APPENDIX TO

REPORT ON EQUIPMENT AVAILABILITY FOR THE THIRTEEN-YEAR PERIOD, 1960-1972

EEI Publication No. 73-46

Issued December 1973

A Report of the

EQUIPMENT AVAILABILITY TASK FORCE

of the

PRIME MOVERS COMMITTEE

EDISON ELECTRIC INSTITUTE

90 Park Avenue New York, N. Y., 10016

APPENDIX

A. EQUIPMENT DEFINITIONS

1. Non-header Unit	Unit in which a single boiler is connected solely and independently to a given turbine-generator.
2. Header Unit	Unit in which the turbine-generator is not solely and independently connected to single boiler.
3. Major Equipment	Major group of equipment within a unit, such as: boiler, reactor, generator, steam turbine, condenser.
4. Component	Part within a "major equipment" group, such as: superheater tube, governor, buckets, boiler feed pump.
5. Maximum Dependable Capacity (MDC)	The dependable main-unit capacity winter or summer, whichever is smaller.

B. OPERATION AND OUTAGE DEFINITIONS

1. Available	The status of a unit or major piece equipment which is capable of service, whether or not it is actually in service.
2. Base Loading	When a unit is generally run at or near rated output.
3. Cranking Loading	When a unit is generally shut down on standby for auxiliary power during emergency.
4. Cycling Loading	When a unit is generally run but at a load which varies widely with system demand.
5. Economy Outage	(See Reserve Shutdown)
6. Forced Outage	The occurrence of a component failure or other condition which requires that the unit be removed from service immediately or up to and including the very next weekend.

APPENDIX

(Continued)

7. Forced Partial Outage	The occurrence of a component failure or other condition which requires that the load on the unit be reduced 30 MW or more immediately or up to and including the very next weekend.
8. Maintenance Outage	The removal of a unit from service to perform work on specific components which could have been postponed past the very next weekend. This is work done to prevent a potential forced outage and which could not be postponed from season to season.
9. Non-curtailing Equipment Outage	The removal of a specific component from service for repair, which causes no reduction in unit load or a reduction of less than 30 MW.
10. Non-operating Equipment Test	A scheduled test or required operation of a back-up system which is not normally operating.
11. Outage Cause	A component failure, preventive maintenance, or other condition which requires that the unit or a component be taken out of service or run at reduced capacity.
12. Peaking Loading	When a unit is generally shut down and is run only during high demand periods.
13. Planned Outage	The removal of a unit from service for inspection and/or general overhaul of one or more major equipment groups. This is work which is usually scheduled well in advance (e.g., annual boiler overhaul, five-year turbine overhaul).
14. Reserve Shutdown	The removal of a unit from service for economy or similar reasons. This status continues as long as the unit is out but available for operation.

APPENDIX

(Continued)

15. Scheduled Partial Outage	The occurrence of a component failure or other condition which requires that the load on the unit be reduced 30 MW or more but where this reduction could be postponed past the very next weekend.
16. Unavailable	The status of any major piece of equipment which renders it inoperable because of the failure of a component, work being performed or other adverse condition.

C. TIME DEFINITIONS

1. Available Hours (AH)	The time in hours during which a unit or major equipment is available; SH + RSH.
2. Demand Period	The time interval each day which is the period of maximum demand on a particular system.
3. Economy Outage Hours (See Reserve Shutdown Hours) (TEOH)	The theoretical value of Economy Outage Hours (TEOH) is the difference between Available Hours and Service Hours. If the TEOH differs by less than 1% with the Economy Outage Hours reported at the end of the year, they are considered equal and flagged with Code 1. If the difference is more than 1%, but less than 10%, they are flagged with Code 3; but the reported Economy Outage Hours are still used. However, if the difference is greater than 10%, the calculated value TEOH is used, and Code 2 is a flag that Economy Outage Hours have been derived.
4. Forced Outage Hours (FOH)	The time in hours during which a unit or major equipment was unavailable due to a Forced Outage.
5. Forced Partial Outage Hours (FPOH)	The time in hours during which a unit or major equipment is unavailable for full load due to a forced partial outage.

APPENDIX

(Continued)

6. Hours Waiting (HW)	That portion of time for any outage during which no work could be performed. This includes time for cooling down equipment and shipment of parts. This is time that could not be affected by a change in work schedule or the number of men worked.
7. Maintenance Outage Hours (MOH)	The time in hours during which a unit or major equipment is unavailable due to a maintenance outage.
8. Period Hours (PH)	The clock hours in the period under consideration. (Generally one year)
9. Planned Outage Hours (POH)	The time in hours during which a unit or major equipment is unavailable due to a planned outage.
10. Reserve Shutdown Hours (RSH)	Reserve shutdown duration in hours.
11. Schedule Partial Outage Hours (SPOH)	The time in hours during which a unit or major equipment is unavailable for full load due to a scheduled partial outage.
12. Service Hours (SH)	The total number of hours the unit was actually operated with breakers closed to the station bus.
13. Unit Years (UY)	This term is the common denominator used to normalize data from units of the same type with different lengths of service. The following example contains 20 UY of experience from 4 units. Unit: A B C D 4 Years in Service: 8 3 7 2 20
14. Work (Manhours Worked) (MH)	The total number of manhours worked on or off site to accomplish repairs.

D. EQUATIONS

1. Average Forced Outage Duration	(Summation of FOH)/(Number of Forced Outages)
2. Capacity Factor	[(Total Generation in MW-Hr)/(PH x MDC)]100
3. Component Outage Severity Index	The average number of forced outage hours of a specific component per incident.

APPENDIX

(Continued)

4. Equivalent Forced Outage Rate (EFOR) (for each forced partial outage, an equivalent full load outage duration is calculated to include the effect of partial as well as full forced outages on the forced outage rate)	EFOR is calculated as follows: TE = FPOH(CR/CF) WHERE: TE is equivalent forced outage time CR is size of reduction or derating from full load CF is rated capacity THEN: EFOR = 100((TF + TES)/(TO + TF + TAS + TPS)) WHERE: TF is total full forced outage time TO is total operation time at 100% availability TAS is sum of actual forced partial outage times TES is sum of equivalent forced outage times TPS is sum of equivalent scheduled partial operating times
5. Forced Outage Incident Rate	[(Forced Incidents)/(Forced + Maintenance + Planned Incidents)] 100
6. Forced Outage Rate	[FOH / (SH + FOH)] 100
7. Forced Outage Ratio	[FOH/(Total Unavailable Hours)] 100
8. Operating Availability	[AH/PH] 100
9. Output Factor LOAD FACTOR	(Total generation in MW-Hr.) x 100/ (SH x MDC)
10. Service Factor	[SH/PH] 100

APPENDIX

(Continued)

11. Relative Mechanical Availability (RMA)

Relative Mechanical Availability is a form of Operating Availability adjusted to show relative effort. The prime assumption is that most outage time is affected by work schedules and crew sizes. Relative Mechanical Availability uses an Adjusted Outage Time (AOT) based on effort. Manhours worked is a measure of effort which is reasonably independent or work schedules and crew sizes. Manhours worked (MH) divided by a standard work force (SWF) gives a derived time worked based on effort. If we assume a round-the-clock schedule, then this derived time worked is almost a derived outage time based on effort. The difference is the amount of outage time which is independent of effort called Hours Waiting (HW). See Appendix C-6. An arbitrary assumption of ten men for the standard work force gives:

$$AOT = HW + MH/10$$

Then substituting AOT for outage time in the equation for operating availability gives:

$$RMA = [(PH-AOT)/PH]\ 100$$
$$= [(PH-(HW + MH/10))/PH]\ 100$$