



# Information Flow

# Power Plant Hierarchy



# Decision Map

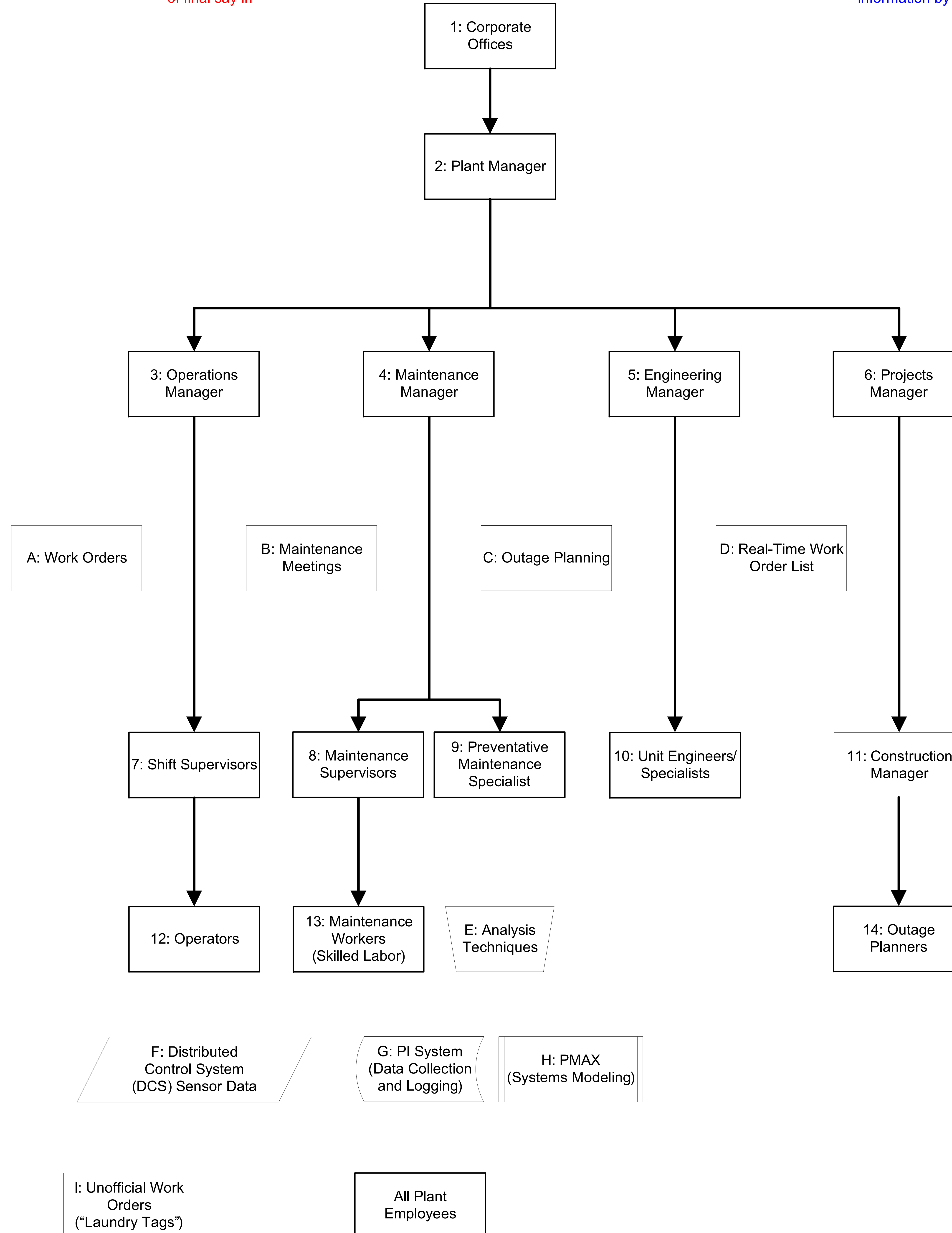
- I-1: All upper-level managers deal directly with the corporate offices when necessary.
- I-2: The corporate offices give the plant manger information about legal and environmental requirements, as well as budget constraints and activity within the fleet.
- I-3: The plant manager receives periodic reports from the other managers and facilitates communication between them.
- I-4: The preventative maintenance specialist provides any information requested to the managers.
- I-5: The work orders are reviewed at every maintenance meeting.
- I-6: The results of the maintenance meeting are collected by the construction manager.
- I-7: The real-time work order list is used as the basis to begin outage planning.
- I-8: Everyone has access to the real-time work order list.
- I-9: The construction manager updates the real-time work order list immediately after each maintenance meeting.
- I-10: The preventative maintenance specialist provides warnings of upcoming failures and other irregularities to each unit specialist or engineer.
- I-11: The units specialists request further analysis of suspect pieces of equipment.
- I-12: Several analysis techniques are used by the preventative maintenance specialist.
- I-13: The unofficial work orders are reviewed by the operators and written up as full work orders if necessary.
- I-14: The DCS shows a summary of its data in real time, which the operators monitor.
- I-15: All data in the PI system and created by PMAX is used in the analysis.
- I-16: The PI system logs all DCS data for easy retrieval later.
- I-17: Everyone can access the PI system.

## Decision Map

-  Takes part in deciding
-  Has some sort of final say in

## Information Map

-  Has access to information from
-  Is given information by



- D-1: The corporate offices set budget constraints and coordinate outages among plants within the fleet.
- D-2: The plant manager, operations manager, maintenance manager, engineering manager, shift supervisor, preventative maintenance specialist, unit specialists, construction manager, and outage planner all take part in the outage planning process. The plant manager and operations manager generally have the final say, although it rarely comes to that.
- D-3: The plant manager, operations manager, maintenance manager, shift supervisor, preventative maintenance specialist, and unit specialists all take part in the maintenance meetings. The plant manager and operations manager generally have the final say, although it rarely comes to that.
- D-4: The operations manager, shift supervisors, and operators can all write work orders based on problems they discovered themselves, or problems reported by others.
- D-5: Anyone can place a “laundry tag” to indicate to the operators that something is wrong with a piece of equipment.

# Other Items

- A: Documentation of a particular equipment issue within the plant.
- B: Weekly or bi-weekly meetings to review all outstanding work orders and assign or reassign a priority to each one (fix immediately, fix at next schedule outage, or fix when we can get around to it).
- C: Starts 3-12 months before the outage. Meet monthly and then more and more frequently to review all outstanding work orders, determining whether each one should be included in the list for this outage. Also ensure that parts and labor are lined up for the outage.
- D: The list of all open work orders which is updated after every maintenance meeting.
- E: Various automated and manually performed analysis techniques used on raw data to spot trends and upcoming problems. SmartSignal's services are a prime example of this.
- F: Huge amounts of temperature, vibration, voltage, amperage, wattage, and other data constantly collected by the tens of thousands of sensors built into the DCS.
- G: Logs all DCS data and anything else given to it. Allows everyone easy access to all previous data from any piece of equipment.
- H: Allows modeling of various systems in the plant, especially the boiler and turbine, for more detailed analysis.
- I: Unofficial work orders, placed on the offending equipment by anyone who notices a problem.

# Typical Employee Hierarchy

- 1: Most power plants belong to a “fleet” of several plants owned by a single company.
- 2: Oversees the entire plant. Deals with corporate and the market to determine when to sell power and how much to sell.
- 3: Oversees the operation of the plant. In charge of ensuring the plant delivers the required amount of power.
- 4: Oversees the maintenance of plant equipment.
- 5: Oversees the engineering department and compiles the analysis of the data from the DCS sensors.
- 6: Oversees and organizes major projects within the plant, such as replacing or upgrading major equipment.
- 7: Runs the plant. Responsible for keeping the plant running smoothly during an 8-12 hour shift.
- 8: Oversees and organizes maintenance during an 8-12 hour shift. Mainly handles immediate problems.
- 9: Monitors equipment sensors and uses the data to predict upcoming problems and failures. Takes a closer look at any equipment if asked to.
- 10: Runs a particular unit, such as the boiler, turbine, feed water heaters, etc. Responsible for keeping his or her unit running efficiently.
- 11: Oversees and organizes planned outages, especially during the outage itself.
- 12: Runs the plant from the central control room for an 8-12 hour shift. Periodically walks through the plant and visually inspects equipment.
- 13: Repairs equipment as needed.
- 14: Plans, organizes, and coordinates planned outages, especially before the outage itself.

# The Life Cycle of a Planned Outage

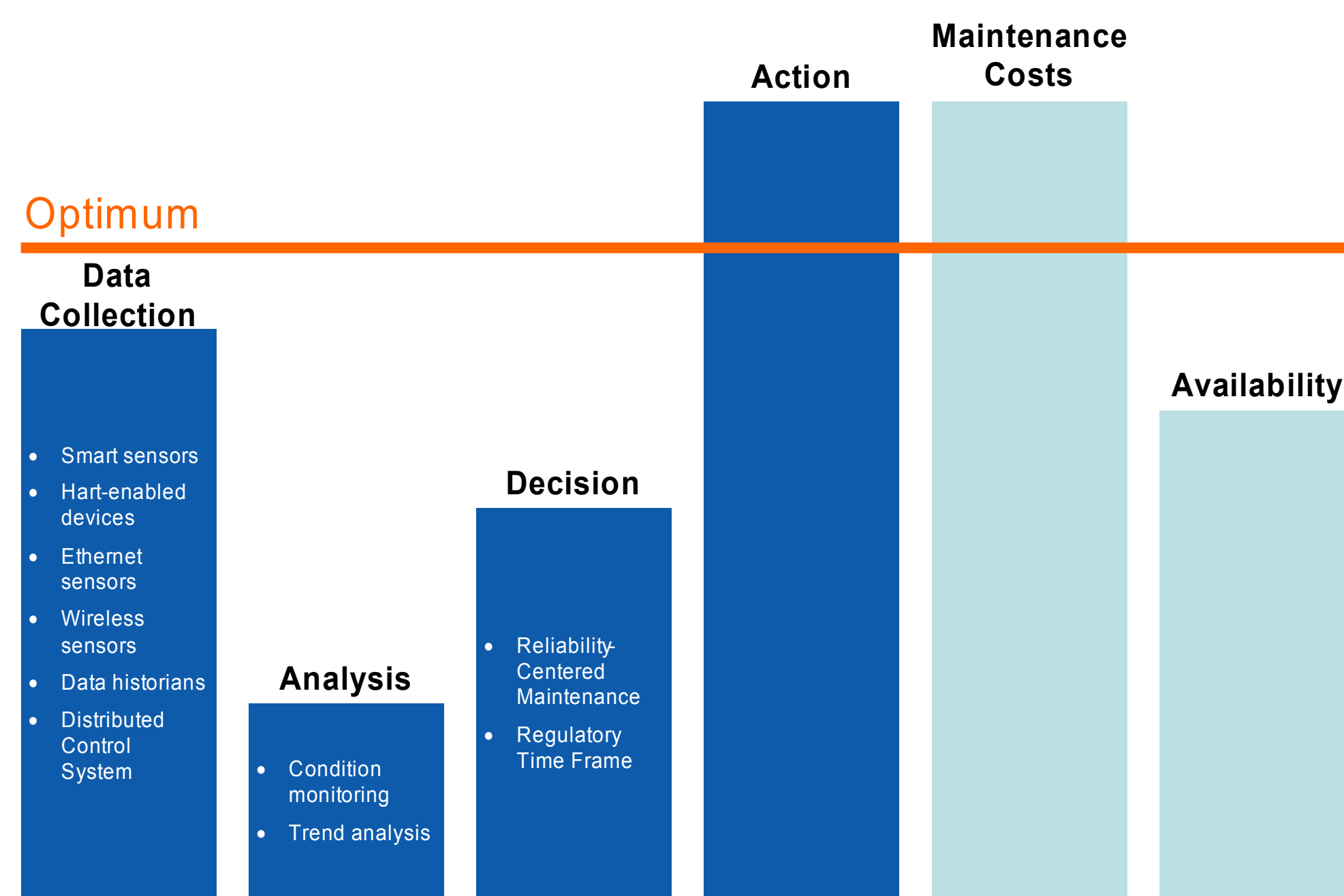
## Analysis Examples

SmartSignal Corporation is a privately held software solutions company that uses Similarity-Based Modeling™ (SBM) technology to enable comprehensive, real-time analytics on any instrumented industrial equipment.

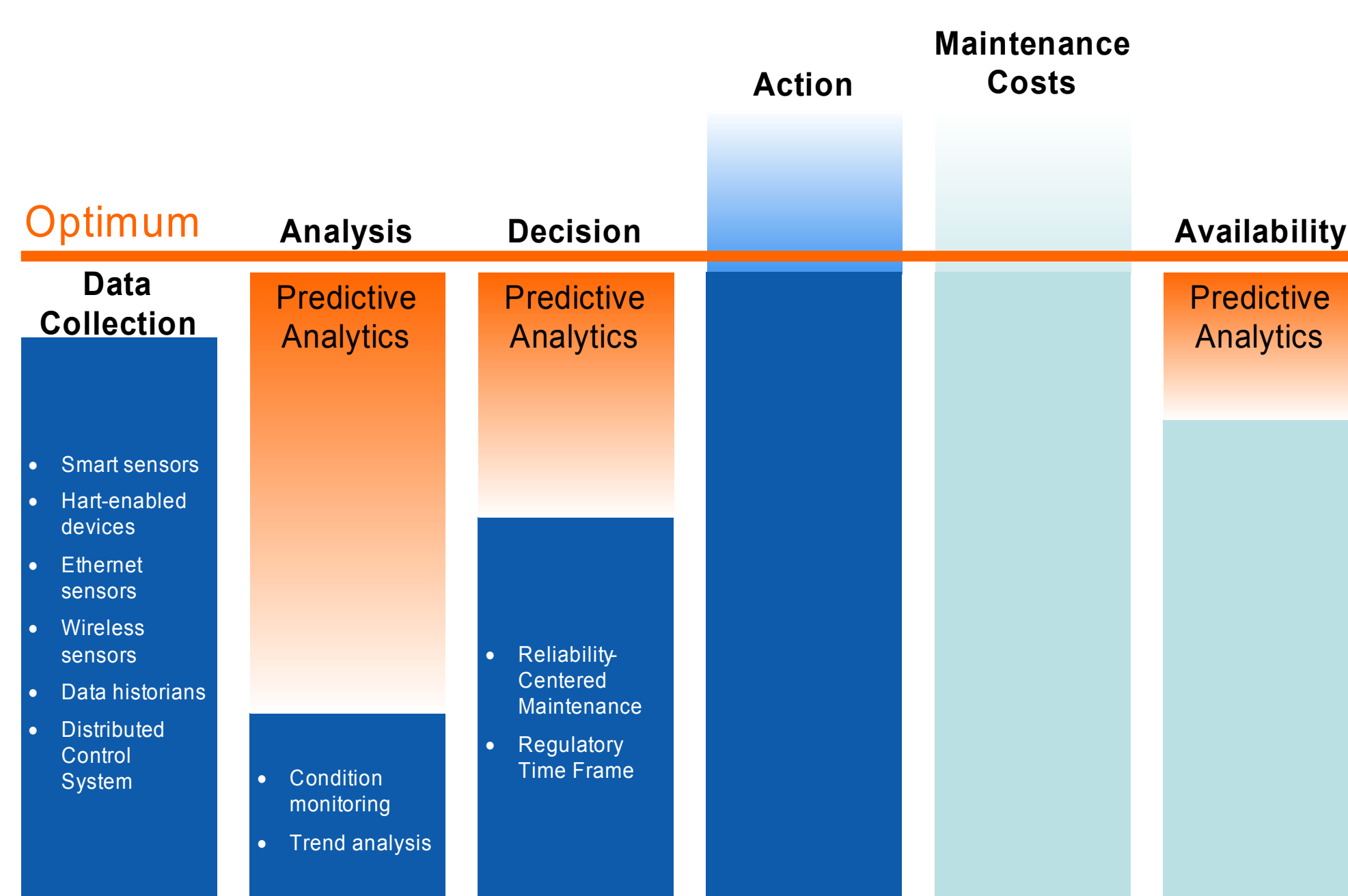
SmartSignal's Predictive Analytics Software provides:

- Early, actionable warnings of impending equipment failure
- Preliminary diagnosis and priority rating of emerging issues
- Validation of sensor data to detect malfunctions
- Adaptation to plants' ever-changing conditions
- The ability to fix a small problem before it grows into a large one

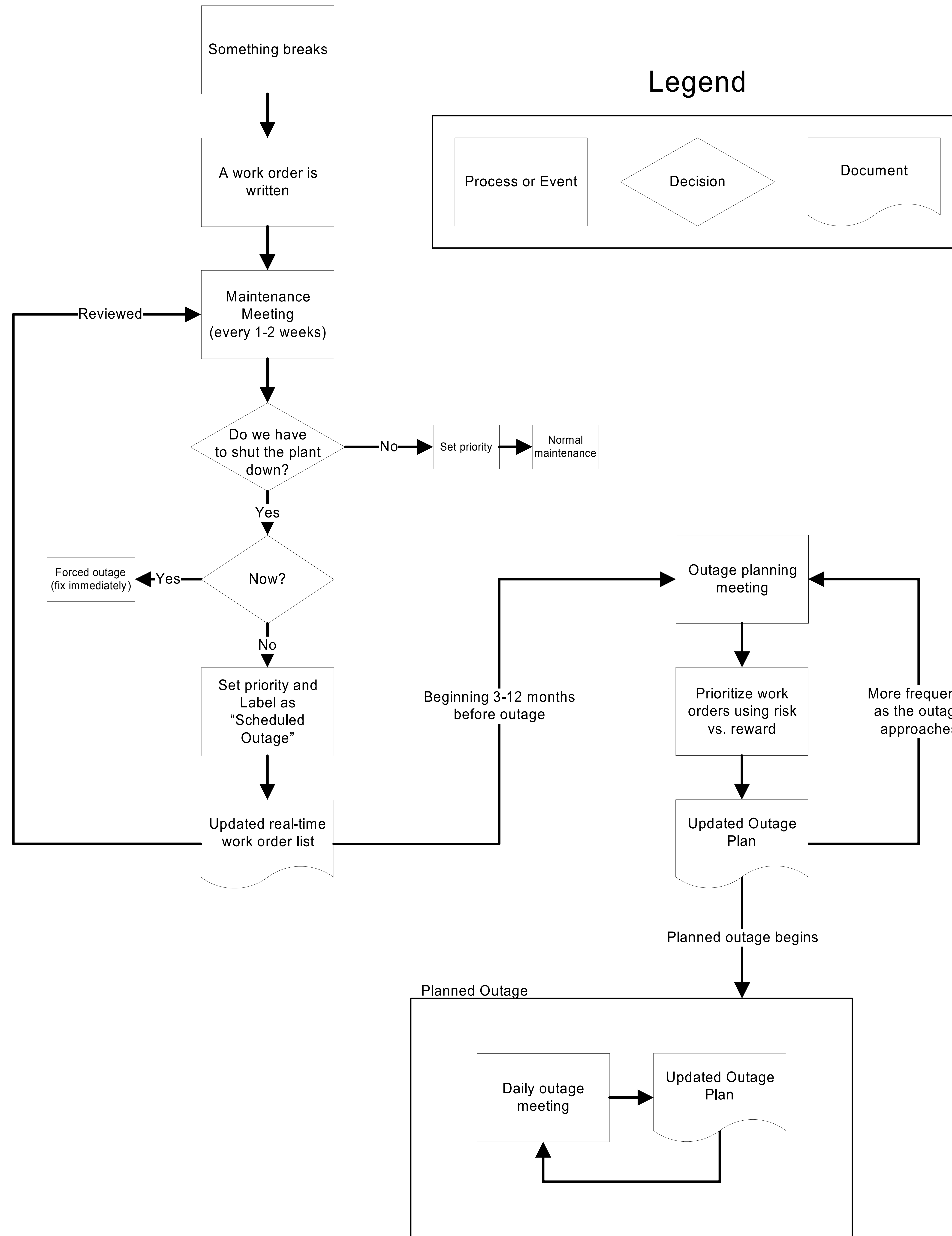
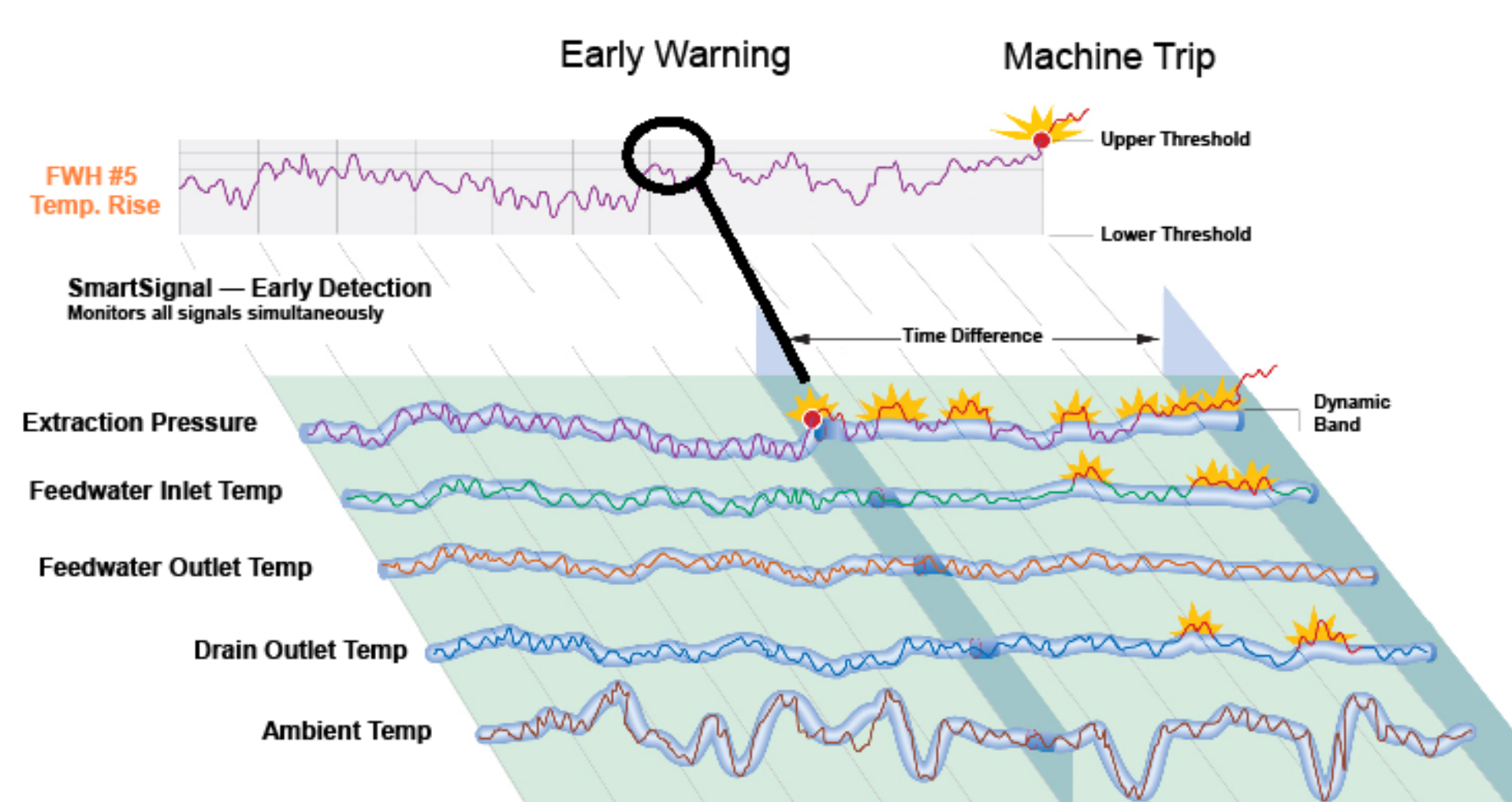
### Typical Power Plant



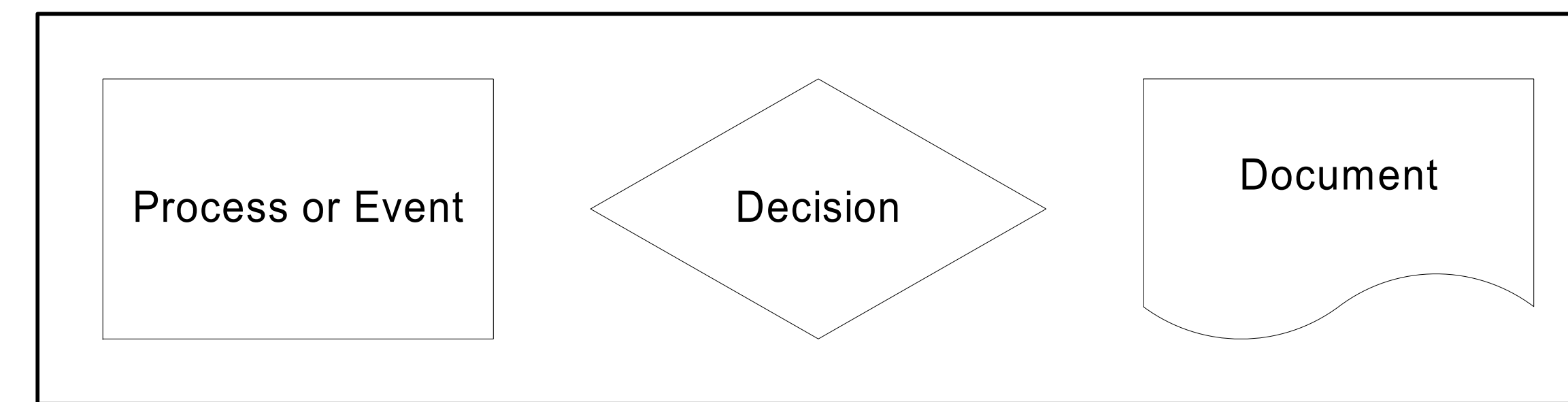
### SmartSignal-Enhanced Power Plants



### SmartSignal Analyzes Multiple Sensor Inputs, Giving Earlier Warning of Failure

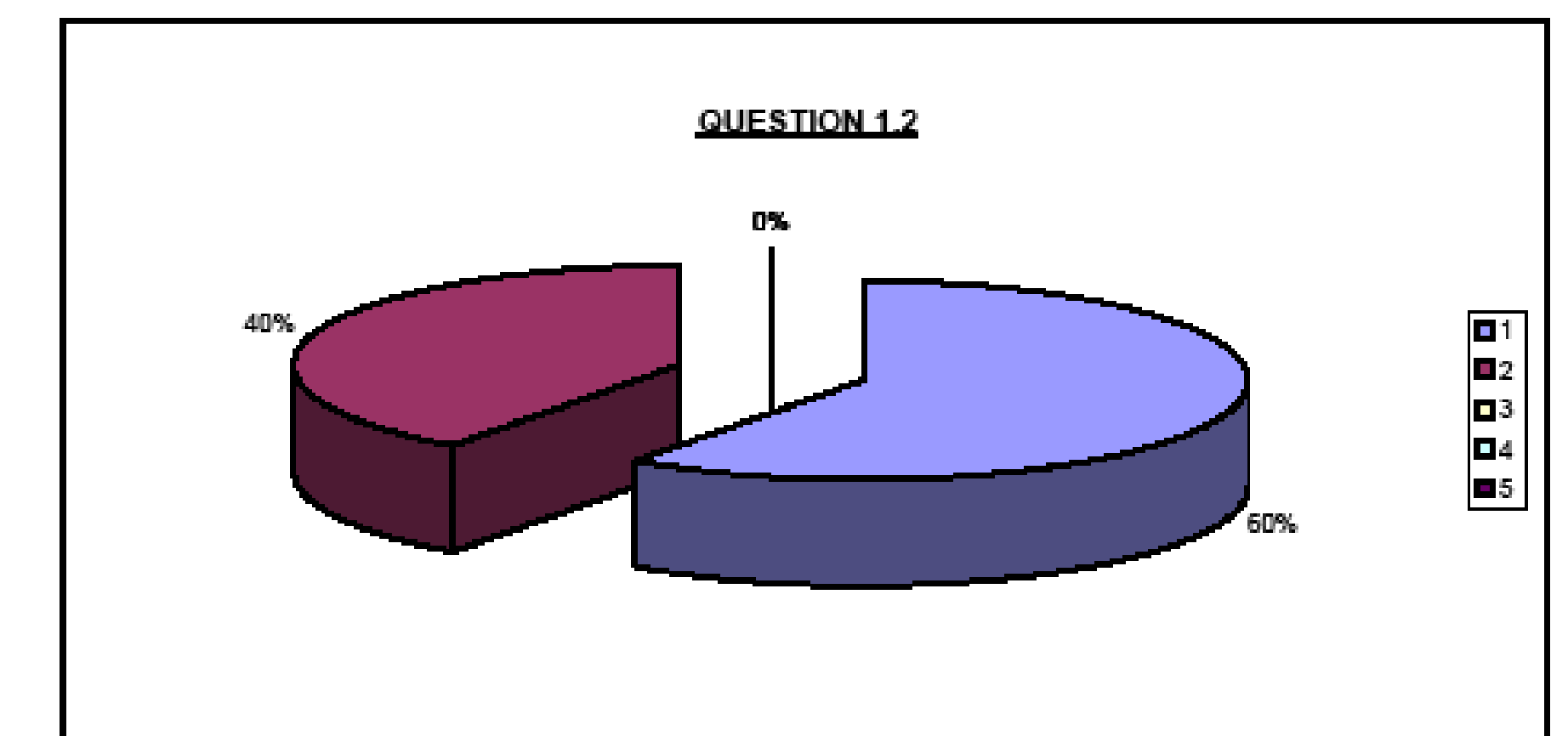
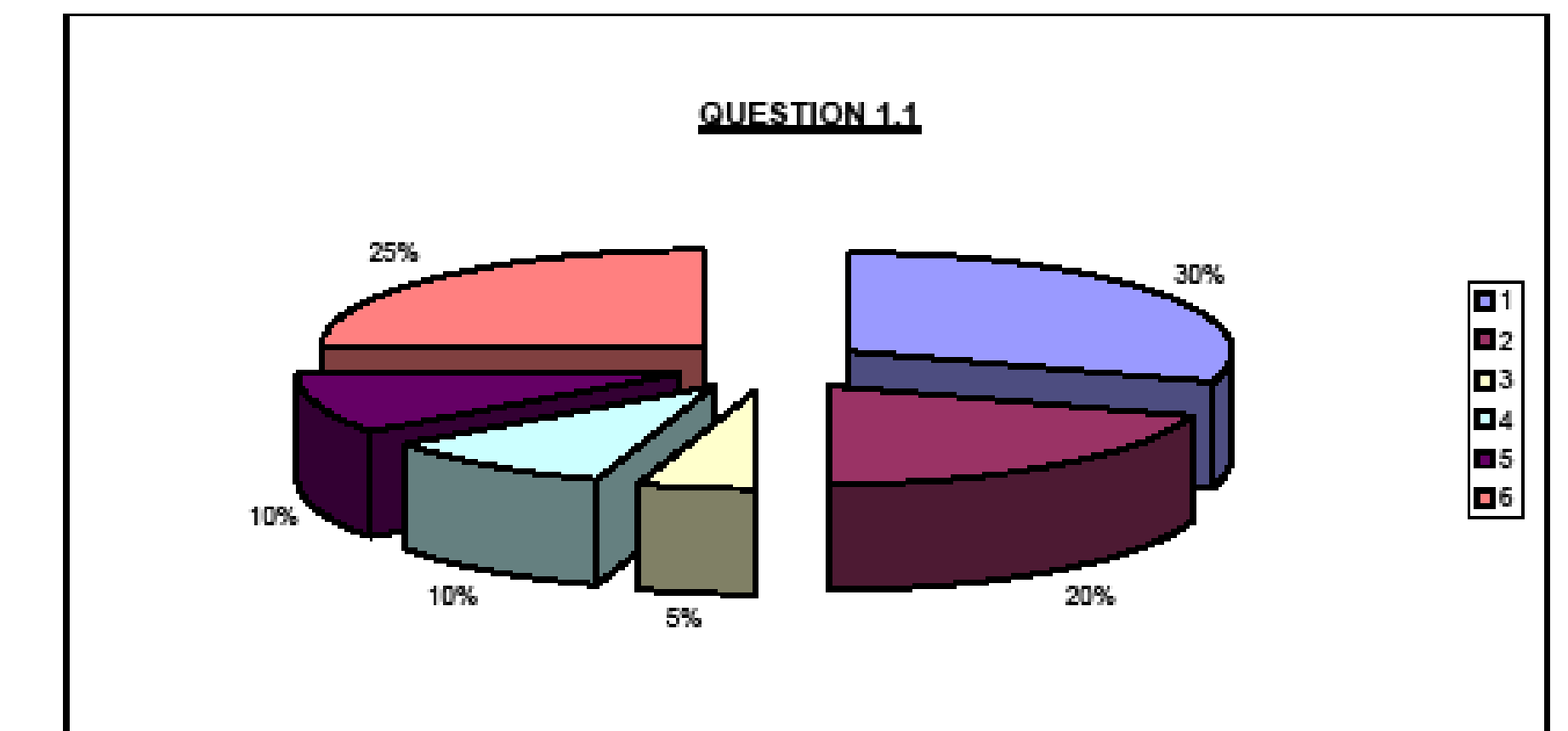


### Legend



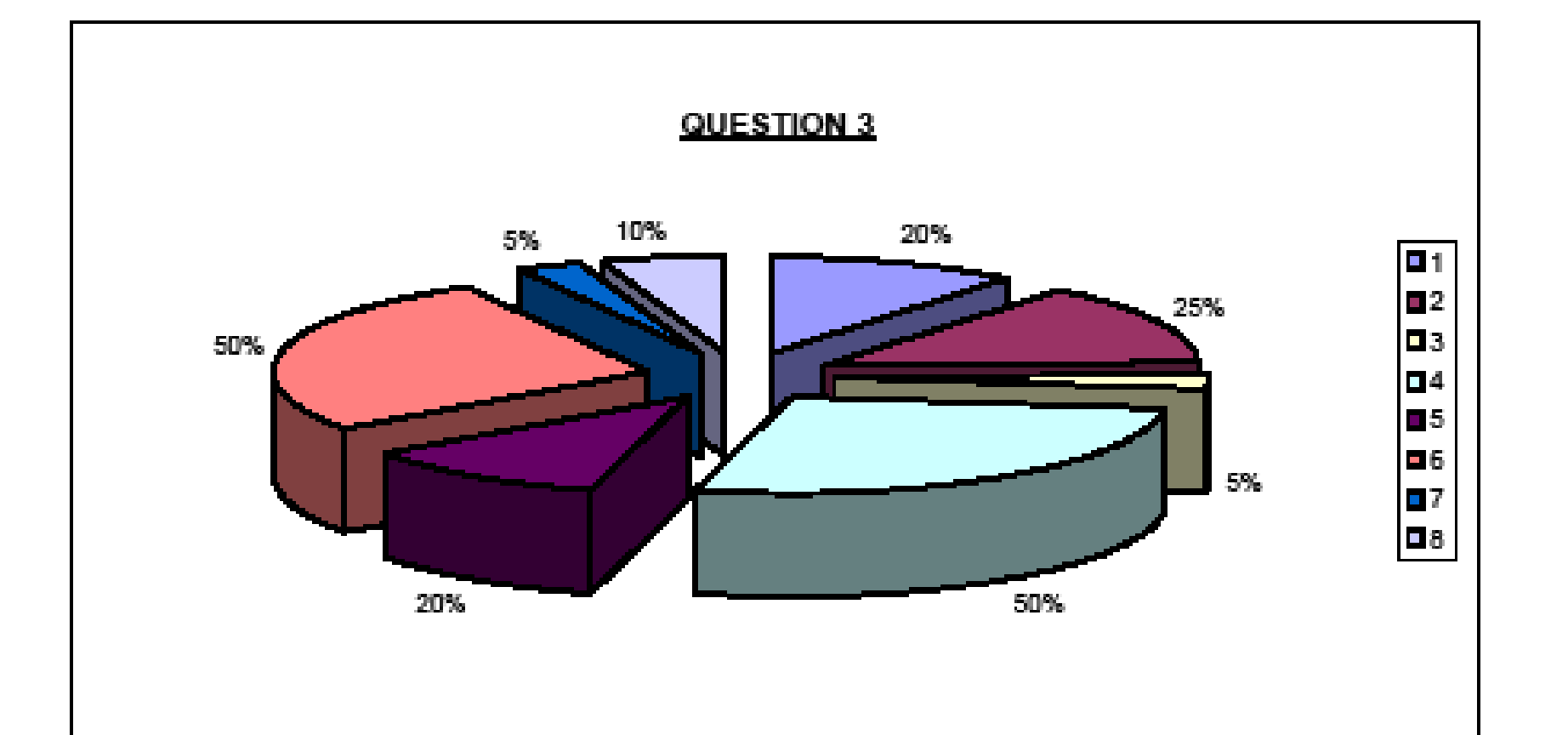
### QUESTION 1

- (1) Please describe your position, background, and plant experience.
- | (1.1)                      | Percentage | (1.2)              | Percentage |
|----------------------------|------------|--------------------|------------|
| 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%        |                    |            |



### QUESTION 3

- (3) Who selects the equipment to be maintained during a planned outage?
- | Role                       | Percentage |
|----------------------------|------------|
| 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 6

- (6) What information do you use to make the selection?
- | Information Source                                 | Percentage |
|--|------------|
| 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%        |

