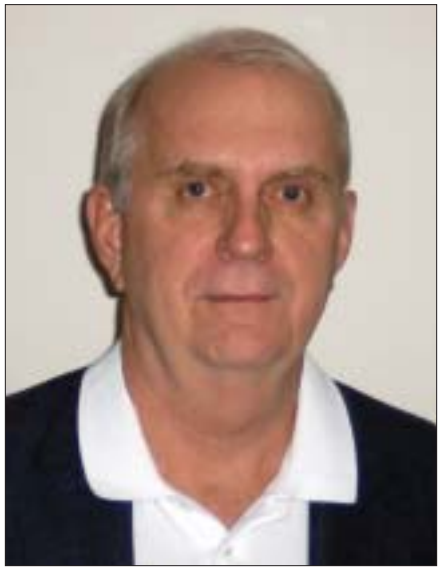
THE *NUCLEAR NEWS* INTERVIEW

Ron Davis: On the industry's Equipment Reliability Index

An industry collective is creating a standardized measure to gauge the health of plant equipment.

The Equipment Reliability Index (ERI) is a measure used to gauge the health of equipment at a single nuclear power plant—or at a fleet of plants—by defining the key plant programs and processes that must perform effectively to ensure safe and reliable operations. These processes that are defined by performance metrics are used in the ERI to highlight past achievement and predict future performance.



Davis: "The ERWG is providing the plants with guidance so they can make intelligent decisions."

Currently, an industry collective—the Equipment Reliability Working Group (ERWG)—is developing an ERI template consisting of standardized input measures to compare performance in key areas across the industry. The ERWG was born in December 2003 when various industry groups—the Nuclear Energy Institute, the Electric Power Research Institute, and the Institute of Nuclear Power Operations (INPO)—decided to come together to form one entity that could speak for the industry with regard to equipment issues. Each nuclear utility in the United States has at least one representative on the ERWG.

Ron Davis, the Equipment Reliability Lead for Entergy Nuclear South, has been involved with the ERWG since its inception. He is the chairman of the ERWG subcommittee that was tasked with making recommendations for standardizing the ERI.

Davis has been with Entergy for eight years in various assignments, but never far from the equipment. Before that, he was a contractor to the nuclear industry for almost two decades, working on various initiatives and new plant pre-operational testing "back when the last nuclear units were being constructed and tested," he said.

Davis talked about the development of the standardized ERI with Rick Michal, *NN* Senior Editor.

What is the ERI and how does it work?

The ERI is the Equipment Reliability Index. It's a metric—a performance indicator—used for gauging equipment reliability. The ERI could be used to measure performance at one specific plant but also for a whole fleet of plants. That means that each plant in the fleet could have an ERI, and those ERIs could be compared from site to site to a common set of parameters.

These parameters consist of what are called "lagging" or "leading" subindicators, which are tied to the plant's processes that are required for safe and reliable operation. An ERI involves defining key plant processes that must work effectively—such as work management, maintenance effectiveness, long-range planning, etc.—and then identifying a metric that depicts the effectiveness of each process.

The ERI is not tied specifically to the nuclear industry. If there is a defined set of processes that are required to function properly for satisfactory performance, an ERI could be created for that industry. For example, the process could be a corrective maintenance program at a nuclear plant, or a widget-production facility at a processing plant. It's just a matter of defining processes—those that are required to operate properly—and then developing a metric for each process. The sum of the weighted defining process metrics is the ERI.

Which nuclear plants are using an ERI?

Most sites in the United States use it in

some form or fashion. Some ERIs are called Plant Health Indexes, for example, while others are called Critical Component Clocks that reset when a critical component fails. [Critical component as defined by INPO AP-913. The AP-913 describes an equipment reliability process to assist plants in maintaining high levels of safe and reliable operation in an efficient manner.] Whatever the name, each individual ERI consists of a certain number of subindicators. The lowest number of subindicators used in the industry is five, while others have used as many as 20.

ERI Subindicators	Industry ERI Count (15)
Corrective Maintenance Backlog (non-outage)	14
Forced Loss Rate/UCLF	12
System Health	9
Safety System Availability	8
Unplanned LCO Entries (SD)	7
Equipment-related Power Reductions	6
Operator Work Arounds	6
Deferred Preventive Maintenance Activities	5
Maintenance Rule System Performance (FF)/MPFF	5
Preventive Maintenance Program	5
Unplanned SCRAMS	5
Unit Capability Factor	5

ERIs used in the industry track a variety of equipment reliability subindicators, the most popular one being for corrective maintenance backlog, tracked by 14 of 15 plants surveyed by the ERWG.

What is a "lagging" subindicator?

Lagging is a reflection of something that has already occurred. For example, it could be a plant's electrical generation or force loss rate for a specific period of time. The plant could assign a metric to each one of those subindicators so that performance could be monitored. These specific parameters represent the outcome of specific key processes required to support satisfactory performance and are therefore lagging.

What is a "leading" subindicator?

Leading or lagging has to do with the information that is being portrayed by that subindicator. It all depends on the status of the process being measured that decides whether it's leading or lagging. For example, using a subindicator for corrective maintenance backlog, if a plant has a metric that monitors the average age of corrective maintenance, then this indicator is leading. If, on the other hand, the plant is monitoring the number of corrective maintenance work items in the backlog, then the subindicator would be lagging, since the effectiveness of a plant's processes cannot be described by a bulk number.

By using the work management process defined by INPO AP-928, a corrective maintenance work issue could normally take 13 weeks to process through the system, and, therefore, the average age of the backlog should be about 90 days. If the average age of a specific backlog is 250 days, then analysis should be performed to determine the "whys" behind the backlog.

Who inputs the information into the ERI?

Continued

Subindicators	Voted Leading, Lagging	General Group	Indicator Type	ERI Usefulness/ Applicability (1, 2, 3, 4, 9)	Weighting 1-9 (1 Hi, 5 Med, 9 Lo)
Corrective Maintenance Average Age (non-outage)	Leading	MA	Corrective Maint.	1	2
Grace Period Management	Leading	PM	PM Program	1	2
Percent of systems with LCM Plans complete	Leading	LT	Long Term Planning	1	8
Long-term planning incorporated into plant budget	Leading	LT	Long Term Planning	1	5
As-found equipment condition feedback trending/actions	Leading	PM	PM Program	1	5
Red/Yellow System Action Plan Status - planned vs. completed (Or System Color Age)	Leading	WM	Work Management	1	5
Work Management Effectiveness	Leading	WM	Work Management	1	5
Work Week Schedule Stability (T12-T6)	Leading	WM	Work Management	1	5
Work Week Schedule Stability (T6-T1)	Leading	WM	Work Management	1	5
Work Week Schedule Adherence T0	Leading	WM	Work Management	1	5
Deferred Preventive Maintenance Activities	Leading	PM	PM Program	1	8
Percent of Work Orders with As-found Feedback	Leading	PM	PM Program	1	8
Thermal Performance	Leading	EG	Thermal Performance	2	5
91-18 issues average age (non-outage)	Leading	LT	GL 91-18	2	5
CMs on Critical Equipment	Leading	MA	Corrective Maint.	2	8
Total Work Order Backlog (non-outage, non-DCN, plant process eq.)	Leading	MA	Corrective Maint.	3	5
Equipment Failure Event Free Days / MRFFs	Leading	OP	Organizational Performance	3	8
Predictive Maintenance - components in Alert Range	Leading	PM	Monitoring & Trending	3	8
Corrective Action effectiveness, Rework, Repeat MRFFs	Leading	OP	Corrective Action	4	8
PM change backlog - age	Leading	PM	PM Program	4	8
IST Equipment in ALERT	Leading	SH	Monitoring & Trending	4	8
PM/CM Ratio on critical equipment	Leading	PM	PM Program	4	9

A chart of "leading" subindicators

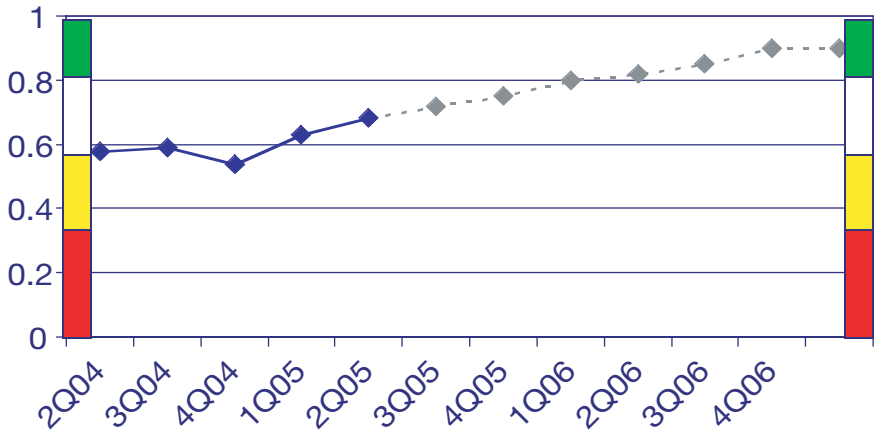
Subindicators	Voted Leading, Lagging	General Group	Indicator Type	ERI Usefulness/ Applicability (1, 2, 3, 4, 9)	Weighting 1-9 (1 Hi, 5 Med, 9 Lo)
Forced Loss Rate/UCLF	Lagging	EG	Generation	1	2
Equipment-related Power Reductions	Lagging	EG	Generation	1	2
Corrective Maintenance Backlog (non-outage)	Lagging	MA	Corrective Maint.	1	2
System Health	Lagging	SH	System Health	1	2
Unplanned LCO Entries (SD or <72 hr)	Lagging	MA	Operations Challenges	1	5
Safety System Availability	Lagging	SH	System Health	1	5
Corrective Actions on Significant Equipment Failures > 6 mo.	Lagging	OP	Corrective Action	2	5
Unplanned SCRAMS	Lagging	EG	Operations Challenges	3	8
Unit Capability Factor	Lagging	EG	Generation	3	8
Operator Work Arounds	Lagging	OP	Operations Challenges	3	8

A chart of "lagging" subindicators

Each key process or program owner at the plant is normally assigned responsibility for a performance metric. If a specific subindicator reflects unsatisfactory performance, that owner would investigate to determine the "whys" of the negative performance and corrective actions specified.

Is the ERI produced as some sort of chart, so that historical performance can be easily seen?

The ERWG provides examples of other utilities' ERIs, but does not recommend one method of representation over another. For example, the ERI can be scaled from 0 to 100 percent, or 0 to 10, or color coded for ease in communication. Most industry ERIs include a graphical representation of the specific subindicators comprising the ERI and the trended ERI number. Specific goals for each subindicator should be assigned, with actions required for unsatisfactory performance.



Equipment Reliability Index	Site A
✶ Electrical Generation	Yellow
✶ Challenge to Operations	Green
✶ System Health	White
✶ Maintenance	Red
✶ Work Management	Yellow
✶ Long Term Planning	White
ERI Color	**White**
ERI Value	**0.65**

An example of an Equipment Reliability Index

How does an ERI forecast future performance?

Some of the specific leading subindicators give intelligence that can be acted upon immediately to improve performance. Other leading and lagging subindicators must be trended to gain intelligence. I will use Preventive Maintenance (PM) Deferrals, a lagging indicator, as an example. One month, a plant may have to defer a PM past its late date to allow more urgent work to be performed. The next month, several other items are deferred, and the trend continues for months afterward. The one month's data point may not be significant, but several months may indicate a problem with the plant's ability to manage workload. The problem then needs to be acted upon because deferring PMs can lead to negative plant performance.

By using an ERI, is a plant trying to cut down on maintenance activities or be able to schedule jobs more efficiently?

Corrective maintenance is an ineffective use of plant resources and it challenges all plant processes. The ERI provides intelligence for action to ensure maintenance is performed to prevent failures instead of reacting to component failures.

Is there an ERI goal for the industry, similar to INPO's yearly performance indicator program, which sets milestones to be reached?

The ERWG is working on a metric so utilities can compare performance in key areas against each other. An ERI goal, or number, for the industry is currently not part of the scope of the ERWG.

Could you explain how the ERI uses weighting?

The recommended ERI is a compilation of key plant metrics. What the ERWG recommends is that the weight assigned to each subindicator should be relative to its impact to plant performance. What the ERWG is proposing is that each subindicator be weighted based on business requirements and the cultures at each site or utility. During the ERWG industry benchmark, it was noted that some utilities approach 1 for satisfactory performance while others approach 100.

How does an ERI help change a plant's work culture?

The ERI is a tool used to project equipment health. By monitoring key plant process effectiveness, areas for improvement are highlighted and actions are taken to resolve negative performance in the area. The ERI can be discussed at management meetings and displayed in key areas of the plant. The idea is to change the culture from one of lagging, or reacting, to equipment issues, to one of leading, or an-

ticipating, equipment issues before they occur.

What are the strengths of the ERI program?

The strengths are that it provides information for management to take action before any particular process can negatively affect plant performance. For instance, a plant may decide to reduce a large Elective Maintenance Backlog. I'll define elective maintenance as those components that are degraded, but not to the point where they are considered unable to satisfy their design functions. The ERI may include a subindicator for PMs in the grace period, i.e., PMs past their due date, but before the PM late date. The risk of component failure increases as the PM late date draws nearer. An effort to reduce elective maintenance backlog may result in an adverse trend in the management of the PM grace period that increases risk of failures. The ERI would provide information needed to identify the cause of unanticipated equipment failures and trigger actions to prevent recurrence.

Does the ERI have limitations?

Any performance metric has limitations. If a plant manages the indicator and not the underlying issues, then it will not be effective.

What does the future hold for the ERI program?

Right now, the ERWG is looking at providing a standard set of subindicators that all plants could use to provide data so they can be gauged against each other. The ERWG will call it the ERI Estimator, consisting of 20 subindicators with specified goals for ranking a plant's health in each area. [The ERI Estimator was scheduled to be presented at the Equipment Reliability Forum taking place in Nashville, Tenn., September 19–20, 2005.]

Was there a pilot program to test the ERI initiative?

Yes, there was, and it's still ongoing as we speak. The pilot program has participation from plants operated by various utilities: Entergy, Dominion, Nuclear Management Company, Florida Power & Light, Exelon, and also some plants involved with the Utilities Service Alliance's Strategic Teaming and Resource Sharing (STARS) initiative, among others. People from those utilities pulled the industry ERI data together and turned it over to the ERWG formally to issue a standardized ERI. The pilot started in 2004.

What has Entergy's experience been with an ERI?

Entergy has had an ERI for more than three years and it has evolved. At first the ERI was composed of lagging subindicators, but as we gained insight and improved performance, we added some subindicators and retired others. We have been looking for the proper mix of subindicators to predict future performance.

Entergy has used the lessons learned from the ERWG and is now compiling what we call a Reliability Culture Index. This index will comprise a mix of weighted leading and lagging subindicators. We will be transitioning to the Reliability Culture Index, which will have 16 subindicators. We are currently doing data sampling and testing to make sure that we get the right weighting for our specific subindicators before we roll it out.

How often is an ERI updated?

It depends on the plant. Entergy updates on a monthly basis except during outage months, but there are plants that update on a quarterly basis. The ERWG recommends quarterly updates, but for the industry as a whole, I'd say it's 50–50—monthly versus quarterly.

Even though the ERWG will look to standardize the ERI, will there be customizing done on a plant-by-plant basis?

Absolutely, based on a plant's needs. The ERWG is just providing the plants with guidance so they can make intelligent decisions on what those subindicators should be for their specific site. NN