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THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

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To: N. S. EMBREY - MANAGER, MARKETING DEPARTMENT

CONFIDENTIAL

From: S. H. ESLEECK - MANAGER, NUCLEAR PROJECTS MARKETING

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Subj. PRESENTATION FOR B&W SYSTEM RESPONSIVENESS	Date JULY 31, 1979

This letter to cover one customer and one subject only.

In response to your request for an August 1 , draft and/or status of the subject presentation and supplemental to my letter to you of July 26, same subject, the attached two narratives are presented, i.e.

1. B&W NSS RESPONSIVENESS (Bucking Bronco Syndrome). Dated July 31, 1979

2. B&W NSS AND FEEDWATER SUPPLY. Dated July 30, 1979

The attachments represent my thoughts and observations after lengthy discussions and analysis with numerous B&W personnel and others. While there may be some differences of opinion on some specifics, there is complete agreement relative to the overall concern of systems operations and reliability and that we have only begun to scratch the surface of the problem.

I draw your attention to Attachment #2 and my discussions of TVA's Bellefonte Units 1 and 2, and the recommendation presented.

S.H. Esleeck

S. H. Esleeck

SHE:emt
Attachments

cc: w/attachments

D. H. Roy
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Good job

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B&W NSS RESPONSIVENESS

At a congressional hearing, following the TMI-2 incident, and as a reaction to a particular presentation, Senator Moynihan of New York, referred to the B&W Nuclear Steam System as a "Bucking Bronco".

The Bucking Bronco Syndrome refers to the frequency and magnitude of the changes in five basic parameters in the B&W NSS system primarily during plant upsets. These parameters are:

1. R.C. pressure
2. Pressurizer level
3. Reactor coolant temperature
4. OTSG pressure
5. OTSG water level

The first three, R.C. pressure, pressurizer level and reactor coolant temperature, are responding to the perturbations being passed through by the OTSG. The R.C. system responds rapidly to the OTSG because of the close coupling of the two. This close coupling is a result of an inherent characteristic unique to OTSGs., which is, the variation in boiling and solid water heat transfer surface area on the secondary side. This heat transfer surface area variation is directly proportional to the OTSG water level, i.e., its inventory. This inherent characteristic that allows for close coupling has a distinct advantage in controlling overall system responses to major plant power changes. Such a characteristic does not exist in recirculation boilers and as such, close coupling for speed of response does not exist.

Relative to the Bucking Bronco Syndrome, most of the fluctuation in the five parameters listed are more pronounced than they should be. This is because the feedwater systems response are not appropriate for the OTSG needs. Steam generators and feedwater systems are functionally close coupled but without benefit of close control coupling upstream of the main feed pumps. Further clarification of feedwater systems responsiveness and reliability follows:

Prior to 1970, a few feedwater systems for electric steam generating plants (nuclear or fossil) had outputs that exceeded 2.5 million pounds per hour in recirculation boilers or 4.5 million pounds per hour in once through steam generators. The introduction of the nuclear steam plant immediately doubled the flow burden on the feedwater system compared to fossil plants for the same power output. As the larger nuclear and fossil steam plants continue to come on line feedwater systems will be supplying feedwater at rates in excess of 17 million pounds per hour for nuclear and 10 million pounds her hour for fossil fired plant---a tripling and quardrupling in less than a decade.

These very large feedwater systems are an extrapolation of that which came before and do not represent a technology development consistent with the state of the art for boilers or turbine generators.

Historically, the boiler designer/manufacturer does not have responsibility or the prerogative to set functional response or reliability criteria for the feedwater system. We do expect feedwater systems to be responsive and reliable.

Upstream of the main feed pump (which is 90 percent of the feed system) the plant's control requirements and/or functional inputs are non-existent. That portion of the feed systems not subject to direct power plant control consist of a number of heaters, tanks and pumps, cascaded in such a fashion that each heater and tank has individual level controls which throttle the outputs of the various pumps which help supply the main feed pumps. These series of individual self-contained controls and valves in many instances do not respond in a timely manner to the needs of the plant and boiler---especially if the self-contained demands of these controls are in opposition to the plant's desires. The result, quite often, for both nuclear and fossil boilers may be a series of compounding perturbations which cause main feed pump fluctuations which reflect in plant performance. Some such perturbations are severe enough to result in the main feed pumps tripping off the line because they lack sufficient NPSH.

In some feedwater systems, large deareating heater tanks (D/A) are used immediately upstream of the main feed pumps. In those plants having such D/A tanks the upstream perturbations are dampened and essentially filtered out by the D/A tanks. Therefore, the main feed pumps which are responding to a plant's need are less susceptable to the upstream perturbations.

In many of the nuclear plants which have been brought on line in recent years, the plant operators have been plagued with continual feedwater system adjustments and in many cases redesigns with field modifications. All of this in order to stabilize their feedwater system and make it more responsive to the plant needs.

In the case of the B&W NSS, these field modifications and feedwater fine tuning have improved the system response but they still may lack the fundamental responsiveness and reliability to fully utilize the plants capability. The plants which minimize the Bucking Bronco Syndrome have fine tuned systems and most of them contain D/A tanks.

S. H. Esleeck

S. H. Esleeck
July 31, 1979

B&W NSS AND FEEDWATER SUPPLY

INTRODUCTION

The designer/manufacturer of steam generating equipment has always been divorced from the responsibility of those supplying the feedwater for the steam generators. Those responsible for steam generation expect reliability and responsiveness from the feedwater system. Unfortunately it appears that the technology of the latter has not kept pace with that of the former.

FEEDWATER SUPPLY

For speed of response and reliability evaluations, feedwater systems can be put in three basic categories as follows:

1. Systems in which the main feed pumps take full suction from deaerating heater tanks.
2. Systems in which the main feed pumps take all or most of their suction flow (70% or more) from the condensate booster pumps discharge; i.e., a system with little "feed forward" from the drain tank pumps.
3. Systems in which the main feed pumps take 50 to 60% of their suction from the discharges of the condensate booster pump with the remainder from the various drain tank pumps, i.e., a system with a large "feed forward" from the drain tank pumps.

Based on various sources of inputs, the relative incidence of loss of feedwater for these three systems appears as follows:

System 1 - minimal
System 2 - some
System 3 - maximum and excessive

From this information, and substantiated by some discussions with steam plant operators, it is my conclusion that the "feed forward" from drain tank pumps imposes a degree of instability with a lack of speed of response that may compromise the relative responsiveness and reliability of the entire feedwater system.

Further analysis indicates that this compromise from the "feed forward" complex within the feedwater system is a result of the following:

a. This portion of the feedwater system is not subject to direct power plant control inputs, be it a boiler following or integrated control system.
b. The control of this portion of the feedwater system is a self-contained

reaction type of control, i.e., numerous heaters are cascaded in such a manner that they discharge into a drain tank - each heater as well as the drain tank may have a level control feeding to a throttle valve which dictates the output of the drain tank pump. The independent level control compounded by cascading can set up perturbations within and to themselves that will directly impact on the downstream performance of the main feed pumps.

c. Feedwater systems have had exceptionally large increases in their outputs (tripling and quadrupling in less than 10 years) and this growth has not been adequately addressed relative to technology of design for the size increases.

d. Feedwater systems, unlike boilers or turbine generators, are not normally the primary design responsibility of a given industry but more often than not, have a shared priority in an industrial organization which specializes in procurement and assembly.

Feedwater System Reliability

No steam generating plant should be subjected to inadequate feedwater system reliability. The lack of reliability usually manifests itself in an unreasonable number of loss of feedwater incidents, especially in those feed systems falling in category #3. In many plants (fossil and nuclear, but more so for nuclear with their much higher demand for feed) field design changes, fine tuning and even modifications to reduce or eliminate the "feed forward" characteristics have been required. These changes have occurred in all types of plants and are not dictated by the boiler or reactor concept utilized. However, it appears that those plants utilizing OTSG with ICS control have had a much better record for being able to accommodate the loss of one main feed pump trip-out. In many plants utilizing recirculation boilers, there is a higher incident of plant tripouts following the loss of one feedwater pump. All plants, nuclear or fossil, are tripped on the complete loss of feedwater, and usually within 10 to 15 seconds following the loss of feed.

Responsiveness

As with reliability, no steam generating plant should be subjected to inadequate feedwater system responsiveness. However, unlike reliability, the degree of responsiveness that may be required from a feedwater system is a result of both the type of steam generating plant and the operation and control philosophy ployed at the plant. Relative to the latter, some plant owners put more emphasis on an operational/control philosophy to accommodate in-house upsets and load rejections than others. Such a philosophy may be dictated by the size of the overall electrical capability of a utility as well as the geographical interties available to him.

Relative to steam boiler designs, some steam boilers have inherent characteristics that encourage speed of response and offer a wider range of operational/control capabilities to accommodate in-house upsets and/or load rejections. The OTSG with ICS control has such inherent characteristics. However, this steam generating system does demand a greater degree of responsiveness from its feedwater system in order to fully utilize its potential. For B&W NSSs in operation, it has been demonstrated that feedwater systems of category #1 can and do meet these responsiveness criteria. It has also been demonstrated that with a dedication to full utilization of the steam plant capabilities, the feedwater systems of category #2 and #3 can be so adjusted and fine-tuned, however with more difficulty.

Feedwater Systems Supplying B&W NSS's

B&W NSS	Feed System Category
Oconee	#3
TMI	#2
SMUD	#2
Florida	#1
TECo	#1
Ark.	(?)
VEPCO	#1
TVA	#3
WPSS	#2
BBR	#1
PGE	#2
Ohio	#2

TVA Bellefonte 1 and 2

These two plants are scheduled for commercial operation in late 1981 and mid 1982 respectively. Their steam output, and therefore feedwater requirements, are about 37% more than other B&W NSS's in operation. These units contain a more advanced steam generator design, the IEOTSG. The IEOTSG should demonstrate a closer coupling with the reactor coolant system and with a degree of responsiveness significantly greater than presently operating OTSGs. The Bellefonte units have a feedwater system that falls in category #3 and they have the largest "feed forward" component (46%) of any system supplying feedwater to a B&W NSS.

There is a strong potential for reduced reliability/responsiveness characteristics in the Bellefonte 1 and 2 feedwater systems. This potential may result in a plant operating performance that will exhibit a more pronounced "Bucking Bronco Syndrome" than experienced to date. The consequences of this could be a severe compromise to plant availability and reliability.

Recommendation

I recommend that NPGD (with support from FPGD) perform a more in-depth analysis of the feedwater systems and their impact on plant performance of Bellefonte 1 and 2. If such an analysis supports my concerns as stated (and I believe it will) then we must consider proposing an engineering plan to TVA to redesign with modifications the Bellefonte 1 and 2 feedwater systems so they may provide the degree of reliability and responsiveness required by these two plants.

S. H. Esleeck

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7/30/79