IPRO It takes a team INTERPROFESSIONAL PROJECTS PROGRAM

IPRO 303

Intra-Plant Communication Regarding Equipment Maintenance During Planned Outages

FINAL REPORT

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CORPORATE SPONSOR

SmartSignal

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1.0 INTRODUCTION

The title of this IPRO is *Intra-Plant Communication Regarding Equipment Maintenance During Planned Outages*. The basic idea of the IPRO was to research and investigate coal-fired power plants and determine how the plant personnel communicate when an equipment malfunction arises. The specific focus was to learn: who makes decisions, how they base those decisions, and what additional information would be helpful in making those decisions. The scope was narrowed to communication during planned outages only.

2.0 BACKGROUND

2.1 Information on the Sponsor

Smart Signal© is a privately-owned corporation specializing in analysis of sensor data, specifically sensor data generated in power generation plants. Smart Signal's solution works alongside the current DCS, or distributed control system, to more accurately detect faults and improper configurations in real-time. Based in Lisle, Illinois, the company has over 20 clients nationwide.

2.2 User Problems

Smart Signal's, early warning system software is not designed well enough for people who make decisions from that software. The software has hundreds if not thousands of alarms. Alarms are prioritized based on seriousness of the problem. Still there are not enough people or time to analyze all incoming data. Another part of the problem is to deliver relevant information to the people who need it (relevant alarms to relevant people).

2.3 Technology and Science Involved

This project will span two semesters and we are in the first one. There will not be much science or technology directly involved in solving our problems, as we will mainly be focusing on interviews dealing with figuring out how to present the data produced by Smart Signal's system. However next semester's IPRO team will be using our data to suggest a user interface

2.4 Historical Success or Failures Addressing the Problem

In September 13, 2005 Smart Signal© and OSIsoft announced alignment to deliver value to their mutual customers and improve equipment performance. OSIsoft's real-time performance management platform (RtPM), complements Smart Signal© technology by gathering information, adding context and ultimately providing a way to analyze and visualize data to deliver predictive capability. The joint solution enables clients to close the equipment performance gap and improve equipment availability, reliability, efficiency and compliance.

There has been previous research done on prioritizing alarms for the person receiving them. That has reduced the number of alarms received; however, it's still not to the point where alarms are manageable size. There has have been research on who needs to receive what alarms, however there is room for improvement.

2.5 Ethical, Moral, Cultural and Scientific Issues

The ethical issues that the team will deal with during the semester will be related to our relationship with the power plants. We will have to deal with issues such as proprietary information and interview confidentiality. This is confidentiality for the company as well as confidentiality for the individual we are interviewing. If the subject thinks that what ever they say will be passed on to their superiors they will be much less inclined to speak honestly. There may be cultural issues, although it will be more related to the power plants' cultures than individual people's backgrounds. We will be interviewing people from every part of the plant, and will have to be careful not to offend anyone by going “over their head” or failing to follow the proper order to approach people. The only scientific issues we face are ensuring that we collect valid data, by asking open questions and letting the people we interview answer instead of being led along.

2.6 Business Costs of the Problem

With all alarms received by a user, if there is not enough time to analyze alarms then potential unexpected break down or maintenance might occur. This would damage the business of a Coal Fired Power Plant. Similar conclusion might be draw if alarms are received do not go to the right personnel. If right personnel receive alarm, and there’s enough time to analyze it then, potential break down might be prevented.

2.7 Implementation of the Proposed Solution

While the solution/information that is presented at the end of the semester will no doubt be helpful to our sponsor its main benefit will be for the next semester's IPRO team. They will use our report and graphical representation to make recommendations for additions to the user interface options of their products.

2.8 Team Implementation of Research

There is no better way to determine the needed information by coal-fired power plant personnel than to conduct interviews and obtain information directly from the power plant personnel. We found no similar research done to address this problem. There have been numerous reports on coal power plants but the internal decision making structure is outside their scope. Surveying is nothing new and there have been many of those done by the IIT Psychology department, which we are using to help us improve our surveys.

3.0 OBJECTIVES AND PURPOSE

IPRO 303 begins its first semester as a project designed to enhance the operations of both coal-burning power plants and the Smart Signal© Corporation. When critical equipment fails, it sends a shockwave throughout an organization and into its supply chain. Smart Signal’s EPI*Center software solution enables companies to fill the equipment performance gap between current operations and corporate objectives through early, actionable warning of any abnormal performance.

Many factors go into planning for a planned outage. The goal of the IPRO was to determine who makes the decisions for a planned outage and what information they use. And, as per our sponsor's request, the IPRO team will also attempt to determine what additional information would be useful when planning an outage. The sponsor is concerned with how plant personnel wish to receive the information and what specific details about equipment they would like to receive. This semester the team will research the decision making culture and information flow within these coal burning power plants as pertains to equipment maintenance.

The overall project goal is to recommend a user interface scheme aimed at maximizing the usefulness of EPI center within the operations staff culture of the plants.

3.1 General Objectives for the Semester

- To locate coal-fired power plants that are not currently customers of Smart Signal© for interview.
- To interview various personnel of the power plants.
- The gathered information will then be distilled into a graphical representation and easily digestible report to be delivered to Smart Signal©.
- The team will also prepare the data acquired to be passed on to the IPRO which will follow next semester.

3.2 Specific Objectives regarding Planned Outages

- Identify critical decisions involved in a planned maintenance outage and who makes them.
- Determine the steps taken before and during a planned outage; examine significant operations that occur after a planned outage is completed.
- Note the sources of information that influence these decisions and assess how this information is interpreted

These narrower and more specific objectives allowed the team to set goals that were manageable and allowed the simplification of the interview process. This will hopefully result in interviews that are more focused and data that is more pertinent. The schedule is displayed below in *Figure 1* in the form of a Gantt chart.

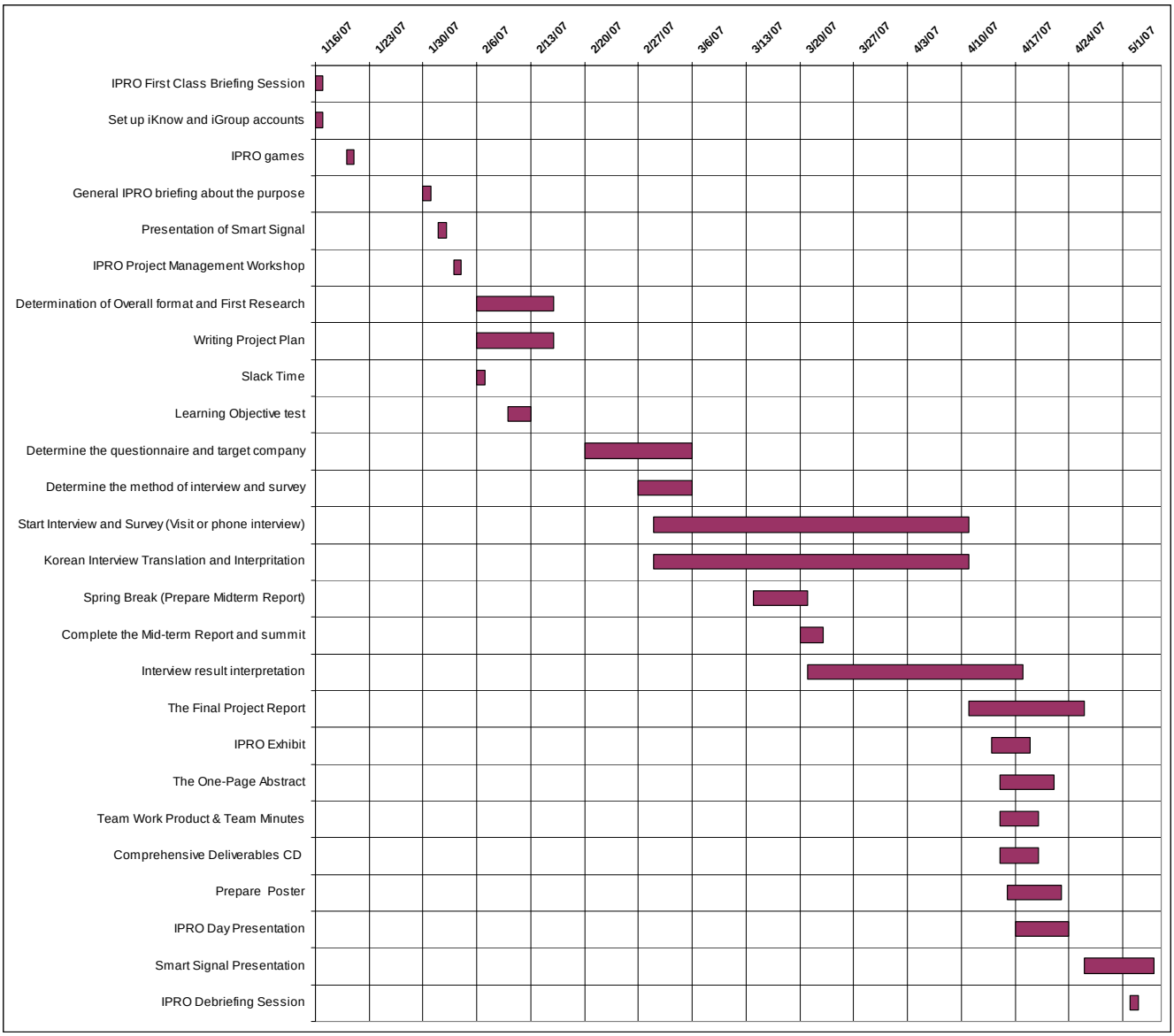


Figure 1: Gantt Chart

4.0 RESEARCH METHODOLOGY AND ASSIGNMENTS

For this particular IPRO, it seems adequate to combine the research methodology and assignments together as one. The reason for this being that the focus of our IPRO was to gather information. A key group assignment was in fact to devise a research methodology and decide as a team the best way to acquire data concerning the flow of information within a coal-firing power plant. However, it soon became apparent that our sponsors might provide us with the most efficient way to extract valuable information. Therefore, as a group, we scheduled a number of sessions with our sponsors to understand what was truly being asked of us, and to identify individual points that needed addressing. Because we met with our sponsors to address our

immediate concerns and issues, we were able to begin developing project tasks. The tasks for our project were developed around the questions that we needed answered, and the time required to obtain these answers and analyze our results. Our complete tasks and assignments loosely followed the following:

- Attend project background debriefing with Smart Signal© sponsors
- Team leader must provide an assignment of goals
- Group will begin preparation of Project Plan
- Create a team to research and develop survey questionnaire
- Research and create a non-disclosure agreement document
- Create a team to find power plant contact information
- Hold mock interview practices
- Perform actual interviews with power plant contacts
- Organize and compile interview data
- Analyze results
- Prepare a final IPRO deliverable/final sponsor report

4.1 Proposed and Accomplished

Of the proposed tasks and assignments listed above, all were achieved. However, the only task not mentioned but considered in a group meeting, the team webpage. This task was proposed, but was never completed. Ultimately throughout the semester, the proposal for a webpage team was discarded.

4.2 Division of Labor

Our group found that selecting a group leader to be an efficient way to divide work and tasks. To help our team leader in the assignment of tasks, when certain members of the team felt most-qualified to handle a particular task, this individual would volunteer themselves first. When work could not be assigned to a single individual, work was divided into different sub-teams and these sub-teams could then assign unique tasks to its members. Throughout the semester a number of teams were developed to handle a particular task for the project. The teams were structured as followed: Team Contact, Team Deliverable, Team Interview, and Team Korea.

Team Contact

Consisting of Kevin Tung, Kevin Lyles, John Rhoda, Omair Rehman. This team is required to maintain/seek power plant contacts and power plant contact information. This team is also responsible for conducting interviews with plants, similar to Team Korea.

Team Deliverable

Consisting of Michael Hatch, Jamie Amber, Sarunas Palikevicius, and Amanda Featherstone. This team ensures that all IPRO deliverables are handled. However, upon completion of IPRO reports, this team will become a part of the Team Contact in order to aid in the power plant contact/interview process.

Team Interview

Consisting of Michael Hatch, Kevin Tung, Kevin Lyles, and Sarunas Palikevicius. This team is responsible for the interviewing of all acquired contacts from Team Contact. This team is required to take notes on all interviewees' responses to give to Team Deliverable.

Team Korea

Consisting of Migun Choi, Taeho Hwang, and Chi Hwan Lee. This team is assigned to maintain relations with our Korean power plants. In addition to performing interviews with these plants, translations from Korean to English have been designated to this team as well.

4.3 The Success of the Team

The complete IPRO team can contribute its overall success to the success of the sub-teams. Each team worked proficiently in delivering any and all results required to achieve the next step in the overall conclusion of the first semester of the IPRO. Again, the success of the hard work of each team can be attributed to the individual efforts within that team. Each team thrived upon the strengths and overcame any weakness that any member may have brought to the team. Each member of each team was unique and can be described in such a way:

4.4 Individual Team Member Assignments

Jamie Amber

Jamie provides a sense of seriousness and legitimacy to our team. He is our team leader as well as our project plan Editor in Chief. He assigns all other tasks and ensures that our goals are achieved in a timely manner.

Migun Choi

Migun brings not only a unique female outlook to the operations of the team, but also a well-respected creative outlook as well. Migun is also responsible for performing Korean interviews as she too speaks Korean. Migun's creativity was also required in preparing our final presentation.

Amanda Featherstone

Amanda has worked on a prior IPRO as well. She is also great at analyzing data and assembling results into a readable form. Amanda also contributes her skills in each deliverable written.

Michael Hatch

Michael supports the team with his dedication and focus to the overall success of the project. He is responsible for the motivation of other members and is willing to handle a variety of tasks asked of him by the team leader. He is also willing to help others with their tasks as well.

Taeho Hwang

His skills range from being fluent in Korean and English, and he has some working knowledge of Chinese characters. Taeho brings a versatile arsenal of strengths to the team. Working on team Korea, he was able to help quickly translate Korean documents for the rest of the team.

Chi Hwan Lee

His active experience in the field of engineering provides a real-life outlook necessary for team development. His father also works in the field related to power plants in South Korea and therefore was able to gain the team additional contacts and an international perspective and solution.

Kevin Lyles

Kevin brings a strong sense of expertise and experience to our team. He has served on an IPRO prior to this one. He was on the interview team and helped devise the theme of our final project deliverable.

Sarunas Palikevicius

Sarunas volunteered his time (he is a commuter) and his car to transport team members to distant power plants. In addition he worked on the deliverable team and the interview team. He brings a quiet and pensive stability to the team.

Mohammed Omair Rehman
Mohammed was a part of the contact team. He assisted John Rhoda in looking up power plant managers and phone numbers and e-mail information. Mohammed brings organizational skills and leadership abilities to the team.

John Rhoda
John is our team's Secretary and makes critical attributions to the team. He is our minute's taker and ensures that the team is aware of upcoming deadlines.

Kevin Tung
Kevin provides a source of calm reliability to the team. He does his fair share of work and does so quickly and correctly. Kevin also plays a role in a number of teams for this IPRO.

4.5 Team Building Process and Activities

Outside of the obvious volunteering to be in a sub-team or being assigned to a sub-team, the complete strength of the sub-teams, and therefore the whole IPRO team itself, lie in the activities which we all performed together. Some of the most notable activities that we performed together, was awakening early (7am) and traveling together to power plants to interview employees together. Many of our team members do not have cars, so the few that did have cars volunteered their time and services to help out. Each member was grateful of this and this certainly contributed to the strength of our team as a unit. The most apparent obstacle in the team building process was matching up our schedules. Outside of class members commuted, held jobs, or were active in other external campus affairs. Scheduling issues were overcome with patience and dedication. Certain group activities were labeled a high-priority and were therefore mentioned in advance so as to eliminate short-notice complications. Doing this proved to make our team truly effective.

4.6 Team Communication

In addition to the traveling for team building, most decisions were not decided by our leader, but instead were voted upon as a group. Taking the time to vote and hold discussion on issues made each member feel as valuable as the other. Group discussions and brainstorming were the two good communication practices that we implemented as a team. This groupthink methodology was a very effective form of communicating. Outside of class we all exchanged e-mail and cell phone numbers, so there was never an issue of communication within our team. Within our team there were no communication obstacles; we were very effective. However, maintaining communication with our sponsors proved to be an obstacle at times. This too was resolved simply by persistence. After continuous phone calls and e-mails, the team was able to secure a line of continuous communication with our Smart Signal© sponsors.

5.0 OBSTACLES

There were a number of obstacles which this team had to face and overcome. The most notable were the issues of ethics. For a time, our team could not decide what ethical obligations were would be required to uphold when interviewing plant employees. Because of this, our interviewing process was delayed and almost fully sidetracked. However, after much deliberation and consultation with learned sources, it was concluded that our sponsor has a right

to privacy of their name and motives, and those whom we interviewed over the phone should not be recorded without their consent. It was also suggested that in our final report, that no plant or employee name should be included in any deliverable. Our primary ethical issues of a right-to-privacy and confidentiality arose because it is understood that without informed consent of the project details, and how the information an employee provides will be used, we ethically had no right to do how we pleased with such privileged information. Ultimately, these ethical issues were resolved with a group vote. Another obstacle that needed resolving was figuring out a way to relay information back and forth with our sponsors. Initially, our sponsors were too preoccupied to respond to our e-mails and voicemails. Because of this, our group was unsure which direction to take the team. Fortunately, after several attempts, we were able to get in touch with our sponsors and they were able to guide us in the right direction. A final pair of obstacles that occurred were actually obtaining power plants and employee contact information. This information was not readily available to us from our sponsors, so a team had to be developed to locate local plants to contact, visit, and interview. This contact team proved very effective, but once these contacts were received, a problem of asking the right interview questions became apparent. This too was resolved by developing an interview team which met with IIT faculty in the psychology department, and devised a strategy for asking direct and precise questions. Fortunately, the teams created were organized and productive enough to eliminate all obstacles faced. However, in the future, obstacles may again rise, possibly issues of what language the software should be written in, who can write the code for this software, and can this software be properly tested before it is successfully implemented. The only plausible solution for these obstacles is to obtain members who are capable of programming, and work efficiently enough to have remaining time afterwards for proper beta testing.

6.0 RESULTS

6.1 Major Accomplishments

The contact team was able to set up multiple interviews with various plant personnel in plants in Midwest and Korea. A total of 20 interviews were successfully conducted by the interview team. After all interview data was discussed, it was tabulated into spreadsheets and interpreted. The data was simplified into statistics from which charts and graphs were made to represent the findings. From this, the IPRO team was able to draw conclusions and make recommendations to the sponsor. The list of questions asked in the interviews is located in *Appendix A.* All tabulated interview data can be found in *Appendix B.* All statistical information and charts are located throughout the report, as well as in *Appendix C.*

6.2 Research Activities

The main source of our research was through primary sources. Those included contacting IIT faculty and receiving their input, as well as by conducting interviews with plant personnel over the phone, via email, or in person. The majority of interviews were with Plant Managers who were experts in their field, as noted in the *Figure 2* below. The IPRO team also participated in a plant tour, which was a great primary source for the team's research.

(1) Please describe your position, background, and plant experience.

(1.1)			(1.2)		
	1 Plant Manager	30%		1 Expert	60%
	2 Planned Outage Manager	20%		2 Very Experienced	40%
	3 Shift Supervisor	5%		3 Experienced	0%
	4 Operations Manager	10%		4 Some Experience	0%
	5 Maintenance Manager	10%		5 Novice	0%
	6 Unit Engineer/Specialist	25%			

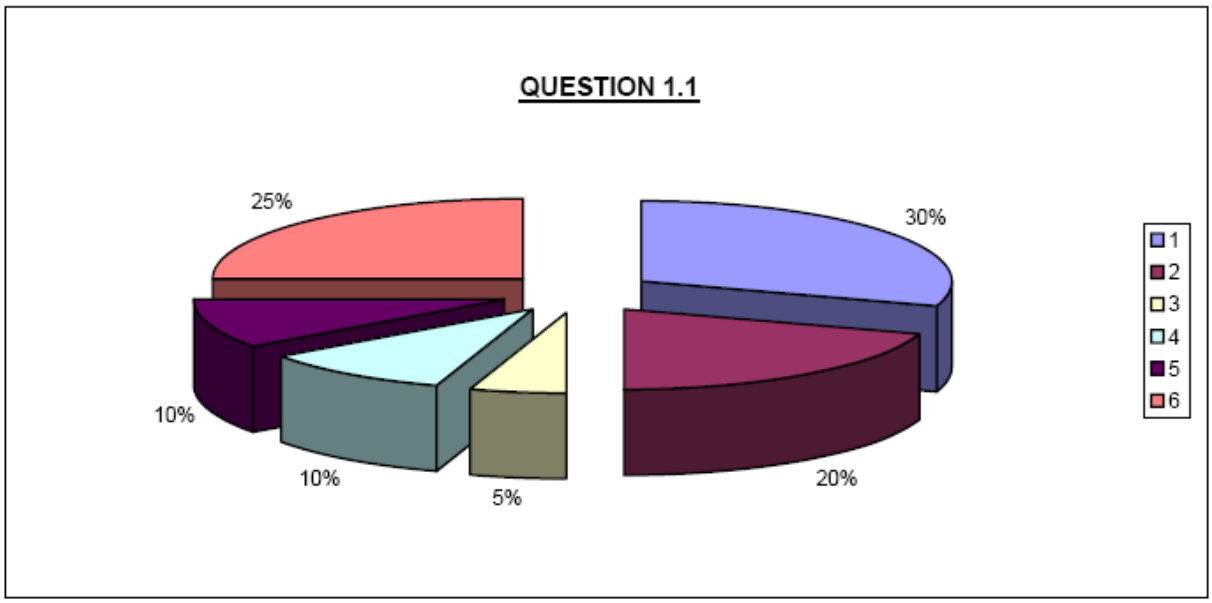


Figure 2: Interview question regarding interviewee position and experience

The team also utilized secondary research, which solely included internet research. This was done by the contact team to try to gain information on local coal-fired power plants in order to potentially set up interviews with them. The team also researched Smart Signal© via the internet to see how they present themselves on a marketing point to potential clients, and to help understand our scope.

6.3 Value of Results

Although, for most questions, there were significantly frequent answers, it is important to note that answers varied based on the particular plant interviewed and especially the specific personnel interviewed. Every plant runs a little differently and has different terminology for departments, personnel, and information sources. Every person in the plant has a different perspective on planned outages. For example, a Plant Manager answers the questions differently than an Engineering Specialist. The answers for the international interviews were also slightly different and affected the overall percentages. Also, some interviewees seemed to give the "ideal" answer to a question, which may not have gotten into the depth of what was actually going on in the plant. Some questions were not answered by many interviewees. However, some questions had several answers which affected the overall percentages. (Note: The percentage of answers for a particular question is based on the number of interviews conducted, not the total number of answers, therefore, the total percentage of answers for a single question can exceed 100%). Also, some interviewees may have failed to mention an answer, or perhaps, misinterpreted the question. The IPRO team remained objective and tried to ignore

any prior biased tendencies. Despite all these differences, the team compiled all the results with each interview weighted the same as the next. And still, the team was able to determine the overwhelming answers.

6.2 Research Findings

6.2.1 Planned Outage Defined

A planned outage is a previously scheduled time period during which a power plant completely shuts down in order to do repairs on equipment that is in need. Equipment is removed from service availability to perform inspections and for general overhaul of major plant equipment. The goal of a planned outage is to tend to as many equipment issues as possible, so that the plant can be up and running with optimum efficiency as soon as possible. Planned outages are usually scheduled around non-peak energy seasons, such as during the spring or fall, so as to maintain maximum power supply and therefore, maximum economic benefit. Many plants run on a 10 year Planned Outage cycle. Another goal of a planned outage is to prevent a forced outage or an unplanned outage from occurring. An unplanned outage is when a plant is immediately shut down due to equipment failure which results in power supply failure.

6.2.2 Plant Hierarchy

From the many interviews conducted, the IPRO team was able to come up with a basic hierarchy chart for a typical coal-fired power plant. As visible in *Figure 3* below, the plant manager is the supervisor of all plant employees. There are four basic divisions in the plant: the Operations Department, Maintenance Department, Equipment Department, and the Construction Department.

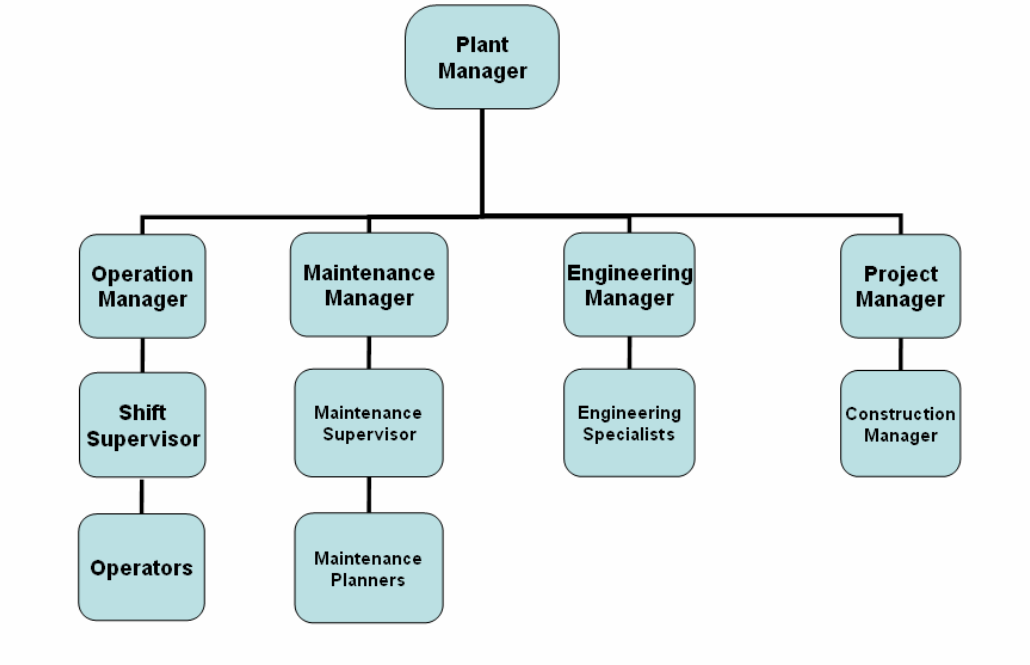


Figure 3: Basic Hierarchy Diagram

6.2.3 Plant Personnel Positions Defined

Plant Manager

Plant managers supervise the production of one specific good: Electricity. Power plants operate twenty-four hours a day, seven days a week, turbines churning out megawatt after megawatt of powerful, invisible current. Plant managers should know that the technical aspects of the job notwithstanding--managing power loads, controlling production and inventory, and handling the continuous maintenance chores--the heart of managing a power plant is managing people.

Operations Manager

The key responsibility is in fulfilling the requirements of the O and M contract and meeting the contractual obligations and commercial targets set for the plant. Other key responsibilities will include in optimizing plant safety and operations, optimizing the trading function, co-ordination of warranty issues with the OEM and enhancements to plant, effectively dealing with outside agencies and contractors, promoting and fostering teamwork and empowering and developing shift teams to deliver optimum operations capability.

Shift Supervisor

Shift Supervisor will direct the total operation of the station on their assigned shift. They ensure the safety of all employees and secure all plant assets. They direct and supervise the operation of boilers, turbines, generators and related auxiliary equipment, coordinates hourly loading, unit start-ups, shutdowns, etc, troubleshoots and corrects plant operating problems that arise from shift to shift, prioritizes and schedules equipment repairs and coordinates work with maintenance departments, both outage- and non-outage. Shift Supervisor will provide training on shift, prepares daily reports of shift operations, facilitates meetings, and performs human resource functions.

Operator

Operator will operate the power generation facility on a fulltime basis, and may be required to serve on an on-call basis as needed. They will operate and maintain the facility as necessary to maximize energy production, and provide prompt notification to Regional Manager if any part of the facility should be inoperable or otherwise damaged, or if an emergency situation should arise. Operator will operate and maintain the facility to a standard that shall prevent deterioration beyond normal wear, assist in developing and executing a preventative maintenance program that is site specific and equipment specific.

Maintenance Manager

Maintenance manager coordinates and supervises all maintenance functions necessary to ensure the efficient and reliable operation of the facility. He/she is responsible for maintaining and monitoring the plants preventive and predictive maintenance programs, using that data to adjust maintenance work procedures to meet scheduled production levels. Schedules all maintenance activities and provides technical direction for all plant equipment repaired. They manage plant projects as assigned by the general manager operations and interfaces with equipment vendors/suppliers as to required needs of the plant, delivery of materials and/or the availability of alternate sources of materials. Inspects completed work for conformance to blueprints, specifications and company standards.

Engineering Manager

Engineering manager is responsible for assuring the assigned systems performance, process, mission and vibration parameters are met. This requires a heavy interface with Design Engineering and Project to assure reasonable limits are established for engine parameters for the capability of todays and future process capability. They must provide the technical leadership role in Assembly to assure an effective interface with all levels of GE management. And they collaborate with manager in setting realistic and challenging operation goals and then contribute to their accomplishment. They do trend analysis of engine test parameters to assure assembly process is producing power plants to customer and specification requirements.

Project Manager

Project manager will direct and manage all aspects of multidiscipline projects for plant upgrades from inception through turnover to client including support of sales in defining project execution plan and, as needed, marketing services; developing organization structure for multidiscipline design team; managing the project schedule; initiating and reviewing engineering design, procurement, manufacturing, and subcontracting plans and implementation; manage project technical quality, financial controls and budget for profitability, schedule, and client relations; assist in negotiations with client and equipment services suppliers and contractors; and ensuring project communications and regular reporting to management.

Preventative Maintenance Supervisor (PMS)

This person checks the equipment during his shifts using oil analysis, vibrations etc. Then he also analyzes the data using software and historical information for the equipment to make a decision.

6.2.4 Plant Data and Information Sources Defined

Before and during the planned outage, a typical coal-fired power plant relies heavily on its input data from various sources to make effective decisions to keep the plant running.

Distributed Control System (DCS)

This system monitors the equipment throughout the day: checking temperatures, equipment monitoring though switches etc. The person monitoring all the equipment in DCS alerts the particular unit operator regarding the problem if something comes up.

Process Information System (PI)

All data and analysis on all equipment in the plant is stored the Process Information (PI) System which is easily accessible by anyone in the power plant for statistical analysis and historically based decisions.

Equipment Log

Equipment logs typically consist of trends of sensors and efficiency calculations.

Work Order

This is a list of all equipment having a problem. It denotes equipment for maintenance and use flags for priority such as red mark for immediate attention and green for later. Later, official decisions are made by significant personnel of the power plant to prioritize maintenance for the equipment on the work order. People making all the decisions also have to keep the budget in mind. They have a given budget for equipment maintenance for instances half a million and if more is required then corporate approval is needed by the plant manager. The corporate also keeps in touch with a few others like the engineering managers (usually managers).

6.2.5 Internal and External Factors affecting Equipment Maintenance

Internal factors apply specifically to the plant itself, including its personnel and data. External factors apply to how the plant survives among other plants and how it maintains clients. The reasons accounted by most of the plant personnel during interviews are the following:

Safety

Power plants can be a very dangerous place. If a piece of equipment can eventually become dangerous to plant personnel, it must be fixed as soon as possible.

Accessibility

If it is dangerous or impossible to repair equipment while the plant is up and running, and if it does not need to be immediately repaired, it can be added to the planned outage. Safety is an important issue in all power plants.

Budget

In a plant, or anywhere for that matter, budget is always an issue. Available financing and available labor is tightly budgeted in a plant in order to make the corporate heads happy and to maintain maximum economic efficiency of the plant. If the replacement part is very expensive for a particular piece of equipment, and there is no eminent rush on that equipment's repair, the management staff will postpone the maintenance to make time for financing and scheduling of it during a planned outage.

De-rating

The main goal of the power plant is to be up and running with out any unplanned outages. If a plant is forcibly shut down, the management staff may be forced to buy out another company's power in order to fill their own quotas. Instead of making money, the plant is spending it. This is very inefficient and is avoided by all power plants.

Efficiency

If the equipment is not fixed soon, will it affect the efficiency of the whole plant? The plant needs to be as efficient as possible. If it would be more effective to repair one piece of equipment over another, as regarding the overall plant efficiency, that equipment will be repaired and not the other.

Risk vs. Reward

Is it better to fix this part of equipment, or that part? The management staff must prioritize the many equipment work orders and determine which must be fixed and which can wait. They must decide which equipment maintenance can be pushed off with relative certainty that it will not affect the efficiency of the plant, or cause a forced outage. Once this is determined, they can finance and schedule for the repairs during the planned outage.

Availability

Availability applies to the available man-power resources, as well as the availability of equipment replacement parts. If a piece of equipment can wait to be repaired during a planned outage, the management staff will have time to plan and finance the equipment maintenance process.

Environmental

The government is very particular about what is released into the atmosphere by power plants. If a piece of equipment is malfunctioning and causing an increase in pollution into the environment, actions will have to be taken and the equipment must be fixed.

6.2.6 Major Steps for Planning an Outage

1. First, an Equipment Operator notices an alert by the DCS equipment, reviews the PI system, and discovers that the equipment is acting abnormally, or is near failing.

2. The Equipment Operator writes a work order for the broken equipment.

3. The Operations Manager or Engineering Specialist reviews the work order and discusses the problem with the Preventative Maintenance Specialist to determine if the equipment will be added to the list of equipment repairs for the planned outage.

4. The Preventative Maintenance Specialist runs further analysis on the equipment.

5. A Maintenance Meeting is held on a weekly basis.
   5.1. The Operations Manager, Engineering Specialists, Preventative Maintenance Specialist, Maintenance Manager, and the Shift Supervisor are present.

5.2. The goal of the meeting is to prioritize the work orders and determine which equipment must be fixed, and which can wait.
5.3. If the equipment is agreed to be fixed during the planned outage, it is added to the schedule by the Construction Manager.
5.4. The basic factors for determining whether equipment will be worked on immediately, during the planned outage, or not at all include:
    5.4.1. Accessibility
    5.4.2. Availability
    5.4.3. Risk vs. Reward
    5.4.4. Budget
    5.4.5. Safety
    5.4.6. Environmental
    5.4.7. Efficiency
    5.4.8. De-rating

6. Outage Planning Meetings are held for 6 months prior to the planned outage.
    6.1. The Operations Manager, Engineering Specialists, Preventative Maintenance Specialist, Maintenance Manager, Shift Supervisor, and Planners are present.
    6.2. The goal of these meetings is to reevaluate the planned outage schedule and equipment that will be fixed and which will not.
    6.3. Final changes to the schedule will be made by the Construction Manager.

7. During the planned outage:
    7.1. The Operations Manager, Engineering Specialists, Preventative Maintenance Specialist, Maintenance Manager, Shift Supervisor, and Planners meet everyday.
    7.2. The goal of these meetings is to determine the status of the planned outage and become up-to-date on what has been fixed.
    7.3. Any new equipment problems that developed during the outage will also be discussed in these meetings.

6.2.7 Key Plant Personnel during a Planned Outage

The key decision makers during a planned outage include the Engineering Specialists, Operations Manager, and the Preventative Maintenance Specialist. From the interviews done, 50% of the interviewees stated that the Operations Manager decides which equipment will be maintained and another 50% stated that the Engineering Specialists make the decisions. These percentages are displayed below in *Figure 4*. 25% of the interviews concluded that the Planned Outage Manager was a key decision maker. However, several interviewees stated that if a decision cannot be made due to uncompromising parties, the final say goes to the Operations Manager, or the Plant Manager.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager	20%
2	Planned Outage Manager	25%
3	Shift Supervisor	5%
4	Operations Manager	50%
5	Maintenance Manager	20%
6	Unit Engineer/Specialist	50%
7	Equipment Operator	5%
8	Maintenance Technician	10%

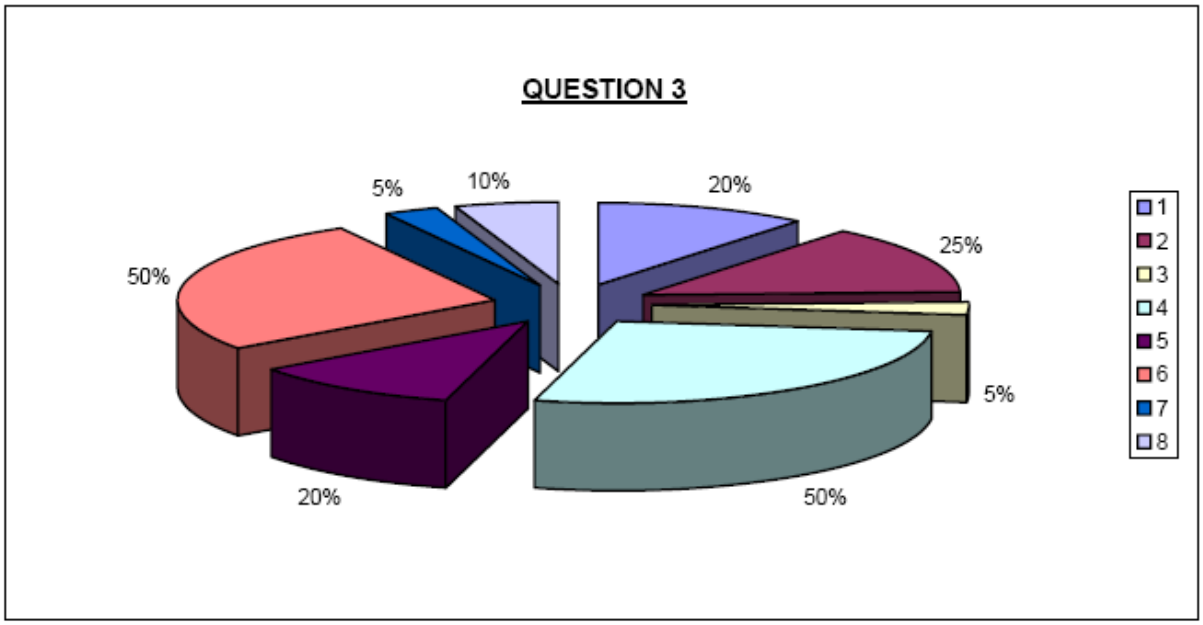


Figure 4: Interview question regarding who makes the decisions for equipment maintenance.

6.2.8 Key Information Sources used in a Planned Outage

The key information sources used to select which equipment will be fixed and which will not primarily included the work orders (55% of interviewees agreed) and routine meetings (35% of interviewees agreed). Work orders are, as stated above; made initially by Equipment Operators, who make the order based on the trends shown in the DCS system, PI system, and equipment logs. As shown in *Figure 5* below, 65 % of interviewees agreed that equipment logs are the primary source of information for making equipment maintenance selections during a planned outage. This was followed by Equipment Operator suggestions at 40% and Diagnostic Computer Software at 20%.

(6) What information do you use to make the selection?

1	DCS Equipment Warnings	5%
2	Diagnostic Computer Software (i.e. Smart Signal)	20%
3	Equipment Logs	65%
4	Equipment Operator Suggestions	40%
5	Preventative Maintenance Specialist Suggestions	15%
6	Maintenance Technician Suggestions	10%
7	Industry Contacts	15%

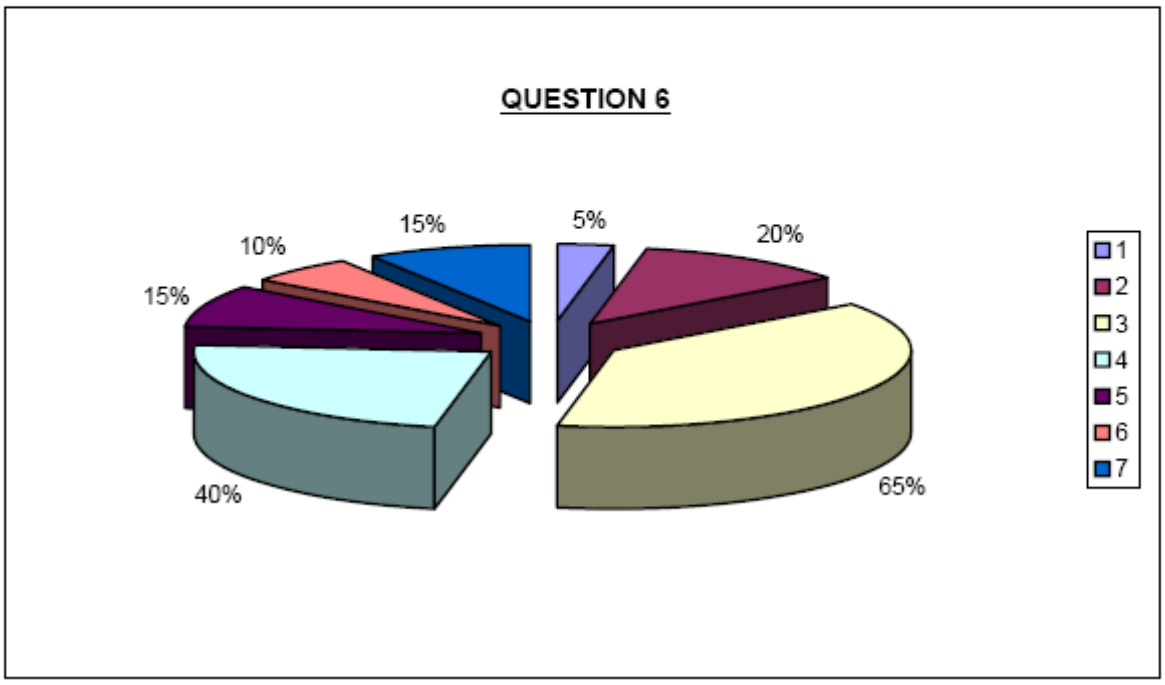


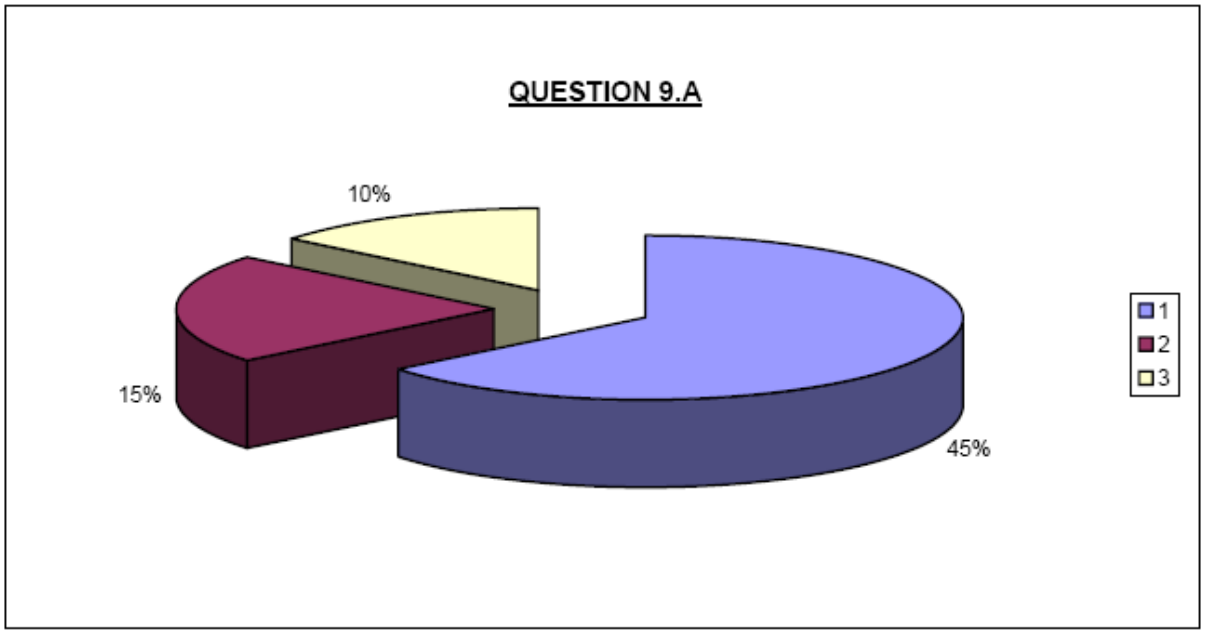
Figure 5: Interview question regarding what information is used in making decisions.

6.2.9 Key Factors affecting a Planned Outage

Figure 6 below clearly depicts the most effective internal and external factors. 45% of the interviewees agreed that economic factors were critical, both internally and externally. Internally, the availability of employee resources as well as information resources took 15% of the interviewees' votes. Externally, 30% of the interviewees stated that the government control of the plant affected decisions when planning an outage. This is mostly due to the influence of the Korean power plant interviews, because these plants are all headed by the Korean government.

(9) What other factors do you take into consideration?

(9.A) Internally?		(9.B) Externally?	
1 Economic	45%	1 Governmental	30%
2 Availability of Resources	15%	2 Economic	45%
3 Safety	10%	3 Availability of Resources	25%



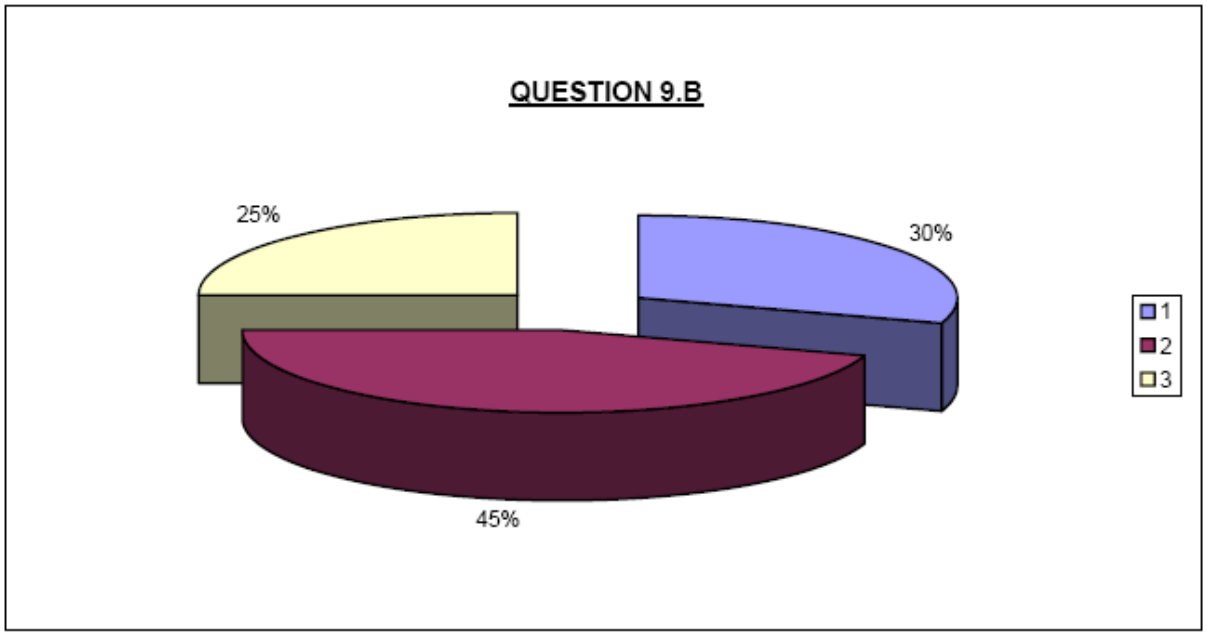


Figure 6: Interview question regarding factors affecting equipment selection.

7.0 CONCLUSIONS

7.1 Simplified Findings

Based off the interviews, the IPRO team was able to narrow down the key players, key information sources, and key factors that go into planning and managing a planned outage. This information gets to the heart of the sponsor's objectives. The main decision makers in preparing for a planned outage are the Operations Manager and the Engineering Specialists. The vital information sources for making the decisions are Work Orders and Routine Meetings. The most influential factor affecting the decisions is economical issues.

7.2 Unsuccessful Planned Outages

Many of the people who were being interviewed admitted that they have encountered problems with unexpected equipment maintenance after the planned outages. They claimed that there is never enough people to catch all potential equipment problems and there is never enough money to tend to these problems.

7.3 Implications of Conclusions for Smart Signal©:

The interviews proved the necessity of the sponsor's product. Most plants admitted that planned outages often result in unfinished work and/or more equipment problems. Better data sources could help a planned outage run more smoothly and help with the decisions made on whether or not to fix defective equipment.

8.0 RECOMMENDATIONS

The next steps that should be taken by the sponsor or future IPRO teams include:

- Conduct follow-up interviews with the same plants.
- Speak specifically with Operations Managers, Engineering Specialists, and Preventative Maintenance Specialists.
- Focus the questioning specifically on what the most effective type or format of data would be useful in planning an outage.
  - How do these people wish to receive data on the equipment?
  - What specific information do they want on the equipment?
  - Do they want it prioritized?
  - What would be the most effective tool in making a planned outage run smoothly and effectively?
  - How can Smart Signal© provide this?

If these questions can be answered, than the goal of the sponsor can be reached.

9.0 REFERENCES

10.1 Local Power Plant Contacts

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APPENDIX A

Interview Questions

General Information:

Power Plant Company: _____

Power Plant Name: _____

Power Plant Location: _____

Relative Size of Plant: _____

Interviewee Name: _____

Interviewee Occupation: _____

Interviewer: _____

Note Takers: _____

_____

Date: ____/____/ 2007____

Script:

Hi. My name is _____. I am a student at the Illinois Institute of Technology in Chicago, Illinois. I am part of a research group that is studying how planned outages are executed in coal-fired power plants. We are working to develop an understanding of what information is needed prior to a planned outage, how various people in the plant are involved in the planned outage, and how decisions are made regarding equipment maintenance during a planned outage. Would it be okay if I ask you a few questions about your job and the power plant that you work at? And, I would like you to know that everything we discuss is for research purposes only and will be kept confidential. Also, please, answer only the questions you are comfortable with.

General Questions:

(1) Please describe your position (or job), background, and plant experience.

(2) How are you involved with day-to-day operations in the plant?
(What does that mean?)

(3) Who selects the equipment to be maintained during a planned outage?

(4) How do they make that selection?

(5) How are you involved in making those selections?

(6) What information do you use to make the selection?
(Machine Data, Other People's Input)

(7) How do you get this information?

(8) What analysis do you use on that information?

(9) What other factors do you take into consideration?

(a) Internally?

(b) Externally?

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

IPRO 303: Interview Data Analysis

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert
2 Planned Outage Manager	2 Very Experienced
3 Shift Supervisor	3 Experienced
4 Operations Manager	4 Some Experience
5 Maintenance Manager	5 Novice
6 Unit Engineer/Specialist	

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant
2 Planned Outage Supervision	2 A lot
3 Operations Supervision	3 Somewhat
4 Maintenance Supervision	4 A little
5 Unit Supervision	5 Insignificant

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

(5) How are you involved in making those selections?

1 Supervises	1 Significant
2 Decides	2 A lot
3 Advises	3 Somewhat
4 Informs	4 A little
5 Listens	5 Insignificant

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

APPENDIX B

Interview Data

IPRO 303: Interview Data Analysis

Interview: A

Interviewer(s): Jamie Amber, John Rhoda, Mohammed Rehman

Date: 22 Febraury 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Manages two different power plants.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes:

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Operators decide if unit can come back online at lower load or if it must be fixed right away. Maintenance crew does rounds and meets with shift supervisor to decide priority of maintenance.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: For smaller issues the shift supervisor and maintenance scheduler meet to decide importance of issue. Data is given to shift supervisor in the form of a work order done by the people on the equipment.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: Plant manager gets called if the DCS reports a failure.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Maintenance Manager keeps an "Equipment Decision Assessment" log and monitors important equipment and submits monthly reports. Unit Operator monitors DCS equipment "eyes and ears" first to know of a failure. Predictive Maintenance Specialists- monitors equipment on a regular basis, mainly manually but also uses DCS for some constant readings (vibration) no degree. A pending list of "forced outage" issues is kept for downtime.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: There is a weekly meeting with the managers to discus any maintenance issues.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes:

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes: Plant Manager meets with Marketing to decide if the market will be good for downtime. If the issue presents a safety issue the market is not taken into account.

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: B

Interviewer(s): Everyone

Date: 8 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Preventative Maintenance Specialist; in charge of monitoring equipment for symptoms of impending failure and performing diagnostics as requested

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: See note for (1)

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Usually a group decision. Each specialist champions their station, but has to cost-justify any work requested.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes:

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: Provides information and analysis to the specialists when needed.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Industry Contacts in this case means within the fleet

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Usually is the one giving the information.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Efficiency trends, too

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Externally) Fleet status—can't have too many plants down at once

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Usually just goes on next list

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: C

Interviewer(s): Michael Hatch, Kevin Lyles, Sarunas Palikevicius, Kevin Tung

Date: 27 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Operations manager for 2.5 years. Operations manager previously for 2.5 years. Engineering manager 2.5 years. Incident and controls engineer 6 years. Graduated from UIC in '94 w/ EE degree. US Navy Nuclear trained submarine electrician.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Overseeing day to day operations at a high level. Set priority of things, helping supervisors keep focus on their shifts during shift changes. Works from 5:30AM to 3:30PM.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Operators always check the machinery. Operators are those that are out in the field, they make the first call on equipment maintenance. Then the supervisors, planners, and specialists consider the equipment. Typically specialists are in charge of their own equipment and area. Operations managers can override decisions but for the most part it is a group planning effort. Planners and Shift supervisors go back and prioritize equipment to be maintained.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: If there is an equipment problem, work order is filed. Work order backlog, preventative maintenance schedule, time maintenance information from previous outage inspection reports.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: Help guide things.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: History of failure, planned maintenance schedules. Look at degrading performance. Look at trends on the equipment. Check for irregularities.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes:

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Priority is considered. Priority 3 is the lowest priority. There is no rush for priority 3. They look at the list of things and their priorities and decide which equipment goes into a planned outage. PI system – allows numerous people to view equipment sensors at one time. PMACS – software package for calculating performance of boilers. Efficiency vs. load calculations.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: Projects typically go into an outage since it affects so many processes. Externally – recommendation from corporate experts. Budget cuts restricts the amount of work. Market prices. If market prices are high, outage is shifted, shortened, or canceled. Availability of craft labor for maintenance. Holidays – cost involved w/ paying staff over the holidays.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: All the time, some are from existing problems, some are new problems that arise because of the outage. There aren't too many startups to judge from.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes: Resources biggest thing, can't have everyone watch everything. Minor work is usually cut first, not possible to do all the work during the outage. There are longer planned outages to take out larger chunks of the work backlog, but it is never cleared.

IPRO 303: Interview Data Analysis

Interview: D

Interviewer(s): Michael Hatch, Kevin Tung

Date: 5 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: ME degree and MBA in charge of entire facility, production, budget, safety, environmental concerns, plant manager

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Approval authority for purchases. Safety and welfare of people working here. Maintenance of equipment.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Engineers technically, but they have a running list of items they must fix when they shut down. Operations maintains the list and makes sure they have the equipment on hand.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: One of the best sources of information is the daily morning status meetings with maintenance and engineering.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: He maintains oversight from his position in the equipment selection. Plant manager deals with a dead tie.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Engineers select equipment.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: One of the best sources of information is the daily morning status meetings with maintenance and engineering.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: History determines whether they need to take a look at it. Vibration analysis frequently, some equipment is monitored constantly. Oil analysis on rotating equipment, gives info about condition of bearings and etc. Thermography to look for hot spots. Equipment most critical to operation is worked on first. Then they also look for additional funding.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) Sometimes impacted by other units in a fleet that are in outages. (Externally) Don't want to do outages during peak season. Outages are planned during spring and fall when power demand is low.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: They can't see everything in an outage. They repair as much as they can during an outage. There are often surprises that require immediate change in plans/resources. Not always analysis that could be performed to prevent it.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: E

Interviewer(s): Michael Hatch, Kevin Lyles, Kevin Tung

Date: 5 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert
2 Planned Outage Manager	2 Very Experienced
3 Shift Supervisor	3 Experienced
4 Operations Manager	4 Some Experience
5 Maintenance Manager	5 Novice
6 Unit Engineer/Specialist	

Notes: Engineering manager @ Waukegan plan. Coal fired plant 789MW on site. Approx. 200 employees. Owned by Edison Int'l, 3 or 4 departments (Operation, Maintenance, Engineering, Constructions). Approx 15 years at current job. About 30 years altogether at power plants. Operations department, maintenance department, supervisor, worked nearly all of the positions. ME degree, MBA, registered P.E. in IL.

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant
2 Planned Outage Supervision	2 A lot
3 Operations Supervision	3 Somewhat
4 Maintenance Supervision	4 A little
5 Unit Supervision	5 Insignificant

Notes: 8 people under him, mostly engineers. Some have technical degrees. All people assigned to different processes. (controls, turbines, coal handling, and etc.)
Also known as process specialists. They all help coordinate planned outages. They are there to support maintenance and operations groups technically. They look down the road to help planned outages. They have a more long term outlook. Each specialist has to know what goes on in their own area. Everybody has access to PIH system containing trends, displays, analysis. PDM does vibration analysis. He physically measures vibrations, does thermography, oil analysis to check viscosity, metals and water percentage.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: In a dead tie, the stations director is ultimately responsible for operation of the facility and the engineering manager is responsible for the budget. Construction planner – organizes and schedules all the outages, he collects work orders, holds a meeting with everyone involved, he is the organizer/meeting chair. Process specialists will make their case. Ultimately in a deadlock, it would probably go to the station director, but usually a consensus is formed.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: A work order is made when a problem arises. Anyone can write a work order, it goes into an outage queue.

(5) How are you involved in making those selections?

1 Supervises	1 Significant
2 Decides	2 A lot
3 Advises	3 Somewhat
4 Informs	4 A little
5 Listens	5 Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Operators – look, listen, touch machinery. They flag engineers when they suspect a problem.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes:

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: PDM – vibration and oil analysis, thermography. Historical information – Process Specialists know this information.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) In the years between, summer peaking area is a critical time for units to be available. Approximately 10 days to tune up around April and May and work on items to prepare for the summer. Over the last year or so, this was not done quite as much anymore, power price fluctuates. They are an independent power producer, they sell mostly to Commonwealth. They sell power into deregulated power pool run by PJM – nonprofit entity that run the auctions. Commonwealth prices are set however. Outages are run by corporate, and they coordinate the planned outages of the fleet. (Externally) Foreign markets are another external factor.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Most unexpected problems arise during the outage when they open a piece of equipment, sometimes there are unexpected results. There is an industry trend to have less spare parts available.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: F

Interviewer(s): Michael Hatch, Kevin Tung

Date: 5 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert
2 Planned Outage Manager	2 Very Experienced
3 Shift Supervisor	3 Experienced
4 Operations Manager	4 Some Experience
5 Maintenance Manager	5 Novice
6 Unit Engineer/Specialist	

Notes: I have 32 years experience. All in operations. 1 year in the Coal Yard. 11 years as a Control Room operator. 13 years supervisory experience. 5 years in upper management. I have worked for 3 month periods for several years in the maintenance portion of the power plant, coal yard, Boiler feed pump, Main turbine/generator, and electrical relay department.

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant
2 Planned Outage Supervision	2 A lot
3 Operations Supervision	3 Somewhat
4 Maintenance Supervision	4 A little
5 Unit Supervision	5 Insignificant

Notes: I manage the operating department. I have 2 supervisors out here around the clock that that make immediate decisions and then they report problems and concerns to me for further direction (Coal yard and Power Block). Total of 10 supervisors, but there are always 2 at hand. The operating department determines 1) day to day maintenance priorities 2) load dispatch requirements 3) fuel handling 4) Waste water and boiler water chemistry 4)

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: The leadership staff (mostly Engineering and Operations) In engineering, each guy is in charge of an area. The make recommendations on what to maintain. There is a day to day assessment of the plant in the leadership group. Corporate direction in equipment life cycles. Corporate is quite involved. They follow a lot of warranty guidelines, manufacturers' guidelines for maintenance. Corporate sets a lot of the cycles for repair.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: Priority work orders. Preventive maintenance. System/equipment upgrades (outdated technologies).

(5) How are you involved in making those selections?

1 Supervises	1 Significant
2 Decides	2 A lot
3 Advises	3 Somewhat
4 Informs	4 A little
5 Listens	5 Insignificant

Notes: Approval. Suggestions. In a dead tie, the station director makes the ultimate decision, but the leadership group makes approvals and sets priorities.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Life cycle data and best practices. Subject matter expert recommendations. There are also vendor recommendations. The warranties are long gone, but manufacturers will send out technical letters to inform stations about the trends among other equipment in other places.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes:

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Engineering reviews.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: The outage schedule is approved by PJM (area load dispatcher), they have to have so many MW available on the system at any time. PJM has to follow govt guidelines. FERC - federal energy regulating commission, determines if plants can go down.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Happens on and off. Not typically, they do a lot of checks from time to time. Most of the problems found are when inspecting equipment during a planned outage.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: G

Interviewer(s): Kevin Tung

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Specialist		

Notes: Process specialist. 7 years @ Waukegan, 10 years previous, 13 years operations background

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Unit Supervision	3	Somewhat
4	Unit Specialist	4	A little
5	Equipment Operator	5	Insignificant
6	Maintenance Engineer		

Notes: Oversees different processes within the plant. Rotating equipment, fluid drives, feed pumps. Assistant to turbine and boiler specialist. Uses numerous monitoring programs. Alarms get sent to him. Walks around seeing how equipment performs live.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Specialist
7	Equipment Operator
8	Maintenance Engineer

Notes: Majority of decision making in group. PDM recommends. Most of the time maintenance is performed. They look at history on equipment, time cycle for the equipment.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes:

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Preventative Maintenance Specialist Suggestions
5 Equipment Operator Suggestions
6 Maintenance Worker Suggestions
7 Industry Contacts

Notes:

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: efficiency testing, benchmarks, see how equipment performs over time

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economicly Based
6 Hands-on (i.e. physically checking equipment)

Notes:

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Maintenance
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) (Externally) summer time is the peak season. Off season is easier to maintain. Economics - certain budget that has to be withheld

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: problems usually triggered by shutdown or startup

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: H

Interviewer(s): Kevin Tung

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert	
2 Planned Outage Manager	2 Very Experienced	
3 Shift Supervisor	3 Experienced	
4 Operations Manager	4 Some Experience	
5 Maintenance Manager	5 Novice	
6 Unit Specialist		

Notes: Shift Supervisor / Operations planner. 22 years electric generation. @ plant 7 years

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant	
2 Planned Outage Supervision	2 A lot	
3 Unit Supervision	3 Somewhat	
4 Unit Specialist	4 A little	
5 Equipment Operator	5 Insignificant	
6 Maintenance Engineer		

Notes: oversee a crew of 12 - 15 operators. Operations planner, focus on work requests and prioritize w/ planners

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Specialist
7 Equipment Operator
8 Maintenance Engineer

Notes: process specialists. What kind needs periodic maintenance, also decides what eeds to be worked on through data. Operations - sets priorities on stuff that needs to be fixed.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: group - process specialists, engineer, station management, operations and construction. History, experience, data, present condition of the equipment

(5) How are you involved in making those selections?

1 Supervises	1 Significant	
2 Decides	2 A lot	
3 Advises	3 Somewhat	
4 Informs	4 A little	
5 Listens	5 Insignificant	

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Preventative Maintenance Specialist Suggestions
5 Equipment Operator Suggestions
6 Maintenance Worker Suggestions
7 Industry Contacts

Notes: machine data, PI data, experience, can plot stuff over time

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes:

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economicly Based
6 Hands-on (i.e. physically checking equipment)

Notes:

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Maintenance
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) made mainly by operations. Is equipment working as designed (Externally) information from process specialists and engineers. Does it affect overall MW output. Anything environmentally impacted. Safety related. Safety -> Environmental -> MW output

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: yes typically when you cycle a unit, expansion and etc. causes problems. Limited by budget and time

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes: if problem was never submitted through work management process

IPRO 303: Interview Data Analysis

Interview: I

Interviewer(s): Kevin Tung

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1 Expert
2	Planned Outage Manager	2 Very Experienced
3	Shift Supervisor	3 Experienced
4	Operations Manager	4 Some Experience
5	Maintenance Manager	5 Novice
6	Unit Specialist	

Notes: Senior Planner (Construction / Outage) takes care of outage schedule. Runs contractors. 28 years in plant business. 17 years in coal, 11 in nuclear. Mechanic starting out.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1 Significant
2	Planned Outage Supervision	2 A lot
3	Unit Supervision	3 Somewhat
4	Unit Specialist	4 A little
5	Equipment Operator	5 Insignificant
6	Maintenance Engineer	

Notes: day to day w/o outage: following small group of contractors. Keeping large schedules updated. Day to day w/ outage: run outage meetings - every Tuesday and Friday for about an hour. Process specialists, maintenance forement, operations, and senior leadership. run contracting crews. interface with operations.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Specialist
7	Equipment Operator
8	Maintenance Engineer

Notes: Operations determine things that are broke that need to be fixed. Process specialists know what preventative maintenance is coming up.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: first, set duration in planned outage. Know how much manpower is available. Make sure it fits into the timeframe. Second, impact of operations on plant . Importance of equipment. Prioirty of things to do.

(5) How are you involved in making those selections?

1	Supervises	1 Significant
2	Decides	2 A lot
3	Advises	3 Somewhat
4	Informs	4 A little
5	Listens	5 Insignificant

Notes: work orders are classified as operational or scheduled outages. He takes care of scheduled outages work orders. Her runs outage meetings, directs everyone.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Preventative Maintenance Specialist Suggestions
5 Equipment Operator Suggestions
6 Maintenance Worker Suggestions
7 Industry Contacts

Notes: biggest thing is how it affects operation

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: sitting in meetings, talking to everyone getting everyone's input. Senior leadership takes charge ultimately

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economicly Based
6 Hands-on (i.e. physically checking equipment)

Notes:

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Maintenance
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) (Externally) manpower. Has to interface with maintenance department. If there is not enough manpower. He sets up contractos and laborers.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: yes, problems arise when equipment gets opened up. Added scope to maintenance can impact job duration and manpower issues

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: J

Interviewer(s): Jamie Amber, Sarunas Palikevicius

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert
2 Planned Outage Manager	2 Very Experienced
3 Shift Supervisor	3 Experienced
4 Operations Manager	4 Some Experience
5 Maintenance Manager	5 Novice
6 Unit Engineer/Specialist	

Notes: Position:1) Planner – electrical instrument

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant
2 Planned Outage Supervision	2 A lot
3 Operations Supervision	3 Somewhat
4 Maintenance Supervision	4 A little
5 Unit Supervision	5 Insignificant

Notes: Ex. Pump breaks, he writes work order. This planner mostly goes through existing work orders, although he does make some work orders as well. All planners go through work orders to determine if they can fix it online.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: Engineering manager looks at the list of work orders on a planned outage plan, as well as plant manager.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: Operations group tells which one gets done first, in monthly meetings.

(5) How are you involved in making those selections?

1 Supervises	1 Significant
2 Decides	2 A lot
3 Advises	3 Somewhat
4 Informs	4 A little
5 Listens	5 Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Work order and people on the plant, also based on limited budget

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: He receives information form accountant who generates list from all planners

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: if work order can be done online than it will be taken out of outage plan and will be done while power plant is running

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: Answer not provided

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: No answer

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: K

Interviewer(s): Jamie Amber, Sarunas Palikevicius

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist

1 Expert
2 Very Experienced
3 Experienced
4 Some Experience
5 Novice

Notes: Position: Instrumental Engineering Supervisor (Part of maintenance).

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision
2 Planned Outage Supervision
3 Operations Supervision
4 Maintenance Supervision
5 Unit Supervision

1 Significant
2 A lot
3 Somewhat
4 A little
5 Insignificant

Notes: Instrumentation control and analytics. Service equipment. Thermography.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: They select if anything needs to be fixed while running.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes:

(5) How are you involved in making those selections?

1 Supervises
2 Decides
3 Advises
4 Informs
5 Listens

1 Significant
2 A lot
3 Somewhat
4 A little
5 Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: 4) Temperature measurements of steam and metal. Optimize trade offs. They receive information through DCS, operations, unit operators.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Operators call them directly if something comes up.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: If it burned, replace it

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes: (Internally) Optimize trade offs

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: No answer was provided (Sarunas guess - it always happens)

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes: Sarunas guess - limited budget

IPRO 303: Interview Data Analysis

Interview: L

Interviewer(s): Jamie Amber, Sarunas Palikevicius

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Position:Maintenance planner. He's been working for 30 years.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: He inputs work orders also materials and services needed to get the work orders done.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: Project manager puts a list of work orders in MS Project for Master Outage Plan

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: Preventive maintenance gives reminders for work that is outage and non-outage. Operators can go to shift supervisor to generate work order, shift supervisor determines priority of work order. Technical staff is responsible for major changes to equipment.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: Evaluates equipment. Reviews work orders twice a week along with shift supervisor, maintenance lead, technical staff, electrical and mechanical engineers.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Vendor information. He relies heavily on specialist data. Specialists monitor their own equipment. Operators monitor equipment also.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Shift supervisor informs him in the morning, he also has a list of work orders from online MS Project.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: He has vibration specialist and others. Contractors might get involved also. He gets players needed to solve problem, or evaluate equipment.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: Nothing to add here

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Additional problems might come up during an outage as well. Work orders are added continuously; never know what will be added in the next hour.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: M

Interviewer(s): Michael Hatch, Kevin Lyles, Sarunas Palikevicius, Kevin Tung

Date: 27 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1 Plant Manager	1 Expert
2 Planned Outage Manager	2 Very Experienced
3 Shift Supervisor	3 Experienced
4 Operations Manager	4 Some Experience
5 Maintenance Manager	5 Novice
6 Unit Engineer/Specialist	

Notes: General supervisor of mechanical maintenance at 1000MW coal generating units, both cyclone fired. In charge of all mechanical maintenance in the plant, welders, repairmen, mechanics. Anything to do w/ the taking care of the power plant. Been in the business for 37 years, started at operations and worked his way up.

(2) How are you involved with day-to-day operations in the plant?

1 Plant Supervision	1 Significant
2 Planned Outage Supervision	2 A lot
3 Operations Supervision	3 Somewhat
4 Maintenance Supervision	4 A little
5 Unit Supervision	5 Insignificant

Notes: Coop w/ operations supervisor every day. His department supports the running of the station.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: Operations supervisor will be involved in it, he will be involved in it, planned acct, engineering, electrical.
Using a lot of experience, he has a pretty good idea of what will work and not work. Collaborative effort with operations supervisor and engineering. Talk to industry, other power stations, other groups, find out their experiences.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes:

(5) How are you involved in making those selections?

1 Supervises	1 Significant
2 Decides	2 A lot
3 Advises	3 Somewhat
4 Informs	4 A little
5 Listens	5 Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Start out with a wishlist, pairing out stuff that have to be done and stuff that can be without. If want to replace, he'll contact others in industry to find out their experience. Computerized maintenance management system. Computer based monitoring, vibration checks, oil analysis. Look at how many hours it has run. Infrared.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes:

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Look at historical information at first, look frequency of repairs, how much spent on repairs, how much spent on inefficiencies(derates). See how much they can fit in w/ a fixed amount of money. Constantly trying to come close to budget. Then consider how much money to invest, repair or replace. Everything they do is to minimize operations and maintenance costs.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) Part of the corporate goals is to maintain shareholders investment. Make sure all parts are in stock. Make sure that there is a tracking system to look over the work of contractors. (Externally) Availability of materials can steer a decision. Availability of skilled manpower, boilermakers, electricians. Starting to get a real shortage of skilled people. Plan work when other companies are not scheduling any work to get the best work force possible. Copper, iron, and steel are becoming short on hand. Raising prices of raw materials for parts. Economical reasons.

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Always find a surprise in an outage. Sometimes there is money to fix it. Sometimes money is deferred from another project. Used to not constrained about economic issues and planning ahead. Studying history and doing homework seem to lower these mishaps.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes: Yes, frequently happens. Human performance issue a lot of the time. Lots of monitoring equipment, sensors everywhere. Forgetting to tell people about a problem or not caring some day. Sometimes information is interpreted by someone else. What really makes a planned outage successful is a good work schedule. Need expertise of qualified hands. Actual planning and scheduling, what jobs to do on what day, is the heart of the planned outage.

IPRO 303: Interview Data Analysis

Interview: N

Interviewer(s): N/A

Date: 29 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: I am currently the plant manager and the majority of my career has been spent in the operations department from shift supervisor to superintendent. I was an engineer and supervisor in the first few years of my employment. I also have a BSEE and MBA.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: The majority of the day to day operations is under the operation and maintenance departments. Problems associated with load reduction, regulatory issues or removing units from service are brought to my attention for discussion and approval.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Work to be completed on a planned outage is determined by the maintenance planners with input from operations, maintenance and technical specialists.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: Outage work orders are divided into repeat and single outage. A repeat outage work order is a Preventative Maintenance (PM) task that can only be completed while the unit is off line. Single outage work orders are repair jobs of equipment. Other single outage work orders may be generated from reports written during an inspection on a previous outage. Boiler repairs fall into this category.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: My major involvement is working with specialists to determine repair work to improve efficiency and availability. This involves the reviewing of the reports and budgeting of the proper resources to complete the task. In the event work has to be deleted in order to complete the outage on schedule, I am involved in the cutting process or the final decision if the outage should be extended.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Many tools are utilized to make these selections including oil sampling, vibration analysis, Plant Information software, employee input, and OEM recommendations to name a few.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Communication in a variety of meetings is the primary method.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Financial analysis is not done on outage work unless a major capital expense is being considered. Risk analysis is completed to determine if postponing work increases the probability of unplanned outages.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes: The price of power on the open market is considered in all decisions.

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Yes. The cause of missed work is usually request which arrive after the unit is off line and the planners were not aware of the situation.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: O

Interviewer(s): N/A

Date: 29 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1 Expert
2	Planned Outage Manager	2 Very Experienced
3	Shift Supervisor	3 Experienced
4	Operations Manager	4 Some Experience
5	Maintenance Manager	5 Novice
6	Unit Engineer/Specialist	

Notes: I am the "Manager – Outage/Project Management". I am responsible for the processes by which we manage our planned outages in our major steam power plants. I have 3 outage managers reporting to me. They manage matrix organizations built from plant and engineering staffs, as well as a number of contractors. I have two major contractor organizations with long-term service agreements.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1 Significant
2	Planned Outage Supervision	2 A lot
3	Operations Supervision	3 Somewhat
4	Maintenance Supervision	4 A little
5	Unit Supervision	5 Insignificant

Notes: My view is long-term (1-5 years) for the planned outages where we perform major projects involving large contracted workforces. The short-notice maintenance outages (to perform repairs on newly emergent and urgent problems with some latitude in scheduling) and the forced outages are managed by the local staff, since the contracted resources are typically minimal.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Each plant has seven "system teams" who each review the equipment condition in the plant. Each team determines their long-term budget and needs, and refines the scope of the outage. Each system team has a combination of skills (maintenance, engineering, operating, electrical, technical).

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: Some work is performed because of insurance requirements, such as 2-year inspection cycles for boilers and 8-year inspection cycles for turbine/generators. There are other annual inspections as well, based on experience. Some equipment has a known life, for example, one year on burner nozzles. Also, a combination of predictive techniques is used. Those include thermography, vibration analysis, and oil analysis. Major projects are based on changing environmental regulations, end of life determinations by our engineering staff, or improvements in efficiency.

(5) How are you involved in making those selections?

1	Supervises	1 Significant
2	Decides	2 A lot
3	Advises	3 Somewhat
4	Informs	4 A little
5	Listens	5 Insignificant

Notes: My processes and staff are responsible for proper execution of work. Project selection of work scope is by the plant and engineering staff.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: A combination of visual inspections, vibration data, oil analysis, insurance requirements, thickness checking, replica testing of headers, inspection for cracks in pipes and headers, eddy current testing on heat exchanger tube bundles during outage, and in some cases equipment failures. Those larger projects are limited by budget constraints.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: We have engineering and technical staff responsible for monitoring the health of equipment, reviewing insurance requirements, reviewing industry experience, performing inspections. They are part of the system teams, or work to support the system teams.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Our technical staff uses vibration monitoring equipment, oil analysis is done by an outside firm, and boiler inspections are performed by our engineering staff. In some cases, instrumentation monitors condition of equipment.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes: (Internally) Budget, budget, budget. (Externally) Available craft labor, environmental regulations, available time in the generation plans (to minimize replacement power costs and assure adequate capacity for the system).

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes: Yes, but this is fairly rare. More often post-outage problems are the result of planned outage activities incorrectly performed, such a marginal welds or improper assembly of equipment.

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes: Usually it is something minor that has major impacts – for example - workmanship on a bolt tightening, QA inspection of a weld.

IPRO 303: Interview Data Analysis

Interview: P

Interviewer(s): Migun Choi, Taeho Hwang, Chi Hwan Lee

Date: 21 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Position: Generation of electric power Chief, Tae An Power Plant Headquarter. Back ground: Seoul National University of Technology Mechanical Engineering. Plant experience: Il san Heating Power Plant 5 years, Tae An Heating Power Plant 8 years.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Operating #1~#4 Power Plants of Tae An Power Plant Headquarter as a generation of electric power chief.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Management by operator under supervision of Generation of electric power team leader.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: By criteria and process documents and manual.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: Making a decision and dealing with happen by alerts character and kinds.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Input Log sheet & PDA Logging.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Wire and wireless phone call or face to face. Daily meeting and business contact. Report the present status of generation of electronic power and share the information when we have a daily meeting, report the present status on the weekly chief meeting. Email and short meeting between relevant government ministries. Emergency: Report by wireless phone call. Generally: Short Report.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes:

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes: After reporting based on the process which is having a conference with between relevant government ministries.

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: Q

Interviewer(s): Migun Choi, Taeho Hwang, Chi Hwan Lee

Date: 21 March 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: The head of boiler part in machinery department
Back ground: graduation from a university. Plant experience: 1994. 04 : Samchunpo Heating 1st Power Plant #1~4 Power Plant, generation of electric power department. 1995. 06 : Samchunpo Heating 2nd Power Plant #5~6 Power Plant. 1997. 03 : Samchunpo Heating 2nd Power Plant, machinery department. 2003. 12 : Samchunpo Heating 2nd Power Plant, operation part of generation of electric power. 2004. 09 : Samchunpo Heating 2nd Power Plant, generation of electric power department. 2005. 05 : Samchunpo Heating 2nd Power Plant, machinery department.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Make a plan, supervision and designing construction related to Power Plant boiler equipment maintenance.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: The operating department make a TM (Trouble Memo). The power exchange department.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes: Publication TM (Trouble Memo).
관련부서간의 협의에 의한 절차에 따른 보고후
절차서에 따른 판단 및 조치

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes: We check it and fix problems and then confirm the operating department.

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Log Sheet : Record various kinds of measurement (every 2 hours). Handover report: Record various kinds of manufacturing status, maintenance status, check list and then hand over to next worker. Report current status from generation of electric power department to equipment department.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Phone contact, meeting, E-mail, Messenger, EDI (Electronic Data Interchange).

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Judgment that important equipments or power plant should be stopped or not. Judgment that important equipments or power plant should be stopped or not, judgment that there is disadvantage for unit if these equipment still running. By Criteria and process documents and manual which designed for all the expected failure status.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes:

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: R

Interviewer(s): Migun Choi, Taeho Hwang, Chi Hwan Lee

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: BS (undergraduate), 24 years of working career. Specialist in Environmental Treatment Unit.

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Managing discharge of pollutant. Environmental facility operating and maintenance.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: From the operating team. Operation manager (specialist) of each unit, discuss with operator.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: Report the opinion of specialist to the related manager and decide after discussion.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: Write down on the log sheet. Prompt makeshift measures and write on the log sheet. After that, report to the related dept. There's a checklist about significant and essential matters.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: By e-mail, phone and document, and regular meeting. E-mail informs daily work, phone is for immediate response, meetings are weekly.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: Priorities depend on the kind of the facility and by judgment of the specialist

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes:

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: S

Interviewer(s): Migun Choi, Taeho Hwang, Chi Hwan Lee

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Position : Korea Midland Power Co. / Power generation Dept. Manager, 1994. 9 ~ 1995. 5 : Boryeong Power Plant Shift operating team, 1995. 5 ~ 2000. 3 : Boryeong Power Plant Measurement and Control team, 2000. 3 ~ 2002. 4 : Boryeong Power Plant Power generation Dept. operating team, 2002. 5 ~ 2004. 5 : Korea Power Learning Institute instructor

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Reporting to outside agency about the errors of generation facilities, plant management assessment (charge on facility reliability assessment), p.s. Set 23% on Division Internal assessment.

(3) Who selects the equipment to be maintained during a planned outage?

1 Plant Manager
2 Planned Outage Manager
3 Shift Supervisor
4 Operations Manager
5 Maintenance Manager
6 Unit Engineer/Specialist
7 Equipment Operator
8 Maintenance Technician

Notes: Scheduled maintenance can be determined by two cases basically. Case 1 : Overhaul -- We shut down the generator according to its usual period, and maintain it by the grade (A, B, C). Case 2 : Slight Maintenance -- Slight maintenance means every else maintenance except Overhaul (usual maintenance).
Generally it is done by maintenance team or operating team.

(4) How do they make that selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Work Orders
4 Routine Meetings
5 Interaction between Plant Workers
6 Preventative Maintenance Specialist Suggestions
7 Required Inspections

Notes: Generally the priority of plant alerts is determined by whether it is involved in “TRIP (shut down)” or not. We do not prioritize every alert. When a high priority alert comes up, usually the generating machine will be “trip (shut down)” to protect machines. If it is not high priority alert right now but it could be in the future, we have to fix it temporarily and report it and shut down later by usual protocol. If it needs to shut down operator machines, we have to report it head department and wait for their acceptance as following our protocol. Involved department plans about failure and report it to manager and fix it. However, if the failure needs to be fixed for long term, we have to report it to the Head department and wait for their acceptance.

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: According to each position, we keep a record of all the work in Log Sheet by using PDA. In case of Maintenance department, they keep a record of everyday works they have done. Paper reports or electronic documents are given to Operations Manager.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Oral reporting immediately from error-occurred facility. Summit prompt report by FAX or systematized E-mail about the error to head office in 4 hours and they accept the report. After restored, summit the error analysis report in 10 days to head office. Mainly working together and share information by phone and E-mail. Mainly communicate by phone or direct person to person contact. Managers meet everyday.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: It depends on how important it is. Minor (If the failure does not affect our operation). Report it to Engineering teams (Mechanical, Electrical, Measurement Control teams) and keep operating (We do not report it to the Head Department). Major (If the failure does affect our operation). When major part goes wrong, we call to Head department and report it to power exchange about shutting down the plant. After shutting down, we let the maintenance department check and fix it.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

Notes:

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

IPRO 303: Interview Data Analysis

Interview: T

Interviewer(s): Migun Choi, Taeho Hwang, Chi Hwan Lee

Date: 9 April 2007

Questions:

(1) Please describe your position, background, and plant experience.

1	Plant Manager	1	Expert
2	Planned Outage Manager	2	Very Experienced
3	Shift Supervisor	3	Experienced
4	Operations Manager	4	Some Experience
5	Maintenance Manager	5	Novice
6	Unit Engineer/Specialist		

Notes: Head department general manager (Team leader), BS (Electrical Engineering). Work experience: Power plant (13 years), Head Department (16 years).

(2) How are you involved with day-to-day operations in the plant?

1	Plant Supervision	1	Significant
2	Planned Outage Supervision	2	A lot
3	Operations Supervision	3	Somewhat
4	Maintenance Supervision	4	A little
5	Unit Supervision	5	Insignificant

Notes: Operating and planning of generation equipment.

(3) Who selects the equipment to be maintained during a planned outage?

1	Plant Manager
2	Planned Outage Manager
3	Shift Supervisor
4	Operations Manager
5	Maintenance Manager
6	Unit Engineer/Specialist
7	Equipment Operator
8	Maintenance Technician

Notes: Important maintenance should be done after reporting to the Head department, but generally general manager in power plant decide it. As soon as field operator find it out, he report it and general manager decide or through manager's meeting.

(4) How do they make that selection?

1	DCS Equipment Warnings
2	Diagnostic Computer Software (i.e. Smart Signal)
3	Work Orders
4	Routine Meetings
5	Interaction between Plant Workers
6	Preventative Maintenance Specialist Suggestions
7	Required Inspections

Notes:

(5) How are you involved in making those selections?

1	Supervises	1	Significant
2	Decides	2	A lot
3	Advises	3	Somewhat
4	Informs	4	A little
5	Listens	5	Insignificant

Notes:

(6) What information do you use to make the selection?

1 DCS Equipment Warnings
2 Diagnostic Computer Software (i.e. Smart Signal)
3 Equipment Logs
4 Equipment Operator Suggestions
5 Preventative Maintenance Specialist Suggestions
6 Maintenance Technician Suggestions
7 Industry Contacts

Notes: We are using an automatic record machine; otherwise we keep a record of all the work directly.

(7) How do you get this information?

1 Computer Based
2 Via Email
3 Over the Phone
4 Routine Meetings
5 Interaction between Plant Workers

Notes: Call and e-mail or cellular phone. Immediately or periodic meeting.

(8) What analysis do you use on that information?

1 Computer Software
2 Analysis Calculations
3 Historically Based (i.e. based on PI data base)
4 Priority/Risk Based
5 Economically Based
6 Hands-on (i.e. physically checking equipment)

Notes: When something goes wrong in the plant, we shut down the generator. We set the priority by protocol. We have colors depends on priority, for example, red means very important and yellow means important.

(9) What other factors do you take into consideration?

(a) Internally?

1 Economic
2 Availability of Resources
3 Safety

(b) Externally?

1 Governmental
2 Economic
3 Availability of Resources

Notes:

(10) After a planned outage,

(a) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

Notes:

(b) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1 Diagnostic Computer Software (i.e. Smart Signal)
2 Improved Intra-plant Communication
3 Employee Resources
4 Economic Resources

Notes:

APPENDIX C

Interview Data Analysis

IPRO 303: Interview Answers

QUESTIONS →	1		2		3	4	5		6	7	8	9		10	
INTERVIEWS ↓	Part 1	Part 2	Part 1	Part 2			Part 1	Part 2				Part A	Part B	Part A	Part B
A	1	1	1	1	2 4 5	3 4	1	1	1 3 5	4		3	2		
B	6	2	4	2	6	3 6 7	3 4	2	3 4 5 6 7	1	2 3 4 5	1	2 3	1	
C	4	2	1 3	2	2 3 4 6	3 4 5	2 3	3	3 4	1 4 5	1 2 3 4	1	2 3	1	3 4
D	1	1	1	1	6	4	1	3		4	2 3 4 5		2	2	
E	6	1	5	2	2 6	3	1	1	4	4	1 2 3	1 2	2	3	
F	4	1	5	2	4 6	2 3 6	3	3	3 7	1			1	4	
G	6	2	4	2	8	5 6	3	3	3 4	1	2 3 4	1	2	3	
H	3	2	1	2	6	4 5	3	3	3 4	1	2 3 4	1 3	1 2	3	2
I	2	2	2	1	4 6	3 4	3	2			4	1	3	3	
J	2	2	2	1	1	3 4	2	1		1	3				
K	5	1	4	1	8	1 5	1	1	6	3 5	6	2			
L	2	1	2	1		6	2	1	4	1 4				2	
M	5	1	5	2	1 2 4 5 6	3	3	3	2 3 4 7	1 4 5	1 2 3 4 5	1 2	2 3	1	2 3
N	1	1	1	2	2 4 5 6	3	1 2	2	2 4	4	4	1	2	1	
O	2	2	2	2	6	6 7	1	2	3 5	5	1 2 6	1	3	4	3
P	1	1	1	1	1 4	3	1 2	1	2 3	2 3 4 5			1		
Q	6	2	5	1	4	3	4	3	3	1 2 3 4	4				
R	6	1	5	2	4	4 5	3 4	1	3	2 3 4	4		1		
S	1	1	1	1	4 5	2	2	3	3	2 3 4 5	4		1		
T	1	1	1	1	1 7	4	1	2	2 3	2 3 4	4		1		

IPRO 303: Answer Totals

QUESTIONS →	1						2						3			4			5					
	Part 1			Part 2			Part 1			Part 2									Part 1			Part 2		
1	6	30%	1	12	60%	1	8	40%	1	10	50%	1	4	20%	1	1	5%	1	8	40%	1	7	35%
2	4	20%	2	8	40%	2	4	20%	2	10	50%	2	5	25%	2	2	10%	2	6	30%	2	5	25%
3	1	5%	3	0	0%	3	1	5%	3	0	0%	3	1	5%	3	11	55%	3	8	40%	3	8	40%
4	2	10%	4	0	0%	4	3	15%	4	0	0%	4	10	50%	4	7	35%	4	3	15%	4	0	0%
5	2	10%	5	0	0%	5	5	25%	5	0	0%	5	4	20%	5	5	25%	5	0	0%	5	0	0%
6	5	25%										6	10	50%	6	5	25%						
												7	1	5%	7	2	10%						
												8	2	10%									
	20			20			21			20			37			33			25			20	

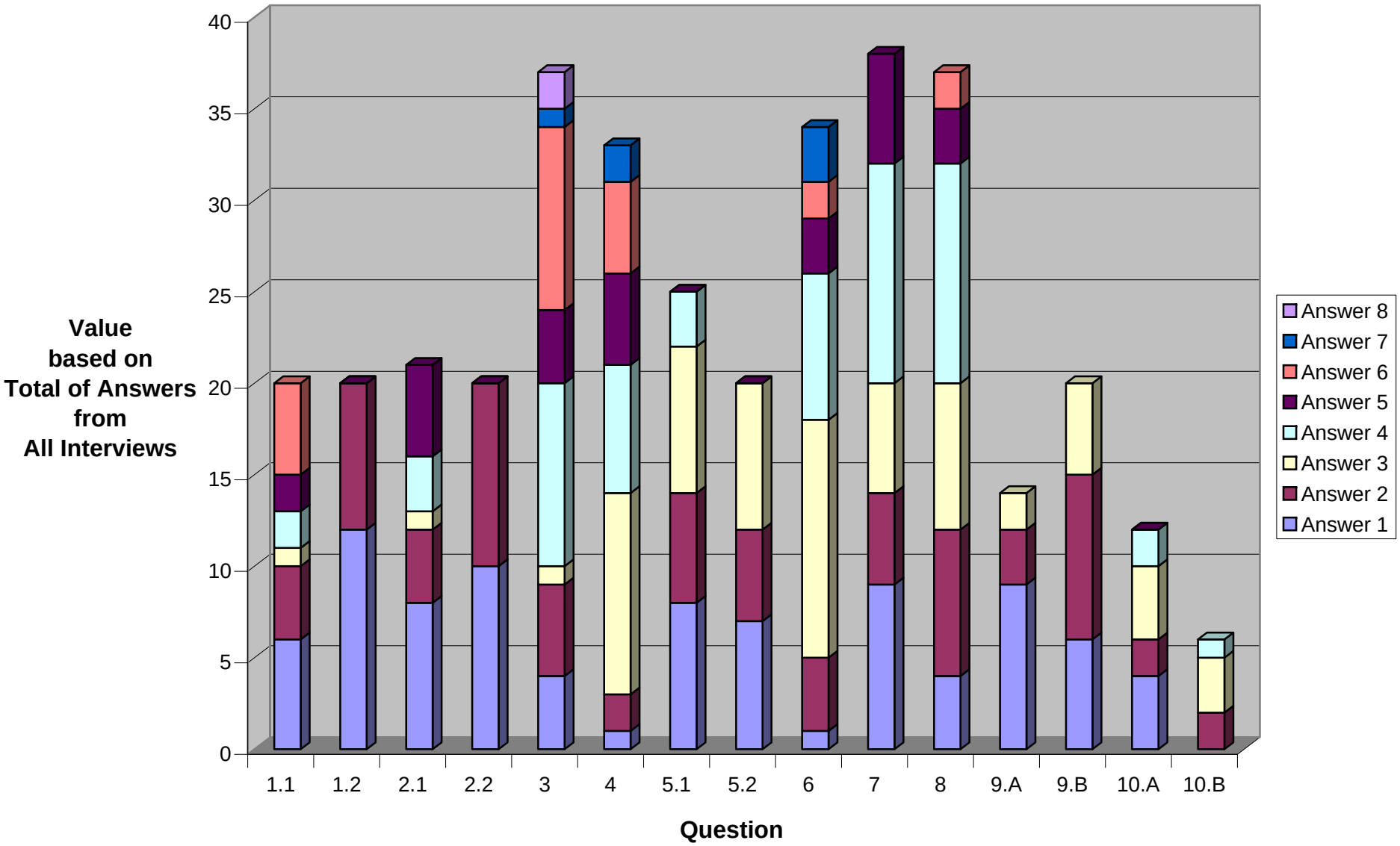
QUESTIONS →	6			7			8			9						10					
										Part A			Part B			Part A			Part B		
1	1	5%	1	9	45%	1	4	20%	1	9	45%	1	6	30%	1	4	20%	1	0	0%	
2	4	20%	2	5	25%	2	8	40%	2	3	15%	2	9	45%	2	2	10%	2	2	10%	
3	13	65%	3	6	30%	3	8	40%	3	2	10%	3	5	25%	3	4	20%	3	3	15%	
4	8	40%	4	12	60%	4	12	60%							4	2	10%	4	1	5%	
5	3	15%	5	6	30%	5	3	15%							5	0	0%				
6	2	10%				6	2	10%													
7	3	15%																			
	34			38			37			14			20			12			6		

IPRO 303: Answer Statistics

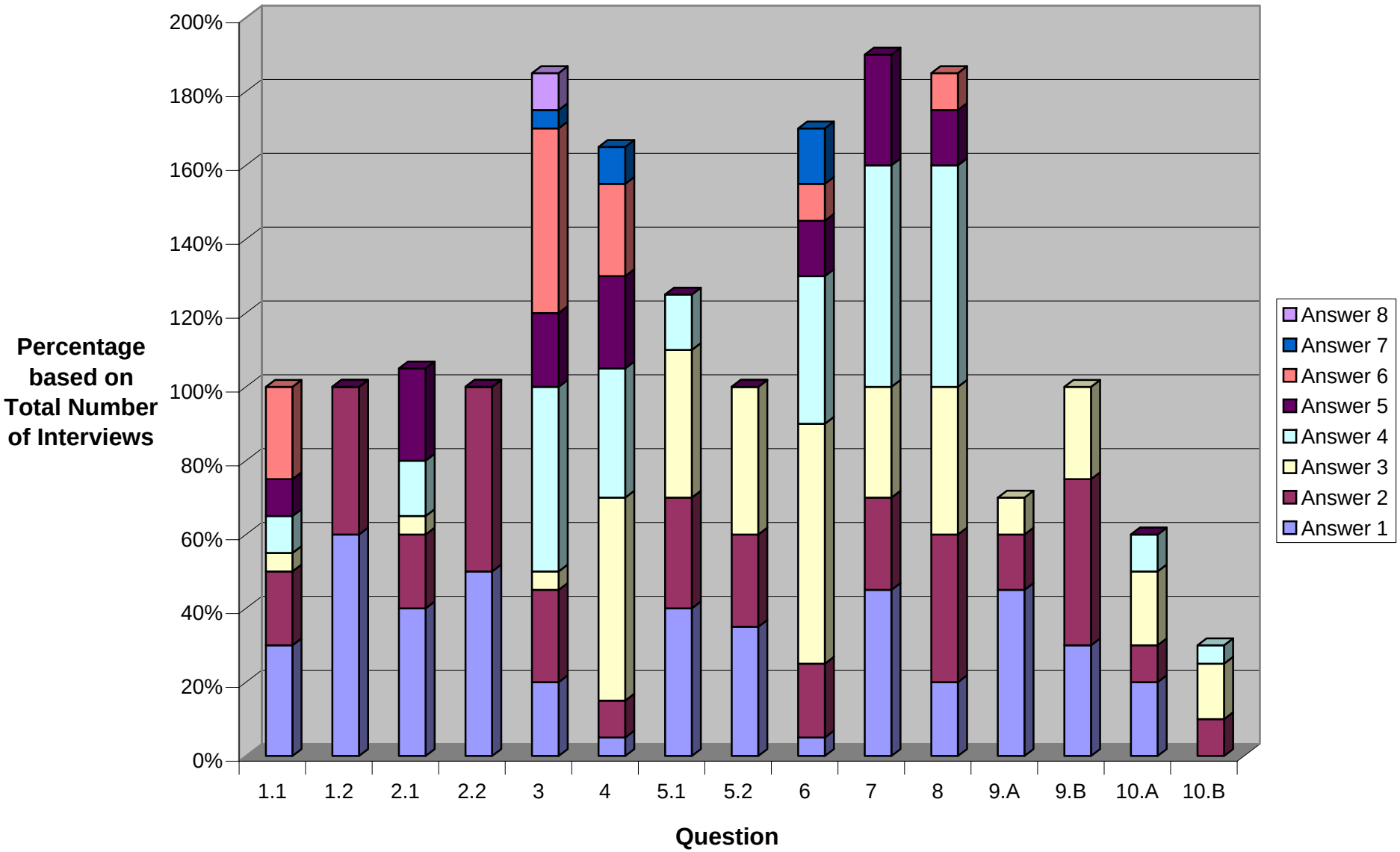
ANSWER →	1	2	3	4	5	6	7	8	TOTAL
QUESTION ↓									
1.1	6	4	1	2	2	5			20
1.2	12	8	0	0	0				20
2.1	8	4	1	3	5				21
2.2	10	10	0	0	0				20
3	4	5	1	10	4	10	1	2	34
4	1	2	11	7	5	5	2		31
5.1	8	6	8	3	0				25
5.2	7	5	8	0	0				20
6	1	4	13	8	3	2	3		31
7	9	5	6	12	6				38
8	4	8	8	12	3	2			37
9.A	9	3	2						14
9.B	6	9	5						20
10.A	4	2	4	2	0				12
10.B	0	2	3	1					6

ANSWER →	1	2	3	4	5	6	7	8	TOTAL
QUESTION ↓									
1.1	30%	20%	5%	10%	10%	25%			100%
1.2	60%	40%	0%	0%	0%				100%
2.1	40%	20%	5%	15%	25%				105%
2.2	50%	50%	0%	0%	0%				100%
3	20%	25%	5%	50%	20%	50%	5%	10%	185%
4	5%	10%	55%	35%	25%	25%	10%		165%
5.1	40%	30%	40%	15%	0%				125%
5.2	35%	25%	40%	0%	0%				100%
6	5%	20%	65%	40%	15%	10%	15%		170%
7	45%	25%	30%	60%	30%				190%
8	20%	40%	40%	60%	15%	10%			185%
9.A	45%	15%	10%						70%
9.B	30%	45%	25%						100%
10.A	20%	10%	20%	10%	0%				60%
10.B	0%	10%	15%	5%					30%

Interview Answer Statistics



Interview Answer Statistics



QUESTION 1

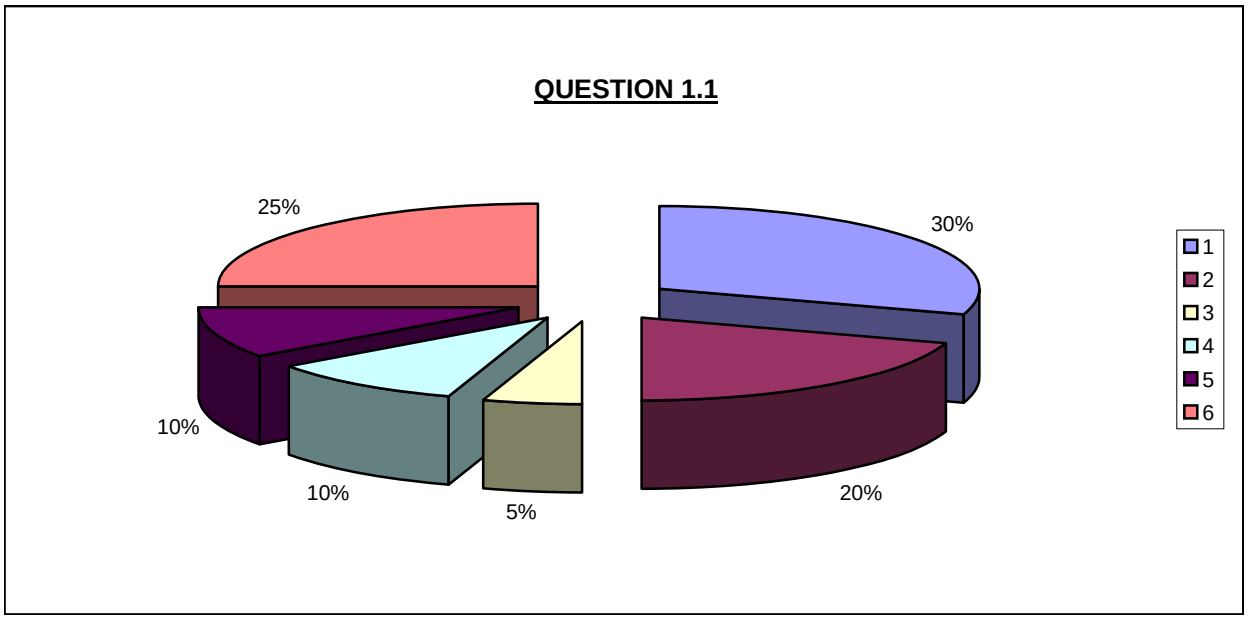
(1) Please describe your position, background, and plant experience.

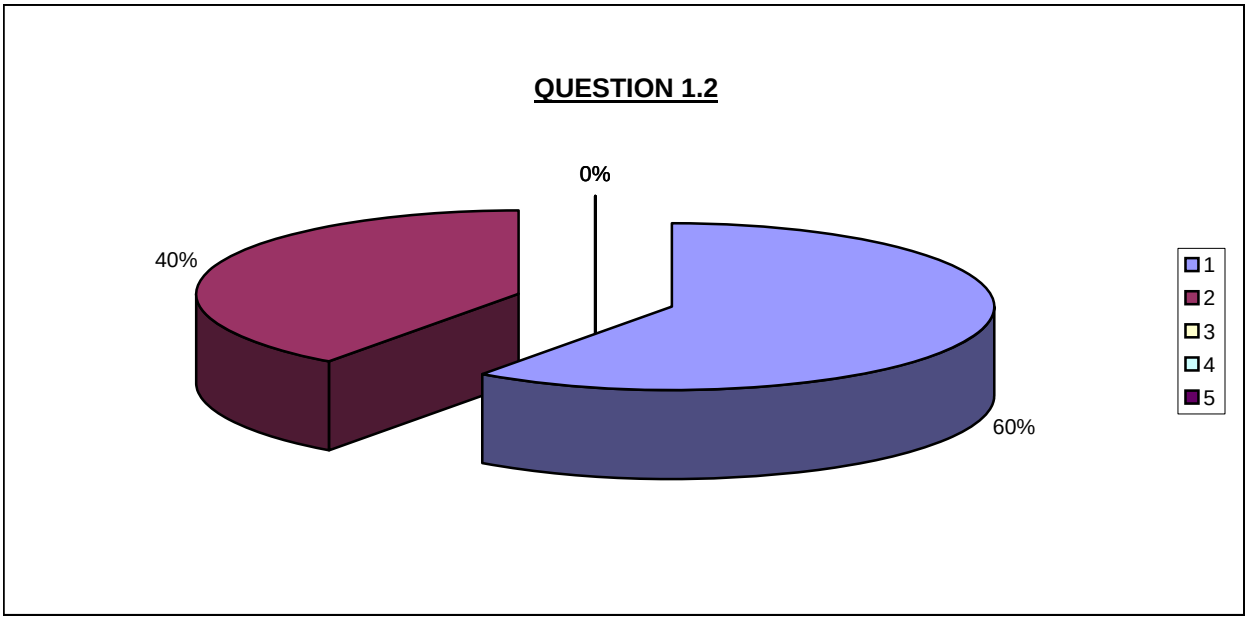
(1.1)

1	Plant Manager	30%
2	Planned Outage Manager	20%
3	Shift Supervisor	5%
4	Operations Manager	10%
5	Maintenance Manager	10%
6	Unit Engineer/Specialist	25%

(1.2)

1	Expert	60%
2	Very Experienced	40%
3	Experienced	0%
4	Some Experience	0%
5	Novice	0%





QUESTION 2

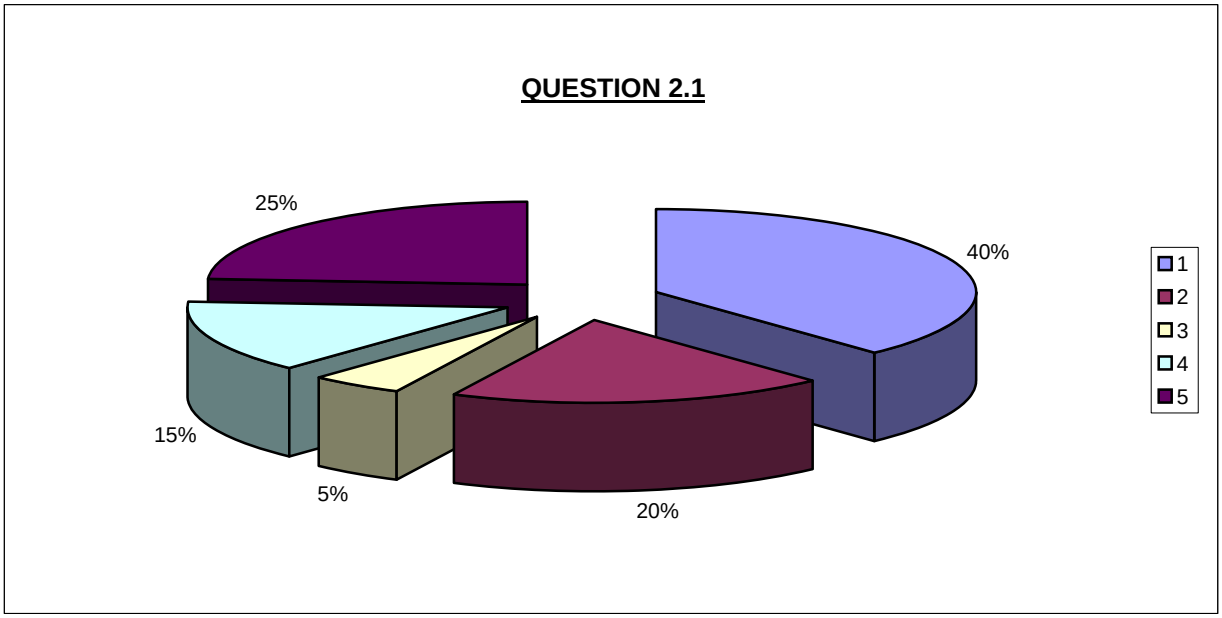
(2) How are you involved with day-to-day operations in the plant?

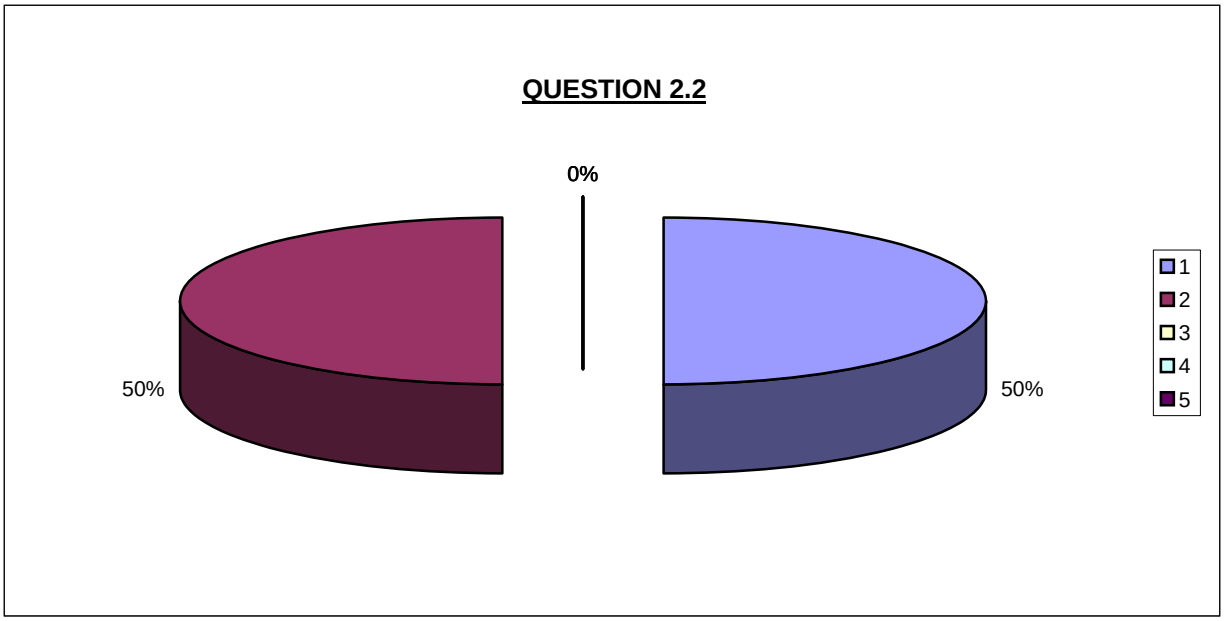
(2.1)

1	Plant Supervision	40%
2	Planned Outage Supervision	20%
3	Operations Supervision	5%
4	Maintenance Supervision	15%
5	Unit Supervision	25%

(2.2)

1	Significant	50%
2	A lot	50%
3	Somewhat	0%
4	A little	0%
5	Insignificant	0%

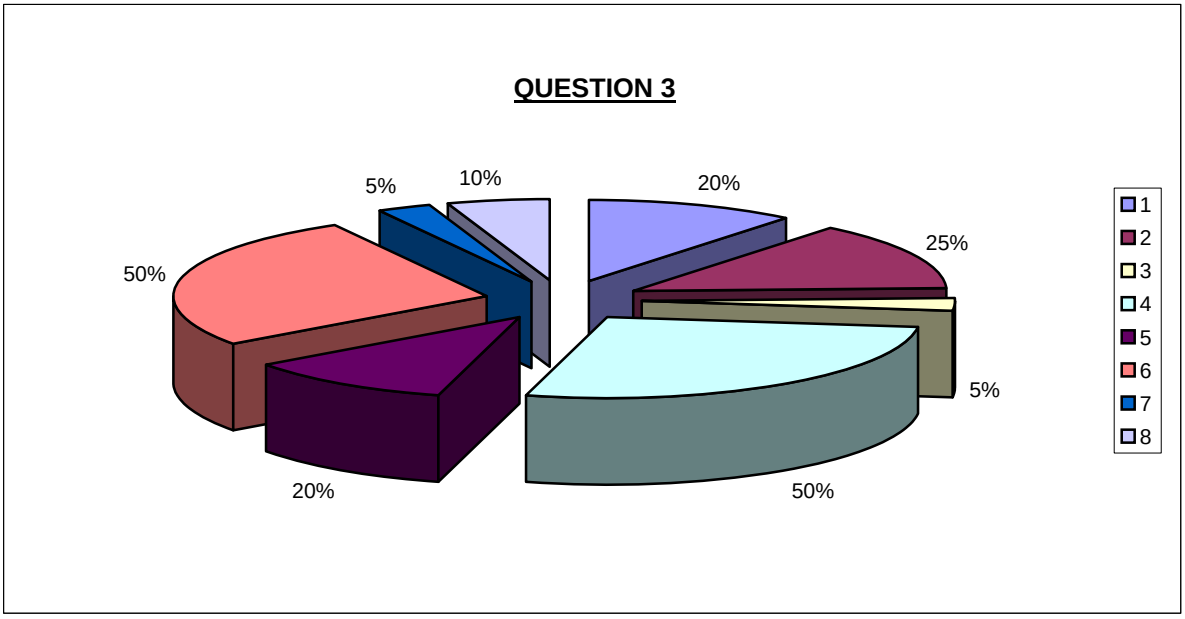




QUESTION 3

(3) Who selects the equipment to be maintained during a planned outage?

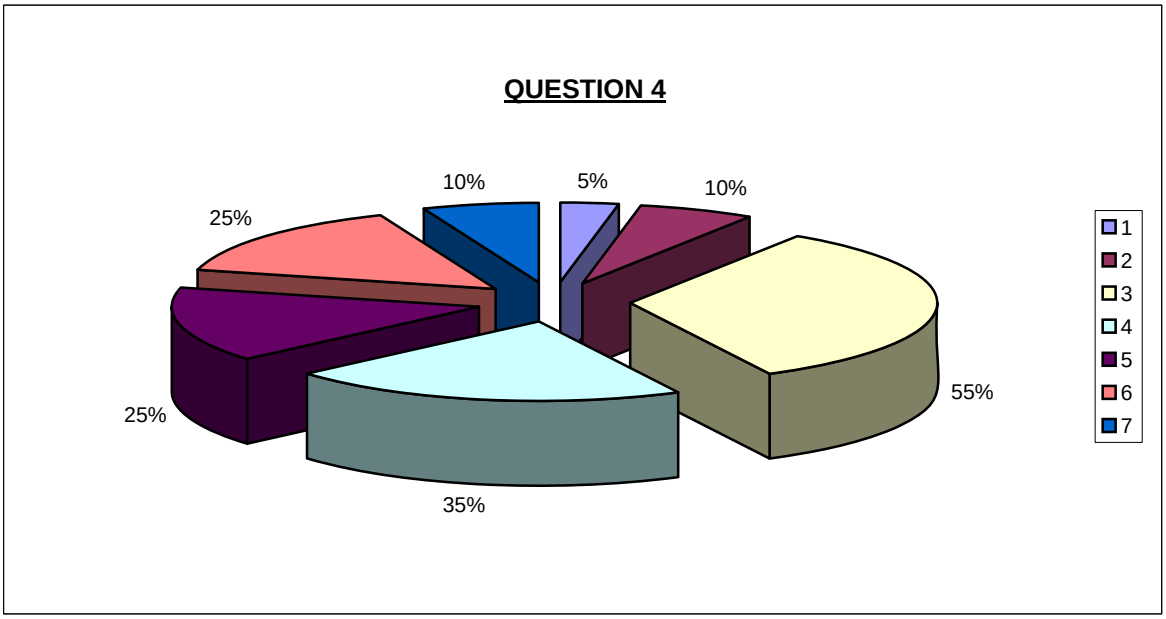
1	Plant Manager	20%
2	Planned Outage Manager	25%
3	Shift Supervisor	5%
4	Operations Manager	50%
5	Maintenance Manager	20%
6	Unit Engineer/Specialist	50%
7	Equipment Operator	5%
8	Maintenance Technician	10%



QUESTION 4

(4) How do they make that selection?

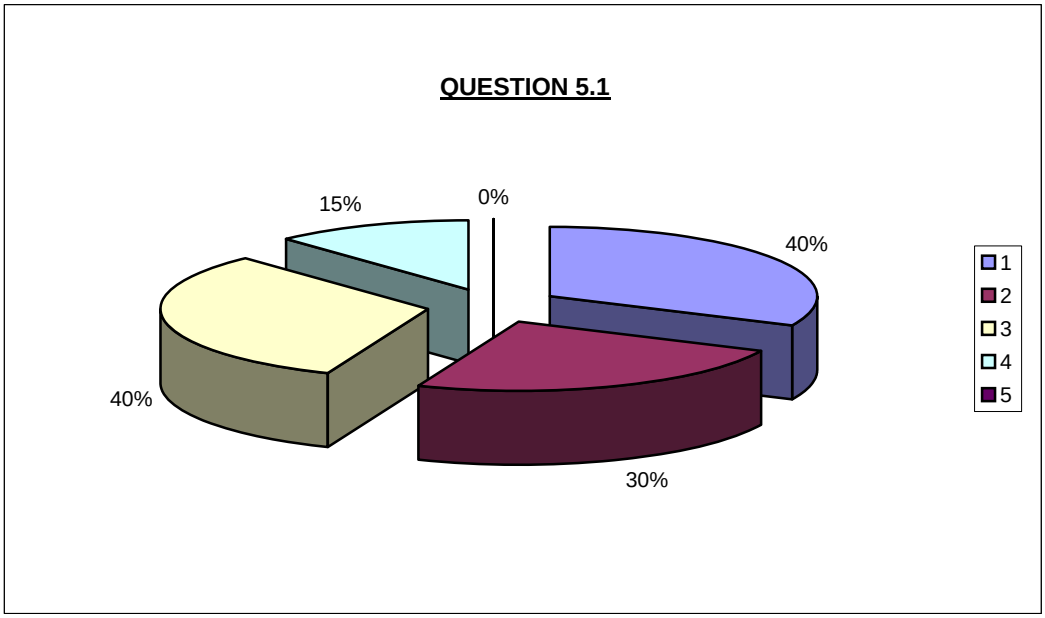
1	DCS Equipment Warnings	5%
2	Diagnostic Computer Software (i.e. Smart Signal)	10%
3	Work Orders	55%
4	Routine Meetings	35%
5	Interaction between Plant Workers	25%
6	Preventative Maintenance Specialist Suggestions	25%
7	Required Inspections	10%

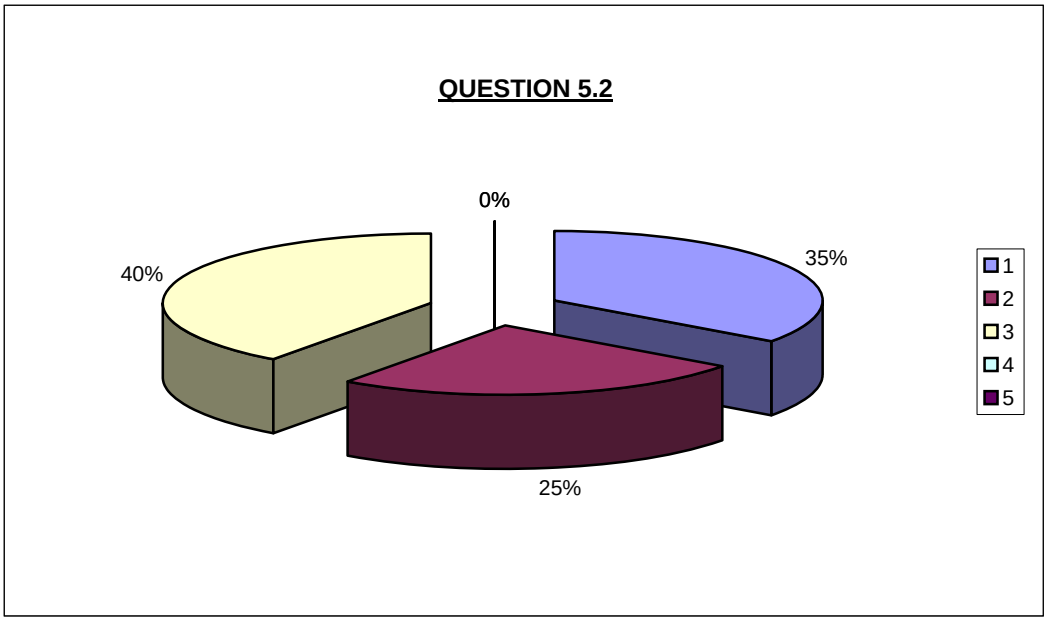


QUESTION 5

(5) How are you involved in making those selections?

(5.1)				(5.2)		
	1 Supervises	40%		1 Significant	35%
	2 Decides	30%		2 A lot	25%
	3 Advises	40%		3 Somewhat	40%
	4 Informs	15%		4 A little	0%
	5 Listens	0%		5 Insignificant	0%

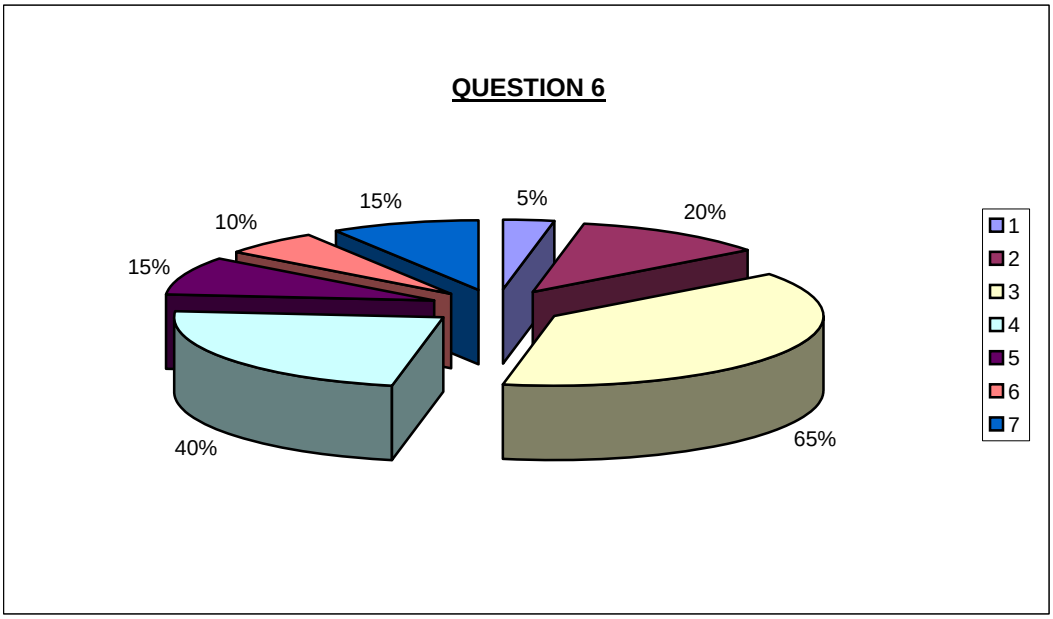




QUESTION 6

(6) What information do you use to make the selection?

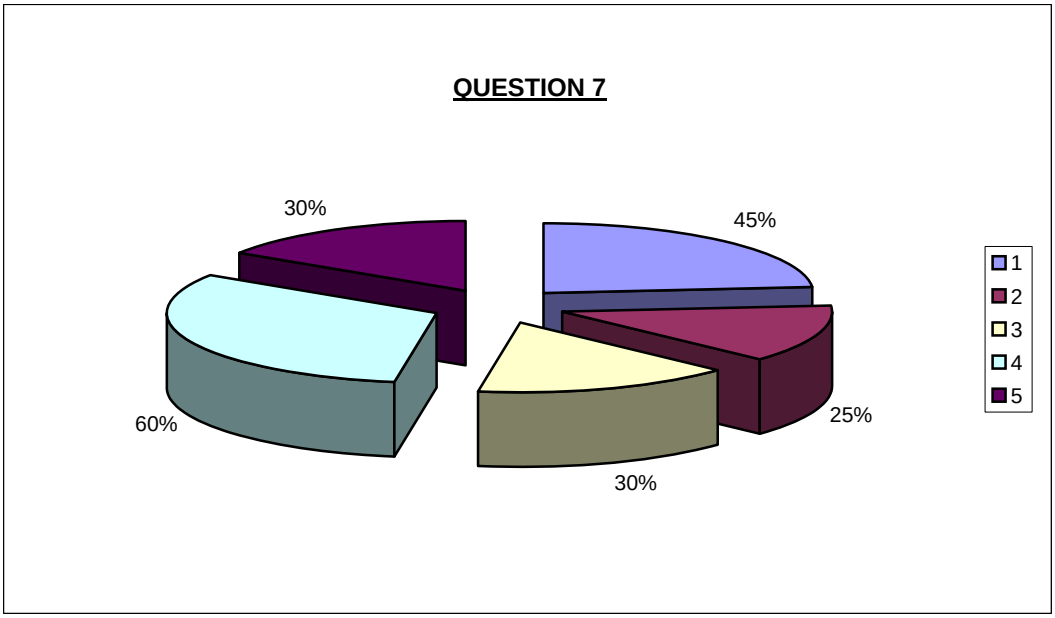
1	DCS Equipment Warnings	5%
2	Diagnostic Computer Software (i.e. Smart Signal)	20%
3	Equipment Logs	65%
4	Equipment Operator Suggestions	40%
5	Preventative Maintenance Specialist Suggestions	15%
6	Maintenance Technician Suggestions	10%
7	Industry Contacts	15%



QUESTION 7

(7) How do you get this information?

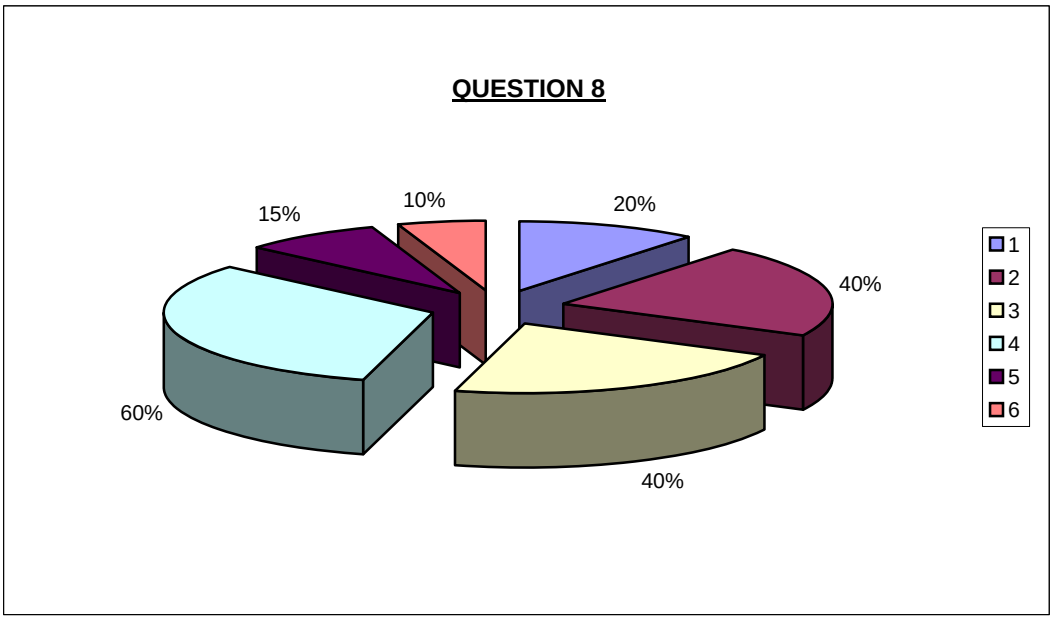
1	Computer Based	45%
2	Via Email	25%
3	Over the Phone	30%
4	Routine Meetings	60%
5	Interaction between Plant Workers	30%



QUESTION 8

(8) What analysis do you use on that information?

1	Computer Software	20%
2	Analysis Calculations	40%
3	Historically Based (i.e. based on PI data base)	40%
4	Priority/Risk Based	60%
5	Economically Based	15%
6	Hands-on (i.e. physically checking equipment)	10%



QUESTION 9

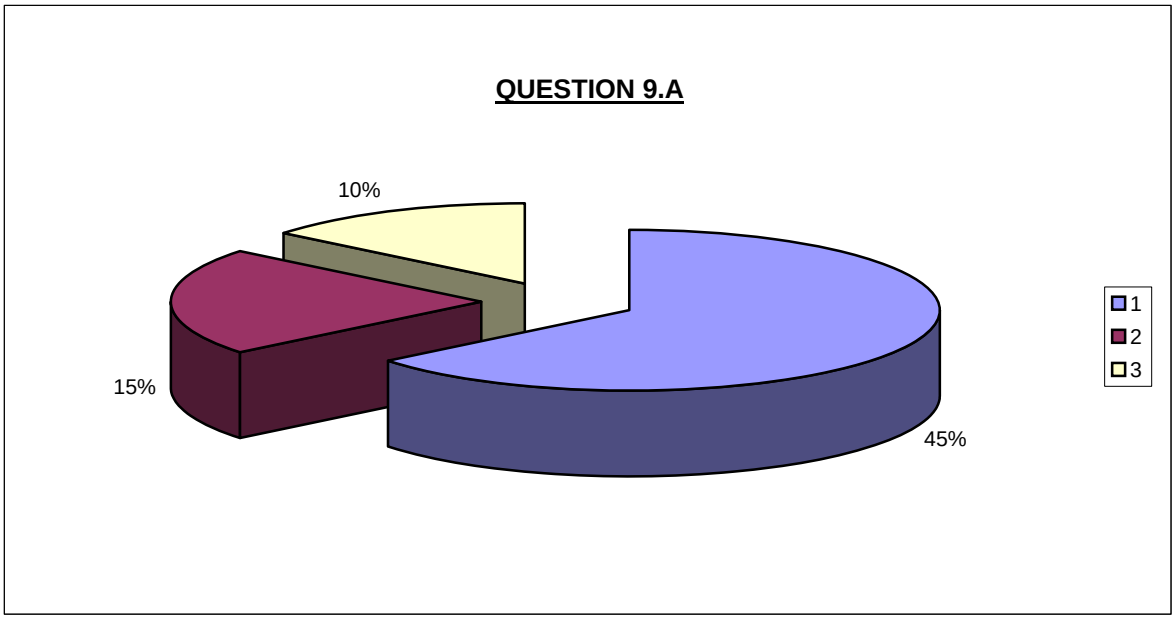
(9) What other factors do you take into consideration?

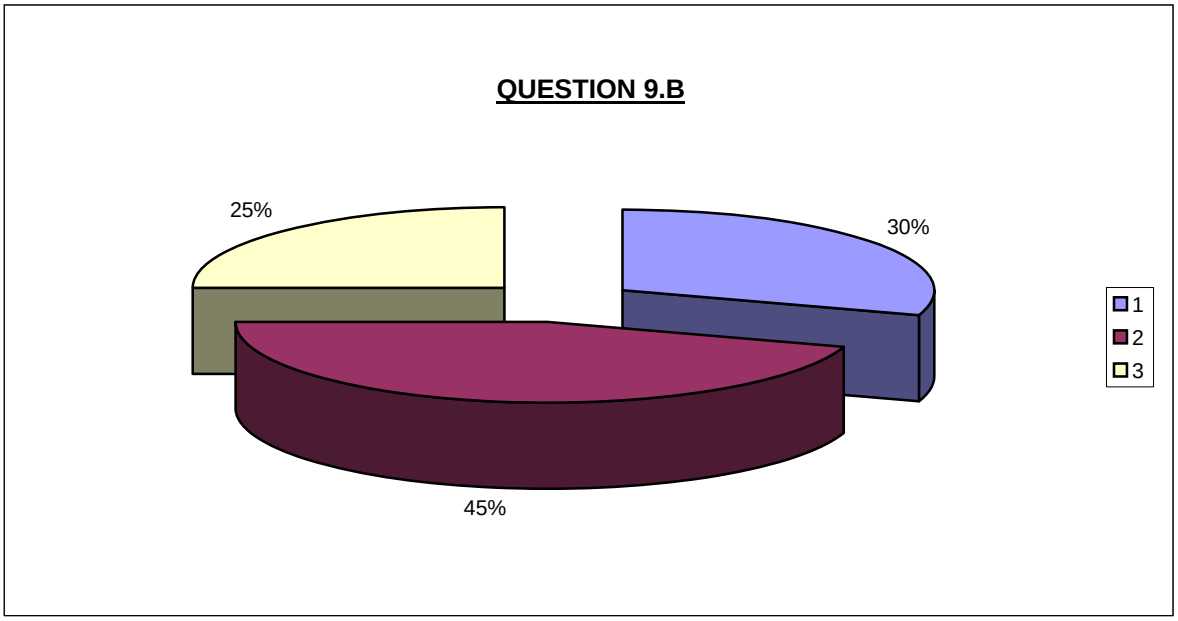
(9.A) Internally?

1	Economic	45%
2	Availability of Resources	15%
3	Safety	10%

(9.B) Externally?

1	Governmental	30%
2	Economic	45%
3	Availability of Resources	25%





QUESTION 10

(10) After a planned outage,

(10.A) Have you ever later discovered maintenance issues that should have been addressed in the planned outage but were not?

1	Always	20%
2	Often	10%
3	Sometimes	20%
4	Rarely	10%
5	Never	0%

(10.B) And if this does happen, what data or analysis was missing that would have allowed you to catch these maintenance issues?

1	Diagnostic Computer Software (i.e. Smart Signal)	0%
2	Improved Intra-plant Communication	10%
3	Employee Resources	15%
4	Economic Resources	5%