Remote Monitoring of Electrochemical Protection Systems in North America

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Presented at the 10th International Congress on Metallic Corrosion
Madras, India • November 1987

Use of Electrochemical protection systems (Cathodic, Papritection®, and Anodic) has significantly increased during the last decade. Cathodic protection has been routinely installed on underground structures such as pipelines and storage tanks however, the use of electrochemical protection systems has now gained acceptance to protect the internal surfaces of expensive process vessels. These systems are extremely cost effective but have a common drawback in that periodic monitoring and minor maintenance is required.

Although the corrosion rates of these structures can be high, the corrosion is largely unseen by the operating personnel until a shutdown and/or a corrosion related accident. As such, maintenance staff are busy putting out "fires" directly related to process operations. Many sites, such as gasoline stations, are completely unmanned in terms of maintenance personnel.

In the process industries a typical history of electrochemical protection goes as follows:

1. The corrosion problem is identified and repairs are undertaken.
2. A project engineer is assigned to evaluate long term mitigation techniques.
3. Electrochemical protection is selected as the most cost effective solution.
4. The vendor supplies and/or installs the protection under the direction of the project engineer.
5. The system is energized and functions correctly.
6. At the next shutdown the vessel is carefully inspected and everyone is delighted at the reduction in corrosion.
7. The project engineer moves on to many other projects and the system is handed over to an overworked maintenance staff.
8. The system is accidently turned off and a minor problem develops which goes unnoticed.
9. The next inspection shows significant corrosion and/or a vessel penetration occurs.
10. A fight ensues between the vendor, the owner, and perhaps an outside consultant on why the vessel corroded and who is responsible.
11. The owner doubts the performance of the system and ultimately claims electrochemical protection is not effective.

Type	Cost	No. of Protection Systems per Monitor	Type of Data Available	Method of Transmission	Data Compression to Minimize Connect Time	Possible Programming Changes	Programming Language	Retrievable Information
1	Low	1 - 2	a) Real time only (Instantaneous)	Tone or Digital	No	No (Hard Wired)	N/A	Low
2	Medium	1 - 25	a) Real time b) Limited amount of past data c) Out of control time	Digital	Maybe	Yes	Basic	High
3	High	1 - 10	a) Real time b) Large amount of data c) Out of control time d) Day file showing all events	Digital	Yes	Yes	Machine and/or Assembler	Very High

TABLE 1 • Attributes and Limitations of the Three Major Types of Monitoring Equipment

The Achilles heel of all protection systems is the need for monitoring. Further, the data must be analyzed by people familiar with system operation. Once a defect is found it must be corrected as soon as possible.

Several years ago it became obvious to vendors of electrochemical protection systems that growth of their technology was based on the need to continuously monitor operation of the system automatically and report the data to knowledgeable personnel.

TYPES OF MONITORING REQUIRED

The type and frequency of access of a monitor for electrochemical protection systems depends on the complexity of the protection system and the possible damage resulting from incorrect system operation.

The actual cost of the monitor is also important. It is difficult to convince an owner to spend as much for the monitoring equipment as the protection system. No single piece of monitoring equipment is cost effective for all types of protection systems. As a result, three levels of sophistication have emerged in the North American market place.

SYSTEM GENERALITIES

The majority of monitors share some common aspects. Most are accessed via the standard dial up telephone system by a base receiver. This receiver can be a custom manufactured unit or simply a personal computer with a modem and telephone access software.

Efficient systems can share a phone line with several monitors and/or a telephone, appearing transparent to each other.

The majority of vendors have selected remote equipment that answers only. That is, the equipment near the protection equipment does not phone out. This feature reduces the possibility of owner paid long distance charges, the need of the base station to be connected to the phone system continuously, and the need for the monitor to have the intelligence to recall on a busy signal or call several numbers to obtain a connection.

The remote unit must automatically recover in case of power outages and/or phone line problems. It is imperative that the remote unit be approved for direct connection to the telephone system.

EXAMPLES OF SPECIFIC SYSTEM TYPES

Table 1 highlights the major attributes and limitations of the three categories of monitoring equipment.

Type 1

A typical type 1 system is marketed under the name of "Status Module" (SM). It is a low cost system designed to monitor up to six variables in real time.

The purpose of this device is to monitor lower cost electrochemical protection systems such as cathodic protection of underground gasoline tankage, elevator hydraulic cylinders, and process vessels suffering from low corrosion rates without protection.

The Status Module (SM has the following features:

- Shares an existing telephone line.
- Monitors up to six parameters with a resolution of 1 mV.
- Interrupts the protection system to obtain and transmit "instant-off" potentials.
- The telephone connect time is less than 60 seconds to minimize long distance telephone charges.

This unit has no programming capabilities. In lieu of expensive modems, this unit uses frequency information to transmit the data.

Type 2

In order to reduce the hardware costs of type 1 systems, no flexibility exists to change the monitor's operation.

Type 2 systems are the entry level of computer controlled data acquisition devices. These monitors can be programmed to accomplish specific functions.

Programming is usually accomplished in Basic, making programme changes relatively simple. Type 2 systems can store data for later downloading.

Access to this previous data (t^-) can be invaluable to determine not only that a problem exists but also when and why the problem occurred.

To gain some insight into type 2 systems we will review a product marketed under the name of a Remote Monitoring Unit (RMU).

Instead of developing a custom computer, the developer of this unit interfaced custom hardware and software to a commercially available portable computer (Figure 1). This approach produces an extremely cost effective product.

This type 2 unit has the following specifications:

- Standard number of input channels - eight.
- Expandable number of input channels - up to 128
- Data resolution - 12 bits
- The RMU can be configured to:
  - alarm on malfunction of the protection system and walk maintenance personnel through trouble-shooting/restart procedures
  - record the amount of time a parameter is out of range
  - provide weeks of past data on access
  - compress the transmission of data to minimize long distance telephone costs.

Figure 2 indicates a typical use of the RMU in conjunction with cathodic protection of concrete.

Type 3

The highest level of monitoring equipment is extremely useful to provide high data resolution and large amounts of previous data (months). These types

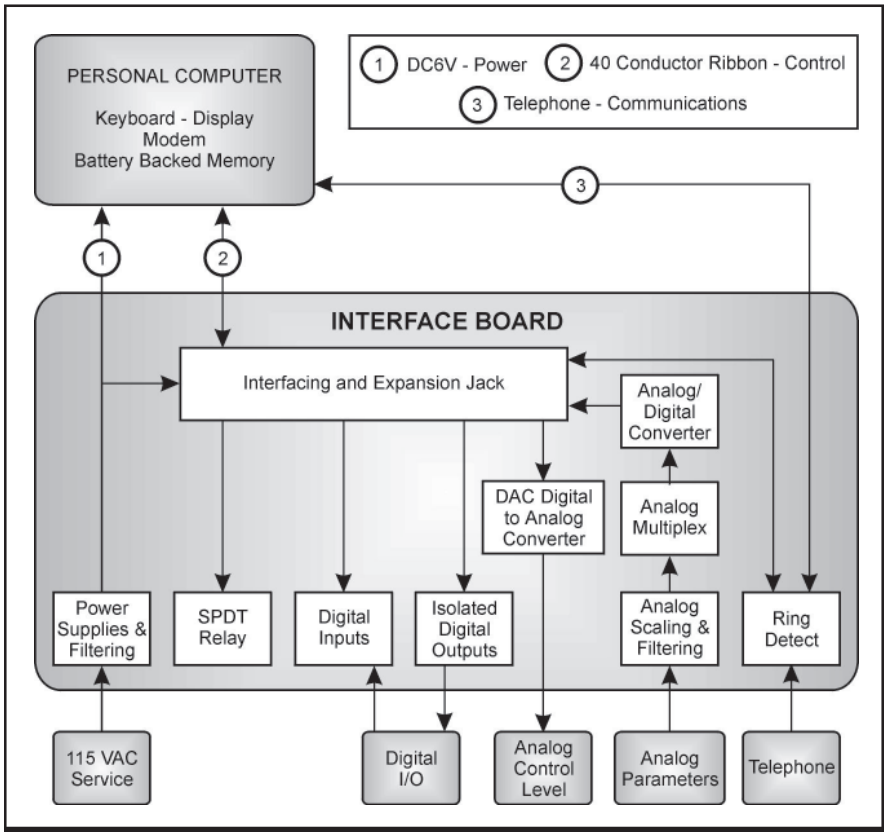

FIGURE 1 • Block Diagram of a Type 2 Monitoring Device

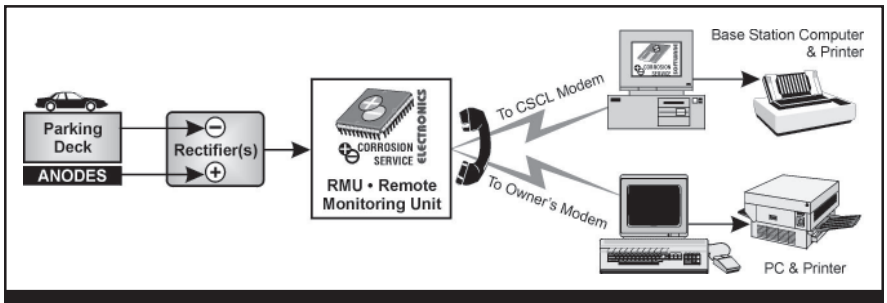

FIGURE 2 • Use of a Type 2 System to Monitor Cathodic Protection of Reinforced Concrete

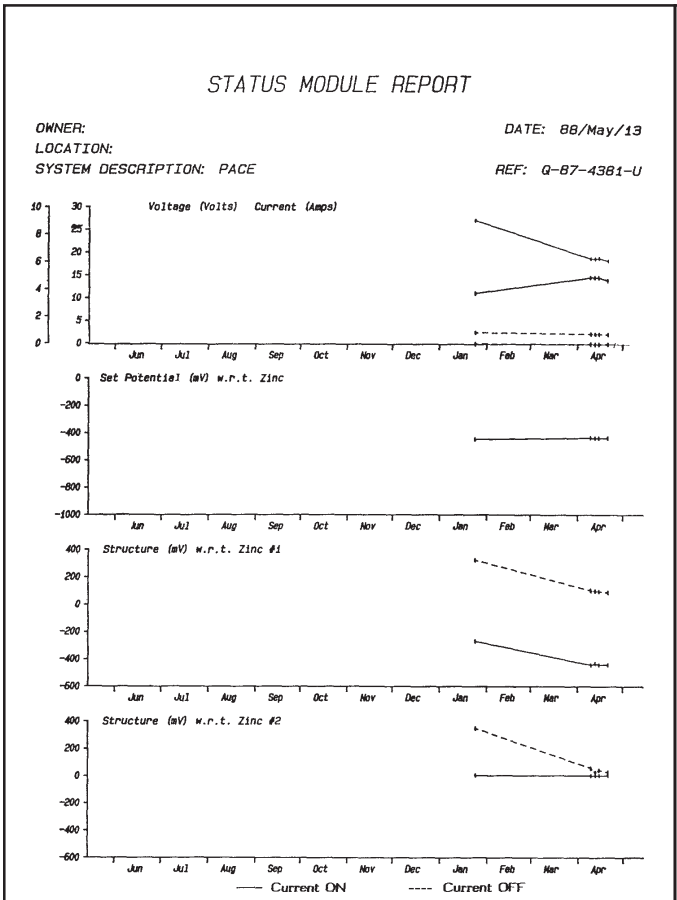

FIGURE 3 • Type 1 Plotted Output

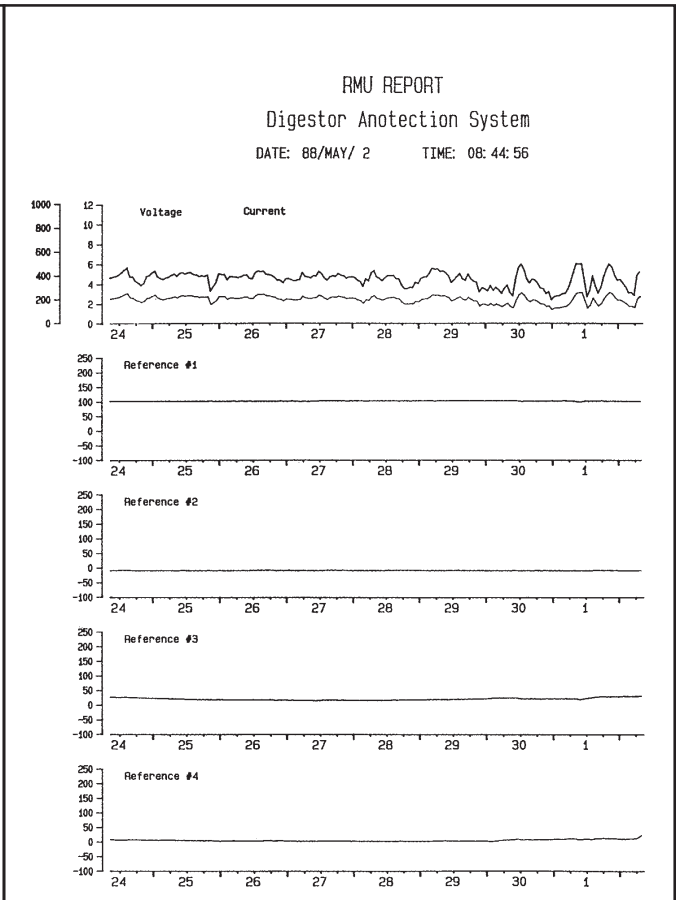

FIGURE 4 • Type 2 Plotted Output

of systems are specified for protection systems that are essential to operate continuously and/or where a minor amount of downtime will result in significant amounts of corrosion.

A typical piece of equipment marketed as a type 3 device is a Computer Communications Unit (CCU).

Data is simultaneously stored in two forms. The 30 day information will ultimately appear as in the form of a strip chart recording. Unlike a simple strip chart recorder, however, all data is synchronized in time. An event can then be traced to a particular process change and/or interruption.

In addition, data is stored in a histogram form in order to quickly analyse the electrochemical protection parameter. For instance, if the protection system is potential controlled, a quick review of the potential histogram will determine the amount of time the vessel potential was carefully controlled.

Protection of process vessels usually results in dynamic changes in the system output to combat process changes causing corrosion. Therefore, detailed information is required to determine system effectiveness.

A day file indicates all activities that have occurred to the monitor such as valid access (with password), attempted invalid access (computer hackers), power outages, etc.

BASE STATION

Although a base station can be in the form of a personal computer, additional hardware is normally required to produce easily understood information. Most data is outputted on a computer controlled plotter. Typical examples of plotted data are shown in Figures 3 through 5.

DATA HANDLING

Although remote monitors automatically collect the data, a regimented schedule of downloads must be undertaken. The information about a system malfunction is of no use if it simply resides in a memory chip.

The frequency of access to the information depends on the sophistication of the monitoring equipment (type 1, 2, or 3), as well as the ramifications of a protection system malfunction.

Our company accesses data at least weekly and reports this information monthly if no problem exists. On the other hand, a problem must be communicated to the owner immediately.

Most owners have contracted with a corrosion engineering firm to routinely access and report the data. The information is therefore reviewed by people intimately familiar with system operation. The chances of overlooking a system malfunction is significantly reduced.

Frequently, the owner will also access the monitor usually as a spot check on system operation.

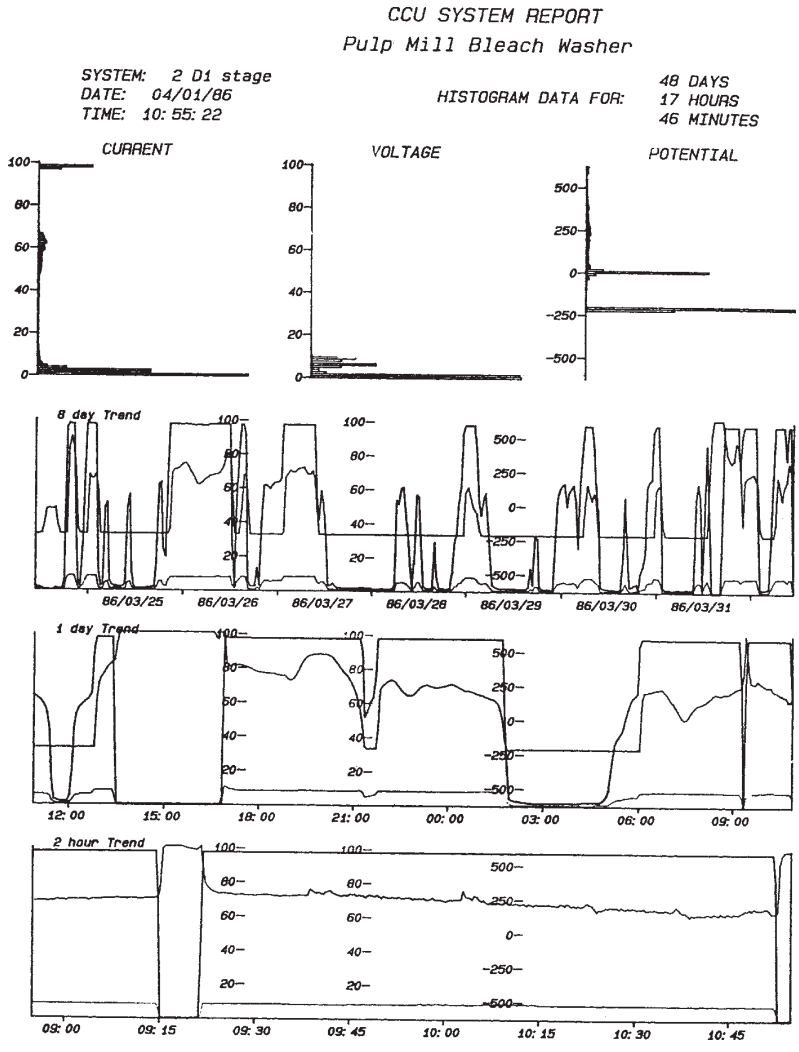

FIGURE 5 • Type 3 Plotted Output

SUMMARY

In North America, the application of electrochemical protection is increasing in volume and sophistication. A major part of this advance comes from the availability of cost effective remote monitoring equipment.

Many different types of monitoring equipment are available. It is important for the owner to choose the type of monitor, frequency of access, and reporting method carefully in order to provide the information required.

Although this paper focused on monitoring of electrochemical protection systems, corrosion and process monitoring can be undertaken in lieu of and/or in conjunction with protection systems. Virtually any parameter that can be converted to a voltage level can be continuously accessed.