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This document consists of

3 pages.

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ESTIMATED OUTAGE REQUIREMENTS - ZIRCONIUM
RETUBING PROGRAM - TYPICAL OLD REACTORS

This document presents an analysis of the incremental reactor outage time (previously transmitted orally for incorporation in current production studies), associated with two zirconium retubing cases, as related to current aluminum tube replacement outage time. The basic assumption used is the current SOS tube replacement average time rate of 0.73 hours, or 44 crew minutes per tube. All other assumptions are listed for each particular program presentation.

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PROGRAM I

This program considers retubing 1500 central zone channels with 1300 smooth-bore zirconium alloy process tubes and 200 ribbed aluminum (spline) process tubes. The basic assumptions are as follows:

1. The work will be a continuation of the current routine tube replacement program and will utilize those trained crews and procedures.
2. Zirconium tube installations will require that free movement of the tube be possible within the graphite stack because of progressive graphite distortion - considering the extended life of a zirconium tube. The outage estimate is based on providing new gunbarrels capable of permitting the gunbarrel to "follow" the tube as graphite distortion occurs, i.e., as the tube follows the graphite distortion, the gunbarrel "sees" it as tube shrinkage.
3. New gas seals (boots) will be installed front and rear on all channels.

Incremental Outage Time Requirement

Gunbarrels	17 minutes/channel
Gas Boots	3 minutes/channel
17' x 1300 =	22100'
3' x 2000 =	6000'
	<u>28100' = 3.9 weeks</u>

Therefore, the incremental outage time over and beyond retubing with aluminum is 3.9 weeks.

PROGRAM II

This program considers overboring 1500 channels and retubing 1300 channels with zirconium tubes and 200 channels with aluminum (spline) tubes. Overbore will be 200 mil. Assumptions used in Program I apply.

Incremental Outage Time Requirement

Gunbarrels (200)	17 minutes/channel
Overbore (Thrust Washer)	7 minutes/channel
17' x 200 =	3400'
7' x 1500 =	10500'
	<u>13900' = 1.9 weeks</u>

Therefore, the incremental outage time for overboring, beyond the zirconium tube case, is 1.9 weeks, the increment beyond aluminum tube replacement is 5.8 weeks.

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It should be recognized that the outage times shown are concerned only with the central zone tube replacement work and do not reflect the time requirements associated with other problems, i.e., stuck gunbarrels in other zones, which if not corrected could lead to uneven shield loadings. The outage time, would of course, increase from that shown above if these problems are considered.

As stated previously, the outage times presented herein are based on current SOS method of operation. It would appear reasonable that some improvement in performance time is possible. For example, if it is assumed that crew size can be doubled, then applying the square root law, it is probable that the time per tube could be decreased from the current 44 minutes to about 31 minutes. Applying the same analysis technique to the outage times specified in Program I and II, the incremental outage requirements would approximate 2.7 and 1.3 weeks, respectively. Therefore, the incremental outage requirement, beyond aluminum tube replacement for the overbore case is 4 weeks.

J W Ballowe

Plant Design Operation
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