DIVISION OF POWER PRODUCTION

Availability and Reliability Improvement Program

June 27, 1978

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6/27/78
A/R Program

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AVAILABILITY AND RELIABILITY OF FOSSIL-FUELED UNITS

I Historical Availabilities And Current Trends

II Factors Contributing To Current Reliability

III Ongoing Programs To Improve Reliability

IV Goals
Historical Availabilities And Current Trends
ANNUAL AVAILABILITY
FOSSIL-FUELED PLANTS

SMALL UNITS (LESS THAN 500 MW)

The historical availability of TVA's small units has been better than industry average. At the end of 16 years of operation in 1977, the 54 units experienced a historical availability of 87.2 percent. The first serious degradation occurred in 1974 primarily as a result of the Gallatin Unit 2 spindle catastrophic failure. The second occurred in 1975 primarily as a result of high-pressure spindle failures in Johnsonville Unit 9 and Gallatin Unit 4 turbines.

LARGE UNITS (500 MW OR GREATER)

The historical availability at the end of 1977 for TVA's 9 large units was 72.9 percent. The negative impact on aggregate availability of the advent of each new unit is apparent. The commercial operating date of each new unit is shown. The availability of each large unit is as follows in chronological order.

1. Widow's Creek Unit 7 - 79.6%
2. Paradise Unit 2 - 73.7%
3. Paradise Unit 1 - 76%
4. Widows Creek Unit 8 - 69.6%
5. Colbert Unit 5 - 65.5%
6. Bull Run Unit 1 - 79.1%
7. Paradise Unit 3 - 69.5%
8. Cumberland Unit 1 - 62.6%
9. Cumberland Unit 2 - 65.7%
TVA FOSSIL STEAM SYSTEM VS. INDUSTRY AVERAGE

The historical availability of TVA's large units has been less than industry average as indicated by data received from EEI. This curve shows TVA's availability being forced below industry average with the advent of the Paradise Unit 3 and Cumberland Units 1 and 2.

There were a number of reasons for the relatively poor availability of TVA's large units—some of which were:

1. Eight of the nine units were prototypes (Widows Creek Units 7 and 8, Colbert Unit 5, Paradise Units 1 and 2, Bull Run Unit 1, and Cumberland Units 1 and 2).

2. Large-scale engineering extrapolation occurred on the prototype units due to the rush to larger and larger units in the industry.

3. Less redundancy and excess capability were designed into the units in an effort to reduce costs per kw.

4. Operating and maintenance problems were encountered due to such things as complexity, untried engineering innovations, and sheer size.
TVA FOSSIL STEAM SYSTEM VS. INDUSTRY AVERAGE (UNITS > 500 MW)
Factors Contributing To Current Reliability
INCREASE IN UNIT CAPACITY
TVA FOSSIL PLANTS

THE MAGNITUDE OF THE INCREMENTAL INCREASE IN MW SIZE OF THE LATER UNITS PURCHASED BY TVA HAS BEEN DRAMATIC. THE MAGNITUDE OF THE INCREASE IN THESE PROTOTYPE UNITS DICTATED THE GREAT ENGINEERING EXTRAPOLATION AND UNTRIED INNOVATION.
INCREASE IN UNIT CAPACITY
TVA FOSSIL PLANTS

■ MULTIPLE UNITS
○ SINGLE UNITS

NAMEPLATE RATING

COMMERCIAL OPERATION DATE

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FOSSIL STEAM
UNIT SIZE VS. YEAR INSTALLED

FROM 1960 TO 1975 TVA WAS IN THE VANGUARD OF THE INDUSTRY IN THE PURCHASE
OF LARGE UNITS. TVA WAS, IN EFFECT, THE TESTING GROUNDS FOR "FIRST OF A
KIND" DESIGN AND COMPONENTS.

THE PRIVATE SECTOR OF THE INDUSTRY, BOTH VENDORS AND PURCHASERS, PROFITED
GREATLY FROM THE EXPERIENCE GAINED IN THE DESIGN, MANUFACTURE, AND OPERATION
OF THE PROTOTYPE TVA EQUIPMENT.
AVERAGE COAL QUALITY
ALL TVA STEAM PLANTS

WE HAVE EXPERIENCED A SIGNIFICANT INCREASE IN ASH CONTENT AND CORRESPONDING DECREASE IN HEATING OF THE COAL BURNED IN TVA BOILERS FROM 1963 TO 1977.
AVERAGE COAL QUALITY
ALL TVA STEAM PLANTS

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>BTU/LB</th>
<th>% Ash</th>
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<tbody>
<tr>
<td>1963</td>
<td>10500</td>
<td></td>
</tr>
<tr>
<td>1965</td>
<td>11000</td>
<td>14</td>
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<td>1975</td>
<td>12000</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td></td>
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</table>
FOSSIL-FIRED BOILER FORCED OUTAGES CAN BE DIRECTLY RELATED TO THE ASH CONTENT OF THE COAL. THE NEGATIVE EFFECT ON TVA BOILERS OF BURNING HIGHER ASH CONTENT HAS BEEN CLEARLY DETERMINED.
TVA FOSSIL STEAM SYSTEM
BOILER FORCED OUTAGE RATE VS.
COAL QUALITY

FORCED
OUTAGE

% ASH

% F.O.R. %ASH
10.0  20
7.5  18
5.0   16
2.5  14
1.0   12
0.0

1963  65  67  69  71  73  75  1977
F CAL YEAR
JOHNSONVILLE STEAM PLANT UNITS 5 AND 6
BOILER TUBE FAILURE ATTRIBUTABLE TO COAL ASH

This example shows the direct effect of the ash content of the coal burned on boiler tube failure rates at the Johnsonville plant. The impact on unit availability is realized when it is known that boiler tube failures are historically among the first five major causes of unit forced outages. It should also be noted that an increase in boiler tube failure rates is only one of four major negative effects poor coal quality can have on fossil unit equipment resulting in equipment failures and forced outages.
JOHNSONVILLE STEAM PLANT-UNITS 5-6
BOILER TUBE FAILURE
ATTRIBUTABLE TO COAL ASH

FAILURE RATE

ASH IN COAL

FAILURE RATE, EVENTS/1000 SERVICE HOURS

% ASH

1967 68 69 70 71 72 73 74 75 76 1977
CAPACITY AVAILABLE FOR MAINTENANCE - 1965

Shown is the monthly capacity available for maintenance in 1965. At that time, we had a maximum of approximately 2,000 MW out of a possible 10,584 available for maintenance at any time. The high maintenance period was the summer with significant maintenance possible almost the entire year.

From the 1950's through mid-1960's an ideal maintenance situation existed because the only peak load requiring near complete availability of generating capability was during the three winter months allowing approximately nine months of the year for scheduling maintenance.

In 1968 the entire maintenance program had to be revised because of two situations. An interchange agreement was formulated whereby TVA supplies up to 2,060 MW to connecting utilities from May through August. The power is returned to TVA by them during the period November 1-March 31. Another was the delay in new generating plants providing no new generating capacity for normal load growth.

The net results were:
1. Longer intervals between outages.
2. Compression of maintenance windows into spring and fall months.
CAPACITY AVAILABLE FOR MAINTENANCE 1965

![Bar chart showing capacity available for maintenance from January to December 1965.](chart.png)
MAINTENANCE MUST NOW BE CONFINED TO TWO PERIODS—SPRING AND FALL. THIS MEANS THAT AS MUCH AS 5,000 MW OF GENERATION OUT OF A POSSIBLE 17,796 MUST BE SCHEDULED OUT FOR MAINTENANCE AT ONE TIME.

THE COMPRESSION OF SCHEDULED MAINTENANCE OUTAGES INTO SMALLER WINDOWS HAS CREATED SEVERAL PROBLEMS IN SUCCESSFUL COMPLETION OF OUTAGE WORK.

1. THE PERMANENT WORK FORCE HAS BEEN INCAPABLE OF PERFORMING ALL SCHEDULED OUTAGE WORK CAUSING HEAVY DEPENDENCE ON TEMPORARY HOURLY CRAFTSMEN.

2. THE NUMBER OF TEMPORARY HOURLY CRAFTSMEN REQUIRED SEVERELY STRAINS THE SKILLED CRAFTSMEN LABOR MARKET IN THE TENNESSEE VALLEY.

3. NEIGHBORING UTILITIES, SHARING MUCH OF THE SAME LABOR MARKET WITH TVA, HAVE BEEN FORCED INTO A SIMILAR OUTAGE SCHEDULING PROBLEM WORSENING THE MANPOWER SITUATION EVEN MORE.

4. THE ABILITY OF THE VENDOR TO PROVIDE ADEQUATE SUPPORT HAS BEEN SERIOUSLY AFFECTED BY THE CONFLICT OF SCHEDULING DATES WITH OTHER UTILITIES. THIS HAS RESULTED IN TVA SOMETIMES HAVING DIFFICULTY IN OBTAINING THE REQUIRED SERVICES OF VENDOR TECHNICAL REPRESENTATIVES AND SPARE PARTS DELIVERY, PARTICULARLY THOSE REQUIRING CUSTOM SHOP WORK.
CAPACITY SCHEDULED FOR MAINTENANCE 1978

MEGAWATTS

<table>
<thead>
<tr>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
</tr>
</tbody>
</table>

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EIGHT NUCLEAR UNITS AND THE FOUR PUMPED-STORAGE UNITS WERE ORIGINALLY SCHEDULED TO HAVE BEEN OPERATING BEFORE 1978 FOR A TOTAL NEW CAPACITY OF 12,000 MW. THE 3,000 MW FROM THE BROWNS FERRY NUCLEAR PLANT PROVIDED SOME RELIEF. IN ADDITION TO THIS, 2,510 MW OF GAS TURBINE GENERATING CAPACITY WAS PURCHASED AND INSTALLED BECAUSE OF THE RELATIVELY SHORT LEAD TIME REQUIRED.

THE FOSSIL GENERATING UNITS WERE ILL-PREPARED FOR THE DEMANDS PLACED UPON THEM BECAUSE TVA PLANNING IN THE MID-1960'S HAD PROJECTED A VERY LOW CAPACITY FACTOR FOR THE OLDER UNITS FOR 1975 AND BEYOND. LARGE EXPENDITURES OF MONEY FOR REHABILITATION OF AGING FOSSIL UNITS WERE DEFERRED FOR THIS REASON.

THE COMBINATION OF DEFERRED MAJOR MAINTENANCE AND INCREASING SYSTEM GENERATING DEMANDS WHICH DICTATED EXTENDING OF PERIODS BETWEEN NORMAL MAINTENANCE OUTAGES RELEGATING MAINTENANCE TO "CATCHUP WORK" AND FORCED OUTAGE WORK HAD A DEVASTATING EFFECT ON AVAILABILITY.
DELAY OF NEW CAPACITY

Original

Actual or Current

THOUSANDS OF MEGAWATTs

1969 70 72 74 76 78 80 82 84 86 1986

CALENDAR YEAR

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IT IS OUR ONGOING PRACTICE TO CONTINUALLY ANALYZE THE OPERATING EXPERIENCE
OF THE FOSSIL UNITS DETERMINING CONTRIBUTORS TO FORCED OUTAGES FOR THE
PURPOSE OF SETTING PRIORITIES IN OUR MAINTENANCE EFFORT.

THIS IS THE ANALYSIS OF OUR 1977 EXPERIENCE. THERE WERE 13 MAJOR FORCED
OUTAGE CONTRIBUTORS. THE GREATEST CONTRIBUTORS WERE FAILURES IN THE HEAT
TRANSFER SURFACES IN THE BOILER (WATERWALLS, SUPERHEATERS, REHEATERS, AND
CYCLONES) FOLLOWED BY TURBINE AND GENERATOR FAILURES (TURBINE WHEELS,
GENERATOR WINDINGS, TURBINE VIBRATION, TURBINE VALVES, AND TURBINE BEARINGS).
THE FORCED OUTAGES ACCREDITED TO SO₂ ALERT WERE ON THE WIDOWS CREEK 1-6
UNITS RESULTING FROM A COURT ORDER.
TVA FOSSIL STEAM SYSTEM
MAJOR FORCED OUT CAPACITY
FISCAL YEAR 1977

TURBINE BEARINGS
FURNACE FLOOR BURN THROUGH
AIR PREHEATER-REGENERATIVE
TURBINE CONTROL AND STOP VALVES
ECONOMIZER
TURBINE VIBRATION AND BALANCING
ROTOR FIELD WINDINGS
TURBINE WHEELS OR SPINDLES
REHEATER
CYCLONE TUBE LEAKS
SO₂ ALERT
SUPERHEATER
WATERWALLS

CAPACITY FORCED OUT, MILLION MWH

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AVERAGE COAL QUALITY
ALL TVA STEAM PLANTS

THE REQUIREMENTS OF OUR AIR QUALITY COMPLIANCE STRATEGY AS WELL
AS THE NEGATIVE EFFECT ON BOILER AVAILABILITY OF THE DECLINING COAL
QUALITY HAS RESULTED IN THE IMPLEMENTATION OF PLANS TO IMPROVE THE
QUALITY OVER THE NEXT FEW YEARS. MOST PLANTS WILL EVENTUALLY BE
BURNING WASHED COAL OR HIGHER QUALITY RAW COAL.

THIS PROJECTION OF THE FUTURE AVERAGE COAL QUALITY SHOWS THE PLANNED
IMPROVEMENT.
AVERAGE COAL QUALITY
ALL TVA STEAM PLANTS

BTU/LB % ASH
12,500 20
12,000 18
11,500 16
11,000 14
10,500 12

FISCAL YEAR

Actual | Estimated

BTU/LB
% ASH

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AVAILABILITY AND RELIABILITY IMPROVEMENT TASK FORCE

It was recognized that there needed to be a closer working relationship between power production and engineering design for exchange of information and experience for the purpose of identifying areas where changes in design, operation, or maintenance would improve reliability and availability at existing and future plants.

For this purpose, the ARI task force was formed with the listed objectives.
OBJECTIVES OF THE AVAILABILITY AND RELIABILITY IMPROVEMENT TASK FORCE

To improve reliability and availability of TVA thermal power plants.

To identify specific plant features and equipment which have caused significant outage or which have potential for reducing plant availability and reliability.

To identify design and operational changes in existing and future plants which will improve availability and reduce forced outages.

To develop expertise in collection, interpretation, and evaluation of reliability and availability data and information.

Provide a coordinated TVA effort for evaluating availability and reliability and provide a coordinated TVA response to industry efforts and request for input to such efforts.
CRAFTSMEN ATTRITION RATE

In order to fully utilize the skills of craftsmen, TVA negotiated an agreement in 1974 with the Tennessee Valley Trades and Labor Council which eliminated strict traditional craft jurisdictional lines for determining the way work was assigned. Under the revised agreement, TVA is permitted to form crews made of several craftsmen from different crafts. At about the same time, TVA found it necessary to perform maintenance on weekends, evenings, and midnight shifts. This was necessitated because of the nonavailability of equipment for maintenance during the peak hours, usually occurring Monday through Friday on the day shift.

These two factors, the mixing of crews and working shifts, contributed to considerable discontent among craft employees resulting in an abnormally higher attrition rate. The graph shows that as time has progressed and craft employees have become more accustomed to the revised agreement, the attrition rate has returned to a level approximately equal to that before the 1972 revision.
CRAFTSMEN ATTRITION RATE

FISCAL YEARS

PERCENT

15
14
13
12
11
10
9
8
7
6
5
4


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CRAFT APPRENTICE TOTALS

ONE OF THE CLEARLY IDENTIFIED PROBLEMS CONCERNING RELIABILITY AND AVAILABILITY IS THE LACK OF COMPETENT CRAFTSMEN. OUR OVERALL NEED FOR CRAFTSMEN HAS CONTINUED TO INCREASE LARGELY DUE TO MANNING NEW PLANTS BUT ALSO DUE TO SOME EXTENT TO THE INCREASED MAINTENANCE NEEDS AT OUR EXISTING FOSSIL PLANTS.

WE ARE PLANNING TO SUBSTANTIALLY MEET THE NEED THROUGH INCREASED NUMBERS OF APPRENTICES. THE GRAPH SHOWS THE STEADILY INCREASING NUMBERS OF APPRENTICES.
CRAFT APPRENTICE TOTALS

<table>
<thead>
<tr>
<th>Fiscal Years</th>
<th>Number of Trainees</th>
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</thead>
<tbody>
<tr>
<td>1976</td>
<td>293</td>
</tr>
<tr>
<td>1977</td>
<td>393</td>
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<tr>
<td>1978</td>
<td>688</td>
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<tr>
<td>1979</td>
<td>870</td>
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<tr>
<td>1980</td>
<td>1029</td>
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<td>1981</td>
<td>1220</td>
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<tr>
<td>1982</td>
<td>1247</td>
</tr>
<tr>
<td>1983</td>
<td>1273</td>
</tr>
<tr>
<td>1984</td>
<td>1278</td>
</tr>
<tr>
<td>1985</td>
<td>1278</td>
</tr>
</tbody>
</table>
III Ongoing Programs To Improve Reliability
OVER 80 PERCENT OF TVA'S FOSSIL TURBINE GENERATORS WERE CONSTRUCTED IN THE 1950'S. THE STATE-OF-THE-ART IN INGOT POURING AND METALLURGY OF LARGE FORGINGS WAS NOT SUFFICIENTLY ADVANCED TO PREVENT PRODUCTION OF SPINDLES WITH SERIOUS FLAWS. NONDESTRUCTIVE TESTING TECHNIQUES WERE NOT SUFFICIENTLY ADVANCED TO BE CAPABLE OF DETECTING SUCH FLAWS.

CATASTROPHIC FAILURE OF SOME OF THESE SPINDLES BEGAN TO OCCUR DUE TO THERMAL CYCLING AFTER EXTENDED SERVICE. THIS OCCURRED IN TVA ON THE GALLATIN 2 UNIT IN 1974.

IN THE LATE 1960'S THE TECHNIQUE OF ULTRASONIC TESTING OF SPINDLE BORES WAS DEVELOPED. AFTER THE GALLATIN SPINDLE FAILURE, AN INSPECTION PROGRAM WAS IMPLEMENTED WITHIN TVA. THE PROGRAM HAS RESULTED IN REDUCED UNIT AVAILABILITY AND CONDEMNATION OF MANY SPINDLES.

THERE ARE 149 SPINDLES OF THE 1950 ERA THAT REQUIRED INSPECTION. ONE HUNDRED AND TWENTY-FOUR HAVE BEEN INSPECTED. NINETEEN HAVE BEEN REPLACED. TWENTY REPLACEMENTS HAVE BEEN ORDERED. SIX REPLACEMENT SPINDLES ARE ON HAND.

THE COST OF SPINDLES ORDERED TO DATE IS $60,630,000.
TURBINE SPINDLE PROGRAM (1968-1982)

- Total spindles in system: 187
- Spindles requiring no inspection: 38
- Spindles left to be inspected: 25
- Installed: 19
- Current and total number of replacement spindles on order: 48
- Total spindles requiring replacement: 20
- Total spindles needing inspection to date: 124
- New unused: 6
- Used: 3

Total cost of replacement spindles: $60,630,000
FOSSIL STEAM SYSTEM BOILER AND AUXILIARY EQUIPMENT REHABILITATION

FIFTY-FOUR OF THE 63 BOILERS IN TVA WENT INTO SERVICE PRIOR TO 1960. MANY ARE APPROACHING 200,000 HOURS OF OPERATION.

IT WAS DETERMINED THAT A COMPREHENSIVE BOILER REHABILITATION PROGRAM WOULD BE REQUIRED IF THE FOSSIL UNITS WERE TO MEET THE REVISED GENERATING FORECASTS. THIS IS A TABULATION OF THAT PROGRAM.

THE FOLLOWING ARE PROBLEMS THAT RESULT FROM LONG-TERM EXPOSURE TO HIGH TEMPERATURES, EROSION, CORROSION, AND CYCLIC THERMAL STRESS.

1. DETERIORATION OF HEAT TRANSFER SURFACES (SUPERHEAT, REHEAT, AND WATERWALL TUBES).
2. DETERIORATION OF OTHER AREAS OF THE BOILER SUCH AS REFRACTORY AND BOILER CASING.
3. DETERIORATION OF CONDENSERS AND FEEDWATER HEATERS.
4. DETERIORATION OF AIR PREHEATING SURFACES.
5. DETERIORATION OF DUCTWORK, BREACHING EXPANSION JOINTS, FANS, AND STACK LINERS.

NOTE THAT THE PROGRAM IMPLEMENTED TO CORRECT EXISTING PROBLEMS WILL COST AN ESTIMATED $72,504,000.
## FOSSIL STEAM SYSTEM
### BOILER REHABILITATION

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<tr>
<th>Section</th>
<th>Total Estimated Cost</th>
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<tr>
<td>WATERWALL</td>
<td>$16,124,000</td>
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<tr>
<td>SUPERHEATER</td>
<td>27,623,000</td>
</tr>
<tr>
<td>REHEATER</td>
<td>5,440,000</td>
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<tr>
<td>ECONOMIZER</td>
<td>1,850,000</td>
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<tr>
<td>FURNACE FLOOR</td>
<td>2,862,000</td>
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<td>EXPANSION JOINT REPLACEMENT</td>
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<tr>
<td>FEEDWATER HEATER REPLACEMENT</td>
<td>2,381,000</td>
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<tr>
<td>AIR PREHEATER MODIFICATION</td>
<td>4,781,000</td>
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<tr>
<td>RETUBE CONDENSER</td>
<td>3,028,000</td>
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<tr>
<td>MISCELLANEOUS</td>
<td>7,065,000</td>
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**Total Estimated Cost** $72,504,000
THE MAJOR FORCED OUTAGE CONTRIBUTORS FOR EACH LARGE UNIT AND GROUPS OF SMALL UNITS WERE ANALYZED FOR THE FISCAL YEAR 1977 FOR THE PURPOSE OF DETERMINING MAINTENANCE PRIORITIES.

THE ANALYSIS OF THE BULL RUN UNIT IS INDICATIVE OF THIS PROGRAM. SHOWN ARE THE MAJOR PROBLEMS AND THE CORRECTIVE PROGRAM. THE CROSSHATCH AREAS REPRESENT THE ANTICIPATED IMPROVEMENT.

THE GREATEST EFFORT WAS DIRECTED TOWARD WATERWALL TUBE REPAIRS. A PORTION OF THE WORK WAS DONE IN 1977 AT A COST OF $300,000 AND ADDITIONAL REPAIRS ARE PLANNED IN 1979 AT A COST OF $500,000. THIS WORK, COUPLED WITH A CHANGE IN COAL AND REVISIONS TO THE SECONDARY AIR FLOW, IS EXPECTED TO REDUCE OUTAGES ON THE UNIT FROM WATERWALL TUBE FAILURES TO APPROXIMATELY 2 PERCENT.

AN ADDITIONAL EFFORT WAS REHEATER REPAIRS DIRECTED TOWARD SOLVING EXPANSION STRESS PROBLEMS. COST WAS $165,000.

THE OVERALL OBJECTIVE IS TO IMPROVE UNIT AVAILABILITY TO 84 PERCENT.
BULL RUN STEAM PLANT
UNIT 1
MAJOR FORCED OUTAGE CONTRIBUTORS
FISCAL YEAR 1977
TOTAL FORCED OUTAGE RATE-20.04%

REWELDED DISSIMILAR WELDS, REPLACED LUGS, INSTALLED
EXPANSION LOOP TUBES-1977

REPLACED PARTIAL BURNER PANELS,
REVISED SECONDARY AIR FLOW- 1977 PROPOSED
COAL CHANGE, ADDITIONAL PANEL REPLACEMENT-1979
TOTAL FOSSIL PLANT INVENTORY
ADJUSTED TO 1977 DOLLARS

THERE HAS BEEN AN ONGOING SPARE PARTS PROGRAM FOR MANY YEARS. THE ERA OF POWER SHORTAGES AND EVER-INCREASING LEAD TIME FOR DELIVERY OF SPARE PARTS HAVE REQUIRED SEVERAL CHANGES IN PHILOSOPHY. IN 1976 A DECISION WAS MADE TO REEVALUATE OUR POLICY ON SPARE PARTS FOR MAJOR COMPONENTS OF FOSSIL PLANTS. THE DECISION WAS BASED ON THE FACT THAT OUR SYSTEM GENERATING CAPABILITY WOULD CONTINUE TO BE LIMITED BECAUSE OF NUCLEAR PLANT AND RACCOON MOUNTAIN STARTUP DELAYS. THE CHANGE WITH THE GREATEST FINANCIAL CONSEQUENCES WAS THAT EXPENSIVE SPARE PARTS COULD BE ECONOMICALLY JUSTIFIED IF THEY IMPROVE THE RELIABILITY AND AVAILABILITY OF UNITS.

THIS CURVE ILLUSTRATES THE CHANGE THAT HAS OCCURRED IN OUR SPARE PARTS PHILOSOPHY.

THE PRESENT PROGRAM, IN GENERAL, ASSIGNS RESPONSIBILITY FOR PROCURING LARGE, EXPENSIVE, INSURANCE-TYPE SPARE PARTS TO THE CENTRAL OFFICE OF POWER PRODUCTION. THE FOSSIL PLANT STAFF IS RESPONSIBLE FOR MAINTAINING ALL OTHER SPARE PARTS.

THE OBJECTIVE OF THE ENTIRE POWER PRODUCTION SPARE PARTS PROGRAM IS TO HAVE A REASONABLE BALANCE BETWEEN INVENTORY INVESTMENTS AND ECONOMICS RESULTING FROM READY AVAILABILITY OF SPARE PARTS. ENGINEERING JUDGMENT AND SOME CALCULATED RISKS MUST BE UTILIZED IN REACHING DECISIONS CONCERNING THIS BALANCE.
TOTAL FOSSIL PLANT CAPITALIZED
SPARE PARTS (ADJUSTED TO 1977 DOLLARS)

The downward curve from 1965 to 1974 reflects the effect on capitalized spare parts of the installation of large units. The cost of spare components for "one of a kind" large units was so great that their purchase was not economically justifiable.

The generating capacity shortage coupled with escalating replacement power costs required a change in that philosophy.

The upturn in the capitalized spare parts inventory from 1974 to the present clearly reflects that change related to purchase of large, expensive, insurance-type spare parts such as turbine steam path components, generator components, transformer components, and pump elements.
TOTAL FOSSIL PLANT CAPITALIZED SPARE PARTS
(Adjusted to 1977 Dollars)

INVENTORY IN $/MW INSTALLED CAPACITY

$9,462,598

CALENDAR YEAR

FOSSIL PLANT DERATED CAPACITY

BY 1977, 1,107 MW OF LONG-TERM DERATED CAPACITY HAD GRADUALLY ACCUMULATED ON EXISTING GENERATING UNITS BECAUSE OF EXTREME GENERATING DEMANDS AND LITTLE OPPORTUNITY FOR OTHER THAN "CATCH-UP" MAINTENANCE. THE GREATEST CONTRIBUTOR WAS TURBINE-RELATED PROBLEMS BUT ALSO INCLUDED BOILER AND COAL QUALITY PROBLEMS.
### FOSSIL PLANT DERATED CAPACITY

<table>
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<tr>
<th>UNIT</th>
<th>CAUSE OF DERATING</th>
<th>MW NET</th>
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</thead>
<tbody>
<tr>
<td>AL 1</td>
<td>REACTION ROW 1 REMOVED FROM HP SPINDLE AND DEFORMATIONS FOUND IN STAGE GROOVES OF IP SPINDLE</td>
<td>41</td>
</tr>
<tr>
<td>BUR</td>
<td>EXCESSIVE SH/RH TEMPERATURE DIFFERENTIAL</td>
<td>30</td>
</tr>
<tr>
<td>COL 1</td>
<td>SONIC INDICATION IN IP TURBINE ROTOR</td>
<td>10</td>
</tr>
<tr>
<td>COL 2</td>
<td>SONIC INDICATIONS IN IP TURBINE ROTOR AND IN THE GENERATOR ROTOR</td>
<td>10</td>
</tr>
<tr>
<td>COL 5</td>
<td>THERMAL STRESS CRACKS IN TURBINE STEAM CHESTS</td>
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<td>L'   1</td>
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<tr>
<td>UNIT</td>
<td>CAUSE OF DERATING</td>
<td>MW NET</td>
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<tr>
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<tr>
<td>J</td>
<td>TURBINE CONTROL VALVE CAM SHAFT</td>
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<td>BLADING REMOVED FROM HP SPINDLE</td>
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FOSSIL PLANT
RESTORATION OF DERATED CAPACITY

SINCE THE 1,107 MW OF LONG-TERM DERATED CAPACITY REPRESENTED THE
GENERATION OF A LARGE UNIT, IT WAS DETERMINED THAT A MAJOR PROGRAM TO
RESTORE MOST OF THE DERATED CAPACITY WAS ECONOMICALLY JUSTIFIED. THIS
PROGRAM WAS IMPLEMENTED AND A TIMETABLE FOR COMPLETION WAS ESTABLISHED.
THIS GRAPH SHOWS THAT THE TIMETABLE FOR 1977 AND 1978 IS GENERALLY
BEING MET.

AN ADDITIONAL ASSET OF THE BASIC IMPROVEMENT PROGRAM IS THAT AS THE
CORRECTIONS ARE BEING MADE, OTHER CAUSES OF LONG-TERM DERATING HAVE
BEEN PRECLUDED.
FOSSIL PLANT
RESTORATION OF DERATED CAPACITY
IV GOALS
GOALS

BASF) UPON THE IMPROVEMENT PROGRAMS, IT IS OUR GOAL TO ACCOMPLISH THE FOLLOWING FOR THE FOSSIL-FUELED SYSTEM:

1. INCREASE THE AVAILABILITY FROM 79 PERCENT TO 83 PERCENT.
2. REDUCE THE FORCED OUTAGE RATE FROM 10 PERCENT TO 7 PERCENT.
3. REDUCE THE EQUIVALENT FORCED OUTAGE RATE RELATED TO FORCED DERATINGS FROM 6 PERCENT TO 2 PERCENT.