LIFE EXTENSION EVALUATION CONSTITUENTS AND EXPECTATIONS

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ABSTRACT

The phrase Life Extension may be new and relatively unfamiliar to some, but for many of you, it will be recognized as a formal approach and packaging of many long established inspection services, diagnostic testing, preventative maintenance and operating techniques which have in part or wholly been utilized within your generating system.

A Life Extension Evaluation Program and its complexity are directly related to the long range plans and operating requirements which the utility must establish to satisfy its system needs. The objectives and flexibility of this element are extremely important in determining the extent of sophisticated non-destructive and/or destructive testing and analytical program to satisfy the comfort level in Life Extension prediction.

When considering extended operation as an alternative to retirement, and/or replacement, it is essential that a remaining-life evaluation be performed. This study should provide the owner with sufficient information on the condition of his equipment in order to evaluate the economics and scheduling required to extend the equipment's useful operating life. Further, it should consider those state of the art methods to minimize the uncertainties in predicting useful life, particularly for those components which are essential to achieve the desired result in the steam generator.

This paper is intended to address the expectations and constituents of a Life Extension Evaluation.

BACKGROUND

There are approximately 2,700 fossil fired generating units operating in the United States today. About 50% of these units, representing 25% of current capacity, will be 30 years old by 1990. Originally, these units had an anticipated commercial life of 25 to 30 years before being retired and/or replaced with equipment designed for increased capacity levels, higher efficiency, improved availability and specific duty requirements. These older generating units are presently assuming an increased burden to provide a reliable source of electric power and the trend is expected to continue on through the 1990's. Studies have shown a pronounced increase in the number of forced outages as a steam generating unit nears 25 years of age. While it may be assumed this phenomenon occurs as a result of components aging and wearing out, it is not necessarily the case. Reduction in maintenance programs and/or changes in duty cycles may have contributed to these conditions.

The high cost of new plant construction has played a significant role in the consideration for Plant Life Extension. With the costs of new plant construction averaging $1,500/kw, extending the life of an existing facility can be accomplished for significantly less capital and the expenditures spread out over a period of time. Depending on operational requirements, some utilities may require only small expenditures beyond normal maintenance costs to upgrade equipment for Life Extension purposes.

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The requirements for permitting a new generating facility can be orders of magnitude greater than the limitations imposed on existing plants. Particulate emissions, sulfur dioxide limits, thermal requirements, ash and waste water disposal are but a few of the environmental issues which contribute to a significant increase in plant operating costs. Some regulations can be prohibitive to Life Extension consideration. If the changes proposed to the plant should cause the facility to be designated as "reconstructed" or as a "modified source", then the plant may be required to meet those environmental restrictions as outlined in the New Source Performance Standards (NSPS).

Many of the older steam generating units were originally designed for base load operation, but have since been relegated to cyclic or peaking type duty. Component wear from cycling is not necessarily related to the equipment's age. Problems may occur in relatively new units if not specifically designed for cyclic operation. Cyclic duty imposes transient thermal changes that can cause low-cycle thermal fatigue of restrained or thick wall components. Particular areas of concern with cyclic operation include the economizer inlet header, main steam drum and connections, furnace wall tubes and attachments, superheat/reheat outlet headers and nozzle connections.

LIFE EXTENSION

Plant Life Extension is the process of rehabilitation and/or operation of older generating units beyond their originally intended commercial life. Although the principal objective of a Life Extension Evaluation is to defer new capacity additions, other considerations may include upgrade in plant capacity, improved availability and reliability, improved operational efficiency and revised maintenance and operating procedures. The extent and magnitude of each study is tailored to the needs and requirements of the equipment owner. It is essential that these factors be clearly understood by all participants prior to undertaking any Life Extension Evaluation.

Many assumptions are required when performing a Life Extension Evaluation. Often these assumptions play a more pronounced role in the decision-making process than the assumptions required during the original design of the unit. Accordingly, there are more risks associated with assumptions. Primarily, these risks and assumptions have to do with how the unit has been operated over the past 20 or 30 years. Particularly, how consistently it was operated within specified parameters. Temperature and pressure excursions can cause undetected weakening and/or damage to components, and generally these occurences are not well documented.

INFORMATION GATHERING AND ANALYSIS

The manufacturer's expertise becomes invaluable integrating the information available on a unit's present condition and expected future operating requirements. A review of the owner's operational, maintenance and forced outage record, a comparison of actual performance characteristics to original design calculations and utilization of a data base of comparative experience are key factors in performing the analytical evaluation, which is performed in conjunction with a physical inspection of the equipment, non-destructive testing and component sampling. This information will establish a detailed histogram for critical components and will allow an analysis of the operating impact on existing material conditions for fatigue and/or creep considerations (Figure 1). It will also provide information necessary to predict performance characteristics under proposed operating requirements and make recommendations on revised operating and maintenance procedures.

The physical inspection of the steam generator will be performed by a multi-disciplined task force consisting of Engineering, Service and Construction personnel. Prior to a scheduled outage, a review of actual operating procedures will be conducted at the plant. Boiler operation during start-up, shut-down and cycling modes will be monitored (Figure 2). The unit will be walked down while in operation to observe operating conditions, expansion movements and obvious external problem areas which may exist. During the scheduled outage, the unit will again be walked down performing a visual inspection of all equipment and components. Measurements will be taken and observations recorded. Those areas included in the inspection are all pressure parts, structural supports, air and flue gas systems, boiler structure and setting, and the associated fuel systems.

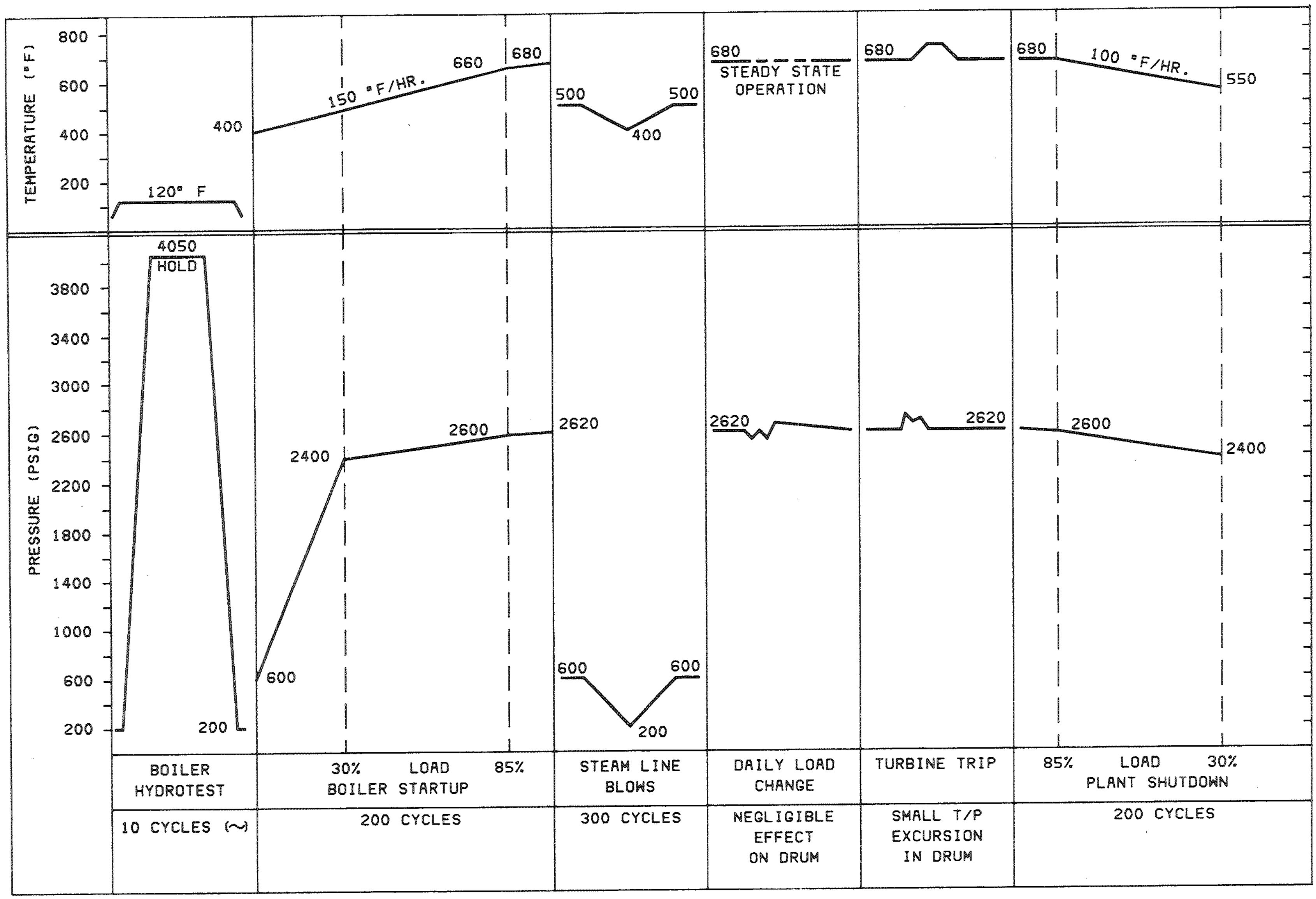

Figure 1 Histogram of a Base Loaded Boiler Drum

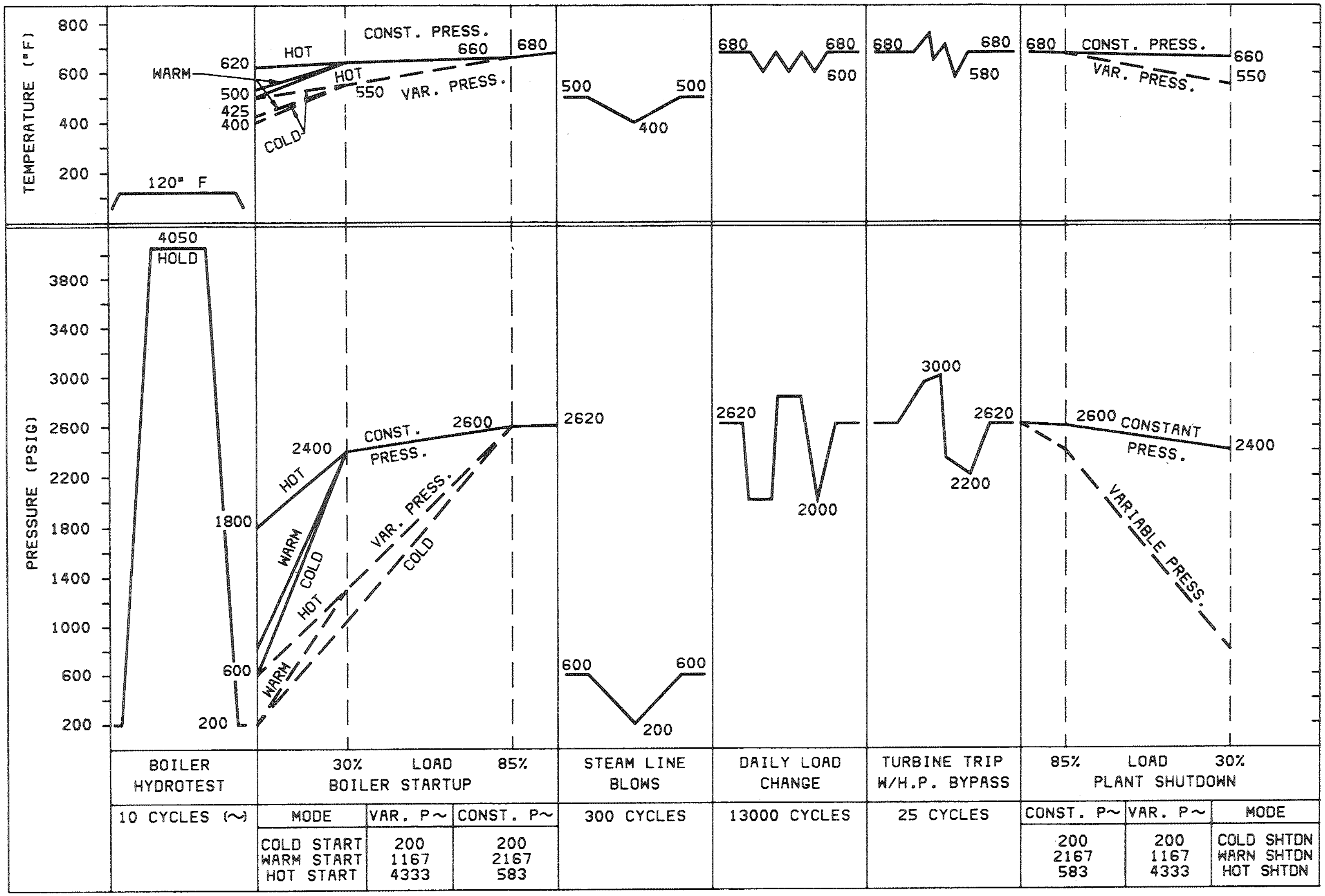

Figure 2 Histogram of a Cyclic Boiler Drum

DIAGNOSTIC PROCEDURES

Non-destructive examination is utilized to obtain a more complete picture of a component's condition. Ultrasonic testing will provide information on a component's material thickness but will not provide data on its physical condition. Dye penetrant and magnetic particle testing will provide information on surface conditions, but will not reflect structural variations through the thickness of a component. Replication is a more sophisticated technique utilized to identify surface metallurgical integrity. It involves the use of plastic film to obtain a reverse image of the component's surface very much like a fingerprint. The replication may provide evidence about failure mechanisms and service conditions. It too is limited to accessible surfaces and cannot provide information on structural variation through the thickness of a component. Radiography may be utilized to obtain information on conditions which exist through the thickness of a component, particularly in the area of weld connections for thick-walled components. Non-destructive examination is an extremely useful tool in failure investigation and analysis. Although it is unreasonable to assume that all imperfections will be detected, it does provide a means to assess those failure mechanisms that are more likely to occur.

Destructive sampling for laboratory analysis is necessary to address the physical condition of the component material. Metallurgical investigation will evaluate micro structural change which may effect the material's physical properties. Metallurgical and chemical analysis will also assess the effects of corrosion, erosion, deposition, fatigue, creep rupture, embrittlement and temperature on materials and assist in determining the root cause of failures.

SUMMARY

In summary, a Life Extension Evaluation is no more or less than equipment owners want it to be, since they make the ultimate decision, and they must decide on the extent of evaluation and testing necessary to satisfy their concerns. In order to minimize those concerns, Riley will ensure that a strong, effective communication network is established at all levels of engineering and management during the course of a Life Extension Evaluation Program.

As the original equipment manufacturer, Riley Stoker provides much expertise, information, and generic experience to the performance of a Boiler Life Evaluation Study.

The benefits realized from a Life Evaluation Study are many and include:

- — a detailed reporting of current physical condition of equipment.
- — a determination of the feasibility, scheduling and cost to extend the boilers operating life for a designated period of time.
- — a determination if boiler uprating can be accomplished in a Life Extension Program.
- — a determination if improvement in operating efficiency and boiler availability can be accomplished in a Life Extension Program.
- — a definition of the boiler's operational requirements in the extended life period.

The Company reserves the right to make technical and mechanical changes or revisions resulting from improvements developed by its research and development work, or availability of new materials in connection with the design of its equipment, or improvements in manufacturing and construction procedures and engineering standards.