constant, incremental improvements. The most important of these is the Management Control and Reporting System.

Overview

MCRS is a broad framework which encompasses many different aspects of planning and operations at THESL. At a fundamental level, it is a methodology of planning and control. MCRS imposes a systematic focus on the right information at the right time, enabling better business decisions at all levels of the organization.

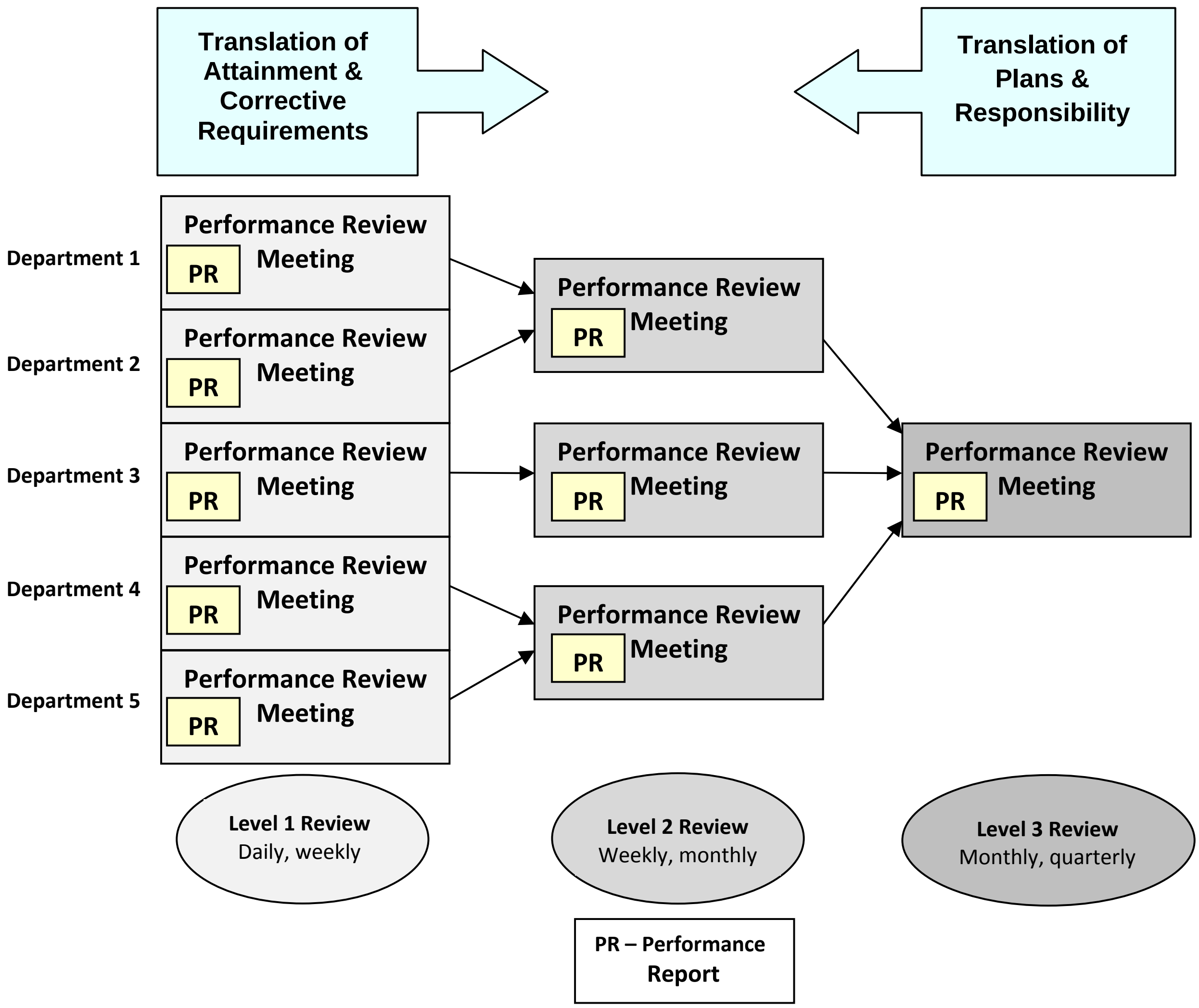
MCRS defines the managerial routines and disciplines required to control the business. As illustrated in Figure 2, the MCRS processes are based on the core cyclical activities of forecasting, planning, executing or controlling, and reporting. THESL applies this methodology explicitly and consistently to all of its programs and initiatives, so that all meet common purposes and shared objectives.

Fig 2. The MCRS Activity Cycle



In addition to being a planning and control methodology, MCRS also contains a sophisticated performance management system. MCRS translates enterprise or departmental goals into Key Performance Indicators (KPIs), which are then tracked and reported at regular intervals in a programmatic manner. As shown in Figure 3, the lower levels of the organization (on the left) are responsible for meeting the goals set out at the higher levels (on the right); they meet these objectives through increasingly frequent performance review meetings. Responsibility flows from right to left; goal attainment or corrective action flows from left to right.

Fig 3. MCRS Performance Management and Review Structure



Within the MCRS framework, KPIs are not treated as independent objectives. Instead, they are interpreted and monitored using balanced scorecards, which include an appropriate mix of people, financial, operational and customer-specific area indicators.

Short Interval Controls

THESL uses short interval controls to ensure that KPIs are monitored rigorously. Short interval controls are regular monitoring of actual performance of a KPI against plan. They typically roll up to weekly or monthly reports. Because KPI tracking at this level requires operational data at the departmental level, THESL implemented MCRS in 2003 in conjunction with the launch of its enterprise system, “Ellipse.” Ellipse features modules which make this aspect of MCRS viable.

Monitoring takes place at monthly Operational Status Review (OSR) meetings at the departmental, divisional and company levels. In these meetings, those responsible review performance and conduct gap analysis for any KPIs which are falling below threshold (as detected by the short interval controls). Depending on the type of response indicated, corrective actions will be taken to address the gaps – which may include launching an initiative or a larger project.

Fig 4. KPI Improvements in Supply Chain Services

As one example of the effectiveness of the detailed planning and monitoring component in MCRS, from 2002 to 2006 Supply Chain Services implemented several business process initiatives to address target KPIs. Significant improvements in inventory performance were achieved, including:

- Inventory turns increased from less than 1 annually to 3.5;
- Order fill rates increased from 75% to 95%;
- Cycle count accuracy increased from 70% to 97%;
- The number of SKUs fell from 20,000 to 8,000;
- Inventory value was reduced from $50 million to $28 million;
- Inventory burden costs decreased from 35% to 10%.

Planning with MCRS

The importance of KPIs and scorecards makes them an integral part of the annual planning process. At the culmination of that process, Executives work with the Board of Directors to select corporate-level KPIs which will represent the desired strategic objectives. Once selected, KPI target levels are established, based upon leadership’s expectations, and taking into account anticipated conditions in the upcoming year and historical performance levels. THESL leadership then communicates these expectations throughout the organization. KPIs may change over time once results become sustainable and operationalized, and when business needs change.

Among THESL’s current corporate KPIs, the following have a significant relationship to productivity improvements:

- People: Safety, “My Goal is Zero” (zero accidents)
- People: Attendance
- Financial: Operating Expense
- Operations: Distribution Plant Capital
- SAIDI (System Average Interruption Duration Index)

All scorecard KPIs cascade out from the corporate KPIs. At lower levels, the KPIs reflect particular areas for which a department or team is responsible, and are more granular and numerous. Once KPI targets have been defined for a department, the managers and supervisors are responsible for meeting them. Their results are scrutinized by the responsible executive, or the full executive team.

Ensuring Alignment

As illustrated in Figure 5 below, MCRS is critical to how THESL ensures that the goals and business activities of teams and individuals are aligned to overall strategic objectives, including those related to productivity.

Fig 5. Strategic Alignment at THESL

THESL's performance-based compensation philosophy – expressed through the Variable Performance Pay Program – incents employees to achieve aligned objectives through the variable component of their overall remuneration. At THESL, all executives, managers, supervisors and professionals are eligible for variable performance pay. Performance pay targets are assigned to each job and/or salary grade, expressed as a percent of the current year's base salary. Most recently, a Gain Sharing program for specific bargaining unit employees was negotiated with the union (this union employee performance reward strategy is discussed later in the report).

The variable component takes into account performance at all levels, including the company, the division or department, and the individual. Departmental goals and scorecards, themselves derived from higher-level objectives, are translated to individual employee objectives and embedded in annual personal performance contracts.

Improving MCRS

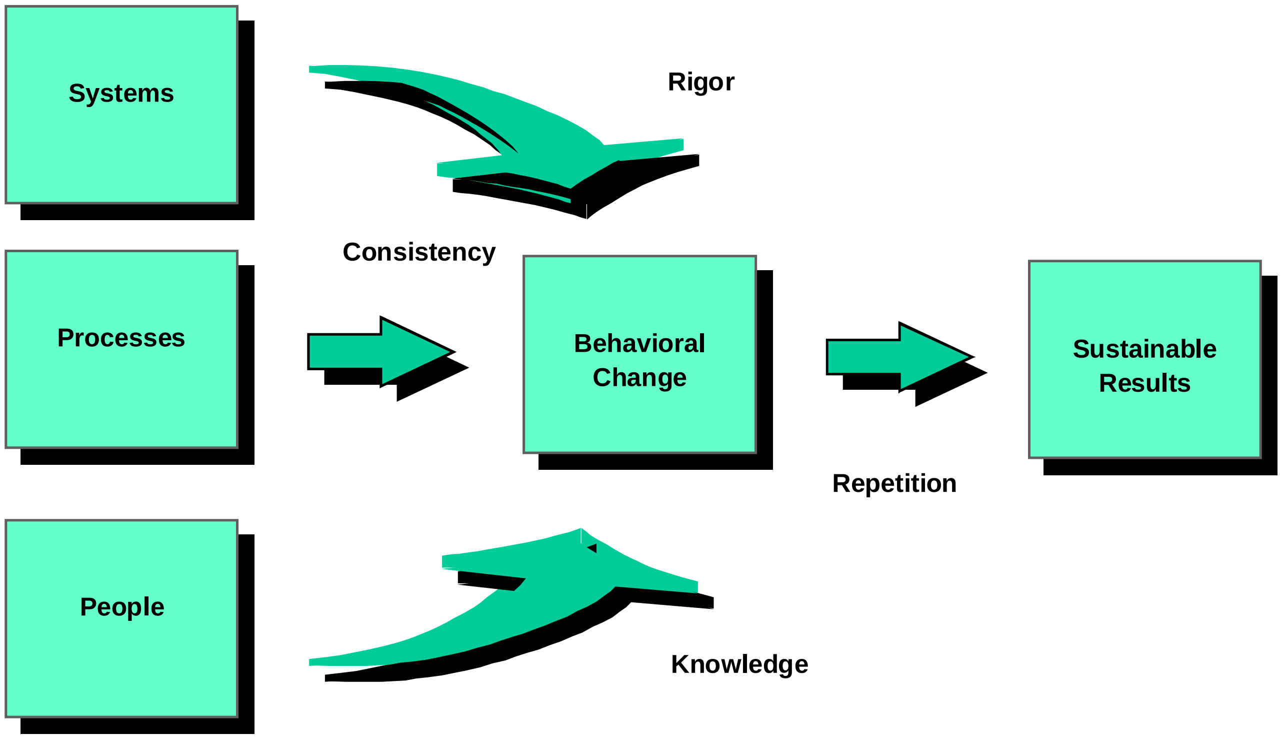
Since MCRS has already proved its value, THESL is investing to make it even more effective and efficient. "DashWay" is a web-based application that will automate the data entry, administration, reporting, and workflow functionality of MCRS – replacing the current version which requires significant manual input and maintenance. DashWay will also introduce a central repository of operational data, enhancing its usefulness as a source of business intelligence. By introducing new functionality such as more detailed and comprehensive gap analysis tracking, as well as improved analytic capabilities, DashWay will enhance the overall governance of the KPI system.

In these ways and more, MCRS is an important enabler for productivity gains. MCRS creates alignment and common purpose in the utility, and provides an effective guarantee that the success of the individual and the business are aligned. Yet there is one other aspect of MCRS which must be explored: its function as a tool for generating cultural change.

Generating a Cultural Shift

THESL is committed to the development of a performance culture, in which continuous improvements to productivity naturally occur. This cultural change is being achieved by continually advancing the key levers of systems, processes, and people. This model is best explained using the following diagram.

Fig 6. The Five-Box Model of Change



In this model, it is the combination of leadership activity, systems, and processes which allows change to succeed through rigorous, consistent, and knowledgeable application. Leadership or systems or processes working by themselves will not be enough to sustainably change the culture of the organization. Instead, a strategy of multiple, mutually-reinforcing initiatives must be deployed, usually supported by learning, development and training tools.

THESL has already employed this framework to achieve productivity improvement on a variety of topics and at a range of organizational levels. To support this framework, THESL has a detailed and proven methodology.

Gain Sharing

One key performance system initiative intended to reinforce the cultural embrace of accountability and productivity does so by using financial incentives. Gain Sharing is a group incentive program that pushes variable performance compensation significantly closer to the front lines. Crew Leaders and System Response Representatives (SRRs) are now enrolled in a scorecard program that entitles them to bonus pay if certain targets are met in group performance. The targets and KPIs in Gain Sharing are a subset of those used in the THESL scorecard. They measure injury reduction, increased attendance, improved productivity, and enhanced customer service reliability. Since Crew Leaders and SRRs can influence whether the goals are met, they are encouraged not only to be accountable for productivity, but also to influence their crews and colleagues.

Gain Sharing marks a groundbreaking achievement in collective bargaining for CUPE Local No. 1 and THESL. Like most such innovations, it required significant collaboration between both parties to bring it about.

Scheduling Planned Work

THESL recognizes that cultural change cannot simply be imposed from above. Initiatives that allow front-line workers to dynamically respond to new challenges and directions are important. Allowing for collaborative decision-making empowers employees to take ownership (and thus accountability) of aspects of the cultural change. The drive for accountability in productivity, and the understanding that the response can be most effective when it is collaborative, has led to myriad improvements and local initiatives at the front line.

Fig 7. Improvements in Work Planning

An experienced manager in THESL's planned work function developed a better way to engage Crew Leaders in work planning as a result of the control and review process. Working with the Crew Leaders, he developed a strong and highly visual method for planning and tracking their work, by location and by level of completion. Significant improvements were achieved by giving crews a more immediate sense of their work at a granular level, along with the authority and flexibility to plan their work. The fact that the new approach transferred authority to the crews made adoption rapid, and brought results quickly. The clear success of this solution means it will soon be rolled out to other areas.

Strategic Projects and Governance

In its drive for accountability THESL has methodically formalized management and measurement systems across the company. This includes the creation of an internal project governance group in Strategic Management to ensure proper alignment of major projects to strategic objectives; to validate project business cases; to monitor ongoing project performance and the accuracy of project status reporting; and, to track achievement of benefits defined and committed to in the business cases.

A key aspect of project governance has been the instituting of standard project management processes, methodologies, and tools – following Project Management Book of Knowledge (PMBOK) principles and other best practices. Recently, a review of the project business case process was completed and an enhanced business case model has been developed to drive better alignment of project goals and benefits with the company's strategic objectives as defined by the four strategic pillars – People, Heath & Safety; Customer Service; Modernization of the Utility; and Financial Performance. As well, the new model will ensure that project benefits are quantifiable and measurable, so that their attainment can be readily tracked and reported on upon completion of the project to objectively evaluate project success.

Elsewhere in the organization, the Information Technology (IT) division has also adopted Control Objectives for Information and Related Technology (COBIT), a generally accepted control framework for IT processes. The 3-year implementation program will result in all IT processes migrating to a mature level of formality and consistency. To ensure that the improvements are sustained, core processes will now include a feedback cycle, which will monitor process effectiveness, and be linked to process-specific KPIs.

Under the COBIT umbrella, IT has undertaken a range of initiatives which help increase efficiency and guarantee that productivity continues to improve. This includes implementing a portfolio management process to align IT projects with business objectives and prioritizing those that improve productivity, as well as adopting best practice frameworks such as the recognized standards of the Project Management Institute (PMI), Information Technology Infrastructure Library (ITIL), The Open Group Architecture Framework (TOGAF), and ISO 17799 (standard for information security management, issued by the International Organization for Standardization). The project governance concepts and processes within IT are consistent and aligned with those managed by the corporate project governance group in Strategic Management.

Employee Health and Safety

THESL is reinforcing the culture shift to accountability by making employees more responsible for their own health and safety on the job. Of course, there is a direct link between productivity and health and safety. Recently, the Workplace Safety and Insurance Board (WSIB) calculated that the average cost of a lost-time injury in Ontario in 2006 was approximately $98,000. Eighty percent of this consisted of costs to the employer through property damage, lost production, manager and supervisor time, compliance costs associated with Ministry of Labour orders, and lowered employee productivity when on light duty[2]. Also employees who are sick or injured do not only become less productive themselves, they may also impact their co-worker's health or morale.

To give employees a greater role in looking after their own health and safety, THESL launched the ZeroQuest® program at THESL in 2007. ZeroQuest® is an industry framework developed

[2] Original Source: WSIB, cited by Electrical and Utilities Safety Association
http://www.eusa.on.ca/Home.aspx?PageID=7&mid=_ctl0_MainMenu__ctl1-menuItem000

by the Electrical & Utility Safety Association (E&USA), which envisions a final goal of completely eliminating lost-time injuries and illnesses. The ZeroQuest® initiative rolls up to the “My Goal is Zero” corporate KPI (which tracks WSIB claims over the enterprise). ZeroQuest® requires an organization to commit to enterprise health and safety, and then make the effort to integrate health and safety with productivity through measured objectives and goals. The outcomes have to be measured, evaluated, and addressed. Finally, the organization must engage in a sustainable continuous improvement effort.

To support the ZeroQuest® program, THESL adopted the Internal Responsibility System (IRS). IRS encourages employees to take the initiative to find ways of doing their job more safely, or to take other steps to protect or improve their good health. Implementation of IRS (training started in 2008) will result in increased productivity as the intervals between accidents or work-related illnesses grow progressively longer. By ensuring that everyone in the organization takes direct responsibility for health and safety as an essential part of his or her job, IRS has become a key tool to support the cultural shift to greater personal accountability.

Undertaking Specific Initiatives Now

In addition to securing productivity gains through the implementation of permanent performance and management systems and the construction of a new culture of accountability, THESL is addressing specific opportunities to realize process efficiencies and better utilize existing resources and assets. Chief among these are projects which improve productivity by decreasing artificial, inefficient variations in how work is done. A series of harmonization and consolidation projects are addressing such opportunities throughout the organization.

Job Consolidation and Harmonization

As a legacy of amalgamation, THESL has been operating with hundreds of different job classifications. Job harmonization delivers a range of productivity outcomes, including:

- Providing more interesting, diverse, and multi-skilled work that enriches jobs and creates greater development opportunities for employees no longer limited by restrictive job classifications;

- Improving work processes, supporting safety, and reducing idle time by reducing the frequency and complexity of hand-offs:

- Improving the distribution of work and avoiding the stranding of labour resources caused by insufficient work of a specific and specialized nature;

- Improving the utilization of resources on inclement weather days, as the broader classifications will give them more work that can be performed indoors;

- Making training more efficient (fewer roles, even if more broad, will require fewer trainers);

- Enhancing attraction and retention by offering jobs of greater depth and breadth supporting continuous learning and opportunities for career advancement.

The first iteration of this exercise consolidated electrical mechanics and jointers (which affected about 100 workers) into a single group: Certified Power Cable Person (CPCP). While there were a number of drivers for this harmonization, the most obvious was the removal of inefficiencies in work procedures. For example, under the previous job classification system, only certain underground trades workers could do their work in a cable chamber, but they were restricted from doing similar work in a cable vault. That meant that two workers had to be available for a job involving a cable chamber and a cable vault even if the actual work being done in the two places was similar. In some cases, this would not affect efficiency, since each could do his or her work concurrently. But if one had to wait for the other to complete work before starting, the work became inefficient and less engaging for the workers.

The CPCP consolidation role is being used as a template to carry out other job harmonizations. Collectively, they will affect roughly one-third of THESL's total workforce. This initiative will result in reclassification of roughly 500 trades workers as some thirty job classifications are collapsed into just eight. The first major step in this process has already been completed: the signing of a Memorandum of Understanding with the workers' bargaining unit.

As job harmonization takes effect, it will result in more efficient work. THESL will document the efficiencies and update ongoing labour and material estimates used for planning construction work (known as compatible units or simply CUs). When work plans are created for the following year using CUs, they will reflect the new efficiencies, and thus lead to a more productive overall work plan. This increase in productivity will be sustained using the mechanisms described earlier: budgets, plans, scorecards and KPIs.

Other Standardization Initiatives

Job consolidation and harmonization is mirrored by a continuing drive to reach full standardization of the physical plant. Just as the legacy of amalgamation was an inefficient job classification structure, so there was a need to harmonize equipment, materials, nomenclature, and work procedures. Some standardization could be brought about immediately, but initiatives such as equipment standardization can only be moved forward as the plant ages and replacement becomes necessary.

A variety of related programs to ensure standardization will reap ongoing productivity gains, as existing workers can be deployed across the full organization, and new workers are trained in a single unified environment.

Grid Response Consolidation

Another type of consolidation initiative occurred recently in Grid Response. The Emergency Response function had been housed in three separate trouble room locations, each having its own unique set of response processes and procedures. In 2009, these facilities were consolidated to one location, using a single set of processes. FTEs were reduced from 70 to 48.

The Emergency Response teams are now focused more narrowly on tasks that are immediately related to power restoration. Previously, these teams had been charged with doing additional work, such as installing surge/lightning arrestors or insulator replacement. These tasks have now been reallocated to the Planned Work function to realize efficiencies and reduce duplication of effort.

Control Desk Consolidation

Control desks are at the heart of distribution system; making changes to them is no easy task. THESL inherited 6 control desks at amalgamation, each with its own map products, nomenclature, and operating practices. In 2002 the desks were centralized in one location, which provided some efficiency improvements. But the real payoff will only come from actually reducing the number of desks, which requires harmonizing the subsystems they control.

At first, THESL was able to reduce the number of desks to 4 through cross-training operators to work on different systems. But a more profound consolidation became possible with the implementation of the Distribution Management System (DMS) – a common software platform. First introduced in 2005, the rollout of DMS to embed more control desks is accelerating. In 2009, the 4 remaining control desks will be consolidated to 3, and then to 2 in 2010. The control desk consolidation allows the Control Room staffing level to remain flat while taking on the increased activity resulting from the new capital program and plant modernization.

Field Crew Initiatives

One of the key determinants of crew productivity is the amount of time they can spend actually carrying out work on the physical plant. After the last round of bargaining, THESL established the groundwork to maximize productivity by increasing the on-site time available to crews.

For some projects, in some locations, this is being achieved by the adoption of an “extended workday” which changes the working week from 5 normal days into 4 longer days. This schedule can be significantly more efficient because it reduces the time spent on daily set-up and take-down at the job site as well as travel time to site, thus increasing the actual productive on-site time for the crew. This also allows crews to take advantage of extended summer daylight hours and increased roadway access.

A similar initiative, recently achieved in collective bargaining, will allow crews to report directly to their job site. Today, crews report initially to the operating facilities, and spend part of their work time travelling to the worksite location. This program will be particularly efficient for jobs where the equipment is staying at the job site for more than a day.

Additional improvements will arise from actively emphasizing Crew Leader performance expectations. This helps to codify and clarify the values which Crew Leaders are expected to display as they take an increasingly active role in ensuring their crews work to maximize productivity. Crew Leaders will continue to focus on delivering work on time, in scope, and within budget, while also emphasizing safety, professionalism, and productivity. In particular, Crew Leaders will manage start, stop, and break times and ensure that crews adhere to collective agreement work hours. The key accountability of Crew Leaders and Field Crews for earning and preserving customer trust has also been actively reinforced, in part through a link to the Gain Sharing program described earlier.

Operations Support Services Initiatives

THESL has also launched other consolidation initiatives that have resulted in clear increases in productivity. As a first step, the separate Supply Chain and Fleet Services organizations were amalgamated to form a single service organization. After this amalgamation, purchasing of fleet safety equipment, parts, and tools was centralized and moved to an RFP process, which netted an 11% reduction in annual cost.

Supply Chain has delivered a number of creative initiatives to help reduce inventory costs and improve productivity. In 2008, Supply Chain implemented a self-service "supermarket" of small parts for high volume, constantly moving inventory. The implementation of this service resulted in a reduction in backlog (reducing crew idle time) and a reduction in FTE in the warehouse from 18 to 15 while preserving the same level of parts availability.

In late 2009, Supply Chain will pilot a "Delivery to Site" program, which will result in major equipment components (such as transformers, poles, and wires or cables) being delivered directly to the job site by the manufacturer or distributor. Besides decreasing crew wait times, this program will eliminate costs to warehouse the materials or transport it from the warehouse to the actual job site.

THESL has substantially improved fleet utilization, and decreased fleet size, through rationalization. Since the initiative started (in 2004) THESL has been able to decrease the number of vehicles by almost 15% even as the work of the utility (for instance the increased capital plan) has grown. This reduction was accompanied by other improvements in vehicle procurement, scheduling, maintenance and outfitting, to ensure that the right vehicle was always available for a particular job.

Fleet management initiatives continue to improve optimization by devising new and more accurate ways to measure vehicle utilization. One such measure is the amount of time the vehicle aerial devices are in use. This measure may be particularly helpful because it can serve as a proxy measure of general crew productivity on certain tasks, as well as provide useful data for deciding on the right mix and size of the fleet.

Investments to Drive Future Productivity Improvements

THESL understands that a vision which is limited to improving current productivity can be short-sighted. Without new spending, efficiency results only from harvesting old investment, which cannot be sustained indefinitely. Therefore the utility continues to make focused investments to drive future productivity improvements. Most of THESL's significant programs include an element of investment for the future, but for four of them (Workforce Renewal, Asset Renewal, Facilities Renewal, and Mobile Enablement) this is the dominant aspect.

Workforce Renewal

Between 2009 and 2018, it is expected that over 650 THESL employees will retire (representing approximately 45% of THESL's workforce). Over 50% of the attrition will occur in supervisory roles or in core trades and technical positions, where the results will be a substantial decrease in the skills and experience available. The challenge of maintaining and enhancing the productivity of the workforce in the face of unprecedented attrition will be magnified by the concurrent timing of a substantial plan to renew the distribution system.

Rather than waiting for this inevitable attrition to create gaps in skills or availability, THESL is rolling out a Workforce Renewal Program. This proactive approach will ensure that a dynamic, rigorously selected, and well-trained workforce will be in place to support or even increase current levels of productivity. THESL is filing a separate document which outlines the projected loss of FTE by year, and the comprehensive renewal program required to address it.

The focus of the renewal program will be on hiring and training for the overhead and underground trades, as well as designers and engineers. THESL created an internal Trades School in 2003, and intends to build on this success.

The impact on simply defined productivity is obvious: apprentices require up to five years of training before they are fully capable of performing all aspects of their jobs. In addition, apprentices will participate in job shadowing, which reduces the productivity of the mentor in the short-term. To ensure that the new workforce is in place at the appropriate time, the overall FTE number for the utility will rise, before falling in subsequent years as program hiring winds up, and attrition continues.[3]

Asset Renewal

The Asset Renewal and Modernization Program is a multi-year undertaking which commenced in 2007. Guided by comprehensive asset condition studies, this initiative will have a long-term positive impact on productivity since an unreliable system is a drag on efficiency in all areas of output, and in particular requires higher emergency maintenance costs. Additional details on this program have been filed in a separate document.[4]

Facilities Renewal

One of the key principles guiding investment decisions in THESL's facilities is to optimize functional benefits. A well-chosen site for a Service Centre can significantly reduce travel time, decreasing response time to emergencies and contribute to increasing the productivity of field workers. A well-designed building can support the optimal flow of materials (such as in a warehouse) and work (such as in a repair shop or engineering design). It also can provide a climate for innovation and creativity, improving team communication and interaction, business processes, corporate culture, and employee pride and loyalty.

THESL's lease of the Monogram and Milner facilities is an example of this strategy in action; these are modern, functional facilities that support productivity.

Mobile Enablement Program

THESL's workforce is highly mobile -- crews move from job site to job site and customer to customer to perform emergency, maintenance and planned work. However, THESL's computer systems are predominantly accessed from stationary workstations and laptops. Aside from a few solutions in some discrete areas of the business, the current work processes include a large number of manual steps, and are not optimized for a mobile workforce. The Mobile Enablement Program seeks to improve this situation by implementing a mobile gateway capability (involving computing and communications infrastructure and applications), deploying mobile computing devices to the field workforce, and installing Global Positioning System (GPS) and navigation devices in all company vehicles.

[3] Compensation: Workforce Staffing Plan document in EB-2009-0139 Exhibit C2 Tab 1 Schedule 5

[4] 2010-2019 Electrical Distribution Plan document in EB-2009-0139 Exhibit D1 Tab 8 Schedule 10

THESL will implement the Mobile Enablement Program over a three-year period, ending in 2011. The mobile computing technology being deployed will allow field crews to enter data directly into their handheld mobile devices, or to view important system or asset information, while at the work site. The expected benefits of these functionalities include:

- Automation of data entry for job costing and elimination of follow-up work to capture maintenance and inspection data (due to poor penmanship or misplaced paper-based forms)
- Enabling field supervisors to spend more time on job sites to improve job execution and worker safety by providing them a “mobile office”
- Better field decision-making arising from access to greater and enhanced distribution system and field asset information
- Reduced time lag for entry of field data into Ellipse to update financials, equipment registry, and job costs.

Using the vehicle position tracking and operating performance monitoring capabilities of GPS and routing features of a navigation system, the following benefits can be expected:

- Shorter response time to emergency calls (most appropriate vehicle will be dispatched to the relevant job site following the most direct route)
- More effective fleet maintenance programs arising from the collection of better vehicle operating data
- Lower fuel costs resulting from more optimized routing of vehicles
- Faster response time for fire, ambulance and police in the event of a worker or public emergency, as accurate vehicle locations are tracked in real time

Dealing with Complexity

The business, regulatory and community environments in which THESL operates change frequently and rapidly; THESL consistently and dynamically responds to or anticipates these changes. As a major utility, THESL is aware that it needs to display leadership and foster innovation as it meets these challenges.

The structure of the industry has changed profoundly over the last decade, with the introduction of quasi-free market forces; greater concern for, and understanding of environmental impacts; and demand for electricity in the face of limited supply. Legislative changes have been dramatic, from the 1998 breakup of Ontario Hydro, through market opening in 2002, and now the Green Energy Act (GEA) of 2009, which promotes or mandates the use of renewable resources, conservation, and distributed energy sources in Ontario.

For THESL, the requirements of the GEA are not unexpected. In fact, the utility has already taken a lead role in providing solutions such as smart meters and conservation and demand management (CDM) programs to its customers.

THESL is undertaking one of the largest deployments of smart meters in Canada. The meters are only the most visible component of the program; supporting them required the implementation of an integrated smart meter back office infrastructure which delivers remote communication, automated meter reading (AMI), and data storage systems which allow Time-of–Use (TOU) billing, web presentment, and a customer web-based information system (allowing customers to see their hourly consumption and the resultant TOU costs).

The strong commitment to smart meters represents a key step in the development of a smart grid in Ontario. A smart grid, using two-way communication, advanced sensors, and distributed computers, improves the efficiency, reliability, and safety of power delivery and use. THESL continues to be a leader in the development of smart grids in Canada, and has already put some of the building blocks in place.

While implementing the smart grid will take a lot of effort, it does provide the long term potential to significantly increase productivity and customer service through the automation of manual processes and the utilization of highly efficient technologies.

Beyond its commitment to the smart grid, THESL has demonstrated industry leadership with award-winning conservation programs, as well as innovation in the area of Demand Response (DR). DR has traditionally been limited to commercial and industrial customers, but THESL has taken it to the residential segment too. Ironically, the success of such programs can make the utility seem less productive, since conservation and demand response decrease the "throughput" which is used in traditional definitions of productivity.

Changing Business Environment

Innovation and leadership are characteristic of THESL's response to all challenges – not just those involving technology. A concrete example of innovation in management approach can be found in a recent decision to partner with Enersource Hydro Mississauga on the development of a new Customer Information System (CIS) platform. When THESL decided to upgrade their existing system, they realized that the costs of working with a vendor to develop a suitable product could be shared with other utilities.

The broad context for THESL's business operations continues to present new challenges. An increased emphasis on internal controls and disclosure places new demands and expectations on the utility, intensified now that the company has issued debt to a wider market than previously. Credit rating agencies require detailed information so that they can evaluate the creditworthiness of the utility. New regulations requiring that company officers attest to the effectiveness of financial reporting controls and procedures lead to greater demands for internal reporting and monitoring.

In 2011, International Financial Reporting Standards (IFRS) will come into force for most major Canadian companies, replacing Canadian Generally Accepted Accounting Principles (GAAP). The new regime will have a broad impact on THESL: it will require changes to reporting, budgeting, and forecasting processes, amongst others, across many functions and departments.

These challenges inevitably create pressure against simple productivity improvements, (i.e. those based on a direct comparison to earlier times) because they divert effort and resources away from traditional utility activities. However, it is clear that THESL as a whole is a more productive organization. The proof can be seen in the fact that the utility is able to deal with so many new challenges, without significantly increasing the resources it needs to do so, and while ensuring that normal operations continue safely, efficiently, and reliably.

THESL's Local Setting

While the larger environment continues to change, THESL's local environment does not remain static either. With a population of more than 2.5 million, Toronto is the largest city in Canada, and the fifth most populous municipality in North America. Annual population growth in the city is averaging 2 %, most of it due to international immigration. Prior to the current slowdown, Toronto's economy was also growing at a fast pace annually.

This pattern of consistent growth has led to an increasing strain on the city's infrastructure. Population densities are increasing in many parts of the city, traffic is becoming more congested, and the space underneath roads and buildings is growing tighter and tighter.

THESL field workers are noting that the company's network is becoming increasingly difficult to service due to traffic restrictions, narrow boulevards and unsafe conditions. While access to the location of the work is subject to the effects of increasing density, the infrastructure space itself is becoming highly congested. This crowding takes its toll on productivity and can create challenges for safety.

A Foundation for the Future

Clearly THESL is a more productive organization today than it has been at any time in the past. This has not come about by luck, nor by simply harvesting past investments. Instead the utility has established a three-pronged approach, by:

1. consciously constructing a methodology for cultural change;
2. advancing performance systems which ensure that change is sustained or expanded upon;
3. continuing to make long-term investments in strategic initiatives that will have a positive impact on future productivity.

This program, with a mixture of long-term and short-term elements, will provide the foundation for ongoing, sustainable productivity improvements at THESL for years to come. As such, it will allow the utility to continue to play a leading role in a time of unprecedented change.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 5:

Reference(s): C1/T5/S1

THESL has provided a copy of its Conditions of Service. Please indicate how, if at all, the conditions have changed since THESL's last rate proceeding. To what extent, if any, have those changes impacted the 2011 revenue requirement?

RESPONSE:

Since THESL's last rate proceeding, THESL's Conditions of Service changed to specify that developers of new multi-unit residential rental buildings and new and existing condominiums (collectively, "MURBs"), or boards of directors of condominiums, may choose to have THESL install smart suite metering, or to have THESL install a bulk interval meter for the purpose of enabling smart sub-metering by a licensed sub-metering service provider. The changes are reflected in section 2.3.7.1.1 of THESL's Conditions of Service and became effective on February 22, 2010.

No specific impact of this change to the 2011 revenue requirement can be quantified.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 6:

Reference(s): **none**

The Board is seeking input on whether it would be appropriate for THESL to commence rate filings under incentive regulation? Please provide THESL's position on whether this year represents an appropriate base case for a future IRM application. If THESL is not of the view that it should be subject to incentive regulation please explain why.

RESPONSE:

Please refer to the response to Board Staff interrogatory 9.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 7:

Reference(s): I1/T1/S1/p. 2

Please provide a schedule in the same format as Table 1 – Other Revenue which includes 2007-2010 Board approved and actual levels.

RESPONSE:

Table 1: Other Revenue ($ millions)

	2007 Actual	2008 Actual	2009Actual	2010 Bridge	2011 Test
Specific Service Charges (including Pole Attachment Rental)	7.6	7.5	7.5	7.0	7.6
Late Payment Charges	5.2	4.8	5.1	4.8	4.9
Other Distribution Revenue	8.6	8.1	7.4	7.0	7.2
Other Income	18.9	10.3	3.6	5.5	0.0
Total Revenue Offset	**40.3**	**30.7**	**23.7**	**24.2**	**19.7**

In recent years the Board has not approved or disapproved specific line item within the Company's request. The Board only approves a controllable expenses budget that is fully supported by the evidence, including the evidence of historical spending norms. The Board-approved total revenue offsets for 2008, 2009 and 2010 are $25.9 million, $21.7 million and $29.4 million, respectively.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 8:

Reference(s): D1/T3/S1

Please recast Table 1 – Distribution Expense Summary to include Board approved numbers for 2008-2010. In addition, please provide actual and board approved numbers for 2006 and 2007.

RESPONSE:

	2006 Historical	2007 Historical	2008 Board-Approved	2008 Historical	2009 Board-Approved	2009 Historical	2010 Bridge	2011 Test
Operations	45.7	54.3	NA	45.7	NA	49.0	61.6	62.8
Maintenance	36.8	42.6	NA	41.3	NA	46.5	42.6	45.6
Billing and Collections	26.4	31.9	NA	31.9	NA	35.1	33.7	35.3
Community Relations	3.8	4.0	NA	3.5	NA	5.5	3.7	4.1
Administrative and General	25.4	26.7	NA	46.1	NA	47.3	60.6	72.2
Other Distribution Expenses	18.2	10.8	NA	14.0	NA	11.8	8.7	6.8
Amortization Expense	124.6	137.0	146.9	149.0	154.4	155.5	164.5	178.3
TOTAL	**280.9**	**307.3**	**337.8**	**331.6**	**349.6**	**350.7**	**375.4**	**405.1**

Note: The TOTAL line in this table includes October.

The Board did not approve or disapprove any specific line item for 2008 or 2009 within this table with the exception of the amortization and the total OM&A; and therefore total distribution expenses.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 9:

Reference(s): C/T2/S3-10

The evidence includes draft Service Agreements between THESL and its affiliates. What is the process for finalizing these agreements? When does THESL expect them to be signed?

RESPONSE:

Upon approval of the 2011 budget by the Board of Directors, the draft Service Agreements between THESL and its affiliates will be signed-off by the appropriate parties and become effective January 1, 2011.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 10:

Reference(s): C1/T3/S1/Appendix A

For 2010 THESL is paying THC $1.66 million for "Governance" and $1.18 million in 2011. Please provide, in detail, a breakdown of these amounts for the two years and explain exactly what services are being provided.

RESPONSE:

For 2010, THESL is paying THC $1.66 million for "Governance", which is comprised of Corporate Stewardship as provided by the Office of the CEO in the amount of $1.58 million and for Corporate Governance as provided by the Board of Directors in the amount of $0.08 million. For 2011, THESL is paying THC $1.18 million for "Governance", which is comprised of Corporate Stewardship as provided by the Office of the CEO in the amount of $1.08 million and for Corporate Governance as provided by the Board of Directors in the amount of $0.11 million.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 11:

Reference(s): **C1/T3/S1/Appendix B**

THESL is providing $1.17 million in services to TH Energy – Please explain in detail exactly what services THESL provides to TH Energy.

RESPONSE:

Please see the Table below for details.

Services Provided to TH Energy	2011 ($, millions)
Procurement	0.16
Consolidated Billings and Other	0.27
Finance - Payroll, Accounts Payable, Reporting	0.04
Finance - Corporate Controllership & Policy	0.22
Finance - Corporate Tax	0.04
Finance - Financial System Support	0.07
Finance - Unregulated	0.11
Treasury, Rates & Regulatory Affairs	0.06
Organization Effectiveness	0.05
Legal - Commercial, Litigation, Real Property,	0.03
Legal - Claims Administration	0.04
IT Stewardship	0.06
Environment, Health & Safety	0.03
Total	1.17

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 12:

Reference(s): C2/T1/S2/Appendix A

Please recast Table 1 – Employee Compensation to include Board approved numbers for 2008, 2009 and 2010.

RESPONSE:

There are no Board-approved amounts or numbers at the business unit level for 2008, 2009, and 2010.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 13:

Reference(s): C2/T1/S3

Please explain, in detail why Pension Costs are increasing from $6.6 million in 2010 to $8.3 million on 2011. What is THESL's current expectation as to what actual pension costs will be for 2010?

RESPONSE:

The increase in the pension costs from 2010 to 2011, as outlined in Table 1, are due to the increase in the OMERS employer contribution rates, the projected employee salary increases, and the increase in FTEs.

The current forecast for the pension costs expensed in 2010 is $6.6 million.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 14:

Reference(s): C2/T1/S5/p. 3

Please provide a table setting out actual and forecast retirements for the years 2006-2010. What is the total number of retirements in 2010 that have actually occurred? Does the 2011 revenue requirement assume a total of 64 retirements in 2010?

RESPONSE:

Year	2006	2007	2008	2009	2010
Forecast	NA	24	18	53	64
Actual	10	19	16	30	53 (Oct 31, 2010) 55 (Year-End)

The total number of retirements in 2010 that have occurred is 53.

The 64 forecast retirements in 2010 is assumed in the 2011 revenue requirement.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 15:

Reference(s): F1/T1/S1p. 3

Please recast Table 2 and include Board approved levels for 2008-2010. Also, please provide an updated number for 2010 based on year to date actuals.

RESPONSE:

Board-approved levels are not available since the Board does not approve THESL's budget at this level of detail.

Table 2: Summary of Distribution O&M Budget ($ millions)

Description	2008 Actual	2009 Actual	2010 Bridge	2011 Test	2010 Actual Sept YTD
Maintenance Programs	**26.8**	**33.3**	**34.0**	**37.1**	**25.1**
Fleet and Equipment Services	9.2	10.9	11.6	13.7	7.8
Facilities and Asset Management	25.4	22.9	25.6	27.0	17.7
Supply Chain Services	8.4	8.8	9.3	11.4	7.3
Control Center	7.2	7.0	7.7	7.5	8.5
Operations Support	37.1	37.1	43.8	45.7	31.0
Customer Services	41.0	46.1	47.6	50.3	36.7
Customer Driven Operating	0.8	0.7	0.1	0.5	0.2
Total	**155.9**	**166.9**	**179.6**	**193.3**	**134.3**

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 16:

Reference(s): F1/T2/S1

Please provide, in detail the reason for the significant increase in the Fleet and Equipment Services Budget.

RESPONSE:

Payroll

- Labour:
  - 2010 upward adjusted 6% over 2009 actuals to compensate for additional personnel and a 3% increase in salary as per Collective Bargaining Agreement
- Inventory and Direct Purchase Budgets:
  - Increase of 3% over 2009 actuals as adjustment for inflation
- External Contract Services:
  - Increase of 47% accounting for GPS hardware/software system and support fees
- Occupancy Charge:
  - Fleet increase of 56% accounting for revised 2010 Facilities sq ft cost re-allocation as well as a residual inflation increase versus 2009

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 17:

Reference(s): F1/T6/S1/p. 6

Please provide a detailed budget for each of the following cost categories: Meter Services, Billing, Remittance/MDM, and Collections.

RESPONSE:

($millions)	Meter Services	Billing/ Remittance/ MDM	Collections
Labour	2.5	7.3	1.9
Vehicles	0.3	-	-
Material and Services	0.7	5.0	2.0
Support	1.3	3.4	0.1
Provision for Bad Debt	-	0.7	7.4
Total Operating Expenses	4.8	16.4	11.4

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 18:

Reference(s): F2/T1/S1/p. 2

Please recast Table 1 to include Board approved numbers for 2008-2010. Please update the 2010 numbers to include year to date actuals.

RESPONSE:

	2008 Actual	2009 Actual	2010 Bridge	2011 Test	2010 Actual YTD
Governance	14.9	11.9	5.0	1.9	3.4
Charitable Contributions	0.1	0.2	0.3	0.1	0.2
Finance	4.3	4.5	10.5	15.3	8.1
Treasury, Rates and Regulatory	9.9	12.2	13.2	14.9	9.1
Legal	3.1	2.9	4.5	5.0	3.4
Communications	4.3	3.6	3.9	4.3	3.7
Information Technology	21.4	22.8	23.7	24.9	18.7
Organizational Effectiveness & Environmental Health and Safety	9.7	12.2	11.9	15.2	9.7
Strategic Management	0.1	1.4	2.3	1.7	1.4
Total	**68.9**	**71.7**	**75.4**	**83.3**	**57.8**

The Board does not approve or disapprove any specific line item within the Company's claim. The Board only approves a controllable expenses budget that is fully supported by the evidence, including the evidence of historical spending norms.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 19:

Reference(s): F2/T4/S1

Please explain how R&D tax credits are included in the 2011 revenue requirement.

RESPONSE:

THESL has included projected investment tax credits from qualifying Scientific Research and Experimental Development ("SRED") costs in its calculation of the revenue requirement in respect of PILs. Please refer to the line, "investment tax credits" on Exhibit P1, Tab 1, Schedule 2. The $0.74 million reported on this line is made up of the SRED credit of $0.65 million and the Federal Apprenticeship credit of $0.09 million.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 20:

Reference(s): F2/T6/S1

Please provide a detailed budget for Regulatory Affairs for each year 2007-2011. Please include all internal and external costs and explain how these costs are recovered. Please include Board approved amounts.

RESPONSE:

Regulatory Affairs is Regulatory Policy & Relations and Regulatory Applications & Compliance together. For budget details, please refer to the Table below. To the extent that these costs are included in revenue requirement, they are recovered through rates. There is no other mechanism of recovery.

	2007 Actual ($ millions)	2008 Actual ($ millions)	2009 Actual ($ millions)	2010 Budget ($ millions)	2011 Budget ($ millions)
Payroll	0.8	0.9	0.9	1.0	1.0
External Contract Services	0.9	0.4	0.7	0.4	0.4
OEB Fixed Costs	3.4	3.1	3.2	3.3	3.4
All Other Categories	0.3	0.6	0.5	0.6	0.5
TOTAL	5.4	5.0	5.3	5.3	5.3

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 21:

Reference(s): F1/T7/S1

Please provide a detailed budget for Legal Services for 2007-2011. Please include Board approved amounts.

RESPONSE:

The table below presents the actual Legal Services expenditures for 2007-2009, the budgeted expenditures for 2010 and the forecast expenditures for 2011 broken down into the major cost categories. No "Board-Approved" amounts are provided because the Board did not approve or disapprove of specific line items in its either EB-2007-0680 (2008 and 2009 rates) or its EB-2009-0139 (2010 rates) decision.

	2007 Historical ($ millions)	2008 Historical ($ millions)	2009 Historical ($ millions)	2010 Bridge ($ millions)	2011 Test ($ millions)
Payroll Costs	1.2	1.4	1.5	2.5	2.8
External Contract Services	0.9	1.2	1.0	1.4	1.8
Employee Expenses	0.0	0.1	0.1	0.1	0.2
Usages Charges	0.3	0.4	0.3	0.5	0.2
Total	2.4	3.1	2.9	4.5	5.0

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 22:

Reference(s): C1/T4/S1/Appendix C

THESL is using the amortization rates outlined in the 2006 EDR Handbook. Why has THESL not undertaken an updated depreciation study? Would THESL be prepared to undertake a depreciation study? If not, why not?

RESPONSE:

THESL is currently applying the amortization rates outlined in Appendix B of the 2006 EDR Handbook. In anticipation of the adoption of International Financial Reporting Standards ("IFRS"), THESL has undertaken its own depreciation study of its assets.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 23:

Reference(s): C1/T6/S1/p. 8

The evidence indicates that in 2009 THESL undertook a third-party audit of the ACA plan. Please provide a copy of that audit.

RESPONSE:

The third-party audit report referenced in the pre-filed evidence was filed as part of THESL's 2010 rate case EB-2009-0139, and attached here for reference as Appendix A.

Toronto Hydro Project
Health Index Calculator Audit

Kinectrics Inc. Report No: K-418015-RA-0001-R05

August 6, 2009

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DISCLAIMER

Toronto Hydro Project
Health Index Calculator Audit

Kinectrics Inc. Report No: K-418015-RA-0001-R05

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Revision History

Revision Number	Date	Comments	Approved
R00	Jun 11, 2009	First Draft	n/a
R01	Jun 17, 2009	Included comparisons for condition data availability and HI classification results. Included audit of cables.	n/a
R02	Jun 24, 2009	Modified wood pole audit	n/a
R03	Jun 30, 2009	Included recommended HI. Modifications according to corrected population numbers	n/a
R04	Jul 9, 2009	Population changes to Station Transformers, Switchgear, CB, Pad-mounted Switches, U/G Cables, Executive Summary, Recommendations	n/a
R05	August 6, 2009	Final Signatures	Ray Lings

Table of Contents

1 Executive Summary

1.1 Background and OEB Decision

The Ontario Energy Board (OEB) required Toronto Hydro Electric System Limited (THESL) to provide a report reflecting its progress in its replacement and maintenance programs for its underground cable replacement and plant replacement program. Specifically, the requirement is that a "**Utility must be in a position to provide asset condition studies and other analyses that support its capital strategies and budgets."** The Board expects that the Applicant will undertake appropriate studies and analysis to address the questions concerning its asset management practices that have been raised during this proceeding, including options for "**increased diagnostic testing, rehabilitation versus replacement**, and better identification of situations where replacement in its distribution network (both in the nature and location) of the assets is needed in whole or in part. "

1.2 Project Scope and Non-Asset Condition Assessment (ACA) Considerations

Asset Condition Assessment (ACA) utilizes a multi-criteria analysis to estimate the condition of assets. An asset's condition is expressed in terms of a Health Index (HI) score from 0% to 100%, where 100% represents perfect condition (i.e. brand new) and the lower the score the worse the asset condition. Furthermore, depending on the HI score, assets are typically grouped into five (5) condition categories:

- Very poor
- Poor
- Fair
- Good
- Very good

This allows us to a) understand assets condition distribution for the asset population within each asset category and b) better predict how many assets are expected to fail and thus would have to be replaced over the next several years.

The methodology to assess the condition of a particular asset is translated into a Health Index formulation. This is then used in conjunction with the collected field data to determine Health Index scores. The HI distribution for each of the asset categories is referred to as the Asset Condition Assessment (ACA) results.

THESL has enlisted the services of Kinectrics Inc. to perform an assessment of the existing methodology used by THESL's Health Indexing application (referred to hereafter as "Calculator"). The objective of this project was to:

1. Compare the Calculator's methodology and latest ACA results with the methodology and results of the 2006 Asset Condition Assessment (ACA) report by Kinectrics Inc.

2. Assess the progress in collecting condition data between 2006 and 2009

3. Recommend changes to the HI methodology to reflect the most recent industry trends

The 2009 ACA information for underground cables and wood poles were not included in the Calculator and were provided by THESL from other sources.

It is worth noting that the objective of the ACA is to estimate condition of assets as it relates to their long-term degradation and remaining life, and not defect management that is dealt with as a part of regular maintenance practices. Furthermore, it is important to remember that factors other than asset condition also play a significant role in determining sustaining capital replacement needs and replace versus refurbish decisions. These factors include but are not limited to:

- Obsolescence
- Regulatory requirements
- Rating limitation due to system additions, such as new load customers and Distributed Generation
- Rating limitations due to the growth of the existing loads
- Operational considerations
- Integration with system expansion

1.3 Comparison of 2006 and 2009 Methodology and Results

HI formulation and results from 2006 and 2009 were compared for the following 16 Asset Categories:

- Station transformers
- Circuit breakers
- Switchgear
- Submersible transformers
- Network transformers
- Pad mounted transformers
- Vault transformers
- Wood poles
- ATS
- Cable chambers
- Network vaults
- Remotely controlled 3-phase Overhead Gang Switches
- Manually operated 3-phase Overhead Gang Switches
- SCADAMATE controlled 3-phase Overhead Gang Switches
- Pad mounted switchgear
- Underground cable

For each Asset Category a comparison between 2006 and 2009 is provided for the following aspects of the ACA methodology and results:

1. HI formulation that includes Condition Parameters, Condition Parameter Weights, and Condition Criteria
2. Granularity within the Asset Category
3. ACA Data Availability
4. HI Classification Distribution

Table 1-1 summarizes the finding for the above aspects for all the Asset Categories. A detail comparison and associated observations are provided for each of the Asset Categories in the body of the report.

Table 1-1 Audit Results

Asset Group	Changes in HI Formulation: Condition Parameters and Weights	Changes in HI Formulation: Changes in Criteria	Changes in Granularity	Changes in Condition Data Availability: Summary of 2009 Sample Size as % of Population (sample size/population)	Changes in Condition Data Availability: Summary of 2006 Sample Size as % of Population (sample size/population)	Changes in HI Distribution between 2006 and 2009 (changes in % of assets in the sample that were classified as poor/very poor)
Stations Power Transformers	yes	yes	no	77.34%	100.00%	21.4% in poor/very poor condition (increase of 10.4%)
Circuit Breakers	yes	no	2009 broken down to Air Blast, Oil, SF6, Vacuum, Air Magnetic	25.26%	3.59%	3.5% in poor/very poor condition (an 8.2% decrease from 11.7%*)
Station Switchgear	yes	yes	no	2.65%	not available for 2006	71.4%* in poor/very poor condition (comparison unavailable**)
Submersible Transformers	no	yes	no	78.34%	30.31%	0.03% in poor/very poor condition (decrease of 0.01%)
Network Transformers	no	no	no	97.23%	95.04%	none in poor/very poor condition (decrease of 0.1%)
Padmounted Transformers	no	yes	no	68.29%	33.34%	none in poor/very poor condition (decrease of 0.1%)
Vault Transformers	yes	yes	no	66.16%	45.66%	0.19% in poor/very poor condition (increase of 0.1%)
Wood Poles	yes	no	no	14.40%	12.49%	23.7% in poor/very poor condition (increase of 8.6%*)
ATS	yes	no	no	6.52%	14.16%	none* in poor/very poor condition (no change from 0%* in 2006)
Cable Chambers	no	yes	no	17.32%	6.18%	2.1% in poor/very poor condition (a 3.5% decrease from 5.6%*)
Network Vaults	no	yes	no	98.98%	100.00%	0.09% poor/very poor condition (no change)
3 Phase Overhead Gang (Rem.) Switches	yes	yes	no	48.70%	9.70%	0.89% in poor/very poor condition, (increase of 0.89%)
3 Phase Overhead Gang (Man.) Switches	yes	yes	no	3.33%	16.60%	none* in poor/very poor condition (no change)
SCADAMATE	yes	yes	new category	3.85%	not available for 2006	none* in poor/very poor (comparison unavailable**)
Padmounted Switchgear	yes	yes	no	56.54%	19.00%	none in poor/very poor (no change)
Underground Cable	no	no	no	N/A	N/A	75% in poor/very poor condition (increase of 63.9%***)

* Sample Size was insufficiently large or random for Health Index extrapolation over entire population

** No data available in 2006 for comparison

*** For underground cables, the HI methodology did not change between 2006 and 2009. However, changes in available data resulted in different Health Index distributions between 2006 and 2009.

1.3.1 Health Index Formulation

For all Asset Categories except underground cables and network transformers, the 2009 HI formulation was somewhat different than that of 2006. Differences involved changes to one or more of the Condition Parameters, Condition Parameter Weights and Condition Criteria. In some cases this was because Condition Parameters that could be addressed during a course of the routine maintenance without affecting the asset's end-of-life (EOL) were excluded from the Calculator. In other cases this was based on different requirements for inclusion of condition data. For example, in some cases only assets with at least 60% of the required condition information were considered.

For underground cables, although some of the work has been done to assess condition based on the segments, in order to facilitate comparison of 2006 and 2009 results, Kinectrics and THESL agreed to convert this information back to circuit-km and use the same HI formulation for both years.

As a part of the continuous improvement process, Kinectrics has provided recommend Health Index formulations for each of the asset categories that were audited. These recommendations are based on Kinectrics' extensive experience with utilities across North America and should be used in future assessments.

1.3.2 Granularity

The assets within each asset category do not represent a homogeneous set of equipment as there are variations in manufacturers, models, types, ratings, installations, environments, etc. All of these factors have impacts on the condition of individual assets and their corresponding Health Index. At the same time, the HI approach is most meaningful when looking at the asset categories with substantial number of assets. Therefore, it is important to establish a right balance between similarity and number of assets in selecting the appropriate granularity for asset categories.

Granularity has significantly increased for circuit breakers and a new separate asset category was added for SCADAMATE overhead switches. It is also recommended to continue with improving granularity for underground cables by collecting and storing condition information for specific segments.

1.3.3 Condition Data Availability

The ideal situation is when condition data are available for every asset in the population. Failing that, the larger the subset of assets with available information, the more confidence one has in extrapolating results from this subset over the whole population. Generally, this requires a sample size to be at least 10% of the population. Table 1-1 denotes asset categories where sample sizes were insufficiently large for extrapolation of results over entire asset populations.

THESL has made a significant progress in collecting condition data. For 8 of the 16 asset categories, the percentage of assets with available data has increased. In some cases, the increase was quite significant: Circuit Breakers, Submersible Transformers, Pad mounted Transformers, and Pad mounted Switchgear. It is worth noting that the wood poles were included here because the number of poles with visual and age information only (the information that was available in 2006) has increased even though the number of poles with actual test data remains relatively small.

For two asset categories, Network Transformers and Network Vaults, the percentage of assets with available data remained close to 100%, both in 2006 and 2009.

For two asset categories, SCADAMATE and Station Switchgear, no assessments were available in 2006 so condition data availability comparisons could not be made. Nevertheless, for both these assets, only very small samples of the populations had data available so more effort is required to increase the percentages.

For three asset categories, percentage of assets with available data decreased. There seems to be a reasonable explanation for three of the four Asset Categories:

1. Manually operated 3-phase Gang Overhead Switches are being replaced with remotely operated switches.

2. ATSs are in the process of being eliminated from the system.

3. For underground cables, the reduction in the sample size could be attributed to two factors: questionable data regarding sample sizes in 2006 Report and usage of segment-based approach when collecting condition data for direct buried XLPE cables.

For Station Transformers, the percentage of assets with available condition data decreased from 100% in 2006 to 77% in 2009. Although 77% is a large enough sample size to extrapolate HI for the whole population, the trend needs to be reversed. This is particularly important as station transformers have a high consequence of failure, and therefore need to be replaced before failure if found to be at the end-of-life.

To summarize, Station Transformers notwithstanding, THESL has made great strides in increasing the amount of condition data collected and should continue with this effort.

1.3.4 Health Index Distribution

The comparison of 2006 and 2009 Health Index distribution was based on the premise that the sample size with the known data is representative for the whole population. In fact, the larger the sample, the more confidence one has that the results can be extrapolated over the entire population.

For four asset categories (Station Switchgear, ATS, Manually operated Three Phase Overhead Switches, and SCADAMATE), extrapolation of the Health Index distribution could not be done in 2009 because the sample sizes were not big enough.

For seven out of the twelve remaining asset categories, the percentage of assets in poor and very poor condition stayed virtually unchanged (the changes were within 1%). For two asset categories (SCADAMATE and Station Switchgear), there were no results for 2006 so comparisons were not possible. Also, because of changes in approach to assessing the condition of wood poles between 2006 and 2009, no meaningful comparison could be made for wood poles.

Two of the asset categories (Circuit Breakers and Cable Chambers) had fewer assets in poor and very poor condition. The decreases were less than 10% and could be attributed to significant increases in the sample sizes (which lead to better data), and/or increased granularity for the Circuit Breakers.

Wood Poles had an 8.6% increase of assets in poor and very poor condition. This could be attributed to the fact that the 2009 sample included 1) poles with strength test data and 2) poles with no strength test data, but only visual observations on overall condition and cross arm rot as the basis for determining condition. In 2006, pole strength test results were a factor in determining overall condition for all poles within the sample size.

Station Transformers had a 10.4% increase of assets in poor and very poor condition. This indicates that THESL should review its maintenance practices, particularly as they relate to Stations Transformers, and be prepared to have more assets in need of replacement or major refurbishment.

Underground cables had a significant increase in percentage of assets in poor and very poor condition based on the number of faults experienced over the last five and a half years: almost 75% of the system seems to be in poor or very poor condition as compared to 11% in 2006. Although it is a clear indication that drastic measures need to be taken to improve overall condition of the underground cable system, such huge increase in the percentage of assets in poor and very poor condition over a fairly short period of three years warrants a closer look at how information is being recorded and processed.

1.4 Future Refinements of the HI Formulation

This report provides recommendations on the “state of the art” HI formulation based on Kinectrics’ experience with other utilities across North America. The fundamental refinements have to do with focusing on data specifically designed to provide a more comprehensive indication of assets condition as it relates to their long-term degradation as opposed to repairable defects that are dealt with in the course of routine planned or corrective maintenance.

To properly do this, inspection forms should be modified to enable inspectors to collect not only maintenance data but also condition information, similarly to how it was done recently for the Network Assets.

1.5 Conclusions

The current status of ACA process in THESL is significantly better than at the time of the last Rate Filing:

- More refined formulas are used to derive HI.
- Higher and better granularity is achieved for circuit breakers, the SCADAMATE category is added for the overhead switches, and underground cables are on the way to have their granularity increased from circuit-km to segments.
- For most asset categories, higher percentage of assets had available condition data.
- Most of the HI calculations were consolidated in one application: the Calculator
- Concentrated efforts were made to modify Network assets inspection practices to include a collection of end-of-life condition information.

Nevertheless, improving ACA is a continuous process and recommendation on how to facilitate future improvements are presented in the Section 1.7.

1.6 Assessment of 2006 Report Recommendations

The 2006 Kinectrics Report made seven specific recommendations to THESL on improving their ACA practices. Following is an assessment of progress made for each of these recommendations:

1. Asset Condition data used in this study was collected by THESL primarily to guide maintenance decisions rather than to provide the input for Health Index calculations. Health Indices have now been formulated for all major asset classes and in the future data can be collected specifically designed to provide a more comprehensive indication of condition. Further data required for formulation of the Health Indices should be collected and recorded in a single, easily accessible database.

- Most of the ACA data are consolidated in the Calculator and ultimately condition data associated with underground cables and wood poles will be migrated there as well.
- In the meantime, HI formulations will be modified to reflect the latest industry practices and in conjunction with the THESL staff to ensure that these processes could be put in place to collect the required condition information.

2. A risk assessment should be conducted to prioritize the assets that require replacement.

- THESL introduced a risk-based approach that estimates optimal replacement time for a number of Asset Categories: Submersible, Vault and Pad-mounted transformers, Underground direct buried cable, Pad-mounted switchgear and Network transformers and protectors.
- The optimal replacement time is estimated based on the asset condition, risk of failure, consequences of failure and asset criticality, and facilitates pro-active replacement of assets with high consequence of failure cost.

3. The Health Index formulation for the asset classes for which the audit found a significantly poorer average condition needs to be re-examined and possibly reformulated.

- More assets were found in the poor and very poor condition for Station Transformers and Underground Cables. The HI for these two asset categories will be revised to focus more on the condition related information. Specifically, THESL will continue with investigating use of Partial Discharge (PD) testing as one of the condition parameters for Underground Cables HI formulation.

4. There is a need to look at some of the asset classes in considerably more granularity than was possible in this study. Considering circuit breakers, for instance, it would be reasonable to divide the 13.8 kV breaker asset class and look at the specifics of the air circuit breakers, oil circuit breakers, etc. It is very important to note that the asset classes used in this study do not represent a homogenous set of equipment. In addition to the variance in age there are variations in models, types, ratings, installations, environments, etc. All of these factors can potentially have an impact on the condition of the individual assets, the ultimate Health Indices and the estimated replacement timing.

- Granularity was significantly increased for circuit breakers and a new asset category, SCADAMATE, was added for Overhead Gang Operated Switches.
- Further granularity improvement is underway for underground cables with HI being assigned to specific segments as opposed to circuit-km.

5. There is a need to further understand the particular failure mode of assets on the THESL system in order to assure that replacement programs are truly warranted and not a result of a repairable condition. Failure investigations are required to determine true mode of failure. This is necessary to determine if the failure could have been prevented by either maintenance or earlier replacement.

- Some of this work has been done already and accounts for changes between 20006 and 2009 formulations.
- As a Pilot Project, inspection practices for Network Assets were revised to allow for collection of not only maintenance data but also condition related information during field inspection. Included in the project were updating of the inspection forms, in class training, and field training of inspectors.

6. Further study is required to gain an improved understanding of the condition information of underground cables. For example, a cable database was constructed for this project. This database should be completed to include age, length, cable type, and insulation type.

- THESL initiated field studies to assess testing accuracy of Partial Discharge (PD) testing methodology and results and their contribution to the overall HI of underground cables. The results will be included in the cable database.
- The information for directly buried XLPE cables has been collected and stored on a line segment basis and this should be extended to PILC and in-duct XLPE cables because increased granularity will improve understanding of the underground cable condition.

7. Statistics should be gathered on the age at which assets were replaced in the past and why they were replaced at that age for the purpose of more comprehensively relating equipment condition to end of life.

- The information on planned replacements and replacements following failures is being collected for some asset categories. This should continue so that it can ultimately form the basis for estimating THESL specific average life and useful life range for the assets and their components.

1.7 Recommendations for Improvements

1. The Calculator needs to continue to be modified to reflect the Kinectrics recommended formulation for HI.

2. To facilitate the implementation of Recommendation 1 above, internal data collection processes should be modified accordingly to facilitate collection of the required condition data, e.g. data collection forms should be updated and field inspection training provided to focus on getting information on asset condition as opposed to information required for making maintenance decisions. This should be extended to all asset groups, similarly to how it was done for network assets.

3. THESL should continue with collecting condition data to increase percentage of assets with available data within each asset group. Particular attention should be paid to asset categories whose percentage of assets with available condition data is less than 10% of the total population identified in Table 1-1.

4. This audit focused on the HI portion of the ACA. There is a need for a more comprehensive review for all asset categories, similar to what is being done for network assets, including:
    a. New HI distribution based on the updated formulation and the latest condition focused data set
    b. Risk Assessment
    c. Replace versus refurbish analysis

5. Comprehensive reviews should be performed at regular intervals so that several of the Asset Categories are fully audited each year.

6. Underground cable and wood pole HI formulations should be included in the Calculator to ultimately amalgamate all THESL ACA databases into one.

7. The number of wood poles tested for strength should continue to increase. It is the combination of test results and visual observations that should form the basis of wood pole condition assessment. The goal is to generate a sample size that is large enough that its Health Index distribution can be extrapolated over the entire population of wood poles.

8. There is still a need to continue gathering statistics on the age at which assets were replaced in the past and why they were replaced at that age as per Recommendation 5 of the Kinectrics 2006 Report.

2 Station Transformers

2.1 Changes in Health Index Formulation

2.1.1 *Condition Parameters and Their Weights*

The changes in condition parameters and weights for station transformers are:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Bushing Condition	1	1
2	Oil Leaks	1	1
3	Main Tank/Corrosion/Paint	1	1
4	Transformer Gaskets	1	N/A
5	Barriers	1	
6	Grounding	1	
7	Foundation/Supporting Steel	1	
8	Secondary Connections/Primary Terminations/IR Scan	2	
9	Overall Power Transformer	2	
10	DGA Oil Analysis[1]	4	4
11	Age	4	4
12	Oil Quality Test	3	3
13	Other/Unusual Conditions	N/A	2
	60% Condition Data Availability Rule[2]	Yes	Yes

Note 1: De-Rating Factor - If condition factor equals 0 (i.e. worst possible rating), the overall HI is divided by 2.

Note 2: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of Changes:

- Some of the condition parameters, namely # 4, 5, 6, 7, 8, and 9, in the 2006 report are not adopted in the 2009 Calculator. These conditions mainly address the connection, foundation, grounding and sealing.

- The 2009 Calculator includes Condition 13 Other/Unusual Conditions. This condition parameter was not used in 2006.

The other condition parameters in the 2006 ACA report are used in the 2009 Calculator and have their weights unchanged. These conditions mainly address transformer oil, insulation and age.

2.1.2 *Changes in Condition Criteria*

In the 2006 report, Moisture PPM, Interfacial Tension (IFT) and Dielectric Strength are adopted in oil quality condition rating (#12), while in the 2009 HI calculator Moisture PPM and Acidity are adopted.

Although IFT and Acidity are different in terms of measurement technique and objective, they both address the sludge formation of insulation oil. In case IFT result is unavailable, the acidity result can be used instead.

Sub-condition criteria for oil quality test

Factor F1	**Moisture PPM (T oC Corrected) Condition Criteria**	
	2006	**2009**
0	less than 20	less than 20
2	20 – 30	20 – 30
4	>30 – 40	>30 – 40
6	greater than 40	greater than 40
Factor F1	**IFT dynes/cm**	
	2006	**2009**
0	>20	N/A
1	16-20	
2	13.5-16	
4	<13.5	
Factor F1	**Dielectric Str. kV**	
	2006	**2009**
0	>50	N/A
1	>40 – 50	
2	30 - 40	
4	less than 30	
Factor F1	**Acidity**	
	2006	**2009**
0	N/A	acidnum < 0.15
2		0.15 <= acidnum <= 0.30
4		acidnum > 0.3

2.2 Changes in Granularities

No change in terms of granularities.

2.3 Changes in Condition Data Availability

Figure 2-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 2-2 presents the information by percentage. As shown, the total population decreased by 12. This was expected, because of decommissioning of specific 4 kV stations. The sample size decreased significantly by 75 units, or 22.7%.

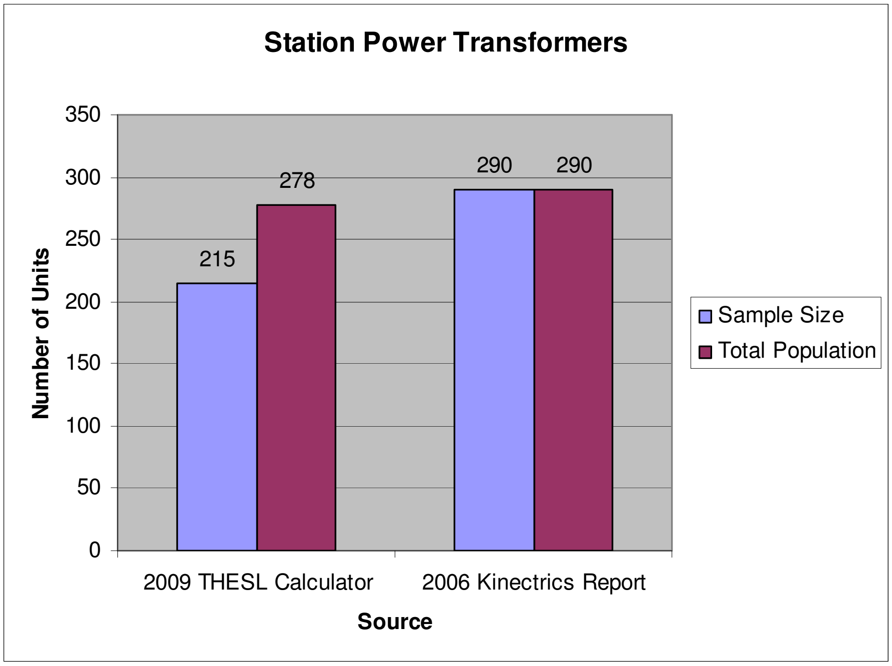


Figure 2-1 Station Transformer Sample Size and Population Comparison

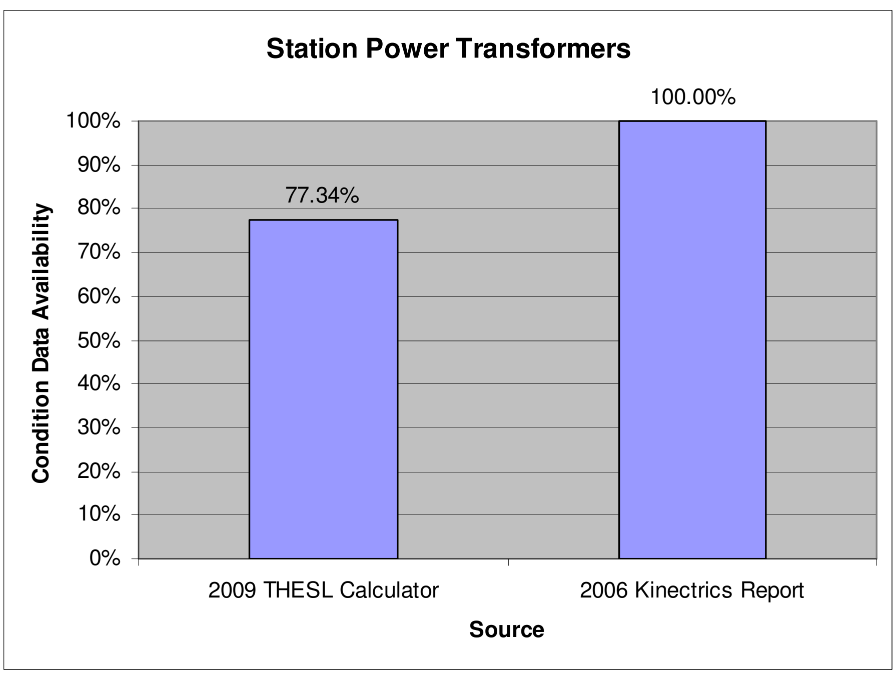


Figure 2-2 Station Transformers Condition Data Availability Comparison

2.4 Changes in Health Index Classification

Figure 2-3 and Figure 2-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 21.4% were in poor and very poor conditions, an increase of 10.4% from 2006.

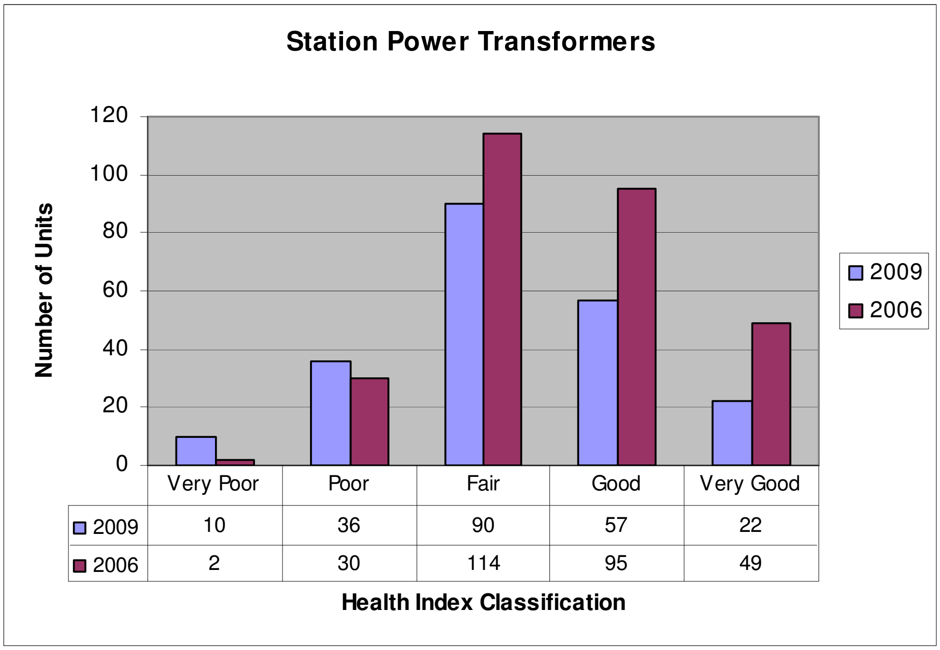


Figure 2-3 Station Power Transformers Health Index Comparison by Units

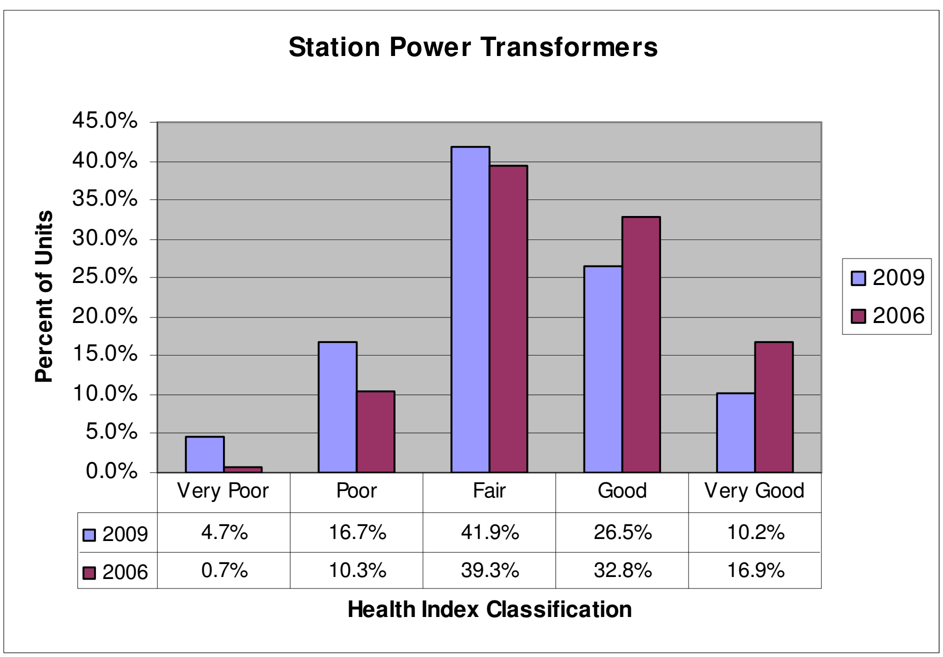


Figure 2-4 Station Power Transformers Health Index Comparison by % of Sample Size

2.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{4} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{4} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF}_n \times \mathrm{WCPF}_n)}{\sum_{n=1} \beta_n (\mathrm{CPF}_{n.\max} \times \mathrm{WCPF}_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 2-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Insulation	6	4
2	Cooling	2	4
3	Sealing & connection	3	4
4	Reliability	3	4

Table 2-2 Insulation (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil quality	8	4
2	Oil DGA	10	4
3	Winding Doble	10	4

Table 2-3 Cooling (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Temperature	10	4

Table 2-4 Sealing & Connection (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Tank oil leak	2	4
2	Conservator oil level	2	4
3	Grounding	1	4
4	IR thermography	10	4

Table 2-5 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Loading	10	4
2	Age	6	4

3 Circuit Breaker

3.1 Changes in Health Index Formulation

3.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and their weights for circuit breakers are listed as follows:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Breaker Contact Resistance	2	3
2	Breaker Trip/Close Time Test	3	3
3	Breaker Interlock/ Drive Rods	3	3
4	Age	4	3
5	Average score for others		2
	60% Condition Data Availability Rule[1]	No	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of changes:

- One new condition parameter (#5, average score for others) is added in 2009 Calculator.
- Two condition parameters (#1 and # 4) have their weights changed: weight increased from 2 to 3 for breaker contact resistance, weight decreased from 4 to 3 for breaker age.
- The 60% Condition Data Availability Rule was not employed in 2006.

3.1.2 *Changes in Condition Criteria*

No change is made on condition criteria.

Conditions # 5 is based on the average of all other qualitative ratings from THESL.

3.2 Changes in Granularities

Compared to the 2006 ACA report, in the 2009 Calculator circuit breakers are sub-categorized into 5 types: air blast, oil, SF6, vacuum and air magnetic. However their HI formulations are the same in terms of condition parameters and weights.

3.3 Changes in Condition Data Availability

Figure 3-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 3-2 presents the information by percentage. The total population decreased by 88 units. This was expected because specific 4 kV stations were decommissioned. In addition, the sample size increased by 442 units, representing a condition data availability increase of 21.66%.

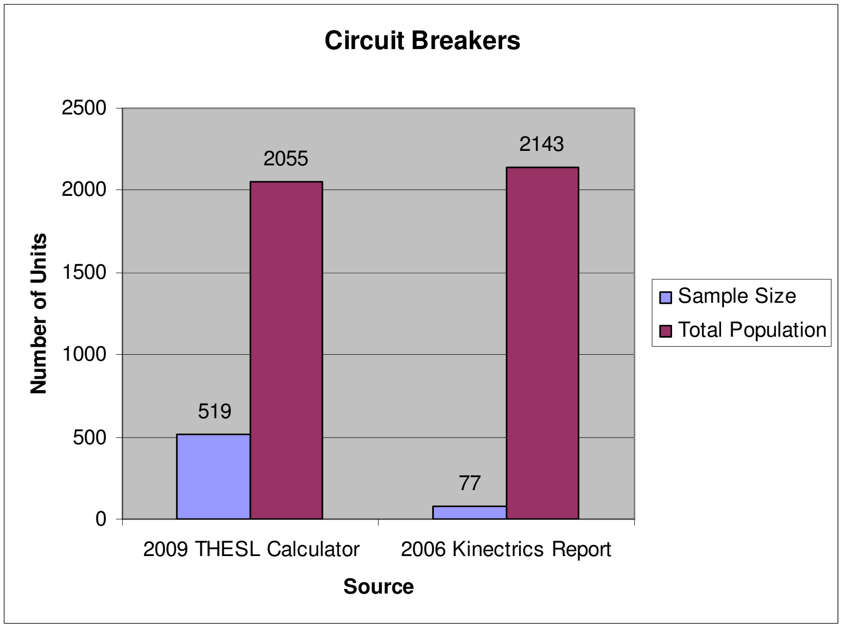


Figure 3-1 Circuit Breakers Sample Size and Population Comparison

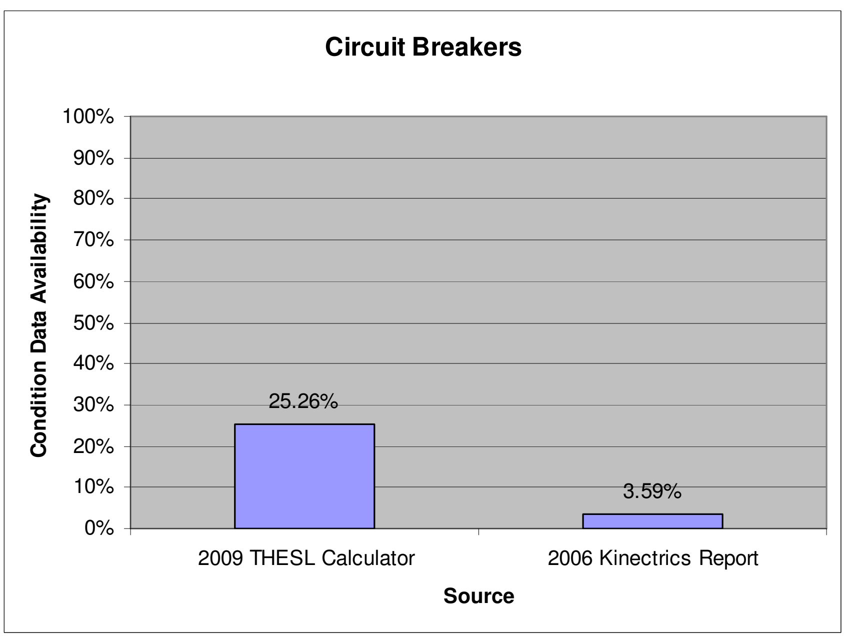
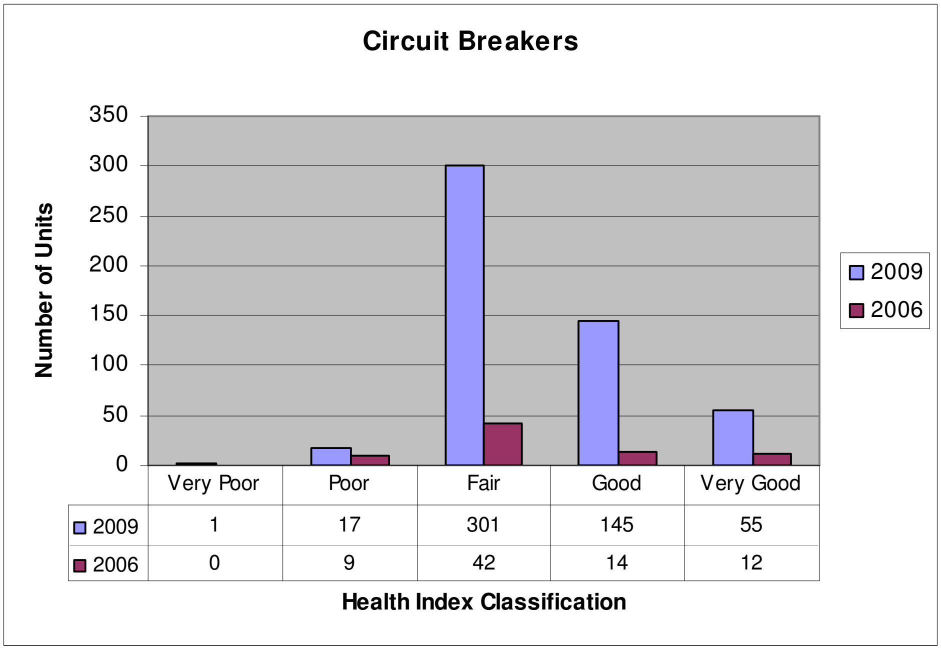


Figure 3-2 Circuit Breakers Condition Data Availability Comparison

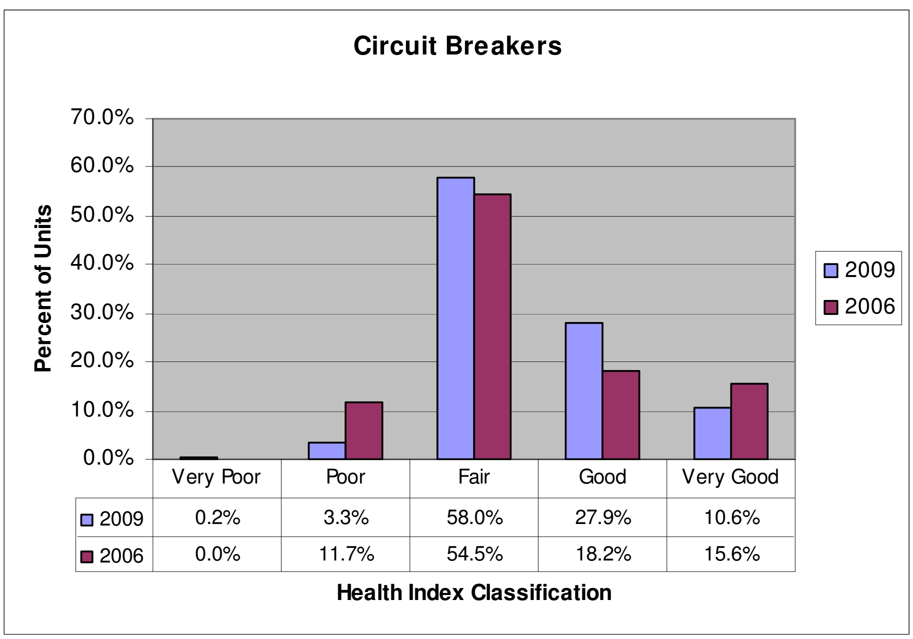
3.4 Changes in Health Index Classification

Figure 3-3 and Figure 3-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 3.47% were in poor and very poor conditions, a decrease of 8.2% from 2006. Note that although a Health Index distribution by percentage for 2006 is shown below, an extrapolation over the entire population was not provided in the 2006 Kinectrics Report, as the sample size was insufficiently random over different types of circuit breakers.



	Very Poor	Poor	Fair	Good	Very Good
2009	1	17	301	145	55
2006	0	9	42	14	12

Figure 3-3 Circuit Breakers Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.2%	3.3%	58.0%	27.9%	10.6%
2006	0.0%	11.7%	54.5%	18.2%	15.6%

Figure 3-4 Circuit Breakers Health Index Comparison by % of Sample Size

3.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 3-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m					$CPS_{m.max}$
		Oil	Air-blast	Air-magnet	Vacuum	SF6	
1	Operating mechanism	14	14	14	7	11	4
2	Contact performance	7	7	7	7	7	4
3	Arc extinction	9	5	5	2	5	4
4	Insulation	2	2	2	2	2	4
5	Reliability	5	5	5	5	5	4

Table 3-2 Operating Mechanism (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$					$CPF_{n.max}$
		Oil	Air-blast	Air-magnet	Vacuum	SF6	
1	Lubrication	9	9	9	5	7	4
2	Linkage	5	5	5	2	4	4
3	Cabinet	2	1	1	1	1	4

Table 3-3 Contact Performance (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$					$CPF_{n.max}$
		Oil	Air-blast	Air-magnet	Vacuum	SF6	
1	Closing time	3	3	3	3	3	4
2	Closing velocity	3	3	3	3	3	4
3	Overtravel	1	1	1	1	1	4
4	Trip time	1	1	1	1	1	4
5	Trip velocity	1	1	1	1	1	4
6	Trip-free time	1	1	1	1	1	4
7	Contact R	1	1	1	1	1	4
8	Arcing contact	1	1			1	4

Table 3-4 Arc Extinction (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$					$CPF_{n.max}$
		Oil	Air-blast	Air-magnet	Vacuum	SF6	
1	Moisture	8	4			4	4
2	Leakage	1	1			1	4
3	Tank	2	2		2	2	4
4	Pressure		1			1	4
5	Dewpoint		4			4	4
6	Oil level	1					4
7	Oil quality	8					4
8	Arc chute			1			4

Table 3-5 Insulation (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1*	Power factor	2	4
	Insulation	2	4

* Insulation is adopted only when power factor data are not available.

Table 3-6 Reliability (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$					$CPF_{n.max}$
		Oil	Air-blast	Air-magnet	Vacuum	SF6	
1	Operating counter	2	2	2	7	2	4
2	Loading	2	2	2	2	2	4
3	Age	1	1	1	1	1	4

4 Switchgear

4.1 Changes in Health Index Formulation

4.1.1 Changes in Condition Parameters and Their Weights

The changes in condition parameters and weights for switchgear are listed as follows:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Breakers (Normalized HI Score for all)	70%	N/A
2	Switches (Normalized HI Score for all)	10%	
3	Overall Assembly and Buses HI	20%	
4	Dirt/Debris/Contamination	N/A	1
5	Age		4
6	Connections/Terminations		1
7	IR Scan		3
	60% Condition Data Availability Rule[1]	N/A	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of changes:

- Due to a lack of data, Health Indexing was not available for this asset in 2006. A HI formulation was, however, proposed based on the normalized HI scores of different components (breaker + switch + assembly) in the switchgear. In the 2009 formulation, only the switchgear assembly and the associated connection are addressed.

4.1.2 *Changes in Condition Criteria*

The following condition criteria apply to the new condition parameters:

Condition Factor	Condition Criteria			
	Dirt/Debris/Contamination (THESL Condition Rating)	Age	Connections/Terminations (THESL Condition Rating)	IR Scan (THESL Condition Rating)
4	1	<20	1	IR_HTSPOT=1 *
3	2	20-30	2	N/A
2	3	30-40	3	
1	4	40-50	4	
0	5	>50	5	IR_HTSPOT=2 *

IR_HTSPOT is a yes/no value, hence THESL Condition Rating = 1 or 2

4.2 Changes in Granularities

No change in terms of granularities.

4.3 Changes in Condition Data Availability

Figure 4-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 4-2 presents the information by percentage. The total population decreased by 18 units. This was expected because specific 4 kV stations were decommissioned. The sample size for 2009, however, was only 7 units or 2.65% of the population. No sample size was available in 2006.

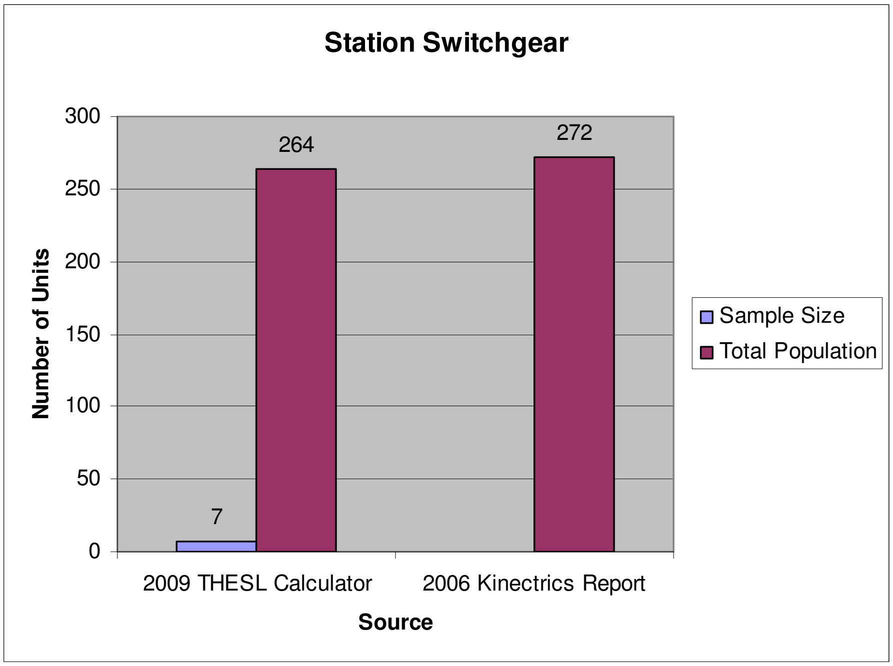


Figure 4-1 Station Switchgear Sample Size and Population Comparison

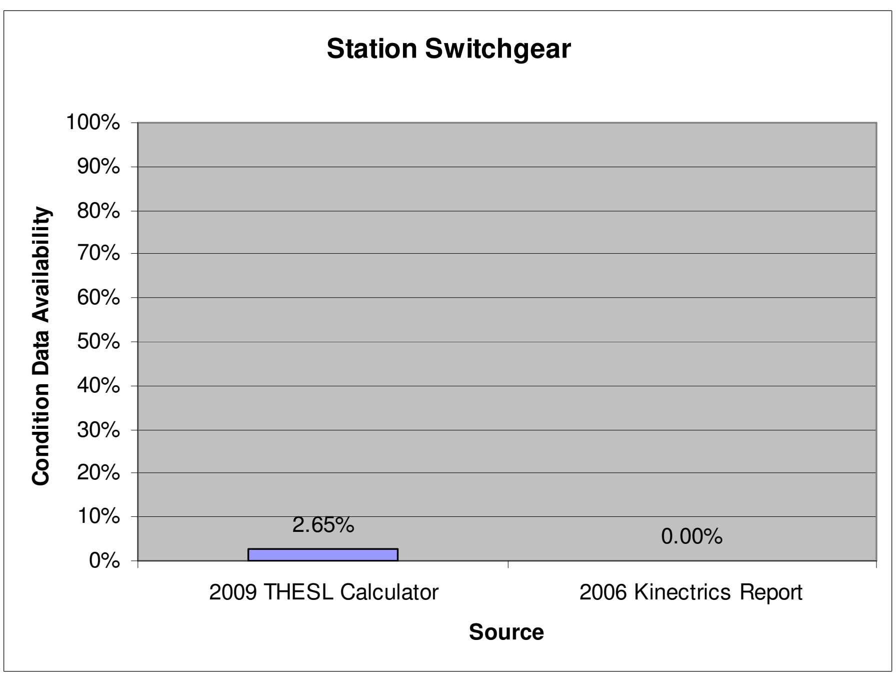


Figure 4-2 Station Switchgear Health Index Data Availability Comparison

4.4 Changes in Health Index Classification

Figure 4-3 and Figure 4-4 show the Health Index classification breakdown of the assets within the sample size. There were 5 units in poor and very poor conditions in 2009. This is 71.43% of the sample size. No Health Index classification was available for 2006.

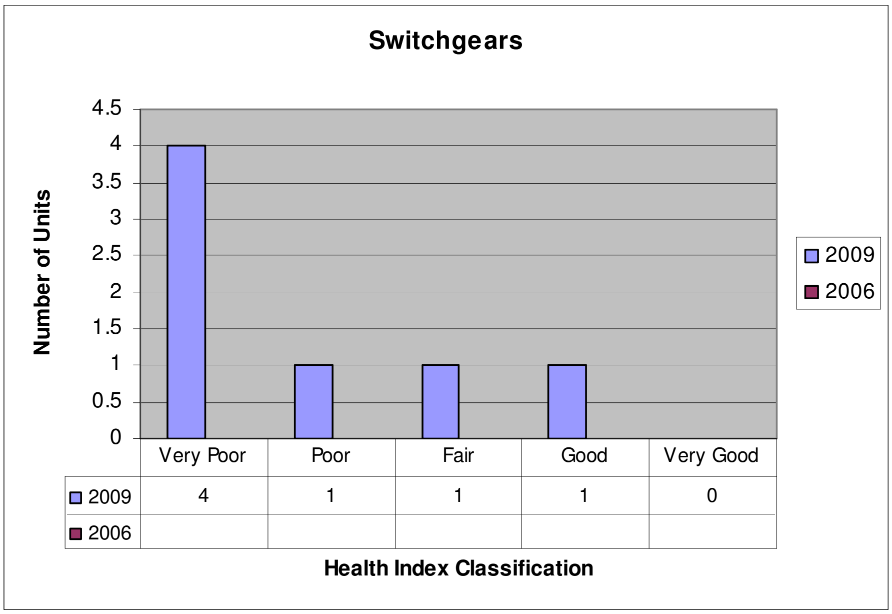


Figure 4-3 Station Switchgear Health Index Comparison by Units

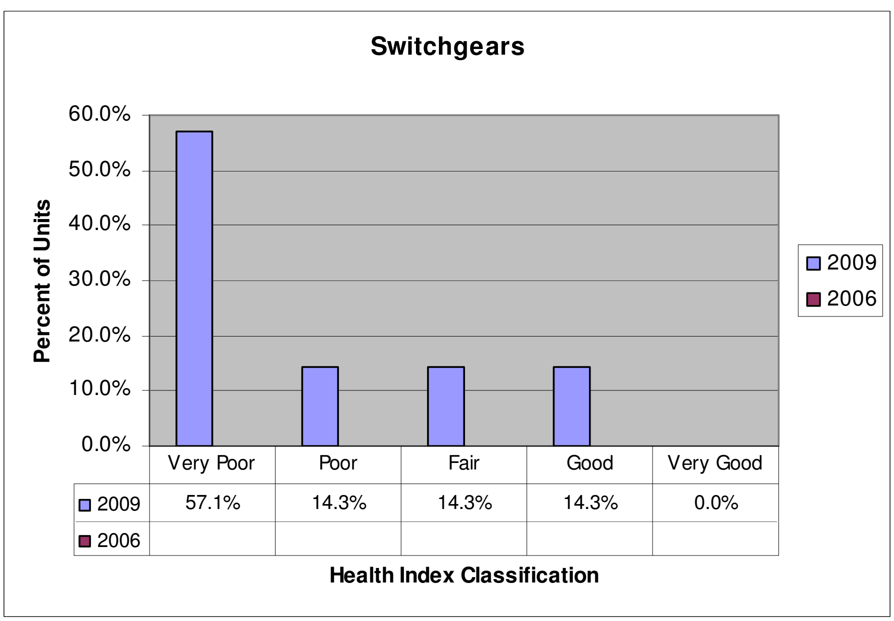


Figure 4-4 Station Switchgear Health Index Comparison by % of Sample Size

4.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{6} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{6} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF}_n \times \mathrm{WCPF}_n)}{\sum_{n=1} \beta_n (\mathrm{CPF}_{n.\max} \times \mathrm{WCPF}_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 4-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	2	4
2	Breaker/switch condition	5	4
3	Cooling	4	4
4	Insulation	7	4
5	Control	2	4
6	Reliability	2	4

Table 4-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Contamination	1	4
2	Mechanical locks	2	4
3	Assembly	3	4
4	Cable connection	3	4

Table 4-3 Breaker/switch Condition (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Breaker	2	4
2	Switch	1	4

Table 4-4 Cooling (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Temperature	1	4
2	IR scan	2	4

Table 4-5 Insulation (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Bushing	2	4
2	Air/gas insulation	3	4
3	Busbar insulation	2	4

Table 4-6 Control (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Control circuitry	1	4
2	Relays	2	4

Table 4-7 Reliability (m=6) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Overall	2	4
2	Age	1	4

5 Submersible Transformers

5.1 Changes in Health Index Formulation

5.1.1 *Changes in Condition Parameters and Their Weights*

There is no change in terms of condition parameters and weights.

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Bushing/Insulator Condition	1	1
2	Oil Leaks	2 (3)	2
3	Corrosion/Paint	1 (3)	1
4	Transformer Lid Gaskets	1 (3)	1
5	Grounding	1	1
6	Secondary Connections/Elbow Connectors	1	1
7	Barriers	1	1
8	Age	3	3
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Note 2: Weights in brackets are suggested future revisions.

In the 2006 report Kinectrics proposed changes on some of the condition parameters (#2, 3, 4, which address the sealing and external condition of oil tank). The proposed changes were not adopted in the 2009 Calculator.

5.1.2 *Changes in Condition Criteria*

The following change is made on the condition criteria of Secondary Connections/ Elbow Connections:

<table>
<tr><td rowspan="2">Condition factor</td><td colspan="4">Condition Criteria for Secondary Connections/Elbow Connections</td></tr>
<tr><td colspan="2">2006</td><td colspan="2">2009</td></tr>
<tr><td>4</td><td>Max(A,B)=1</td><td rowspan="5">A = SEC_CONN
B = IR_ELBCON</td><td>Max(A,B)=1</td><td rowspan="5">A = SEC_CONN
if IR_HTSPOT = 2 then B = 5
elseif IR_HTSPOT = 1 then B = 1
else B = 0;</td></tr>
<tr><td>3</td><td>Max(A,B)=2</td><td>Max(A,B)=2</td></tr>
<tr><td>2</td><td>Max(A,B)=3</td><td>Max(A,B)=3</td></tr>
<tr><td>1</td><td>Max(A,B)=4</td><td>Max(A,B)=4</td></tr>
<tr><td>0</td><td>Max(A,B)=5</td><td>Max(A,B)=5</td></tr>
</table>

SEC_CONN, IR_ELBCON, IR_HTSPOT are THESL ratings

In the 2006 report, IR_ELBCON (IR result on elbow connection) were ranked from 1 to 5, while in the 2009 calculator, IR_HTSPOT (IR result on hot spot) were ranked either 1 or 5 (no intermediate status).

5.2 Changes in Granularities

There is no change in terms of granularities.

5.3 Changes in Condition Data Availability

Figure 5-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 5-2 presents the information by percentage. The total population decreased by 60 units. This decline was expected as smaller, obsolete 50 kVA units were removed from service. The sample size increased significantly by 3940 assets. This represents a 48.10% increase in condition data availability.

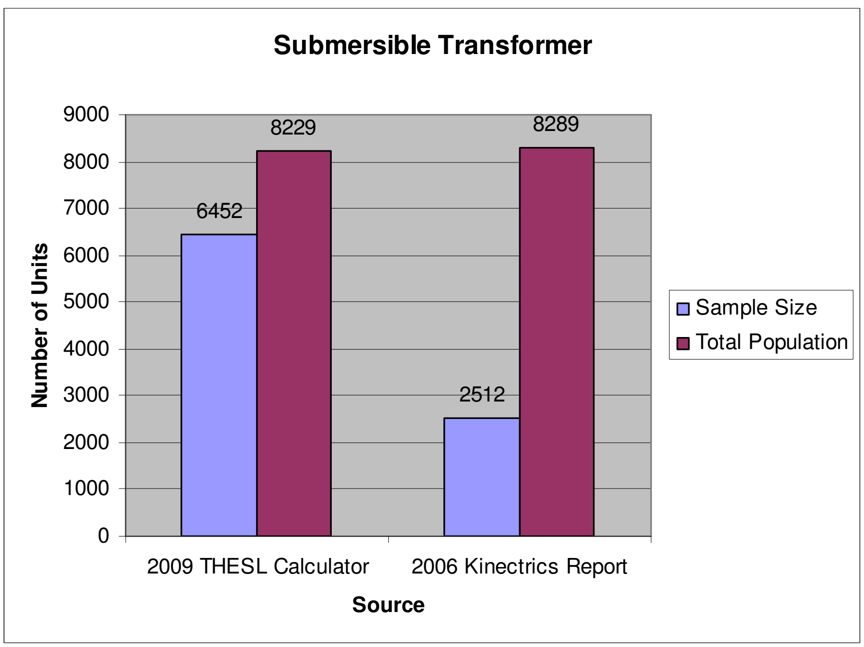


Figure 5-1 Submersible Transformer Sample Size and Population Comparison

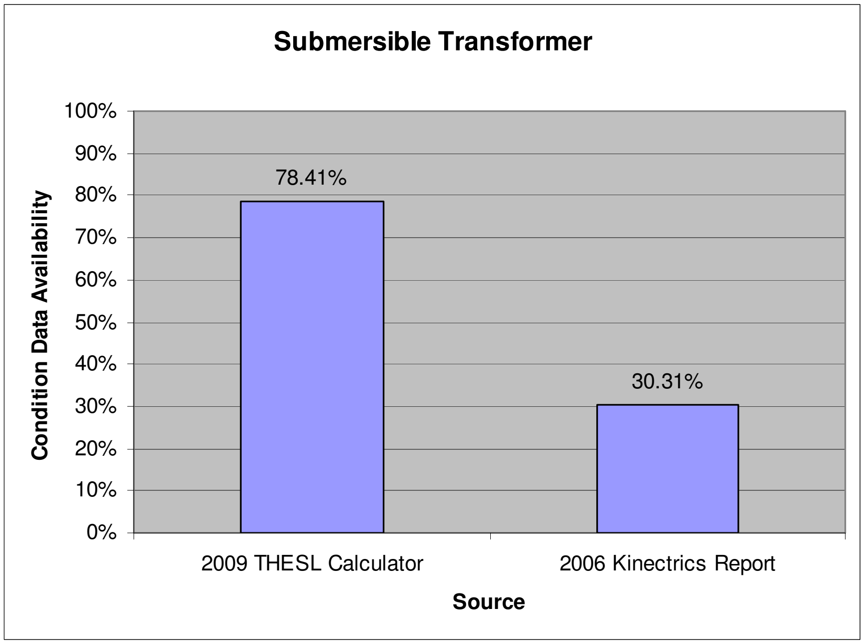


Figure 5-2 Submersible Transformer Condition Data Availability Comparison

5.4 Changes in Health Index Classification

Figure 5-3 and Figure 5-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 0.03% were in poor or very poor condition, a decrease of 0.01%.

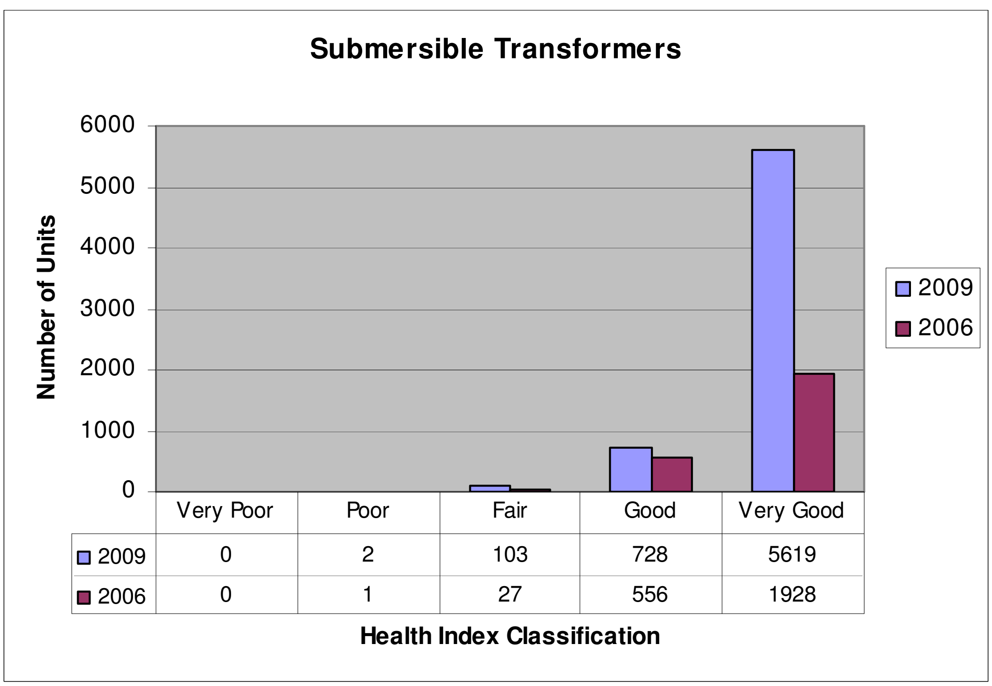
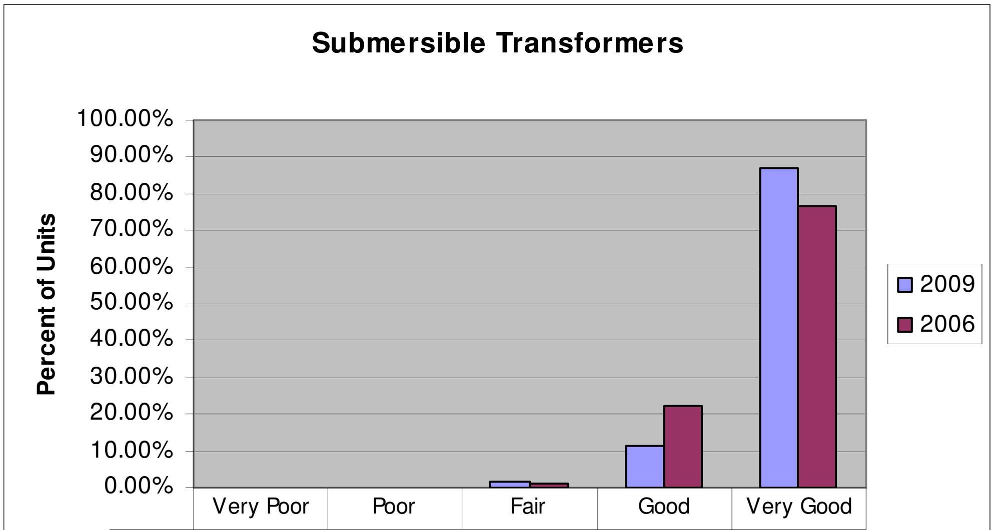


Figure 5-3 Submersible Transformer Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.00%	0.03%	1.60%	11.28%	87.09%
2006	0.00%	0.04%	1.07%	22.13%	76.75%

Figure 5-4 Submersible Transformer Health Index Comparison by % of Sample Size

5.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{4} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{4} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF}_n \times \mathrm{WCPF}_n)}{\sum_{n=1} \beta_n (\mathrm{CPF}_{n.\max} \times \mathrm{WCPF}_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 5-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	7	4
2	Cooling	5	4
3	Environment	5	4
4	Reliability	5	4

Table 5-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Corrosion	3	4
2	Access	1	4

Table 5-3 Cooling (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil leak	1	4

Table 5-4 Environment (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	PCB	1	4

Table 5-5 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	overall	2	4
2	age	1	4

6 Network Transformers

6.1 Changes in Health Index Formulation

6.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and weights for network transformers are:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Bushing/Insulator Condition	1	1
2	Oil Leaks	2 (4)	2
3	Corrosion/Paint	1 (2)	1
4	Transformer Lid Gaskets	1	1
5	Dirt/Debris/Contamination	1	1
6	Pothead Termination	1	1
7	Overall Condition/Other	2	2
8	Switch Unit	2 (3)	2
9	Age	3 (4)	3
10	Location	0 (4)	N/A
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Note 2: Weights in brackets are suggested future revisions.

Summary of changes:

- Condition parameter #10 (location) was not used in 2009
- All the other condition parameters remain in the 2009 Calculator with their weights unchanged.

In the 2006 report Kinectrics proposed changes on some of the condition parameters (#2, 3, 8, 9, 10). Those proposed changes were not adopted in the 2009 Calculator.

6.1.2 *Changes in Condition Criteria*

There is no change in terms of condition criteria.

6.2 Changes in Granularities

There is no change in terms of granularities.

6.3 Changes in Condition Data Availability

Figure 6-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 6-2 presents the information by percentage. The total population decreased by 73 units. This expected decline was a result of spot network removal and conversion of existing network customers to 13.8 kV radial. The sample size decreased by 26, however this is condition data availability increase of 2.19%.

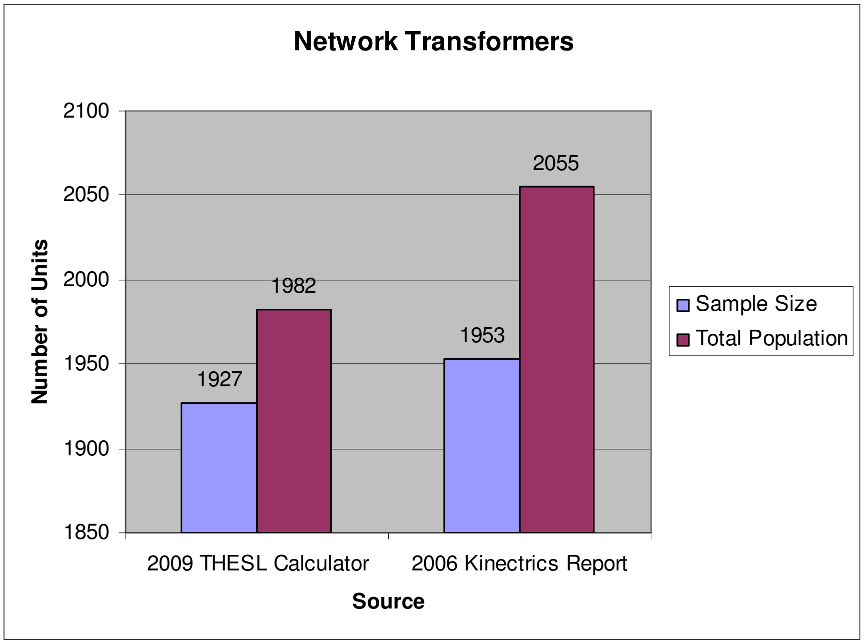


Figure 6-1 Network Transformer Sample Size and Population Comparison

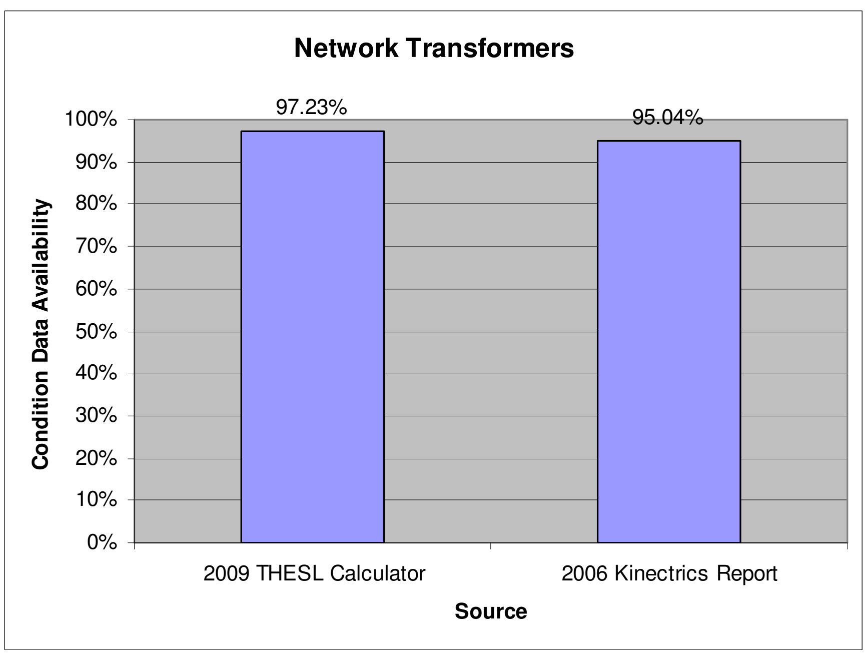
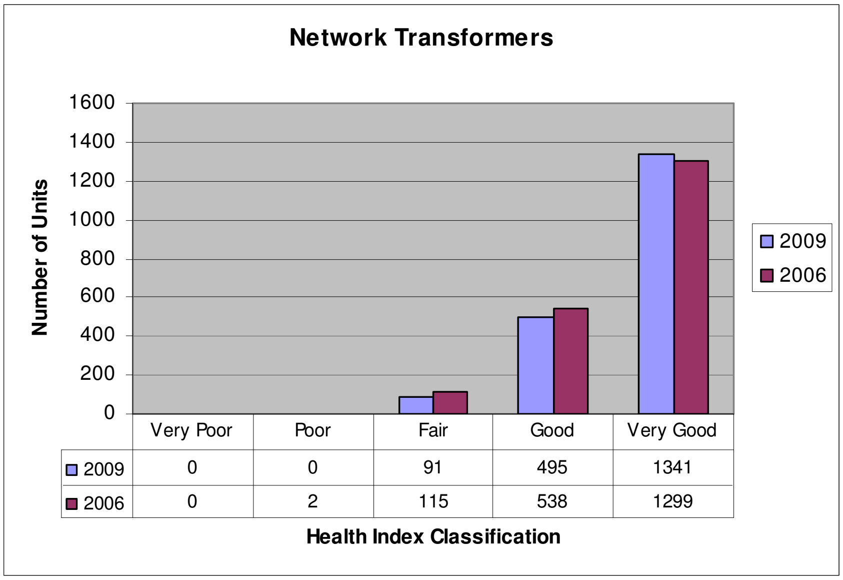


Figure 6-2 Network Transformer Condition Data Availability Comparison

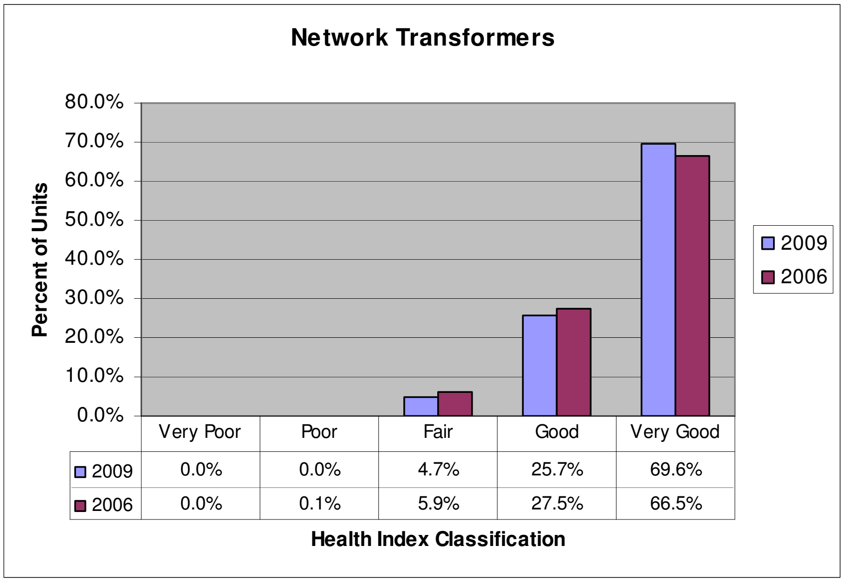
6.4 Changes in Health Index Classification

Figure 6-3 and Figure 6-4 show the Health Index classification breakdown of the assets within the sample size. There were no units in poor and very poor conditions in 2009, a decrease of 0.1% from 2006.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	91	495	1341
2006	0	2	115	538	1299

Figure 6-3 Network Transformer Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.0%	4.7%	25.7%	69.6%
2006	0.0%	0.1%	5.9%	27.5%	66.5%

Figure 6-4 Network Transformer Health Index Comparison by % of Sample Size

6.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 6-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Insulation	6	4
2	Cooling	2	4
3	Sealing & connection	3	4
4	Reliability	3	4
5	Other condition	1	4

Table 6-2 Insulation (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil quality	8	4
2	Oil DGA	10	4
3	Winding Doble	10	4
4	Bushing	5	4

Table 6-3 Cooling (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil temperature	1	4

Table 6-4 Sealing & Connection (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Tank oil leak	2	4
2	Conservator oil level	2	4
3	Grounding	1	4
4	Pothead termination	3	4
5	Gasket fitting	2	4
6	Corrosion/paint	1	4
7	Oil leak- switch	2	4

Table 6-5 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Loading	5	4
2	Age	3	4

Table 6-6 Other Condition (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Dirt/Debris	1	4
2	Switch unit	3	4

7 Padmounted Transformers

7.1 Changes in Health Index Formulation

7.1.1 *Changes in Condition Parameters and Their Weights*

There is no change in condition parameters for padmounted transformers.

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Bushing/Insulator Condition	2	2
2	Oil Leaks	1	1
3	Corrosion/Paint	2	2
4	Transformer Gaskets	2	2
5	Barriers	1	1
6	Grounding	1	1
7	Concrete Base	2	2
8	Secondary Connections/Primary Terminations/IR scan	2	2
9	Latches/Handles/Locks/Door	1	1
10	Age	3	3
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

7.1.2 *Changes in Condition Criteria*

The following change is made on condition criteria of Secondary Connections/Primary Terminations/IR scan:

<table>
<tr><th rowspan="2">Condition factor</th><th colspan="4">Condition Criteria for Secondary Connections/Primary Terminations/IR scan</th></tr>
<tr><th colspan="2">2006</th><th colspan="2">2009</th></tr>
<tr><td>4</td><td>Max(A,B,C)=1</td><td rowspan="5">A = SEC_CONN

B = PRI_TERM

C = IR_ELBCON</td><td>Max(A,B,C)=1</td><td rowspan="5">A = SEC_CONN

B = PRI_TERM

if IR_HTSPOT = 2 then C = 5
elseif IR_HTSPOT = 1 then C = 1
else C = 0;</td></tr>
<tr><td>3</td><td>Max(A,B,C)=2</td><td>Max(A,B,C)=2</td></tr>
<tr><td>2</td><td>Max(A,B,C)=3</td><td>Max(A,B,C)=3</td></tr>
<tr><td>1</td><td>Max(A,B,C)=4</td><td>Max(A,B,C)=4</td></tr>
<tr><td>0</td><td>Max(A,B,C)=5</td><td>Max(A,B,C)=5</td></tr>
</table>

SEC_CONN, PRI_TERM, IR_ELBCON, IR_HTSPOT are THESL ratings

In the 2006 report, IR_ELBCON (IR result on elbow connection) is ranked from 1 to 5, while in the 2009 calculator, IR_HTSPOT (IR result on hot spot) is ranked either 1 or 5 (no intermediate status).

7.2 Changes in Granularities

There is no change in terms of granularities.

7.3 Changes in Condition Data Availability

Figure 7-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 7-2 presents the information by percentage. Due to new customer connections, the total population increased by 947 units between 2006 and 2009. With 2607 more assets in the sample size, there was also a 34.95% improvement in condition data availability.

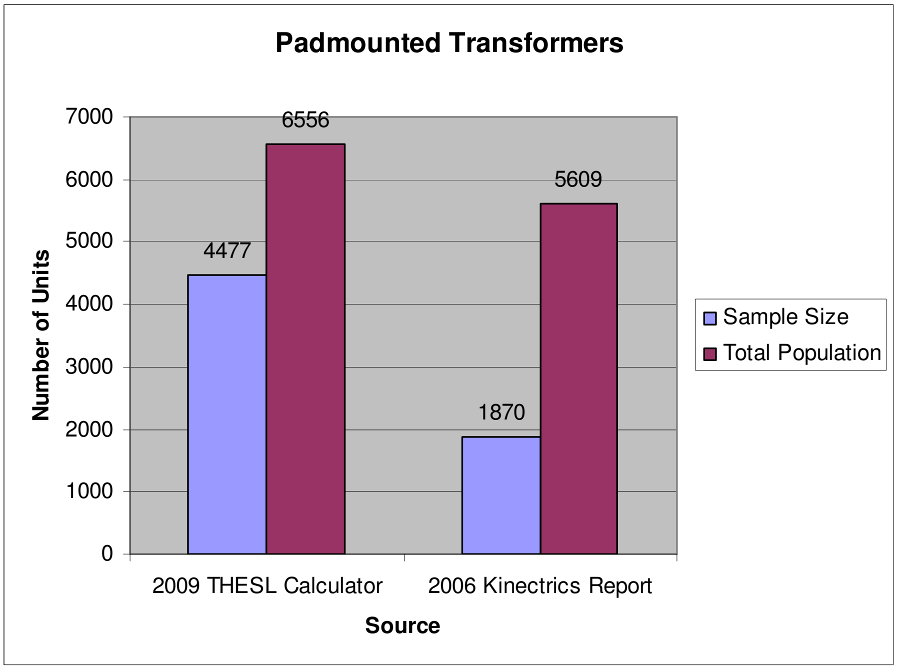


Figure 7-1 Padmounted Transformer Sample Size and Population Comparison

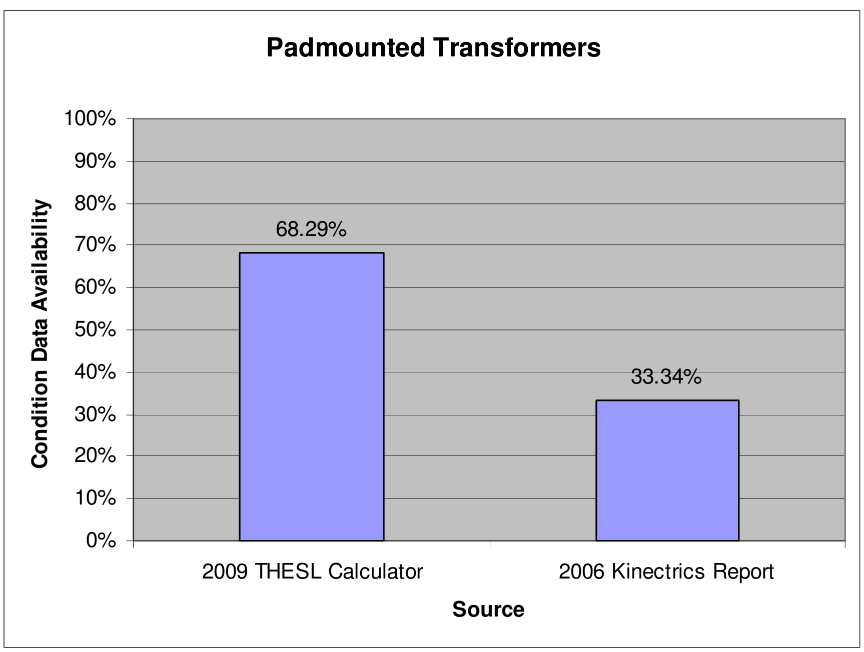
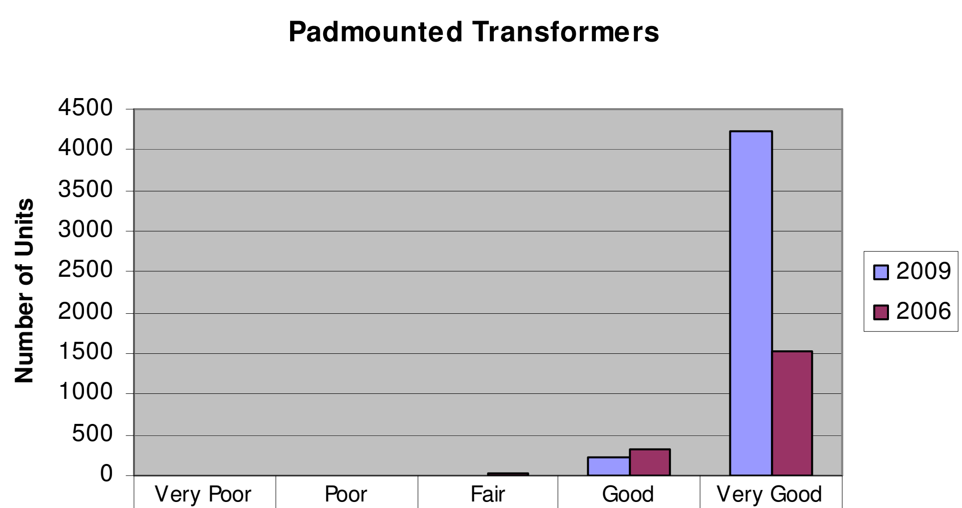


Figure 7-2 Padmounted Transformer Condition Data Availability Comparison

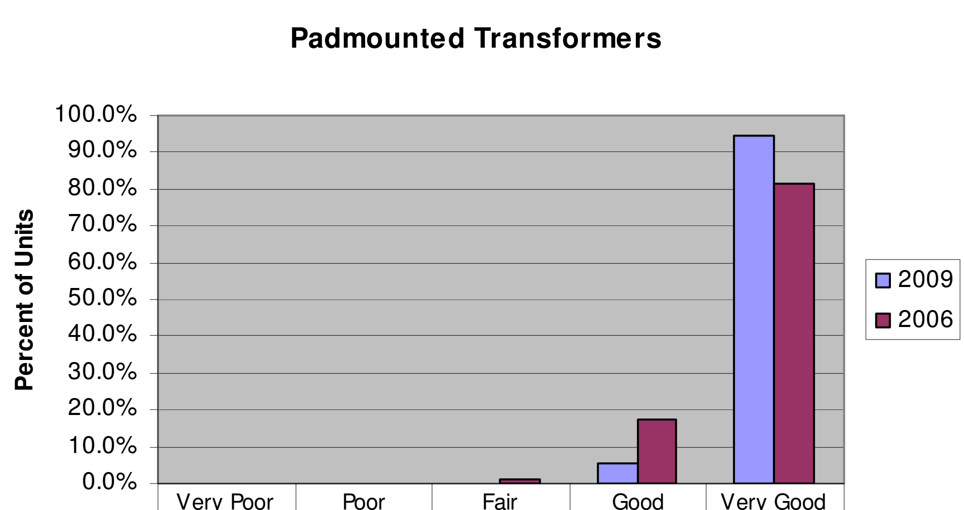
7.4 Changes in Health Index Classification

Figure 7-3 and Figure 7-4 show the Health Index classification breakdown of the assets within the sample size. There were no assets in poor and very poor conditions in 2009, a decrease of 0.1% unit from 2006.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	7	232	4238
2006	0	1	18	327	1524

Figure 7-3 Padmounted Transformer Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.0%	0.2%	5.2%	94.7%
2006	0.0%	0.1%	1.0%	17.5%	81.5%

Figure 7-4 Padmounted Transformer Health Index Comparison by % of Sample Size

7.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{4} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{4} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF_n} \times \mathrm{WCPF_n})}{\sum_{n=1} \beta_n (\mathrm{CPF_{n.max}} \times \mathrm{WCPF_n})} \times 4$$

m = Condition parameter m

n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 7-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	3	4
2	Cooling	5	4
3	Environment	5	4
4	Reliability	5	4

Table 7-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Corrosion	3	4
2	Access	1	4
3	Base	2	4

Table 7-3 Cooling (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil leak	1	4
2	IR scan	2	4

Table 7-4 Environment (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	PCB	1	4

Table 7-5 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Overall	2	4
2	Age	1	4

8 Vault Transformers

8.1 Changes in Health Index Formulation

8.1.1 *Changes in Condition Parameters and Their Weights*

There were no changes in Health Index formulation.

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Bushing/Insulator Condition	1	1
2	Oil Leaks	2	2
3	Corrosion/Paint	1	1
4	Transformer Gaskets	1	1
5	Grounding	1	1
6	Secondary Connections/IR Scan	1	1
7	Barriers	1	1
8	Age	3	3
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

8.1.2 *Changes in Condition Criteria*

The changes in condition criteria are as follows:

Condition factor	Condition Criteria for Secondary Connections/Elbow Connections			
	2006		2009	
4	Max(A,B)=1	A = SEC_CONN B = IR_ELBCON	Max(A,B)=1	A = SEC_CONN if IR_HTSPOT = 2 then B = 5 elseif IR_HTSPOT = 1 then B = 1 else B = 0;
3	Max(A,B)=2		Max(A,B)=1	
2	Max(A,B)=3		Max(A,B)=3	
1	Max(A,B)=4		Max(A,B)=4	
0	Max(A,B)=5		Max(A,B)=5	

SEC_CONN, IR_ELBCON, IR_HTSPOT are THESL ratings

8.2 Changes in Granularities

There is no change in terms of granularities.

8.3 Changes in Condition Data Availability

Figure 8-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 8-2 presents the information by percentage. Due to new customer connections, the total population increased by 391 units. The sample size increased by 2802 assets, or 20.5%.

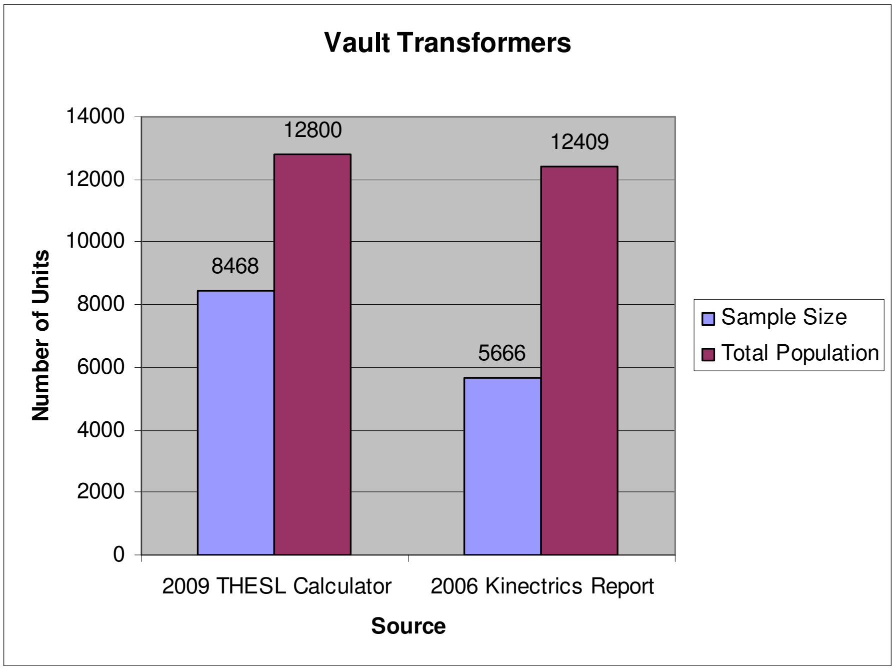


Figure 8-1 Vault Transformer Sample Size and Population Comparison

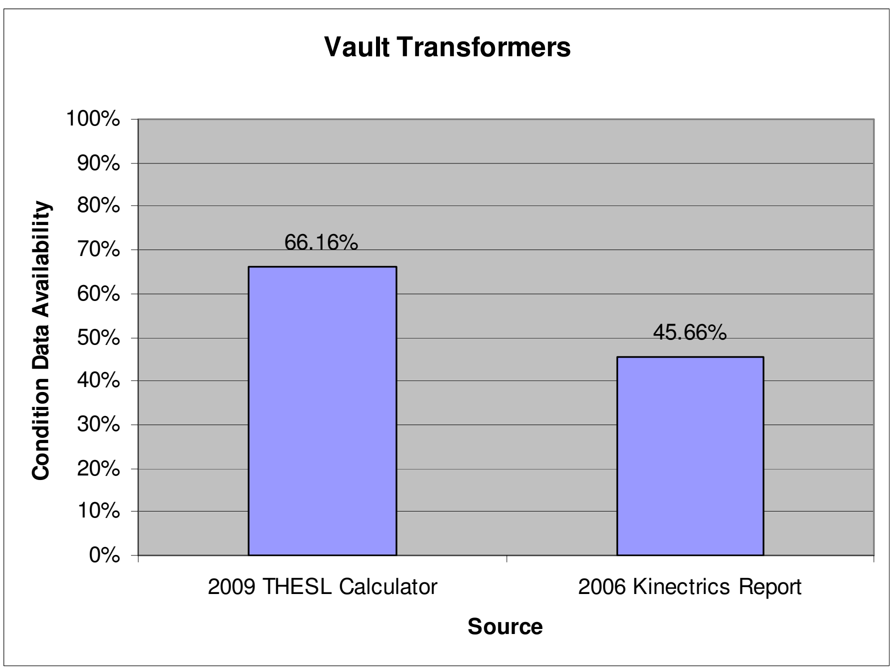
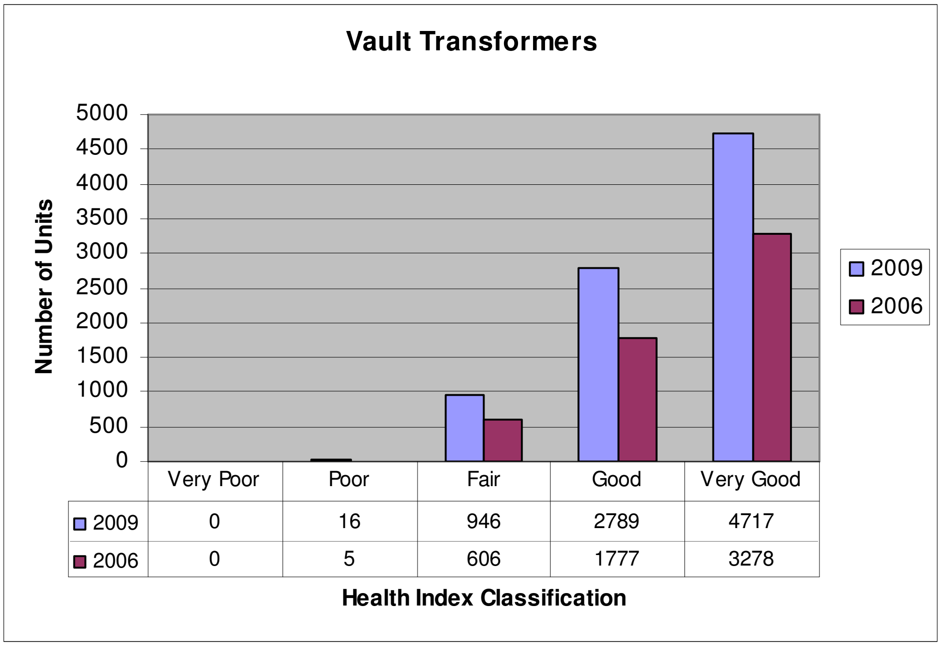


Figure 8-2 Vault Transformer Condition Data Availability Comparison

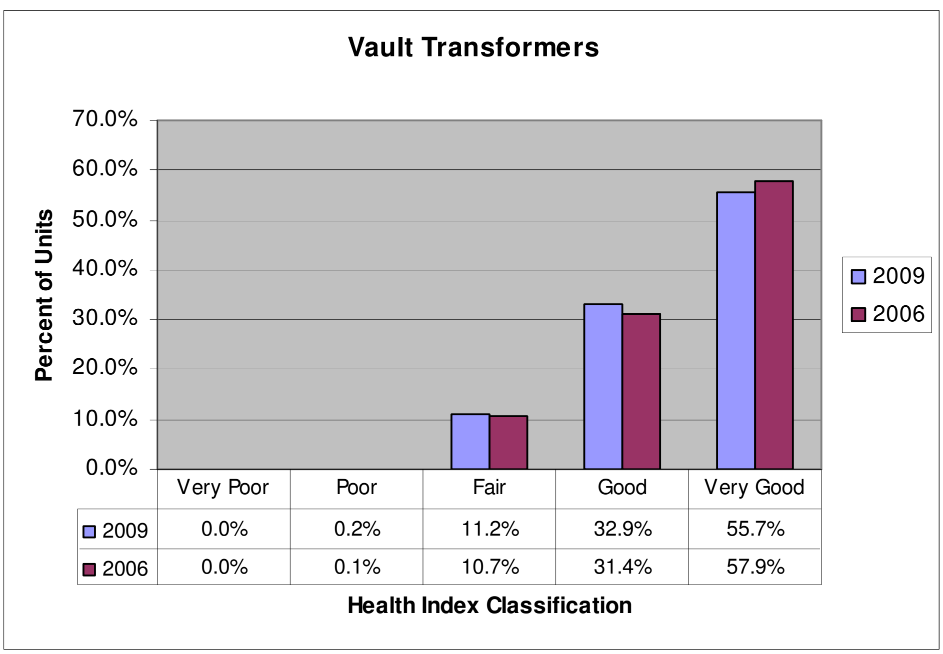
8.4 Changes in Health Index Classification

Figure 8-3 and Figure 8-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 0.19% were in poor or very poor condition, an increase of 0.1%.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	16	946	2789	4717
2006	0	5	606	1777	3278

Figure 8-3 Vault Transformer Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.2%	11.2%	32.9%	55.7%
2006	0.0%	0.1%	10.7%	31.4%	57.9%

Figure 8-4 Vault Transformer Health Index Comparison by % of Sample Size

8.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{4} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{4} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF}_n \times \mathrm{WCPF}_n)}{\sum_{n=1} \beta_n (\mathrm{CPF}_{n.\max} \times \mathrm{WCPF}_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 8-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	7	4
2	Cooling	5	4
3	Environment	5	4
4	Reliability	5	4

Table 8-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Corrosion	3	4
2	Access	1	4
3	Housekeeping	5	4

Table 8-3 Cooling (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil leak	1	4
2	IR scan	2	4

Table 8-4 Environment (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	PCB	1	4

Table 8-5 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	overall	2	4
2	age	1	4

9 Wood Poles

9.1 Changes in Health Index Formulation

9.1.1 *Changes in Condition Parameters and Their Weights*

Due to the fact that wood pole inspection data has not been migrated into Ellipse since 2006, THESL conducted a manual analysis of the 2007/2008 pole inspection data. The calculations are found on "Pole Data Analysis HIUPDATED-Jul142009.xlsx".

The differences found between the 2006 and 2009 are outlined below:

#	Condition Parameters	Weight	
		2006 Report	2009 THESL Pole Data Analysis HI Spreadsheet
1	Overall Condition	3	3
2	Wood Pole Strength	5	5 (if available) 0 (if unavailable)
3	Cross Arm Rot	2	2
4	Cracks	Note 2	Note 2
5	Wood Pecker/ Carpenter Ant Damage		
6	Surface Rot At/Below/Above Ground Level		
7	Pole Top Feathering		
8	Mechanical Fire Damage		
9	Wood Loss		
10	Other Criteria (Loose Shell, Soft Wood etc)		
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Note 2: De-Rating Factor - If condition rating equals E (extensive), the overall HI is multiplied by 0.25. If condition rating equals M (moderate), the overall HI is multiplied by 0.75.

The main difference between the 2006 and 2009 formulation was Wood Pole Strength. In 2009, the weight assigned to the Wood Pole Strength parameter was 5 if pole strength was available; 0 if it was not. In general, if pole strength data was available for an asset, this condition parameter was used; if pole strength was not available, the condition is omitted.

This pole strength inclusion/exclusion method was used by THESL on the basis that:

1. Pole strength data is not widely available for wood poles. A large proportion of assets in this category (specifically assets for which data collected in 2007) do not have pole strength data. However because there is a large amount of data collected for the other condition criteria, these assets should not be excluded from the sample size.

2. An asset for which this parameter is available is likely to be in poor or very poor condition (i.e. insufficiently random).

9.1.2 *Changes in Condition Criteria*

The condition criteria used in 2009 was consistent with 2006.

9.2 Changes in Granularities

There is no change in terms of granularities.

9.3 Changes in Condition Data Availability

In 2006, the total population of wood poles was 58414. In 2009, the population of wood poles was reported as 85769 out of a total pole population of 141,000. The increase of 27355 wood poles between 2006 and 2009 was expected because the 2006 Ellipse extract did not include wood poles in Etobicoke. The 2009 population count now includes the Etobicoke data.

In 2006, 7298 poles had sufficient condition data to for assessment. In 2009, there were 12351 poles with sufficient condition data for assessment, an increase of 5068. This represents a condition data availability increase of 1.91%.

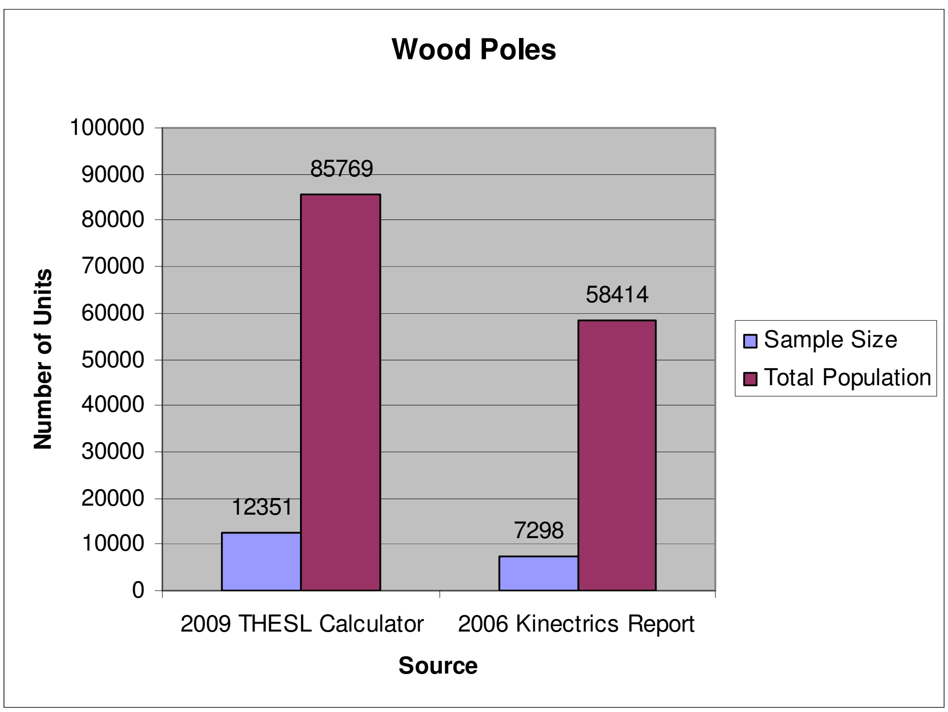


Figure 9-1 Wood Poles Sample Size and Population Comparison

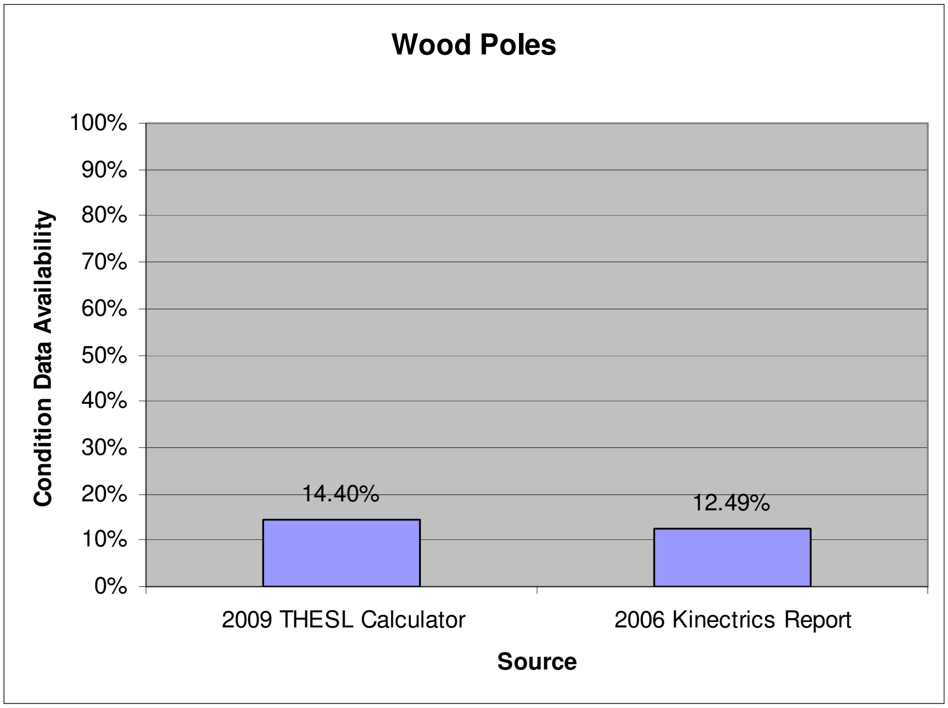
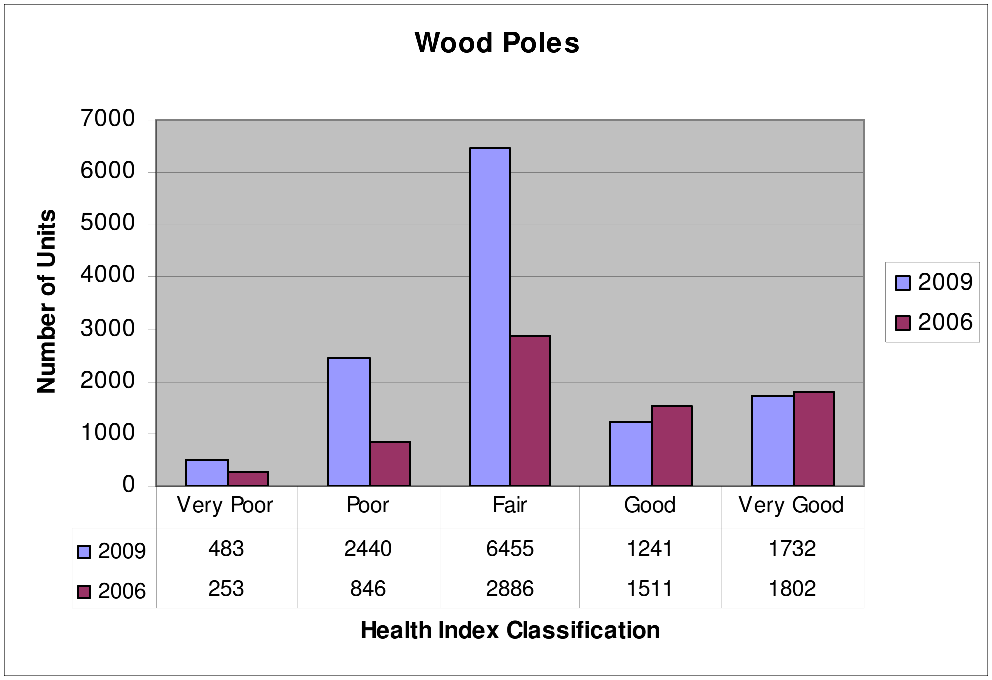


Figure 9-2 Wood Poles Condition Data Availability Comparison

9.4 Changes in Health Index Classification

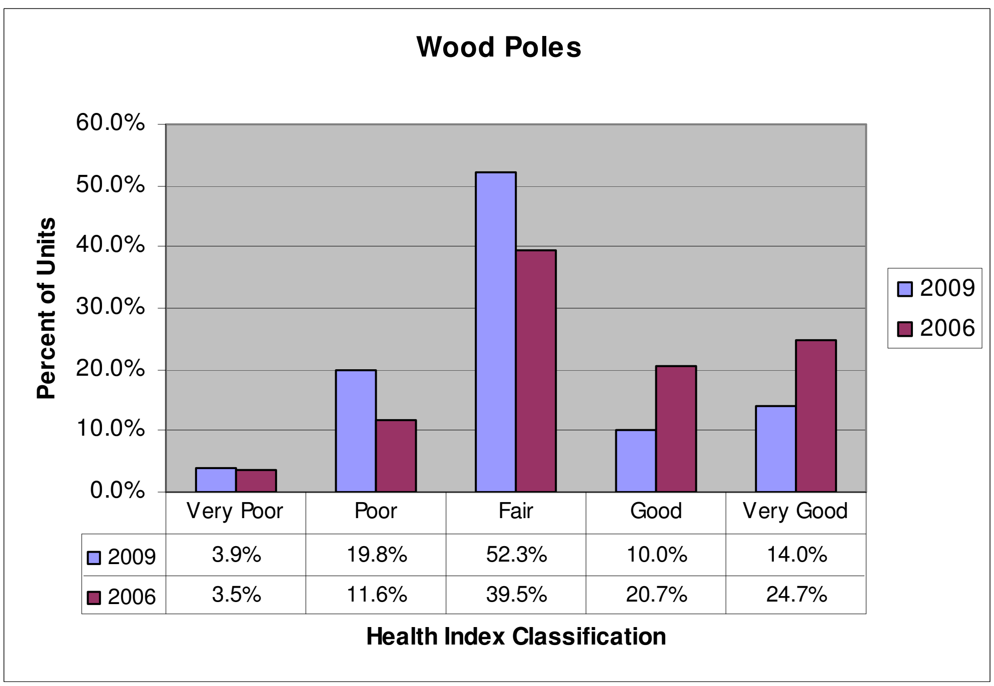
In 2006, Health Index extrapolation over the entire population would have been possible, had the units with data been sufficiently random. However it was found that the samples with data were from the same geographical region (Etobicoke), and therefore they may not be representative of the entire population. Thus, in 2006, there was insufficient data to extrapolate the Health Index classification over the remaining population.

In the 2009 assessment, 2923 out of 12371 (i.e. 23.7%) of the assets with data were found to be in poor or very poor condition. In 2006, 1099 of 7298 (15.1%) were found to be in poor or very poor condition. This represents an increase of 8.6%.



	Very Poor	Poor	Fair	Good	Very Good
2009	483	2440	6455	1241	1732
2006	253	846	2886	1511	1802

Figure 9-3 Wood Pole Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	3.9%	19.8%	52.3%	10.0%	14.0%
2006	3.5%	11.6%	39.5%	20.7%	24.7%

Figure 9-4 Wood Pole Health Index Comparison by % of Sample Size

9.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{4} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{4} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF_n} \times \mathrm{WCPF_n})}{\sum_{n=1} \beta_n (\mathrm{CPF_{n.max}} \times \mathrm{WCPF_n})} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 9-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Mechanical & electrical	5	4
2	Pole physical	3	4
3	Pole accessories	1	4
4	Overall	4	4

Table 9-2 Mechanical & Electrical (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	pole test results	3	4
2	ground test	1	4

Table 9-3 Pole Physical (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	rot	2	4
2	damage	2	4
3	hole	2	4
4	separation	2	4
5	void	1	4
6	ant	1	4
7	lean	1	4

Table 9-4 Pole Accessory (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	tree in wire	3	4
2	guy wire	3	4
3	ground	2	4
4	riser	1	4

Table 9-5 Overall (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	visual	1	4
2	estimated life	3	4
3	age	1	4

10 ATS

10.1 Changes in Health Index Formulation

10.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and weights for ATSs are listed as follows:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Phase Barriers	1	1
2	Gasket	1	1
3	Overall Condition	2	2
4	Years Since Last Overhaul	2	N/A
5	Age	3	3
	60% Condition Data Availability Rule[1]	50 % Rule	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of changes:

- In the 2009 Calculator, the condition parameter #4 (last overhaul time) is not used.
- A 50% Condition Data Availability rule was used in 2006; 60% is the Condition Data Availability rule for 2009.

All the other condition parameters in the 2006 report remain in the 2009 Calculator with their weights unchanged.

10.1.2 *Changes in Condition Criteria*

No change is made on condition criteria.

10.2 Changes in Granularities

There is no change in terms of granularities.

10.3 Changes in Condition Data Availability

Figure 10-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 10-2 presents the information by percentage. Because ATSs are being eliminated from the system, the population decreased by 21 units between 2006 and 2009. For the same reason, there was a 10 unit or 7.64% decrease in sample size.

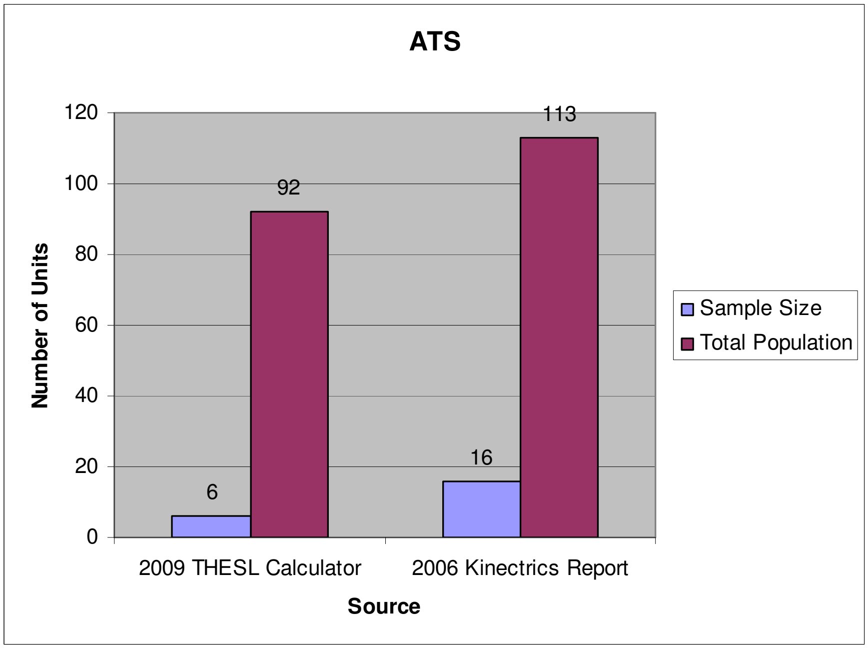


Figure 10-1 ATS Sample Size and Population Comparison

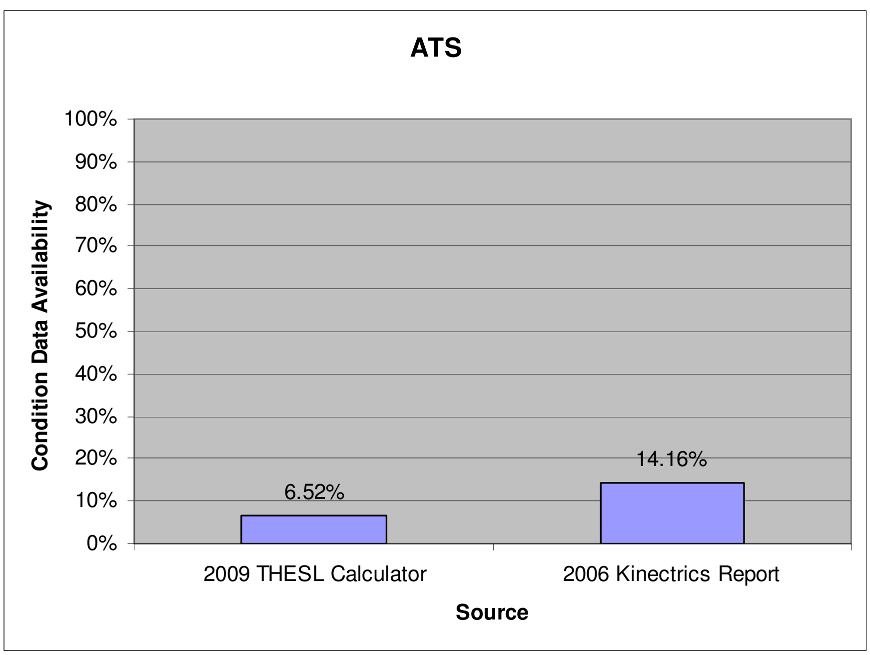
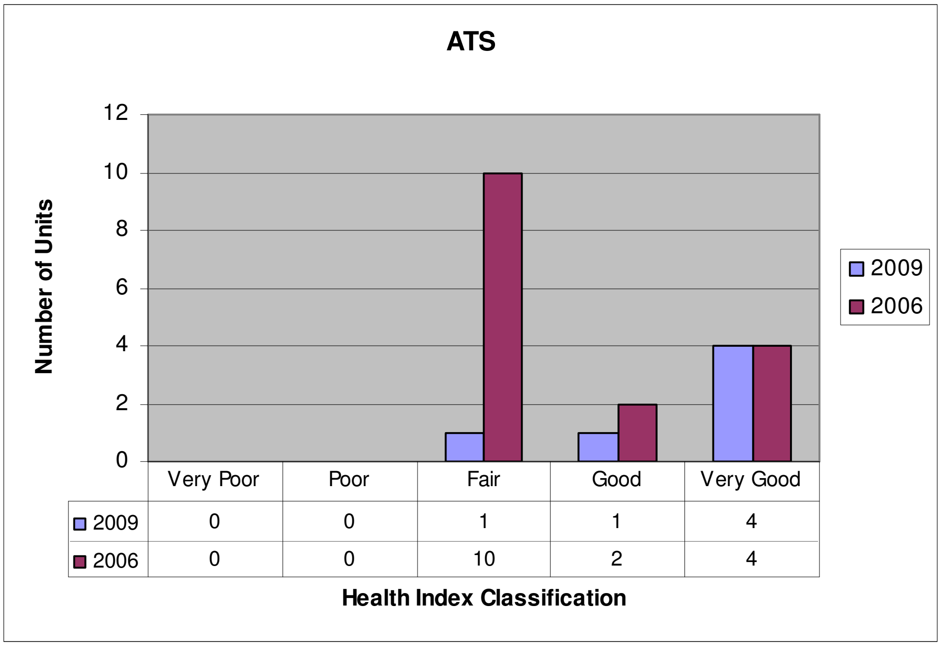


Figure 10-2 ATS Condition Data Availability Comparison

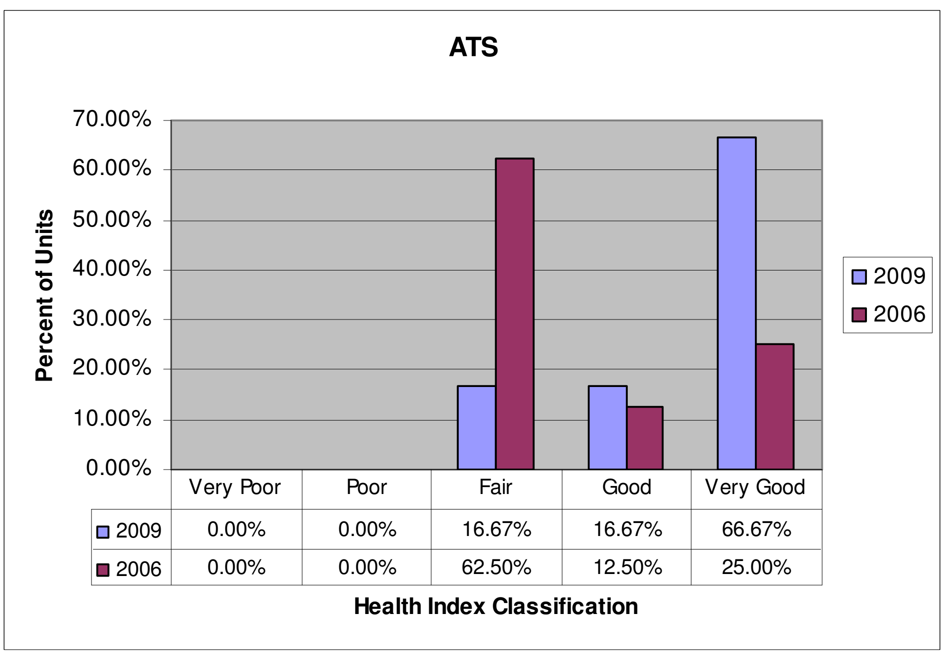
10.4 Changes in Health Index Classification

Figure 10-3 and Figure 10-4 show the Health Index classification breakdown of the assets within the sample size. There were no units in poor and very poor condition in 2009 or 2006. It should be noted that in 2006, the samples obtained at the time of the ACA assessment were insufficiently random. Therefore, the 2006 Health Index Extrapolation (i.e. a breakdown by percentage) is to be used for guidance only.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	1	1	4
2006	0	0	10	2	4

Figure 10-3 ATS Health Index Classification Comparison



	Very Poor	Poor	Fair	Good	Very Good
2009	0.00%	0.00%	16.67%	16.67%	66.67%
2006	0.00%	0.00%	62.50%	12.50%	25.00%

Figure 10-4 ATS Health Index Comparison by % of Sample Size

10.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{3} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{3} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 10-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	7	4
2	Control system	7	4
3	Reliability	5	4

Table 10-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Motor	2	4
2	Switch	2	4
3	Ground	1	4
4	Bus tie	3	4

Table 10-3 Control system (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Control panel	5	4
2	Fuse	2	4
3	Relay	3	4
4	Sensor	1	4
5	Timer	1	4
6	PT	1	4
7	Light	1	4
8	Card	1	4

Table 10-4 Reliability (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Age	1	4
2	Outage	2	4
3	Operating count	2	4

11 Cable Chambers

11.1 Changes in Health Index Formulation

11.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and weights for cable chambers are:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Floor/Roof/Walls/Slabs	4	4
2	Ducts/Cable Racking	1 (0)	1
3	Locks/Hinges/Entry/Door/Ladder	1 (0)	1
4	Flooding	1 (0)	1
5	Grounding	1 (0)	1
6	Working Space	3 (0)	3
7	Age	N/A	0
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of changes:

- In the 2006 ACA report, age is not a condition parameter for HI formulation. In the 2009 Calculator, age is included in HI formulation however it is assigned a weight of 0.

All the other condition parameters in the 2006 report remain in the 2009 Calculator with their weights unchanged.

In the 2006 report, Kinectrics proposed removal of some condition parameters (#2 - #6). These proposed changes were not adopted in the 2009 Calculator.

11.1.2 *Changes in Condition Criteria*

The following change is made on condition criteria of age.

Condition factor	Condition criteria for age (year)
4	0-20
3	20-40
2	40-60
1	60-80
0	>80

11.2 Changes in Granularities

There is no change in terms of granularities.

11.3 Changes in Condition Data Availability

Figure 11-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 11-2 presents the information by percentage. Due to work for conversion from direct buried to cable in duct, downtown relocation, and overhead to underground conversion, the number of units increased by 413. The sample size increased by 1194 units or 11.15%.

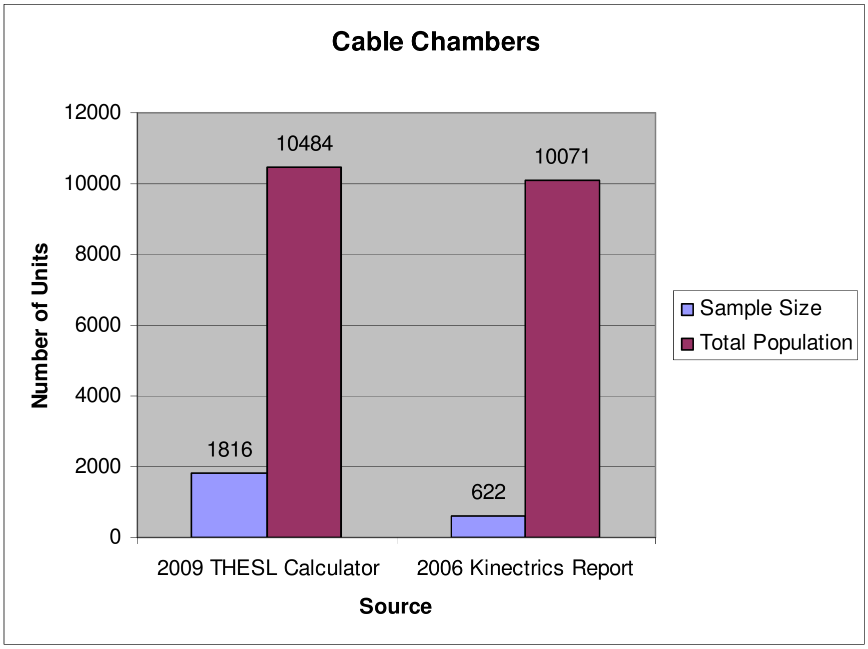


Figure 11-1 Cable Chambers Sample Size and Population Comparison

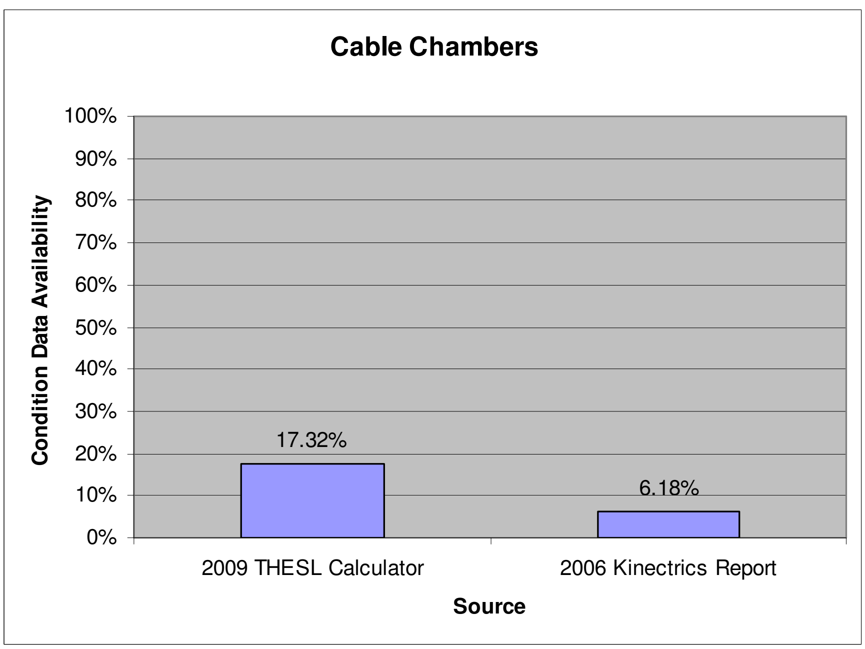
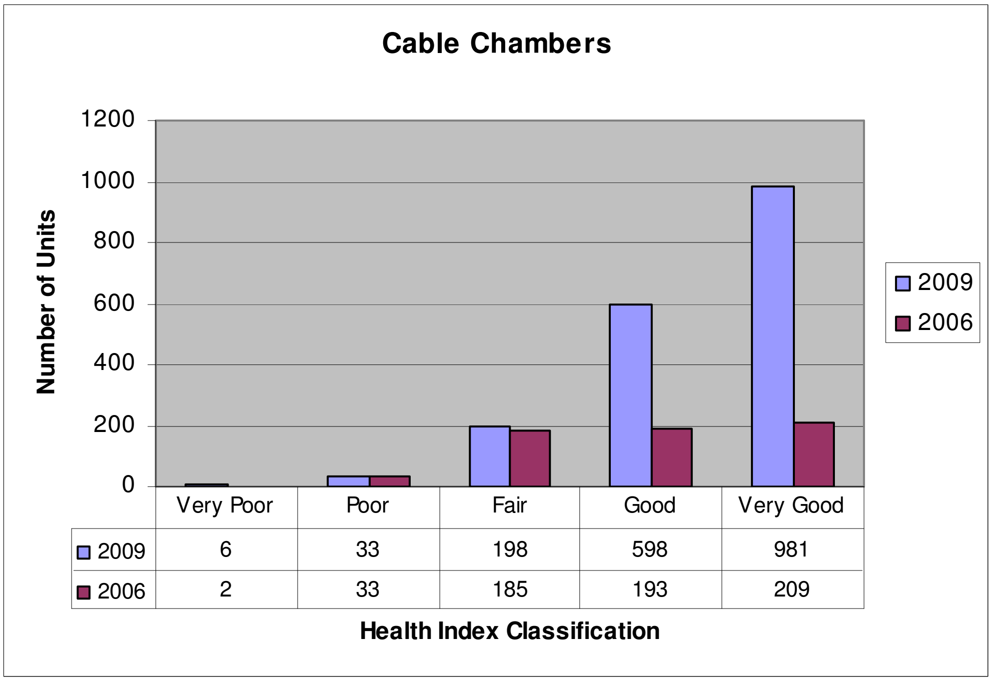


Figure 11-2 Cable Chambers Condition Data Availability Comparison

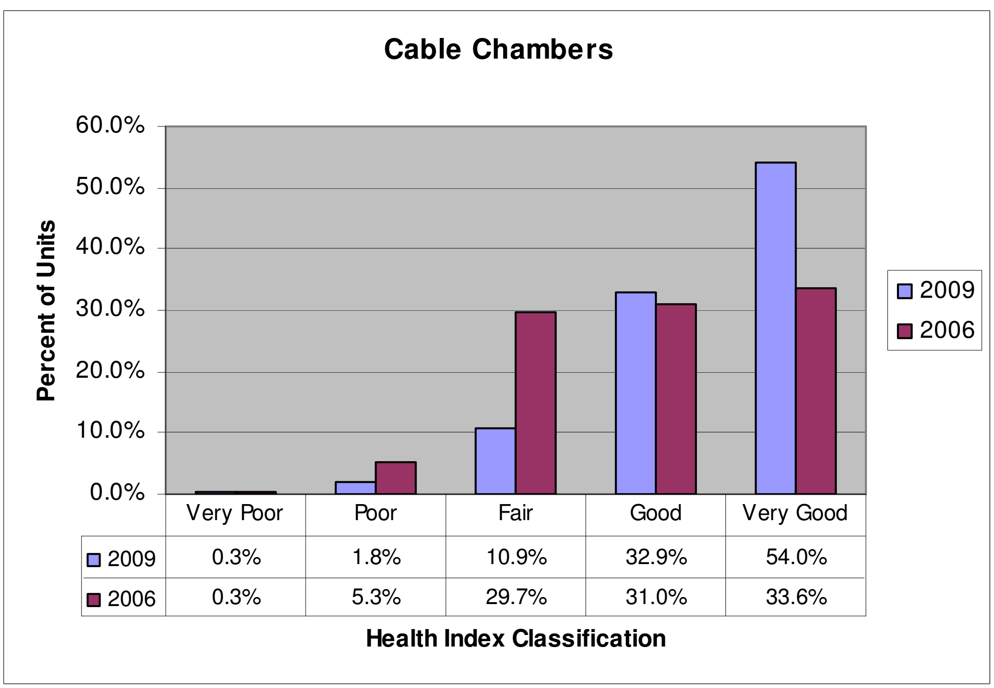
11.4 Changes in Health Index Classification

Figure 11-3 and Figure 11-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 2.15% were in poor or very poor condition, a decrease of 3.5%.



	Very Poor	Poor	Fair	Good	Very Good
2009	6	33	198	598	981
2006	2	33	185	193	209

Figure 11-3 Cable Chambers Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.3%	1.8%	10.9%	32.9%	54.0%
2006	0.3%	5.3%	29.7%	31.0%	33.6%

Figure 11-4 Cable Chambers Health Index Comparison by % of Sample Size

11.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 11-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Structure	3	4
2	Ventilation & drainage	2	4
3	Lighting	1	4
4	Access & work environment	1	4
5	Overall	2	4

Table 11-2 Structure (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Roof	3	4
2	Walls	3	4
3	Floor	1	4

Table 11-3 Ventilation & Drainage (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Flooding	1	4
2	Contamination	1	4

Table 11-4 Lighting (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Grounding	1	4
2	Internal support	2	4

Table 11-5 Access & Work Environment (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Access	2	4
2	Clearance to operate	3	4

Table 11-6 Overall (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Overall condition	1	4
2	Age	2	4

12 Network Vaults

12.1 Changes in Health Index Formulation

12.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and their weights for network vaults are:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Floor/Roof/Walls/Slabs	2 (3)	2
2	Vents/Grills/Ventilation	1 (2)	1
3	Ducts/Cables	1	1
4	Locks/Hinges/Entry/Door/Ladder	1	1
5	Flooding	2	2
6	Drain/Sump Pump	1	1
7	Dirt Debris/Contamination	2 (0)	2
8	Ground Grid	1	1
9	Fuses	1 (0)	1
10	Age	2 (3)	2
11	Location	0 (4)	N/A
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.
Note 2: Weights in brackets are suggested future revisions.

In the 2006 ACA report, item (#11) is a condition parameter (though a weight of 0 is assigned). In the 2009 Calculator, this condition parameter is removed.

In the 2006 report, Kinectrics proposed changes on some of the condition parameters (#1, 2, 7, 9, 10, 11). Those proposed changes were not adopted in 2009 Calculator.

12.1.2 *Changes in Condition Criteria*

The following change is made on condition criteria of age.

Condition factor	Condition criteria for age (year)	
	2006	2009
4	0-20	0-20
3	20-40	20-40
2	40-50	40-60
1	50-60	60-80
0	>60	>80

12.2 Changes in Granularities

There is no change in terms of granularities.

12.3 Changes in Condition Data Availability

Figure 12-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 12-2 presents the information by percentage. The total population decreased by 9 units between 2006 and 2009. This is a result of spot network removal and conversion of existing network customers to 13.8 kV radial. The sample size decreased by 20 units, or 1.02%.

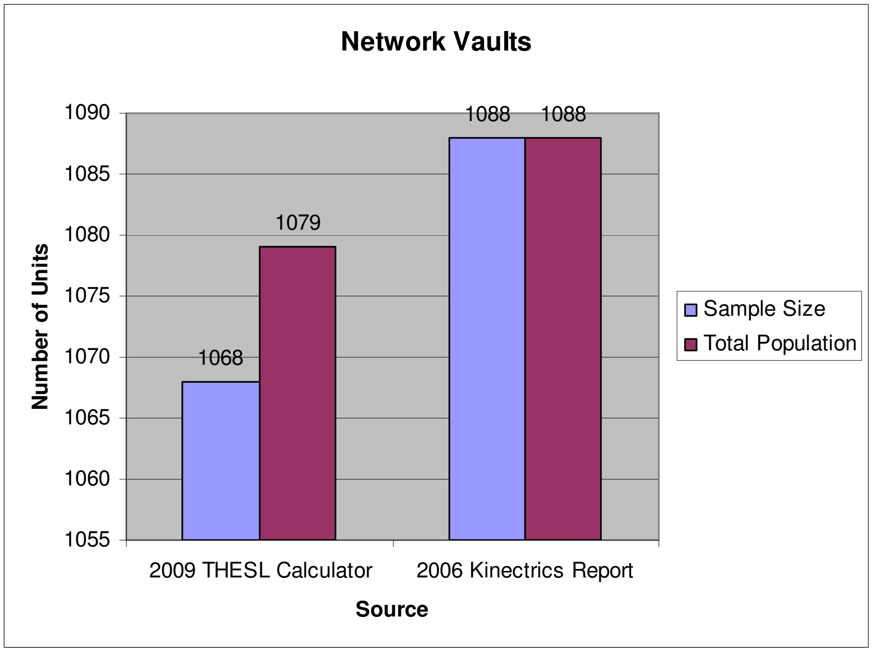


Figure 12-1 Network Vaults Sample Size and Population Comparison

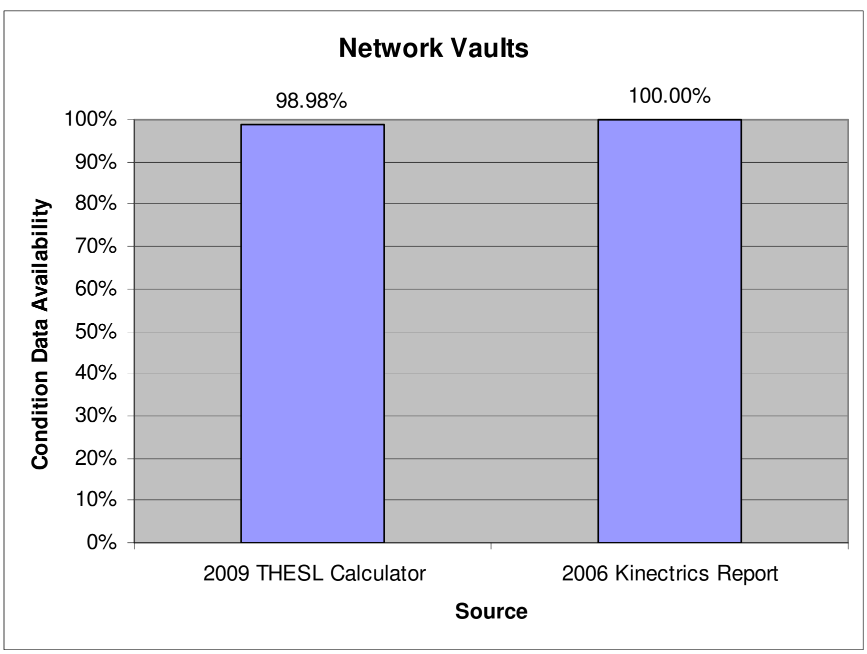


Figure 12-2 Network Vaults Condition Data Availability Comparison

12.4 Changes in Health Index Classification

Figure 12-3 and Figure 12-4 show the Health Index classification breakdown of the assets within the sample size. In 2009, 0.09% were in poor or very poor condition, no change from 2006.

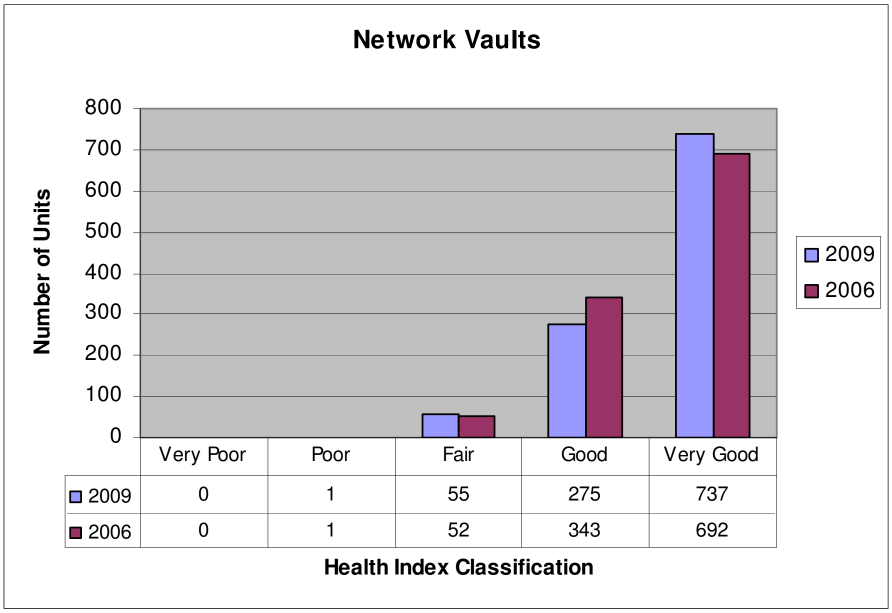


Figure 12-3 Network Vaults Health Index Comparison by Units

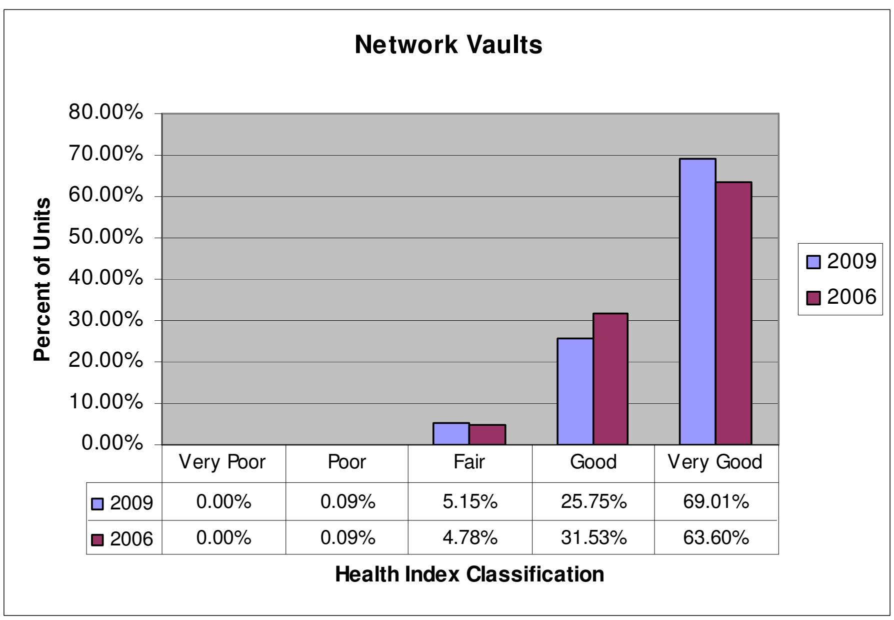


Figure 12-4 Network Vaults Health Index Comparison by % of Sample Size

12.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m ($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n ($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 12-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Structure	3	4
2	Ventilation & drainage	2	4
3	Lighting	1	4
4	Access & work environment	1	4
5	Overall	2	4

Table 12-2 Structure (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Roof / Slabs	3	4
2	Walls	3	4
3	Floor	1	4

Table 12-3 Ventilation & Drainage (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Vents/Grills/Ventilation	3	4
2	Drain	2	4
3	Sump pump	2	4
4	Flooding	2	4
5	Dirt/Debris	1	4

Table 12-4 Lighting (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Lighting	2	4
2	Cables	1	4
3	Grounding	1	4
4	Ducts	1	4

.

Table 12-5 Access & Work Environment (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Entry	1	4
2	Ladder	1	4
3	Door	1	4
4	Locks	1	4
5	Hinges	1	4
6	Clearance to operate	2	4
7	Asbestos friable (Y/N?)	3	4
8	Non-friable asbestos	1	4

Table 12-6 Overall (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Overall condition	1	4
2	Age	2	4

13 Switches

13.1 Changes in Health Index Formulation

13.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and their weights for switches are listed as follows.

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Blade/Arm/Mounting	2	
2	Connections/Terminations	1	1
3	Arc Suppressors/ Interrupters/Arc Horns	2	2
4	Grounding/Shunt Contact	1	1
5	Lock/Handles	1	1
6	Switch Insulator	2	2
7	Mechanism	3	3
8	Operations	2	2
9	Remote Open/Close Operation*	4	4
10	Age	N/A	0
	60% Condition Data Availability Rule[1]	50%	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Summary of changes:

- The 2009 HI Calculators for 3-phase OH gang remote operated type and manual operated type switches, condition parameter #1 is not used.
- In 2006, a 50% condition data availability rule was used; in 2009 a 60% condition data availability rule was used.
- In the 2006 report, age is not a condition parameter for HI formulation. In the 2009 Calculator, age is included in HI formulation however a weight of 0 is assigned.

All the other condition parameters in the 2006 report remain in the 2009 Calculator with their weights unchanged.

13.1.2 *Changes in Condition Criteria*

The following change is made on condition criteria of age (#10).

Condition factor	Condition criteria for age (year)
4	0-20
3	20-30
2	30-40
1	40-50
0	>50

13.2 Changes in Granularities

In the 2009 Calculator switches are sub-categorized into 3 types: 3-phase OH gang remote operated, 3-phase OH gang manual operated, SCADAMATE. In 2006, SCADAMATE was not included.

13.3 Changes in Condition Data Availability

An overall increase in the total population of switches was expected: There are more sectionalizing switches on the distribution feeders for operational flexibility improvements, replacement of manual switches with remote switches, and in some cases additional switches are put onto distribution feeders.

13.3.1 *Three Phase Overhead Gang Switches (Remotely Operated)*

Figure 13-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 13-2 presents the information by percentage. The total population decreased by 275 units, however, the sample size increased by 63 assets, or 38.99%.

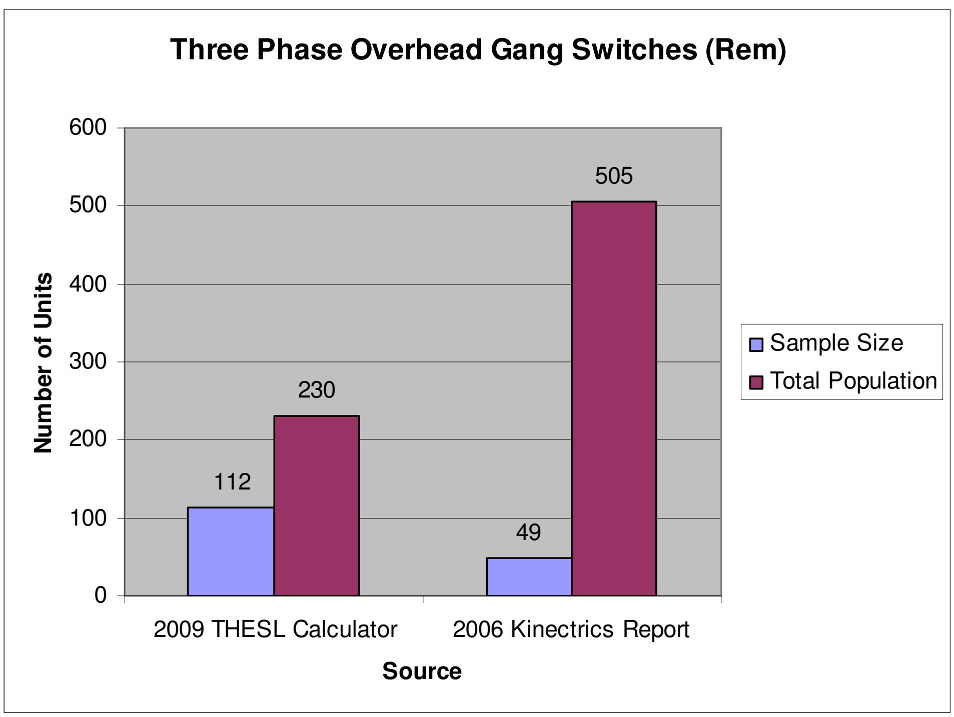


Figure 13-1 Three Phase O/H Gang Switches (Remote) Sample Size and Population Comparison

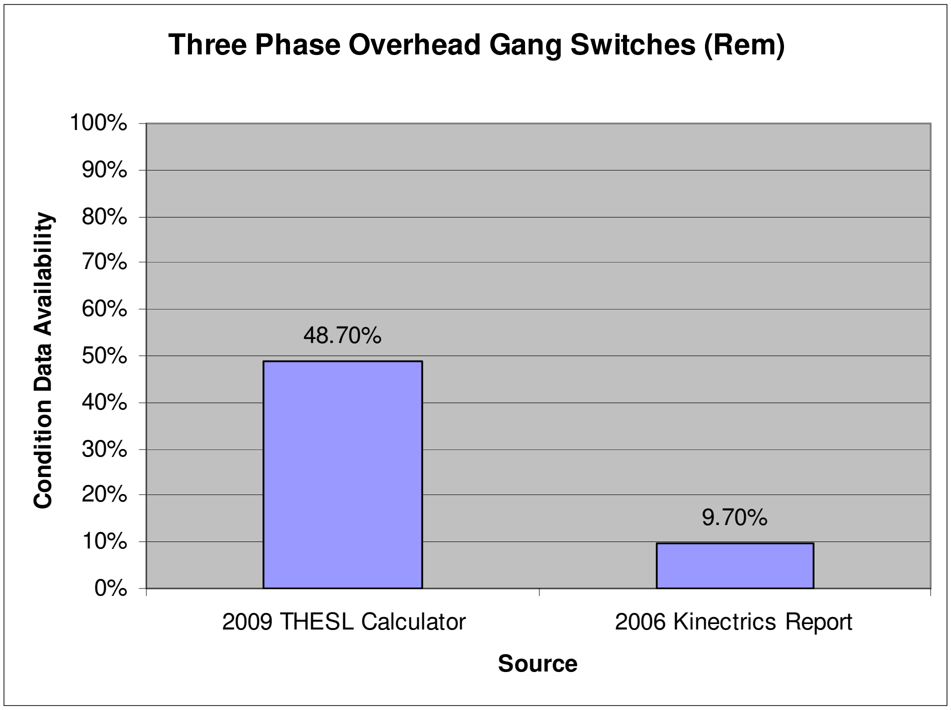


Figure 13-2 Three Phase O/H Gang Switches (Remote) Condition Data Availability Comparison

13.3.2 *Three Phase Overhead Gang Switches (Manually Operated)*

Figure 13-3 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 13-4 presents the information by percentage. The total population increased by 467 units, but, the sample size decreased by 110 or 13.27%.

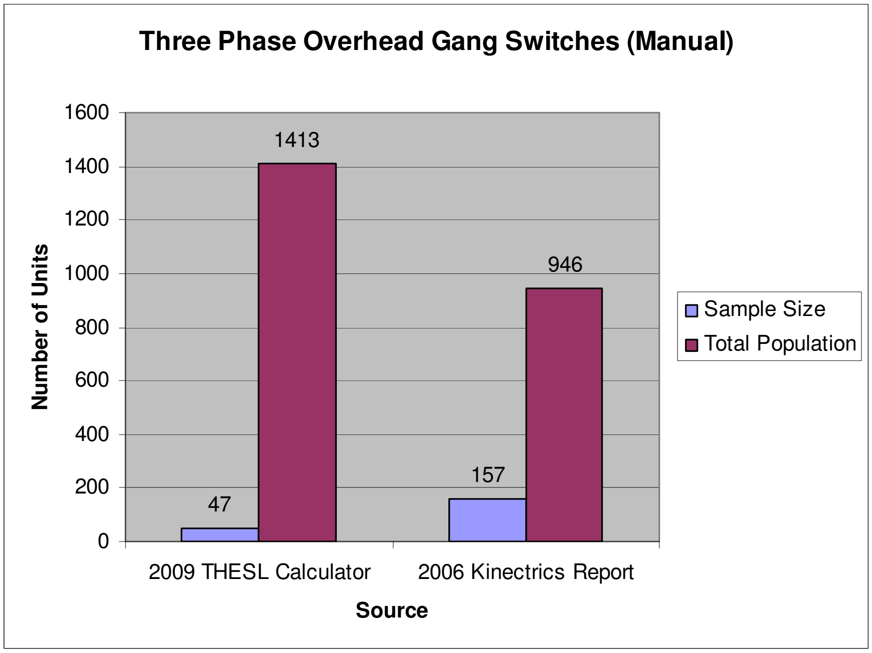


Figure 13-3 Three Phase O/H Gang Switches (Manual) Sample Size and Population

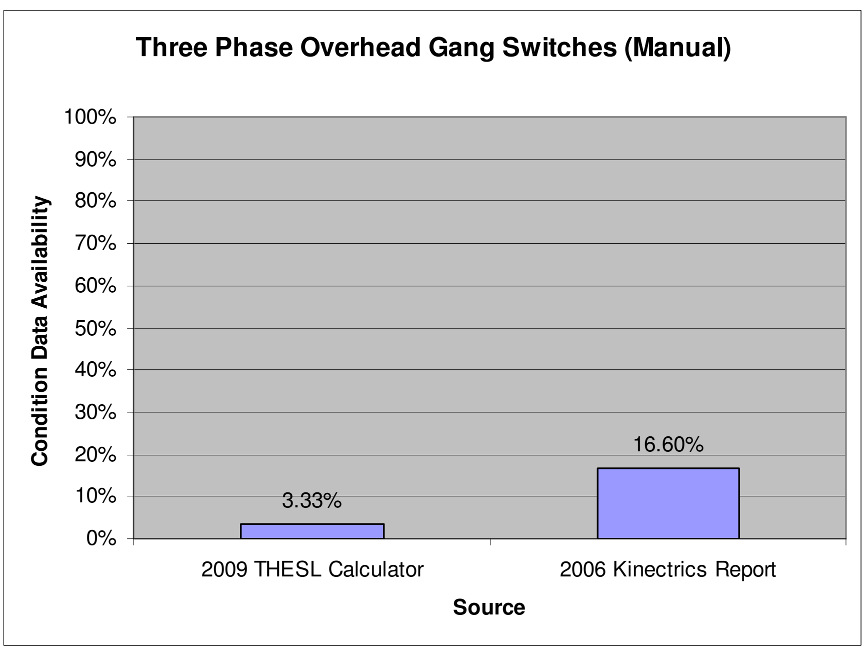


Figure 13-4 Three Phase O/H Gang Switches (Manual) Condition Data Availability

13.4 SCADAMATE

Figure 13-5 shows the total populations and sample sizes (assets with sufficient condition data) for 2006. Figure 13-4 presents the information by percentage. Only 11 out of 286 assets (3.85%) had sufficient condition data in 2009. An assessment for SCADAMATE was not conducted in 2006.

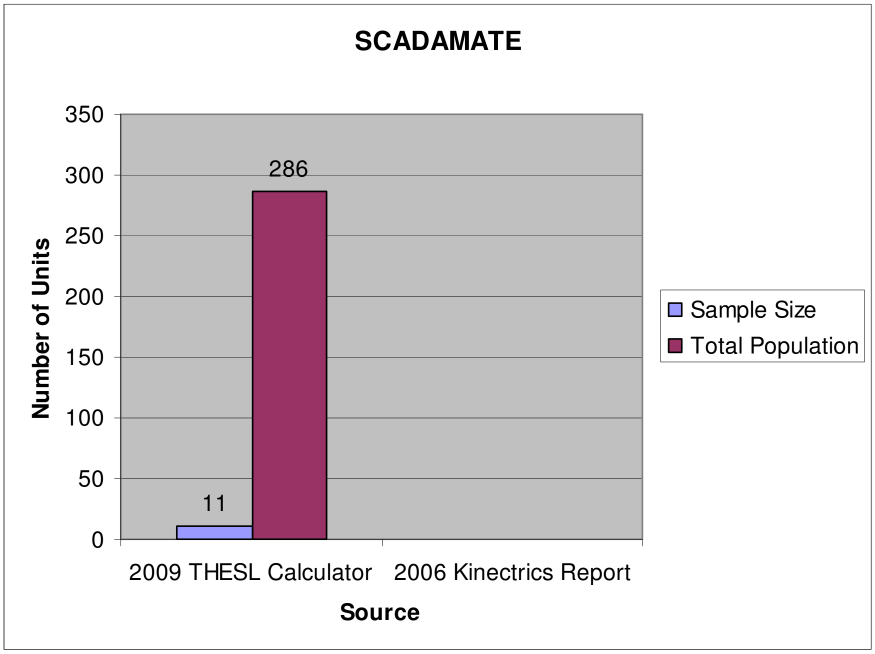


Figure 13-5 SCADAMATE Sample Size and Population Comparison

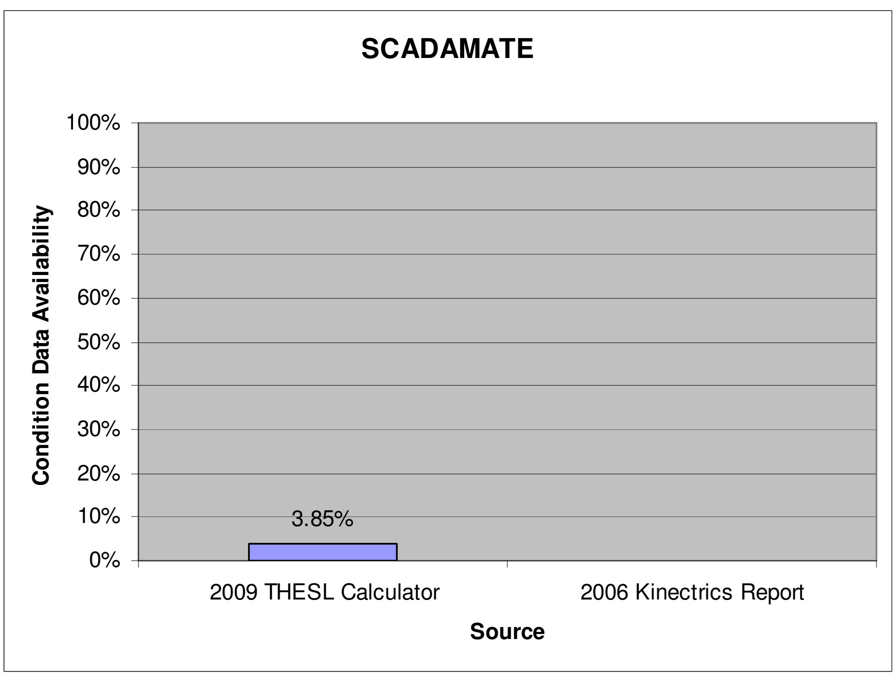
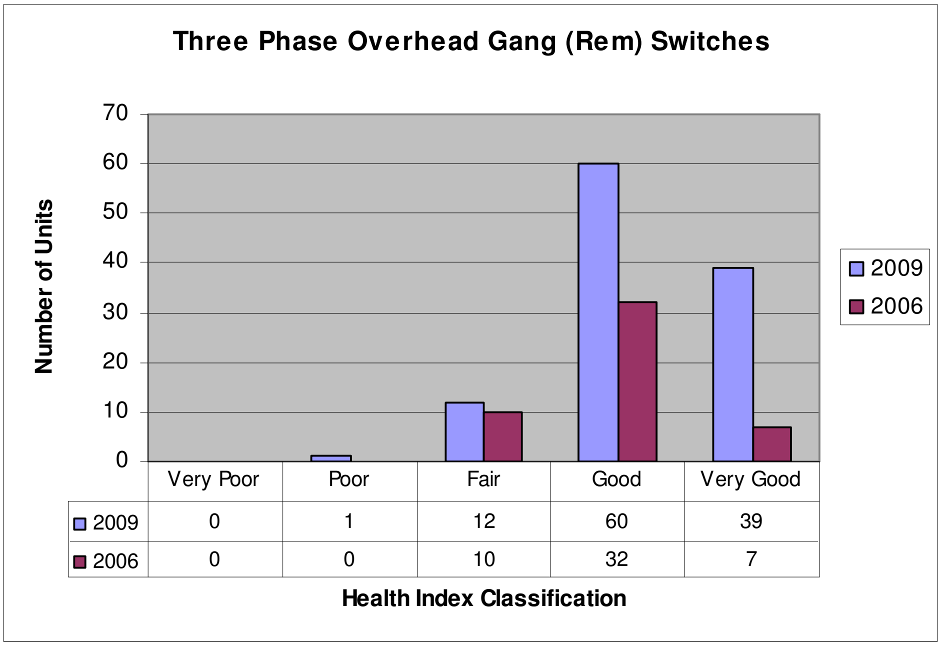


Figure 13-6 SCADAMATE Condition Data Availability Comparison

13.5 Changes in Health Index Classification

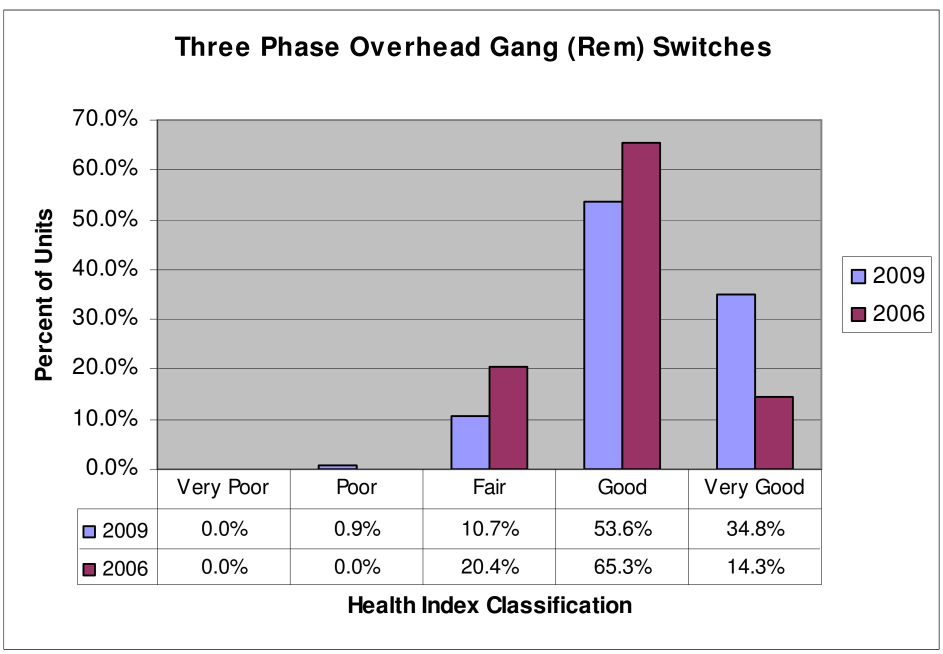
13.5.1 *Three Phase Overhead Gang Switches (Remotely Operated)*

Figure 13-7 and Figure 13-8 show the Health Index classification breakdown of the assets within the sample size. In 2009, 0.89% were in poor or very poor condition, an increase of 0.89%.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	1	12	60	39
2006	0	0	10	32	7

Figure 13-7 Three Phase O/H Gang Switches (Remote) Health Index by Units

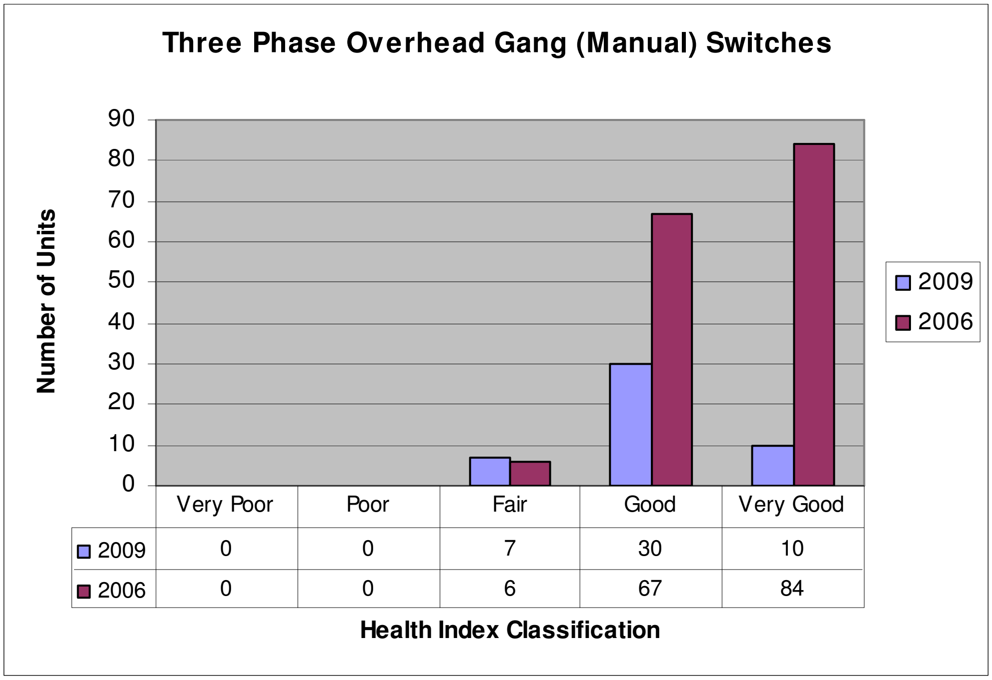


	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.9%	10.7%	53.6%	34.8%
2006	0.0%	0.0%	20.4%	65.3%	14.3%

Figure 13-8 Three Phase O/H Gang Switches (Remote) Health Index by % of Sample Size

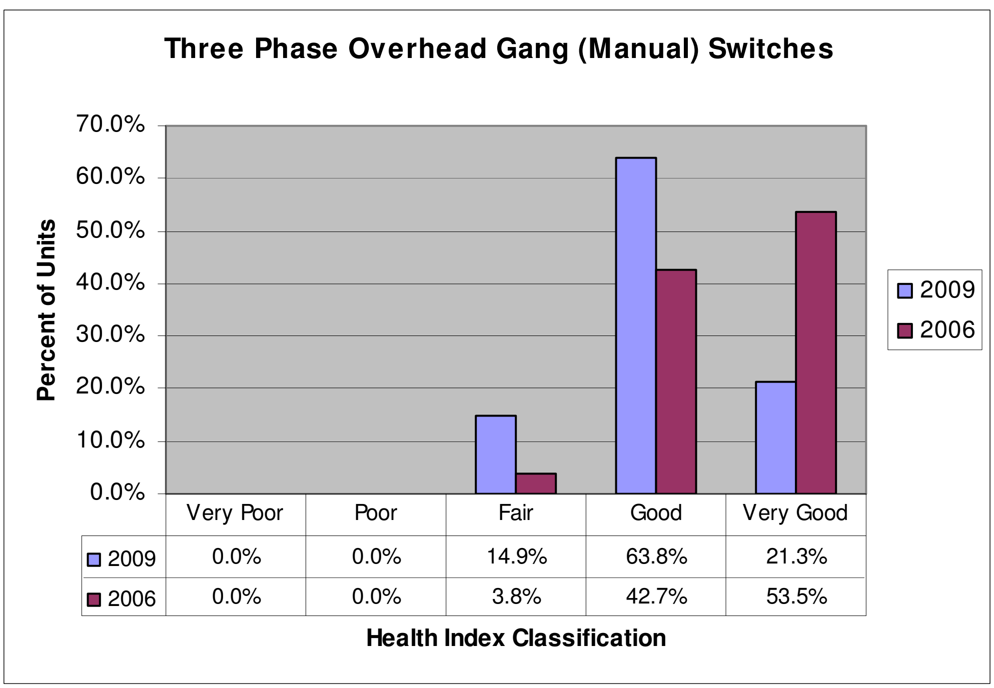
13.5.2 *Three Phase Overhead Gang Switches (Manually Operated)*

Figure 13-9 and Figure 13-10 show the Health Index classification breakdown of the assets within the sample size. No assets were in poor or very poor condition in 2006 or 2009.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	7	30	10
2006	0	0	6	67	84

Figure 13-9 Three Phase O/H Gang Switches (Manual) Health Index Comparison by Unit

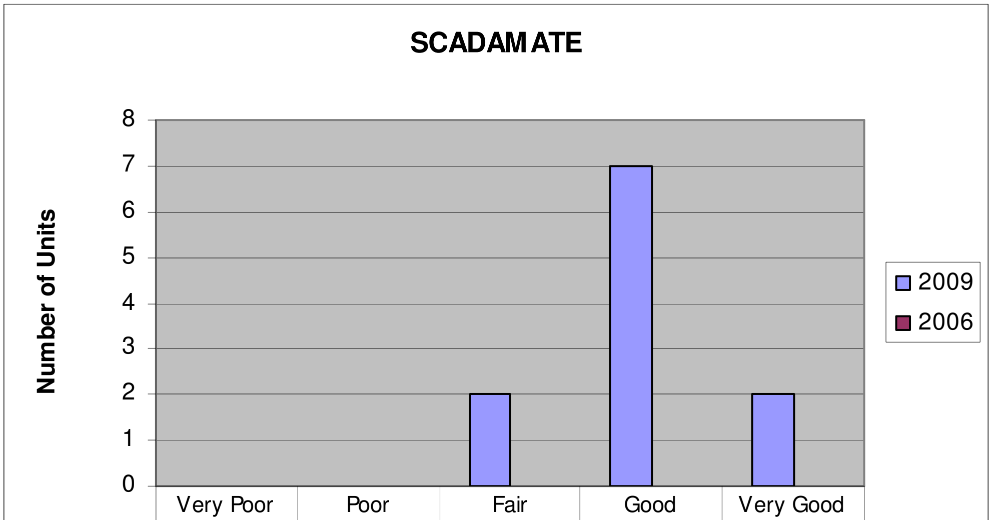


	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.0%	14.9%	63.8%	21.3%
2006	0.0%	0.0%	3.8%	42.7%	53.5%

Figure 13-10 Three Phase O/H Gang Switches (Manual) Health Index by % of Sample Size

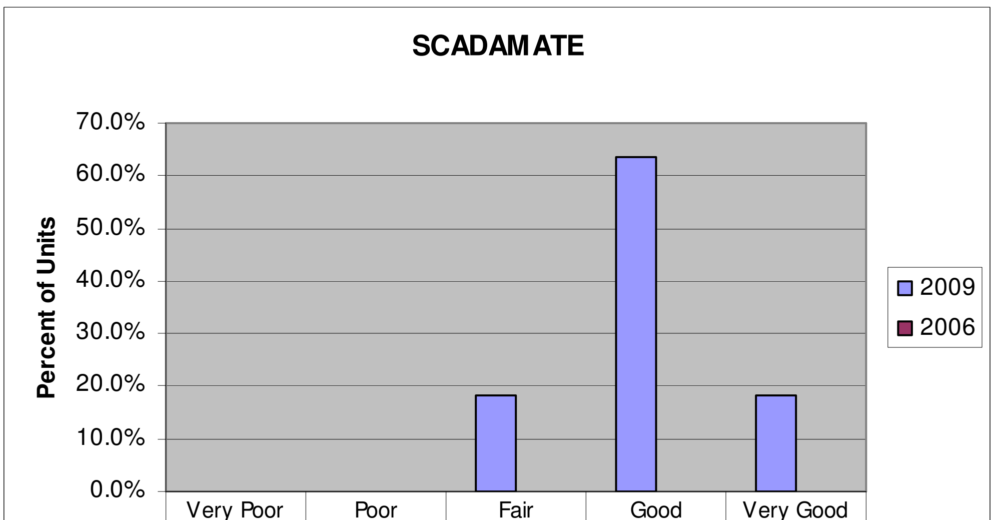
13.5.3 *SCADAMATE*

Figure 13-11and Figure 13-12 show the Health Index classification breakdown of the assets within the sample size. There were no units in poor and very poor condition in 2009. Health Indexing was not used for this asset in 2006.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	2	7	2
2006					

Figure 13-11 SCADAMATE Health Index Comparison by Units



	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.0%	18.2%	63.6%	18.2%
2006					

Figure 13-12 SCADAMATE Health Index Comparison by % of Sample Size

13.6 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
(α_m = 1 when data available, α_m = 0 when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
(β_n = 1 when data available, β_n = 0 when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 13-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Operating mechanism	**14**	4
2	Contact performance	**7**	4
3	Arc extinction	**5**	4
4	Insulation	**2**	4
5	Reliability	**7**	4

Table 13-2 Operating Mechanism (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Mechanism	9	4
2	Mechanical support	1	4

Table 13-3 Contact Performance (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Contact	1	4

Table 13-4 Arc Extinction (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Tank/Bottle	1	4

Table 13-5 Insulation (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Insulator	1	4

Table 13-6 Reliability (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Failure factor	3	4
2	Age	1	4

14 Padmounted Switchgear

14.1 Changes in Health Index Formulation

14.1.1 *Changes in Condition Parameters and Their Weights*

The changes in condition parameters and weights for padmounted switchgear are:

	Condition Parameters	Weight	
		2006 Report	2009 Calculator
1	Latches/Handles/Locks/Doors	1	N/A
2	Grounding/Bonding	1	1
3	Corrosion/Paint	2	2
4	Barriers	1	1
5	Concrete Base	2 (0)	2
6	Arc Suppressors/Interrupters	2	2
7	Hot Spot in IR Scan	3	3
8	Age	3	3
9	Contamination	0 (4)	N/A
	60% Condition Data Availability Rule[1]	Yes	Yes

Note 1: An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. If an asset's condition data availability is 60% or greater, it will be included in the sample size. Please refer to Section 16 Glossary of Terms for details.

Note 2: Weights in brackets are suggested future revisions.

Summary of changes:

- In the 2006 ACA report, latches/handles/locks/doors (#1) is a condition parameter. In the 2009 Calculator this condition parameter is removed.

- In the 2006 report, contamination (#9) is a condition parameter (though a weight of 0 is assigned). In the 2009 Calculator this condition parameter is removed.

All the other condition parameters in the 2006 report remain in the 2009 Calculator with their weights unchanged.

In the 2006 report, Kinectrics proposed changes on some of the condition parameters (#5, 9). Those proposed changes were not adopted in the 2009 Calculator.

14.1.2 *Changes in Condition Criteria*

The following change is made on condition criteria of age (#8).

Condition factor	Condition criteria for age (year)	
	2006	2009
4	0-10	0-20
3	10-20	20-30
2	20-30	30-40
1	30-35	40-50
0	>35	>50

The following change is made on condition criteria of hot spot in IR scan (#7).

Condition factor	Condition criteria for IR scan	
	2006	2009
4	IR_HTSPOT=1	IR_HTSPOT=1
3	IR_HTSPOT=2	N/A
2	IR_HTSPOT=3	
1	IR_HTSPOT=4	
0	IR_HTSPOT=5	IR_HTSPOT=2
-1	Other IR_HTSPOT value	No valid IR_HTSPOT value

In the 2006 report, IR_HTSPOT (IR result on hot spot) is ranked from 1 to 5, while in the 2009 Calculator, it is ranked either 1 or 2 (no intermediate status).

14.2 Changes in Granularities

There is no change in terms of granularities.

14.3 Changes in Condition Data Availability

Figure 14-1 shows the total populations and sample sizes (assets with sufficient condition data) for 2006 and 2009. Figure 14-2 presents the information by percentage. The total population increased by 62 units between 2006 and 2009. With an increase of 313 assets, there was a significant (37.54%) improvement in sample size.

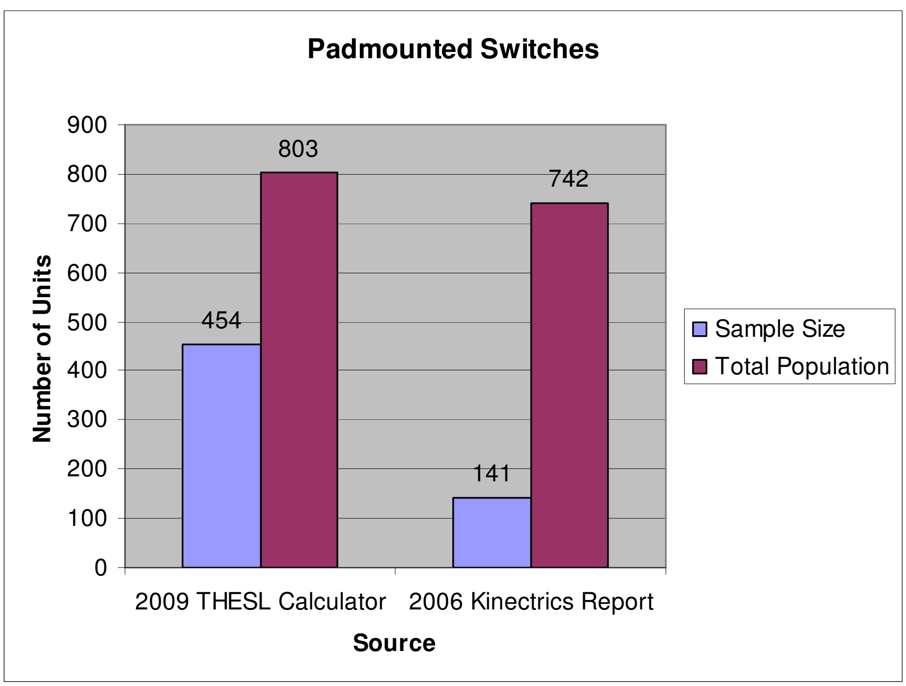


Figure 14-1 Padmounted Switchgear Sample Size and Population Comparison

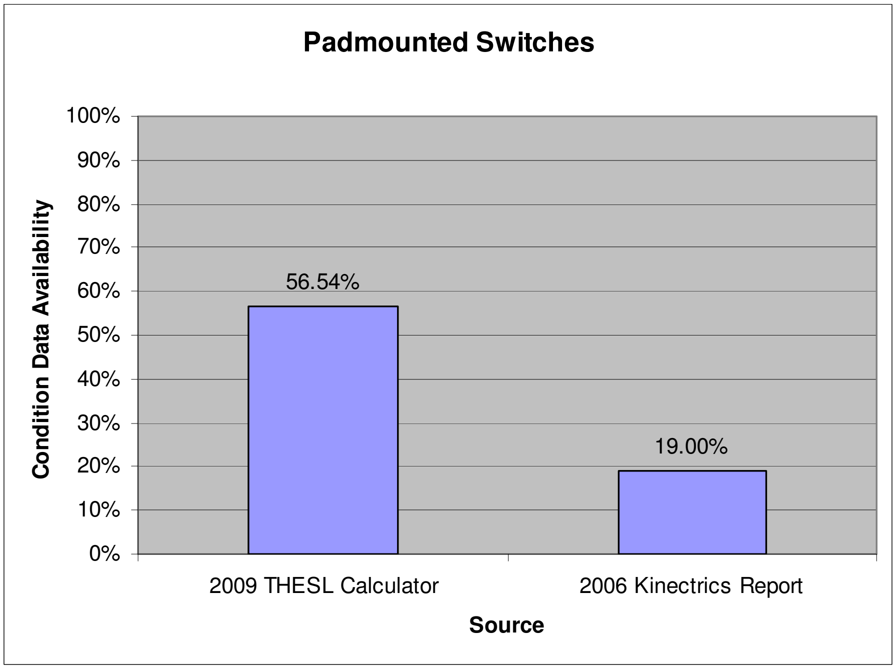
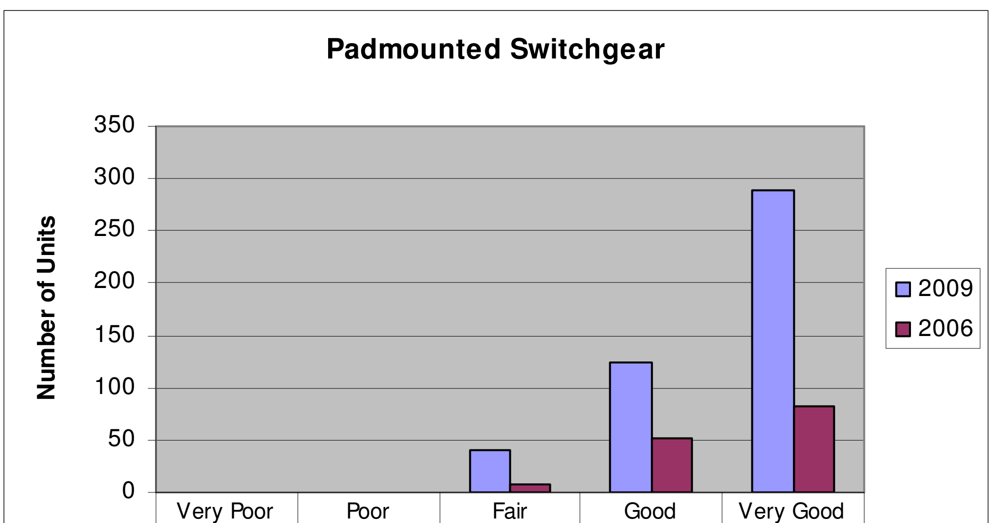


Figure 14-2 Padmounted Switchgear Condition Data Availability Comparison

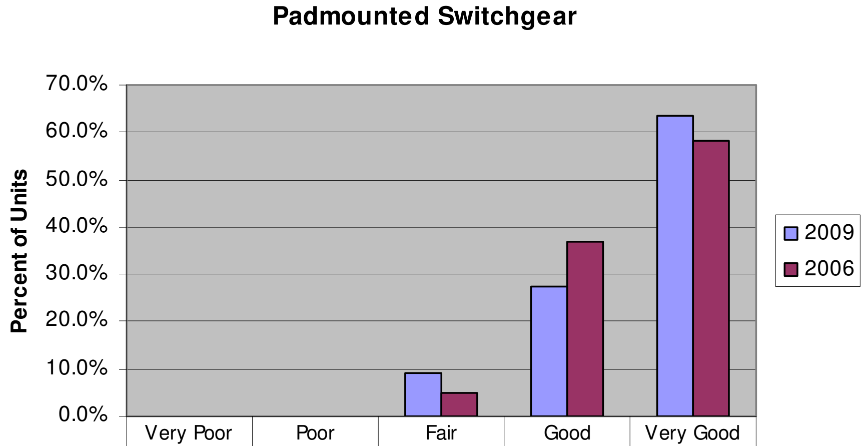
14.4 Changes in Health Index Classification

Figure 14-3 and Figure 14-4 show the Health Index classification breakdown of the assets within the sample size. There were no units in poor or very poor condition in 2006 and 2009.



	Very Poor	Poor	Fair	Good	Very Good
2009	0	0	41	124	289
2006	0	0	7	52	82

Figure 14-3 Padmounted Switchgear Health Index Classification Comparison



	Very Poor	Poor	Fair	Good	Very Good
2009	0.0%	0.0%	9.0%	27.3%	63.7%
2006	0.0%	0.0%	5.0%	36.9%	58.2%

Figure 14-4 Padmounted Switchgear Health Index Comparison by % of Sample Size

14.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{5} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{5} \alpha_m (CPS_{m.max} \times WCP_m)}$$

where

$$CPS = \frac{\sum_{n=1} \beta_n (CPF_n \times WCPF_n)}{\sum_{n=1} \beta_n (CPF_{n.max} \times WCPF_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
($\alpha_m = 1$ when data available, $\alpha_m = 0$ when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
($\beta_n = 1$ when data available, $\beta_n = 0$ when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

Table 14-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	3	4
2	Switch/fuse condition	5	4
3	Cooling	5	4
4	Insulation	7	4
5	Reliability	5	4

Table 14-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Corrosion	3	4
2	Access	1	4
3	Base	2	4

Table 14-3 Switch/Fuse Condition (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Switch/fuse	5	4
2	Cable connection	2	4

Table 14-4 Cooling (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Temperature	1	4
2	Oil leak	1	4

Table 14-5 Insulation (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Bushing	2	4
2	Flashover	3	4

Table 14-6 Reliability (m=5) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	overall	2	4
2	age	1	4

15 Underground Cable

Note: Cable Asset Condition Assessment data was not included in the 2009 ACA Calculator. Current THESL cable data was compiled and a 2009 Asset Condition Assessment (ACA) was performed using the same methodology as that in 2006. This audit compares the Health Index results of 2006 and 2009.

15.1 Changes in Health Index Formulation

As noted above, due to the fact that the same methodology was used in 2009, there were no changes in condition parameters, weights, or criteria. Note that the methodology are independent of cable type (e.g. PILC, XLPE, direct buried, duct, etc).

The condition parameters and weights for 2006 and 2009 are:

Item	Condition Parameter	Weight (2006 and 2009)
1	Cable Failures	2
2	Age	1

The condition criteria for 2006 and 2009 are:

Condition Factor	Cable Failures (faults/yr/km)	Age
4	0	<=17
3	0.006696	
2	0.013393	>17 && <=20
1	0.044643	>20 && <=25
0	0.071429	>25

For age (or install date) the condition factor 3 was not used.

15.2 Changes in Granularities

In 2006, an overall assessment for all cables was performed. In addition, the overall cable class was sub-divided into “XLPE Direct Buried” and “PILC in Duct”. At that time, there was insufficient detail in the data to assess “XLPE in Duct”. In 2009, an overall assessment includes “XLPE in Duct”.

15.3 Changes in Condition Data Availability

In 2006, Health Indexing was performed on a total of 5,252 km of cable. In 2009, information and cable lengths were available on a total of 2,824 km of cable, from the cable failure data files provided. Of that total, 2,394 km of cable had sufficient data for

Health Index calculation. The 2009 Cable ACA is based on files of cable failures data where the failures are given on a segment basis. The 2006 Cable ACA failures data was not localized to segments which required an implied extrapolation to feeders (circuits). Hence, the sample size in terms of km appears larger in 2006 than in 2009.

15.4 Changes in Health Index Classification

In 2006, the data availability was very low, and therefore there were only three Health Index Condition groups: Poor (0-50%), Fair (50-70%), and Good (70-100%). In 2009, the data availability improved, and the number of condition groups was expanded to five: Very Poor (0-30%), Poor (30-50%), Fair (50-70%), Good (70-85%), and Very Good (85%-100%). Comparisons in Health Index Results are shown for: All Cables, XLPE – Direct Buried, PILC - in Duct, and XLPE – in Duct.

Health Index Classification for All Cables With Data (Overall Assessment):

Figure 15-1and Figure 15-3 show the HI classification for all cables with data in 2006 and 2009. Figure 15-2 and Figure 15-4 show the classification by percentage. In 2009, 75% were classified as having Health Indices of below 50% (i.e. poor/very poor). This is a 63.9% increase from 2006, where 11.1% of all cables had Health Indices below 50%.

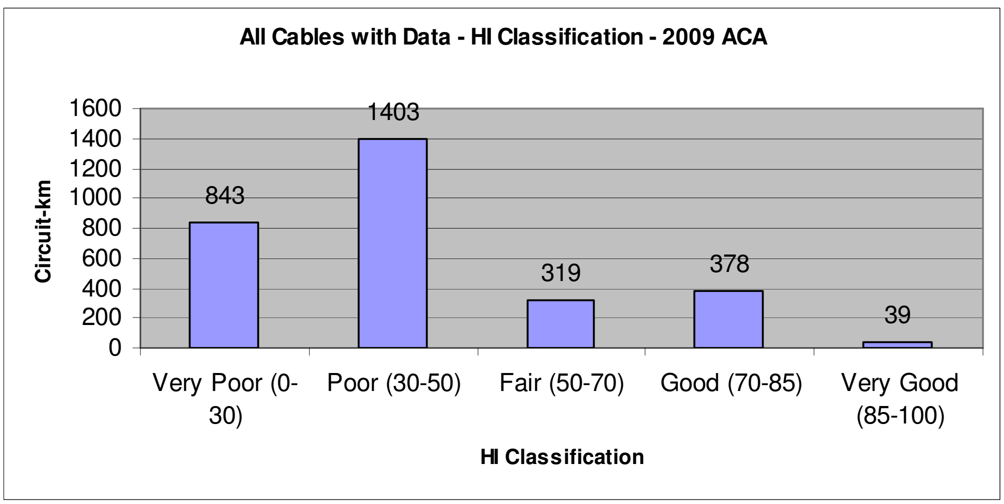


Figure 15-1 2009 HI Classification for All Cables by Length

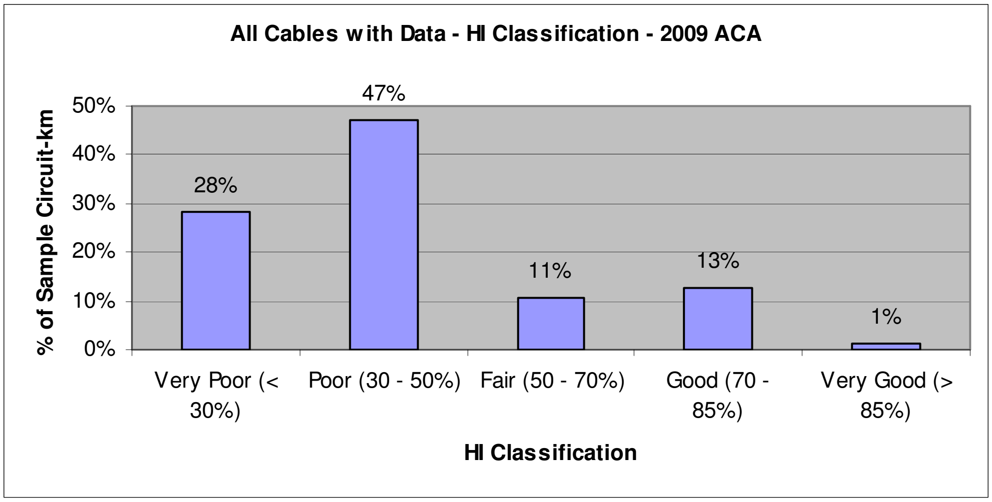


Figure 15-2 2009 HI Classification for All Cables by %

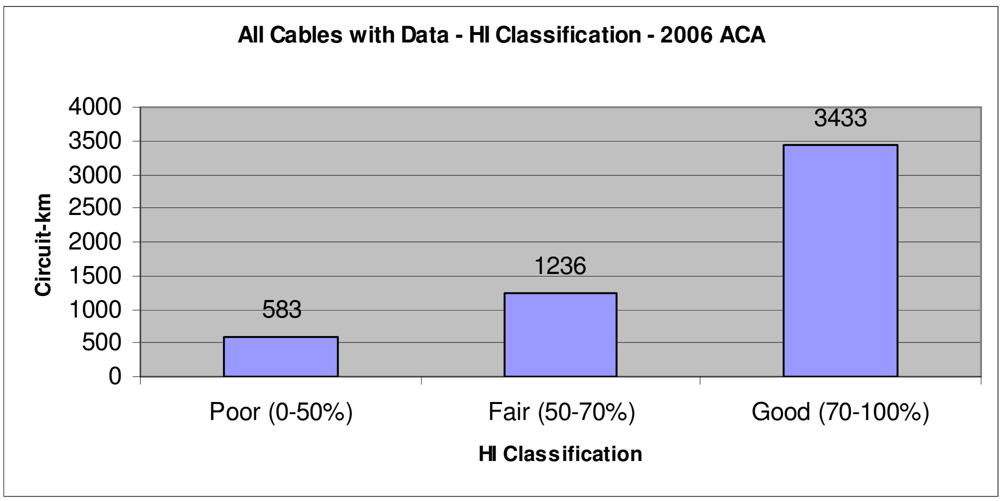


Figure 15-3 2006 HI Classification for All Cables by Length

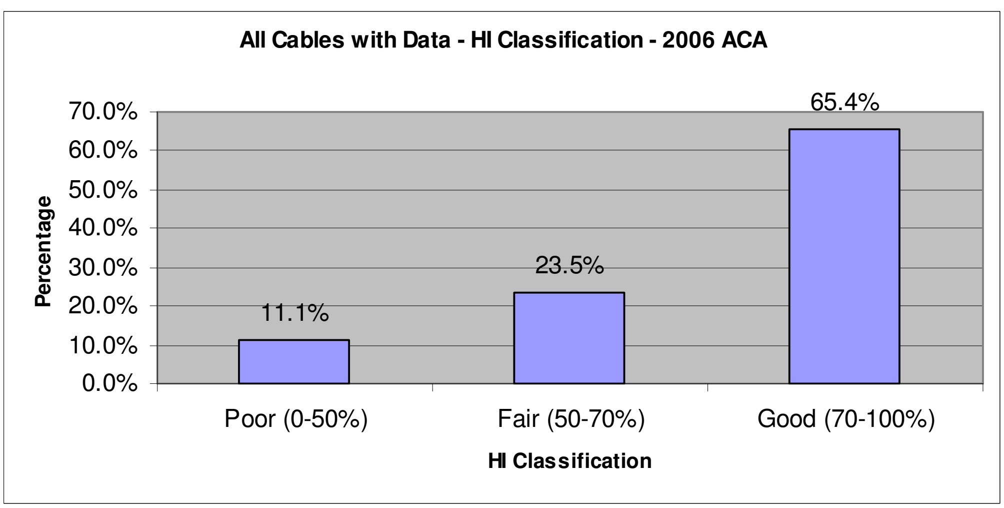


Figure 15-4 2006 HI Classification for All Cables by %

Health Index Classification for XLPE- Direct Buried:

The 2006 and 2009 data was sufficient to assess XLPE-Direct buried cables. Because the 2009 data for XLPE – Direct Buried cables was provided in terms of segments, it was necessary to convert the given data into circuit-km and to apply the HI formulation of 2006 in order to make an appropriate comparison between 2006 and 2009 data. Figure 15-5 and Figure 15-7 show the HI classification for XLPE-direct buried cables with data in 2006 and 2009. Figure 15-6 and Figure 15-8 show the classification by percentage. In 2009, 49% were classified as having Health Indices of below 50% (i.e. poor/very poor). This is a 25.6% increase from 2006, where 23.4% of XLPE direct buried cables had Health Indices below 50%.

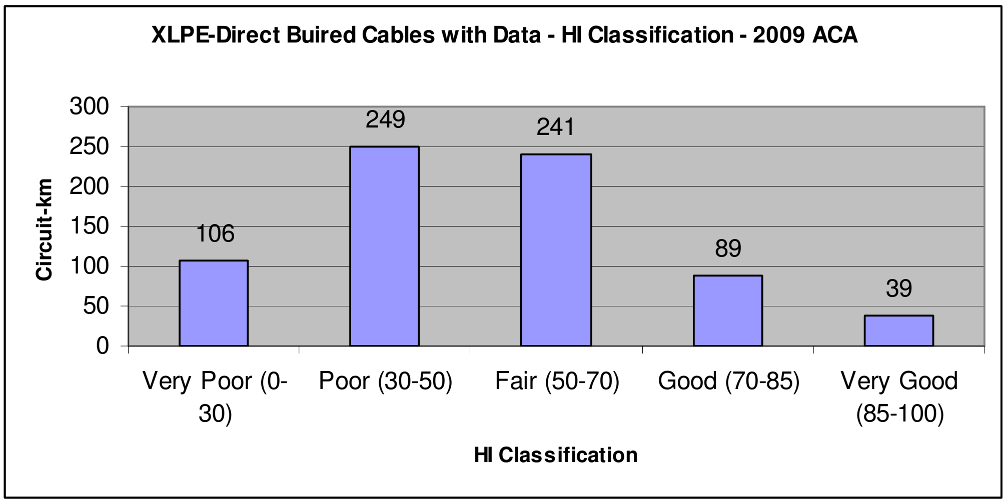


Figure 15-5 2009 HI Classification for XLPE Direct Buried by Length

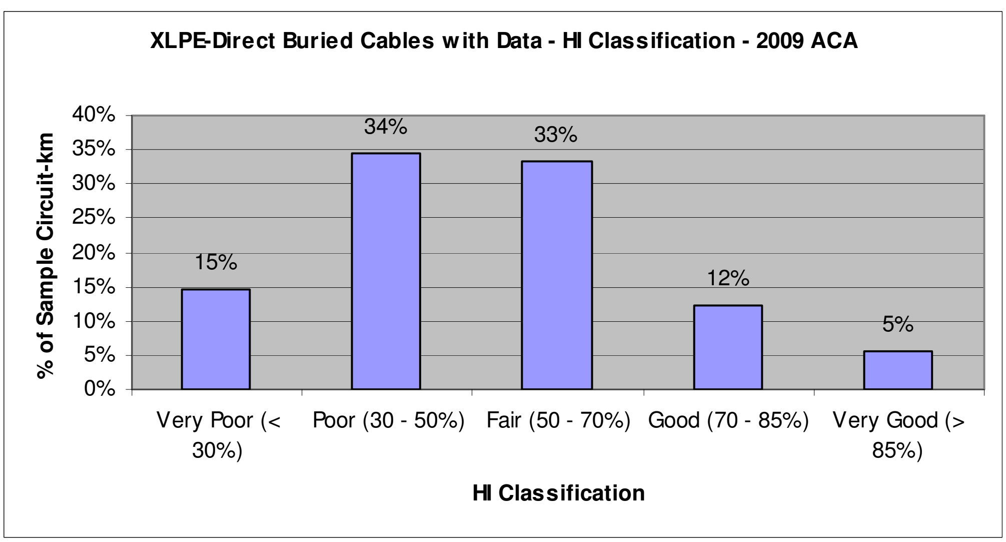


Figure 15-6 2009 HI Classification for XLPE Direct Buried by %

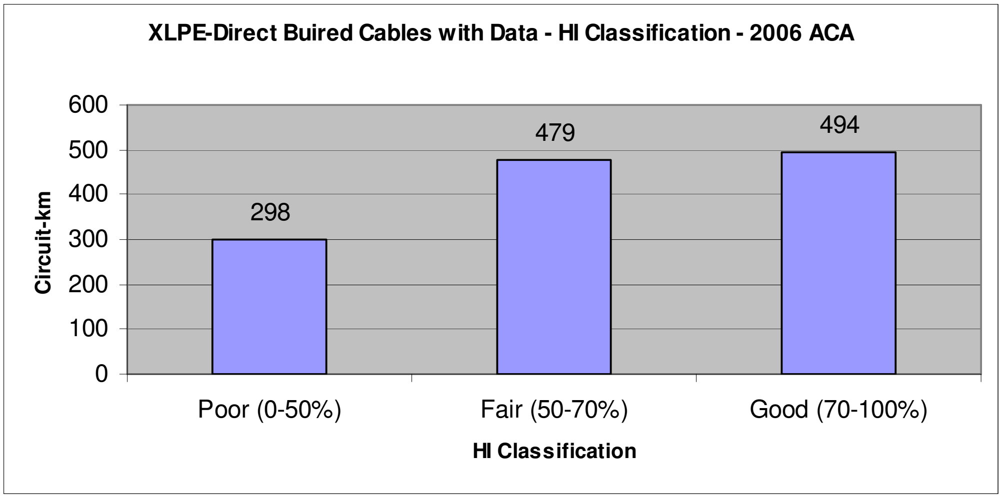


Figure 15-7 2006 HI Classification for XLPE Direct Buried by Length

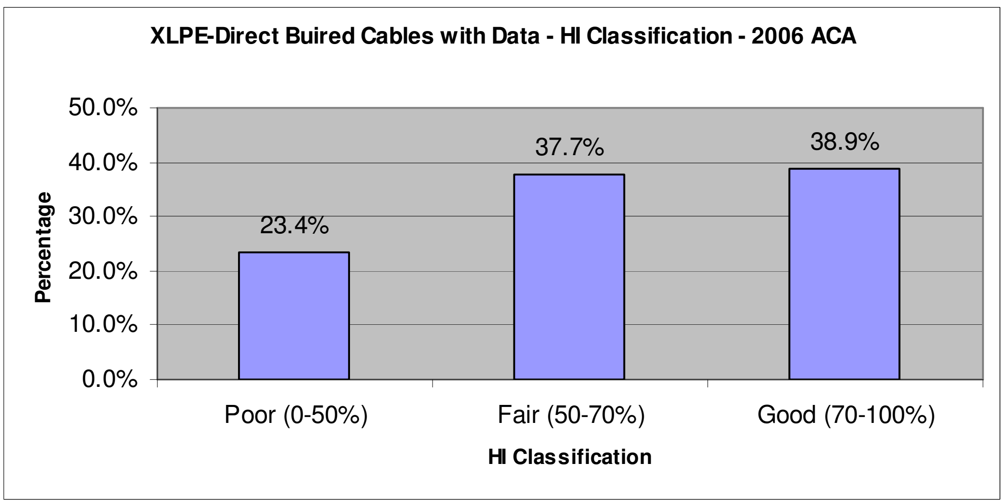


Figure 15-8 2006 HI Classification for XLPE Direct Buried by %

Health Index Classification for PILC – in Duct:

The 2006 and 2009 data was sufficient to assess PILC in Duct. Figure 15-9 and Figure 15-11 show the HI classification for cables with data in 2006 and 2009. Figure 15-10 and Figure 15-12 show the classification by percentage. In 2009, 83% were classified as having Health Indices of below 50% (i.e. poor/very poor). This is a 52.3% increase from 2006, where 30.7% of PILC in Duct had Health Indices below 50%.

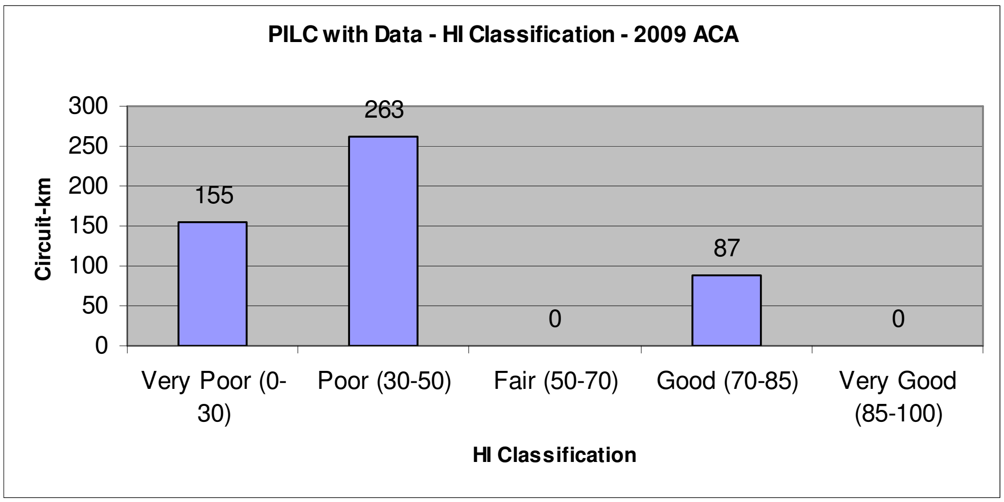


Figure 15-9 2009 HI Classification for PILC by Length

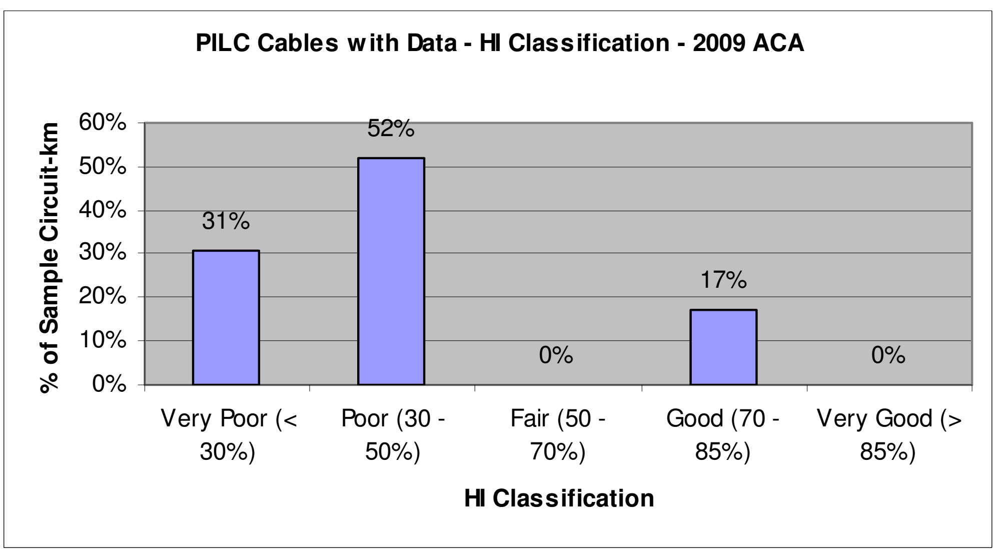


Figure 15-10 2009 HI Classification for PILC by %

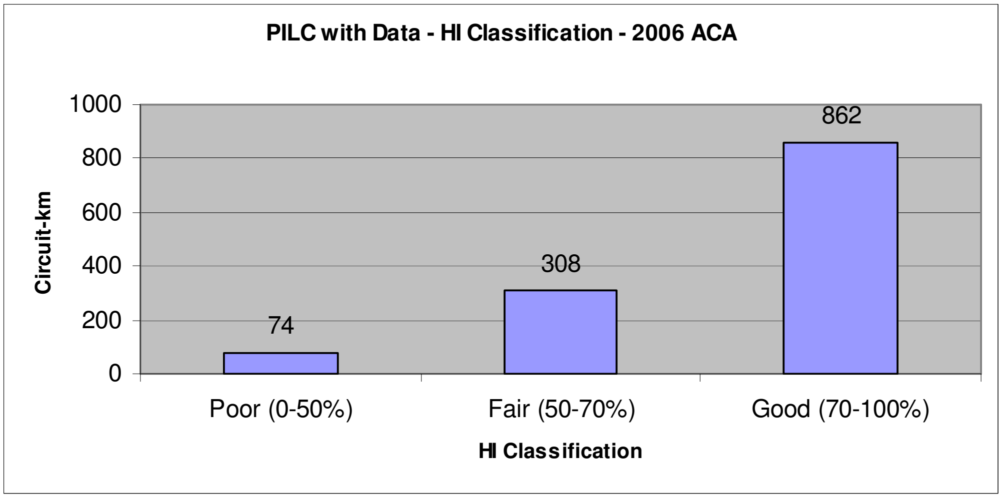


Figure 15-11 2006 HI Classification for PILC by Length

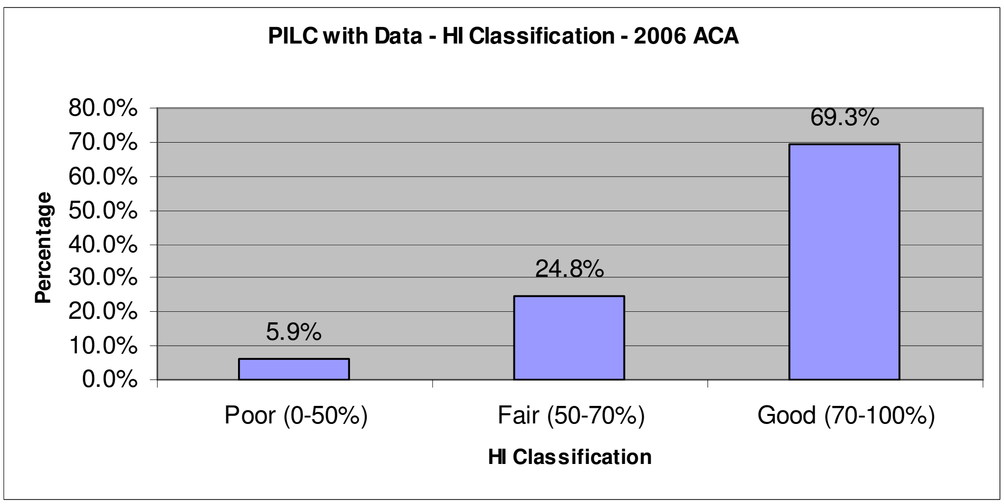


Figure 15-12 2006 HI Classification for PILC by %

Health Index Classification for XLPE – in Duct:

The 2006 data was insufficient to assess XLPE – in Duct. Although a Health Index assessment was conducted in 2009 where 100% of the cables were in very poor condition, the sample size (3 circuit-km) is not sufficient for extrapolation over a total population of 3049 circuit-km.

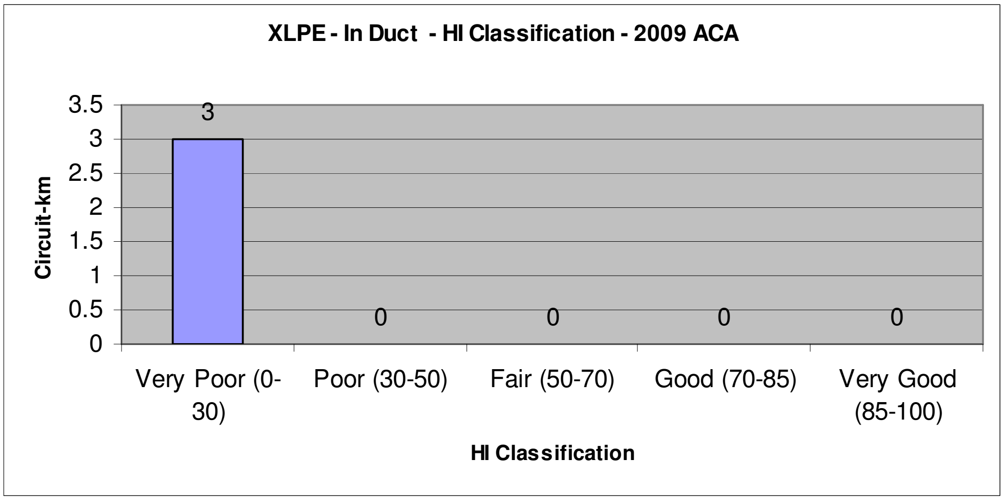


Figure 15-13 2009 HI Classification for XLPE in Duct by Length

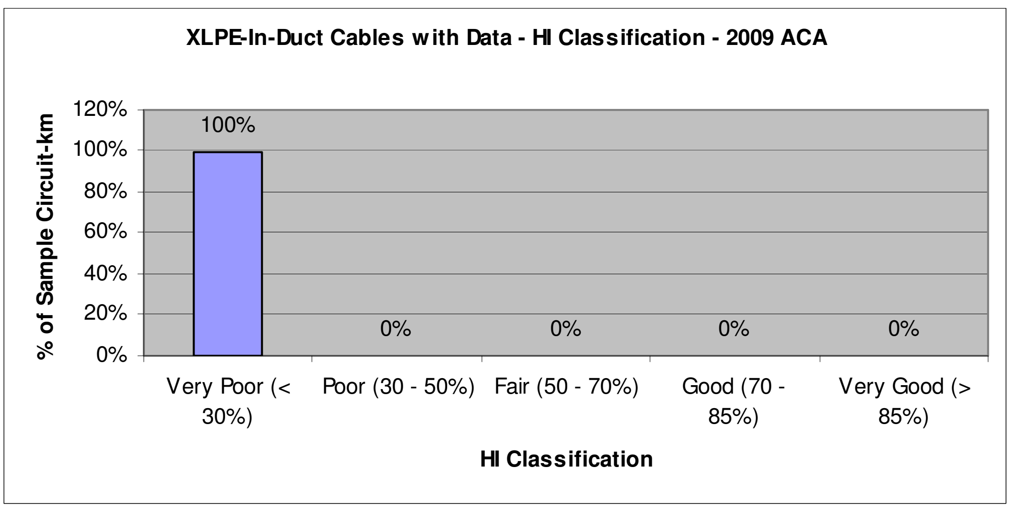


Figure 15-14 2009 HI Classification for XLPE in Duct by %

15.5 Recommended Health Index Formulation

An improved Health Index Formulation is presented in this section. It is recommended that this formulation be used for future asset condition assessments.

$$HI = \frac{\sum_{m=1}^{\forall m} \alpha_m (CPS_m \times WCP_m)}{\sum_{m=1}^{\forall m} \alpha_m (CPS_{m.\max} \times WCP_m)}$$

where

$$\mathrm{CPS} = \frac{\sum_{n=1} \beta_n (\mathrm{CPF}_n \times \mathrm{WCPF}_n)}{\sum_{n=1} \beta_n (\mathrm{CPF}_{n.\max} \times \mathrm{WCPF}_n)} \times 4$$

m = Condition parameter m
n = Sub-condition Parameter n

CPS = Condition Parameter Score
WCP = Weight of Condition Parameter

CPF = Sub-condition Parameter Factor
WCPF = Weight of Sub-condition Parameter Factor

α_m = Data availability coefficient for condition parameter m
(α_m = 1 when data available, α_m = 0 when data unavailable)
β_n = Data availability coefficient for sub-condition parameter n
(β_n = 1 when data available, β_n = 0 when data unavailable)

Tables depicting condition parameter scores and weights are shown below. Please refer to the Glossary section on *Health Index Formulation - Sub-System Definitions* for details on condition parameters.

XLPE Direct Buried Cables

Table 15-1 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	1	4
2	Operation condition	3	4
3	Reliability	4	4

Table 15-2 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Cable splice (cm)	1	4
2	Overall (total cm)	1	4
3	PD (measurement)	2	4

(cm) --- Corrective maintenance record

Table 15-3 Operation Condition (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Loading (measurement)	1	4

Table 15-4 Reliability (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	5-yr fault rate	4	4
2	age	3	4

PILC Cables

Table 15-5 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	1	4
2	Operation condition	2	4
3	Insulation	4	4
4	Reliability	3	4

Table 15-6 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Cable splice (cm)	1	4
2	Overall (total cm)	1	4
3	PD (measurement)	2	4
4	Oil leak (cm)	1	4

(cm) --- Corrective maintenance record

Table 15-7 Operation Condition (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Loading (measurement)	1	4

Table 15-8 Operation Condition (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Oil DGA (measurement)	4	4
2	Oil quality (measurement)	2	4
3	Oil power factor (measurement)	1	4

Table 15-9 Reliability (m=4) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	5-yr fault rate	2	4
2	age	1	4

XLPE in Duct

Table 15-10 Condition Weights and Maximum CPS

m	Condition parameter	WCP_m	$CPS_{m.max}$
1	Physical condition	1	4
2	Operation condition	3	4
3	Reliability	4	4

Table 15-11 Physical Condition (m=1) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Cable splice (cm)	1	4
2	Overall (total cm)	1	4
3	PD (measurement)	2	4
4	Cable duct bank (cm)	1	4

(cm) --- Corrective maintenance record

Table 15-12 Operation Condition (m=2) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	Loading (measurement)	1	4

Table 15-13 Reliability (m=3) Weights and Maximum CPF

n	Sub-condition parameter	$WCPF_n$	$CPF_{n.max}$
1	5-yr fault rate	4	4
2	age	3	4

16 Glossary of Terms

1. Asset Condition Assessment (ACA)

The purpose of Asset Condition Assessment is to detect and quantify the extent of long-term degradation and to provide a means of quantifying remaining asset life. This includes identifying assets that are either at or near their end-of-life or are at high risk of generalized failure and will require capital expenditures to either refurbish or replace them.

2. Condition Data Availability

An asset's condition data availability is the ratio of the sum of its maximum scores of available conditions to the sum of its maximum scores for all possible conditions. For example, say an asset has condition parameters A, B, and C with weights of 1, 2, and 3 respectively. Condition parameter factors are rated from 0 through 4, so the maximum factor is 4. The maximum score for a condition parameter is therefore given by (maximum factor)*weight. Thus, for conditions A, B, and C, the maximum scores are 4*1 = 4, 4*2 = 8, and 4*3 = 12 respectively. It follows that the sum of maximum scores for all possible conditions = 4+8+12 = 24. If asset X only has data for conditions A and B, the sum of maximum scores of available conditions = 4+8 = 12. Its condition data availability is therefore 12/24 = 50%. According to the 60% Condition Data Availability rule, asset X will not be included in the sample size because its condition data availability is less than 60%. Conversely, if asset Y has data for conditions A and C, its condition data availability = 16/24 = 67%, and it will be included in the sample size.

3. Condition Parameter

A condition parameter is an asset characteristic that is used to determine its Health Index. An assessment of the relative degree of importance of the different condition parameters is important in determining the overall health of the asset. Each condition parameter is measured against an established condition criterion using available data and must be assessed as falling into one of the four categories shown below:

Low Impact Condition Parameter	**Reflects defects or deterioration measure that have no impact on overall asset health e.g. Silica gel in Transformers**
Contributing Condition Parameter	**Reflects defects or deterioration measures that range from low to high in importance, but typically in combination with other measures as part of a formulation of generalized deterioration. e.g. Contacts in Circuit Breakers.**
Combinatorial Condition Parameter	**Reflects a measure which does not represent asset condition in isolation, but is a critical component in a complex logical and/or mathematical formulation of asset health. e.g. Oil Quality Test in Transformers.**
Dominant Condition Parameter	**Reflects the health of dominant subsystem or component that makes up the asset, and end-of-life based on this single factor can represent end-of-life for the entire asset. e.g. DGA Test in Transformers or remaining strength in Wood poles.**

4. Condition Ratings versus Condition Factors

For the purposes of formulating a Health Index, numerical values must be assigned to each of the condition parameters available for an asset. THESL uses condition ratings of 1-5. This is then translated to condition factors of 4-0. Condition factors are used in the numerical calculation of the Health Index. Factor/Rating are interpreted as:

THESL Condition Rating	Factors	Interpretation
1	4	Component is in "As new" condition
2	3	Some minor problems or evidence of aging
3	2	Many minor problems or a major problem that requires attention – THESL category 3 equipment "Repaired during maintenance were mapped into this category
4	1	Many problems and the potential for major failure
5	0	Completely failed or is damaged/degraded beyond repair.

5. De-Rating Factor

In some cases, a certain condition parameter is considered so important (a dominant factor) that a computed Health Index is "de-rated" if that certain condition parameter is found to be a certain value. For example, in station transformers, DGA Oil Analysis is a dominant factor. If DGA has a condition rating of 5 (i.e. factor = 0), the overall Health Index is divided by 2. Say that for station transformer X, the HI is calculated as 70%. However, its DGA rating is 5. Its HI will therefore be de-rated as HI = 70/2 = 35%.

6. Health Index (HI)

The Health Index quantifies equipment condition by comparing an asset's Condition Parameters with the Condition Criteria that are measures of the long-term degradation that cumulatively lead to an asset's end-of-life. Health Indexing differs from maintenance testing whose objective is finding defects and deficiencies that need correction or remediation in order to keep the asset operating prior to reaching its end of life. When using the Health Indexing method it is important to understand the differences between defect management and the resultant unplanned maintenance versus long-term asset condition assessment that evaluates long-term asset degradation leading to its end-of-life.

The Health Index can be used as a tool for assessing the overall health of a complex or relatively simple asset. Distribution assets may consist of several components, e.g. distribution station transformer, or be less complex, e.g. pole mounted transformer. In either case there may be one dominant mode of failure, or there may be several independent failure modes, either for components comprising the asset or for the asset itself. The Health Index combines scores indicating the condition of all of these Condition Parameters into a single indicator of the health of the asset.

The critical objectives in the formulation of a Health Index are:

- The index should be indicative of the suitability of the asset for continued service and representative of the overall asset health.
- The index should contain objective and verifiable measures of asset condition.
- The index should be understandable and readily interpreted.

7. Health Index Formulation - Sub-System Definitions

a) **Insulation:** a sub-system that indicates the overall dielectric status of an asset. This overall status is based on the evaluation of all the involved insulating materials such as insulating oil, polymer, porcelain, or other composite material.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: transformers, breakers, switchgears, and network transformers.

b) **Cooling:** a sub-system that indicates the overall operation temperature status for the asset whose life expectancy is closely correlated to temperature rise. This overall status is based on all the available indications of temperature rise, such as IR scan, temperature monitoring, cooling fluid leakage etc.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: all types of transformers and switchgear.

c) **Reliability:** a sub-system that indicates the overall probability of failure status for the assets whose statistical failure rate is closely correlated to their operation duration, loading mode or combined effect from multiple independent contributing factors. This overall status is based on the evaluation of all the involved conditions such as age, long-term loading trend and asset overall grading.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: transformers (all types), breakers, switches, and switchgear (all types).

d) **Operating Mechanism:** a sub-system that indicates the overall mechanical operation performance for circuit breakers and switches. This overall status is based on the evaluation of all components and factors that contribute to the mechanical operation, such as linkage, lubrication etc.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: breakers and switches.

e) **Contact Performance:** a sub-system that indicates the overall status of switching timings and contact degradation, for circuit breakers and switches. This overall status is based on the evaluation of all the switching timings as well as contact surface condition.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: breakers and switches.

f) **Arc Extinction:** a sub-system that indicates the overall status of arc extinguishing mechanism during breaking operation of circuit breakers and switches. This overall status is based on the evaluation of all the components and medium for extinguishing breaking arc, such as oil, gas, vacuum bottle, or the factors that affect arc extinction such as leakage, moisture etc.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: breakers and switches.

g) **Physical Condition**: a sub-system that indicates the overall status of outer surface defects visible during routine inspection. This overall status is based on the evaluation of the non-critical components to which one has direct assess, the factors that might hinder such direct access, or the working environment that might accelerate the deterioration of those components.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: switchgear, distribution transformers, poles and ATS.

h) **Sealing & Connection**: a sub-system that indicates the overall status of physical interfaces among the major components of transformers. This overall status is based on the evaluation of all the component interfaces, such as cable connection, tank gasket etc.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: station transformers and network transformers.

i) **Control**: a sub-system that indicates the overall status of attached control circuitry for switchgear and ATS. This overall status is based on the evaluation of all the components in control cabinet, such as relay, light, sensor, fuse etc.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: switchgear and ATS.

j) **Overall:** a sub-system that indicates the overall status of non-electric structures. This overall status is based on the evaluation of all the involved conditions such as age, estimated life and asset overall grading.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: poles, cable chambers and network vaults.

k) **Access:** a sub-system that indicates the overall status of operation convenience and work environment of non-electric structures. This overall status is based on the evaluation of work clearance as well as presence of hazard materials.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: cable chambers and network vaults.

l) **Environment:** a sub-system that indicates the overall status of presence of toxic PCB stuff. This overall status is based on the detection of PCB content in distribution transformers.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: distribution transformers.

m) **Switch/Fuse:** a sub-system that indicates the overall status of switches and/or fuses inside switchgear. This overall status is based on the evaluation of the physical conditions of switches and fuses by means of visual inspection.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: all types of switchgear.

n) **Structure**: a sub-system that indicates the overall status of civil structure. This overall status is based on the evaluation of the conditions of roof, walls and floors.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: cable chambers and network vaults.

o) **Mechanical & Electrical:** a sub-system that indicates the overall status of pole characters. This overall status is based on the evaluation of both the mechanical strength and the soil condition.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: different types of poles.

p) **Pole Accessories**: a sub-system that indicates the overall status of pole hardware. This overall status is based on the evaluation of all the hardware attached to poles, such as guy wire, ground etc.

   The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: different types of poles.

q) **Ventilation:** a sub-system that indicates the overall status of structure interior contamination. This overall status is based on the evaluation of all the detrimental findings inside a structure during routine inspection.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: cable chambers and network vaults.

r) **Lighting:** a sub-system that indicates the overall status of structure interior lighting, cabling and ducting. This overall status is based on the evaluation of all such components inside a structure during routine inspection.

The Health Index formulation weighting of this sub-system depends on the degradation mechanism of an asset. Assets that employ this sub-system are: cable chambers and network vaults

8. Population

Population refers to the total number of assets within the asset group.

9. Sample Size

Sample Size refers to number of assets within an asset group that have sufficient condition parameter data for Health Index calculation.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 24:

Reference(s): C2/T2/S2/p. 20

THESL has plans to spend $11.9 million in 2010 on Facilities and an additional $13.2 million in 2011. What has been spent to date in 2010[?] Of the projects planned please identify those that could be deferred until 2012 or later.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

RESPONSE:

THESL has commitments to spend $12.5M on facilities for 2010.

2011 Projects That Could Be Deferred	Amount ($M)	Comment
Building Automation & Control at 14 Carlton	0.2	Will limit ability to take full advantage of improved mechanical equipment to reduce energy use.
Computer Room Fire Suppressions System (14 Carlton, 5800 Yonge, 28 Underwriters)	0.25	This is not a mandatory requirement, however replacement of the existing halon system is a good business practice
500 Commissioners – Supply & Install Generator	$0.52	The current generator is under capacity to serve the entire facility in an emergency. From past experience, THESL has determined that the entire facility needs to be operational to better address emergency situations.
500 Commissioners, 14 Carlton, 5800 Yonge – Miscellaneous Mechanical & Electrical replacements & Upgrades.	$0.60	These components are operational but are nearing or have exceeded their normal life. Replacing these components (compressors, backflow preventers, faucets, lighting, electrical panel, unit heaters, transformers, water heaters, booster heater, etc) will improve building efficiency and reduce energy use.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 25:

Reference(s): C2/T3/S3/p. 9

External Services – Civil Construction costs are increasing by $41.3 million in 2010 and $32.2 million in 2011. Please provide a detailed explanation for each year as to why these costs are more than doubling relative to historical levels. Please explain the methodology used to forecast these costs.

RESPONSE:

As shown in Exhibit D1, Tab 7, schedule 1, the capital program has increased from 2008 to 2011 as shown below:

	2008 Actual	2009 Actual	2010 Bridge Year	2011 Test Year
Total Capital	205.7	241.7	351.1	498.0

Within the total capital program, the following portfolios and programs consisted of civil construction required to support those portfolios and programs:

	2008 Actual	2009 Actual	2010 Bridge Year	2011 Test Year
Total Capital with Civil Constructions	164.9	171.2	261.5	367.4
Corresponding Civil Construction as per Exhibit C2, Tab 3, Schedule 3	48.2	46.4	89.5	121.8

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

The increase in civil construction for 2011 Test Year is prorated based on past civil construction costs and is in-line with the increase in capital portfolios and programs that required civil infrastructure.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 26:

Reference(s): D1/T1/S1/p. 3

Please provide an updated opening balance for 2011 based on THESL's most recent forecast of capital additions for 2010. Please explain the assumptions around the updated calculation.

RESPONSE:

The updated fixed assets opening balance for 2011, based on THESL's most recent forecast of capital additions for 2010 is $4,183.5 million. This represents a $22.1 million variance from original filed 2011 opening balance. This variance is due to the estimated delay in capitalization of the IT Customer Information System ("CIS") project.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 27:

Reference(s): D1/T3/S2/p. 3

Please recast Table 3 to include Board approved levels for 2009 and 2010.

RESPONSE:

The Board did not approve or disapprove any specific line item that makes up the total net fixed assets. The Board did approve a total net fixed assets amount of $1,867.1M for 2010, and $1,775.7M for 2009.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 28:

Reference(s): D1/T7/S1/p. 16

Please recast Table 2 – Summary of Capital Investments to include Board approved numbers for 2008-2010. In addition, please provide the most updated forecast of the 2010 capital budget.

RESPONSE:

a) The Board does not approve or disapprove any specific line item within the Company's claim. The Board indicated in its Decision with Reasons on EB-2007-0680 that it does not seek to micro-manage the Company's business, only to approve a controllable expenses budget that is fully supported by the evidence, including the evidence of historical spending norms. The total Board-Approved Capital spending was $230.1 million, $240.1 million, and $350.0 million, for 2008 to 2010, respectively.

b) Please see response to BOMA Interrogatory 10 at Exhibit R1, Tab 3, Schedule 10.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 29:

Reference(s): D1/T7/S1/p. 16

Please indicate the estimated impact on the revenue requirement of a $10 million reduction in the 2011 capital budget. Please indicate the impact assuming a $50 million reduction in the 2010 capital budget.

RESPONSE:

Assuming the half-year rule, the impact of a $10 million dollar reduction would be a $5 million reduction in Rate Base for 2011. Based on the requested Cost of Capital of 7.03% this would result in a reduction in Revenue Requirement for 2011 of approximately $350,000. The impact of the reduced capital spend would also impact PILS and OM&A and depreciation. The impact on these components is impossible to estimate based on a blanket reduction as it will depend on what type of capital is reduced. Generally however, OM&A would be increased (less labour capitalized) and depreciation would be lower.

A reduction of $50 million of capital in 2010 has a full impact on Rate Base in 2011. Based on the 7.03% Cost of Capital, the reduction in Revenue Requirement for 2011 would be approximately $3.5 million (not including any resulting PILs, OM&A, and/or depreciation impacts).

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 30:

Reference(s): D1/T7/S1/P. 16

If the Board were to reduce THESL's capital budget to $350 million how would THESL go about implementing that reduction? Please identify all projects that could potentially be deferred until 2012 or beyond.

RESPONSE:

Please see response to Schools Interrogatory 46 part a) at Exhibit R1, Tab 9, Schedule 46.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 31:

Reference(s): D1/T7/S1/p. 16

THESL is increasing its Capital Budget from $205 million in 2008 to $498 million in 2011. Please explain, in detail how THESL has the capacity to ramp up its capital spending in such a significant way.

RESPONSE:

Approximately $200 Million of the increased Capital Budget is associated with contributions to Hydro One, the purchase of transformer station lands, technology enablement, general plant, and so on. For the remaining increase in capital, where extra resource capacity is required to modernize the infrastructure, THESL has adopted a multi-pronged approach:

- New staff hires are underway
- Specialized trades are being harmonized into multi-functional trades
- Planned overtime is being used where appropriate
- External contractors are being deployed where appropriate

These steps allow sufficient ramp up in capacity to meet the greater capital spend.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 32:

Reference(s): D1/T7/S1

For 2010 please provide a detailed list of projects over that have been deferred to 2011 or beyond and explain the reason for the deferral.

RESPONSE:

The following is a list of projects that have been deferred to 2011 or beyond:

PORTFOLIO 1 - UNDERGROUND DIRECT BURIED CABLE			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
13419	13419_001 W09264 Albion MG-F4 Kittiwake UG VC RLBT	2010/2011	Construction permit delays and change of scope requirements. Also, this led to switching restrictions in winter months.
13500	13500_001 W9265 Albion MG F1/F4 Sultan Pool	2011	Construction permit delays and change of scope requirements. Also, this led to switching restrictions in winter months.
13504	13504_001 W09266 Albion MG-F4 Hun Cres UG VC RLBTY	2010/2011	Construction permit delays.
13505	13505_002 W09267 Albion MGF4 Banda UG VC Rear Lot	2010/2011	Completion of this project is dependent on above projects.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

PORTFOLIO 1 - UNDERGROUND DIRECT BURIED CABLE			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
15219	15219_001 E09344 Crow Tr. NAr26M34 UG Cable Inject	2012	The experience from the recent cable injection project was not satisfactory. [Multple swiching and extended outages created customer annoyance. Injected cables failed number of times.] The decision from injection to rebuild needed some monitoring of the performance of the injected cables. The rebuild project now is planned for 2012 execution.
17013	17013_001 E08220 Leeward 53M9 UG rehab	2010/2011	City moratorium. Negotiations with the City on-going.
PORTFOLIO 2 - UNDERGROUND REHABILITATION			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
14054	14054_001 W10132 Ridelle Distribution ENCH	2010/2011	Delay due to Standards issue. Currently, this issue has been resolved.
15626	15626_005 E10182 Conlins Morningside NT47M8, M15	2011	Other emerging project priorities advanced

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

PORTFOLIO 2 - UNDERGROUND REHABILITATION			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
16235	16235_001 W5319 LAKESHORE B-5-10-PQ CONVERSION	2011	Change/improvement to project scope.
16307	16307_001 W09250 HL - Horner Ave Fdr Exp/ load	Cancelled	Feeder expansion and load transfer was initially required to accommodate a new large telecom company. The Development did not materialize.
16616	16616_001 W10275 Manby TS Load Trsf to Horner TS	2011	Delay in switchgear equipment purchase and installations by Hydro One at Horner TS.
16756	16756_001 Wallsend feeders tie	2010/2011	Co-ordination conflicts with City Water project.
16885	16885_001 Yorkdale SC Rbuild -2010	2010/2011	Co-ordination with customer.
PORTFOLIO 3 - OVERHEAD SYSTEMS			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
16168	16168_001 RC 4360 2010 edr Woodbine29M31 OH [50%]	Cancelled	Project initially required to accommodate Development. This did not materialize.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

PORTFOLIO 5 - TRANSFORMER STATIONS			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
15703	S10160 Wiltshire TS: Replace A1-2W SWGR	2011	Hydro One delay on switchgear interface
15450	S10157 Glengrove TS: Replace A5-6GL SWGR	2011	Manufacturer delay
16587	S10270 Carlaw TS: Purchase A6-7ET SWGR	2011	Civil work required leading to Legal-related delays
11885	S10008 Strachan TS: Replace A3-4T SWGR	2011	Hydro One delay on switchgear
PORTFOLIO 6 - MUNICIPAL STATIONS			
PROJECT NUMBER	PROJECT DESCRIPTION	EXPECTED IN-SERVICE DATE	REASON FOR DEFFERAL
14189	S10109 University MS-Repl 4 transformers	2011	Equipment delay

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 33:

Reference(s): D1/T8/S10

Please provide the 2009-2019 Electrical Distribution Capital Plan.

RESPONSE:

There is no 2009-2019 Electrical Distribution Capital Plan.

There was a 2010-2019 Electrical Distribution Capital Plan filed in the EB-2009-0139 filing and there was a 2007-2016 Electrical Distribution Capital Plan filed in the EB-2007-0680 filing.

Both filings can be found on the OEB website.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 34:

Reference(s): E1/T6/S1

DBRS states that it "expects capital investment to average approximately $300 million per year through 2011". Please reconcile this with THESL's plans to spend $498 million on 2011. How will this increased spending potentially affect the its rating reports[?]

RESPONSE:

It is clear from DBRS' report that the agency is quoting an average number. That is, DBRS is simply taking the total capital expenditures actually made in 2007, 2008, on a projected basis for 2009 (since the report was produced in 2009), and projected for 2010 and 2011, and averaging this total spend over five years to derive a figure of $300 million. THESL submits that the agency is likely incorporating the relatively lower-than-$300 million capital spend in 2007, 2008 and 2009, and averaging this with the relatively higher-than-$300 million capital spend projected for 2010 and 2011.

DBRS will likely not look to the capital budget in isolation. Rather, the rating agency will examine the entire Decision and all of the financial metrics which flow from the yet-to-be approved revenue requirement. Accordingly, THESL cannot, at this time, opine on how the increased capital spending could potentially affect DBRS' next ratings report.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 35:

Reference(s): Exhibit E1

Please explain THESL's dividend policy with the City of Toronto.

RESPONSE:

THESL has no dividend policy with the City of Toronto, nor does THESL have a dividend policy with THC.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 36:

Reference(s): **Exhibit E1**

Does THESL engage in discussions with its shareholder regarding the specific elements of its rate application. If not, why not? If so, please provide all materials provided to the City of Toronto regarding THESL's 2011 rate application.

RESPONSE:

THESL does not engage in formal discussions with its shareholder regarding the specific elements of its rate application. However, a verbal briefing on the rate application is given to the City CFO and the Deputy and City Manager by senior staff at Toronto Hydro.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 37:

Reference(s): M1/T1/S1/p. 2

The residential fixed charge is increasing from $18.25 to $20.95 per month. Please provide a detailed rationale for the change. Does THESL intend to communicate the rationale for this increase to its customers? Has THESL undertaken any research regarding consumer acceptability of this change? If not, why not?

RESPONSE:

As explained on page 5, lines 8 to 14 of the referenced exhibit, THESL has maintained the proportion of revenue collected through the fixed and variable rates at the same proportions as approved for 2010 rates for all rate classes except for the GS 1000-4999 kW and Large User classes (the fixed component for these classes is well above the ceiling rate determined in the Cost Allocation Model). The overall increase in revenue requirement plus the reduction in the revenue to cost shortfall for the residential class is driving the proposed increases in the fixed and variable rates proportionally.

THESL regularly communicates with its customers at the time of rate changes explaining the approved changes that will be reflected on their bills.

THESL has not undertaken any research regarding consumer acceptability of rate changes or the fixed/variable split.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 38:

Reference(s): M1/T1/S1/p. 2

Why does THESL regard it necessary to move the 2011 residential revenue to cost ratio to 92%?

RESPONSE:

As explained on page 4, lines 1 to 21, THESL has continued to move the revenue to cost ratios incrementally towards unity on the principal that each class should appropriately being paying the full amount of costs that they incur. THESL acknowledges that the cost allocation model involves judgment and estimation which may make the resulting revenue to cost ratios less than precise. However, THESL is comfortable enough with the model results to continue to move the revenue to cost ratios for all classes incrementally closer to full recovery. THESL believes the resulting changes are fair for all rate classes – both those shown to be under recovering, and those shown to be over recovering.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 39:

Reference(s): D1/T8/S7/p.2

Please provide one schedule setting out the total expenditures, by year, both capital and operating, that have been spent on the smart meter program since its inception. Please differentiate between residential and others. This will include, but not be limited to:

1. Total metering costs – both capital and operating costs
2. Total network costs (AMRC and WAN)
3. Total AMCC costs
4. Total costs related to MDM/R
5. Costs of any pilots
6. Cost for customer communication and education
7. Costs for incremental functionality
8. Any other costs considered part of the smart metering program

RESPONSE:

The requested information pertains to historical costs of THESL's smart meter rollout program, which is not an issue in this proceeding. THESL will provide comprehensive information on its historical smart meter program costs when it applies for clearance of the amounts in the smart meter deferral accounts. The Board has directed that that application not be brought until audited information is available for the year in which the rollout program is completed, 2010.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 40:

Reference(s): none

In the same format, please provide the forecast costs for 2010 and 2011. In addition, please provide a schedule setting out the annual recovery of smart meter costs from THESL's customers to date.

RESPONSE:

For 2010 and prior years' smart meter costs and cost recovery, please refer to the response to CCC Interrogatory 39.

For 2011, $12.6 million in capital cost has been included to complete the remaining smart meter installations: $1.2 million for residential meter installations, $10.8 million for commercial and industrial meter installations and $0.6 million for developing Wide Area Network and Local Area Network data collection functions.

The total Meter Services operating costs for 2011 of $4.8 million include $1.3 million in smart meter operating costs.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 41:

Reference(s): D1/T8/S7/p. 2

Please identify all costs related to THESL's MDM/R. Please provide a business case for these expenditures. Please explain how these costs are to be recovered. Please explain why THESL has chosen to develop its own MDM/R when it has been required to utilize the MDM/R developed by the IESO. To what extent is THESL seeking to recover costs from its customers related to the IESO MDM/R?

RESPONSE:

THESL does not operate an MDM/R. However, THESL's Operational Data Store (ODS) and billing system have the ability, among other purposes, to bill customers on a TOU basis, and THESL has been authorized by the province to use those systems for that purpose. The original business case for THESL's ODS is shown as Appendix A.

The costs for THESL's ODS, shown in Table 1, have been proposed through successive IT budgets, and are recovered through THESL's approved distribution rates.

Table 1: Capital Spending on Operational Data Store ($ millions)

2007Actual	2008 Actual	2009 Actual	2010 Bridge	2011 Test	**Total**
0.9	0.6	1.0	0.3	1.3	4.1

THESL will commence using the MDM/R for TOU billing when that system is ready to accommodate THESL's billing volume and after other utilities who have no alternative but the MDM/R to bill on TOU have been accommodated on that system.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

The Smart Meter Entity has not yet filed an application for a smart meter charge and the outcome of any such application is not yet known; therefore THESL cannot comment at this point on what MDM/R costs may be required to be recovered from THESL and its customers.

PROJECT BUSINESS CASE

PROJECT NAME: OPERATIONAL DATA STORE - SMART METER BACK OFFICE

CORPORATION: THESL

AFFILIATE: THESL

DATE: OCT 15, 2007

Prepared By:	Sponsored by:
Dave Barnes <Name> **SME Smart Meter Program** <Title> **IT&S** <Business Unit>	**Eduardo Bresani** <Name> **Chief Information Officer** <Title> **IT&S** <Business Unit>
Feasibility Approved By:	**Business Case Reviewed By:**
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Document based on "Business Case Template for 2008-09-10 V7.doc"

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1 Executive Summary

1.1 Strategic Purpose and Objectives

The Operational Data Store ("ODS") project extends the capabilities of the information systems being built for smart meter implementation. Business benefits accruing from this technical project include operational effectiveness through improved information management, decision support and streamlined business processes in the areas and functions specified below.

1.2 Solution Summary and Recommendation

Operational Data Store / Data Integration
Operational processes within customer care, metering services and billing require increased automation and exception management in conjunction with the introduction of large volumes of smart meters. Data integration and business process automation can facilitate the many new detailed processes and exception handling situations as smart meters are installed, registered with communications services, provisioned for data collection and commissioned into the customer billing processes. During 2007, the infrastructure base was developed for ongoing ODS development. With this in place, the 2008-10 activities add new customer types (specifically Commercial and Industrial in 2008) by building upon and also maintaining this framework.

An integrated view of energy use is required that captures the full range of customer installations and metering types regardless of loads or metering infrastructure. Meter changes and Advanced Metering Infrastructure ("AMI") support work require efficient work management and information management support. Operational Data Store / Data Integration support is designed to span the inherent technical differences of various AMI systems and data interfaces to various stakeholder systems. As AMI, Customer Information System ("CIS"), Customer Presentment and Meter Data Management / Repository ("MDM/R") systems evolve to address technical and functional requirements, the ODS & Data Integration components will support this managed migration with minimum disruption to THESL business operations.

1.3 Next Steps

The next step is to continue with the introduction of ODS throughout 2008-2010 to continue support of the balance of the Smart Meter back office implementation.

2 Proposal Description and Situational Assessment

2.1 Investment Categorization/Classifications

*	**Maintenance** investments are necessary to maintain the functionality and performance levels of the current asset base.
	Productivity investments focus on driving short-term profitability and asset utilization improvements within existing processes.
	Growth investments relate to an increase in the scale of the business without improving the underlying performance of the asset.
	Innovation investments present the testing of new opportunities to reveal productivity improvement or growth potential for scaled up initiative.

Installation and data quality from current and future Smart Meter installations relies on the information management and data integration abilities provided via ODS. The direct, programmatic interface between ODS and each AMI mean that ongoing configuration management during meter installs, repairs and replacements as well as events, alerts and alarms related to the operation of the AMI are directly coupled to TH business operations in a timely manner that support effective field operations and customer support.

	Regulatory – required to remain in regulatory compliance or to implement the direction of the government or regulator.
	Technology Refresh – required to maintain the usability of the current technology infrastructure and assets; upgrades or replacements at the end of asset life-cycles
*	**Strategic** – initiated to implement a corporate priority or key business strategy; aligns with corporate values and strategic direction.
	Discretionary – brought forward as a result of identified productivity gains, pre-emptive maintenance initiatives or in order to investigate potential for future productivity enhancements.

Use of information management repositories and data integration technologies is central to the IT&S strategic capability. ODS is an example of this approach to information management and integration in the area of Smart Meters. It employs SOA integration approaches to integration via the use of ESB and CIM based messages and Web services and is acting as the initial realization of this strategy.

2.2 Proposal Description

ODS is a necessary project for THESL due to the tight timelines to implement large quantities of Smart Meters. Installation of these meters can only be proven operational by the continued inspection of the information retrieved. The AMI / AMCC products that perform data collection for different varieties of Smart Meters are not adequate to ensure that the installations are done correctly. Validation routines within ODS use corroborating with comparable manual reads from Smart Meters during the provisioning process to ensure that Smart Meters are successfully and correctly installed in each customer location. Exceptions to the installation process, ongoing changes of account association of meters to customer delivery points (meter bases), the need to provide timely verification of data collection and or any editing and estimating processes applied to these meter readings and the ongoing management of the changes to the meter installations (troubleshooting, records of maintenance work to meters and communications systems) and other aspects of the Smart Meter program not otherwise addressed within the CIS, AMCC, MDM/R or other supporting systems are implemented, in a complementary fashion to these other systems, within ODS. This capability is delivered by the project-specific use of energy information management software. In this case, the software is sourced from eMeter Corporation. The software was selected through competitive procurement (RFQ for software and installation services). The timely implementation of this software has been key to TH progress on provisioning smart meters for use. With the ODS is in place, information containing within this data store is used by other components of the Smart Meter program to present information to customers on detailed energy use via the Web and to Customer Service Representatives (and later via IVR), to prepare the energy portion of the billing determinants for customers and to provide an integrated repository of energy use information regardless of customer type.

Coupling ODS via event and message based interfaces to AMIs to create this form of operational data store enables TH to handle the large volumes of information exceptions arriving from Smart Meters and to intelligently process the unique information flags and other AMI data that accompanies the meter usage data arriving from Smart Meters. Such additional information is key to qualifying the meter information that is to be presented to customers and used for utility billing. In the Ontario context, the ODS is being implemented as complementary functionality to the provincial Meter Data Management / Repository as a way to move the Smart Meter program both during the OEB declared Transition Period as well as for long term support of automated business processes such as SDP registration and data interchange with the MDM/R. Because this interchange will be done in a data neutral format already established by the MDM/R for their use, the existence of multiple AMI technologies from which TH Smart Meter data is sourced can be administered in a uniform manner. This ODS approach creates a set of extensible, event-based information services that support customer access, energy billing and other utility uses for information.

2.3 Scope

The project under discussion is the continued technology enablement and benefits realization of ODS on behalf of the Smart Meter back office during the 2008-2010 period. However, the following discussion provides the context in which the ODS will support other project implementation and provide continuing value. In late 2006 the necessary computer hardware for ODS was installed. In 2007, the ODS software was installed. ODS was then initialized with meter inventory and service delivery point information derived from CIS and historical and daily energy usage information from the Elster EnergyAxis AMI. In the 2008-2010 period additional AMIs will be added to TH's Smart Meter program to support the full range of residential and commercial installation and communications challenges. Also, the existing TH CIS will be retired and a new CIS put in place. Web presentment of Smart Meter information will be expanded from the pilot implementation undertaken in 2007. A flexible means for supporting a wide range of complex billing functions will be implemented including those for Time of Use rates and Hourly Spot Price. Integration with the provincial MDM/R will be undertaken. ODS will be instrumental in carrying out this 2008-2010 Smart Meter work program.

Out of scope for this ODS project are the technical and business uses of this technology for the capture and transformation of data and the support of automated business processes to address billing, customer presentment and other meter services and customer support tasks in support of the Smart Meter program.

2.4 Dependencies on other Projects/Work Processes

This ODS project is a necessary precursor to the other elements of the Smart Meter Back Office. The other projects assume the availability of the set of information and integration services provided by ODS.

2.5 Scenario/Alternatives Evaluation

Two alternatives to implementing an ODS were considered.

1. Installing the bulk of the THESL Smart Meters as “dumb” meters. This option entailed no immediate potential to validate the installation, troubleshoot any factors affecting the quality of collected metering data and no early prospect for using collected meter usage information to inform customers about the impact of forthcoming time-

of-use rates. A key risk was identified of this installation approach was that the AMCC was insufficient to validate the meter installations as fully operational. One critical aspect of this was that with wireless reads available via AMI, it is especially important to ensure that the meter is identified with correct premise – the confirmation of meter to location that come from manual, physical reads go away once the AMI is performing the reads.

2. Connect THESL CIS and AMI systems directly to the provincial MDM/R when it was ready for implementation and to perform the LDC-specific information management and exception handling without the benefit of an ODS. This option implied a design with very limited opportunity to automate the exception processing of billing and meter services issues. This option would also significantly constrain the ability of THESL to ensure the integrity of LDC business processes in the area of meter installations and changes, complex cancel/rebill, rate adjustments and impede or delay the impact analysis of rate changes on cash flow, or delivery of price-adjusted load profile information to customers (to preview or document the price impact of time-sensitive rates). A key risk was that the MDM/R would not be ready to accept the scale of TH information before the bulk of the initial target of 400,000 Smart Meter units had been installed.

3 Solution Descriptions

3.1 Strategic Alignment (Business and IT&S)

ODS is strategically aligned with IT&S's technical direction to apply information management and integration technology for support of business process automation. Under the strategic direction, raw information from complementary sources is to be transformed and combined in ways that enhance business decision support and enhance the ability of THESL management to monitor and manage its areas of key performance in customer relationship management, revenue processes and asset management (metering). This integration and management is to be achieved by the introduction or reusable information services under the general guidance of Service Oriented Architecture principles.

3.2 Resource Requirements

This business case captures the software, hardware and internal and contracted information technology resources necessary for the introduction of the ODS system. These resources and costs are as documented in the corresponding POD

3.3 Implementation Timelines

Overall guidance on the project duration and stages of implementation are as provided in the POD.

3.4 Risk Analysis (Internal)

- **Implementation Risks:** (solutions failure, partial failure, delays)

  Implementation risk is moderate because of the relative immaturity of the software available for the management and manipulation of such large volumes of data as are being presented and manipulated daily by ODS and as applied at THESL. On a relative scale, the THESL business size is small to moderate compared to other distribution utilities world-wide that have adopted this approach to facilitating the introduction of large numbers of smart meters into their service territory.

- **Potential Impacts: (strategic, financial, customer satisfaction, market share, operational performance, KPI performance)**

  As a key technical component of and necessary precursor to further implementation of THESL's Smart Meter program, the ODS project is necessary to achieve the business and public policy objectives within THESL that have been outlined for the Smart Meter Initiative as a whole within the Province of Ontario.

- **Risk Mitigation Actions to: (remove risks, reduce probabilities, lessen impact of occurrences)**

  Governance procedures, systems delivery life cycle and good project management practices are being applied to spot schedule and project risks and devise effective risk mitigation approaches.

- **Do Nothing Risk Comparison: (impact of solution risks versus impact of status quo)**

  After extended analysis, it was concluded that the timeline and scope of THESL's Smart Meter program would not be possible without the inclusion of the ODS capability. If ODS was precluded for technical or other reasons, the ability of THESL to contribute as substantially to the Smart Meter Initiative in the numbers and at the pace that has been demonstrated would not have been possible.

3.5 Organizational Change Impact

People / Process

- Business processes within Metering Services are substantially altered for the better as the ODS implementation matures and reaches its goals of being used to integration information and processes across the multiple AMIs that are deemed necessary to achieve universal Smart Meter deployment at THESL. So, after an initial period of adjustment and learning, it is expected that the simplifying impact of ODS will substantially advance the ability of Metering Services to address the vastly increased use of interval-capable, remotely-interrogated meters i.e. Smart Meters.
- Customer Care and Billing services are expected to be similarly advanced as new rates and customer inquiries related to these rates are introduced and the ODS provides a flexible complex billing engine to produce the needed range of billing determinants.
- Information technology staff are challenged to learn the introduction of new SOA architectures and new approaches to program and project work as used in the context of the ODS implementation. This learning however, is essential to all future information technology implementations planned for THESL.

Technology (Architecture / Security / Infrastructure)

- Introduction of new elements of information and integration architecture, distributed systems security and technology infrastructure occur with the ODS project.

Support / Maintenance

- Maintenance of distributed, high performance systems requires an increased level of systems documentation, training and troubleshooting skills for both infrastructure and applications support staff.

3.6 Key Assumptions and Constraints

Assumptions

- ODS is based on standard software products and requires little customization for the THESL implementation. The majority of the ODS implementation effort involves the configuration of the infrastructure and software and the loading of data.
- ODS project deliverables are dependent on the software release schedules of the ODS vendor (eMeter).
- Issues of performance, scale and data volumes are to be addressed through increased computer hardware and software optimizations that occur in the natural course of software releases and improvements over time and that these improvements are expected to be timed to address the growing processing requirements for the THESL implementation of ODS technology.
- Each new AMI deployed for the support of a segment of TH's Smart Meter deployment plan introduces AMCC technology that must be addressed. ODS takes all AMI information and processes and renders these as uniform information and services that can be used by THESL business processes including its need to integrate with the MDM/R.
- Standard AMI software adapters from the ODS supplier (eMeter) will exist for each of the new AMIs that TH needs to implement to complete its Smart Meter program.

Constraints

- The backlog of meter installations that still require provisioning into the ODS means that a large effort is still required to load and qualify all the meter asset, delivery point information and other information required to provision and commission these and new Smart Meters into the existing and future CIS billing and Web customer presentation functions.

3.7 Critical Success Factors

- Continuity of the teams working on ODS or the successful handoff through documentation and training between implementers and support staff are key to the continued, effective support of this system.
- Timely and high quality software releases from the ODS supplier, as required to achieve the timing and scale of the THESL implementation, are necessary for project success.

4 Financial Valuation

4.1 Tangible Cost and Benefit Analysis

The POD captures the expected areas of and scale of business benefits. The key observation is that ODS is an enabling technology. Other parts of the Smart Meter program need to be successfully carried out to realize the listed benefits. The size of the posted benefits assumes that the introduction of Smart Meters will cause a significant increase in effort to deal with the customer inquiries that are expected to result from general or even widely adopted application of time-of-use rates. The projection is that clerical and supervisory staff needed to address all these inquiries and billing exceptions would substantially increase with large-scale deployment of Smart Meters. Therefore ODS tangible savings are based on offsetting these projected increases of such labour. The offsetting is to be achieved by the extensive use of business process automation and event-based or service-oriented integration. The benefits that are being ascribed to the ODS project arise from implementation savings within the Smart Meter program as compared to alternatives. Because the AMI and CIS integrations to ODS are specific to the TH systems but employ industry inspired data interchange standards, the degree of automation possible is greatly in excess of what might otherwise be contemplated. The resultant benefits are in improved work management within customer care, billing, meter services and reduced change management costs within these departments and within information technology. These complement the expected benefits in resolving estimating and editing exceptions, troubleshooting problems with smart meters and billing exceptions, streamlined service processing, improved operational reporting, accounts receivable cash flow analysis and information presentation capabilities to customers. These represent functions that are essential to LDC operation arising from the introduction of Smart Meters (but are not included in the scope of the MDM/R).

4.2 Intangible Costs and Benefits / KPIs

- ODS is the technical basis for delivering a range of future business benefits -
    - ODS provides the means to render all customer loads into a common energy information data store from which THESL business units can extract details of hourly consumption, track patterns of energy use by neighbourhoods, attached distribution equipment, by classes of customer etc. This general capability to provide such timely, detailed energy information is expected to become invaluable during the substantial distribution asset renewal program currently getting underway at THESL. This form of data analysis and data mining assumes that data relationships can be built and sustained between meters, premises, service transformers, planning districts, work orders, customer classes etc.
    - Processing of outage flags captured by Smart Meters and then held within ODS will provide a detailed information source that can be exploited to target maintenance and rebuild activities that target customers and areas that are experiencing reliability below the design thresholds established by THESL for and with its customers and as monitored by OEB on behalf of THESL's customers.
    - Processing of tamper flags captured by Smart Meters for revenue protection purposes.
    - Processing of voltage information from Smart Meters to populate a distribution system voltage profile for measuring adherence to electric system distribution standards and energy delivery quality.
    - Facilitate the indirect addressing between source systems and multiple AMIs to conduct on-demand reads, remote disconnects for outage management and revenue protection.
    - Facilitate the balancing of wholesale, primary and secondary metering to itemize and localize wholesale billing issues, line losses, power diversions, and equipment overheating problems.

4.3 Summary of Project Valuation

Summary financials are as contained within the corresponding section of the POD.

5 Conclusion and Recommendation

We recommend that the $1.0M budget as defined within the 2008-2010 for the ODS project be approved and that we continue with the execution of this project. This budget reflects the continuation of the realization of benefits after the bulk of the software, hardware and implementation services have been undertaken in 2006-2007.

6 Appendix 1 – Details of Cost Estimation Process

The cost estimates are based on the original project estimates conducted by Dave Barnes and updated based on the experience to date with implementing and realization of benefits from the ODS project in 2006-2007. The 2008-2010 estimates are extrapolations based only on the technical portion of the ODS implementation and expected to be quite reflective of the expected costs. Possible exceptions to this estimate would be if scaling-up of the ODS solution introduced an unexpected need for additional computer hardware to achieve the intended full coverage of Smart Meters for all THESL customers. The hardware configuration was sized for full use and any increased performance is expected to be obtained, in a timely fashion, through continued software enhancements as made available to THESL through the annual software maintenance contracts (whose cost is included in the annual OPEX portion of the cost projections). Any costs related to extending ODS beyond the full set of current residential and C&I customers (including normal organic growth which is addressed under maintenance protection) such as with retrofitting bulk metered condominiums with suite metering is outside of the scope of this cost projection.

	Rough Order of Magnitude - no specific solution selected, estimate based on heuristics or rule of thumb
*	**Solution Level** - a number of solutions were looked at briefly as points of reference for our estimate
	Project Level - a specific solution has been selected and cost estimates closely reflect the implementation costs

7 Appendix 2 – Details of Benefit Estimation Process

Overall, Smart Meters are intended to direct customers to new energy usage habits or otherwise move customers to acceptance of the inherent time-sensitive nature of electricity pricing and thereby get customers closer to paying for the actual electricity cost as it relates to both the volume and time of their usage. As a regulated public policy initiative, Smart Meters neither increase revenue for THESL (in fact it is likely to reduce the energy useage driven portion of the distribution charge as conservation is effected) nor reduce distribution activity costs. The tangible benefits emerge when the overall impact of Smart Meters is considered in the context of the overall electricity sector including generation and transmission requirements and costs.

So, the objective of the THESL Smart Meter program must be to implement in a cost effective manner, get reasonable recognition of implementation costs through rate recovery and make efforts throughout to reduce and contain the operating costs that flow from this new initiative.

Introduction of Smart Meters will likely carry long-term increased operating costs for THESL even with active cost containment and careful management of the program. The intention of the ODS portion of the automation program is to offset these costs where they are knowable in advance by preparing technical solutions that would more than offset business labour costs or forestall problems with service delivery (due to shortage of available staffing).

The ODS project is being conducted to support the Smart Meter program through a form of technology enablement that allows the program to proceed in a timely and flexible fashion. Benefits for ODS are therefore estimated on the basis of containing costs through automation of those processes that would otherwise result in an increase in labour costs to provided necessary and regulated customer services.

The apportioning of the cost containment benefits between ODS and other elements of the Smart Meter Back Office is based on giving specific recognition to the process simplifications made possible by ODS. The simplifying effects of ODS are such that it allows one set of business processes to be built and operated regardless of the multiple AMIs required and the planned change of CIS within the timeframe for the implementation of the Smart Meter program.

	Rough Order of Magnitude - no specific benefits referenced, estimate based on heuristics or rule of thumb
*	**Solution Level** - a number of generic benefits were looked at briefly as points of reference for our estimate
	Project Level - specific benefits and costs savings have been quantified

The likelihood of the process simplifications taking place and the benefits realized depends on those projects that follow from ODS. So, each successive AMI that is introduced and the design and implementation of the replacement CIS are being conducted to rely on ODS capabilities and thereby avoid some of the data management and integration complexities that would otherwise exist within these projects.

PROFIT & LOSS (C$'000)	Initial	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16
Net Initial Investment Outlay (Capital Exp.)	**$ (3,572)**	**$ (2,673)**	**$ (764)**	**$ (50)**	**$ (150)**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Cash inflow		**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operating, Support, & Maintenance Costs (Operational Exp.)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Earnings Before Interest, Taxes, Depreciation and Amortization		**$ (2,673)**	**$ (764)**	**$ (50)**	**$ (150)**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Depreciation		$ (535)	$ (687)	$ (697)	$ (727)	$ (727)	$ (193)	$ (40)	$ (30)	$ -	$ -
Operating Profit (EBITDA - Depreciation)		**$ (3,208)**	**$ (1,451)**	**$ (747)**	**$ (877)**	**$ (727)**	**$ (193)**	**$ (40)**	**$ (30)**	**$ -**	**$ -**
Interest Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pre-Tax Income (Operating Profit - Interest)		**$ (3,208)**	**$ (1,451)**	**$ (747)**	**$ (877)**	**$ (727)**	**$ (193)**	**$ (40)**	**$ (30)**	**$ -**	**$ -**
Tax (@ 36.12%)		$ 1,159	$ 524	$ 270	$ 317	$ 263	$ 70	$ 14	$ 11	$ -	$ -
Net Operation Profit After Tax		**$ (2,049)**	**$ (927)**	**$ (477)**	**$ (561)**	**$ (465)**	**$ (123)**	**$ (26)**	**$ (19)**	**$ -**	**$ -**
Depreciation		$ 535	$ 687	$ 697	$ 727	$ 727	$ 193	$ 40	$ 30	$ -	$ -
Interest Income		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Net Free Cash Flow		**$ (1,515)**	**$ (240)**	**$ 220**	**$ 167**	**$ 263**	**$ 70**	**$ 14**	**$ 11**	**$ -**	**$ -**
Cumulative Net Cash Flow		**$ (1,515)**	**$ (1,754)**	**$ (1,534)**	**$ (1,367)**	**$ (1,105)**	**$ (1,035)**	**$ (1,021)**	**$ (1,010)**	**$ (1,010)**	**$ (1,010)**
Discount Rate (@ 5.3%)		1.00	0.95	0.90	0.86	0.81	0.77	0.73	0.70	0.66	0.63
Discounted Net Cash Flow		**$ (1,515)**	**$ (228)**	**$ 198**	**$ 143**	**$ 214**	**$ 54**	**$ 11**	**$ 8**		
Cumulative Discounted Net Cash Flow		**$ (1,515)**	**$ (1,742)**	**$ (1,544)**	**$ (1,401)**	**$ (1,187)**	**$ (1,133)**	**$ (1,123)**	**$ (1,115)**	**$ (1,115)**	**$ (1,115)**

NPV ($'000)	**$ (1,115)**
IRR (%)	**Not Available**
PROFITABILITY INDEX (#)	**0.7**
DISCOUNTED PAYBACK PERIOD (YEAR)	**No Payback**
ROI (%)	**-0.31**
EQUIVALENT ANNUAL ANNUITY ($'000)	**-$ 260**
Return on Equity (ROE)	

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 42:

Reference(s): Exhibit D1, Tab 8, Schedule 7

Has THESL done any type of cost-benefit for its smart meter implementation plan? If not, why not? Would THESL be prepared to undertake such a study? If not, why not?

RESPONSE:

THESL, along with all other Ontario utilities, was mandated by the province to undertake a smart meter implementation plan and therefore the question of a cost-benefit analysis of the plan is not at issue. THESL is not now prepared to undertake such a study, in part because the costs are no longer prospective and such a study could not affect the decision to undertake them, and in part because the benefits of smart meters cannot be independently assessed without information on future TOU rates and consumer price elasticities of demand. THESL does not have adequate information on either of these latter items.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 43:

Reference(s): **G1/T1/S1/p. 3**

Please provide all of the relevant business cases for THESL's smart grid projects. Please explain how the budgets for these projects were derived.

RESPONSE:

Each of the smart grid projects has been subject to a business case analysis. THESL's efforts have been dedicated to actively explore the needs of developing the smart grid in compliance with provincial mandate and in meeting utility and distributed generation requirements. THESL also has the responsibility to explore, be familiarized with, and apply new technologies considering the uniqueness of its customer base and infrastructure. However, not all projects have gone through an economic assessment as explicit benefits and costs have yet to be measured The primarily purpose of the demonstration is to learn about the technology, its impact to THESL operations, and to collect information which will enable THESL to further evaluate the potentials of project deployment.

The business case analyses for each of the 2011 initiatives are discussed in Exhibit G1, Tab 2, Schedule 1. Each project is fully aligned with the definition and requirements of the GEGEA, THESL's corporate strategy, and the smart grid objectives as described in Exhibit G1, Tab 1, Schedule 1, page 2.

The budget for each project was developed based on determining the scope of the project that would be appropriate and sufficient for demonstration of the benefits of the project.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

Available external resources were considered (e.g., government funds, vendor trial supplies), and material and labour cost requirements were then calculated.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

INTERROGATORY 44:

Reference(s): G1/T1/S1/p. 8

Please provide an updated budget for THESL's 2010 smart grid projects based on actuals spent to date.

RESPONSE:

The updated budget for THESL's 2010 smart grid projects based on actuals spent to date is included in the Tables 1 and 2 below.

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

1 **Table 1: 2010 Actuals Spent to Date for Smart Grid Projects – Operations**

Project	Description	Capital and Operating Cost ($000s)	Actual YTD Capital and Operating Cost ($000s)
Feeder Automation	Intelligent fault recovery on distribution switches	2,680	3,084
Secondary Network Automation	Microprocessor relays and SCADA communications in the secondary network	115	0
Transformer Smart Metering	Smart meters installed on distribution transformers	184	2,336
Power Line Monitoring	Monitors installed on overhead line conductors	41	19
Submersible Vault Monitoring	Monitors installed in submersible transformer vaults	10	
Environmental Protection	Studies and demonstrations to support distributed generation and plug-in vehicles, and in developing effective customer energy management programs	450	
Total Distribution Expenditures		**3,480**	**5,440**

INTERROGATORIES OF CONSUMERS COUNCIL OF CANADA

Table 2: 2010 Actuals Spent to Date for Smart Grid Projects – Information Technology

Project	Description	Budget Capital Cost ($000s)	Actual YTD Capital Cost ($000s)
Customer Display Integration – Pilot	Introduction of customer displays (pilot project) and integration with other corporate systems	200	0
Web Energy Portal	Update the customer portal with additional functionality to support energy management	400	714
OMS Integration – Customer Portal	Integrate OMS information with the customer portal	300	0
Smart Meter Connect / Disconnect Pilot	Pilot the functionality to remotely connect / disconnect smart meters	100	0
Smart Meter – Outage identification – pilot	Pilot the functionality to utilize smart meters for the purpose of outage identification (last gasp function)	100	0
Network Meters Integration – pilot	Pilot the integration to new network meters (transformer meters)	100	0
Network Monitoring Integration – pilot	Pilot the integration to new network monitoring devices (power line monitoring devices, vault monitoring devices)	100	0
Integration Architecture and Design	Design and implement the infrastructure required in support of integrating Smart Grid hardware and applications.	1,281	185
Access Network – Pilot	Deployment of a pilot wireless network in a selected area of Toronto	310	1,162
Internal Network Readiness	Internal Network upgrade required in support of Smart Grid devices and applications	1,400	0
Smart Grid Network Security	Changes to the security infrastructure and processes in support of the implementation of the smart grid.	1,671	0
Total IT Expenditures		**5,962**	**2,062**