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1 Executive Summary

Year 2000 issue seems to be a simple problem that is intuitively understood. However, solutions vary and are complex in nature. The core of the problem is in the encoding of a year as two digits in the hardware elements and software in computers and other technologies. This encoding, for example, can cause the hardware and software to malfunction. These malfunctions can be in the form of:

- Mistakes in calculating, comparing, sorting (in anyway), or sorting (with numerals) arithmetically that causes the failure or logical operations, relational operations, and other operations;
- Problem of recognizing leap years;
- Conflicts with values in data used in non-date-related, i.e. "no date provided" or "never expires"' and
- Date fields overused

In general, Year 2000 Compliance means that the functionality is not affected by dates before, during, and after the year 2000. This means that

- Date based functions must run consistently before, during, and after year 2000 dates. The non-existence of date value functioning at the point in time will cause various operational interruptions.
- In all data interface and storage, the century for all dates must be specified explicitly or in clear algorithm or inference rules.
- Year 2000 must be known as a leap year.

Much of a power system, from generation to distribution, incorporates computers and embedded systems. Power plants use digital distributed control systems, programmable logic controllers, data acquisition systems, and chips and systems that monitor smokestack emissions. Transmission networks have control systems that regulate the flow of electricity and microprocessor-based safety relays that protect them from overloads.

The electric power industry is complex and highly automated. The industry is made up of an interconnected network of generation plants, transmission lines (commonly referred to as the "grid") and distribution facilities responsible for providing electricity from the grid to every household and company in the world.

The interconnectedness of grids gives the power system unprecedented reliability and efficiency, but on the other hand this very interconnectedness makes the grid fragile and susceptible to YEAR 2000 disruptions. An outage in one part of a grid can cascade, causing ripple effects on other parts of the grid. It takes a high degree of automation to operate the grid. Power control systems, energy management systems, supervisory control and data acquisition (SCADA) systems, telecommunications systems, and substation control systems, all use automation and computerization, and are vulnerable to YEAR 2000 problems.

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Left unaddressed, YEAR 2000 anomalies could lead to the malfunction of software programs on mainframe computers, servers, personal computers, and communications systems. Corrupted data could be passed from one application to another, causing erroneous results or shutdowns.

While several developed countries seem to have made impressive progress in their power system Year 2000 readiness, the current situation does not look that great for the developing countries. Several weaknesses have become known while conducting test drills and simulations on power systems across the world. Section 2 lists a summary of some such reported incidences in Brazil, US, UK, and Sweden. Although US, UK and Sweden are expected to be mostly compliant by December 31, these incidents serve as an indicator of the troubles that can be expected post-Y2K.

Electric power has to be transmitted over long distances, since it is only rarely generated and consumed at the same location. Power stations and transformer substations at the regional level are served by a grid operated at 220 and 380 kV. Electric power is mainly distributed in secondary and primary distribution system (up to 20 kV) but also in systems up to 110 kV, especially in areas where the load density is high, and there are large-scale consumers. Section 3 provides a brief summary of potential problems and failures that may show up at different components of a power system. Blackouts of power systems that affect large areas are rare. However, when they do occur, it may be extremely difficult to thoroughly investigate them and find their real causes. Section 3 also elaborates on how vulnerable the different components of power systems are to the YEAR 2000 threat, and what are the Year 2000 threats to the system components.

Section 4 focuses on regional assessment of Year 2000 impact and outlines the regional preparedness in the power systems sector. It must be cautioned that in many ways, taking a global perspective on the problem can create a deceiving vision of YEAR 2000, since technology itself is spread unevenly around the globe. The lack of technology in some countries and its late adoption in others will help to mitigate against some of the global meltdown scenarios painted by YEAR 2000 alarmists.

Several studies, reports, surveys etc. have been published stating the YEAR 2000 preparedness of global power systems and on the expected impact due to system malfunctions. There is a very wide range of opinions about system readiness. The verdict is mostly dependent on whom one listens to. Several factors from 'national pride' to 'ignorance' result in distortions of the facts. Most nations, on their official YEAR 2000 sites (see References, Section 7), state that their electrical systems have been made fully YEAR 2000 ready. This of course cannot be the truth.

Reports published by analysts (consultants) have frequently been relied on as judges of who is ready and who is not. That is because little independent verification on YEAR 2000 fixes is available in most countries -- especially when it comes to public sector utilities. Most governments have simply not subjected their YEAR 2000 programs to outside audits. Countries have complained that these ratings are often inaccurate and have unfairly damaged their international image, perhaps even hurting foreign investment. "Consultants has a vested interest in stirring up panic," stated a Jamaica's government YEAR 2000 coordinator who said he has never once been approached by anyone attempting to evaluate YEAR 2000 compliance in his country.

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Summaries of studies by two international investigation teams are included in Section 4. YEAR 2000 preparedness of five Asian countries (Egypt, India, Indonesia, Malaysia, and Philippines) three African countries (Ghana, Tanzania, and Uganda) and three South American countries (Chile, Colombia, and Venezuela) is also discussed in detail in this section.

The list published by GartnerGroup, who are among the world leaders in promoting awareness of the Year 2000 computer bug, shows the seriousness of the threat by Year 2000 failures to the power systems globally:

Level 1: *Mostly isolated and minor incidents in utilities, communications and financial services, for example, but may include moderate disruption in some government services*

Australia, Belgium, Bermuda, Canada, Denmark, Ireland, Israel, the Netherlands, Switzerland, Sweden, Britain, U.S.

Level 2: *There will be isolated disruptions in utilities and transportation, but they will b4e moderate rather than minor. Possible severe interruptions in some government services*

Bahamas, Brazil, Chile, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Japan, South Korea, Mexico, New Zealand, Norway, Peru, Portugal, Singapore, Spain, Taiwan, Thailand.

Level 3: *Moderate power interruptions, such as brownouts, along with moderate air traffic problems and possible severe loss of some government services*

Argentina, Armenia, Austria, Bulgaria, Colombia, Czech Republic, Dominican Republic, Egypt, Guatemala, India, Jamaica, Jordan, Kuwait, Malaysia, Panama, Poland, Puerto Rico, Saudi Arabia, South Africa, Sri Lanka, Turkey, United Arab Emirates, Venezuela, Yugoslavia.

Level 4: *Widespread or severe problems predicted in utilities, communications and imports/ exports, and especially in air traffic and government services*

Afghanistan, Bahrain, Cambodia, Chad, China, Costa Rica, Ecuador, El Salvador, Ethiopia, Fiji, Haiti, Indonesia, Kenya, Laos, Lithuania, Morocco, Mozambique, Nepal, Nigeria, Pakistan, Philippines, Romania, Russia, Somalia, Sudan, Uruguay, Vietnam, Zaire, Zimbabwe.

For YEAR 2000 problems that cannot be resolved internally, firms must seek outside service providers with YEAR 2000 expertise. In doing so, depending on several factors such as budget, need, and reliability, a firm seeking assistance can choose either local or international help. Section 5 provides sources for technical assistance. These can be used as a starting point for countries that are experiencing YEAR 2000 difficulties and for financial support in dealing with Year 2000 failures.

The YEAR 2000 solutions provider must be able to do the job. The solution provider should thoroughly understand the scope of the YEAR 2000 problem. A proven track record on similar projects, such as those involving the electricity or energy industry, will help to determine the right solution provider. The YEAR 2000 solution provider's methodology and/or products should fit the organization's processing environment. Most

importantly, the service provider must be able to deliver a satisfactory solution on time and within budget.

Depending on the nature of the problem, organizations may decide to hire either locally or internationally based YEAR 2000 solution providers. Local providers are appealing for a number of reasons; they are readily deployable in that they don't have to fly in and set up shop, they have experience with region-specific systems, or they have established working relationships with the organization. Should an organization determine that there aren't any local solution providers capable of meeting its needs, there are many international solution providers that offer a wide range of YEAR 2000 related products and services that perhaps better serve the organization's needs. Section 5 also outlines some of these providers both at the local and international levels.

Though, it is commonly assumed that the YEAR 2000 problem will hit industrialized countries harder than developing ones because of their greater degree of automation, it is possible that the impact could be much greater in developing countries. These countries are more dependent on limited and aging computing systems, and have much more limited resources available to address the millennium bug. Since the power industry in developing countries follow or lags behind in the Year 2000 preparedness in other sectors, the scenario for power systems is not encouraging.

There are several scenarios on how the Year 2000 threat could hit the power systems. The blackouts in the Western System Coordinating Council (WSCC) can be reiterated to demonstrate how severe these scenarios can get in the case of cascading effects. In this incident, the electric service to about 2 million customers in the western United States was interrupted. The event triggering this was a short circuit on a HV power line caused by a tree growing into the line. At nearly the same time another line failed for very different reasons. From this point on, there was a cascading series of events. In addition to the specific reasons that triggered the situation, the overall status of the system at the particular moment was another important reason for the severity of the outage. Near-record hydropower generation in the Pacific Northwest, high power transfers on the transmission lines between the Pacific Northwest and California, power transfers through Idaho to Utah, high levels of coal-fired power transmission from Wyoming to Utah, and record demand for power in Idaho and Utah; all were contributing factors. In addition, the system status was affected by a combination of unfavorable conditions. This actual example shows how important it is for system-wide aspects to be taken into account in the YEAR 2000 preparation of the electrical grid.

Section 6 outlines a methodology to approach such failure in a systematic way.

It is expected that due to Y2K non-compliance, assistance will be required by countries to make their electrical systems operational post-Y2K. It is expected that expert 'Teams' will have to be sent to these regions to evaluate the problems and to estimate the level of effort required to make the electrical systems operational. Based on the type of assistance required, it is expected that two levels of experts will be required in the post Y2K scenario.

(1) Experts who have a broad picture of the domain

(2) Experts capable solving problems in specific electrical system component

Domain knowledge experts must have the capability to analyze and solve post-Y2K problems, in the following mission-critical sub-sectors: Power generation, Energy Management System (EMS) and Supervisory Control and Data Acquisition (SCADA) System, Substation controls, Distribution engineering, telecommunications, Billing and accounting, and Nuclear plant engineering.

Component specific expertise will be required to solve individual problems, once the domain and scope of the problem has been identified. A list of the type of expertise required is listed in section 6.

A expert Team that will evaluate the impact of Y2K in a country seeking assistance, and provide the roadmap to solving the problems should be equipped appropriately to facilitate their work. The resources that must be made available the Team include, Y2K Research Databases, Data Communication Links, Transmission and Distribution Grid Maps, Laptops PCs with car battery adapters, Satellite phones, Cars / Drivers, and Translators.

Section 6 also outlines the 'Targets and time estimates for Team accomplishments.' The Team should be expected to (1) Liaison with local Utility personnel, (2) Determine primary area(s) of failure, (3) Diagnose the cause(s) of failure, (4) Propose correction and define/identify required resources, and (5) Provide 'Order of Magnitude' estimate for funding purposes. It is expected that such a project can be accomplished within 30days.

Section 7 provides a list of resources used to compile this report. Also provided is a list of national Y2K websites, and a list of international electric utilities.

2 Introduction

Year 2000 issue seems to be a simple problem that is intuitively understood. However, solutions vary and are complex in nature. The core of the problem is in the encoding of a year as two digits in the hardware elements and software in computers and other technologies. This encoding, for example, can cause the hardware and software to malfunction when the dating system or date-related applications exceeds the limit of year 2000 (whether it be at the moment of the date-change or for date-processing purposes) or when the system or application requires it to refer at the date, prior, or after 1 January 2000. The malfunctioning can be in the form of:

- Mistakes in calculating, comparing, sorting (in anyway), or sorting (with numerals) arithmetically that causes the failure or logical operations, relational operations, and other operations;
- Problem of recognizing leap years;
- Conflicts with values in data used in non-date-related, i.e. "no date provided" or "never expires"' and
- Date fields overused

The Y2K problem is not just the 00 roll over on the night of December 31, 1999. February 29, 2000 can also be a potential pit fall. The year 2000 is not only a leap year; it is a leap century—the first since Shakespearean times. Unfortunately, since they are so rare, many programmers were taught that all years ending in "00" are not leap years.

This report provides a summary of the Y2K preparedness of the electricity sector and recommendations for tackling the Post-Y2K situation.

2.1 Report overview

Section 1 of this report provides an Executive Summary of the project.

Section 2 summarizes the Y2K problem and defines what is meant by 'compliance'. An overview of the sub-components within the electric energy sector, which are vulnerable to Y2K related problems is provided. One of the contingency plans to tackle Y2K problems is switching to 'manual' operations. The feasibility of such operations is summarized. During the testing and investigation for Y2K compliance, utilities across the world have experienced unexpected problems. A summary of such reported incidents is also provided in this section.

Section 3 elaborates on the effects, consequences of Year 2000 problems for different components of power delivery as well as equipment that use embedded systems and are an integral part of supplying reliable power. Maintaining a functioning infrastructure across all components of power delivery, e.g., power generation, transmission, and generation, for a reliable supply of electricity, has proven to be a difficult task. Across the whole of industry, intensive work has been required to identify and fix potential Year 2000 problems in computer systems, process control equipment and all other kinds of system with embedded intelligent devices.

Section 4 discusses the global Y2K preparedness. Summaries of studies by two international investigation teams are included, along with status reports of select countries. Y2K preparedness of five Asian countries (Egypt, India, Indonesia, Malaysia, and Philippines) three African countries (Ghana, Tanzania, and Uganda) and three South American countries (Chile, Colombia, and Venezuela) is discussed in detail. For each of these the following is provided

- Summary
- Status report of the Y2K preparedness of electricity sector,
- Summary of the Oil, Gas and communication sectors, and
- Possible pitfalls and impact scenarios.

Since technology-dependence of industrial sectors can be directly correlated with the possibility of Y2K bugs, Section 4 also lists the technology-dependence of energy, communication, and transport sectors in 86 countries. Countries have been classified according to regions (Asia, Sub-Saharan Africa, Middle East and North Africa, South America and Mexico, and Central America and Caribbean)

Section 5 provides information regarding technical and financial assistance. With respect to technical assistance, numerous contacts are provided both at the local and at the international levels. Recommendations for local Y2K technical assistance are provided for Egypt, India, Indonesia, Malaysia, Philippines, Ghana, Tanzania, Uganda, Chile, Colombia, and Venezuela. The second part of Section 4 contains overviews and contact information of lending agencies and other organizations that can provide assistance to countries inflicted with Y2K problems.

Section 6, provides Recommendations on methodologies for providing technical assistance to countries in the post-Y2K scenario. Methods for determining the causes of large-scale blackouts and other potential failures are discussed. It is expected that 'Expert Teams' will need to be sent to the effected countries to help. Composition of such Teams is discussed, along with the tools that should be provided to them to succeed. In addition, an outline of the tasks that these Team can be realistically be expected to complete, with time estimates, is provided.

Section 7 provides a detailed reference list of various resources that were used to compiling this report. Also provided is a list of National Y2K sites and a list of international electric utilities (with web links)

2.2 Year 2000 Compliance

Year 2000 Compliance means that the functionality is not affected by dates before, during, and after the year 2000. This means that

- Date based functions must run consistently before, during, and after year 2000 dates. The non-existence of date value functioning at the point in time will cause various operational interruptions.
- In all data interface and storage, the century for all dates must be specified explicitly or in clear algorithm or inference rules.

– Year 2000 must be known as a leap year.

2.3 Y2K and the electrical system

The electric power industry is complex and highly automated. The industry is made up of an interconnected network of generation plants, transmission lines (commonly referred to as the "grid") and distribution facilities responsible for providing electricity from the grid to every household and company in the world.

The interconnectedness of grids gives the power system unprecedented reliability and efficiency, but on the other hand this very interconnectedness makes the grid fragile and susceptible to Y2K disruptions. An outage in one part of a grid can cascade, causing ripple effects on other parts of the grid. It takes a high degree of automation to operate the grid. Power control systems, energy management systems, supervisory control and data acquisition (SCADA) systems, telecommunications systems, and substation control systems, all use automation and computerization, and are vulnerable to Y2K problems.

Left unaddressed, Y2K anomalies could lead to the malfunction of software programs on mainframe computers, servers, personal computers, and communications systems. Corrupted data could be passed from one application to another, causing erroneous results or shutdowns.

Of greater concern to the electric power industry are embedded computers— small electronic chips or control devices. These chips are used extensively in all parts of the electric power industry, including generating plants, transmission lines, distribution systems, and power control systems. Although only a small number of these embedded devices will have a Y2K problem, it is impossible to tell which will malfunction until each chip has been checked and tested.

2.4 Incidents due to Y2K non-compliance - Examples

Utilities all over the world are attempting to make their systems Y2K-conforming. Power system components have been tested by rolling forward the current date. This has resulted in some unexpected outcomes, illustrating that the weakness will exist even after corrections have been put in place. The following is a summary of some such reported incidences.

1999 March 21: **Brazilian** hydro plant test rings alarm in Latin America. In A Global Warning on Y2K, Colin McMahon and Laurie Goering of the Chicago Tribune report that as part of an experiment last year, technicians at the huge Xingó Hydroelectric Dam on Brazil's Sao Francisco River set the dates on the plant's main computer forward to 2000 January 1.

"What happened next is still sending chills through Latin America. 'When they put the date forward, the whole control board went haywire,' remembers Marcos Ozorio, one of the members of Brazil's presidential Year 2000 commission. 'Twelve thousand warning lights flashed all across the board, with all kinds of alarm information.'

Technicians quickly switched back the date, and are now ferreting out the plant's Y2K bugs. But 'if you had been surprised by a situation like this, what you'd have had to do is

shut down the plant until you found where the failures were,' Ozorio said. 'Automatically you'd be taking off the energy board 30 percent of Northeast Brazil'.

This report out that Brazil, and much of Latin America, is struggling to deal with Y2K with less money and less expertise than the U.S. and, in most cases, with a very late start. Much of the region is in a recession, unemployment is high and growing, and recent privatization in Brazil eliminated governmental responsibility for fixing Y2K bugs leaving the new owners scrambling to catch up.

1999 February 8: Y2K testing glitch at nuclear plant. The Philadelphia Inquirer reports that two monitoring systems at Peco Energy's Peach Bottom nuclear power plant near **York, PA.**, crashed for seven hours as the utility conducted tests for Year 2000 computer problems on February 8.

Peco said the plant continued to operate normally and the public was not at risk. Engineers were testing a system on Peach Bottom's Unit 2 reactor that helps track the position of the control rods that regulate the nuclear reaction. The device, a rod worth minimizer, is used mostly during periods of low power output, Peco spokesman Michael Wood said. It is one of several systems that feed data into the plant monitoring system, a display station in the control room from which technicians can track multiple plant operations. The primary and backup monitoring system computers, not the rod worth system itself, went dark because of the test, Wood said. Peco had replaced the rod worth minimizer earlier that day because it found it was not ready for Y2K. To test the replacement system, plant engineers were supposed to connect it to an external clock and set that clock ahead to 2000 January 1. They had done this successfully in a simulator. But in the real control room, instead of using an external clock, an engineer changed the time on a backup monitoring system computer that was off-line at the time.

"The backup computer locked up due to the date change, and the system automatically transferred to the primary, online PMS computer," the Nuclear Regulatory Commission said in a notice. The engineers re-entered the date command "contrary to procedure," the NRC said, and the primary computer crashed. NRC public affairs officer Neil Sheehan said the monitoring system computers had not yet been reprogrammed to handle a large date move-up. The monitoring system was not safety-related and was not the primary source of information in the control room, which still uses dials and gauges, plus digital instruments that are not open to Y2K problems. Sheehan said the NRC considered the crash a result of human error, not a Y2K problem "Even though it was Y2K-testing-related, it wasn't Y2K-related," he said.

1997 October 31: Power plant control system failure. To test for Y2K compliance in a generator temperature control system at a power plant in the **United Kingdom**, the control system's clock was set to just prior to midnight, December 31, 1999. Twenty seconds past midnight, the unit tripped on high generator temperature. The process value for the control valve for generator cooling is time-smoothed and when the year became 00, the value was integrated over infinity. The valve closed (fail safe), tripping the unit on high generator temperature. The algorithms used in this control system are apparently common throughout Europe. This is unlikely to be a big problem if it occurs in isolation, but simultaneous failures in many systems would be.

1997 August 11: Power grid management problems. **Hawaiian** Electric Company ran tests for its Energy Management System's (EMS) Year 2000 compliance in a simulator. The EMS is comprised of over 20 VAX/VMS servers and workstations. One "system" serves as the primary controller which scans remote points in the field, stores information in a database and displays it to load dispatchers in a graphic display format. Another system is a hot standby. The Year 2000 simulation found that both EMS systems would become confused and keep "failing" over to the other. Under these conditions, the EMS became inoperable. Load dispatchers could not schedule generation; power plant operators would have to monitor and control frequency at the plant; field personnel would have to manually open and close breakers at substations and give dispatchers readings of loads; the ability to detect transmission line failures and route around them was lost; the ability to schedule generation based on the generating unit's most efficient use was lost. After an attempt to use standard language and operating system services to fix the problems, the utility decided to scrap the C source code for the date-dependent parts of the EMS system and instead modify the existing assembly code.

In **Sweden,** a number of problems have already been found in nuclear power stations. At the three-reactor Forsmark station maintenance personnel found that the plant's data system was unable to recognize the first two digits of the year 2000 and that this would have resulted in an automatic shutdown. Vattenfall, the owner of the Forsmark station, has been working on the Y2K problem since 1996.

In the **US,** a Midwestern electricity utility ran a test for Y2K compliance. When the clock turned over to the year 2000, a safety system mistakenly detected dangerous operating conditions and the power generators shut down. It took programmers three days to fix the problem. When they re-ran the test a different sector failed, again shutting down the system.

3 Affect of YEAR 2000 Non-compliance on Power Systems

3.1 Introduction

Power systems are made up of three main different systems: a) an interconnected network of generation plants, b) a network of transmission lines, and distribution facilities. The generation plants may run on nuclear, fossil fuel, gas, hydro, etc., and a country's generation make-up vary depending on its resources. Planning and operation of power systems in a stable manner is a very difficult task due to the complexities within each component as well as in between them. As a result, especially during the last couple of decades, the electric power industry has become highly automated.

In addition, power systems have been recently interconnected with each other to improve the overall reliability and efficiency. However, the interconnectedness also makes the grid fragile and susceptible to wide-spread outages due to YEAR 2000 problems. A small outage caused by a YEAR 2000 problem in one part of the grid can cascade causing ripple effects on other parts of the grid.

The electricity industry may be better prepared to deal with YEAR 2000 effects than some other industries because it uses contingency plans on a daily basis. A reserve margin is maintained to allow for power station outages and spikes in demand, though, the size of this margin often heavily depends on the nation's economic stature.

The electrical engineering industry building systems and developing procedures guarantee a very high reliability for its supply. An overwhelming reliance on electricity has developed as a result. Local blackouts occur only occasionally, usually being caused by excavators accidentally cutting into cables or lightning causing short circuits. Service teams on continuous standby respond to problems immediately and restore the supply within a short time. Blackouts affecting larger areas are extremely rare.

When they do occur they are thoroughly investigated and the lessons learned are invested in more robust system layouts and made generally available. Against this background, the Year 2000 problem raises the following questions:

- How vulnerable is the electrical grid to the YEAR 2000 threat?
- Which are the most critical system components?
- Is the established system layout robust enough to withstand the specific YEAR 2000 threat?
- Are the existing service and emergency procedures adequate?

Besides knowing the critical system components and their YEAR 2000 vulnerability, there is also the highly important question of overall system behavior. System studies and simulations of every kind are the responsibility of the utilities, who have the tools and the data necessary to carry them out routinely. However, to mitigate the YEAR 2000 risk it is suggested that these be applied in close cooperation with the product and system supplier. All the available experience and field data have to be combined to achieve the highest possible reliability for the electricity supply.

3.2 Power Systems

A generic power system consists of a generating system, a transmission system, a sub-transmission system, a distribution system, and a control center. Power plant generation systems may include steam turbines, diesel engines, or hydraulic turbines connected to alternators that generate AC electricity. This configuration is illustrated in the following Figure.

Electric power has to be transmitted over long distances, since it is only rarely generated and consumed at the same location. Power stations and transformer substations at the regional level are served by a grid operated at 220 and 380 kV. Electric power is mainly distributed in secondary and primary distribution system (up to 20 kV) but also in systems up to 110 kV, especially in areas where the load density is high, and there are large-scale consumers.

The figure shows, in a simplified form, the flow electric power from the power generation plants via the transmission network to a regional supply system, with primary and secondary distribution systems. Overhead lines are predominantly used at the grid level; whereas, cables are largely employed in systems operating at or below 110 kV.

All the main parts of an electrical system, from the generation of the electrical power through its transmission over the high-voltage lines to its distribution via medium-voltage and low-voltage systems to industrial and domestic users, were originally built without any digital devices. Due to the installations having a service life of 40 years and more, much of the original non-digital equipment is still in service. Digital devices are found either in the more recent system extensions or replacements, or in add-on equipment installed to improve the monitoring and supervision of the system.

Electricity Flow Diagram: From Source to End-User

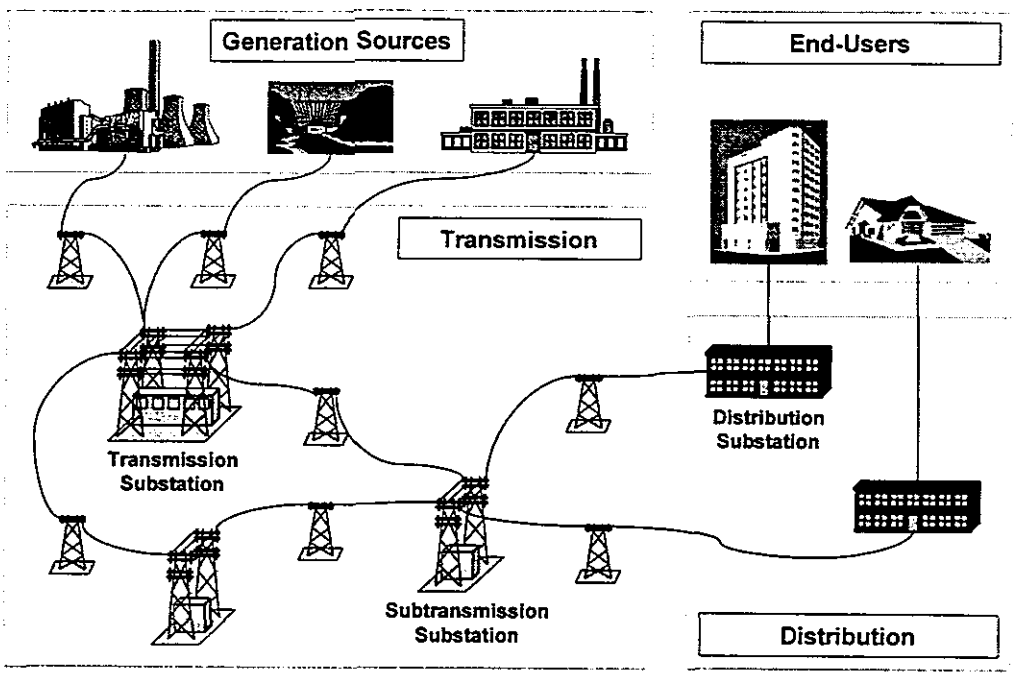

Figure 1. Electric Power System Sub-sectors

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As a rule, these extensions and additions have no adverse effect on the robustness of the system, e.g. the flow of electricity does not directly depend on proper functioning of the computers in the network control center; in fact, it would continue to flow if the computers were switched off. In addition, the digital devices are typically of a robust design, without 'nice-to-have' add-ons. As a result, digital relays and protection devices are, with very few exceptions, Year 2000 compliant.

The system control loop, which has to ensure that the generated power and consumed power are balanced at all times, is based on local frequency control in certain, selected generation plants. These frequency control loops usually do not depend on digital technology, and where they operate with computers no date or time function is normally found in the control loop.

3.2.1 Generation

Generating facilities may use a variety of fuels: nuclear, coal, oil, gas, and hydro are examples. Generating facilities rely upon digital equipment to varying degrees. Hydro generation uses rather simple systems compared to nuclear generation. Nuclear generation is especially complex in terms of the variety of processes it relies upon and may employ both analogue and digital control systems. With hydro and nuclear being on two extreme sides of the spectrum, all are often highly automated and use remote processor control systems. Digital technology is also used in the safety systems, normal operation and support functions of some generating facilities. Most generating facilities cannot function for long without digital technology.

It is imperative for the sake of the overall system integrity that generating units are able to operate through critical YEAR 2000 periods without disruption. Units that are scheduled to operate must be able to start up and deliver electricity as planned. Power plants with Digital Control Systems (DCS) are most susceptible to YEAR 2000 problems, where as, older plants with analog controls may operate through such critical periods without any problems. Numerous control and protection systems within the DCS use time-dependent algorithms, which may result in generating unit trips when encountering a YEAR 2000 anomaly. Digital controllers built into station equipment, protection relays, and communications may also cause problems.

As mentioned, only those power plants with modern digital control systems need to be focused on. For the large number of older plants without any digital control equipment, the so-called 'millennium bug' is obviously not an issue. Hydropower plants are usually in the latter category, and even those built more recently and which do have digital control are equipped with comparatively simple systems.

A careful check nevertheless has to be carried out in these plants, targeting especially auxiliary systems such as the fire alarm or access control systems, which may have been installed later and could, if not working properly, indirectly affect plant operation. The YEAR 2000 problem is a bigger issue in coal- or gas-fired plants and nuclear power plants equipped with distributed control systems, simply because these plants are highly complex and many auxiliary functions are needed to make them work properly.

3.2.2 Non-nuclear Generation

Testing of non-nuclear generators continues to indicate a minimal number of failures that might cause an unremediated unit to trip. Fully remediated units are all expected to be able to operate into the Year 2000. The more typical types of failures that have been detected affect a date stamp of a historical function or a display screen, but would not impact unit operation.

The most serious concern for power production continues to be in the more modern plants operated by a Digital Control System (DCS). These stations are highly automated to obtain maximum efficiency. The DCS controls nearly all aspects of a generating unit from fuel and airflow for combustion, to water and steam flows, to turbine-generator controls, to auxiliary systems. Most of the technical expertise for these highly complex digital systems is with the original vendor, making this one of the more important vendor dependencies for the electric industry. Although DCS vendors are generally cooperative, the resources of some are stretched under the current demand. DCS vendor support is one of the constraints often quoted for units that will be completed past the industry target dates. There have been a few instances during Year 2000 testing in which it is thought that a lock up of an unremediated DCS system might have caused the unit to trip.

Another type of system reported as being somewhat more problematic than others are continuous emissions monitoring systems (CEMS). Problems being detected, however, do not appear to be limiting the operation of a unit, because they are linked to the data management rather than the monitoring devices themselves. A spectrum of approaches exists to deal with emissions monitoring from use of internal expertise for testing to dependence on vendor support, to replacing systems with those known to be Year 2000 compliant.

Of particular interest are the results of integrated tests involving the entire power station. These tests consist of simultaneously moving as many systems and components as possible forward or backward to various critical dates. These tests require an extraordinary level of preparation and coordination to ensure the safety of all systems and that the impact to the electric system would be minimal should a unit trip during the test.

Of all the integrated unit tests reported to date in the United States, not one test of a fully remediated unit has resulted in a Year 2000 failure that caused the unit to trip. In some cases, units that were moved forward to a post January 1, 2000 date have been left to continue running with clocks set ahead with no negative consequences. Others report setting back the date at which their units operate. A typical setback is 28 years to closely align the calendar dates with days of the week and leap years.

3.2.3 Nuclear Generation

Few problems are being reported in the developed countries where detailed assessments are mostly completed. However, due to the possible catastrophic consequences, it is of utmost importance that contingency plans are in place where detailed assessments have not been competed yet. Pollution control equipment at power stations is typically controlled by embedded processors and if they are not YEAR 2000 compliant unwelcome emissions could escape, thereby compromising air and water quality.

Of all the components of the power system, nuclear plants seem to be the least susceptible because they have the least amount of automation. Computers are used to provide information to operators; however, the actual safety systems that shut down the nuclear reaction are hardwired analog technology, and are insensitive to YEAR 2000.

Internationally, Canada is held to be just as far along in YEAR 2000 preparedness. After all, many of its power networks are interconnected with those of the United States. But in the former Soviet Union, the nuclear plants give grounds for alarm. By and large, the power industry is agreed that little work has been done there on repelling the YEAR 2000 bug. In the Ukraine, though, officials have responded that the bug would not affect Chernobyl or their other nuclear plants because they use such unsophisticated equipment.

Power analysts indicate that the worst-case scenario would be that nuclear plants simply stop operating, and that the stoppage, while not in itself a threat to safety, would cause widespread power outages. Last year, in fact, according to Reuters, Sweden underwent a nuclear plant shutdown as a result of a YEAR 2000 test. Still, these plants do need a supply of electricity to shut down safely, so the United States may have to provide Russia with backup generators and batteries.

3.2.4 Transmission

Transmission facilities maintain the integrity of the interconnected grid by ensuring that frequency and voltage are maintained within limits as the balance between capacity and load is maintained. Furthermore, subsequent to loss-of-offsite-power incidents at nuclear stations, they expedite the restoration of offsite power for reasons of safety.

The substations throughout the electric transmission grid contain control equipment such as circuit breakers, disconnect switches, and transformers. Remote terminal units (RTUs) in substations serve as the communications hubs for the substations, allowing them to communicate with the control centers. Substations also contain most of system protection relays, which serve to operate circuit breakers to quickly isolate equipment should an electrical fault occur on a line, transformer, or other piece of equipment.

These facilities employ sophisticated digital control and monitoring systems, though, the dependence of these facilities on digital equipment is a lot less pronounced in the developing countries than in the developed ones.

The integrity of the electricity grid depends on frequency and voltage being maintained within limits, as capacity and load is balanced. Failures in equipment that adjusts frequency and voltage would have serious consequences. Even partial failures of the grid may produce serious disruption. They could cause overloading or localized outages.

Most entities report finding no system protection devices that would cause power interruptions or safety concerns as a result of a Year 2000 rollover in digital electronics. Some report minor issues with microchips and relays, which may result in minor cosmetic results such as two-digit years in logs. Entities report repair of these devices using vendor supplied chip upgrades. Many electric systems still utilize electromechanical relays, which are not date sensitive. Most report known work around procedures for cosmetic problems.

A few entities report using test beds or test labs for testing substation and system protection devices. Typically these are portable laptop computers with special customized software. Generally no date rollover problems are found. Some event recorders may experience date problems, but most other items are date insensitive. Event recorders should be fully tested and remediated, as they may provide valuable information following a disturbance. Some relays and devices do not recognize a leap year, but this condition exists in other years as well, is not unique to Year 2000, and is not an operating problem.

3.2.5 Distribution Systems

Distribution systems deliver electricity from the transmission network to customers. There is a lot of commonality in the types of substation equipment in distribution compared to transmission. This makes the YEAR 2000 analysis easier compared to the one for transmission systems. However, distribution systems are most commonly radial in nature unlike the transmission systems which are highly interconnected with several loops. The low connectivity (compared to the transmission systems) makes the distribution systems especially vulnerable to outages. Distribution systems also have additional equipment outside substations along a distribution feeder. The equipment may as well have electronic controls. Examples include reclosers (relays that open and close a feeder in rapid succession to allow a fault to clear, capacitors, voltage regulators, and special monitoring devices.

It is also possible to consider the customer load as a part of the distribution system for simplicity. A fully remediated delivery system will still be challenged by YEAR 2000 if the load that is typically present on the date rollover rapidly reduces due to failures in consumer or commercial systems. Although such widespread common-mode failures are unlikely, the operators of the electrical delivery system must be mindful of the possibility and pre-position their facilities in anticipation of such an event. Another possibility that may cause loads lower than usual may be the YEAR 2000 paranoia. If YEAR 2000 paranoia derails consumers from their usual activities and makes them shut down or decide to run off generators, demand for power may be well below par. If so, the mismatch between generation and load might create outages.

Distribution system control, communication, monitoring, and data gathering equipment can be separated into three categories: 1) electromechanical, 2) analog electronic, and 3) digital electronic. Electromechanical equipment is the predominant type of equipment in distribution systems and is not date sensitive because it has no electronics.

Analog electronic equipment generally monitors voltage, current, or frequency and has little or no need for a date function. Also, much of the voice communications equipment used by distribution systems is analog electronic.

Although EMS and SCADA hardware devices and operating software depend on date functions, relatively few distribution systems use these systems. Two thirds of rural electric distribution cooperatives do not have significant investments in SCADA or EMS equipment. Revenue metering equipment falls into all three categories.

With few exceptions, digital electronic equipment is the category in distribution systems that may be susceptible to Year 2000 rollover problems. There are some recent trends

toward automation and computerization of some distribution devices, including regulators, reclosers, meters, recorders, relays, capacitor controls, automatic transfer switches, time-of-use meters, communication with mainframe, and interfaces to SCADA, where microprocessor and/or digital electronics are involved. These devices need to be evaluated, assessed, and tested for Year 2000 readiness.

With regard to telecommunications systems, like the rest of the industry, distribution systems rely on the publicly switched telephone network, as well as private wireless and wired networks for mission critical power delivery functions. Telecommunications equipment owned or used by rural electric cooperatives is under scrutiny for Year 2000 deficiencies.

Distribution entities have reported that the assessment of protective relaying systems have not uncovered any problems that would prevent these systems from being Year 2000 Ready. Further testing of specific systems will be done to confirm these findings. Equipment manufacturers have indicated that most of the date-related information does not affect the system protection aspects of the relays. Companies are testing more than just the calendar function of the devices. They are also testing normal device operation as devices pass through critical dates in testing.

Distribution entities are reporting some problems in the metering and fault recorders area involving software that is not compliant. Vendors are providing new software versions in each case.

No universal guidance exists to date on the need to test all microprocessor-based components in distribution systems. At issue is whether every individual device should be tested. The question is most difficult in distribution systems, where thousands of a specific type of device could be found. An alternative would be to apply statistically valid sampling methods or to rely on the vendor certification of a particular model of a device. Distribution equipment in this category includes communications devices, relays, reclosers, and some metering with digital components.

Further evaluation is needed to assess the benefits of one testing strategy over another within distribution systems. Pending further research, it is recommended that if the failure of a digital device alone could result in customer outages, each individual device should be tested. Otherwise statistical measures or vendor certification may be more appropriate.

3.2.6 Energy Management Systems

System operators at bulk electric control centers monitor and control the backbone of the electrical systems and dispatch generation to meet demand. Computer systems within these control centers use complex algorithms to manage the operations of transmission facilities and to dispatch generating units. At any moment in time, a percentage (usually 10–20%) of generating units may be on automatic control for the purpose of following load and regulating interconnection frequency.

Many of the control center software applications contain built-in time clocks used to run various power system monitoring, dispatch, and control functions. Some energy management systems are dependent on time signal emissions from Global Positioning

Satellites. Beyond the main operating centers, there are hundreds of additional control centers used to manage sub-transmission and distribution systems.

These systems are typically operated using a subset of an energy management system, called Supervisory Control and Data Acquisition (SCADA).

Network control centers allow monitoring of certain areas of an electrical grid. Information about the status of the breakers and current and voltage transformer measurements from substations, power plants, etc, are processed and transmitted over remote terminal units (RTUs) to the central database in the network control center. The status of the grid, which lines are active, how much power is flowing over which lines, etc, is displayed, while a large number of supervisory functions are performed on the basis of the available data. Thus, operators receive early indications of changes in power production or consumption in an area. Based on this information, generation requests are dispatched to the different power plants in the area. An optimum grid structure in terms of routing of the power flows, lines in operation, etc, can be established. From stations in the network control center, breakers in the area can be remotely operated to obtain the required system configuration.

This briefly described functionality determines the main features of these very complex and large computer systems, which are based on high-performance workstations with millions of lines of code in the operating systems and the application software. The level of customization is very high as the systems have to be configured according to the specific structure and needs of the different parts of the grid.

The highly complex network control software and the workstation operating system on which it runs complicates the YEAR 2000 issue. Typically, the operating systems in use are earlier versions, and are neither maintained nor investigated by the computer vendors. Due to the complexity of the installations, upgrades to the latest versions are not usually possible. An adequate methodology therefore involves combined tests carried out on the overall systems and checks made on the main functionality, supported by engineering judgement based on the release notes from the computer vendors.

A large number of such tests carried out on different network control center products and generations, carried out by vendors, have not revealed any cases of complete system failure (dark screen or shut-down of the computer). Typically, however, several cases of malfunctioning have been observed in earlier systems with functions involving date-sensitive data. Such malfunctions are normally corrected with a software patch or, in the case of very old systems, replacement by a new system, which also offers considerable additional functionality. Some of the typical malfunctions are: non-synchronization with the external clock; wrong time-tagging of data; wrongly archived data; erroneous event lists and reports; incorrect 'alarm filtering' (selection of alarms within a predetermined time window); inability to reboot computers after the Year 2000.

The RTUs connected to the network control center are, as a rule, YEAR 2000 compliant. What are critical, however, are the protocol converters acting as interfaces between the RTUs and the communication channels. The RTUs or control centers within a system may not be from the same supplier. Particularly important for the system stability is the communication of the generation set-points to the power plants. The entire communication chain must be carefully checked together with all the interfaces between

the different system components. Two potential errors are dangerous in this chain: a wrongly communicated set-point, which would cause problems immediately, and a loss of communication for the updating of set-points. In the latter case, the previous set-point would remain valid and over time, if the deviation became too large, the state of the system would become critical. This example illustrates the extremely important role that communication plays in the electrical system, and emphasizes the need to check all of its critical functions.

3.2.7 Telecommunications Systems

Electric power systems are highly dependent on microwave, telephone, VHF radio, and satellite communications. If the control centers are the "brains" of the electrical grids, communications systems are the "nervous system." Telecommunications is the single most important area in which the electric systems depend on another industry. Many of the telephone, microwave, and network services used for communications in the electric industry are provided by telephone companies and other communications and net-work service providers. The dependency of electric supply and delivery systems on external service providers is a crucial factor in successful performance during YEAR 2000 transition periods.

In addition to the areas outlined above that focus directly on the production and delivery of electricity, other support systems are essential to sustained operations of the electrical service provider. These systems have been grouped under the heading "Business Information Systems" in this report. They include among others customer service call centers, supply and inventory systems, and accounting systems.

3.3 Embedded Systems in Power Systems

Much of a power system, from generation to distribution, incorporates computers and embedded systems. Power plants use digital distributed control systems, programmable logic controllers, data acquisition systems, and chips and systems that monitor smokestack emissions. Transmission networks have control systems that regulate the flow of electricity and microprocessor-based safety relays that protect them from overloads.

Embedded systems" refer to either single-or multi-purpose computerized devices that are literally embedded within some larger piece of engineering equipment or industrial product. The Year/2000 embedded systems problem deals with embedded systems that are subject to failure because their software is not Year/2000 compliant.

There are several reported cases of embedded electronic systems, used at critical or significant systems for producing power, failing during a Year/2000 rollover simulation. Their predominance is certainly seen in the following example.

"In the testing of two coal-fire power plants (which were currently off-line and being used as 'hot spares') for Year/2000 compliance, the clocks were simultaneously rolled over to the year 2000, causing immediate plant failure. In an attempt to better understand the failure, the roll over test was repeated. In the second test, the plants again failed, but a different embedded controller was determined to be at fault. The roll over test was repeated a third time in hopes of replicating one of the previous failures. In this test, the

plants failed from yet a different embedded controller. It was determined that this last failure would have caused a portion of the grid to fail had the plants been on-line. It took 13 days in order to restore the plants to working condition from the last failure."

The Gartner Group predicts that more than 50 million embedded system devices will exhibit Year/2000 date anomalies. The problem is determining which 50 million devices out of an estimated 25 billion devices that are projected to be in existence by the Year/2000 and which of these devices are critical. One petrochemical firm tested 150,000 embedded chips and found 100 to be non-compliant. It is known by now that two or three embedded chips are found to need correction for about every 1,000 chips tested. However, these small numbers of chips still have the potential of causing significant problems along the generation-transmission-distribution power delivery chain.

Discovering problems with embedded systems is much harder than with software. It is sometimes necessary to deal with devices that use embedded timing devices that have no visual display of date/time, nor any means of input to see that a date/time has been installed at factory-creation time. It is easier, though time-consuming, to find and fix problematic lines with software. However, with hardware, both the discovery and fixing processes take significantly longer periods of time.

To further complicate the problems, occasionally manufacturers use chips from different vendors, and some equipment produced by the same manufacturer can exhibit irregularities during simulation tests, e.g., some may handle 1, 1, 2000 very well; where as, one or two of the same may fail. Documentation down to this level of detail is often not specified. As a result, the remediation of such equipment is very difficult.

Table 1 lists several devices, equipment, and systems that use embedded systems and are used at power utilities. Please note that not all of them are critical for power delivery, nor are they all known to be significantly impacted by Year/2000 problems. However, some of them have shown to cause definite problems at some utilities.

Embedded Systems Locations and Functions

Location	Function
Building systems and temperature controllers	Multi-loop control and monitoring -- DCS, SCADA, telemetry
Date sensitive computer systems (used for forecasting electrical load demand on a given day, hour, and minute basis)	Panel mounted devices - control, display, recording and operations
Date sensitive systems (used for bidding purposes in wheeling and power pools)	Programmable logic controls (PLC's) and embedded date sensitive controls (they exist in transformers, protective relaying and breaker control)
Energy metering	Real time control systems
Environmental monitoring equipment	Remote terminal units
Field devices -- measurement, actuation, recorders, sensors	Residential and commercial smart meters
Flow controllers	Simulators
Fossil plant boiler control systems	Single loop controllers

Location	Function
Global positioning system (GPS) problem	Smart instrumentation and recorders
Heating, cooling and ventilating systems	Substation equipment (such as scan log and alarm recorders, digital fault recorders, smart relays and breakers
Load dispatch and remote switchyard breaker control for power plants	Telephone exchanges and switches
Monitoring and signaling systems	Test equipment used to program, maintain and test control systems
	Valve actuators

In a general survey of embedded systems conducted by IEE, the embedded systems were categorized in three groups:

- Not programmable microcontroller based systems
- Programmable microprocessor based systems
- Computer based systems

Among these, the not programmable microcontroller based systems are not affected by Year/2000 problems, as they are extremely simple devices and almost never have any date functionality.

The microprocessor based systems in second category included logging and monitoring, PLC, SCADA, smart instruments, stand alone instruments, and others. Together, these represented about 60% of the total. After merging the similar areas, the areas reported as having most problems with 'non-computer' based systems with percentages representing the proportion of problems, are shown in Table 3-2.

Year/2000 Problems in 'Non-computer' Based Systems

Calibration, monitoring, data logging, detectors, analyzers	36%
Building management, including HVAC, fire and security systems	22%
Manufacturing and process systems (SCADA, PLC, DCS)	20%
Other	14%
Telecommunications and networking	8%

Of the remaining 40% that included more complex systems with a 'computer', the percentages representing the proportion of problems in each area are shown in the Table.

Year/2000 Problems in 'Computer' Based Systems

Building management systems (including fire and security control)	26%
Manufacturing and process control systems	24%
Logging and monitoring equipment	21%
Other	29%

For these systems, 71% of the time, the problem was caused by the millennium rollover, 9% of the time by the leap year problem, and 6% of the time by multiple date problems.

Related data to some of the equipment relevant to the power systems is shown in Table.

Embedded System Types and Problems

Application	Function	Computer based	Problem	Solution	Consequences to system
Data tape recorder	Logging/ monitoring	No	Year/2000 rollover	Upgrade software	System stops
Stand Alone Instrument	UPS	No	Loss of remote data/ alarm logging.	Upgrade microprocessor	Erroneous Result
Smart Instruments	Metering	No	On testing electronic meters and rolling through the dates post 2000, the calibration equipment 'stuck' at 2010	Insert upgrade patch	System Stops
Data Logger	Monitoring	No	Fail to log data after 31/12/99	Replace EPROMS	System stops
SCADA	Monitoring / logging alarms	No	Incorrect dates after 31/12/1999	Upgrade software	Erroneous Result
SCADA	Bought-in graphics/ display package	No	Core functionality OK but some optional modules fail rollover test	Upgrade or replace	Cosmetic
SCADA	Overview of the operation	No	System failed during power down rollover test	Modify software	System stops

3.3.1 Other Potential Year 2000 Failures

There also several 'computer' based systems which are vulnerable to Year 2000 problems. Some earlier versions of the operator stations, which are based on workstations from different computer vendors, have been found to be seriously non-compliant. Year 2000

problem with such systems would lead, unless corrected, to tripping of the plant. For example, unclear or unreliable operator information about the status of the plant may be displayed. In such a situation, the operator would be forced to shut the plant down after a short while. Another serious YEAR 2000 problem found in earlier generations of computers is an inability to reboot after 2000.

Another category of problems and risks results from those devices and interfaces connected to the control system. The system clock is set by means of a signal from a radio clock (more recently the GPS signal). A Year 2000 non-compliance can lead here to synchronization failure, so that the system runs on its own time. The time drift which this may cause can create severe problems in the communication with other systems. This is one example of an effect which, although not leading to immediate problems, can cause severe distortions later, sometimes much later.

Other critical equipment connected to the DCS includes intelligent measuring and monitoring devices, e.g. vibration monitoring devices for rotating machines. Some of these devices perform highly complex functions and therefore use extensive computing power. Normally, dates are not involved in this primary function. Dates are used, however, quite often to monitor maintenance intervals and to time-stamp the measured signals.

Non-compliant time-stamps run the risk of being misread or rejected by the DCS, which could mean that a signal is shown as 'invalid' on the display. In the case of an important (e.g., safety-related) signal this may force the operator to shut down the plant.

Interfaces to control systems of other suppliers (e.g., when the DCS for the boiler and the turbine island come from different suppliers) are critical. The data exchange between the two systems must be carefully checked for date-related data and their mutual understanding of the data verified. As a rule, non-compliance in this area do not have serious consequences. Quite often, however, they can lead to malfunctioning of certain services, such as archiving and documentation.

For example, in one installation with an archiving computer the system test showed the computer to be non-compliant. While non-compliant archiving obviously does not place plant operation at risk, it can have serious consequences if regulations specify such a function as a precondition for plant operation. For nuclear plants, in particular, there exist a number of regulatory requirements which are mandatory for plant operation; in other plants, certain environmental sensors also belong in this category. Many of these functions are computer-controlled and are connected to monitoring and documentation devices.

As already mentioned, all kinds of auxiliary functions are important. A large coal-fired plant has a large number of such functions, some of which are obviously critical for plant operation (e.g., those for coal transportation, cooling-water and compressed-air systems). Often, these peripheral systems make use of programmable logic controllers (PLCs). PLCs are a major Year 2000 concern as they perform their functions on the basis of an application-specific program with numerous timing functions. The documentation of such programs is often poor. A typical remediation process involves eliminating PLCs and implementing the required function in the existing DCS.

Patches are developed as a corrective measure for the malfunctions identified in system tests. Based on field experience, the following two main risks in network control centers may occur if remedial measures are not applied to all the installations in time: loss of some communication to substations and alarms and reports shown in the wrong sequences on the screens. The effect of this could be to reduce the operational availability of network control centers.

While this alone would not have immediate and dramatic consequences, in combination with other disturbances in the system such occurrences could become dangerous and trigger cascading effects. Problems and risks with intelligent devices or primary equipment featuring built-in computer control

The intelligent devices most commonly found in electrical systems are protection gear (relays). Most of the installed relays, however, do not work with digital technology, only the more recent generations being microprocessor-based. The protection algorithms are time-critical and quite sophisticated. For this reason and because of the criticality of the protection, all unnecessary functions are avoided, i.e. either no date function is used at all, or when it is it is not close to the critical functions. Thus, the YEAR 2000 investigation usually shows protection devices to be compliant.

Metering devices also seem to be generally compliant. Any non-compliance that there are do not effect the supply of electricity since these devices are primarily for commercial transactions, which can be backed up by 'work-arounds'.

What are important are the systems and devices used for automatic load management. These systems work with date functions and, as they influence large loads, have a strong impact on the system dynamics. Examples of primary equipment with built-in computer control are static VAR and HVDC devices used for the transmission of bulk energy, for coupling asynchronous systems and stability control. These make use of power semiconductors connected to a control system. Design reviews and system tests have shown that such systems use no YEAR 2000-critical date functions for direct loop control.

3.4 Conclusions

The date-sensitive functions of those computers and chips are, for the most part, limited to stamping dates on documents and files. In extensive testing, Kenith Ehalt, Year 2000 project director for Northern States Power, Minneapolis, Minn, said his company "found very little functional processing that is directly affected by YEAR 2000." What it did find was that a few monitors went fuzzy and had to be rebooted. The company also discovered that a relay lost one-fifth of a second during a test, whereupon a backup relay took over. It turned out that this failure had occurred at midnight every 31 December, when the device reset its counter, but had never been noticed before the system was scrutinized for any YEAR 2000 problems. However, the following guidelines still need to be followed for each component of power delivery.

3.4.1 Guidelines for Non-Nuclear

1. Organizations with generating facilities should adjust schedules and resources to meet the recommended industry milestones. Specific exceptions should be reported beginning in the first quarter 1999.

2. Organizations with DCS controls on generating units should collaborate through vendor user groups to optimize available resources and information necessary to test and remediate DCS systems.

3.4.2 Guidelines for Nuclear

1. Nuclear facility managers need to apply additional attention to detailed assessments that are scheduled for completion after December 31, 1998. Facilities should review outstanding work to ensure critical systems are tested first and, where possible, schedules accelerated.

2. Any remediation scheduled to be completed after June 30, 1999 warrants special management attention. In some cases low risk items will continue to be scheduled for fall outages. For other items, schedules should be reviewed and accelerated or alternate remediation strategies considered.

3.4.3 Guidelines for Transmission

1. Organizations with transmission or distribution substations should adjust schedules and resources to meet the recommended milestones.

3.4.4 Guidelines for Distribution

1. All distribution organizations should plan to have mission-critical systems and components Year 2000 Ready by June 30, 1999. This includes remediation and testing of components identified to have Year 2000 problems and measures to mitigate the possible loss or malfunction of systems and components that can not be repaired and will not be replaced.

2. Distribution entities should prepare Year 2000 plans including special operating procedures, training, contingency plans, and emergency response.

3. Pending further research, it is recommended that if the failure of a digital device alone could result in customer outages, each individual device should be tested. Otherwise statistical measures or vendor certification may be more appropriate.

4 Regional assessment of impact and preparedness

4.1 Estimate of Global Y2K Preparedness in the Electricity Sector

There are several reasons why the world is not Y2K ready. There have been hurricanes, flooding, earthquakes, the Asian financial crisis, civil war in Africa, etc. These have been the priorities of the countries effected. To many, the Year 2000 problem is a flyspeck. The scenario for most countries indicates potential for infrastructure failure possibly lasting anywhere from 2 days to 8 weeks. The Y2K risk horizon to last for 2-4 months after January 1, 2000.

It must be cautioned that in many ways, taking a global perspective on the problem can create a deceiving vision of Y2K, since technology itself is spread unevenly around the globe. The lack of technology in some countries and its late adoption in others help mitigate against some of the global meltdown scenarios painted by Y2K alarmists.

Several studies, reports, surveys etc. have been published stating the Y2K preparedness of global power systems and on the expected impact due to system malfunctions. There is a very wide range of opinions about system readiness. The verdict is mostly dependent on whom one listens to. Several factors from 'national pride' to 'ignorance' result in distortions of the facts. Most nations, on their official Y2K sites (see bibliography), state that their electrical systems have been made fully Y2K ready. This of course can not be the truth.

Reports published by analysts (consultants) have frequently been relied on as judges of who is ready and who is not. That is because little independent verification on Y2K fixes is available in most countries -- especially when it comes to public sector utilities. Most governments have simply not subjected their Y2K programs to outside audits. Countries have complained that these ratings are often inaccurate and have unfairly damaged their international image, perhaps even hurting foreign investment. "*Consultants* has a vested interest in stirring up panic," stated a Jamaica's government Y2K coordinator who said he has never once been approached by anyone attempting to evaluate Y2K compliance in his country.

Technology consultants GartnerGroup are among the world leaders in promoting awareness of the Year 2000 computer bug, advising global corporations, foreign governments and the U.S. Senate. The GartnerGroup has published a series of reports on the Y2K readiness status of select countries. These are amongst the most cited. The following is a summary of the study published by the GartnerGroup (Although the projections were based on the status in 3Q98, they serve as a measure of where the countries are expected to be on Dec 31 1999)

> Level 1: *Mostly isolated and minor incidents in utilities, communications and financial services, for example, but may include moderate disruption in some government services*
> Australia, Belgium, Bermuda, Canada, Denmark, Ireland, Israel, the Netherlands, Switzerland, Sweden, Britain, U.S.
>
> Level 2: *There will be isolated disruptions in utilities and transportation, but they will b4e moderate rather than minor. Possible severe interruptions in some government services*

Bahamas, Brazil, Chile, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Japan, South Korea, Mexico, New Zealand, Norway, Peru, Portugal, Singapore, Spain, Taiwan, Thailand.

Level 3: *Moderate power interruptions, such as brownouts, along with moderate air traffic problems and possible severe loss of some government services*
Argentina, Armenia, Austria, Bulgaria, Colombia, Czech Republic, Dominican Republic, Egypt, Guatemala, India, Jamaica, Jordan, Kuwait, Malaysia, Panama, Poland, Puerto Rico, Saudi Arabia, South Africa, Sri Lanka, Turkey, United Arab Emirates, Venezuela, Yugoslavia.

Level 4: *Widespread or severe problems predicted in utilities, communications and imports/ exports, and especially in air traffic and government services*
Afghanistan, Bahrain, Cambodia, Chad, China, Costa Rica, Ecuador, El Salvador, Ethiopia, Fiji, Haiti, Indonesia, Kenya, Laos, Lithuania, Morocco, Mozambique, Nepal, Nigeria, Pakistan, Philippines, Romania, Russia, Somalia, Sudan, Uruguay, Vietnam, Zaire, Zimbabwe.

GartnerGroup's Strategic Analysis Report "Year 2000 World Status, 2Q99: The Final Countdown" showed that several countries listed in the previous list as Level 3 & 4 had made 'significant' progress towards Y2K compliance. These countries included **Argentina**, **China**, and **India**. The report stated that "no longer are there any countries that have made no remediation at all." Every government covered in the report has made some compliance effort.

International Monitoring (IM), a technology consulting group based in Britain, has also ranked nations around the world according to their preparedness for Y2K. The firm sought third-party verification of each government's reports on cleansing computers and embedded circuits of the millennium bug, and it based its ratings on the risk of disruptions in a given country's power, telecomm, finance and transportation infrastructures.

IM predicts 10 percent of Y2K failures will occur on Jan. 1, with most of the rest occurring in the days and weeks that follow. IM analysts think that the majority of bug-related troubles will not be directly related to systems failures but to follow-up events.

Best prepared (least at risk): Bermuda, Chile, Canada, United States, Australia, Hong Kong, Singapore, Denmark, Ireland, Netherlands, Sweden, Switzerland, Britain, Israel

Better prepared: Benin, South Africa, Bahamas, Barbados, Grenada, Mexico, Panama, Puerto Rico, Trinidad & Tobago, Fiji, Japan, New Zealand, South Korea, Sri Lanka, Taiwan, Thailand, Belgium, Finland, France, Germany, Hungary, Norway, Portugal, Spain, Syria

Moderately prepared: Italy, Lithuania, Macedonia, Poland, Ukraine, Yugoslavia, Bahrain, Iran, Jordan, Kuwait, Lebanon, Morocco, Saudi Arabia, Sudan, Tunisia, United Arab Emirates, Yemen, Colombia, Costa Rica, Haiti, Honduras, Jamaica, Paraguay, Peru, Suriname, Uruguay, Venezuela, China, India, Indonesia, Malaysia, Myanmar, Nepal, North Korea, Pakistan, Philippines, Armenia, Austria, Bulgaria, Czech Republic, Georgia, Greece, Botswana, Cape Verde,

Chad, Republic of Congo, Djibouti, Eritrea, Ghana, Kenya, Malawi, Mauritania, Mauritius, Mozambique, Rwanda, Seychelles, Tanzania, Argentina, Brazil, Dominica, Dominican Republic

Less prepared: Central African Republic, Congo (former Zaire), Ethiopia, Guinea, Guinea-Bissau, Lesotho, Namibia, Nigeria, Senegal, Swaziland, Gambia, Bolivia, Ecuador, Guatemala, Cambodia, Laos, Samoa, Vietnam, Albania, Bosnia, Croatia, Estonia, Latvia, Romania, Russia, Turkey, West Bank & Gaza Strip

Worst prepared (Most at risk): Liberia, Madagascar, Niger, Somalia, Belize, El Salvador, Bangladesh, Moldova, Tajikistan, Egypt, Oman, Qatar

Inadequate information: Angola, Burkina Faso, Burundi, Cameroon, Comoros, Ivory Coast, Equatorial Guinea, Gabon, Mali, Sao Tome & Principe, Sierra Leone, Togo, Uganda, Cuba, Guyana, Nicaragua, Azerbaijan, Macau, Mongolia, Papua New Guinea, Tonga, Belarus, Cyprus, Iceland, Kazakhstan, Kyrgyzstan, Slovakia, Slovenia, Turkmenistan, Uzbekistan, Algeria, Iraq, Libya

Asian power utilities are in a race to keep electricity running as the shadow of the Year 2000 computer bug creeps closer, but according to responses from a Reuters survey preparations vary widely across the region.

Hong Kong, Singapore, the **Philippines, New Zealand, Taiwan** and **Thailand** appear well down the road towards early Y2K compliance in the electricity industry. But indications are that countries such as **Indonesia**, struggling to recover from financial meltdown, and mainland **China**, experiencing its worst floods in decades, may be less prepared.

Merrill Lynch in a research report published in June said the **Pakistani, Malaysian** and **Chinese** companies appeared to be the least prepared of all the Asian electricity companies.

Earlier in the year, the head of the U.S. Central Intelligence Agency office looking at the general issue of Y2K compliance said most **Pacific Rim countries** were "maybe nine months to a year behind in terms of where the work should be".

China--the United States' fourth-largest trading partner--is considered so far behind that there is little hope of its avoiding serious problems. The country's Y2K czar, Zhang Qi, ominously noted recently that the country's electric power network has the furthest to go of all agencies in repairing the glitch. According to reports, the Ministry of Finance has yet to receive funds that have been budgeted for Y2K repairs, leading one official, Xiao Mingquan, deputy director of China's State Quality Supervision and Testing Center for Electronic Computers, to note that New Year's Eve could be "one dark joke."

An official from the technical department of the State Power Corporation of **China**, formerly the Ministry of Power Industry, said the group had not got beyond general investigations. Some equipment would be renovated, and foreign suppliers would be asked to help where possible, he said. But he said the group had been tied up securing power supply to flood-stricken areas and hoped focus on Y2K work would begin in September, after the flood season. (It is unreal to expect that very much would have been done to mitigate all Y2K problems)

A senior computer supervisor at the Electricity Generating Authority of **Thailand** (EGAT) said the group should have no problems meeting a mid-1999 target for Y2K compliance. EGAT, the largest government-owned wholesale power producer in Thailand, had earmarked 475 million baht ($11.4 million) for the project.

"We should be millennium compliant by July 1, 1999," said Wen Chao-gui, information systems director at Taiwan's Taipower. He said he did not expect **Taiwan** would have to shut down any of its nuclear plants, which supply nearly a quarter of the island's power.

The Manila Electric Co (Meralco), the **Philippines'** largest power distributor, said its systems will be 100 percent millennium-compliant by year-end. "We expect all the systems to be compliant by the end of the year. For the big systems, I would estimate that at present they are between 85 to 90 percent compliant," Porfirio Palo, head of Meralco's Y2K project said.

Other countries like **Korea, Singapore** and **Hong Kong** say their compliance programmes should be completed sometime next year.

Venezuela and **Saudi Arabia**, which provide about a third of all imported oil to the United States, are 12 to 18 months behind the United States and are at risk of moderate power blackouts, telephone disruptions, government service failures and air transport delays. Chinese Far Behind in Preparations

At Petróleos de Venezuela SA (PDVSA), **Venezuela's** state oil company, a sharp decrease in oil prices is forcing the company to make deep cuts almost everywhere-but not in approximately US$200 million the company has set aside for its Y2K conversion. "Top management understands this to be a matter of survival," says Nelson Nava, the company's IT director, adding that the company has created a high-level Y2K steering committee, made up of high-ranking PDVSA vice presidents and subsidiary presidents, to oversee the project's progress.

Mexico, the United States' third-largest trading partner, is also considered well advanced in its repair work. The government, which controls the crucial energy and oil industries, is expecting to complete its work well before Dec. 31st.

In **Colombia,** Mauricio Arias Toro, IT director for Empresas Públicas de Medellín (EPM) says the public utility began fixing its year 2000 problems last year. With over US$800 million in annual revenues, the agency provides services such as water and sewer, electricity and telecommunications to Medellín and about eight other neighboring municipalities. "The company's general manager declared [Y2K] the company's overall top priority, not just IT's top priority," Arias Toro says. He expects EPM to have fixed about 70 percent of its systems by the end of this year and the remaining 30 percent by next summer (1999).

4.2 Status of Electricity Sector Y2K preparedness in select countries

The following is a compilation showing the Y2K preparedness in select countries in Asia, Africa, and in South America. This information has been compiled from public-domain information. The amount of information available varies greatly between the countries. For some countries (such as Egypt), very limited information has been made available in English for public awareness. In many countries (such as Brazil), no information was available in English.

4.2.1 Asia - Egypt

Summary

Totals in Governmental Sector

- Average Readiness for IT components 96%
- Average Readiness for Embedded Systems 96%
- All Systems will be Ready before end of October 99
- All Governmental Sectors prepared Contingency plan for emergency

According to the official Y2K site, Egypt has 108454 P.C Computers, 2327 Minicomputers, 166 Mainframe Computer, 7362Applications, and 9542Embedded Systems.

Status

Egypt started its Y2K preparedness program in 1998. The program covered the following phases;

- First Phase: Awareness (Jun. 1, 1998)
- Second Phase: Inventory (Jul. 1, 1998 to Aug. 31, 1998)
- Third Phase: Assessment Phase (Sep. 1, 1998 to Oct. 31, 1999)
- Fourth Phase: Remedy Phase: (Nov. 1998 to Feb. 1999)
- Fifth Phase: Test phase (Mar. 1, 1999 to Jun. 30, 1999)
- Sixth Phase: Follow up (July 1,1999 - Dec. 31,1999)

  Remedy for residual non-compliant cases
  Implementation, Testing and fixing
  Preparation, Documentation, and training on Contingency plans are done weekly

In the electricity sector, Egypt claims to have a total available Y2K free generation capacity of 13GW. This is equal to 97% of installed capacity and can meet 134% of peak load.

Egyptian utility's claim to have tested and made Y2K ready 100% of their P.C Computers, M99% of the Minicomputers, 100% of Mainframe Computers, 99% of software applications, and 95% of the Embedded Systems.

Summary of Oil, Gas, and Communication system's Y2K preparedness

All systems in the petroleum sector are reported to be compliant. Contingency plans have been prepared and documented, training on contingency, mobilisation plans are carried on by the organisation staff.

Transport & Communications have reported almost 100% compliance. 99% of the embedded systems have been tested and made Y2K compliant.

Possible pitfalls and impact scenarios

Based on official reports, electric supply should not have any problems due to Y2K incompatibility. However, official government reports do not show the complete picture. It is expected that Egypt will see Y2K related outages.

Egypt reports that it has sufficient generation that is Y2K ready to meet 134% of its peak demand. Therefore, disruptions due to incompatibilities in the T&D system will only cause short duration outages. Most of the system, it is expected, will be able to operate manually.

4.2.2 Asia - India

Summary

99% Y2K ready; Balance 1% was expected to be compliant by the end October 1999

- The total installed capacity of electric power generation in the country is 93239 MW with an effective capacity of 92904 MW. About 66% of this capacity is immune to Y2K problems because it is based on analog controls.
- The remaining 34% of the effective capacity was, before rectification, potentially vulnerable to the Y2K problem.
- The AC transmission and distribution is already Y2K ready or has been made Y2K compliant.

Status

As of 14 October 1999, 97.5% of the affected capacity had been made Y2K compliant. Therefore, about 99.15% of the total effective installed capacity of power generation in the country has become Y2K compliant/Y2K Ready. The work for rectification of the remaining capacity which constitutes only 0.85% of the effective installed capacity is under progress.

The AC transmission and distribution is already Y2K ready or Y2K rectified. In the HVDC transmission, confined to the ownership of Powergrid, equipment vendors were asked to test the equipment for certifying for the Y2K preparedness. This work was expected to be completed by mid October. Notwithstanding the above, the equipment manufacturers were also asked to gave in writing that similar equipment supplied by them in the U.S. was already Y2K compliant. Some field tests have been conducted by Vendors and have passed the Y2K tests. Power flow in the Powergrid's system is not expected to be effected by Y2K problems.

Status of Y2K effects in power sector - All India (As on 15.10.99)

Particulars	MW
Installed Generating Capacity (Name plate)	93239
Effective installed Capacity	92904
Capacity not influenced by Y2K	61196*
Capacity influenced by Y2K	31708
Capacity already rectified (As on 14th October, 1999)	31073
Capacity under rectification	635

Note : '' Includes Old Hydro and Thermal plants having Analogue Controls.*

Region wise status of Y2K rectification(MW) - All India (as on 15.10.99)

Region	Effective Capacity	Capacity Influenced	Capacity Already Rectified	Capacity Yet to be Rectified
Northern	25051	10075	10075	0
Western	27594	12634	12559	75
Southern	23969	3476	3056	420
Eastern	14598	4960	4750	210
N.Eastern	1657	563	423	140
Islands of A&N and Lakshadweep	35	-	-	-
TOTAL	92904	31708	31073	635

In the non-control areas such as application software and hardware for commercial and other purposes, rectification program has been completed. In some areas the same was in progress and was likely to be completed by October 1999.

India has evolved contingency planning for mission critical task in the regional power systems was to ensure integrated operation of the concerned Regional Grid and avert cascade tripping through separation of the affected system.

- Power stations having Analog Controls and lending themselves immune to Y2K would be kept in full operation at year 2000 transition time. This includes Hydro Power stations with assured water availability.
- Adequate spinning reserves will be kept in the system keeping the period with near zero planned maintenance.
- Power flow across regions would be kept at low so that problem in one region does not affect other regions.
- Raw material supplies would be kept for 15-20 days so as to maintain continuity and exigencies.

- Communication among regional centers, state centers and large plants would be augmented with satellite phones.
- Board guidelines for grid operations, hydel and thermal plants have been prepared to help the regional centers to prepare more detailed contingency plans.

Summary of Oil, Gas, and Communication system's Y2K preparedness

Public Sector Undertakings (PSUs) in the Oil and Gas sector initiated steps to rectify the problem in early 1998.

- In the IT area the Oil & Gas PSUs have applications which are either developed in-house or developed through external software companies or bought out packages. Most commercial applications and other applications and bought out packages have been made compliant internally or externally depending upon the requirement of each application and are being tested internally through simulation, roll over of date etc.
- IT infrastructure comprising hardware (servers, desktops etc) and software (operating systems etc.) have been upgraded or replaced as per need.
- Production both onshore and offshore is mostly manually controlled. No problems are expected in oil production. The few critical Programmable Logic Control Systems (PLCs) and Digital Control Systems (DCSs) used in offshore production have been identified and have been made Y2K compliant. Nearly 85% mission critical and 97% non-critical systems have been made Y2K ready. Rest was expected to be ready by the end of October 1999.
- The fourteen public sector Y2K compliant. The testing of these have been completed. The refineries in the joint and private sectors have also reported readiness about their preparedness for Y2K related problems.

In a recent update (December 16th) the President of the Telecom Industry and Services Association, P K Sandell, said that his organization is waiting until the 31 December before reporting on Y2K prepardeness. He says disruption may occur due to incompatibility of at least 15% of non-digital telephone exchanges - mainly in rural areas and small towns.

Possible pitfalls and impact scenarios

Wide power system failures are not expected in India due to Y2K problems. Generation sites and transmission systems are expected to remain functional. However, some localized outages may occur due to non-compliance of some equipment in substations.

Outages, if any are expected to be not expected to be life threatening. Since electricity supply in India, even at best of times is un-reliable, most establishments where supply is critical have backup generation systems. Since outages are not expected to last for long, these backup sources may be able to overcome dangers in critical sectors.

India has the required technical manpower to ensure Y2K compliance. Failure to ensure Y2K compliance of critical systems in India will stem from callus attitude of the personnel, and the unavailability of sufficient funds to implement the mitigation.

The Indian oil industry is vulnerable to oil import. Studies have shown that this is a weak link in India's Y2K preparedness. It is apprehensive about risks due to the non-compliance of foreign supplies.

4.2.3 Asia - Indonesia

Summary

PT PLN (Indonesian Electricity Company - a state owned company) is responsible for the electric power in Indonesia. Based on report dated October 1999, the PLN Y2K progress is as follows:

- Power plant control system : 100% ready
- SCADA and telecommunication system : 100% Ready
- Protection and Meter System : 100% Ready
- Billing and Accounting System : 100% Ready
- Contingency Planning : 100% Ready

Status

PT PLN is Indonesia's state owned electricity company and is responsible for the supply of electricity throughout Indonesia. PLN operates in all 27 provinces, which are scattered across 5 large islands, two smaller islands, in addition to the majority of the remaining 17 thousand small islands. PLN serves over 26 million customers and generate 20.580 MW of energy. PLN interconnected Java Bali system forms the largest system with 74% of the national generating capacity.

To cope with the Y2K issues and to ensure smooth functioning of its operations leading up to the year 2000 and beyond, PLN began to implement its Y2K program in late 1997. Committees and working groups were formed to formulate and implement Y2K remedial plans.

PLN's Java Bali interconnection system is the most automated, while the majority of the systems outside Java Bali are manually operating systems or analog (see table). Thus, the impact of Y2K issues in sections outside Java Bali will be limited. PLM targeted the Power Plant Control Systems, SCADA and telecommunication systems, Protection and Meter Systems, and the Billing and Accounting in Java Bali.

Automation of Indonesia's Generation and SCADA system

Items	Java Bali	Outside
Generation		
Control System	36	19
Units	120	47
SCADA/EMS		
Transmission - ACC	6	3
Distribution - DCC	4	-
Protection & Meters (No. of Substation)	345	126

Generation

- The total number of power generation units are 4,443 which 94% are Diesel Generators scattered outside Java-Bali system. The control systems of these Diesel Generators are analog and are therefore not affected by Y2K Problems.
- Of the remaining 6% of generation units,120 are in Java Bali interconnected system and 47 generation units 19 control systems outside Java-Bali are all now Y2K Ready.
- 63% of the control systems for Java-Bali Power Generation are not affected by Y2K issue. The remaining 37% systems or 36 main control systems has been investigated and proven to be Y2K ready, meaning that the functionality of the equipment will not change materially as a result of the date change from 1999 to 2000.

SCADA/EMS (Energy Management System)

- There are 9 SCADA systems for transmission/load dispatching center and 4 SCADA systems for distribution control center, these have all been checked to ensure Y2K ready.
- PLN has received certificates of compliance from most vendors.

Telecommunication

- All of those communications system are proven to be Y2K ready.

Protection & Meters

- All analog and digital relays use within PLN have been Y2K ready.

Billing & Accounting

- PLN has upgraded and tested the effected system hardware and system software and these system are now been Y2K ready.

Throughout the Y2K readiness process PLN has identified and qualified the risks associated with each potential problem area and developed comprehensive contingency plans to ensure that in the event of problems the impact of these events will have a minimum negative impact to the public and industry. These contingency plan consist of these components:

- Supply chain, implementing dual firing (using fuel oil) facility, especially for coal fired & natural gas power plants.
- SCADA system, fall back to manual operation
- Identification of alternative operating scenarios for each interconnection system, with optimal spinning reserve
- Around the critical periods, PLN will enhance the monitoring of certain facilities and apply proven manual intervention routines to allow for any automated process malfunction that may arise

- During the critical periods, operation personnel will be on duty at all major facilities in order to timely response to any unexpected event.
- The number of operation support staff available at each operating plant will be increased as required to provide the level of support to ensure the appropriate execution of all required manual intervention.
- Technical supervisory support personnel will be placed on standby at the head office and branch office over the critical periods to provide active response support to the field personnel and third parties questions.

Summary of Oil, Gas, and Communication system's Y2K preparedness

The Oil & Gas sub-sector is being represented by PERTAMINA (state oil company). In general, activities to correct the systems are complete, but several projects must still be finished. Overall, progress in Y2K handling in PERTAMINA is 91%. PERTAMINA has completed 92% Remediation/ Mitigation, 83% Contingency Planning, and 70% Training & Simulation towards handling Y2K problems.

The status of the Communication sub-sector is as follows:

- 13 companies are in the final stages (>80%) of taking Inventory of their operations
- 13 companies have also completed more than 80% of the Assessment stage
- The status of the remediation stage: 8 companies have reached 75% and above, 4 are in the 50-75% stage, while one company is in the 25-50% completion status.
- The status of Y2K testing phases: 3 companies in the 75% and above stages, 5 are in the 50-75% stages, while another 5 companies are in the 25-50% stages.
- The situation for Industry Test is not as good as the other phases, 11 companies are below 25% completion status, with one between 25-50%, and another one with above 50% completion status.
- Contingency planning for the communication companies are mostly in the 25-50% stage with 6 companies claiming to be in that range, 3 companies are in the 50-75% stage, 2 companies in the >75% completion status, and another 2 in the 25% and below status.

Possible pitfalls and impact scenarios

PLN has extensively investigated all critical control systems and corrective action taken where applicable. The testing simulation now indicate that power outages, voltage irregularities, frequency fluctuation and other situations resulting from the Y2K issues that could pose supply or safety problems will not occur (The system are not date sensitive).

In term of crisis management, PLN is routinely prepared to response to natural disasters and other emergencies. To ensure preparedness for Y2K problems, PLN has completed its preparation for crisis management that includes establishing the Y2K task force, communication arrangements, deployment of additional standby personnel, and preparation for manual operation of power plants and facilities

PLN claims that it is ready for Y2K. Based on the official claims made by the utility, the country should not see any Y2K related electricity outages.

4.2.4 Asia - Malaysia

Summary

The Malaysian electric sector already had an average readiness across the sector of 94% As at 15th October 1999,

- Overall Progress (99.5%)
- Awareness and training (100%)
- Inventory, impact assessment, and implementation plan (100%)
- Compliance, testing and acceptance (98%)
- Contingency plan (100%)

Status

The Y2K validation reports issued by the Government-appointed National Y2K Project Team (NYPT) shows Malaysia making excellent progress towards achieving full compliance of all computer-controlled systems in the country.

The critical electric energy sector had an average readiness across the sector of 94% and the report says that it is highly unlikely that there will be nation-wide disruptions in electric power supply on January 1st, 2000. Most power plants are Y2K ready and this high level of readiness already guarantees generation capacity above the anticipated demand during the Millennium rollover.

Tenaga Nasional Berhad (TNB) is the largest electricity utility in Malaysia. The company's core activities are in the transmission and distribution of electricity. TNB remains a major player in electricity generation which forms a significant part of the company's diversified range of business activities. TNB Generation Sdn Bhd has the largest generation capacity of over 8,100 MW, accounting for more than 66 per cent of the total power generation in Peninsular Malaysia.

TNB Generation Sdn. Bhd. (Overall readiness is 97%)

- Y2K work has been completed in two of TNBG power stations, namely Kenyir and Cameron Highlands. Siemens has completed upgrading work at Port Dickson, Pasir Gudang, Perai and Serdang power stations. Y2K Rollover and Stability tests were also successfully conducted for all these power stations after upgrading works completed.
- Siemen's project group under contract obligation handles Y2K work for Connaught Bridge. Upgrading work on Operating System and modules were carried out on 13th to 24th July 1999.
- Upgrading work of gas metering stations for Paka, Kapar, Connaught Bridge, Pasir Gudang and Malacca power stations has been completed by Petronas Gas. The upgrade work involved replacement of PLC, HMI and flow computers.

- A live test was done in Pasir Gudang on 12th July 1999 and was successful.

TNB Transmission Network Sdn Bhd (Overall readiness is 100%)

- Y2K work on SCADA/EMS has been completed. Operation plan and Contingency plan for SCADA/EMS are also ready.
- Y2K tests and upgrades on RTUs have been completed. Operation plan and Contingency plan are ready.
- 12 system tests comprising Telecommunication and Protection equipment have been completed and verified to be Y2K Ready.
- 12 substations with SCS/SAS have been tested and considered to be Y2K Ready.

TNB Distribution Sdn Bhd (Overall readiness is 98%)

- Y2K work on Papan, Penang, Johore, Kajang, Malacca, Bangsar and Klang Regional Control Centres (RCCs) has been completed.
- Sub Station Control System and Numerical Relays are being tested at the factory and found to be Y2K Ready (No date dependant functions.) Compliant letters from the vendors have been received.
- Test on meters has been completed and all 19 highly critical meters are Y2K Ready.

Other Corporate Systems (Overall readiness is 100%)

- Corporate Systems such as CIBS, FMIS, HRIS and MMIS are currently running on Y2K compliant version.

Very limited information is available on the status of other utilities in Malaysia, however the following has been reported,

- SESCO is similarly in a satisfactory position, especially in the area of embedded systems. They still have some work to do in the IT side, but overall is expected to achieve Y2K readiness in a timely manner.
- SESB is also in a satisfactory position to achieve Y2K readiness in a timely manner.
- Most of the IPPs are now Y2K ready

Summary of Oil, Gas, and Communication system's Y2K preparedness

The oil and gas sector is, for all practical purposes, ready. Sector average as of end of August was 94%. Almost all the corrective work had been completed at the end of August and the work remaining was not in areas critical to companies operations. By the nature of its business operations, the petroleum industry has comprehensive contingency plans in place as standard operational procedure. These have been refined to cater for Y2K and are being extensively tested.

Average readiness across the communications sector was 85% with progress towards full Y2K compliance very strong. Telekom Malaysia Berhad had successfully completed all the planned local and international testing in alive-environment. All switching equipment

was Y2K ready, as was most transmission equipment. In case of any minor disruptions, contingency plans are in place to deal with them.

Possible pitfalls and impact scenarios

Tenaga Nasional Berhad (TNB) wants consumers to use electricity as on Dec31st. TNB Chief Executive Officer Tan Sri Dr. Ahmad Tajuddin Ali announced on Dec 7th that the power utility is now 100 per cent Y2K ready. Official studies have stated that wide disruptions in electric power supply in areas served by TNB are unlikely.

Other utilities in Malaysia have also reported Y2K compliance.

According to the United Nations (UN) International Y2K Cooperation Center, all of Malaysia's critical sectors are now Y2K ready and the Millennium Meltdown, is unlikely to happen in the country.

4.2.5 Asia - Philippines

Summary

In Philippines, power distribution is the domain of private distribution companies and more than 100 electric cooperatives.

Power distribution company, The Manila Electric Company (Meralco), the largest utility in the Philippines accounted for 62% of the total energy consumption of the entire country. Meralco claims to have achieved 100% Y2K compliance. As of October 31, 1999, Meralco stated that its status was

- Awareness 100%
- Assessment 100%
- Conversion 100% of critical systems
- Testing 100% of critical systems
- Implementation 100% of critical systems
- Contingency Planning 95%

Status

The Manila Electric Company (Meralco) has received its official Year 2000 State of Readiness Validation Certificate from the Hampton Enterprises Inc. (HEI) International Trading, the Presidential Commission on Year 2000 Compliance registered independent third party auditor which conducted a comprehensive Year 2000 state of readiness validation audit on the company. HEI-IT is an independent third party auditor accredited by the Y2K Commission, which conducted a comprehensive Year 2000 state of readiness validation audit on the company.

Meralco presented the prescribed documentation, equipment, and computing systems for the audit, including interviews of its personnel on mission critical issues. This include real time and year 2000 simulated time operation of its computing and control systems, specifically the supervisory control and data acquisition (SCADA) system. Random

63

sample testing was performed, traceable to the British Standards Institute (BSI) definition of Year 2000 conformity requirements. Original equipment manufacturer (OEM) Y2K certificates were examined.

Philippine electrical utilities are coordinating towards contingency analysis, system studies, and operational planning. Several steps have been decided on to meet any eventualities. These include,

- Put more generating units on-line (no units on economic shutdown; excess generation capability on standby mode); minimize planned/scheduled outages of generating units;
- Run older units with predominantly electromechanical or analog controls and which are less vulnerable to the Y2K problem;
- Ensure that adequate spinning reserves and quick start units are available;
- Coordinate with independent power producers (IPPs) for generation availability;
- Review, update (if necessary) and make ready the load shedding scheme;
- Review, update (if necessary) and make ready the black start capability and restoration plans;
- Ensure that all available transmission facilities (including the Luzon - Leyte HVDC link) are in service; minimize planned/scheduled outages of transmission lines and transformers;
- Review, update (if necessary) and make ready the control center contingency recovery plan (including availability of a backup control center);
- Ensure that radio communications facilities are available as backup to primary voice communications for manual power system monitoring and control; and
- Make available key technical support staff on site at power plants, critical substations and control centers during the rollover period.

Philippine utilities expect that New Year's Eve (December 31, 1999) will most probably be declared a special non-working holiday based on tradition and New Year's Day (January 1, 2000) is a legal holiday. From an electric reliability perspective, because of this, demands on the electric system are expected to be greatly reduced, and the system conditions are likely to be favorable with light power transfers and excess generating capacity available during the most critical Y2K period.

Summary of Oil, Gas, and Communication system's Y2K preparedness

No information was available about the Oil and Gas Y2K preparedness in Philippines

The telecommunication sector is 85 % ready. Its readiness status has seen a marked improvement in the months leading to December. This improvement has been brought about by the increase in the number of private telephone companies submitting their Y2K Statements especially those belonging to the PAPTELCO (Philippine Association of Private Telephone Companies). The major carrier, like the Philippine Long Distance

Telephone Company (PLDT), Globe, BayanTel and Smart have been Y2K ready since September 1999.

Possible pitfalls and impact scenarios

Trouble can be expected in nations electrical supply due to Y2K noncompliance of Transmission and distribution systems. Philippine electrical system consists of several small companies. It can be expected that many of these will not be ready for Y2K.

Effects in these small players, could effect the national grid's stability. 'Islanding' of the electrical system is a possibility due to Y2K related problems.

No information about Y2K compliance was available in public domain from these regional utilities (e.g. Davao Light & Power Co., Inc. (DLPC), the nation's third largest electric utility company).

4.2.6 Africa - Ghana

Summary

Ghana, according to governmental publications, has reported a national compliance index of 66.58%. Ghana's Electric Supply Company has reported 96.86% compliance.

Status

Overall in the energy sector, Ghana reports 88.19% compliance. Individual sub-sector compliance within the power system was not available.

Within the energy sector, the following companies have reported the listed compliance.

- Unipetrol Ghana Ltd. - 12.86%
- Ghana Oil Company - 66.43%
- Bulk Oil Storage &Transport Comp. Ltd. - 94.29%
- Electricity Company of Ghana - 96.86%
- Elf Oil Ghana Limited - 97.86%
- Mobil Oil Ghana Ltd. - 83.57%
- Tema Lube Oil Co. Ltd. - 99.57%
- Tema Oil Refinery - 97.14
- Total Ghana Ltd. - 100.00
- Volta River Authority - 97.14

Summary of Oil, Gas, and Communication system's Y2K preparedness

Summary of other sectors of the economy is as follows,

- Communications - 82.35%
- Finance/Bank - 95.16%

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- Financial/Non-bank - 75.26%
- Government Business - 38.93%
- Health - 38.37%
- Industrial/Commerce - 73.02%

Possible pitfalls and impact scenarios

Very limited information is available to accurately access the Y2K scenario in Ghana.

4.2.7 Africa - Tanzania

Summary

Overall readiness level for the energy sector is about 85%

Tanzania Electricity Supply Commission (TANESCO) engaged South African consultants to help assess the compliance status of their equipment and draw up contingency plans to minimize risk of power failure. Following this study TANESCO have declared publicly that it is Y2K ready.

However another report stated that TANESCO has achieved critical compliance of about 90%

Status

The Government since August 1998 has addressed the Y2K problem in Tanzania.

Independent tests to check that the plants and systems are not affected by date have been conducted. This covered date rollover of non-operational system followed by date rollover testing of a fully operational system, including startup, shutdown, and running operation of two units in the Year 2000.

The contingency plans are in place.

TANESCO are now running one of the plants that has already been proven ready for the Year 2000 on a long term test as if it is in the Year 2000 right now, it means TANESCO is in the 21st century on this plant.

The Technical systems are generally immune to Y2K. However the main problem here is with the Ubungo power plant where the compliance status is still unknown and the operator has been charged with resolving the issue. (The results of this have not been published)

TANESCO has assured the public that for power generation and distribution, no Y2K related problem will be experienced. TANESCO is still continuing with the process of remediating the problem of hardware and software for their business systems.

The main remediation is with the billing system for LUKU that is being done by CONLOG the South African supplier.

Summary of Oil, Gas, and Communication system's Y2K preparedness

According to Tanzanian Italian Petroleum Refinery (TIPER) management, fuel distribution by the oil companies is not highly automated, and petrol stations can pump manually or using stand-by generators. Efficient use of all available fuel reserves should ensure that supply to the consumer is not effected.

Overall readiness level for the communication sector is about 85%.

- TTCL - The company declared officially to be compliant and this is what they said "we have checked all our systems and rectified all problems pertaining to the problem and we expect no service interruption based on the Change to the Millennium". It is completing remediation exercise as well as contingency plans.
- Mobile phone companies (Mobitel, Tritel, Datel, Zamtel), have completed remediation, and now they are busy with contingency plans. Most likely to be compliant within their own networks, but depend on TTCL for international, inter-city, and inter-network connections.
- Media companies - RTD and IPP have contracted a consultant to deal with Y2K media problems and are now in the remediation process. CCO will visit key media institutions before the end of November to make an assessment of Y2K compliance.
- Tanzania Posts Corporation - The World Bank is funding a Y2K project in this corporation and they are confident that no disruption will be experienced as a result of Y2K bug.

Possible pitfalls and impact scenarios

Electric supply reliability is not expected to change in Tanzania due to Y2K related bugs. TANESCO has hired international consultants to ensure compliance. Tanzania may see few breakdowns in their communication infrastructure.

4.2.8 Africa - Uganda

Summary

Uganda states that disruptions in electric power supply will be unlikely on January 1, 2000.

Status

Power generation, communication, distribution, and metering systems are now ready. Remediation of transmission control systems was completed early September 1999. The SCADA system had been the main outstanding sub-system, and it has been fixed. Emergency preparedness drills are in progress, which means the "national critical systems of UEB is now compliant.

Under the "administrative critical systems", testing of the billing and accounting systems has been completed and crossover to the new systems has been done, and bills from the new system have been sent to consumers. Acceptance tests for the various modules of

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the Financial Management Information System have been completed. The "administrative critical systems" are now compliant

An international consulting firm hired to assist with contingency planning has completed its work with UEB in September. Contingency plans for all risk areas to reduce risks in UEB's operations have been developed and documented.

Summary of Oil, Gas, and Communication system's Y2K preparedness

The oil supply sector (operated by private companies) has detailed project plans and these are continuously updated. Resources are in place and remediation carried out. Detailed contingency plans have been developed and reviewed. All individual oil companies have achieved Y2K compliance. It should be noted that there is a heavy cross border dependence in the East African Region in oil supply. Uganda depends on harbours, refineries and oil pipelines in the neighbouring countries Kenya and Tanzania for its supply.

Progress has been made with the critical compliance of Uganda Telcom Ltd (UTL), this has been assessed at 100% assured. Working with an embedded systems expert from the United States of America, tests have been done on mission critical equipment both in Kampala and upcountry and no new Y2K bugs discovered in operational equipment. The Kagera Basin Organisation (KBO) link has been tested and found to be Y2K ready, therefore no upgrades are required. UTL is continuing with the documenting and testing of its contingency plans. The Regional Telecom Sector Working Group has completed a series of meetings to review contingency plans, and has successfully completed tests to use spare capacity for international and regional gateways on each others' network as part of the plans

Possible pitfalls and impact scenarios

Based on the information reviewed, the UEB will be in a position to maintain its current ability for Power Delivery. Power delivery is not expected to be affected by the malfunction of date and time in its mission critical power delivery systems"

4.2.9 South America - Chile

Summary

As of October 30th, the overall reported Y2k Ready Status of Chilean economy is 90%. The electric power sector reports 84% readiness (generation 84%, fuel 85%, and transmission 84%).

Status

Chile has four Interconnected Electric Power Systems with up to 69 companies providing Generation, Transmission, and Distribution, organized in a Pool Model coordinated by an Economic Dispatch Center.

As of October 30, the Y2k Ready Status of the power sector is 84 %. This includes contingency plan for: critical Y2k Objects (PLC, Process Computer, etc.), Subsystems (EMS/SCADA, DCS system, etc.) and the Contingency Plan for every company.

For each interconnected system, the CDEC (coordination of the power generation and transmission) has implemented a set of rules to minimize the impact of any Y2K contingency on the operation of the system. The main rules are the following:

- Operate the system under security criteria rather than on economic basis.
- Provide sufficient generation capacity,
- Additional reserve and quick start back-up units,
- Demand forecasting under special conditions, and
- Sufficient communications redundancy.

Summary of Oil, Gas, and Communication system's Y2K preparedness

Fuel 83%

- Town / Natural Gas 84%
- Fuel 83%

Telecommunications 98%

- Basic Telephony 99%
- Mobile phones 98%
- National Long Distance Telephony 98%
- International Long Distance Telephony 96%

Possible pitfalls and impact scenarios

Chile appears to be prepared to deal with the Y2K problem. Chile continues remediation efforts and contingency planning. However, the electrical power sector may experience minor disruptions of short duration.

In Chile, it appears that there is a low risk of potential disruption in the health sector, small and medium size companies, and private sanitary services. However, the fuel and communication systems, which show only 85% compliance, are a cause of concern.

Chile and Argentina share a trans-frontier infrastructure, including oil and gas pipelines, power lines, an optical fiber line, and transportation system. Chile exports electric power to Argentina. Problems on either end of a common pipe or power line could mean problems for both countries.

4.2.10 South America - Colombia

Summary

The repair and test stage of the systems and equipment used for electric energy generation in the country has been judged as - 95% ready.

Status

Colombia has identified high impact sectors as those where a failure caused by Y2K in any entity might produce the loss of a human life or the loss of more than the 1% of the Gross Domestic Product. This list included Power Supply, and Oil and Gas.

- The repair stage of the energy transmission process systems and equipment has been completed The test program of the repair stage foreseen for the regional systems ended with satisfactory results.
- Energy generation and transmission processes show a LOW risk level.
- Companies of the electric energy distribution area have participated in several regional tests with a satisfactory performance. Close to 90% of the companies have contingency plans and are at present performing the implementation.
- The repair stage of the system and equipment for electric energy invoicing in large cities has been completed and the companies' contingency plans are at the implementation stage. Due to this, the energy service invoicing related risk went from medium to LOW.

Regional electric companies present a MEDIUM risk level regarding electric power service invoicing, since some of them still are in the repair stage. The companies are preparing contingency plans, for which a guide for invoicing contingency plans was disseminated.

In Colombia 99.5% of the final consumers are served by the National Interconnected System (Sistema Interconectado Nacional - SIN). This system concentrates generation in eight companies that produce 80% of the total energy consumed in Colombia.

Transmission is mainly carried out by Interconexión Eléctrica S.A. – ISA, which manages most of the network, Centro Nacional de Despacho – CND and Bolsa Nacional de Energía – BNE.

Thirty-seven companies carry out the distribution – most of them covering a specific region or a large city – from which 14 are public regional entities.

The technical coordination of the National Interconnected System is the responsibility of the National Operation Council (Consejo Nacional de Operación – CNO) and counts with the active participation of ISA and the Ministry of Mines and Energy. These entities have been directly involved in preparing contingency plans for the global operation of the system in the event of failures caused by Y2K. The Gas and Energy Regulation Commission (Comisión de Regulación de Energía y Gas - CREG) supports their work, issuing regulations to facilitate the implementation of alternative operation plans.

As a group, the interconnected distribution companies that present less progress are the 14 regional public companies. The problem in these particular entities is the need to improve their administrative and invoicing systems. Under such circumstances, both the Minister of Mines and the CNO are working in the preparation of coordinated contingency plans to support the invoicing critical process.

The electric power supplier, Codensa, with a large foreign capital share, has been reported making proper progress in its risk mitigation plan. As regards to operation, the

company has a low sensitive infrastructure, although it is already conducting the design of alternative plans for local, manual operation of its substations. Regarding administrative systems, the repair of the commercial system has been completed and final tests are currently under way.

Electric energy distribution is not Y2K vulnerable, since it is based on electromechanical processes. In view of the additional factors that could cause failures, contingency plans are being developed to ensure service continuity. Electric energy distribution in the country shows a LOW risk level.

A MEDIUM risk exists for possible failure of electric energy service invoicing, both in large cities and at regional level. In the four main cities of the country the companies have worked on software repair and testing, but the design and implementation of contingency plans has been delayed due to systems complexity which makes manual operation difficult. At regional level, invoicing systems are being repaired, but contingency plan development is delayed. However, an invoicing failure impact at regional level will be smaller than in large cities. Methodology support is being provided for the entire sector, in order to supply companies that lack resources, with the necessary information to implement solutions used in other regions. These tasks are expected to be ready during October and November.

Summary of Oil, Gas, and Communication system's Y2K preparedness

No information was available about Columbia's Y2K preparedness in the Oil and Gas sectors.

The telephony service interoperability tests conducted among the different operators, both direct and indirect, secure the provision of the national voice network services. Due to this the failure risk for this service is LOW.

Possible pitfalls and impact scenarios

Difficulties are not expected in the normal provision of the electric power service throughout the country. The highest risk for the sector is the possible interruption due to problems in any of the 14 regional distribution companies.

However, contingency plans are expected to be timely implemented within the critical companies.

Major difficulties are not expected in the normal supply of the service, taking into consideration two main facts:

- The high level of progress achieved by generation and transmission companies (particularly ISA); and
- The low probability of failure in the systems used by distribution companies, most of which are electromechanically operated.

4.2.11 South America - Venezuela

Summary

Venezuela is one of the least-prepared countries for Y2K, according to the country's own Central Office of Statistics and Computing.

According to a Reuters' report, Venezuela's electrical system is particularly vulnerable to the Year 2000 Y2K computer bug. Reuters quoted Alfredo Pena, the country's presidential chief of staff, as saying that the country is "very behind" in fixing the Y2K bug. "We need US$1.5 billion for this, which was not approved by the previous government," said Pena. The country is already US$5 billion in debt, and the previous government, which just left office in February of this year, did not allocate any funds for dealing with the Y2Kproblem. Said Pena, "Public services could be paralyzed, mainly because of problems with electricity."

However, if one is to form an opinion based on the official reports from Venezuela then it may seem that things are very much under control.

Status

The Ministry coordinating the electric sector in Venezuela is the Ministry of Energy and Mining. Electric generation, transmission and distribution is accomplished through 17 companies: 12 public and 5 private utilities. All electric utilities are connected to each other through the Sistema Interconectado Nacional – SIN (National Interconnected System or Power Grid), managed by OPSIS.

The coordinated actions on the Year 2000 problem were initiated at the end of 1998, through OPSIS and CAVEINEL, which groups all utilities and other agencies in this sector. They coordinated and further developed the efforts already undertaken by companies in this sector at that time. CAVEINEL coordination includes circulation of methodology guidelines and technical information, as well as progress follow up in each company and agency. This sector invested an estimated of over US$ 60 million in remediation actions. Thanks to this effort, the sector shows considerable progress in risk mitigation and Y2K compliance. Risks in this sector are concentrated in two critical systems: operation or electric power distribution devices, and administrative systems.

- Most of the electric power distribution devices are electromechanical, and therefore not exposed to Y2K hazards.
- The few existing digital electronic devices are used in companies with higher progress, they have been fully upgraded and tested, and therefore they are not expected to be affected by Year 2000 rollover.
- More specifically, the five main utilities in this sector, CADAFE (national), Electricidad de Caracas (Caracas district), EDELCA (SIN and Guayana), ENELVEN (Zulia State) and ELEVAL (Valencia), have successfully completed inventory and upgrading of their distribution systems.
- These five companies account for 95% of generation installed capacity, 100% of high-voltage transmission systems, and 90% of direct supply to end-users.

Under the coordination of OPSIS, companies in this sector have also been working on possible failures and adequate contingency planning for the interconnected network (power grid). So far, specific contingency plans have been designed for more than 30 identified scenarios, including possible communications failures. Final documentation on contingency planning, as well as the required tests, were expected to be completed by the end of October.

As far as company administrative systems are concerned, the progress achieved is uneven. Utilities that still need to complete administrative system upgrading are CADAFE, CALIFE and ENELBAR. Although each of these companies expects to complete such processes by November, Y2K-related delays or inconveniences are likely to occur. Billing mistakes or delays are considered very high impact risks, as they could have adverse economic impact on the companies involved and cause serious inconveniences to the public.

Summary of Oil, Gas, and Communication system's Y2K preparedness

Petróleos de Venezuela S.A. (PDVSA) represents the whole oil industry of Venezuela. PDVSA is the sole carrier, refiner, distributor and exporter of oil and its by-products. PDVSA has tackled the Y2K problem through the PDVSA 2000 Program, started in 1995 and comprising five main areas: Information Systems, Industrial Automation, Telecommunications, General Systems, and Internal and External Relations. At this stage, most of the company's critical systems are fully remediated and tested, and contingency planning is ready in case of any failure that may occur.

As of October 1999, critical systems and equipment of the industrial automation area were 95% ready, with only a few isolated systems to be repaired during October and November. PDVSA states that "Considering the financial resources, organization and time spent, as well as the progress achieved, no problems are expected in PDVSA critical processes and the oil industry in Venezuela."

Critical telecommunication services show a minimum risk of Y2K-related interruptions. The country is highly dependent on Cantv, a private company that is directly or indirectly involved (through interconnection) in all local and long-distance telecommunication operations. Cantv, 49% of which is owned by multinational company GTE, is adequately prepared to face the Y2K.

Possible pitfalls and impact scenarios

If one goes by the official claims, then no interruptions of electric power supply are expected in Venezuela. However, statements by officials indicating the lack of Y2K compliance in Venezuela indicate that not all is well.

Disruptions in electric supply could cause failures in the oil drilling, pumping, transport sectors. Thereby effecting the economy of the entire country.

4.3 'Technology-dependence' in Energy, Communication and Transport sectors

- ● Highly dependent on technology for the sector
- ⊙ Moderately dependent on technology for the sector
- ○ Slightly OR Not dependent on technology for the sector
- ? Do not know OR Not specified

4.3.1 Asia

Country	Energy	Comm.	Transportation		
			Air	Sea	Land
Australia	●	●	●	●	●
China	⊙	●	●	⊙	⊙
Fiji	⊙	●	●	⊙	○
India	⊙	●	●	⊙	⊙
Indonesia	○	●	●	○	○
Japan	●	●	●	⊙	⊙
Malaysia	●	●	●	⊙	⊙
Myanmar	○	○	○	○	○
New Zealand	⊙	●	⊙	⊙	⊙
Pakistan	⊙	●	●	○	○
Palau	⊙	●	●	⊙	○
Philippines	⊙	●	●	⊙	○
Republic of Korea	●	●	●	⊙	⊙
Singapore	●	●	●	●	●
Sri Lanka	⊙	●	●	●	○
Taiwan	⊙	●	⊙	⊙	⊙
Thailand	⊙	●	●	○	○
Vietnam	⊙	●	●	○	○

4.3.2 Sub Saharan Africa

Country	Energy	Comm.	Transportation		
			Air	Sea	Land
Angola	○	●	●	○	○
Botswana	●	●	⊙	?	○
Burundi	⊙	⊙	○	○	?
Central African Rep	●	●	●	?	?
Democratic Republic of Congo	●	●	⊙	⊙	○
Eritrea	⊙	●	●	○	○
Gabon	⊙	●	●	○	○
Gambia	●	●	●	⊙	?
Ghana	●	●	●	⊙	○
Guinea	●	●	●	⊙	○
Kenya	●	●	⊙	○	○
Mauritania	⊙	⊙	⊙	○	○
Mauritius	○	●	●	○	?
Mozambique	○	●	●	○	○
Namibia	⊙	●	●	⊙	⊙
Rwanda	⊙	●	●	?	?
Senegal	●	●	●	⊙	○
Seychelles	○	●	⊙	○	?
Sierra Leone	●	●	●	●	?
South Africa	⊙	●	●	⊙	○
Swaziland	⊙	●	●	?	○
Tanzania	●	●	●	⊙	○
Uganda	●	●	⊙	○	○
Zambia	⊙	●	●	○	⊙
Zimbabwe	●	●	●	?	●

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4.3.3 Middle East and North Africa

Country	Energy	Comm.	Transportation		
			Air	Sea	Land
Algeria	●	●	●	⊙	○
Cyprus	●	●	●	○	?
Egypt	●	●	●	○	○
Iran	⊙	●	●	●	○
Israel	●	●	●	⊙	⊙
Jordan	⊙	●	●	○	○
Lebanon	⊙	●	●	⊙	?
Morocco	⊙	●	●	⊙	●
Oman	●	●	●	⊙	?
Saudi Arabia	●	●	●	⊙	⊙
Tunisia	○	●	⊙	○	○

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4.3.4 South America

Country	Energy	Comm.	Transportation		
			Air	Sea	Land
Argentina	⊙	●	●	⊙	○
Bolivia	○	●	⊙	?	○
Brazil	⊙	●	●	⊙	⊙
Chile	●	●	●	⊙	⊙
Colombia	●	●	●	⊙	○
Ecuador	⊙	●	⊙	⊙	○
Peru	⊙	●	●	⊙	○
Uruguay	⊙	●	⊙	○	○
Venezuela	⊙	●	⊙	○	○

4.3.5 Central America and the Caribbean

Country	Energy	Comm.	Transportation		
			Air	Sea	Land
Antigua & Barbuda	●	●	⊙	○	?
Aruba	●	●	●	●	?
Bahamas	●	●	⊙	○	?
Barbados	●	●	●	⊙	?
Belize	●	●	●	?	?
British Virgin Islands	⊙	●	⊙	⊙	?
Cayman Islands	○	●	⊙	○	?
Costa Rica	○	●	⊙	○	○
Cuba	⊙	⊙	●	○	○
Dominican Republic	⊙	●	●	⊙	?
El Salvador	○	●	⊙	○	○
Grenada	●	●	●	⊙	?
Guatemala	○	●	●	⊙	○
Haiti	○	●	?	?	?
Honduras	○	●	⊙	⊙	○
Jamaica	●	●	⊙	⊙	○
Mexico	●	●	●	⊙	○
Nicaragua	⊙	●	⊙	○	?
Panama	●	●	●	⊙	?
St. Kitts & Nevis	○	●	⊙	○	?
St. Lucia	●	●	⊙	⊙	?
St. Vincent & Grenadines	⊙	●	⊙	⊙	?
Trinidad & Tobago	●	●	●	○	?

5 Technical assistance and funding sources

5.1 Technical Assistance

For Y2K problems that cannot be resolved internally, firms must seek outside service providers with Y2K expertise. In doing so, depending on several factors such as budget, need, and reliability, a firm seeking assistance can choose either local or international help. This section attempts to provide reliable sources for technical assistance to firms that are experiencing Y2K difficulties. Successful selection of the appropriate Y2K solutions provider will depend on the organization's needs and expectations combined with the abilities of the solution provider to meet them. The following are several criteria that should be evaluated before an organization decides a Y2K solution provider.

The Y2K solutions provider must be able to do the job. They must have employees with expertise specific to the Y2K issues the organization is facing. If the solutions provider will be working at the client's site, they should be able to interact with the organization's employees in as seamless a manner as is possible. Measures should be sought that will allow insight into the technical and professional strengths of prospective solution providers and how well those strengths fit the needs of the organization.

The solution provider should thoroughly understand the scope of the Y2K problem. A proven track record on similar projects, such as those involving the electricity or energy industry, will help to determine the right solution provider. For each Y2K solution provider being considered, the organization should follow up on references and perform background checks to ensure reliability.

The Y2K solution provider's methodology and/or products should fit the organization's processing environment. The organization should have a detailed understanding of what the provider's Y2K conversion solutions are and how well they will serve the organization's architectural needs.

The service provider must be able to deliver a satisfactory solution on time and within budget. Due to the nature of the problem, time is of utmost importance. Schedule and cost are extremely important management performance criteria and the solution provider should demonstrate the maturity, ability and desire to assume this level of project responsibility. Beyond the technical resources needed to build a system, this requires a core set of management and administrative skills and a commitment to serve in the client's best interests. The solution provider should be able to submit a project management work plan that supports its proposal.

Depending on the nature of the problem, organizations may decide to hire either locally or internationally based Y2K solution providers. Local providers are appealing for a number of reasons; they are readily deployable in that they don't have to fly in and set up shop, they have experience with region-specific systems, or they have established working relationships with the organization. Should an organization determine that there aren't any local solution providers capable of meeting its needs, there are many international solution providers that offer a wide range of Y2K related products and services that perhaps better serve the organization's needs. The next two sections outline some of these providers both at the local and international levels.

5.1.1 Local Y2K Assistance Providers

For several developing countries, including Chile, India, Indonesia, Malaysia, the Philippines, and Tanzania, here are some recommendations for local technical assistance.

Egypt

"Y2K Egypt" provides information of the Year 2000 problem specific to Egypt. Y2K Egypt can provide consulting, speakers and Year 2000 solutions for all sectors. Contact Information,

Telephone:
USA 512-682-6982 x-1083
Cairo + 20-2-350-5577
FAX: USA 1-630-604-1158

Postal address: 16 Cox St. Johnstown PA 15905 USA

E-mail
General Information: info@y2kegypt.com
Sales / Support: sales@y2kegypt.com

India

NASSCOM, the apex body and chamber of commerce for software industries in India, has prepared the following directory of IT companies providing Y2K solutions in India.

To find more detailed descriptions for each company, please visit this website: http://www.y2kindia.com/html/solution.html

ACCESS COMPUTER SERVICES	ADA SOFTWARE AND SERVICES PVT. LTD.
ASTRAL TELE*FOUNDATION PVT. LTD.	Akshay Software Technologies Ltd.
AllSoft Technologies Limited	Amex Information Technologies Ltd.
Amsoft Information Services (India) Private Limited	Ashok Leyland Information Technology Limited
B&K INFORMATION TECHNOLOGIES LIMITED	BAEHAL SOFTWARE LIMITED
BCC COMPUTERS LTD.	BFL SOFTWARE LIMITED
BIRLA HORIZONS INTERNATIONAL LIMITED	Bhari Information Technology Systems Pvt. Ltd.
Binary Semantics Limited	Birla Consultancy & Software Services
Blue Star Limited	CG Maersk Information Technologies Ltd.
COMPLETE BUSINESS SOLUTIONS (INDIA) LTD.	COMPUTRONICS INTERNATIONAL LIMITED
CREDENCE TECHNOLOGY PVT. LTD.	CYBERMATE INFOTEK LIMITED
Canbank Computer Services Ltd	Citicorp Information Technology Industries Ltd.

Cognizant Technology Solutions	DATAMATICS LTD.
DCM Data Systems Pvt. Ltd.	DDE ORG Systems Ltd.
DSQ Software Limited	DSS Infotech Pvt. Ltd.
Data-Core (India) Limited (Wholly Owned subsidiary of Development Consultant)	Decision Software India
Duratech Solutions	ENGINEERS INDIA LTD.
EUROLINK SYSTEMS LIMITED	Electronics Corporation of India Limited
Enpro India Limited	Era Software Systems Pvt. Ltd
Friendly Advanced Software Technology	GMDSS Elektronik lab pvt. ltd.
Gartner Group - Info Technology Advisor (I) Pvt. Ltd.	Gebbs India Limited
Genisys Integrating Systems (India) Pvt. Ltd.	Globsyn Technologies Limited
HCL CONSULTING LIMITED	Hamilton Research & Technology Ltd.
Hcl Perot Systems	Hexaware InfoSystems Ltd.
IBM Global Services Pvt. Ltd.	IIS Infotech Limited
INFOSYS TECHNOLOGIES LIMITED	ISC Consultancy Services (I) Pvt. Ltd.
Information Management Resources (India) Limited	Information Technologies (India) Ltd
Infotech Enterprises Limited	International Comptech Engineering Services Limited
International Computers India Limited	KALE CONSULTANTS LTD.
KEJRIWAL COMPUTERES LIMITED	KPIT Systems Limited
Kaytek Computer Services Pvt. Ltd.	L&T Information Technology Ltd.
LEADING EDGE SYSTEMS LIMITED	LINC SOFTWARE SERVICES PVT. LTD.
M.N. Dastur & Company Ltd.	MAARS Software International Limited
MAFATLAL CONSULTANCY SERVICES (I) LTD.	MANGALYA SOFT-TECH LIMITED
MTC (India) Pvt. Ltd.	MX Software Services Ltd.
Mahindra British Telecom Limited	Management & Computer Consultants
Mandayal Computing Pvt. Ltd	Mascon Technical Services Ltd.
Mascot Systems Pvt. Ltd.	Mastek Limited
Metamor Global Solutions Limited	MicroGiga Infotech Pvt. Ltd.
Mindware	Motorola India Electronics Ltd.
NEPTUNE INFORMATION SOLUTIONS LTD	Network Systems & Technologies Pvt. Ltd.
Odyssey Technologies Limited	Origin Information Technology (India) Ltd
PAR Computer Sciences (Int.) Ltd.	PHOENIX SOFTWARE LTD.
PRT Software Services (India) Pvt. Ltd.	Patni Computer Systems Ltd

Pentafour Software & Exports Ltd.	Polaris Software Lab. Ltd.
Prime Infotech (Computer Division of PCI Limited)	Quest Syscon International (Pvt.) Ltd.
R S SOFTWARE INDIA LIMITED	R Systems (India) Pvt. Ltd.
RAFFLES SOFTWARE PRIVATE LIMITED	RAM Informatics Ltd.
RITES	Rolta India Limited
SIP Technologies & Exports Limited	SOFTPRO SYSTEMS PVT. LTD.
SOFTSPEC SOFTWARE PVT. LTD.	SOFTSTAR COMPUTER CONSULTANCY PVT. LTD.
SQL STAR INTERNATIONAL LTD.	SRA SYSTEMS LIMITED
SRISHTI SOFTWARE PVT. LTD.	SSG SOFTWARE SYSTEMS (P) LTD.
STRABUS SOFTWARE SOLUTIONS PVT. LTD.	SYSTEMS & SOFTWARE
Satyam Computer Services Ltd.	Siemens Information Systems Ltd.
Sierra Optima Limited	Silverline Industries Limited
Software Frontiers Limited	Software Moguls India Pvt. Ltd.
Sonata Software Limited	Southstar Data Consultants Pvt. Ltd.
Syntel Software Pvt. Ltd.	Systime Computer Systems (I) Ltd
THIRDEYE TECHLABS PVT. LTD.	TRIGENT SOFTWARE LIMITED
Tata Consultancy Services	Tata Infotech Limited
Telecommunications Consultants India Limited	Twinstar Software Exports Limited
UBEST	VJIL Consulting Limited
VisualSoft (India) Ltd.	Vulcan InfoTECH, (A division of Vulcan Engineers Ltd.)
Wave Infosys Technologies Ltd.	Wipro Infotech (Enterprise Solution)
Zenith Software Limited	

The following table lists Indian companies that provide Y2K solutions specific to the utility or energy industry.

Region	Company / Website	Description
Hyderabad	Infotech Enterprises Ltd http://infotech.stph.net/	Business areas include: Conversion, Internet, and Geo-Engineering Services, Technical and Business Software, and Engineering Solutions
Bangalore	Wipro Infotech (Enterprise Solution) http://www.wipro.com	A provider of software services, Wipro consults on numerous IT and IS issues, including Y2K

Delhi	Engineers India Limited http://www.engineersindia.com	Provide services to petroleum refineries, oil and gas processing, metallurgical, fertilizer and pipeline projects, ports and terminals in India and overseas.
Delhi	HCL Perot Systems http://www.perotsystems.com	Assist customers with deregulation, privatization and liberalization, market restructuring, and customer product and service development
Pune, Noida	International Computers India Limited http://www.icil.co.in/	ICIL's services include software export, research and development.
Pune, Bangalore, Mumbai	KPIT Systems Limited http://www.kpit.com/	KPIT provides software developers, Y2K solutions and developers of real time systems
Mumbai, Navi Mumbai, Chennai, Pune, Mysore, Bangalore	L & T Information Technology Limited http://www.ltitl.com/	LTIT provides mainframe, ERP, Y2K and other solutions
New Delhi	ASAP Solutions http://www.asapsolutions.com/	ASAP provides software consulting, technical staffing, Y2k solutions etc.
Mumbai	IT Secure Software Pvt. Ltd. http://www.y2ksolutions-india.com/	ITSS offers solutions for Y2K problems in PCs and networks.

Indonesia

The following is an Indonesian company that provides Y2K solutions.

Region	Company / Website
Jakarta	SDI Technologies, http://www.sdiworld.com/

Malaysia

The following are two Malaysian companies that provide Y2K solutions.

Region	Company / Website
Kual Lampur	ML IT Partners Sdn. Bhd., http://www.mlit.com.my/
Selangor Darul Ehsan	Millenium Conversions SDN BHD, http://www.y2k.gov.my/vendor/vendor_list/mc/index.htm

Philippines

The following two Philippines companies offer Y2K solutions.

Region	Company / Website
Makati City	Software Implementors, Inc., E-Mail: sii@wtouch.com.ph
Manila	RCG Information Technology, http://www.rcgitmanila.com/

Ghana

We were unable to discover any Y2K consultants in Ghana that specialize in utilities. For more information, contact Ato Wilson, the Y2KAFRIK correspondent for Ghana, at the e-mail address: awilson@ghana.com.

Tanzania

The following is a Tanzanian company that offers Y2K solutions.

Region	Company / Website
Dar es Salaam	Computer Centre, http://www.cctz.com/

For more information, contact Vipul Shah, the Y2KAFRIK correspondent for Tanzania, at the e-mail address: pcsolutions@twiga.com.

Another contact is David Sawe with the Tanzanian Year 2000 National Project. His e-mail address is david.sawe@cats-net.com.

Uganda

We were unable to discover any Y2K consultants in Uganda that specialize in utilities. For more information, try two other sources:

Baguma Rogers, the Y2KAFRIK correspondent for Uganda. E-mail address: infotech@starcom.co.ug;

or

The Ugandan Year 2000 National project, E-mail address: y2kntf@infocom.co.ug or write to Mr. Elisha Wasukira, Task Force Manager, PO Box 5828. Kampala, Uganda., Tel: +256 41 340181. Fax: +256 41 340180

Chile

The following table lists Chilean consultants that provide Y2K solutions.

Name	Company	Phone	Fax	Address	City	E-mail / Web Site
Wilson Castillo	U. Arturo Prat	57-447070, a-403		Av.11 De Septiembre N°2120	Iquique	wacastil@cec.unap.cl
Claudio Ragni V.	U. Catolica Del Maule	71-245700		Av. San Miguel 3605	Talca	cragni@spock.ucm.cl
Rodolfo Villarroel	U. Catolica Del Maule	71-245700		Av. San Miguel 3605	Talca	rvillarr@spock.ucm.cl
Dix Toloza Reyes	Xtremo S.A.	6649386	6649409	Mac-Iver 440, Of.902	Santiago	dtoloza@xtremo.cl
Jose M. Bettancourt	Xtremo S.A.	6649386	6649409	Mac-Iver 440, Of.902	Santiago	jmbettancourt@extremo.cl
Rebeca Bittencourt	Tice S.A.	6388098	6388114	Huerfanos 669, Of.404	Santiago	rbittencourt@tice.cl
Martin Montalva	U. De Santiago	6817435	6813324	Av. Bernardo O'Higgins 3363	Santiago	mmontalv@lauca.usach.cl
Christian Ramirez U.	U. Del Bio Bio	41-245501	41-232898	Colocolo N°379, Of.504	Concepción	chrissvolka@yahoo.com rgsoftware@entelchile.net
Sergio Bravo Silva	U. Del Bio Bio	41-261513		Av.Collao N°1202	Concepción	sbravo@raven.face.ubiobio.cl
Claudio Robles	U. De Concepción	41-203564			Concepción	crobles@udec.cl
Jaime Alvarez	U. De Concepción	41-204479/203638		Tucapel 50, Depto.404	Concepción	jalvarez@manet.die.udec.cl riogag2@hotmail.com
Jose Arizabalo	U. De Concepción	41-204694	41-221770	Pompello N°1024-J, Depto 1004	Concepción	jarizaba@ing.udec.cl
Rodrigo C. Saavedra	U. De Concepción	41-785327			Concepción	rsaavedr@ing.udec.cl
Javier Gomez	U. De La Frontera	325816			Temuco	jgomez@ufro.cl diag2000@ufro.cl
Luis Figueroa	U. De La Frontera	45-325816		Prat 321	Temuco	lfigu001@pinhue.ufro.cl
Eduardo Peña	U. De Magallanes	61-244523	61-223193	Av. Bulnes Km. 2 1/2	Punta Arenas	edopena@ona.fi.umag.cl
University of Chile						www.u2000.uchile.cl

Colombia

We were unable to discover any Colombian Y2K consultants that specialize in utilities.

Venezuela

We were unable to discover any Venezuelan Y2K consultants who specialize in utilities.

5.1.2 International Y2K Assistance Providers

Worldwide, there are many consultants capable of providing Y2K solutions. This table provides information on a number of consultants who specialize in Y2K solutions. Consultants that specialize in Y2K solutions for power utilities are shaded.

Provider	Website or E-Mail	Location/HQ
AB Software	http://www.ab-software.dk	Lexingtonv MA
ABT Corporation	http://www.btcorp.com	Petaluma CA
AEA Technology plc	http://www.aeat.co.uk/	Warrington, England
Booz Allen and Hamilton	http://www.bah.com/default.html	Global
Bridgeway Systems, LLC	http://www.bridgeway2k.com	San Rafael CA
CACI International Inc.	http://www.caci.com	Arlington VA
Caliber Year 2000 Education	http://www.yr2000edu.com	Baltimore MD
Cap Gemini America	http://www.usa.capgemini.com/y2k	New York NY
Capricorn Systems, Inc.	http://www.capricornsys.com	Atlanta GA
Century Services, Inc.	http://www.zmax.com/CSIsite.html	Germantown MD
Chiyoda Corporation	http://www.chiyoda.co.jp/index-e.html	Yokohama, Japan
CMG	http://www.cmgplc.com/Markets/Year2000/offers/offers.htm	Europe
COMPAQ	http://www.compaq.com/year2000/	Stow MA
Computer Associates International, Inc.	http://www.cai.com	Islandia NY
Computer Generated Solutions, Inc.	http://www.cgsinc.com	New York NY
Computer Horizons Corp.	http://www.computerhorizons.com	Mountain Lakes NJ
Computer Sciences Corporation	http://www.csc.com	Falls Church VA
Contahal Limited	http://www.contahal.co.il/	Israel
DMR Consulting Group Inc.	http://www.dmr.com	Jersey City NJ
Don LeMaster, Tava/Beck	http://www.tavabeck.com/services.htm	Seattle WA
Duke Energy	http://www.dukenergy.com	Houston TX
Dynamics Research Corporation	http://www.drc.com	Andover MA
Edge Information Group, Inc.	http://www.edge-information.com	Mt. Prospect IL
EDS Corporation	http://www.eds.com/general/cio_services/offerings/cio_services_offerings.html	Plano TX

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Provider	Website or E-Mail	Location/HQ
Electric Power Development Co., Ltd.	http://www.ecfa.or.jp/english/index.html	Tokyo, Japan
Electricity and Power Research Institute (EPRI)	http://year2000.epriweb.com/index.html	Palo Alto CA
ERA Technology Ltd.	http://www.era.co.uk/	Surrey, England
Forecross Corporation	http://www.forecross.com	San Francisco CA
Gopal Kadagathur, President, Advanced Engineering Associates International	E-mail: gopal@aeai.net ; aeaiinc@aol.com	
Greenwich Mean Time - UTA	http://www.gmt-uta.com	Arlington VA
Hendela System Consultants, Inc.	http://www.scany2k.com	Lyndhurst NJ
IBS Conversions, Inc.	http://www.ibs2000.com	Oak Brook IL
IMRglobal	http://www.imrglobal.com	Clearwater FL
Information Business Systems	http://wwww.ibsltd.com	U.S., U.K., India, Malaysia
Infrastructure Control Services (ICS)	http://www.icsgroup.com.au/	Sydney, Australia
InnovativeSoft Corporation	http://www.innovativesoft.com	Dallas TX
International Business Machines	http://www.ibm.com/year2000	White Plains NY
Into 2000 Inc.	http://www.into2000.com	Jasper GA
JGC Corporation	http://www.jgc.co.jp/	Yokohama, Japan
JGW Systems	http://www.jgw.com	Montreal, Canada
Litton PRC	http://www.prc.com	Reston VA
Lockheed Martin Information Support Services	http://www.iss.lmco.com	Falls Church VA
Martec Computer Services Company	http://www.martecsolutions.com	Dallas TX
Mary Louise Vitelli, Vice President, Advanced Engineering Associates International	E-mail: mlv@aeai.net	
MASTECH Corporation	http://www.mastech.com	Oakdale PA
Mikrotek Solutions, Ltd.	http://www.mikroteksolutions.co.uk/	Oxon, England
Millenium Consultant Systems Engineering	http://www.mcse-resources.com/	West Midlands, England
Napersoft, Inc.	http://www.napersoft.com	Naperville IL

Provider	Website or E-Mail	Location/HQ
Olga Mandrugina, Associate, Advanced Engineering Associates International	E-mail: om@aeai.net	
Oracle Corporation	http://www.oracle.com/year2000/	Washington DC
Primeon, Inc.	http://www.primeon.com	Burlington MA
PRINCE Software, Inc.	http://www.PRINCEsoftware.com	Allendale NJ
Reed Wiegle, CANUS Corporation	http://www.canuscorp.com/home.htm	Lake Forest CA
Rila Software LLC	http://www.rila.com	New York NY
RPM International Ltd.	http://www.rpmc.net/	London, England
Safetynet, Inc.	http://www.safetynet.com	Springfield NJ
Science Applications International Corporation (SAIC)	http://www.saic.com	Falls Church VA
Signet Systems LLC	http://www.ssllc.com	Milwaukee WI
Silverline Technologies, Inc.	http://www.silverline.com	Piscataway NJ
Solution-Soft	http://www.solution-soft.com	Santa Clara CA
Stone and Webster Management Consultants	http://www.stoneweb.com/management/v2k.htm	North America, Middle East, Europe, Southeast Asia
SVI America Corporation	http://www.sviamerica.com	Charlotte NC
Tasa Kocic, Associate, Advanced Engineering Associates International	E-mail: AKocic@compuserve.com	
Tata Consultancy Services	http://www.tcs.com	New York NY
Telcordia Technologies	http://www.bellcore.com	Piscataway NJ
The Software Factory	http://www.swfactory.com	South Boston VA
Tomohiro Taniguchi (Coordinator for Y2K Cooperation Center)	TEL 81-3-3215-0159 FAX 81-3-3201-5348	Tokyo, Japan
TRW	http://www.trw.com/systems_it/smart2k	Reston VA
TSI International Software, Ltd.	http://www.tsisoft.com	Wilton CT
Unisys	http://www.corp.unisys.com/Unisys/v2k.NSF	Reston VA
VIASOFT, Inc.	http://www.viasoft.com	Herndon VA
Welitzkin, Mark	http://www.twow.com/markwelitzkin/home.htm	England
WSP Business Technology	http://www.wsp-y2k.com/	London, England

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Provider	Website or E-Mail	Location/HQ
Y2K Integration	http://www.y2kintegration.com.au/	Ultimo, NSW, Australia
Y2Kplus	http://www.y2kplus.com	Lexington MA
Yardeni, Dr. Edward	http://yardeni.com/	New York City NY
Yokogawa Electric Corporation	http://www.yokogawa.co.jp/Information/Solution/2000-e.html	Tokyo, Japan
Zitel Corporation	http://www.zitel.com	Fremont CA

5.2 Sources of Financing

This section provides information about several agencies that provide, either directly or indirectly, access to financial resources to be used to mitigate or solve Y2K problems.

5.2.1 Direct Sources of Financing

The following organizations are directly involved in providing financial resources for countries in monetary need. Several of these organizations have already allocated Y2K emergency funds.

African Development Bank

The African Development Bank is a multinational development bank supported by 77 nations from Africa, North and South America, Europe and Asia. It's regional and non-regional member countries are as follows:

Regional Member Countries		Non-Regional Member Countries
Algeria	Lesotho	Argentina
Angola	Liberia	Austria
Benin	Libyan Arab Jamahiriya	Belgium
Botswana	Madagascar	Brazil
Burkina	Malawi	Canada
Faso	Mali	China
Burundi	Mauritania	Denmark
Cameroon	Mauritius	Finland
Cape	Morocco	France
Verde	Peoples Republic of Mozambique	Germany
Central African Republic	Namibia	India
Chad	Niger	Italy

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Regional Member Countries		Non-Regional Member Countries
Comoros	Nigeria	Japan
Congo	Rwanda	Korea
Côte d'Ivoire	Sao Tome and Principe	Kuwait
Democratic Republic of Congo	Senegal	Netherlands
Djibouti	Seychelles	Norway
Egypt	Sierra Leone	Portugal
Erithrea	Somalia	Saudi Arabia
Equatorial Guinea	South Africa	Spain
Ethiopia	Sudan	Sweden
Gabon	Swaziland	Switzerland
The Gambia	Tanzania	United Kingdom
Ghana	Togo	United States
Republic of Guinea	Tunisia	
Guinea	Uganda	
Bissau	Zambia	
Kenya	Zimbabwe	

With respect to member countries'Y2K concerns, the African Development Bank has focused its efforts mostly on increasing Y2K awareness and providing member countries with information to liaise with InfoDev (see below World Bank) and seek financial assistance. To learn more about the African Development Bank, either visit their web site at http://www.afdb.org/ or contact them at,

African Development Bank
01 Bp 1387, Abidjan 01, Cote D'ivoire
Telephone: (225) 20.44.44
Fax: (225) 20.40.06
Telex: 23717

Asian Development Bank

The Asia Development Bank has the following five Y2K-related initiatives

- Identify and prioritize Y2K activities based on an analysis of projects and critical sectors
- Develop a Bank Y2K Action Plan which includes a database for managing Y2K compliance covering Y2K critical projects, critical sectors, and Developing Member Countries (DMC), indicating prioritization, assistance from Y2K corrective measures, progress, contingency plans, and achievement of compliance

- Establish standards for problem diagnosis, contracts and monitoring Y2K work
- Support DMCs in identifying problems, setting parameters for contracts to undertake investigation and Y2K corrective measures, establishing contingency and recovery plans, and monitoring progress
- Increase awareness and supporting initiatives aimed at minimizing potential Y2K adverse impacts

The ADB's Membership includes both regional and non-regional countries:

Regional Member Countries		**Non-Regional Member Countries**
Afghanistan	Australia	Austria
Bangladesh	Bhutan	Belgium
Cambodia	China, People's Republic of	Canada
Cook Islands	Fiji Islands, Republic of the	Denmark
Hong Kong, China	India	Finland
Indonesia	Japan	France
Kazakhstan	Kiribati	Germany
Korea, Republic of	Krygyz Republic	Italy
Lao People's Democratic Republic	Malaysia	Netherlands
Maldives	Marshall Islands	Norway
Micronesia, Federated States of Mongolia	Myanmar	Spain
Nauru	Nepal	Sweden
New Zealand	Pakistan	Switzerland
Papua New Guinea	Philippines	Turkey
Samoa	Singapore	United Kingdom
Solomon Islands	Sri Lanka	United States
Tajikistan	Taipei,China	
Thailand	Tonga	
Tuvalu	Uzbekistan	
Vanuatu	Viet Nam	

With respect to Y2K resolution, a number of ADB's Developing Member Countries (DMCs) have requested assistance, some of which is being provided through reallocation of resources under existing loans. Assistance has also been requested for diagnostic work, remediation and contingency planning. The ADB is collaborating closely with the World Bank and other bilateral agencies. In addition, the ADB recommends that interested

parties visit the following web sites to discover more information on the nature of the Y2K problem:

International Organizations	Web Site
Bank for International Settlements (BIS)	http://www.bis.org/ongoing/
IEEE Computer Society	http://www.computer.org/standard/p2000web/index.htm
IMF	http://www.imf.org/external/np/exr/facts/y2k.htm
Institution of Electrical Engineers	http://www.iee.org.uk/2000risk/
International Organization of Securities Commissions (IOSCO)	http://www.iosco.org/year2000.html
International Telecommunications Union (ITU)	http://www.itu.ch/y2k/
International Y2K Cooperation Center	http://www.iy2kcc.org/
Organization for Economic Cooperation and Development and (OECD)	http://www.oecd.org/dsti/sti/it/infosoc/news/y2k.htm

Further information on Asian Development Bank-financed projects and their DMCs can be obtained by visiting the ADB's web site at http://www.asiandevbank.org/mainpage.asp, or by contacting the Bank's Senior Y2K Coordinator:

Mr. Silvio R. Cattonar
Phone +632 632 6588
Fax +632 636 2444
E-mail: scattonar@mail.asiandevbank.org

Australia Agency for International Development

AusAID is an administratively autonomous agency within Australia's Foreign Affairs and Trade division. It is responsible for the management of the official Australian Government overseas aid program. Australia's aid program focuses on the Asia Pacific region, with Papua New Guinea, the Pacific and the poorest regions of East Asia being the areas of highest priority. Australia also contributes selectively to development needs in South Asia, Africa and the Middle East. The sectors of highest priority for the aid program are governance, health, education, agriculture and rural development, and infrastructure.

To learn more about AusAID, visit their web site at http://www.ausaid.gov.au/ or contact them at

62 Northbourne Avenue
Canberra ACT 2601, Australia
Telephone +61 2 6206 4000, Fax +61 2 6206 4880, E-Mail: InfoAusAID@ausaid.gov.au

Caribbean Development Bank

The Caribbean Development Bank (CDB) provides financial assistance to member countries to promote their economic cooperation and integration. Member Countries of the CDB are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, British Virgin Islands, Canada, China, Colombia, Cayman Islands, Dominica, France, Germany, Grenada, Guyana, Italy, Jamaica, Mexico, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, Turks and Caicos Islands, United Kingdom and Venezuela

To learn more about the Caribbean Development Bank's financing processes, either visit their web site at http://www.caribank.org/ or contact them at

Caribbean Development Bank
P.O. Box 408
Wildey, St. Michael
Barbados
West Indies
Telephone: 246-431-1600
Fax: 246-426-7269

European Bank for Reconstruction and Development

The EBRD provides direct financing for private sector activities, restructuring and privatization as well as funding for the infrastructure that supports these activities. Its investments also help to build and strengthen institutions. The main forms of EBRD financing are loans, equity investments (shares) and guarantees.

Member Countries include Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FYR Macedonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan

To learn more about the some of EBRD's operations, either visit their web site at http://www.ebrd.com/ or contact the EBRD at:

Project inquiries / proposals:
Project Inquiries
Tel: +44 171 338 6282/6252
Fax: +44 171 338 6102
E-mail: projectenquiries@ebrd.com

General inquiries about the EBRD:

Communications Department
Tel: +44 171 338 7931/6372
Fax: +44 171 338 6102

Inter-American Development Bank

The IDB's efforts focus on increasing the awareness of the Y2K problem within Latin American and Caribbean governments and providing a line of credit to help fund national Y2K programs.

The IDB has cooperated with the World Bank, the United Nations, the Organization of American States, the Global 2000 Group, and other Multilateral Development Banks in raising international awareness of the Y2K problem. Further, the IDB has hosted an international Y2K event for borrowing member countries and co-hosted with the World Bank/InfoDev Y2K events for Multilateral Development Banks.

In April 1999, the IDB approved a special US$200 million "Line of Credit" to help public institutions in Latin American and Caribbean member countries finance the cost of making their computer systems Y2K compliant, preparing contingency plans, and/or coping with the potential disasters resulting from non-compliant system failures.

For more information, visit their web site at http://www.iadb.org, or contact

Armando JosÈ Namis, IDB Y2K Working Group
Phone: (202) 623-3332
E-Mail armandon@iadb.org

International Monetary Fund

The IMF has established a temporary facility to enable it to extend short-term financing to countries that experience problems associated with potential or actual Y2K-related failures of computer systems. The IMF's Y2K Facility came into effect on October 15, 1999 and will expire on March 31, 2000.

For more information about the IMF and their Y2K Facility, visit these websites: http://www.imf.org/ (IMF) or http://www.imf.org/external/np/exr/facts/y2k.htm (Y2K Facility)

Inquiries about Y2K problem should be e-mailed to: y2k@imf.org or mailed to

International Monetary Fund
700 19th Street, NW
Washington, D.C. 20431 USA

Japan International Cooperation Agency and Institute for International Cooperation

One of JICA's programs involves the Survey and Administration of Grant Aid Programs. Grant aid is a form of financial assistance extended to the developing countries without obligation of repayment, and constitutes a major portion of Japan's bilateral Official

Development Assistance (ODA). In 1996, JICA distributed grants valued at over 134Billion Yen ($1.3Billion US) to the following regions: Asia (33.0%), Africa (28.8%), Latin America (13.7%), Middle East (10.3%), Oceania (7.6%), and elsewhere (6.6%).

For more information, visit JICA's web site at http://www.jica.go.jp/Index.html or contact JICA's central office, which is located at:

Shinjuku Mines Tower, 2-1-1,
Yoyogi, Shibuya-ku, Tokyo
TEL:03(5352)5311~5314

United Nations Development Programme

The United Nations Development Programme (UNDP) is the UN's largest source of assistance for development and the main body for coordinating its development work. The UNDP's goals are to

- Strengthen international cooperation for sustainable human development and to serve as a major substantive resource on how to achieve it.
- Help the United Nations family become a unified and powerful force for sustainable human development.
- Focus UNDP's strengths and assets to make the maximum contribution to sustainable human development in countries served.

UNDP's program resources are currently in the neighborhood of US$2 billion a year. This total includes both core (voluntary contribution) and non-core (targeted) resources. From 1994 to 1997, The UNDP has distributed $6.4 billion in the following areas: Poverty Eradication and Livelihoods for the Poor (26%), Good Governance (25%), Environmental Resources and Food Security (24%), Public Resource Management for Sustainable Human Development (23%), and Other (2%). For more information, visit their web site at http://www.undp.org, or contact them at

United Nations Development Programme
One United Nations Plaza
New York, NY 10017
USA
Telephone: (212) 906 5315
Telefax: (212) 906 5364
E-mail: hq@undp.org

U.S. Agency for International Development

The U.S Agency for International Development is the U.S. Federal Government agency that implements America's foreign economic and humanitarian assistance programs. USAID focuses on six principal areas of development: economic growth and agricultural development; population, health and nutrition; environment; democracy and governance; education and training; and humanitarian assistance. The four world regions that USAID provides assistance to are Sub-Saharan Africa; Asia and the Near East; Latin America and the Caribbean, and; Europe and Eurasia.

For more information, visit USAID's web site at http://www.info.usaid.gov/

For the USAID Mission Directory, see
http://www.info.usaid.gov/procurement_bus_opp/osdbu/guide10a.htm

World Bank and the infoDev Year 2000 Initiative

To better serve countries with foreseeable Y2K problems, the World Bank established the infoDev Year 2000 initiative in September of 1995. The program is an outreach effort to developing countries and includes Y2K lending. So far, several Y2K specific loans have been approved to countries such as Argentina, Sri Lanka, and Bulgaria. In addition to loans devoted exclusively to Y2K work, Y2K components have been added to World Bank loans for Turkey and the Ukraine. Funds in existing loans have also been reallocated to do Y2K repair work.

The infoDev Y2K initiative is financed by US$34.95 million in donor trust funds. It has received, as of Oct. 15, 1999, 152 grant proposals of which 109 have been approved for Y2K planning and repair work.

Guidelines for Requesting Technical Assistance for Y2K Contingency Planning can be found at the following web site:
http://www.worldbank.org/infodev/y2k/y2ktechassist.htm. Other questions or correspondence should be e-mailed to sboulos@worldbank.org.

5.2.2 Indirect Sources of Financing

The following organizations, while not lenders, may serve as valuable contacts with respect to developing project goals, establishing other contacts, or simply to gather more information.

Association of Southeast Asian Nations

ASEAN's aims and purposes are:

- "to accelerate the economic growth, social progress and cultural development in the region through joint endeavors in the spirit of equality and partnership in order to strengthen the foundation for a prosperous and peaceful community of Southeast Asian nations, and
- to promote regional peace and stability through abiding respect for justice and the rule of law in the relationship among countries in the region and adherence to the principles of the United Nations Charter."

Web Site: http://www.asean.or.id/

Organization for Economic Cooperation and Development – Development Assistance Committee

The Organization for Economic Cooperation and Development (OECD), based in Paris, France, is an organization that has been established to provide governments a setting in which to discuss, develop, and perfect economic and social policy. The OECD's Development Assistance Committee (DAC) is the principal body through which the Organization deals with issues related to co-operation with developing countries. The DAC's mission is "to foster coordinated, integrated, effective and adequately financed international efforts in support of sustainable economic and social development." The

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DAC provides a forum by which major bilateral donors can work together to increase the effectiveness of their effort to support sustainable development.

OECD and DAC member countries (DAC members in bold type) include: **Australia, Austria, Belgium, Canada, Commission of the European Communities (member of DAC only),** Czech Republic, **Denmark, Finland, France, Germany,** Greece, Hungary, Iceland, **Ireland, Italy, Japan,** Korea, **Luxembourg,** Mexico, **New Zealand, the Netherlands, Norway,** Poland, **Portugal, Spain, Sweden, Switzerland,** Turkey, **United Kingdom, United States.**

For more information, visit the OECD Development Assistance Committee's (DAC) web site at http://www.oecd.org/dac or contact:

Publications Unit
Development Co-operation Directorate
Organisation for Economic Co-operation and Development
2 rue André Pascal
75775 PARIS CEDEX 16, France
Tel: 33 (0) 1 45 24 17 89
Fax: 33 (0) 1 45 24 16 50

Inter-Agency Procurement Services Office

The Inter-Agency Procurement Services Office (IAPSO) was established by the United Nations Development Program (UNDP) in 1978 to assist its partner organizations within the UN system, in the most economical acquisition of essential equipment and supplies. Although the IAPSO does not directly provide funding, it does provide a wide range of procurement services - including advisory, direct procurement, and training/capacity building services - to governments of program countries, donor Government development agencies, NGOs, United Nations organizations and staff of the UN system.

To learn more about the some IAPSO's operations, either visit their web site at http://www.iapso.org/ or contact one of the following individuals:

Jack Gottling, Chief, Procurement Support Services
+45 3546 7050
E-Mail: jack.gottling@iapso.org

Michael Cora, Chief, Technical Services
Phone: +45 3546 7075, E-Mail: michael.cora@iapso.org

Karsten Bloch, Chief, Information Technology
Phone: +45 3546 7064, karsten.bloch@iapso.org

World Trade Organization

The WTO is an international organization dealing with the global rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably and freely as possible.
Web Site: http://www.wto.org/

6 Recommendations

Within the limitations of this study, recommendations are provided to how best to target and provide post-Y2k assistance to the affected countries.

6.1 Methodologies for Providing Assistance

6.1.1 Large Scale Blackouts

There are several reports and surveys that indicate the possibility of at least one mission critical system failure in the oil, gas, power, transport, shipping and water industries. According to a report issued by the World Bank in January 1999, the lack of general YEAR 2000 preparation is most acute in sub-Saharan Africa, but some countries in Asia, Latin America and the former Soviet Union could also be hit hard. The survey undertaken by the World Bank covered 139 developing countries and showed that only 15% were taking concrete steps to address the problem. Some 24% were aware of the problem but were not taking any action and 38% had appointed a YEAR 2000 coordinator.

Though, it is commonly assumed that the YEAR 2000 problem will hit industrialized countries harder than developing ones because of their greater degree of automation, it is possible that the impact could be much greater in developing countries. These countries are more dependent on limited and aging computing systems, and have much more limited resources available to address the millennium bug. Since the power industry at developing countries follow and even lag behind in the Year 2000 preparedness compared to the other sectors, the evidence for power systems is generally not encouraging.

It is possible to derive some 'typical' Year 2000 risks. These range from malfunctioning of certain devices - most likely peripherals - in a power plant to the incorrect display of information from the power plant control system. If not remedied, such malfunctioning has the potential to cause tripping of the plant. This will not necessarily happen immediately after the millennium roll-over; the effects can show up later, since some of the errors have a delayed effect. Also, the independent real-time clocks in some of the black boxes may exhibit a considerable drift. In many cases, enough time is available to respond to this problem providing its source is properly understood and the correct course of action can be decided upon.

The main risk in the network control centers is a loss of system overview, e.g. due to an excessive number of alarms or wrong alarm sequences. Another risk is the loss of communication to one of the substations, making it impossible to operate certain breakers by remote control. While this once again has no direct consequences, in combination with other events it could lead to the system state becoming critical.

One crisis scenario that would require intervention by the operators could be as the following. As a result of increased demand for power from a certain area due to a local plant tripping, the power flowing over an important feeder line rises to a critical level where thermal overload relays would trip the line. Under normal service conditions the operators would order a plant in the area of high demand to increase power generation or

alternatively activate a parallel line to reduce the load on the critical line. If the available information does not allow this response, the overloaded line could trip.

Such an event, namely the loss of a critical system component, can trigger cascading effects in the system. The root cause for brownouts and blackouts in most cases is a combination of incidents that leads to a cascaded sequence of events. The blackouts in the WSCC system demonstrate this. In this incident, the electric service to about 2 million customers in the western United States was interrupted. The event triggering this was a short circuit on a HV power line caused by a tree growing into the line. At nearly the same time another line failed for totally different reasons. From this point on, there was a cascading series of events. In addition to the specific reasons that triggered the situation, the overall status of the system at the particular moment was another important reason for the severity of the outage: near-record hydropower generation in the Pacific Northwest, high power transfers on the transmission lines between the Pacific Northwest and California, power transfers through Idaho to Utah, high levels of coal-fired power transmission from Wyoming to Utah, and record demand for power in Idaho and Utah. In addition, the system status was affected by a combination of unfavorable conditions. This actual example shows how important it is for system-wide aspects to be taken into account in the YEAR 2000 preparation of the electrical grid.

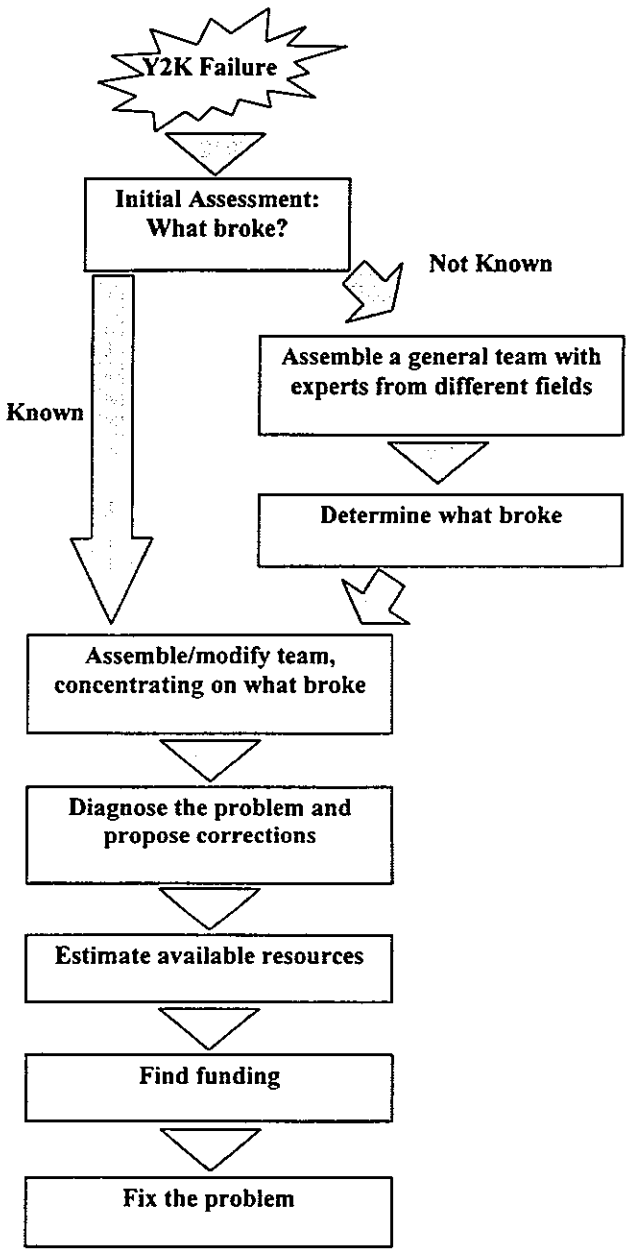
The specific Year 2000 risk for electrical systems, namely that which makes it different from normal emergencies, is the risk of multiple coincidence failures: i.e., whatever happens in the different system components will happen at the same time or within a limited period of time, and the events can occur in different geographical areas.

In normal operating conditions, 'system failures are restricted to a certain area. The utilities are able to deal with local events of this kind, since they have crews on standby which can be sent out at short notice to fix problems. However, not enough emergency crews are normally available to handle several such occurrences at the same time in different areas. The biggest risk therefore comes from cascading system events which develop from multiple sources.

The methodology outlined below prescribes a systematic way of approaching a failure of significant proportions. In case there are failures that result in large scale blackouts that will persist for long periods of time, a full team of experts may be required to provide emergency technical assistance. The technical assistance required for such cases will be proportionally larger than the one for local failures or disturbances.

This scenario assumes that an inquiry would initiate the assistance. The process starts with an inquiry from the country/utility that experienced outage due to Year 2000 problem. If the utility initially knows what part of the supply chain broke, then a team of experts who are relevant to the problematic area can be formed. However, occasionally due to the complex infrastructure of power industry and cascading effects of single failures on the overall supply chain, what might have been the primary cause of a general outage may not be known. In this case, the initial team may need to encompass an expert from each field that is outlined in the following section; basically experts with generation plant control, transmission and distribution engineering, energy management systems, substation automation, etc. experience.

Once the primary source of failure is identified, then the team can be modified to best fit the problem at hand. Next, the team works on diagnosing the real causes in detail within the system that caused the outage, and propose a course of action that will remedy the situation. After that, a rough estimate of the available resources needs to be formulated to define the required funding and its sources. The final step would be to follow all the required corrective steps to fix the problems. The last step may need further international assistance depending on the size and the nature of the failures.



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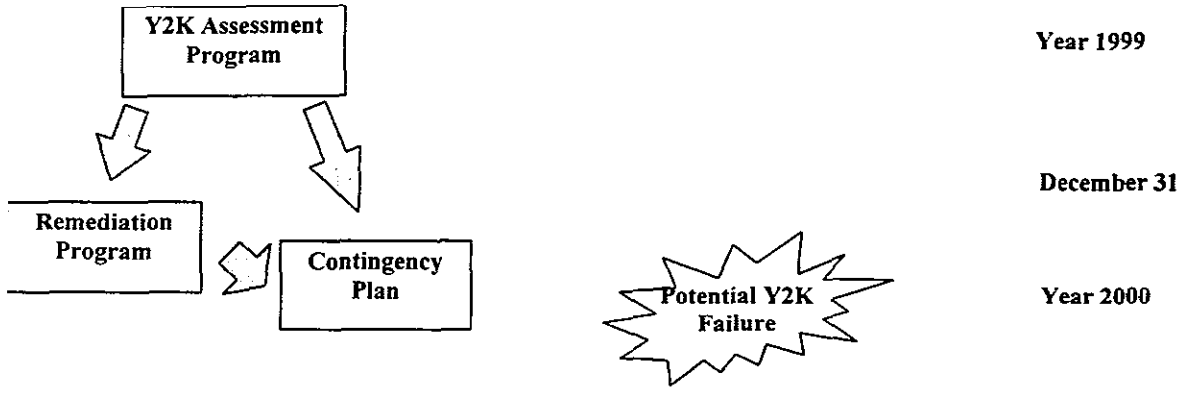
6.1.2 Potential Failures Post December 31st

While only a fraction of Year 2000 failures may occur at midnight on December 31st, several problems may linger or even show up long after December 31st. While there has been significant public awareness on this time boundary, the potential problems that may follow the time boundary and stretch into the year 2001 have not received enough attention.

There are studies that predict that majority of computer failures will spread to years 2000 and 2001, while the majority of the failures due to embedded computer chip problems will not last long.

The root causes of the failures in computer systems will be primarily from software that look backward in time. As the number of such systems in power systems operations is not large, there are not significant failures expected after December 31st. However, since not all utilities will have completed their Year 2000 remediation programs, and efforts to fix Year 2000 problems inevitably may introduce other software errors, there may be potential Year 2000 failures well into 2000.

The following scenario assumes that the that the utility under scrutiny may not have completed its assessment and contingency programs by December 31st, 1999. In this case, the utility may need emergency technical assistance due to new assessments that point to potential failures, or due to small scale blackouts that may occur locally and may have the potential to occur at other regions by their nature. The following figure summarizes this scenario.

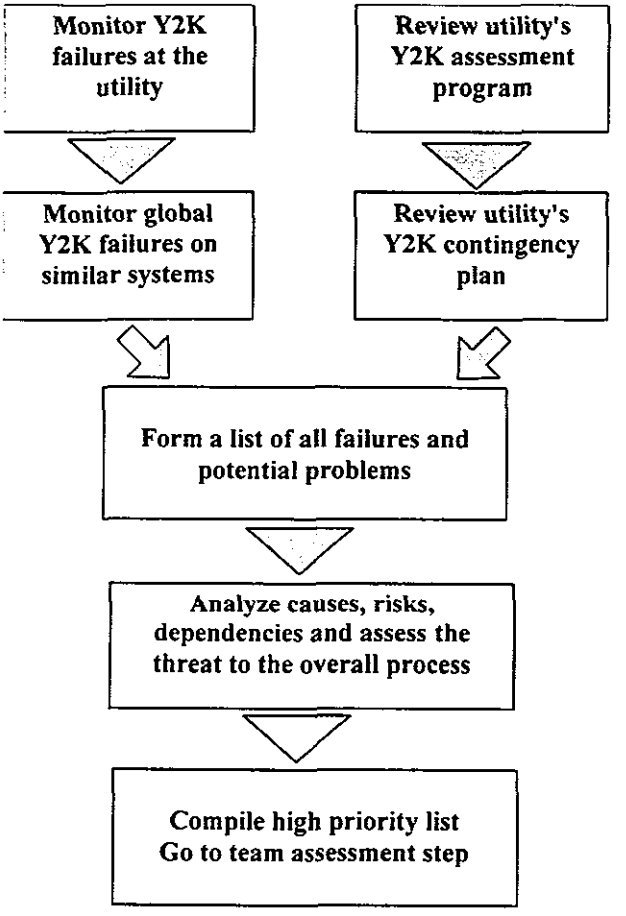


In this case, the utility may need to address these failures, their causes and ways of fixing them in addition to continuing their assessment and remediation programs. The principal objective of these efforts would be to determine the effect of such local or regional failures, or failures on similar systems elsewhere around the globe on the operations of the overall utility energy delivery process.

The key steps in this process would be as the following

1. Monitor and document Year 2000 failures within the utility
2. Monitor and document Year 2000 failures on similar systems around the globe
3. Review the utility's Year 2000 assessment program

4. Review the utility's Year 2000 contingency plan
5. Compile a list of all potential failures and problems
6. Perform risk and impact analyses, defining the dependencies for each potential problem on overall energy delivery process
7. Compile a priority list of potential problems and the related risks. Highest priority could be given to the power plants and the systems in them which could lead to loss of the plant. Second priority could be given to the network control centers, where the focus must be on the functions needed for early correction of drifting of the system towards an unstable configuration. Once the high priority targets are defined, a team of experts from required fields would be formed and the process would continue on a similar course that was outlined for large scale blackouts outlined in the previous section.



6.2 Technical Assistance Teams

It is expected that due to Y2K non-compliance, assistance will be required by countries to make their electrical systems operational post-Y2K. It is expected that expert 'Teams' will have to be sent to these regions to evaluate the problems and to estimate the level of effort required to make the electrical systems fully operational.

6.2.1 Composition of Teams

Based on the type of assistance required, it is expected that two levels of experts will be required in the post Y2K scenario.

(1) Experts who have a broad picture of the domain

(2) Experts capable solving problems in specific electrical system component

Domain Knowledge

The capability to provide electric service by a utility is disrupted when the core utility business functions - generation, transmission, and distribution - get affected. To analyze and solve post-Y2K problems, expertise is required in the following mission-critical sub-sectors:

Power Generation

Generating units must be able to operate through critical Y2K periods without tripping off-line. Units that are scheduled to operate must be able to start up and deliver electricity as planned. A reliable supply of power generation is essential to minimizing the operational impacts of the Y2K anomaly. Personnel, who have domain knowledge of the following area will be beneficial.

- Modern generator control systems: Generating units are complex and vary substantially in their use of computers and digital controls. The threat is most severe in power plants with digital control systems (DCSs). Numerous control and protection systems within the DCS use time-dependent algorithms that may result in generating unit trips when encountering a Y2K anomaly. Digital controllers that have been built into plant equipment, protection relays, and communications may also pose a risk. Working closely with vendors of these DCS systems is critical to identifying and correcting Y2K problems.

  Source of expertise: Engineering and Construction companies, equipment manufacturers, and consultants

- Older analog control systems: Many older power plants are operated principally with electromechanical or analog controls. Although these face very little Y2K problems, it may be necessary to make sure that these older system do not face problems and go off-line when the transmission system that they are connected to faces problems

  Source of expertise: Engineering and Construction companies, and consultants

- Facility and support system in a power plant: Knowledge of the following sub-system is also required by Y2K analysis experts
  - Boiler controls
  - Gas turbine controls
  - Protection systems
  - Communication systems

- Environment protection and waste management systems

Source of expertise: Equipment manufacturers, consultants

Energy Management System (EMS) and Supervisory Control and Data Acquisition (SCADA) System

EMS and SCADA systems are complex combinations of computer hardware, operating systems, and software, as well as communications equipment. Experts in this area will need to have knowledge in the following fields.

- Transmission systems: This includes expertise in generation scheduling, monitoring and controlling voltage and MVAR flows, transmission line and reactive switching, load shedding, preventing voltage collapse, etc.

  Source of expertise: Electric utilities

- Software engineering: For all software domain problems in the EMS and SCADA systems

  Source of expertise: Consultants and electric utilities

Substation Controls

Throughout electric power transmission and distribution systems, there are substations that contain control equipment such as circuit breakers, disconnect switches, and tap-changing transformers. Y2K problems can occur in these embedded systems. Domain expertise will be needed in the following areas.

- Substation automation: Remote terminal units (RTUs) in substations serve as the communications hubs for the substations, allowing them to communicate with the control centers. Substations also contain most of the transmission and distribution system protection relays, which serve to operate circuit breakers to quickly isolate equipment should an electrical fault occur on a line, transformer, or other piece of equipment.

  Source of expertise: Electric utilities, equipment manufacturers, and consultants

- Pre-automation operation procedures: If failures were to take place, expertise should be available to switch to manual operations to avoid more permanent damage to an electrical line or facility.

- *Source of expertise:* Consultants and electric utilities

Distribution engineering

- Distribution equipment: Distribution systems have additional equipment outside substations (for example along a distribution feeder) that may have electronic controls. Examples include reclosers (relays that open and close a feeder in rapid succession to allow a fault to clear), capacitors, voltage regulators, and special monitoring devices.

  Source of expertise: Equipment manufacturers, and electric utilities

- Distribution operational procedures: These include emergency operations, load shedding, system restoration

Source of expertise: Electric utilities and consultants

- Monitoring and analysis systems: These include events and alarms recording, disturbance analysis, operational statistics, and system diagnostics

  Source of expertise: Electric utilities and consultants

Telecommunications

Electric power systems are highly dependent on microwave, telephone, and UHF/VHF radio communications. If the control centers are the "brains" of the power grids, communications systems are the "nervous system." Telecommunications systems handle numerous voice, control, protection and data communications requirements, and are critical to reliable operation of electric power systems.

If voice and data communications are lost during the Y2K transition, operational continuity could be at risk, especially if information is lost for an extended period (hours or longer) and system conditions begin to change beyond those known to the operator.

Domain knowledge is necessary in the working of the following communication systems and its constituent components.

- Audio communication systems

  Source of expertise: Consultants and equipment manufacturers

- Data communications systems

  Source of expertise: Consultants and equipment manufacturers

- Wireless communication systems

  Source of expertise: Consultants and equipment manufacturers

- Satellite communication systems

  Source of expertise: Consultants and equipment manufacturers

Billing and Accounting

Although billing and accounting is not a life-endangering sub sector of a utility's operations, it is never the less important to keep these alive if the ability of the utility to serve its customers is to be maintained. These systems have become increasingly computerized. Many of the programs used in this sub sector are old and it can be expected that these will face Y2K compliance issues. The following expertise will be required

- Software engineering

  Source of expertise: Consultants

- Utility economists

  Source of expertise: Consultants and electric utilities

Nuclear Plant Engineering

Nuclear power plants have many components that are common to other power plants. However, some issues are unique to them. Although it is expected that all nuclear plants will be fully Y2K compliant by December 31, some post Y2K problems may appear.

- Nuclear plant engineers

  Source of expertise: Engineering and Construction companies and consultants

Component Knowledge

Below is a partial list of equipment are installed in power plants, substations, control centers, distribution systems, etc. In the 'computerized' versions of these equipment, Y2K non-compliance issues can be expected. It is desirable that the 'Team' consist of experts who have solid knowledge of these equipment.

- Ash handling system
- Automatic voltage regulator (AVR)
- Boiler control system
- Breaker control system
- Communication system
- Condition monitoring system
- Converter
- Conveyor control system
- Data acquisition system
- Data logger
- Digital read-out
- Distributed control system
- Disturbance recorder
- Energy meter
- Environmental monitoring equipment
- Event recorder
- Fault locator
- Flow meter and controller
- Governor
- Machine diagnostics equipment
- PABX
- Programmable logic controller (PLC)
- Protective relay
- Recloser
- Remote terminal unit (RTU)
- SCADA
- Simulator

- Test equipment
- Turbine control system
- Uninterruptible power supply (UPS)
- Valve actuator
- Vibration analyzer

Source of expertise: Equipment manufacturers and consultants

6.2.2 Equipment and resources for the Teams

A project team that will evaluate the impact of Y2K in a country seeking assistance, and provide the roadmap to solving the problems should be equipped appropriately to facilitate their work. The following is a list of such items.

- Y2K Research Databases: Certain research organizations have formulated databases providing methodologies and roadmaps to analyze and solve Y2K bugs. Such research may be made available to the expert Teams (and to the affected countries). It would be best if the database were available both digitally and in hard copy form. If possible, such database along with other resources must be made available over the web to allow remote access.

- Data Communication Links: Data communication links will need to be provide to the personnel in field so that they can maintain communication with the outside world. This may be possible by association with a large (global) ISP. It can be expected that web access using wireless and satellite media is a new technology, and the major players have the benefit of large resources, these services will not be affected by Y2K problems. Internet access will allow team members to send and receive e-mail and browse the Internet for additional resources.

- Transmission and Distribution Grid Maps: As much information as possible should be made available with respect to the physical constructs of the utility. Such information should be made available to the team 'before' it is sent out into the field.

- Laptops PCs with car battery adapters: Due to electricity outage and the need for computer use, power supply must be provided by alternative sources, such as car battery adapters.

- Satellite phones: Communication in remote areas is likely to suffer due to Y2K problems. This may be due to the disruptions in electricity supplies, or due to the fact that the telephone system itself has Y2K bugs. Team members may need satellite phones to communicate with the outside world to speed the solution of the problems. However, it must be noted that such a scenario is unlikely.

- Cars / Drivers: Depending on the condition of the roads, the team members' knowledge of the road systems, and the proximity of the utility to the project team, cars and drivers may have to be provided.

- Language translator: It will be difficult to find team members who are fluent in the project country's native tongue. It is very likely that the Team members will

come from outside the country requiring assistance. In the event that team members are not fluent, interpreters or foreign dictionaries should be made available.

6.2.3 Targets and time estimates for Team accomplishments

Liaison with local Utility personnel

The aim of the expert Teams should be to utilize the 'local' resources fully. Every effort must be made to get the local utility engineers and the management involved in solving post-Y2K problems.

The Y2K expert Teams will have to guide the local utilities to formulate task forces so that the actual groundwork of identifying the problem and for the implementing the recommended solutions is performed by the local personnel. This will reduce the time required for implementation, decrease the cost of the project, and allow the training of local personnel.

This task will require domain expertise. It is expected that this task will take 2-3 days. Liaison with local personnel must start before the Team is sent out into the field.

Determine primary area(s) of failure

The Team will query the local utility about the status of various sub-sectors of the power system to determine the current system status. Additional information that will be required by the Team will be made available to them by the local task forces.

This task will require domain expertise. It is expected that within 5-7 days after the expert Team contact the local utilities, the Team will be able to narrow down the primary causes of failure. This will allow the identification of critical sub-sectors where the effort should be concentrated.

Diagnose the cause(s) of failure

Once the domain of post-Y2K problems has been identified, expert Team members who have component specific knowledge should be brought in to identify the effected components.

This task will require component-level expertise. It is expected that this work will take 7 days.

Propose correction and define/identify required resources

The expert Team will identify the resources needed to solve the problem, evaluate different alternatives, and provide a road map that can be used to calculate the level of effort required. The Team will list the required corrections in an order of priority.

This task will require component-level and domain expertise. It is expected that this will take 10 days.

Provide 'Order of Magnitude' estimate for funding purposes

The expert Team will provide an estimate of the cost of the project.

This task will require domain expertise. It is expected that this task will take 3 days.

The following is a summary of the Team tasks and time estimates.

Task	Time estimate
Liaison with local Utility personnel	10 days
Determine primary area(s) of failure	
Diagnose the cause(s) of failure	7 days
Propose correction and define/identify required resources	10 days
Provide 'Order of Magnitude' estimate for funding purposes	3 days

6.2.4 'Regional' proficiency for Teams members

It will be beneficial if the Team members are chosen such that they have some familiarity with the region where technical assistance is being provided. This is required for communication (language and customs) and for attaining faster solutions of the problems.

Personnel with knowledge of the region's Transmission and Distribution system will be able to work faster. Wherever possible efforts must be made to recruit such personnel into the Expert Teams.

However, for many regions it may not be possible to find experts with regional knowledge. In such cases efforts must be made to provide a 'skilled' assistants who will be able to provide the regional system information (technical) and provide the necessary language support.

7 References

7.1 Sources used to compile this report

(1) *British Standard Institute (BSI) DEFINITION OF YEAR 2000 COMPLIANCE REQUIREMENTS*

(2) *IEEE Std 2000.1-1999 -- IEEE Standard for Information Technology -- Year 2000 Terminology* -- IEEE Std 2000.1-1999 defines the terms and concepts necessary for addressing Y2K issues for information technology. The standard revises a previous standard, approved in 1998, and includes changes in requirements for claims of conformance. The new standard specifies that components and systems perform correct date processing for a minimum of 10 years, including 1999 and 2000.

(3) *IEEE Std 2000.2-1999 -- IEEE Recommended Practice for Information Technology -- Year 2000 Test Methods* --- This recommended practice describes the process, test methods, and remediation for Year 2000 assessment and validation. It is intended for individuals or organizations that develop, test, acquire, or use software, firmware, or hardware. Due to the extremely wide range of platforms and applications that are being tested for Y2K problems, this document cannot claim to provide a complete or rigorous solution. Further, the document is not intended to be used as a Y2K compliance verification suite. Rather, it is an extensive compendium of recommended testing methods, only some of which may be applicable for any single system or component.

(4) NERC Status Report, Third Quarter 1999 progress report, dated November 18,1999, assessing the Y2K-readiness of the electric power industry. The plan includes information on industry system remediation, testing, and contingency planning.

(5) http://www.gartnerweb.com/ GartnerGroup Year 2000 World Status, August 17, 1999, Fact Sheet. The GartnerGroup provides research, analysis, consulting, measurement, decision evaluation, and product and vendor selection advice in the field of information technology

(6) http://www.iy2kcc.org/ The International Y2K Co-operation Center (IY2KCC) was created in February, 1999 under the auspices of the United Nations, with funding from the World Bank. Its mission is to promote increased strategic co-operation and action among governments, peoples, and the private sector to minimize adverse Y2K effects on the global society and economy.

(7) http://www.y2k.gov.in/ Government of India, official Y2K site. This web site's purpose is to create awareness on the Y2K problem and its impact on the IT applications and to provide all relevant information and practical advice to IT users and those seeking solutions to tackle the Year 2000 problem

(8) http://www.doe.gov.in/ Government of India, Department of Electronics. This site contains information from the India's Ministry of Information Technology (MIT) regarding MIT organizations, people and offices, publications, electronics associations, investment policies, R & D proposals, Indian electronics industry,

electronic governance, human resource development, application development, technology development, infrastructure facilities, tender/notices, and links to other sites.

(9) http://www.y2k.gov.my/ Government of Malaysia, official Y2K site. The site strives to provide a complete understanding of the situation in Malaysia with regards to the millennium bug. It's aim is to be useful to companies and organizations in addressing the challenges posed by this problem.

(10) http://www.tnb.com.my/newtnb/links/tnbh/y2k/y2kstatus.htm TNB (Malaysian Utility) Y2K site. This site contains a factsheet containing information on Tenaga Nasional's status with respect to addressing the Year 2000 issues. It also contains Ministrial, Utility, and Malaysia Links.

(11) http://meralco.com.ph/y2k/y2k_main.html The Manila Electric Company (Meralco) Y2K site. Meralco's service area, equivalent to only 3% of the country's total land area, produces about 50 percent of the Philippines' gross domestic product (GDP), 30% from Metro Manila alone.

(12) http://www.2000.gov.co/home.htm Republic of Colombia, Consejo Asesor Sistemas Año 2000, official Y2K site. "Year 2000 Systems" Consulting Council progress reports.

(13) http://www.presidencia.gov.co/politica/civtec/as2000.htm Republic of Colombia , Presidencia de la Repúbica (NOT FOUND)

(14) http://www.mincomunicaciones.gov.co/ConsejoSistemas/portada.htm Republic of Colombia, Ministerio of Comunicaciones. (NOT FOUND)

(15) http://www.banrep.gov.co/ControlInterno/ano2000.html Republic of Colombia, Banco de la República.

(16) http://www.modernizacion.cl/utic/a2000.html Chile, División de Modernización de la Gestión Pública del Ministerio Secretaría General de la Presidencia. (NOT FOUND)

(17) http://www.2000.cl/ Chile, Ministerio del Interior (Comisión Especial Año 2000): This site established the discussion group "Grupo Latinoamericano de Discusion 2000".

(18) http://www.a2000.cl, Chile, Acción 2000, official Y2K site. This site has information about Chile's A2000 committee, progress status, technology, and links to articles and papers on the topic.

(19) http://www.sonda.cl/websonda/a2000/ Chile - Y2K information site. (NOT FOUND)

(20) http://www.venezuela2000.gov.ve Venezuela national Y2K Site, contains information on Venezuela's Y2K Status Report, the Venezuelan Y2K Presidential Commission, and more.

(21) http://www.platino.gov.ve/año2000.htm Venezuela, Oficina Central de Estadística e Informática.

(22) http://www.ucab.edu.ve/Documentos/Postgrado/GU2000/ Venezuela, Universidad Catolica Andres Bello. (NOT FOUND)

(23) http://www.y2kghana.gov.gh/ The Ghana Y2K Home Page. (NOT FOUND)

(24) http://www.ispo.cec.be/y2keuro/year2000.htm The CIO Magazine, special Year 2000 issue. This site contains information on other web sites, press/surveys, related issues, various sectors, member states, the European Union, and other international regions.

(25) http://www.intl-monitoring.com/ International Monitoring is a specialist consultancy based in London, assessing Y2K damages and delays. This site contains research notes, reports and maps, sample data, and consulting information.

(26) http://www.bakersfield.com/sp2/index.asp: *Y2Krisk list, 11/29/99, The Associated Press*. This site contains lots of Y2K information, most of which pertains to Bakersfield, a city in southern California.

(27) http://www.y2k.gov.my/news/index.htm Malaysian Y2K news and highlights reported in the press. This site also contains information regarding industry reviews, Y2K legal aspects, vendor listings, companies that are Y2K compliant, Y2K resources, and links to other Y2K sites.

(28) http://www.y2kuganda.go.ug/ Uganda's National Y2K Task Force site. The site contains information on Uganda's national status, contingency plans, codes of conduct, legal aspects, related articles, as well as links to other Y2K sites.

(29) http://www.citu.gov.uk/2000/ev_study/ev_menu.htm This is the British government's Central Information Technology Unit (CITU) web site. It contains, among other things, Y2K status information for various sectors of Britain's infrastructure.

(30) http://info.cv.nrao.edu/y2k/sighting.htm This site is from the NRAO, a facility of the National Science Foundation, and contains numerous summary descriptions of Y2K or computer related glitches and the effects they had on their systems.

(31) http://www.iaea.org/ns/nusafe/y2000/y2k.htm This site was created by the Nuclear Installation Safety Net (NISN), a division of the International Atomic Energy Agency (IAEA). It contains lots of information on safety and Y2K impacts.

(32) http://ourworld.compuserve.com/homepages/roleigh_martin/y2journ.htm This site contains an article reprinted from Year/2000 Journal. It contains information about embedded systems, potential problems, device faults, how critical testing is, and utility readiness.

(33) http://energy2k.denken.or.jp This site is from the International Y2K Cooperation Center (IYCC). It contains an overview of the energy sector as well as numerous Y2K links for countries all over the world.

(34) http://energy2k.denken.or.jp/model/model.html IYCC's overview of how Y2K Contingency Planning can be applied to the Electric Power Industry.

(35) http://www.tepco.co.jp/corp-sys/y2k/contin-e.html This site presents TEPCO's (Tokyo Electric Power Company) rather detailed overview of a Y2K contingency plan for an electric utility.

(36) http://www.electricity.org.uk/uk_inds/mn_y2k.html The Electricity Association represents major electricity companies in the UK. This site has information regarding press releases, literature and publications, as well as links to other Y2K sites.

(37) http://www.startribune.com/stOnLine/cgi-bin/article?thisStory=75682445 This is an article found on the Star Tribune's web site. It discusses how long Y2K aftermath might last.

(38) http://www.wpcorp.com.au/corpinfo/year2000/documents/testing_guidelines/index.html This site has information on Western Power's Y2K Testing Guidelines. It contains sections on target dates, planning, and methodology.

(39) http://www.worldbank.org/html/fpd/energy/y2k/y2kguide_power.htm This is the World Bank's Guide for Power Utilities. It contains guideline information, case studies, and other related sector information.

(40) http://www.iy2kcc.org/ChileConclusions.htm This site presents the conclusions from the South American Y2K forum.

(41) http://www.iaea.org/ns/nusafe/y2000/y2k.htm This site was created by the Nuclear Installation Safety Net (NISN), a division of the International Atomic Energy Agency (IAEA). It contains lots of information on safety and Y2K impacts.

(42) http://www.iee.org.uk/2000risk This site is hosted by the Institution of Electrical Engineers. It discusses embedded systems and their potential impacts for the year 2000.

(43) http://www.iee.org.uk/2000risk/guide/year2k10.htm This site is hosted by the Institution of Electrical Engineers.

(44) http://www.wpcorp.com.au/corpinfo/year2000/news/1999Apr01a.html This site is hosted by Western Power and raises some Y2K concerns with respect to the electricity industry.

(45) http://www.esaa.com.au/y2k.htm This site is hosted by the Electricity Supply of Australia, Ltd. And contains information on Year 2000 readiness with respect to the Australian electricity supply business.

7.2 National Y2K sites

(1) Albania - National Y2K Site http://www.inima.al

(2) Algeria - National Y2K Site: http://www.y2k.net.dz

(3) Angola - National Y2K Site: http://www.y2kangola.ao

(4) Argentina - Secretaría de la Función Pública: http://www.sfp.gov.ar/2000/2000.html

(5) Armenia - Armenian Academy of Sciences http://y2k.sci.am/

(6) Aruba - National Y2K Web Site http://www.aruba2000.org

(7) Australia - Office of Government Information Technology: http://www.y2k.gov.au/html/index.html, http://www.ogit.gov.au/year2000/yr2000.html

(8) Austria - Chamber of Commerce: http://www.wifi.at/tub/2000

National Y2K Site: http://www.austria.gv.at/e/jahr2000e/year2000.htm

(9) Azerbaijan - National Y2K Site: http://y2k.gov.az/

(10) Bahamas - National Y2K Site: http://www.bahamasgov.org/y2k

(11) Bahrain - National Y2K Site: http://www.worldbank.org/infodev/y2k/www.y2k.gov.bh

(12) Bangladesh - National Y2K Site: http://www.bccbd.org/

(13) Barbados - National Y2K Site: http://www.barbados.gov.bb/y2kbarbados

(14) Belarus - National Y2K Site: http://y2k.bas-net.by/

(15) Belgium - National Y2K Site: http://www.a2mben.bj/

Programme for Research and Technology Development in Information Technology of the European Commission: http://www.ispo.cec.be/y2keuro

Federal Government Forum 2000: http://y2000.fgov.be/

(16) Belize - National Y2K Site: http://www.belizeweb.com/y2k

(17) Benin - National Y2K Site: http://www.a2mben.bj/

(18) Bolivia - Comité Nacional de Emergencia Año 2000:

http://www.sisteco-bo.com/bolgob-y2k

(19) Bosnia and Herzegovina - http://www.mvp.gov.ba/y2k

(20) Botswana - National Y2K Site: http://www.y2k.gov.bw/

(21) Brasil - Site do Portal do Programa Brasileiro: http://www.a2000.gov.br/

Site do Forum da América do Sul: http://www.forov2kamericadelsur.org/

Governo do Distrito Federal (Companhia do Desenvolvimento do Planalto Central): http://www.gdf.gov.br/codeplan/ano2000/

Ministério da Administração Federal e Reforma do Estado (A2000 - Sistema de Acompanhamento das Adaptações: http://www.mare.gov.br/A2000/

Ministério da Fazenda (SERPRO): http://www.serpro.gov.br/2000/CONTADOR/USR/SK00929/JAVA/ANO2000/INDEX1.HTM

Unicamp (Centro de Computação): http://www.ccuec.unicamp.br/ano2000/

(22) British Virgin Islands - National Y2K Site: http://www.bviy2k.vg/

(23) Brunei - National Y2K Site: http://www.brunet.bn/gov/y2k/akhbar.htm

(24) Bulgaria - National Y2K Site: http://www.y2k.govrn.bg/

(25) Canada - Treasury Board: http://www.info2000.gc.ca/

Industry Canada: http://strategis.ic.gc.ca/sc_mangb/y2k/engdoc/homepage.html

(26) Cayman Islands - National Y2K Site: http://www.year2000.ky/

(27) Central African Republic - National Y2K Site: http://www.socatel.intnet.cf/

(28) Chile - División de Modernización de la Gestión Pública del Ministerio Secretaría General de la Presidencia: http://www.modernizacion.cl/utic/a2000.html

Ministerio del Interior (Comisión Especial Año 2000): http://www.2000.cl/

This site established the discussion group "Grupo Latinoamericano de Discusion 2000": Acción 2000: http://www.a2000.cl

http://www.sonda.cl/websonda/a2000/

(29) Colombia - Presidencia de la Repúbica: http://www.presidencia.gov.co/politica/civtec/as2000.htm

Consejo Asesor Sistemas Año 2000:http://www.2000.gov.co

Ministerio of Comunicaciones: http://www.mincomunicaciones.gov.co/ConsejoSistemas/portada.htm

Banco de la República: http://www.banrep.gov.co/ControlInterno/ano2000.html

(30) Congo, Democratic Republic of - Comite Bancaire 2000: http://www.citeweb.net/banconet

(31) Costa Rica - National Y2K Site: http://www.micit.go.cr/

(32) Croatia - Povjerenstvo Vlade Republik Hrvatske za rješavanje "Problema 2000.": http://www.2000.hr

National Action Plan: http://www.2000.hr/engleski/nac_y2ke.doc

(33) Cuba - http://www.islagrande.cu/y2k/homeie.html

(34) Cyprus - National Y2K Site: http://www.y2kcommitee.cytanet.com.cy/

(35) Czech Republic - National Y2K Site: http://www.y2k.nks.sz/

(36) Denmark - Ministry of Research and Information Technology: http://www.fsk.dk/fsk/div/aar-2000/

(37) Dominican Republic - National Y2K Site http://www.comision2000.gov.do

Banco Central de la República Dominicana: http://www.bancentral.gov.do/p2000.html

(38) Ecuador - Superintendencia de Bancos: http://www.superban.gov.ec/doc/impacto.htm

(39) Egypt - National Y2K Site: http://www.sis.gov.eg/online/y2k/html/y2kfrm.htm

(40) El Salvador - Comisión Presidencial para la Modernización del Sector Público: http://www.cpmsp.gob.sv/

(41) Estonia - National y2000 web site: http://www.riik.ee/2000 (Estonian); http://www.riik.ee/2000/y2k (English)

(42) Ethiopia - National Y2K Site: http://www.telecom.net.et/~ncic

(43) Fiji - National Y2K Site: http://www.y2kfiji.com

(44) Finland - http://www.iki.fi/~jpatokal/y2k/

http://www.vn.fi/vm/kehittaminen/tietohallinto/hko33.htm

(45) France - Ministère de l'Economie, des Finances et de l'Industrie: http://www.industrie.gouv.fr/pratique/conseil/an2000/sp_passa.htm

Mission pour le Passage Informatique a l'An 2000: http://www.telecom.gouv.fr/francais/activ/techno/dossier_therv.htm

Site National: http://www.an2000.gouv.fr/

(46) Georgia - http://www.y2k-pmu.kheta.ge

(47) Germany - Bundesamt für Sicherheit in der Informationstechnik: http://www.bsi.bund.de/aufgaben/projekte/2000/jahr2000.htm

Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie: http://www.iid.de/jahr2000/

(48) Ghana - National Y2K Site: http://www.v2kghana.gov.gh/

(49) Greece - National Y2K Site: http://www.year2000.gr/

(50) Guatemala – National Y2K Site: http://www.dia2000.org.gt/

(51) Guyana - National Y2K Site: http://www.sdnp.org.gy/guy2k

(52) Honduras - National Y2K Site: http://www.v2k.hondunet.net/

(53) Hong Kong - http://www.year2000.gov.hk/

(54) Hungary - http://www.itb.hu/fejlesztesek/2000/

(55) Iceland - http://www.skyrr.is/2000/

(56) India - Department of Electronics: http://www.doe.gov.in/~doe/v2k.htm

National Y2K Site: http://www.y2k.gov.in/

(57) Indonesia - Magister Teknologi Informasi UI: http://www.mti.or.id

National Y2K Site in Idonesian: http://www.y2k.or.id

National Y2K Site in English: http://www.y2k.go.id/english.htm

(58) Iran - National Y2K Site: http://www.y2k.hci.or.ir/

(59) Ireland - Department of Enterprise, Trade and Employment: http://www.irlgov.ie/entemp/2000.htm

Department of Finance: http://www.irlgov.ie/finance/y2k2.htm

http://www.2000aware.ie/

(60) Italy - Autorità per l'Informatica nella Pubblica Amministrazione: http://www.aipa.it/attivita/anno2000[11/index.asp

Ministero dell'Industria, del Commercio e dell'Artigianato: http://www.minindustria.it/Gabinetto/Seg_Tecn/Inf2000.htm

http://www.comitatoanno2000.it

(61) Jamaica - Year 2000 Project Office: http://www.cabinet.gov.jm/y2k.htm

(62) Japan - Office of the Prime Minister:

http://www.kantei.go.jp/jp/pc2000/index.html [JAPANESE]

http://www.kantei.go.jp/foreign/y2k/index.html [ENGLISH]

Ministry of International Trade and Industry:

http://www.miti.go.jp/intro-e/a228201e.html

(63) Jordan - National Y2k Site http://www.y2k.gov.jo

(64) Kazakhstan - National Y2k Site http://y2k.minfin.kz

(65) Kenya - Central Bank of Kenya: Workshop On Year 2000(Y2K) Computer Bug: http://www.worldbank.org/infodev/y2k/Communique/CBKenya.htm

National Y2K Site: http://www.y2kkenya.go.ke

(66) Korea - National Computarization Agency: http://y2000.nca.or.kr

(67) Kowait - Y2K National Central Team - the Ministry of Planning: http://kuwaity2k.org/

(68) Kyrgyz Republic - National Y2K Site: http://www.y2k.kg/

(69) Latvia - National Y2K Site: http://www.sam.gov.lv/2000gads.nsf

(70) Lebanon - National Y2K Site: http://www.omsar.gov.lb/omsar/english/year2000/year2000.htm

(71) Lithuania - National Y2K Site: http://www.2000.lt/

(72) Luxembourg - National Y2K Site: http://www.etat.lu/

(73) Macau - National Y2K Site: http://www.cpttm.org.mo/y2k/english/index.htm

(74) Macedonia - National Y2K Site: http://www.y2k.gov.mk/

(75) Malaysia - Ministry of Energy, Telecommunications and Posts: http://www.y2k.gov.my

(76) Malta - National Y2K Site: http://challenge2000.magnet.mt/

(77) Mauritania - National Y2K Site: http://www.mauritania.mr/

(78) Mauritius - National Computer Board's Y2K Initiative http://ncb.intnet.mu

(79) México - Banco de México: http://www.banxico.org.mx/public_html/t2000/2000.html

Comisión Nacional para la Conversión Informática del Año 2000: http://pdi.inegi.gob.mx/2000/

Secretaría de Contraloría y Desarrollo Administrativo: http://www.secodam.gob.mx/proy2000/

Asociación Mexicana de la Industria de Tecnologías de Información: http://www.amiti2000.org.mx/

(80) Moldova - National Y2K Site: http://mci.gov.md/year2000/y2k_moldova.html

(81) Morocco - National Y2K Site: http://www.septi.gov.ma/

(82) Mozambique - National Y2K Site: http://www.utv2k.gov.mz/

(83) Namibia - National Y2K Site: http://www.opm.gov.na/y2k

(84) Netherlands - http://www.mp2000.nl

(85) Nicaragua - National Y2K Site: http://www.oas.org/y2k/main.htm

(86) New Zealand - NZ IT Association: http://www.itanz.org.nz/year2000

Department of Internal Affairs: http://Y2k.dia.govt.nz/

(87) Niger - National Y2K web site: http://www.delgi.ne/projets/pass2000/an2000.html

(88) Norway - http://odin.dep.no/aad/publ/aar2000/index.html

(89) Oman - National Y2K Site: http://www.oman-y2k.gov.om/

(90) Pakistan - Pakistan Computer Bureau: http://www.pcb.gov.pk

(91) Panama - National Y2K Site: http://www.y2k.gob.pa/

(92) Peru - Instituto Nacional de Estadística e Informática: http://www.inei.gob.pe/pia2000/

(93) Phillipines – Philippine Presidential Commission on Year 2000: http://www.y2k.gov.ph/

(94) Portugal - Instituto de Informática:

http://www.inst-informatica.pt/ANO2MIL/2mil0001.htm

Ministério da Ciência e da Tecnologia: http://www.missao-si.mct.pt/P2000/

EUnet: http://www.EUnet.pt/ano2000/

(95) Sénégal - Site National An 2000: http://www.primature.sn/an2000

(96) Singapore - National Computer Board: http://www.ncb.gov.sg/ncb/yr2000/index.html

(97) Slovakia - National Y2K Site: http://www.infostat.sk/

(98) Slovenia - Center for informatics: National Y2K site: http://www.sigov.si/cvi/slo/2000/2twww2.htm

(99) South Africa - Computer Society of South Africa: http://www.cinderella.co.za/cssa.html

Ministry for Posts, Telecommunications and Broadcasting: http://www.doc.org.za/docs/presentations/v2k/index.htm

National Year 2000 Decision Support Centre: http://www.y2k.org.za

Telkom: http://www.telkom.co.za/year2000/

(100) Spain - Consejo Superior de Informática: http://www.map.es/csi/2000.htm

(101) Sri Lanka - National Y2K Site: http://www.cintec.lk/y2k1.htm

(102) St. Kitts & Nevis - National Y2K Site: http://www.y2k.kn/

(103) Sweden - IT Kommissionen: http://www.itkommissionen.se/

Medicinsk Teknik Malmö: http://www.mta.mas.lu.se/2000/

Nytt från Landstingsförbundet: http://www.lf.se/sekelskifte.htm

Svenska IT-företagens Organisation: http://www.sito.se/2000/index.htm; Stockholmssjukvårdens 2000-konferens: http://www.svit.sll.se/2000/wwwboard/wwwboard.html

The Swedish Agency for Administrative Development's (Statskontoret): http://www.statskontoret.se/2000/

http://www.2000-delegationen.gov.se/aktuellt/index_1.html

(104) Switzerland - Universität Bern: http://www.ie.iwi.unibe.ch/zobis/jahr2000/

Universität Bern: http://www.millennium.ch

(105) Taiwan - National Y2K Site: http://www.year2000.gov.tw/

(106) Tanzania - National Y2K Site: http://www.y2ktanzania.go.tz/

(107) Thailand - Thailand's official national Y2K website at NECTEC http://www.y2k.nectec.or.th

(108) Tunisie - Secrétariat d'Etat à l'Informatique: http://www.an2000.tn/

(109) Turkey - http://y2000.dpt.gov.tr

(110) Trinidad & Tobago - National Y2K Site: http://www.tradeind.gov.tt/

(111) Uganda - National Y2K Site: http://www.y2kuganda.go.ug/

(112) Ukraine - National Y2K Site: http://www.ipi.kiev.ua/

(113) United Arab Emirates - National Y2K Site: http://www.gccy2k.com/

(114) United Kingdom - Year 2000 Team: http://www.open.gov.uk/year2000

British Standards Institution: http://www.bsi.org.uk/bsi/disc/year2000.html

UK Central Computer and Telecommunications Agency: http://www.ccta.gov.uk/mill/mbhome.htm. This site includes a discussion group.

Home Office: http://www.homeoffice.gov.uk/yr2000/index.htm

http://www.bug2000.co.uk

(115) United States - Federal Chief Information Officers (CIO) Council: http://y2k.policyworks.gov

Federal Communications Commission: http://y2k.policyworks.gov/

http://www.fcc.gov/year2000/

Federal Financial Institutions Examination Council: http://www.ffiec.gov/y2k/

MITRE Corporation: http://www.mitre.org/technology/y2k/

National Institute os Standards and Technology (NIST): http://www.nist.gov/y2k/

President's Council on Year 2000 Conversion: http://www.y2k.gov

U.S. General Services Administration's Office of Governmentwide Policy: http://www.itpolicy.gsa.gov/mks/yr2000/cioy2k.htm

Small Business Administration: http://www.sba.gov

(116) Uruguay - National Y2K Site: http://www.opp.gub.uy/y2k

(117) Venezuela - National Y2K Site: http://www.venezuela2000.gov.ve

Oficina Central de Estadística e Informática: http://www.platino.gov.ve/año2000.htm

Universidad Catolica Andres Bello: http://www.ucab.edu.ve/Documentos/Postgrado/GU2000/

(118) Vietnam - National Y2K Site: http://www.itnet.gov.vn/y2k

7.3 International Electric Utilities

(1) Argentina

Compañia Administradora del Mercado Mayorista Eléctrico, S.A.: http://www.cammesa.com.ar/

(2) Australia

ACTEW Corporation: http://www.actew.com.au/

Advance Energy: http://www.advanceenergy.com.au/

AlintaGas: http://www.alintagas.com.au/

Aurora Energy: http://www.auroraenergy.com.au/

Austa (generation): http://www.austaelectric.com.au/

Australian Gas Light Company: http://www.agl.com.au/

Australian Inland Energy: http://www.aienergy.com.au/

Boral Energy: http://www.boralenergy.com.au/index.htm

CitiPower: http://www.citipower.com.au/

CS energy - A government owned company that owns and operates three power station sites in Queensland: http://www.csenergy.com.au/

Delta Electricity: http://www.de.com.au/

Duke Energy in Australia: http://www.duke-energy.com.au/

Eastern Energy: http://www.easternenergy.com.au/

ECOGEN Energy: http://www.ecogen-energy.com.au/

Electric Projects Division, Victoria: http://www.energy.dtf.vic.gov.au/domino/web_notes/energy/dtf_epd_www.nsf/WebPages/Home

ENERGEX - The largest electricity corporation in Queensland: http://www.energex.com.au/

Energy 21 - One of Australia's new natural gas retailing companies, formed through the restructure of Victoria's Gas and Fuel industry: http://www.energy21.com.au/

Energy Developments: http://www.edl.com.au/

EnergyAustralia - One fifth of the of the Australian electricity market: http://www.energy.com.au/

Envestra: http://www.envestra.com.au/company.htm

Epic Energy - Australian based, privately owned company with a strong track record in natural gas transmission and development: http://www.epicenergy.com.au/

Ergon Energy The interactive, multi-media website of one of Australia's largest electricity retailers: http://www.ergon.com.au/

ETSA Corporation: http://www.etsa.com.au/

Far North Queensland Electricity Corporation: http://www.fnqeb.com.au/

Gas and Fuel: http://www.gasfuel.com.au/

Generation Victoria: http://www.ozemail.com.au/~btiltman/

Gorgon Australian LNG: http://www.gorgon.com.au/

GPU PowerNet: http://www.gpupowernet.com.au/index.html

Great Southern Energy: http://www.gsenergy.com.au/homefs.htm

Hazelwood Power (generation): http://www.hazelwood-power.com.au/

Hydro-Electric Corporation: http://www.hydro.com.au/

Integral Energy: http://www.integral.com.au/

Kinetik Energy: http://www.kinetik.com.au/

Kleenheat Gas: http://www.kleenheat.com.au/

Loy Yang Power: http://www.loyyangpower.com.au/

Macquarie Generation: http://www.macgen.com.au/

Multinet Gas: http://www.multinetgas.com.au/

National Electricity Market Management Company: http://www.nemmco.com.au/

NEMMCO - Australian wholesale electricity spot market: http://www.nemmco.com.au/

North Queensland Electricity Corporation: http://www.norqeb.com.au/

Northpower: http://www.northpower.com.au/

NRG Energy: http://www.nrgenergy.com/index.htm

Pacific Power International: http://www.pp.nsw.gov.au/ppi/

Powercor Australia LTD: http://www.powercor.com.au/

Snowy Mountains Hydro-electric Authority: http://www.snowyhydro.com.au/

Stanwell Corporation: http://www.stanwell.com/

Swanbank Power Station: http://www.home.gil.com.au/~swanbnk2/

Tarong Energy Corporation: http://www.tarongenergy.com.au/

Transend Networks Pty Ltd (Tasmanian transmission): http://www.transend.com.au/

TransGrid - NSW State Wholesale Electricity Market: http://www.tg.nsw.gov.au/sem/

TU Australia: http://www.txu.com.au/

United Energy: http://www.ue.com.au/

VENCorp - Transmission and distribution networks in Victoria: http://www.vencorp.com.au/

Westar: http://www.westar.com.au/

Western Power: http://www.wpcorp.com.au/

Yallourn Energy Pty Ltd: http://melbourne.citysearch.com.au/E/V/MELBO/0091/87/99/

(3) Austria

Energie Steiemark: http://www.estag.com/

(4) Belgium

Electrabel: http://www.electrabel.be/

(5) Brazil

CEB (language skills required): http://www.ceb.com.br/

Celesc (language skills required): http://www.celesc.com.br/

CEMAT - Centrais Elétricas Matogrossenses: http://www.cemat.com.br/

CEMIG Companhia Energética de Minas Gerais: http://www.cemig.com.br/cemig_i.htm

Centrais Elétricas do Norte do Brasil S.A.: http://www.eln.gov.br/

Centrais Elétricas de Goiás: http://www.celgsa.com.br/

CESP Centrais Elétricas de São Paulo: http://www.cesp.com.br/

CHESF - Companhia Hidro Elétrica do São Francisco. (language skills required): http://www.chesf.gov.br/

COELCE (language skills required): http://www.coelce.com.br/

coleba (language skills required): http://www.coelba.com.br/

CPFL - Companhia Paulista de Forca e Luz: http://www.cpfl.com.br/

Electronorte - Centrais Elétricas do Norte do Brasil S.A.: http://www.eln.gov.br/#

Electrosul: http://www.eletrosul.gov.br/ing/port.htm

Eletrobrás - Centrais Elétricas Brasileiras SA.: http://www.embratel.net.br/infoserv/eletrobr/emenu.htm

Eletropaulo - Eletricidade de São Paulo S.A. (languange skills required): http://www.eletropaulo.com.br/estrutura/homepage.htm

Furnas Centrais Elétricas S.A.: http://www.furnas.gov.br/

GERASUL (language skills required): http://www.gerasul.com.br/

Itaipu Binacional (language skills required): http://www.itaipu.gov.br/

REDE: http://www.gruporede.com.br/

(6) **Canada**

Ajax Hydro: http://www.ajaxhydro.on.ca/

Alberta Power Limited: http://www.albertapower.com/

ATCO Electric: http://www.atcoelectric.com/

ATCO & Canadian Utilities Limited: http://www.atco.ca/

BC Gas - British Columbia: http://www.bcgas.com/

BC Hydro - British Columbia: http://eww.bchydro.bc.ca/

Brantford Hydro Electric Commission: http://www.brantpower.on.ca/index.html

Cambridge and North Dumfries Hydro - Ontario: http://www.camhydro.com/

Canadian Niagara Power: http://www.niagara.com/cnpower/

Centra Gas Manitoba Inc.: http://www.centragas.mb.ca/

Chatham-Kent Public Utilities Commission:

http://www.city.chatham-kent.on.ca/puc/

Churchill Power Projects: http://www.ptm.ca/churchill/

Cobourg Public Utilities Commission: http://www.cobourgpuc.com/

Cochrane Public Utilities Commission - Ontario: http://www.puc.net/puc/

Collingwood Public Utilities Commission - Ontario: http://www.cpuc.on.ca/

Cornwall Electric: http://www.cornwallelectric.com/

DirectElectricity - Ontario. [Ontario Power Generation]: http://www.directelectricity.com/

Dundas Hydro: http://www.mea.on.ca/dundas/

Edmonton Power: http://www.edpower.com/

Enbridge Consumers Gas: http://www.cgc.enbridge.com/

ENERconnect: http://www.enerconnect.com/

ENMAX - Calgary Electric System - Alberta: http://www.enmax.com/

EPCOR ~ Edomonton Power: http://www.epcor-group.com/

ESBI Alberta Ltd.: http://www.eal.ab.ca/

Gaz Metropolitain - Québec.: http://www.gazmetro.com/

Gloucester Hydro: http://www.glhydro.on.ca/

Goderich Public Utilities Commission - Ontario: http://www.goderichpuc.on.ca/

Great Lakes Power Limited - Ontario: http://www.glp.on.ca/

Guelph Hydro: http://www.guelphhydro.com/

Halton Hills Hydro - Ontario: http://www.hhhydro.on.ca/

Hydro Mississauga - Ontario: http://www.hydromiss.com/

Hydro-Quebec: http://www.hydro.qc.ca/en/index.html

IEMO - Operating Ontario's Wholesale Electricity MarketPlace: http://www.iemo.com/

IPL Energy Inc.: http://www.iplenergy.com/

Kanta Hydro: http://www.kanatahydro.on.ca/

Kitchener Utilities: http://city.kitchener.on.ca/utilities/kitchenerutilities_index.html

Lethbridge Electric Utility Services - Alberta: http://www.lethpower.com/

Lucan Hydro: http://www3.sympatico.ca/lucanhec/electric.htm

Manitoba Hydro: http://www.hydro.mb.ca/

Maritime Electric: http://www.maritimeelectric.com/

Newfoundland and Labrador Hydro: http://www.nlh.nf.ca/

Newfoundland Power: http://www.newfoundlandpower.com/

North Bay Hydro: http://www.northbayhydro.on.ca/

Nova Scotia Power: http://www.nspower.com/

Ontario Hydro: http://www.hydro.on.ca/

Ontario Power Generation: http://www.ontariopowergeneration.com/

Ontario Power Generation Inc.: http://www.directelectricity.com/

Orillia Water Light & Power Commission: http://www.orilliawlp.on.ca/

Oshawa Public Utilities Commission: http://www.opuc.on.ca/

Pembroke Hydro: http://www.renc.igs.net/~pemhydro/

Pickering Hydro: http://www.pickeringhydro.on.ca/

Power Pool of Alberta: http://www.powerpool.ab.ca/

Red Deer EL&P: http://www.city.red-deer.ab.ca/engin/power.html

Richmond Hill Hydro Electric Commission: http://www.rhhydro.org/

Sask Energy: http://www.saskenergy.com/

Saskatchewan Power Corporation: http://www.saskpower.com/

Sudbury Hydro: http://www.shec.com/

Toronto Hydro: http://www.torontohydro.com/

TransAlta Corporation: http://www.transalta.com/

TransCanada: http://www.ncl.ab.ca/

TransGas Limited: http://www.transgas.sk.ca/

Union Gas: http://www.uniongas.com/

Utilities Kingston: http://www.kingstonpuc.on.ca/

Waterloo North Hydro - Ontario: http://www.wnhydro.on.ca/

West Kootenay Power - British Columbia: http://www.wkpower.com/

Westcoast Energy: http://www.westcoastenergy.com/

Woodstock Public Utility Commission - Ontario: http://www.woodstockpuc.on.ca/

Yukon Energy Corporation Main: http://www.yec.yk.ca/

(7) Caribbean

Anguilla Electricity Co. Ltd: http://www.anglec.com/

Belize Electricity Limited: http://www.bel.com.bz/

Caribbean Utilities Company: http://www.cuc-cayman.com/

Grenada Electricity Services Ltd.: http://www.carilec.org/grenlec/

Jamaica Public Service Company Ltd.: http://www.jpsco.com/

Kompania di Awa i Elektrisidat di Kòrsou N.V.: http://www.kaenv.com/index.html

Trinidad and Tobago Electricity Commission: http://www.ttec.co.tt/

(8) Chile

Chilectra S.A.: http://www.chilectra.cl/invers_ing/invers.htm

ENERSIS: http://www.enersis.com/

Gas Valpo (lanuage skills required): http://www.gasvalpo.cl/

Gener: http://www.gener.com/english/

(9) China

Changshu Power, Inc.: http://www.changshupower.com/

China Light & Power Company, Ltd.: http://www.chinalightandpower.com.hk/

CLP Holdings: http://www.clpgroup.com/

The Hong Kong and China Gas Company Ltd.: http://www.hkcg.com/

The Hongkong Electric Co. Ltd.: http://www.hec.com.hk/

(10) Colombia

Interconnexión Eléctricia S.A. E.S.P. - ISA: http://www.isa.com.co/

ISAGEN: http://www.isagen.com.co/isagen_ingles/index1.html

(11) Croatia

(12) Czech Republic

Czech Power Company CEZ, a.s.: http://www.cez.cz/

PRE: http://www.pre.cz/eng/default.htm

(13) Denmark

DEFU: http://www.defu.dk/gb/index.htm

Elsam: http://www.elsam.dk/engelsk/

Eltra: http://www.eltra.dk/

Fynsvæket: http://www.fv.dk/

Himmerlands Elforsyning: http://www.hef.dk/

NESA A/S: http://www.nesa.dk/english.htm

Odense Kommunale Elforsyning: http://www.oke.dk/engelsk/okeindex.htm

(14) Estonia

EESTI Energia: http://www.energia.ee/

(15) Finland

Energy in Finland: http://www.energia.fi/eindex.html

Finnish Power Grid Plc: http://www.fingrid.fi/

IVO Group: http://www.ivo.fi/

Jakobstad Energy Utility: http://www.multi.fi/~jev/jevhome.html

Kemijoki Oy: http://www.kemijoki.fi/kejoe.htm

The Länsivoima Group: http://www.lvo.fi/

NESTE: http://www.neste.com/

Teollisuuden Voima Oy: http://www.tvo.fi/

TVO: http://www.tvo.fi/

(16) France

Electricité de France: http://www.edf.fr/

Electricité de Strasbourg: http://www.electricite-strasbourg.fr/

Gaz de France: http://www.gazdefrance.com/

Gaz de Strasbourg (lanuage skills required): http://www.gaz-de-strasbourg.fr/

(17) Germany

Bayernwerk: http://www.bayernwerk.de/

Bewag - Energy supplier to Berlin: http://www.bewag.de/

Energie Baden-Wuerttemberg AG (language skills required): http://www.enbw.com/

Energieversorgung Schwaben - (language skills required): http://www.evs.de/main.shtml

EVS: http://www.evs.de/

HEW Group: http://www.hew.de/english/index.html

Ruhrgas: http://www.ruhrgas.de/

RWE Energie: http://www.rweenergie.de/strom/index.htm

STROM: http://www.strom.de/

VIAG: http://www.viag.com/

(18) Greece

Electricity Authority of Cyprus: http://www.sepaik.org.cy/page3.html

Prometheus Gas S.A.: http://www.addgr.com/comp/kopel/promet/index.html

Public Power Corporation: http://www.dei.gr/

(19) Guatemala

Empresa Eléctrica de Guatemala: http://www.bizinfonet.com/guatemala-electric/

(20) Iceland

Rafveita Akureyrar (Akureyri Municipal Electric Works): http://www.nett.is/rafak/

RARIK - Iceland State Electricity: http://www.rarik.is/

(21) India

Ahmedabad Electricity Co Ltd: http://www.aec-psd.com/

Bombay Power Supply - unofficial: http://theory.tifr.res.in/bombay/amenities/power/

BSES Limited: http://www.bses.com/home.html

Gas Authority of India: http://www.nic.in/gail/

Gujarat Electricity Board: http://www.gseb.com/

Mangalore Power Company: http://www.mangalorepower.com/index.html

(22) Indonesia

Indonesian Electricity Company: http://www.pln-jatim.co.id/index.html

(23) Ireland

Bord Gáis Éireann: http://www.bge.ie/

Electricity Supply Board: http://www.esb.ie/

(24) Israel

Israel Electric Corporation: http://www.israel-electric.co.il/

(25) Italy

Acqua Gas Azienda Municipale (language skills required): http://www.see.it/agam/

Aem - The Municipal Electricity Company of Milan: http://www.aem.it/

AGES: http://www.ages.it/index1.html

Edison SpA: http://www.edison.it/

Enel (language skills required): http://www.enel.it/

Italgas Gruppo: http://www.italgas.it/

(26) Japan

Chubu Electric Power: http://www.chuden.co.jp/indexE.htm

The Chugoku Electric Power Co.,Inc.: http://www.energia.co.jp/

Hokkaido Electric Power Company: http://www.hepco.co.jp/english/

Hokuriku Electric Power Company: http://www.rikuden.co.jp/

The Japan Atomic Power Company Co, Ltd: http://www.japc.co.jp/english/index.htm

Japan Nuclear Fuel Limited: http://www.jnfl.co.jp/index-e.html

Kansai Electric Power Co. Inc.: http://www.kepco.co.jp/

Kyushu Electric Power Co.,Inc.: http://www.kyuden.co.jp/English-Home.html

Okinawa Electric Power Company: http://www.okiden.co.jp/english/index.html

Osaka Gas: http://www.osakagas.co.jp/

Shikoku Electric Power Co.: http://www.yonden.co.jp/index_e.htm

Toho Gas: http://www.tohogas.co.jp/toho_eng/

Tohoku Electric Power: http://www.tohoku-epco.co.jp/index-e.htm

Tokyo Electric Power Company: http://www.tepco.co.jp/index-e.html

Tokyo Gas: http://www.tokyo-gas.co.jp/

(27) Kazakstan

Kazakstan Electricity Grid Operating Company: http://www.kegoc.kz/

(28) Korea

Korea Electric Power Corporation: http://www.kepco.co.kr/

Korea Gas Corporation: http://www.kogas.or.kr/

(29) Latvia

Latvenergo: http://www.energo.lv/

(30) Lithuania

Lietuvos energija - (Lithuanian Power): http://www.lpc.lt/index.html

(31) Luxembourg

Cegedel: http://www.cegedel.lu/uk/index.html

SUDGAZ: http://www.sudgaz.lu/

(32) Malaysia

Sabah Energy Corporation: http://www.borneo-online.com.my/sec/

Tenaga Nasional Berhad: http://www.tnb.com.my/

(33) Mexico

(34) Netherlands

EDON Group: http://www.edon.nl/

Electriciteitsbedrijf Zuid-Holland: http://www.ezh.nl.com/

ENECO - One of the main power companies in the Netherlands: http://www.eneco.nl/

Energie Noord West (language skills required): http://www.enw.nl/

Energiebedrijf Midden-Holland (language skills required): http://www.emhgouda.nl/

EnergieNed: http://www.energiened.nl/engels/index.html

ENW Amsterdam: http://amsterdam.enw.nl/index.htm

EWR (lanuage skills required): http://www.ewr.nl/

GAMOG (lanuage skills required): http://www.gamog.nl/

Gasbedrijf Midden Kennemerland N.V.: http://www.gasbedrijfmk.com/

MEGA Limburg Maastricht (language skills required): http://www.megalimburg.nl/

NUON: http://www.nuon.nl/

NV EDON Group: http://www.edon.nl/

N.V. Nederlandse Gasunie (Dutch Gas): http://www.gasunie.nl/

N.V. REMU (language skills required): http://www.remu.nl/

PNEM (language skills required): http://www.pnem.nl/

Obragas: http://www.obragas.nl/

(35) New Zealand

Central Power: http://www.centralpower.co.nz/

Dunedin Electricity: http://www.electricity.co.nz/

Electricity Corporation of New Zealand Limited - (ECNZ): http://www.ecnz.co.nz/

Electricity Market Company Ltd.: http://www.emco.co.nz/

EMCO: http://www.emco.co.nz/

First Electric Limited: http://www.firstelectric.co.nz/welcome.html

MainPower New Zealand Limited: http://www.mainpower.co.nz/

Mercury Energy: http://www.mercury.co.nz/

New Zealand National Electricity Market: http://www.electricity.net.au/

Power New Zealand: http://www.pnz.co.nz/

Scan Power: http://www.scanpower.co.nz/

Southpower Limited: http://www.southpower.co.nz/

Transpower: http://www.transpower.co.nz/

Trust Power: http://www.trustpower.co.nz/

(36) Norway

EnFo (language skills required): http://www.enfo.no/

Hafslund: http://www.hafslund.no/e_index.html

Nordisk Krafthandlerforening (language skills required): http://www.krafthandel.no/

Norsk Hydro Energy: http://www.hydro.com/

Norwegian Power Grid: http://www.statnett.no/engelsk/index.html

Oslo Energi (language skills required): http://www.oslo-energi.no/

Statkraft SF: http://www.statkraft.com/english/content/index.asp

Statnett: http://www.statnett.no/

Tronder-Energi: http://www.tronderenergi.no/english/

(37) **Paraguay**

(38) **Peru**

EDEGEL: http://www.edegel.com/

edelnor (language skills required): http://www.edelnor.com.pe/

EGEM (language skills required): http://ekeko.rcp.net.pe/EGEMSA/

Luz del Sur: http://www.luzdelsur.com.pe/english/index.htm

(39) **Philippines**

Davao Light & Power: http://vismin.com/davao/dlpc/

Meralco: http://meralco.com.ph/

(40) **Poland**

Beskidzka Energetyka SA: http://www.energetyka.bielsko.pl/besaother/english.htm

Energetyka Kalisz SA: http://www.energetyka.kalisz.pl/images/25ang/index.htm

GZE SA: http://www.gze.pl/pages/o_firmie_ang/index.html

LZE SA: http://www.lze.lodz.pl/lzeen/index.html

STOEN: http://www.szesa.waw.pl/index-en.html

Stoleczny Zaklad Energetyczny S.A. - (languange skills required): http://www.szesa.waw.pl/

Tadeusz Kosciuszko Power Plant: http://www.elpolsa.polbox.com/eindex.htm

(41) **Portugal**

Electricidade de Portugal - (language skills required): http://www.edp.pt/edp/

Gáz de Portugal - (languange skills required): http://www.gdp.pt/

(42) **Russia**

Elektra: http://www.elektra.ru/

Lenenergo: http://www.energo.ru/

(43) **Singapore**

Public Utilities Board: http://www.pub.gov.sg/

Singapore Power: http://www.spower.com.sg/

(44) **South Africa**

Eskom - South Africa's Power House: http://www.eskom.co.za/

(45) **Spain**

Compañia Operadora del Mercado Español de Electricidad S.A.: http://www.omel.com/

Electra de Viesgo - (language skills required): http://www.viesgo.es/

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Endesa Group: http://www.endesa.es/english/index.htm

Eneco - (language skills required): http://www.eneco.es/

Enher: http://www.enher.es/english/index.htm

ERZ: http://www.erz.es/

FECSA: http://www.fecsa.es/

Gesa: http://www.gesa.es/english/index.htm

Hidroeléctrica Del Cantábrico: http://www.h-c.es/index.cgi

Iberdrola: http://www.iberdrola.es/index.htm

RED Electricia - The electricity transmission system in Spain: http://www.ree.es/

Sevillana de Electricidad - (language skills required): http://www.sevillanelec.es/

SKS Energy Trading S.A.: http://www.sks.es/iindex.html

Unelco (language skills required): http://www.unelco.es/

Unidad Eléctrica, S.A. (UNESA) -The Spanish associtaion of electric utilities: http://207.92.102.104/

Union Fenosa: http://www.uef.es/indexeng.html

(46) Swaziland

Swaziland Electricity Board: http://www.seb.co.sz/

(47) Sweden

Gullspång Kraft AB: http://www.gka.se/birkaweb/start.nsf

NUTEK: http://www.nutek.se/

Stockholm Energi: http://www.seab.se/

Svenska Kraftnät: http://www.svk.se/english/index.html

Sveriges Elleverantörer (language skills required): http://www.svel.se/

Swedish nuclear fuel and waste management company: http://www.skb.se/

Sydkraft: http://www.sydkraft.se/koncern/ineng.htm

Vattenfall Group: http://www.vattenfall.se/

Öresundskraft AB (language skills required): http://www.helsingborgenergi.se/okab/index.htm

(48) Switzerland

AEK Gruppe Solothurn (language skills required): http://www.aek.ch/

AEW Aargauische Elektrizitätswerke (language skills required): http://www.aew.ch/

atel-Aare Tessin AG für Elektrizität Olten (language skills required): http://www.atel.ch/

Aziende Municipale Bellinzona (language skills required): http://www.amb.ch/

BKW FMB (language skills required): http://www.bkw-fmb.ch/

Bündner Karftwerke (language skills required): http://www.strom.ch/wasser/speicherkw/

Centralschweizerische Kraftwerke (language skills required): http://www.ckw.ch/

EBL Elektra Baselland (language skills required): http://www.ebl.ch/

EEF Freiburgische Elektrizitätswerke (language skills required): http://www.eef.ch/

EKS-Elektrizitätswerk des Kantons Schaffhausen (language skills required): http://www.eks.ch/

Electricite Romande (language skills required): http://www.electricite.ch/

Elektrizitäts-Gesellschaft Laufenburg AG: http://www.egl.ch/

Elektrizitätswerk Stadt Schaffhausen EWS (language skills required): http://www.shpower.ch/

Elektrizitätswerke des Kantons Zürich (language skills required): http://www.ekz.ch/

Energie Ouest Suisse (EOS) - Grande Dixence (GD) (language skills required): http://www.eos-gd.ch/

Energie Service Biel (language skills required): http://www.esb.ch/

EWBO-OES (language skills required): http://www.ewbo.ch/

EWHöfe (language skills required): http://www.ewh.ch/

Kraftwerk Schaffhausen AG (language skills required): http://www.shpower.ch/

Nordostschweizerische Kraftwerke NOK: http://www.nok.ch/general/english.htm

Steiner Energie AG (language skills required): http://www.se-malters.ch/

Städtische Werke Schaffhausen und Neuhausen a/Rhf. (language skills required): http://www.shpower.ch/

Swiss Electricity Price Index (language skills required): http://194.209.133.67/swep/

WWZ-Wasserwerke Zug AG (language skills required): http://www.wwz.ch/

(49) Thailand

EGAT - The Electricity Generating Authority of Thailand: http://www.egat.or.th/

(50) Taiwan

Taiwan Power Company - (language skills required): http://www.taipower.com.tw/

(51) Ukraine

National Nuclear Energy Generating Company: http://www.gca.atom.gov.ua/ENGLISH.HTM

(52) United Kingdom

Alliance Gas: http://www.alliancegas.co.uk/

British Energy: http://www.british-energy.co.uk/

British Gas: http://www.centrica.co.uk/

British Gas Service - Corporate Home Page: http://www.britishgasplc.co.uk/

Calor Gas: http://www.calorgas.co.uk/

Centrica: http://www.centrica.co.uk/

East Midlands Electricity: http://www.eme.co.uk/

Eastern Group: http://www.eastern.co.uk/

First Hydro: http://www.fhc.co.uk/

Hyder: http://www.hyder.co.uk/

Hydro-Electric: http://www.hydro.co.uk/

Independent Energy UK Limited: http://www.independentenergy.co.uk/

London Electricity: http://www.lebusiness.co.uk/

Manweb: http://www.manweb.co.uk/

Midlands Electricity: http://www.meb.co.uk/

National Grid Company plc: http://www.ngc.co.uk/whatwedo/whatwedo.html

National Power: http://www.national-power.com/

Northern Electric: http://www.northern-electric.co.uk/

Northern Ireland Electricity: http://www.nie.co.uk/

Nuclear Electric Ltd: http://www.nuclear-electric.co.uk/

Phoenix Natural Gas: http://www.phoenix-natural-gas.com/

Power Gen plc: http://www.powergen.co.uk/

Scottish and Southern Energy plc:
http://www.scottishandsouthern.co.uk/homeie3.html

Scottish Hydro-Electric: http://www.hydro.co.uk/

Scottish Power: http://www.scottishpower.plc.uk/

SEEBOARD: http://www.seeboard.co.uk/

Sterling Gas: http://www.sterlinggas.co.uk/

SWEB: http://www.sweb.co.uk/

Transco - [British Gas]: http://www.transco-bgplc.com/

United Utilities - United Utilities PLC was created in October 1995 following the merger of the UK utility companies Norweb and North West Water: http://www.unitedutilities.com/

Viridian Group: http://www.viridiangroup.co.uk/home/index.htm

Yorkshire Electricity: http://www.yeg.co.uk/

(53) Venezuela

Electricidad de Caracas: http://www.edc-ven.com/

Lago Gas: http://uranus.colossus.net/ciberespacio/lagogas/