SAN/1109-8/4

SOLAR PILOT PLANT, PHASE 1
PRELIMINARY DESIGN REPORT

Volume 2, Book 3

Dynamic Simulation Model and Computer Program Descriptions (CDRL Item 2)

May 1, 1977

Work Performed Under Contract No. EY-76-C-03-1109

Honeywell, Incorporated
Energy Resources Center
Minneapolis, Minnesota

U.S. Department of Energy

Solar Energy

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Paper Copy $12.00
Microfiche $3.00

SAN/1109-8/4
Distribution Category UC-59c

Honeywell

ERDA Contract No. E(04-3)-1109 1 MAY 1977

SOLAR PILOT PLANT
PHASE I

PRELIMINARY DESIGN REPORT

VOLUME II - BOOK 3

DYNAMIC SIMULATION MODEL AND COMPUTER PROGRAM DESCRIPTIONS

CDRL Item 2

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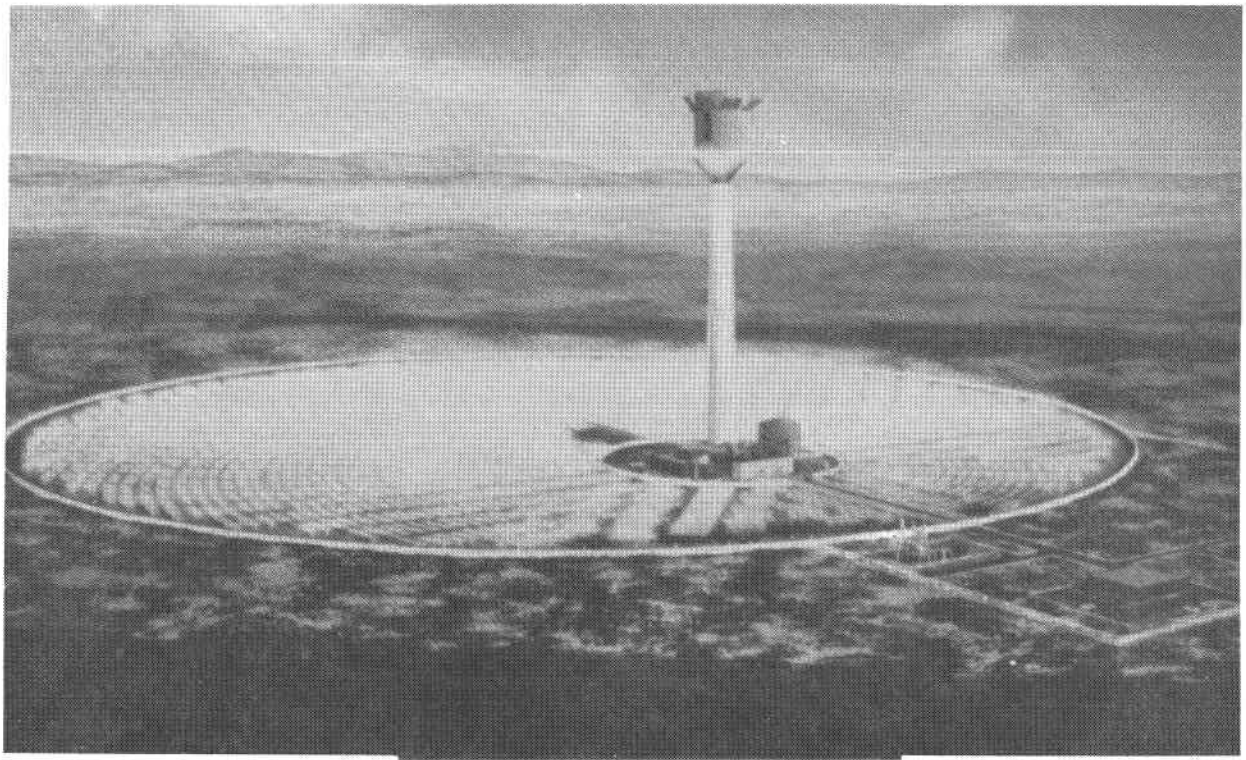
FOREWORD

This is the initial submittal of the Solar Pilot Plant Preliminary Design Report per Contract Data Requirement List Item 2 of ERDA Contract E(04-3)-1109. The report is submitted for review and approval by ERDA. This is Volume II - Book 3 of seven volumes.



10 MEGAWATT SOLAR PILOT PLANT
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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SECTION 1
INTRODUCTION AND SUMMARY

This book presents a description of the mathematical models and computer program comprising the SPP Dynamic Simulation.

The SPP Dynamic Simulation is a computerized model representing the time-varying performance characteristics of the SPP. The model incorporates all the principal components of the pilot plant as illustrated in Figure 1-1.

Time-dependent direct normal solar insulation, as corrupted by simulated cloud passages, is transformed into absorbed radiant power by actions of the heliostat field and enclosed receiver cavity. The absorbed power then drives the steam generator model to produce superheated steam for the turbine and/or thermal storage subsystems. The thermal storage subsystem can, in turn, also produce steam for the turbine.

The turbine using the steam flow energy produces the mechanical shaft power necessary for the generator to convert it to electrical power. This electrical power is subsequently transmitted to a transmission grid system.

Exhaust steam from the turbine is condensed, reheated, deaerated, and pressurized by pumps for return as feedwater to the thermal storage and/or steam generator.

A master control/instrumentation system is utilized to coordinate the various plant operations. The master controller reacts to plant operator demands and control settings to effect the desired output response.

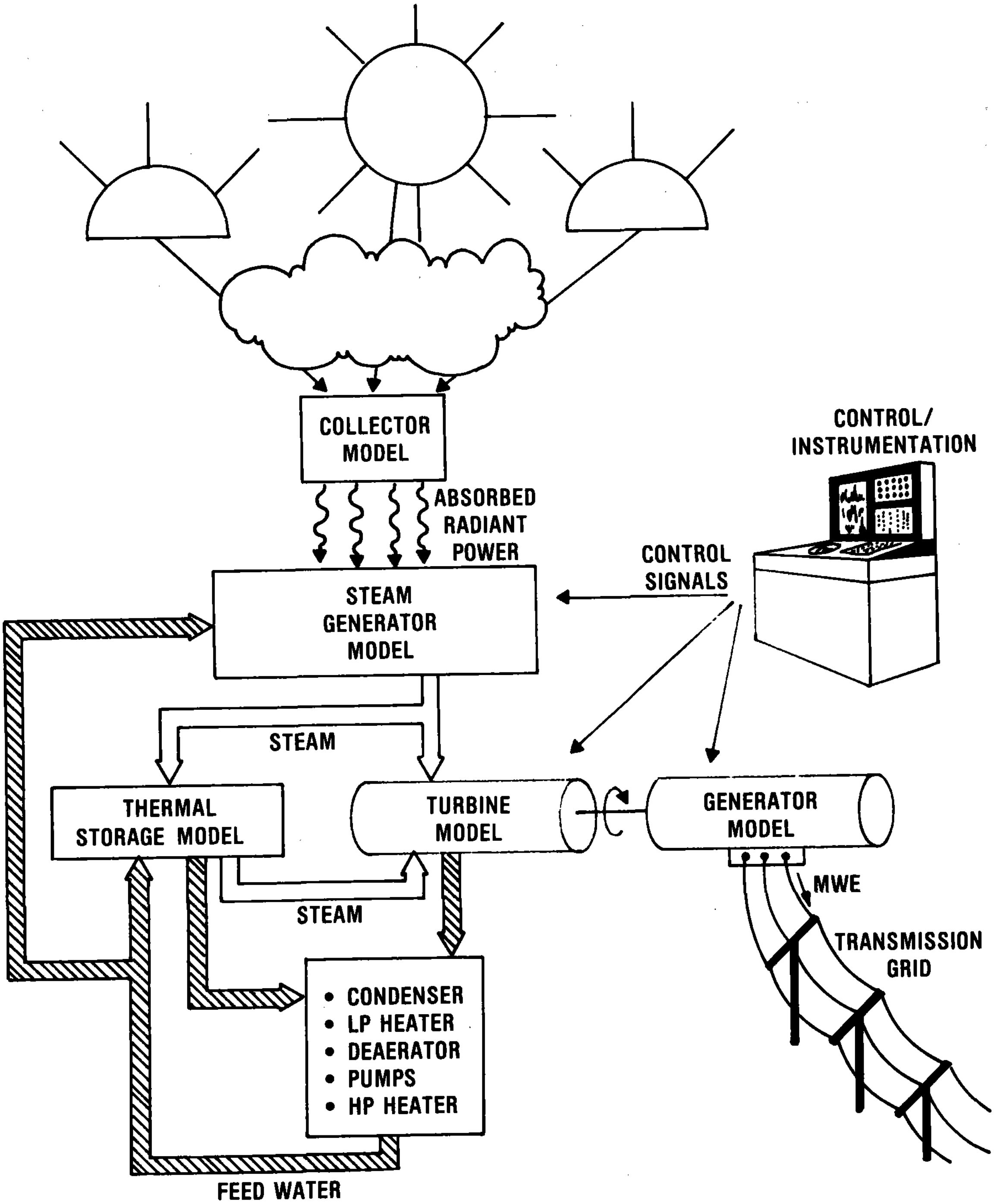


Figure 1-1. Schematic of SPP Dynamic Simulation Elements

The SPP Dynamic Simulation Computer program is written in FORTRAN language. Various input options (e.g., insolation values, load demands, initial pressures/temperatures/flows) are permitted. Plant performance may be monitored via computer printout or computer generated plots. The remainder of this document describes the detailed pilot plant dynamic model, the basis for this simulation, and the utilization of this simulation to obtain analytical plant performance results.

SECTION 2
MODEL DESCRIPTION

This section describes in detail the various models which comprise the SPP dynamic simulation. The discussion is divided into the following subsections:

- Overall Plant model
- SGS (Steam Generator Subsystem)
- EGS (Electrical Generation Subsystem)
- TSS (Thermal Storage Subsystem)
- CS (Collector Subsystem)
- MCS (Master Control Subsystem)

OVERALL PLANT MODEL

The overall model of the SPP is shown in the functional schematic of Figure 2-1. Figure 2-2 illustrates the elements explicitly modeled in the SPP dynamic simulation. As shown, each major subsystem is modeled, in addition to the major valves and piping dynamics.

The simulation employs a collector model to provide the radiant heat input stimulus to the system. The collector model integrates, on a 20 x 20 matrix cell averaging basis, the results of the 1598 individual heliostats collecting direct normal solar insolation to provide redirected radiant power into the receiver cavity on six separate nodal surfaces. This redirected energy is then combined with calculated reradiated power levels to provide the total absorbed radiant heat input onto the various SGS active surfaces.

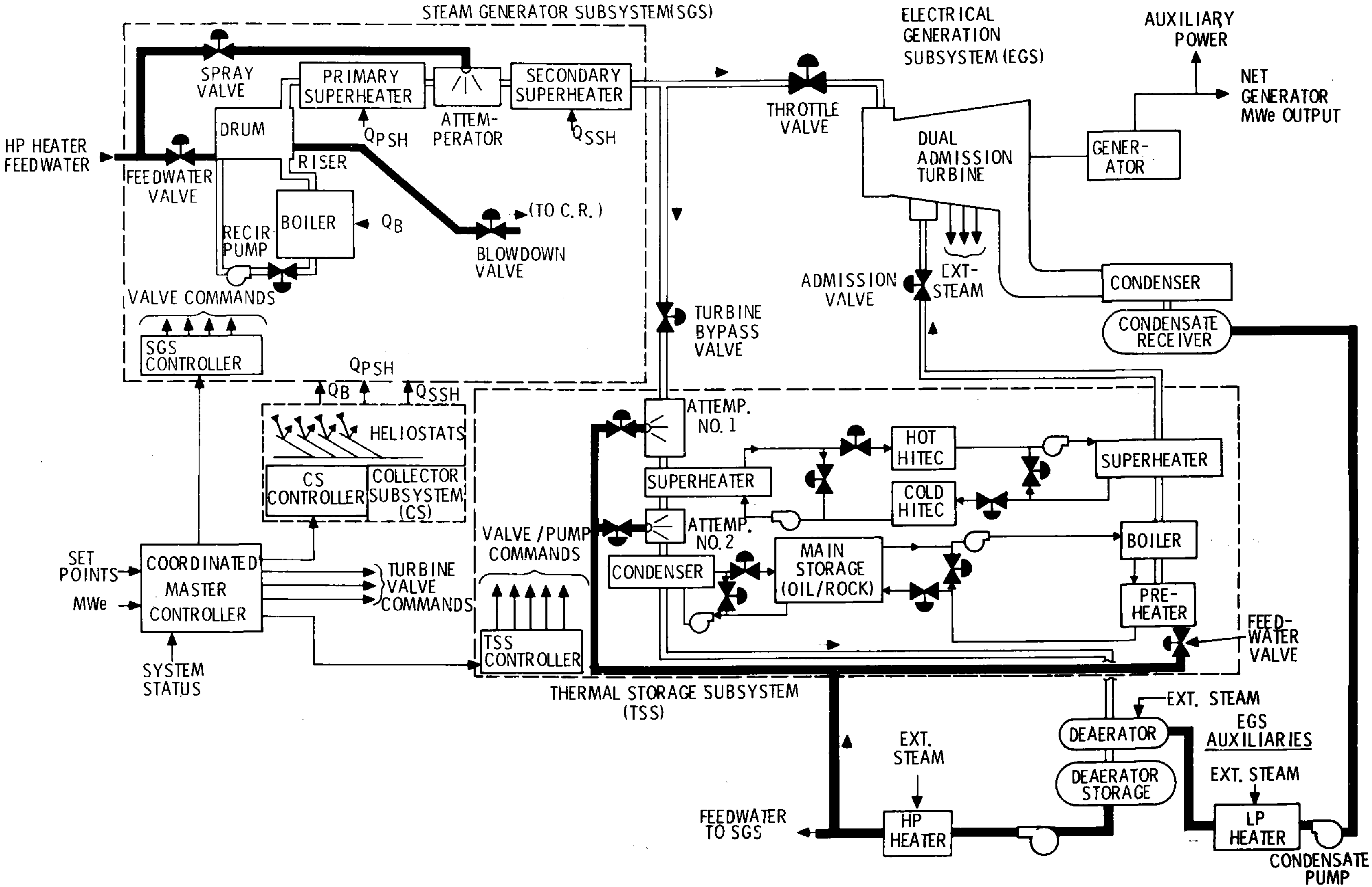


Figure 2-1. SPP Dynamic Simulation Functional Diagram

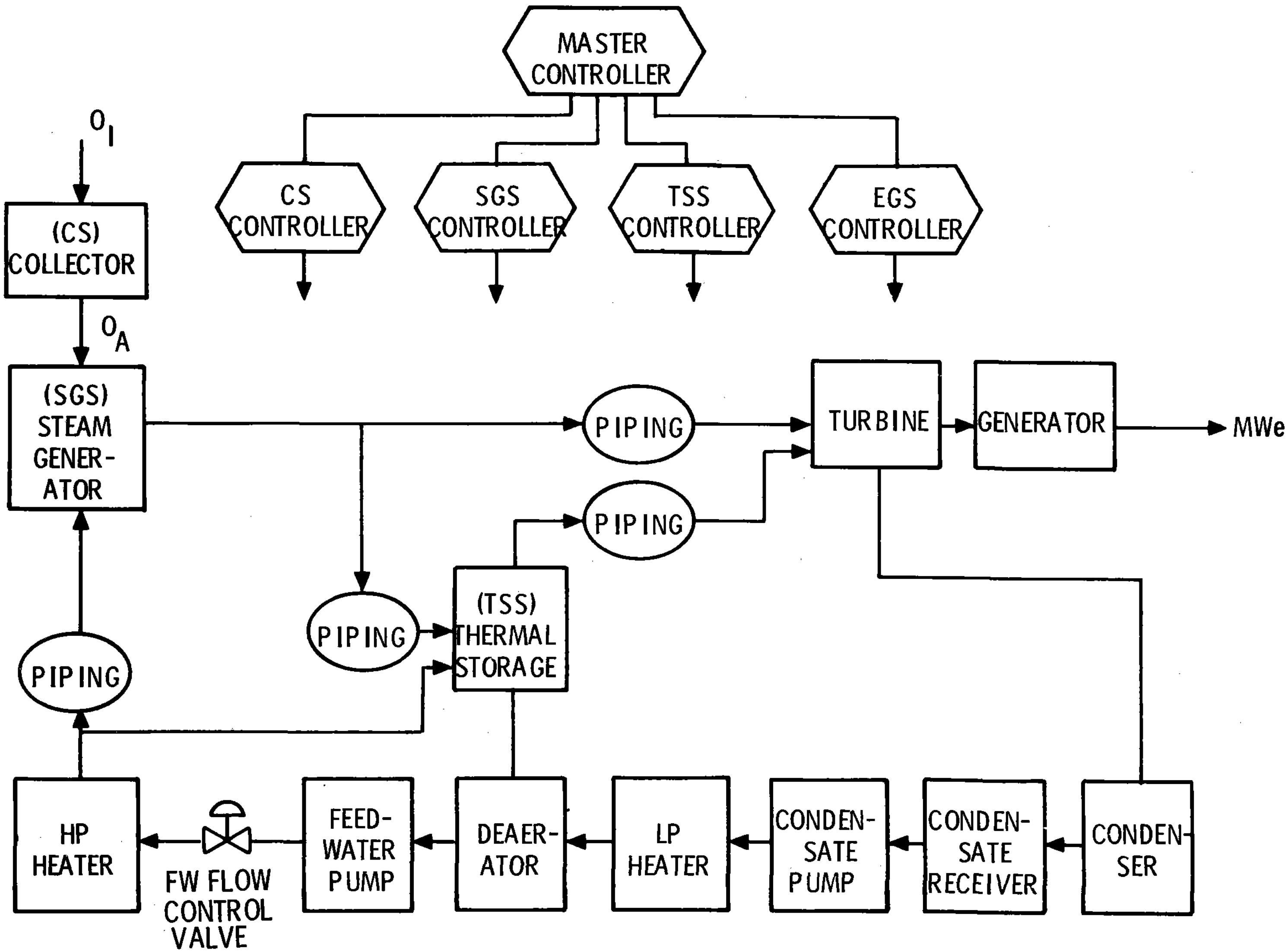


Figure 2-2. Modeled Elements SPP Dynamic Simulation

The SGS, using the absorbed radiant power, produces steam for flow either to the turbine through the throttle valve, or to the TSS through a turbine bypass valve. Because of the relatively long pipe lengths involved for steam flow (e.g., some 198m (650 ft) for receiver/turbine steam due to the tall receiver tower height), piping flow dynamics are included.

Steam flow continues to the turbine where mechanical power is extracted from the thermodynamic flow power. This mechanical power is then converted into electrical power by the generator.

Turbine exhaust steam is condensed and then reheated as feedwater by a series of heaters and other heat exchanging devices.

A sensible-heat thermal storage subsystem is modeled. It can either be charged, using steam flow from the SGS, or discharged, sending steam flow to the turbine.

Each of the individual subsystem models is described in the following subsections.

SGS (STEAM GENERATOR SUBSYSTEM) MODEL DESCRIPTION

The modeled SGS elements consist of the following modules:

- Drum/boiler
- Primary superheater (PSH)
- Attemperator
- Secondary superheater (SSH)
- Steam control valves

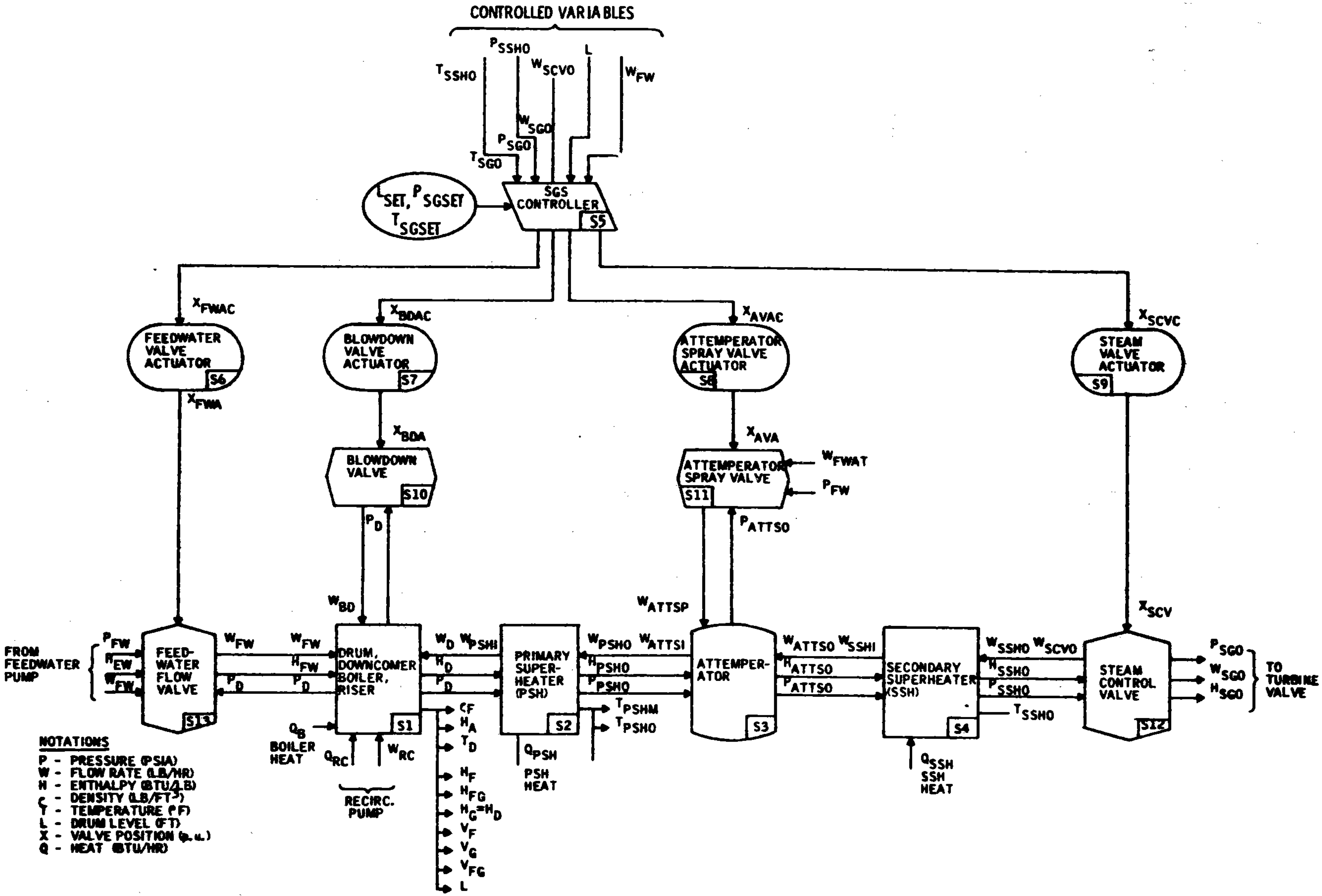


Figure 2-3. Steam Generator Subsystem Model Elements

- Water valves
- Valve actuators

Each of these elements is described in this subsection. (Tables 2-1 and 2-2 list symbols and model parameter values used in the simulation.

Figure 2-3 illustrates the breakdown of SGS modeled elements, including interface parameter variables, utilized in the SGS model.

Drum/Boiler

The drum/boiler is shown schematically in Figure 2-4. It is divided into four separate sections:

- Downcomer section
- Boiler section
- Riser section
- Drum section

In addition, an overall drum/boiler section is required to complete the model.

Mass and energy equations are determined for the first three of the four elements above, plus the complete unit. Fluid mass for the fourth element (drum) is computed by subtracting the masses of the downcomer/boiler riser from the overall drum/boiler subsystem mass.

Downcomer (Region 2) -- Fluid from the drum is delivered to the recirculation pump bottom suction through the downcomer. In the downcomer, the fluid is normally subcooled. However, should the drum pressure drop suddenly, the fluid in this region can go into saturation. The model accounts for such a possibility.

Table 2-1. List of Symbols

Location	Symbol	Description	Units
Drum/Boiler	H_{DC}	Fluid enthalpy, fluid entering downcomer	Btu/lb
	H_{FW}	Feedwater enthalpy	Btu/lb
	H_F	Fluid saturation enthalpy of drum fluid	Btu/lb
	H_2	Enthalpy of fluid exiting downcomer into boiler	Btu/lb
	H_G	Saturated vapor enthalpy of drum fluid	Btu/lb
	H_{FG}	Evaporation enthalpy of drum fluid	Btu/lb
	$H(Z)$	Boiler tube enthalpy along vertical distance Z	Btu/lb
	$H_{AVG}(Z)$	Average enthalpy along boiler tube height	Btu/lb
	H_A	Average boiler/drum enthalpy	Btu/lb
	M_5	Drum fluid mass	lb
	M_2	Downcomer fluid mass	lb
	M_3	Boiler fluid mass	lb
	M_4	Riser fluid mass	lb
	M_T	Total drum/boiler fluid mass	lb
	W_{RC}	Drum/boiler recirculation flow	lb/hr
	W_{FW}	Feedwater flow into drum	lb/hr
	W_B	Drum fluid flow into downcomer	lb/hr
	W_O	Steam flow out of drum	lb/hr
	W_{BD}	Blowdown flow	lb/hr
	XX	Fluid quality in downcomer	N. D.*
	X_2	Downcomer exit fluid quality	N. D.
	$X(Z)$	Fluid quality along boiler tubes	
	ς_2	Fluid density of fluid exiting downcomer to boiler	lb/ft^3
	$\varsigma(Z)$	Boiler tube fluid density as function of height	lb/ft^3
	ς_F	Average overall boiler/drum specific density	lb/ft^3

*Non-Dimensional.

Table 2-1. List of Symbols (Continued)

Location	Symbol	Description	Units
Drum/Boiler (continued)	$\phi(Z)$	Boiler flux distribution along boiler tubes	Btu/hr/ft
	V_T $(= V_1)$	Overall drum/boiler volume (= V_T)	ft^3
	V_{DC} $(= V_2)$	Downcomer fluid volume (= V_{DC})	ft^3
	V_2	Downcomer fluid volume	ft^3
	V_3	Boiler fluid/vapor volume	ft^3
	V_4	Riser fluid/vapor volume	ft^3
	V_5	Drum fluid/vapor volume	ft^3
	Q_{RC}	Heat added by recirculating pump	Btu/hr
	$Q(Z)$	Boiler heat distribution along tube distance Z	Btu/hr
	Q_B	Total boiler absorbed heat input	Btu/hr
	Q_{PSH}	Total absorbed heat input to PSH	Btu/hr
	Q_{SSH}	Total absorbed heat input to SSH	Btu/hr
	Q_R	Total radiant heat input to SGS	Btu/hr
	v_f	Specific volume of drum saturated liquid	ft^3/lb
	v_{fg}	Specific volume of drum evaporation fluid	ft^3/lb
	v_g	Specific volume of drum saturated vapor	ft^3/lb
	v_2	Specific volume of downcomer outlet fluid	ft^3/lb
	A_D	Effective drum cross-sectional area	ft^2
	A	Boiler tube effective cross-sectional area	ft^2
	a	Boiler flux distribution constant	ft^{-1}
	C_1	Boiler constant used to compute average	hr/lb
	K_{MB}	Factor accounting for metal/fluid storage	N. D.*
	K_1	Boiler flux distribution constant	Btu/hr/ft
	L	Maximum height of boiler tubes	Ft
	T_D	Drum saturation temperature	°F
	P_D	Drum saturation pressure	psia
	Z	Boiler tube vertical distance	ft
	ℓ	Drum liquid level	ft
	L_D	Effective drum height	ft

*Non-Dimensional.

Table 2-1. List of Symbols (Continued)

Location	Symbol	Description	Units
Drum/Boiler (concluded)	α	Boiler tube fluid density variable	$\frac{Btu}{lb}\ \frac{ft^3}{lb}$
	β	Boiler tube fluid density variable	$\frac{Btu}{lb}\ \frac{ft^3}{lb}$
Primary Superheater (PSH)	C_{MPSH}	Specific heat of metal	Btu/lb-°F
	K_{FRPSH}	Flow friction coefficient of PSH	hr^2/in^2-ft^3
	K_{MSPSH}	Metal-to-steam heat transfer coefficient	Btu/lb-°F
	M_{MPSH}	PSH metal mass	lb
	H_{PSHO}	Outlet steam enthalpy	Btu/lb
	Q_{PSH}	PSH radiant heat energy input	Btu/hr
	T_{PSHM}	PSH average metal temperature	°F
	T_{PSHO}	PSH outlet steam temperature	°F
	V_{PSH}	PSH steam volume	H^3
	W_{PSHi}	Inlet steam flow to PSH	lb/hr
	W_{PSHO}	Outlet steam flow from PSH	lb/hr
	P_D	Drum pressure	psia
	P_{PSHO}	PSH outlet pressure	psia
	ζ_{PSH}	PSH specific density at outlet	lb/ft^3
	K_1	Callendar's relationship constants	---
	K_2		---
Attemperator	W_{ATTSO}	Attemperator outlet flow	lb/hr
	W_{SSHi}	SSH inlet steam flow	lb/hr
	W_{ATTSP}	Spray flow	lb/hr
	P_{FW}	Feedwater pressure	psia
	P_{ATTSO}	Attemperator chamber pressure	psia
	X_{AVA}	Attemperator valve port opening area	pu
	C_{VAT}	Valve characteristics	$\frac{lb/hr}{psia}$
	H_{ATTSO}	Outlet enthalpy	Btu/lb
	H_{PSHO}	PSH outlet enthalpy	Btu/lb
	W_{ATTSi}	Attemperator inlet flow	lb/hr

Table 2-1. List of Symbols (Concluded)

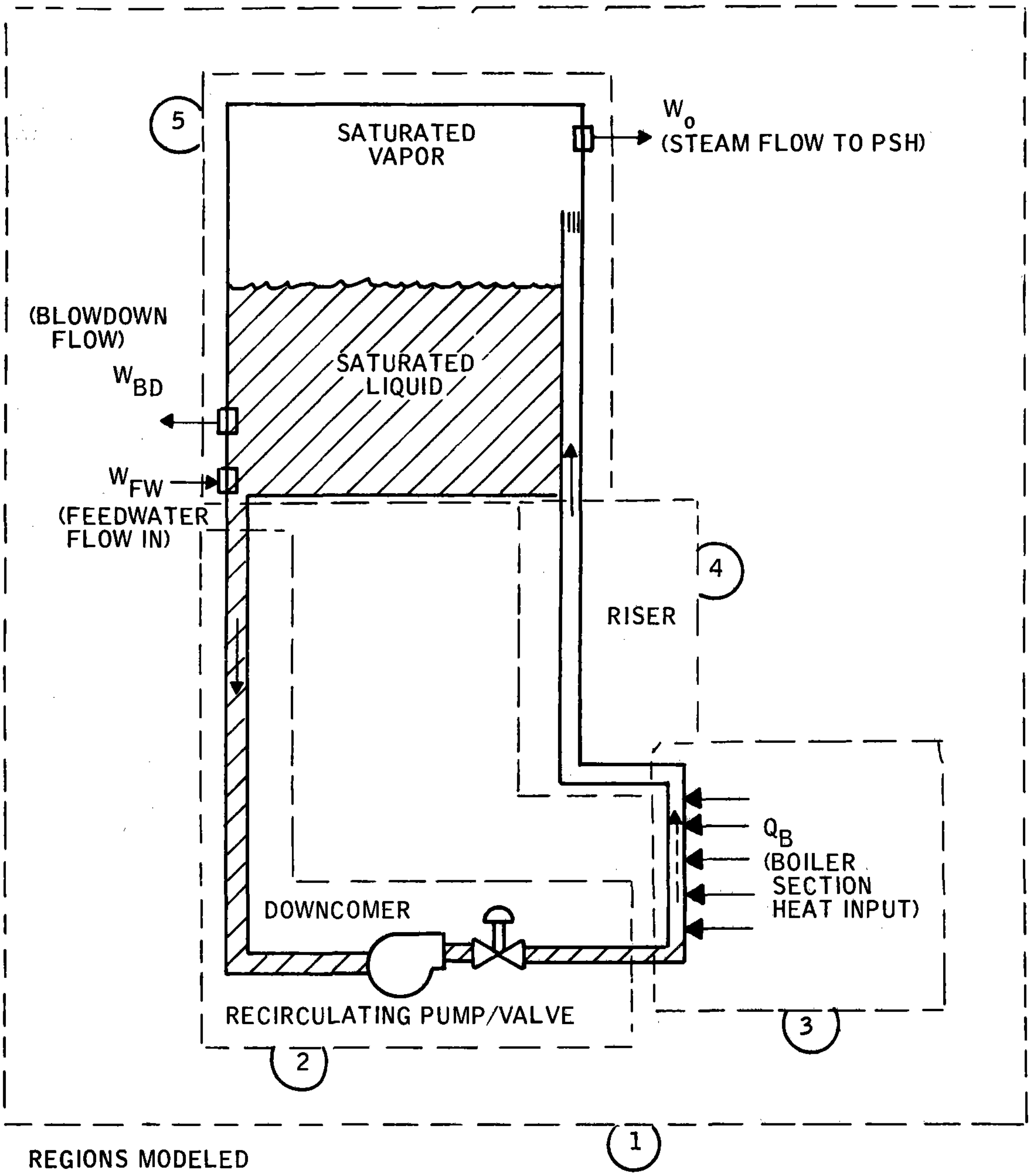
Location	Symbol	Description	Units
Secondary Superheater	C_{MSSH}	Specific heat of metal	Btu/lb-°F
	K_{FRSSH}	Flow friction coefficient	Hr^2/in^2-ft^3
	K_{MSSSH}	Metal-to-steam heat transfer coefficient	Btu/lb-°F
	M_{MSSH}	SSH metal mass	lb
	H_{SSHO}	SSH outlet steam enthalpy	Btu/lb
	Q_{SSH}	Radiant heat input	Btu/hr
	T_{SSHM}	Average SSH metal temperature	°F
	T_{SSHO}	Outlet steam temperature	°F
	V_{SSH}	SSH steam volume	ft^3
	W_{SSHi}	SSH inlet steam flow	lb/hr
	W_{SSHO}	SSH outlet steam flow	lb/hr
	P_{SSHO}	SSH outlet pressure	psia
	P_{ATTSO}	Attemperator outlet pressure	psia
	ρ_{SSH}	SSH specific density	lb/ft^3
	K_1	Callendar's relationship constants	---
	K_2		---

Table 2-2. SGS Model Parameter Values

Parameter	Value SRE	SPP	English Units	SI Units
1) Valve/Valve Actuator Parameters:				
a) Attemperator Valve:				
C_{AVA} – Time-constant factor	10.0		sec^{-1}	
$\dot{X}_{AV}$ – Rate limit	0.1		sec^{-1}	
X_{AVAH} – High position limit	1.0		pu	
X_{AVAL} – Low position limit	0.0		pu	
C_{VAT} – Valve characteristic	120.0 (7,894.6)		lb/hr/psi	(kg/hr/MPa)
b) Feedwater Valve:				
C_{FWA} – Time-constant factor	1.667		sec^{-1}	
$\dot{X}_{FW}$ – Rate limit	0.05		sec^{-1}	
X_{FWAH} – High position limit	1.2		pu	
X_{FWAL} – Low position limit	0.0		pu	
C_{FWV} – Valve characteristic	1596.45 (105,027.27)		lb/hr/psia	(kg/hr/MPa)
c) Steam Control Valve:				
C_{SCVA} – Time-constant factor	10.0		sec^{-1}	
$\dot{X}_{SC}$ – Rate limit	0.1		sec^{-1}	
X_{SCVH} – High position limit	1.1		pu	
X_{SCVL} – Low position limit	0.0		pu	
C_{SCV} – Valve characteristic	786.4 (51,735.7)		lb/hr/psia	(kg/hr/MPa)
d) C_{BDA} – Time-constant factor	20.0		sec^{-1}	
$\dot{X}_{BD}$ – Rate limit	0.0667		sec^{-1}	
X_{BDH} – High position limit	1.0		pu	
X_{BDL} – Low position limit	0.0		pu	
C_{VDB} – Valve characteristic	55.56 (3,655.18)		lb/hr/psia	(kg/hr/MPa)
2) Boiler/Drum Parameters:				
W_{RC} – Recirculating flow	160,640 (72,865)		lb/hr	(kg/hr)
V_1 – Total drum/boiler volume	43.8 (0.12403)		ft^3	(m^3)
V_2 – Downcomer volume	13.5 (0.03823)		ft^3	(m^3)
V_4 – Riser volume	4.55 (0.01288)		ft^3	(m^3)
Q_{RC} – Boiler recirculating pump heat	190,000 (20,046)		Btu/hr	(kJ/hr)
$(Q_R)_{max}$ – Maximum total absorbed power	16.622 (10^6) (17.537 (10^5))		Btu/hr	(kJ/hr)

Table 2-2. SGS Model Parameter Values (Concluded)

Parameter	Value SRE	SPP	English Units	SI Units
A_D – Drum cross-sectional area	2.875 (0.2671)		ft^2	(m^2)
A – Boiler tube cross-sectional area	0.5266 (0.0489)		ft^2	(m^2)
a – Boiler tube flux distribution constant	0.3586 (1.177)		ft^{-1}	(m^{-1})
K_{MB} – Factor for metal/fluid storage	1.56 (0.475)		---	
L – Boiler tube height	5.875 (1.791)		ft	(m)
L_D – Drum height	8.2 (2.499)		ft	(m)
3) Primary Superheater Parameters:				
C_{MPSH} – PSH metal specific heat	0.12 (0.5)		Btu/lb-°F	(kJ/kg-°C)
K_{FRPSH} – Flow friction coefficient	1.06 (10^{-6}) (1.937$(10^{-7}$)		hr^2/in^2-ft^3	$(hr^2/cm^2$-$m^3)$
K_{MSPSH} – Metal-to-steam heat transfer coefficient	27.817 (116.47)		Btu/lb-°F	(kJ/kg-°C)
M_{MPSH} – Metal mass	2500 (1134.0)		lb	(kg)
V_{PSH} – Fluid volume	3.47 (0.00983)		ft^3	(m^3)
K_1 – Callendar's relationship constants	1.244		---	
K_2	1039.38		---	
4) Secondary Superheater Parameters:				
C_{MSSH} – SSH metal specific heat	0.12 (0.5)		Btu/lb-°F	(kJ/kg -°C)
K_{FRSSH} – Flow friction coefficient	7.75 (10^{-7})		hr^2/in^2-ft^3	
K_{MSSSH} – Metal-to-steam heat transfer coefficient	26.3 (110.12)		Btu/lb-°F	(kJ/kg-°C)
M_{MSSH} – Metal mass	2500.0 (1134.0)		lb	kg
V_{SSH} – Fluid volume	3.47 (0.00983)		ft^3	m^3



REGIONS MODELED

1 COMPLETE DRUM/BOILER UNIT
2 DOWNCOMER SECTION
3 BOILER SECTION
4 RISER SECTION
5 DRUM SECTION

Figure 2-4. Drum/Boiler Schematic Representation

In modeling the downcomer section, the following assumptions are made:

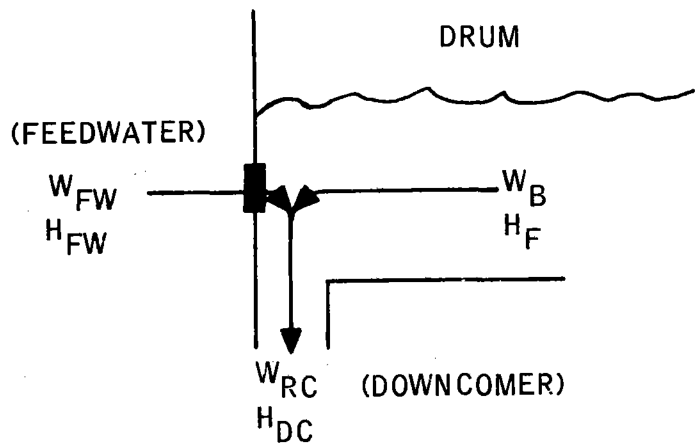
1) Recirculation mass flow is constant due to the recirculation pump. Therefore, pump dynamics are not modeled.

2) Mass storage in the downcomer is negligible.

3) Pressure along the downcomer is at the saturation pressure of the drum (i. e., the pressure rise due to gravity is negligible).

4) All feedwater enters the inlet of the downcomer and is thoroughly mixed with the saturated water exiting the drum separator.

An energy balance equation is written at the entrance to the downcomer based on adiabatic mixing of the feedwater and drum fluid streams, as shown below.



The energy balance equation for adiabatic mixing is

$$W_{RC} H_{DC} = W_{FW} H_{FW} + W_B H_F \tag{2-1}$$

The mass balance is always correct by letting

$$W_B = W_{RC} - W_{FW} \tag{2-2}$$

Then the energy balance equation (2-1) can be rewritten as

$$W_{RC} H_{DC} = W_{FW} H_{FW} + (W_{RC} - W_{FW}) H_F \tag{2-3}$$

or

$$H_{DC} = \left(\frac{W_{FW}}{W_{RC}}\right) H_{FW} + \left(1 - \frac{W_{FW}}{W_{RC}}\right) H_F \tag{2-4}$$

By defining

$$XX = W_{FW}/W_{RC} \tag{2-5}$$

the energy balance equation can be rewritten as

$$H_{DC} = (XX) H_{FW} + (1 - XX) H_F \tag{2-6}$$

The quantity "XX" is approximately the quality X of the downcomer fluid. If the drum level is held constant, the quantity XX is equivalent to the fluid quality.

An energy balance equation for the downcomer control volume is needed if any bubbles are to form during sudden drum pressure decreases. The energy balance equation is

$$3600 \frac{d}{dt} (\zeta_2 V_{DC} H_2) = W_{RC} (H_{DC} - H_2) + Q_{RC} \tag{2-7}$$

The density of downcomer fluid is computed by either of two alternate methods, depending on whether the fluid is subcooled or saturated:

- Subcooled:

  If $H_F > H_2$, the fluid in the downcomer is subcooled and the density is given by

  $$\varsigma_2 = f(H_2) \qquad (2\text{-}8)$$

  where $f(H_2)$ is a polynomial fit of the steam tables.

- Saturated:

  If $H_F < H_2$, then ς_2 is calculated as follows. First, the quality is determined as

  $$X_2 = \frac{H_2 - H_F}{H_{FG}} \qquad (2\text{-}9)$$

  The specific density is then given by

  $$V_2 = (1 - X_2)\,V_F + X_2 V_G \qquad (2\text{-}10)$$

  and the density by

  $$\varsigma_2 = 1/V_2 \qquad (2\text{-}11)$$

The H_F, H_{FG}, V_F and V_G terms are functions of saturated drum pressure only. These quantities are continuously calculated by polynomial fits of the steam tables.

Notice that the only time bubbles can form in the downcomer is when $H_2 > H_F$.

The mass in the downcomer is given by

$$M_2 = \zeta_2 V_{DC} = \zeta_2 V_2 \qquad (2\text{-}12)$$

In Figure 2-4, a valve and pump are shown in the downcomer region. There will be a pressure rise across the pump, and a pressure drop across the valve. The magnitudes of these two pressure terms is nearly the same, and are therefore neglected in the model.

Boiler (Region 3) -- Recirculating water discharging from the recirculation pump enters a distribution header along the lower outside portion of the cavity. Water then rises in the boiler tubes where it is subjected to heat transfer from solar radiation. Nucleate boiling occurs and a saturated mixture then proceeds up the riser section to the drum.

In modeling the boiler section, the following assumptions are made:

1) The heat flux distribution is fixed along the vertical distance from the boiler inlet to outlet headers. The flux amplitude, but not the distribution, can be varied.

2) At all points along the boiler tube walls, the pressure is equivalent to the drum saturation pressure.

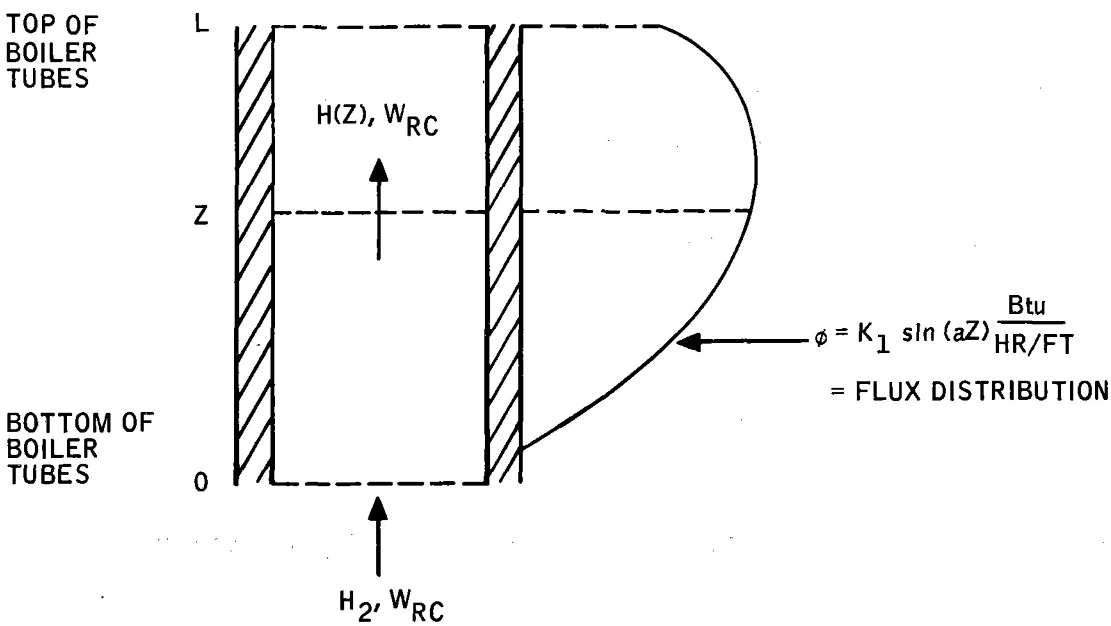
3) Mass storage effects in the boiler tubes are negligible.

4) The energy stored in the boiler tubes is negligible. Since the heat transfer coefficient is high, and the metal mass is small, the lag is generally insignificant.

The drum for the SGS is a vertical unit, so that shrink and swell effects are much larger than would exist for a horizontal drum with equal volume and a larger surface area. The shrink and swell variations have been determined to be quite small by comparison.

In order to determine the drum level accurately, the mass in the boiler region must be calculated accurately as the heat input is varied. The quality of the boiler fluid also significantly affects drum level.

The mass of the fluid in the boiler tubes is strongly dependent upon the heat flux distribution. For the SGS, a sine-wave type of flux distribution pattern has been determined to be representative of the absorbed radiant heat input. This flux distribution pattern is shown in the figure below.



The flux distribution is assumed to be uniform around the cavity. The amount of heat absorbed by a section of the boiler tubes of length "Z" can be written as

$$Q(Z) = \int_0^Z \phi(Z)\, dZ$$

$$= \int_0^Z K_1 \sin(aZ)\, dZ$$

$$= \frac{K_1}{a} [\, 1 - \cos(aZ) \,] \qquad (2\text{-}13)$$

where the value of the constant, K_1, is given by

$$K_1 = \frac{aQ_B}{1 - \cos(aL)} \qquad (2\text{-}14$$

Any increase in boiler heat input, Q_B, increases the amplitude of the flux, ϕ, but not the distribution.

During boiling, the fluid enthalpy at any point along the boiler tubes is obtained by writing an energy balance equation for the control volume:

$$W_{RC} H_2 + Q(Z) = H(Z) W_{RC} \qquad (2\text{-}15)$$

or

$$H(Z) = H_2 + \frac{Q(Z)}{W_{RC}} \qquad (2\text{-}16)$$

The quality at any point along the boiler tubes can be written as

$$X(Z) = \frac{H(Z) - H_F}{H_{FG}} \qquad (2\text{-}17)$$

where H_F and H_{FG} are functions of drum saturation pressure.

The specific volume within the tubes can then be written as

$$V(Z) = (1 - X)\,V_f + XV_G \tag{2-18}$$

and the specific density as

$$\zeta(Z) = \frac{1}{V(Z)}$$

$$= \frac{1}{(1-X)\,V_F + XV_G} \tag{2-19}$$

Combining Equations (2-16) through (2-19), the expression for specific density can be rewritten as

$$\zeta(Z) = \frac{H_{FG}}{\alpha + \beta \cos(aZ)} \tag{2-20}$$

where

$$\alpha = H_2V_{FG} - \beta + H_GV_F - H_FV_G \tag{2-21}$$

$$\beta = \frac{-K_1}{a}\,\frac{V_{FG}}{W_{RC}} \tag{2-22}$$

The total mass in the boiler tubes, M_3, can then be found by the expression

$$M_3 = \int_0^L A\,\zeta(Z)\,dZ \tag{2-23}$$

where A is the effective cross-sectional area of the boiler tubes. Integrating the expression of Equation (2-23) yields:

- $\underline{\alpha^2 > \beta^2:}$

$$M_3 = \left(\frac{2A}{a}\right)\left(\frac{H_{FG}}{\sqrt{\alpha^2 - \beta^2}}\right) \tan^{-1} \left\{ \frac{\sqrt{\alpha^2 - \beta^2} \tan \left(\frac{aL}{2}\right)}{\alpha + \beta} \right\} \quad (2\text{-}24)$$

- $\underline{\beta^2 > \alpha^2:}$

$$M_3 = \left(\frac{AH_{FG}}{a}\right)\frac{1}{\sqrt{\beta^2 - \alpha^2}} \ln \left\{ \frac{\beta + \alpha \cos (aL) + \sqrt{\beta^2 - \alpha^2} \sin (aL)}{\alpha + \beta \cos (aL)} \right\} \quad (2\text{-}25)$$

Prior to boiling, as during a cold startup situation, the density in the boiler tubes will be nearly equivalent to the density in the downcomers (ζ_2). The computerized model uses the density, ζ_2, value for temperatures less than boiling. When the average enthalpy in the boiler tubes exceeds 118.57 Kjoules/kg (180 Btu/lb) (i.e., boiling), the density is computed on the basis of Equation (2-20) and the mass on the basis of Equation (2-23). Otherwise, before boiling, the mass in the boiler tubes is computed as

$$M_3 = \zeta_2 AL \quad (2\text{-}26)$$

The average enthalpy in the boiler tubes is computed using Equation (2-16). which can be expressed as

$$H(Z) = H_2 + \frac{Q(Z)}{W_{RC}}$$

$$= H_2 + \frac{K_1}{aW_{RC}} [1 - \cos (aZ)] \quad (2\text{-}27)$$

Then the average boiler tube enthalpy is computed as

$$H_{AVG}(Z) = H_2 + \frac{1}{L} \int_o^L \frac{Q(Z)}{W_{RC}} \, dZ$$

$$= H_2 + \frac{K_1}{aW_{RC}} \left[1 - \frac{\sin(aL)}{aL}\right]$$

$$= H_2 + C_1 Q_B \qquad (2\text{-}28)$$

where

$$C_1 = \frac{1 - \sin(aL)/aL}{W_{RC}[1 - \cos(aL)]} \qquad (2\text{-}29)$$

Riser Section (Region 4) -- This region of the drum/boiler includes the risers and boiler outlet header. For the risers, it is assumed that the inlet and outlet enthalpies are equivalent, and that the inlet and outlet flows are equal. The riser mass and its effect upon drum level is the significant item to be modeled.

After boiling, the riser fluid volume, M_4, can be written as

$$M_4 = \zeta(L) V_4$$

$$= \frac{H_{FG} V_4}{\alpha + \beta \cos(aL)} \qquad (2\text{-}30)$$

Prior to boiling, the riser fluid mass is approximately

$$M_4 = \zeta_2 V_4 \qquad (2\text{-}31)$$

Overall System (Region 1) -- Figure 2-4 illustrates the SGS model breakdown into five regions. Only four of these regions are independent, since one region (No. 1) is the overall system. Thus only four independent energy balance equations can be written. For the representation selected, Regions 1, 2, 3, and 4 have been selected as these independent regions. Region 5 (the drum) energy and mass balance equations are therefore not explicitly written.

For the overall system, the average density and enthalpy can be obtained from a continuity equation and an energy balance equation:

- Mass Balance (Continuity) Equation:

$$3600\ V_T \frac{d}{dt}(\zeta_F) = W_{FW} - W_O - W_{BD} \tag{2-32}$$

- Energy Balance Equation

$$3600\ \zeta_F V_T K_{MB} \frac{d}{dt}(H_A) = W_{FW}(H_{FW}-H_A) - W_O(H_G-H_A) - W_{BD}(H_F - H_A) + Q_B + Q_{RC} \tag{2-33}$$

where

V_T = Overall system volume

ζ_F = Overall average system specific density

H_A = Overall average system enthalpy

W_O = Steam flow out of drum

K_{MB} = Energy storage effect correction factor

The primary assumption used in these equations is that the internal energy was approximately equal to the enthalpy.

The term K_{MB} used in the energy balance equation represents a factor to account for the energy stored in the metal. In effect, the term combines the metal and fluid energy storages.

After the average specific density and enthalpy terms (ζ_F and H_A) are determined, the following drum/boiler saturation properties are determined using polynomial fits of the steam tables:

- $T_D = T_{SAT}(H_A, \zeta_F)$ = Saturation temperature
- $P_D = P_{SAT}(T_D)$ = Saturation pressure
- $H_F = f(P_D, T_D)$ = Fluid enthalpy
- $H_{FG} = f(P_D)$ = Evaporation enthalpy
- $H_G = f(P_D)$ = Vapor enthalpy
- $V_F = f(P_D)$ = Fluid specific volume
- $V_{FG} = f(P_D)$ = Evaporation specific volume
- $V_G = V_F + V_G$ = Vapor specific volume

Calculation of Drum Mass and Drum Level -- The total overall system mass is given by

$$M_T = \zeta_F (V_2 + V_3 + V_4 + V_5) \tag{2-34}$$

$$= \zeta_F V_T$$

$$= M_1$$

The mass in the drum, can therefore be determined by

$$M_5 = M_T - M_2 - M_3 - M_4 \tag{2-35}$$

Assume that all the liquid is at the bottom of the drum, and the vapor at the top. Then, since this is a vertical drum, the volume varies approximately linearly with height (even considering drum internals). Thus, the drum can be considered as a right cylinder and we can write

$$A_D \zeta_F \ell + A_D \zeta_G (L_D - \ell) = M_5 \tag{2-36}$$

where

L_D = Effective height of drum

ℓ = Liquid level of drum

A_D = Effective drum cross-sectional area

Thus, the drum level is determined by

$$\ell = \frac{V_F (M_5 V_G - A_D L_D)}{A_D V_{FG}} \tag{2-37}$$

Primary Superheater (PSH)

In the PSH, dry steam entering from the drum is heated by radiant heat absorbed by the metal prior to exiting to the attemperator. A single-node representation has been adopted, allowing the PSH to be represented by a set of ordinary differential equations. A multiple-node representation of the PSH would be possible provided nodal parameters were available.

The PSH metal temperature and enthalpy are determined by the respective energy conservation equations:

$$3600\, C_{MPSH}\, M_{MPSH}\, \dot{T}_{PSHM} = Q_{PSH} - K_{MSPSH}\, W_{PSHO}^{0.8} (T_{PSHM} - T_{PSHO}) \tag{2-38}$$

$$3600\, \rho_{PSH}\, V_{PSH}\, \dot{H}_{PSHO} = W_{PSHi}\, H_D - W_{PSHO} H_{PSHO} + K_{MSPSH}\, W_{PSHO}^{0.8} (T_{PSHM} - T_{PSHO}) \tag{2-39}$$

Flow through the PSH coil is found by assuming a quasi-static relationship between flow in and out of the PSH; i.e.:

$$W_{PSHO} = W_{PSHi} \tag{2-40}$$

The outlet flow is then a function of pressure differential and specific density:

$$W_{PSHO} = \sqrt{(P_D - P_{PSHO})\, \rho_{PSH} / K_{FRPSH}} \tag{2-41}$$

where

K_{FRPSH} is the flow friction term.

The outlet flow, W_{PSHO}, will be set by the flow into the attemperator. A second relationship between outlet pressure and specific density is required in order to determine these two variables. Using Callendar's relation (Ref. 1),

$$P = \zeta (K_1 H - K_2) \quad (2\text{-}42)$$

provides this second relationship. For the PSH, Callendar's relationship is therefore

$$P_{PSHO} = \zeta_{PSH} (K_1 H_{PSHO} - K_2) \quad (2\text{-}43)$$

where

$K_1 = 1.244$

$K_2 = 1039.38$

in units consistent with psia (pressure), lb/ft^3 (density), and Btu/lb (enthalpy).

Using Equations (2-41) and (2-43) results in the relationships:

$$(P_D - P_{PSHO}) \zeta_{PSH} = K_{FRPSH} W^2_{PSHO} \quad (2\text{-}44)$$

$$\left[P_D - \zeta_{PSH} (K_1 H_{PSHO} - K_2)\right] \zeta_{PSH} = K_{FRPSH} W^2_{PSHO} \quad (2\text{-}45)$$

Finally,

$$\zeta^2_{PSH} (K_1 H_{PSHO} - K_2) - \zeta_{PSH} P_D + W^2_{PSHO} K_{FRPSH} = 0 \quad (2\text{-}46)$$

Since this equation has only one unknown variable, ζ_{PSH}, the solution is found by quadratic equation solution.

Once the specific density, ζ_{PSH}, is known, the outlet pressure, P_{PSHO}, can be determined from Callendar's relationship:

$$P_{PSHO} = \zeta_{PSH} (K_1 H_{PSHO} - K_2) \tag{2-47}$$

The remaining PSH variable of interest is outlet steam temperature (T_{PSHO}). This is determined by a polynomial fit of the steam tables:

$$T_{PSHO} = f (P_{PSHO}, \zeta_{PSH}, H_{PSHO}) \tag{2-48}$$

Attemperator

The attemperator adiabatically mixes feedwater with the PSH outlet steam for SSH outlet steam temperature control. A constant-pressure process with no energy or mass storage effects is assumed.

The attemperator outlet flow is determined from the SSH steam inlet flow, i. e. :

$$W_{ATTSO} = W_{SSHi} \tag{2-49}$$

The attemperator spray flow is determined from

$$W_{ATTSP} = C_{VAT} X_{AVA} (P_{FW} - P_{ATTSO})^{1/2} \tag{2-50}$$

where

C_{VAT} = Attemperator valve characteristic

X_{AVA} = Valve opening

P_{FW} = Feedwater pressure

P_{ATTSO} = Attemperator pressure

The attemperator chamber pressure is assumed equivalent to the PSH outlet pressure (P_{PSHO}).

The attemperator enthalpy (H_{ATTSO}) is then determined by the energy balance relationship:

$$H_{ATTSO} = (W_{ATTSi} H_{PSHO} + W_{ATTSP} H_{FW}) / W_{ATTSO} \qquad (2\text{-}51)$$

For pressures less than 1.38 MPa (200 psia), the attemperator and PSH enthalpies are set equivalent; i.e.,:

$$H_{ATTSO} = H_{PSHO} \qquad (2\text{-}52)$$

<u>Secondary Superheater (SSH)</u>

This unit adds further superheat to the steam flowing from the attemperator. It is physically nearly identical to the PSH, and therefore the same model equations hold. Following the methods outlined in the PSH section, the SSH metal temperature and enthalpy energy balance relationship are:

- $$3600\, C_{MSSH} M_{MSSH} \dot{T}_{SSHM} = Q_{SSH} - K_{MSSSH} W_{SSHO}^{0.8} (T_{SSHM} - T_{SSHO}) \qquad (2\text{-}53)$$

- $$3600\, \zeta_{SSH} V_{SSH} \dot{H}_{SSHO} = W_{SSHi} H_{ATTSO} - W_{SSHO} H_{SSHO} + K_{MSSSH} W_{SSHO}^{0.8} (T_{SSHM} - T_{SSHO}) \quad (2\text{-}54)$$

- $${}^{2}_{SSH} (K_1 H_{SSHO} - K_2) - \zeta_{SSH} P_{ATTSO} + W_{SSHO}^{2} K_{FRSSH} = 0 \quad (2\text{-}55)$$

- $$P_{SSHO} = \zeta_{SSH} (K_1 H_{SSHO} - K_2) \quad (2\text{-}56)$$

- $$T_{SSHO} = f\,(P_{SSHO}, \zeta_{SSH}, H_{SSHO}) \quad (2\text{-}57)$$

Steam Control Valves

The SSH steam control valve (SCV) model is valid for both choked and unchoked flow, and for saturated and superheated steam. The valve model does not include the actuator, and is valid only when the inlet pressure is greater than the outlet pressure (i. e., no reverse flow). This valve model is used only for operation of the SGS as an isolated subsystem. For operation in the total pilot plant, the throttle valve on the turbine and the storage bypass valve determine steam flow.

The equations used in describing the steam valve are as follows:

- $$\Delta P_{SCV} = \text{Min} \begin{cases} P_{SSHO} - P_{out} \\ 0.45\, P_{SSHO} \end{cases} \quad (2\text{-}58)$$

- $$P_{ratio} = \frac{P_{SSHO} - P_{out}}{P_{SSHO}} \quad (2\text{-}59)$$

- $$Z_{SCV} = \begin{cases} 0.75, & P_{ratio} \le 0.47 \\ 1-0.532\, P_{ratio}, & P_{ratio} > 0.47 \end{cases} \quad (2\text{-}60)$$

- $$V_{SCV} = f\,(H_{SSHO}, P_{SSHO}) \quad (2\text{-}61)$$

where

Z_{SCV} = SCV expansion factor

and

V_{SCV} = Outlet steam specific density

The outlet steam flow, W_{SGO}, from the steam control valve is then determined by the relationship:

$$W_{SGO} = X_{SCV}^2 C_{SCV} Z_{SCV} (\Delta P_{SCV}/V_{SCV})^{1/2} \quad (2\text{-}62)$$

where

C_{SCV} = SCV valve characteristic parameter

X_{SCV} = SCV valve port opening area

X_{SCV} = SCV valve stem position (constant-percentage valve)

Water Valves

The feedwater, blowdown, and attemperator valves are represented as follows:

- Attemperator:

$$W_{ATTSP} = C_{VAT} X_{AVA} (P_{FW} - P_{ATTSO})^{1/2} \quad (2\text{-}63)$$

- Blowdown:

$$W_{BD} = C_{VBD} X_{BDA} (P_D - 14.7)^{1/2} \quad (2\text{-}64)$$

- <u>Feedwater</u>:

$$W_{FW} = C_{FWV} X_{FW}^2 (P_{FW} - P_D)^{1/2} \tag{2-65}$$

In these water valve expressions, a specific density factor should actually be enclosed under the square root parentheses. However, a relatively constant value of feedwater density in the normal operating regions of the system has been assumed and the density effects lumped together with the valve characteristic parameter (C_V).

Valve Actuators

The generalized actuator model block diagram is shown in Figure 2-5.

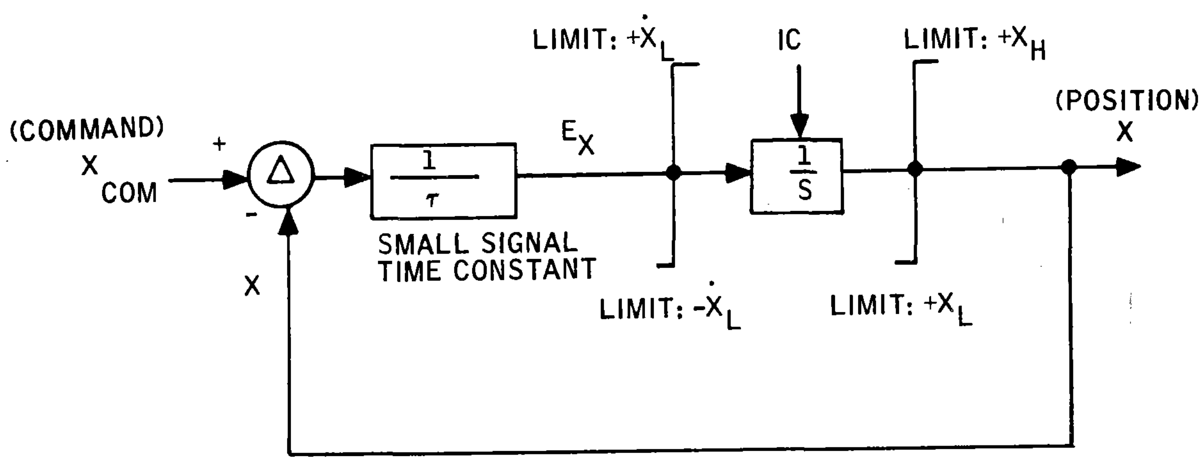


Figure 2-5. Generalized Actuator Model Block Diagram

The variables used in the computerized model for the four SGS actuators are listed in Table 2-3.

Table 2-3. Actuator Variables

Parameter		Steam Control	Actuator		
			Feedwater	Attemperator	Blowdown
Position command	(X_{com})	X_{CVC}	X_{FWAC}	X_{AVAC}	X_{BDAC}
Position	(X)	X_{SCV}	X_{FWA}	X_{AVA}	X_{BDA}
Time constant	($1/\tau$)	C_{SCVA}	C_{FWA}	C_{AVA}	C_{BDA}
Rate limit	($\dot{X}_L$)	$\dot{X}_{SC}$	$\dot{X}_{FW}$	$\dot{X}_{AV}$	$\dot{X}_{BD}$
Error signal	(E_X)	E_{SVA}	E_{FWA}	E_{ATVA}	E_{BDA}
High position limit	(X_H)	X_{SCVH}	X_{FWAH}	X_{AVAH}	X_{BDH}
Low position limit	(X_L)	X_{SCVL}	X_{FWAL}	X_{AVAL}	X_{BDL}

Cavity Surface Temperatures

The collector model requires calculation of six cavity temperatures, as shown below, corresponding to the six nodes representing the cavity:

Node	Cavity Region	Temperature
1	Cavity ceiling	T_{CAV1}
2	SSH metal	T_{CAV2}
3	PSH metal	T_{CAV3}
4	Boiler metal	T_{CAV4}
5	Aperture opening	T_{CAV5}
6	Cavity floor	T_{CAV6}

Temperatures of three of the nodes (Nos. 2, 3, and 4 above) are computed as part of the SGS model previously described, i.e.,

$T_{CAV2} = T_{SSHM}$ (SSH metal temperature)

$T_{CAV3} = T_{PSHM}$ (PSH metal temperature)

$T_{CAV4} = T_D$ (Boiler/drum saturation temperature)

Temperature of the aperture opening (T_{CAV5}), is equivalent to the ambient temperature. The program uses a constant value of 37.8 deg-C (100 deg F).

Temperatures of the cavity top and bottom (T_{CAV1}, T_{CAV6}) are determined in the following manner. For both the top and bottom, a uniform-density, cylindrical volume of material is assumed. An energy equation using temperature rate of change is then written for each of the two nodes in order to determine temperature as a function of time. The general equation for temperature rate is

$$3600\, M_{CAV}\, C_P\, \dot{T}_{CAV} = Q_{AB}$$

where

M_{CAV} = cavity nodal mass

C_P = cavity nodal specific heat

$\dot{T}_{CAV}$ = cavity nodal temperature rate of change

Q_{AB} = absorbed power into node

For the cavity top (node 1), a 2.54 cm (1-inch) thick steel plate of cavity top radius R_1 was assumed. Therefore,

$$M_{CAV1} = \zeta_1 A_1 t_1,$$

$$= \zeta_1 (\pi R_1^2)(t_1/12)$$

where

M_{CAV1} = top of cavity mass

ζ_1 = density of steel = 7865.8 Kg/m^3 (491 lb/ft^3)

R_1 = cavity top radius

t_1 = thickness of material = 2.54 cm (1-inch)

A specific heat value of $0.502 \frac{KJ}{Kg\text{-}°C}$ $(0.12 \frac{Btu}{lb - °F})$ is used in the program.

For the cavity bottom (node 6), a solid concrete cylinder 5-ft thick was assumed. In this case

ζ_6 = concrete density = 2306.9 Kg/m^2

R_6 = bottom of cavity radius

t_6 = thickness of material = 1.524 m (5 ft)

M_{CAV6} = bottom of cavity mass

$= \zeta_6 (\pi R^2_6) t_6$

A specific heat value of 0.653 $\frac{Kj}{Kg\text{-}°C}$ (0.156 $\frac{Btu}{lb\text{-}°F}$) is assumed.

EGS (ELECTRICAL GENERATION SUBSYSTEM) MODEL DESCRIPTION

The EGS portion of the SPP Dynamic Simulation is comprised of:

- Turbine
- Generator
- EGS Auxiliaries
  - Condenser/Condensate Receiver
  - Condensate pump
  - LP heater
  - Deaerator/Deaerator storage
  - Boiler feed pump
  - HP heater

The interrelationship between these EGS elements and the other SPP subsystems is illustrated in Figure 2-1.

For the SPP Dynamic Simulation, the model elements of the EGS are shown in Figure 2-6. As shown, the model includes piping dynamics between those EGS elements where significant piping distances are involved.

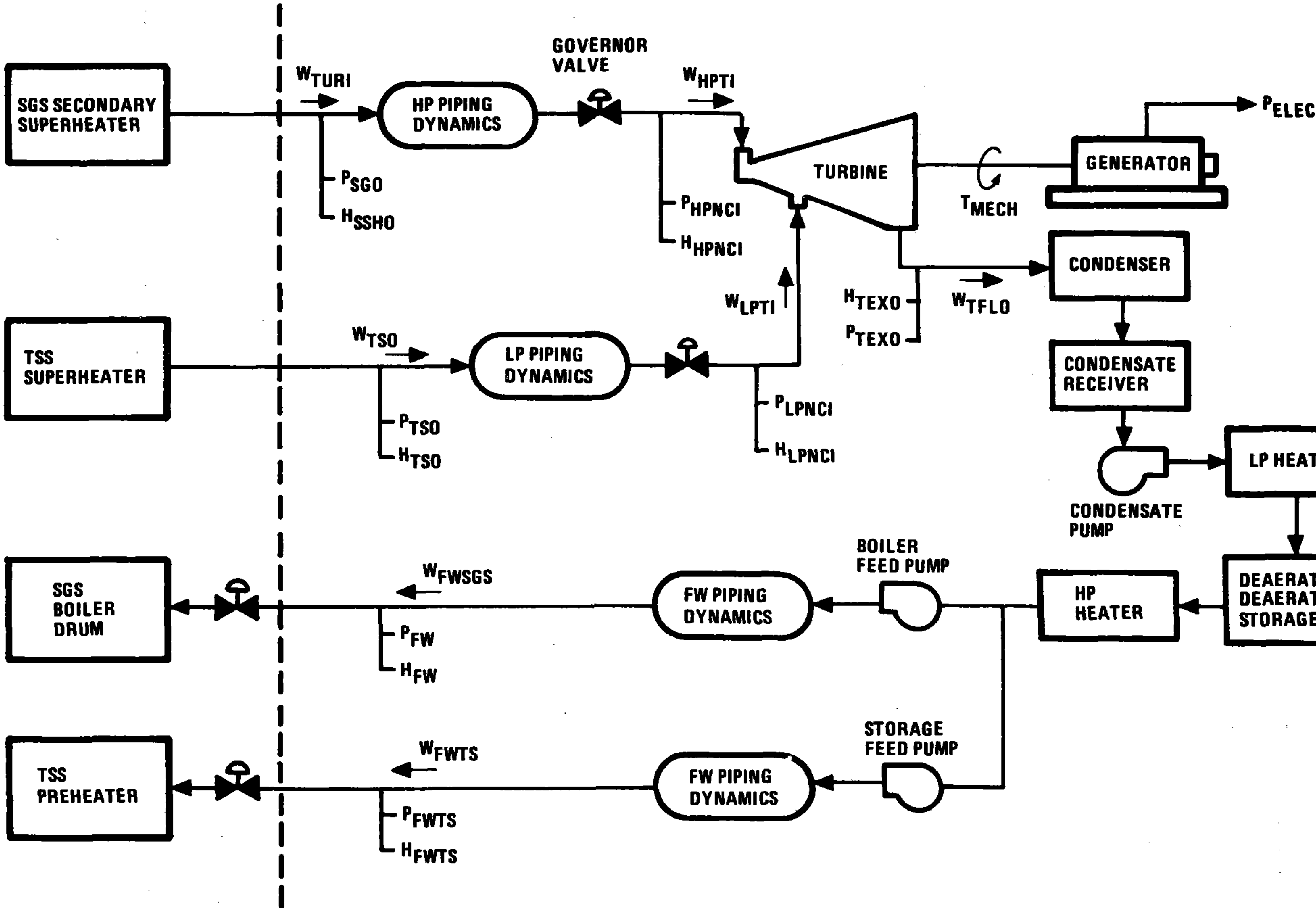


Figure 2-6. EGS Model Elements for SPP Dynamic Simulation

The following description of the EGS model for the dynamic simulation is organized into two major discussion areas:

- Turbine/Generator Dynamics
- Fluid flow dynamics (to and from the turbine/generator)

Turbine/Generator Dynamics

Figure 2-7 shows a cutaway drawing of the type of turbine to be utilized on the SPP. This dual-admission turbine is equipped with stop valves at both the HP (i. e., steam inlet port) and the LP (i. e., TSS steam admission) ports.

The turbine is an impulse-type turbine. Inlet control valves will probably be poppet type to minimize throttling effects and effect higher overall efficiency. Multiple valves at the upper and lower shaft positions will probably utilize opening overlap to minimize dead spots. Extraction valves are expected to be spool type, capable of handling large steam volumes.

A steam by-pass valve is shown in Figure 2-7. This valve is opened whenever the turbine is to be operated from TSS admission steam only. This valve permits cooling steam to be "pumped" backwards through the HP section, thereby preventing excessive front-end temperature buildup.

The primary turbine/generator model is based upon composite information contained in References 1, 2, and 3. A p. u. (per unit) system of measurement units is utilized, avoiding cumbersome conversion factors and permitting development of the model with limited technical data.

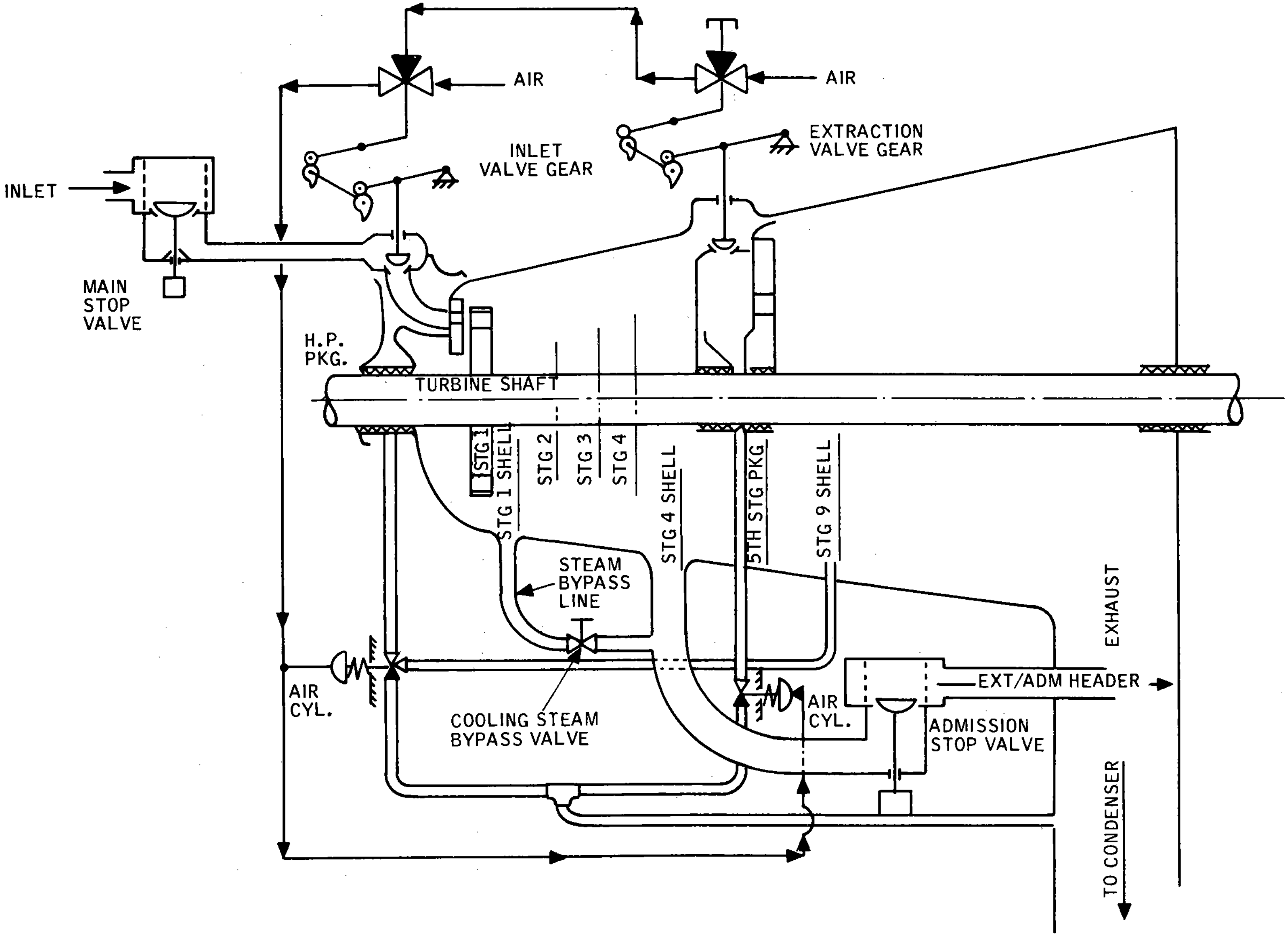


Figure 2-7. EGS Turbine/Generator Cutaway View

Turbine Governing System -- The turbine speed-governing system is expected to be an electro-hydraulic control (EHC) type, and is appropriately modeled in the simulation. A block diagram of this system is shown in Figure 2-8 for both the HP (i.e., SGS inlet steam) and LP (TSS admission steam) sections.

Both of the speed-governing systems modeled in the simulation are basically identical. The models represent the best available information of the type of speed-governing controls to be implemented on the SPP turbine. As more information is acquired, it is anticipated that the model could be revised in several respects:

- Integrate the LP and HP governing sections into a single control unit for control of the LP and HP valves in a coordinated fashion. It is expected that the actual control unit is, in fact, a single electronics unit functionally integrated.
- Provide for overspeed and startup/synchronization.
- Provide for limiting maximum startup rotor acceleration.

As shown in Figure 2-8, the rotor speed error signal is amplified by a governor speed gain. Typically, the value of this gain is 20 (=100/(% steady-state speed regulation)), since speed regulation values of 5 percent are common.

The resulting speed error signal, altered by the mass flow feedback gain (K_{PHP}), is then differenced with the mass flow-feedback signal. This steam flow (or first-stage pressure) provides improved linearity over mechanical-hydraulic systems, which do not employ this term. As information on the exact representation of the SPP turbine-governing system is not available at this time, however, the SPP dynamic simulation employs a unity gain

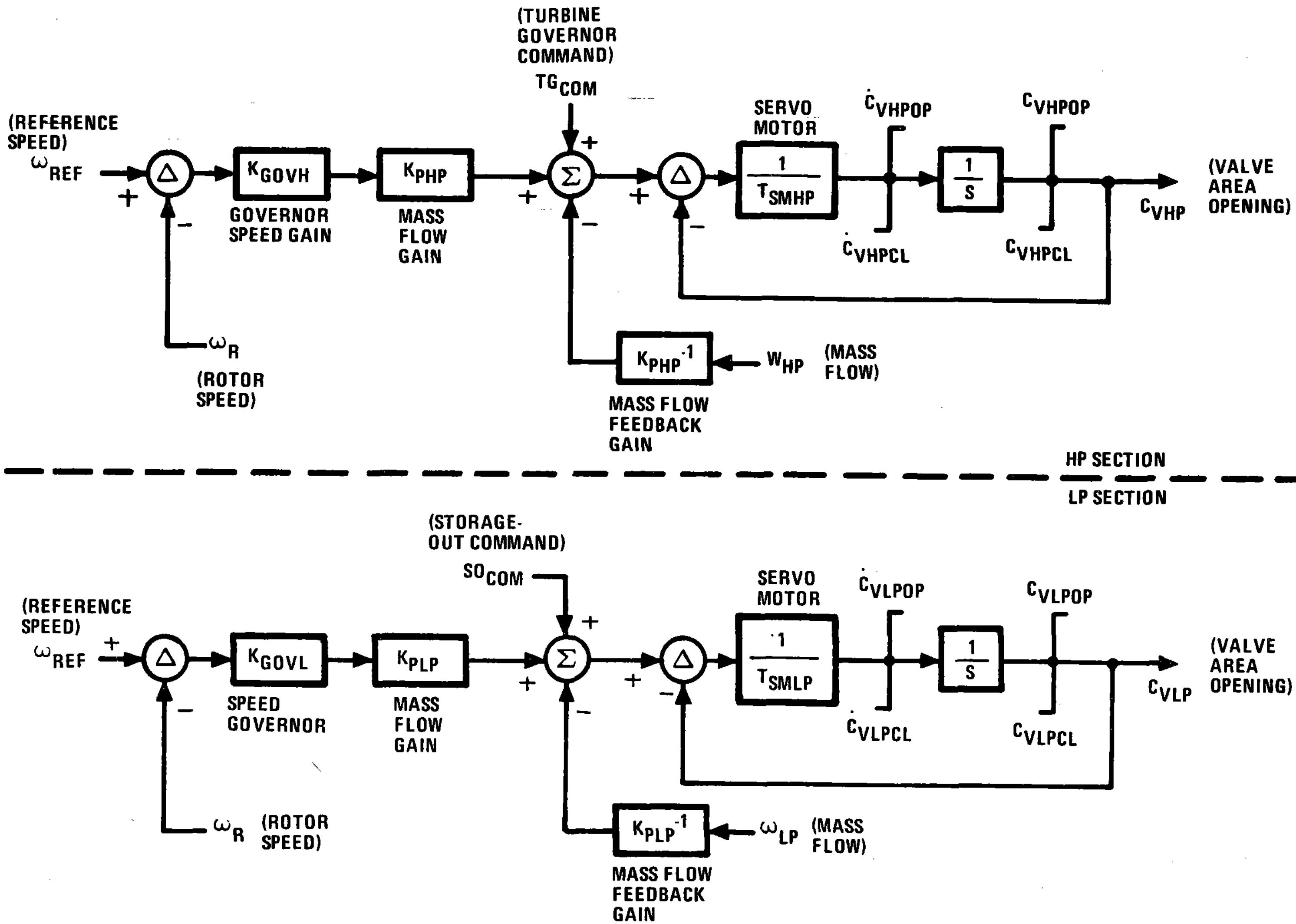


Figure 2-8. Speed Governing Systems (EHC-Type Control) For Turbine Model

factor value for the gain K_{PHP}. Therefore, this results in an effective zero mass flow feedback signal.

Prior to entering the servo motor loop, the turbine governor command signal (TG_{COM}) is summed with the speed and mass flow error signals. This turbine governor signal represents the composite pressure and load reference signal as described later in the Master Controller description.

The servo motor loop consists of a time constant factor (T_{SMHP}) and an integration term to produce the desired valve opening command position. The servo motor moves the throttle valves, which are normally quite large. Rate limits are imposed to reflect the limits at which the valves can be opened or closed whenever large, rapid speed variations occur. Position limits are also indicated to reflect closed and wide-open valve positions.

Normally, the valve position is a nonlinear function of servo motor position. However, nonlinear feedback compensation is normally employed to cancel this nonlinear effect. The dynamic simulation is modeled without representing either of these cancelling nonlinear effects, and should provide a good net representation of the actual unit.

Governor deadband is not utilized in the model. Reference 3 indicates that deadband need not be included for power system studies where performance of the speed-governing system is not the primary concern.

Typical values of the terms (for both LP and HP sections) identified in Figure 2-8 were taken from Reference 3 as listed below.

Parameter	Parameter Description	P. U. Value
W_{REF}	Reference Speed (120π rad/sec)	1.0
K_{GOVH}, K_{GOVL}	Governor gain, speed error (5% regulation)	20.0
K_{PHP}, K_{PLP}	Mass flow feedback gain	1.0
T_{SMHP}, T_{SMLP}	Servo motor time constant	0.1 sec
C_{VHPCL}, C_{VLPOP}	Valve opening rate limit	0.1 pu/sec
C_{VHPCL}, C_{VLPCL}	Valve closing rate limit	-0.1 pu/sec
C_{VHPOP}, C_{VLPOP}	Valve full open position limit	1.0
C_{VHPCL}, C_{VLPCL}	Valve closed position limit	0.0

Turbine Mechanical Torque Generation -- Figure 2-9 represents the block diagram employed in the simulation to generate mechanical torque. Both inlet (HP) and admission (LP) steam flows may be admitted independently or in combination to produce the necessary mechanical torque for power generation.

Consider first the HP inlet steam section. As shown in the figure, throttle inlet pressure (P_{HPNCi}) is modulated by the throttle valve opening (C_{VHP}) to produce steam mass flow (W'_{HPTi}) into the HP nozzle steam chest. The steam chest and inlet piping introduce time delays between valve movement and steam flow changes. Consequently, a HP nozzle chest time constant term (T_{HPNC}) is incorporated to account for this delay. The nozzle chest exit steam flow (W_{HPTi}) then represents torque producing mass flow through the various turbine stages.

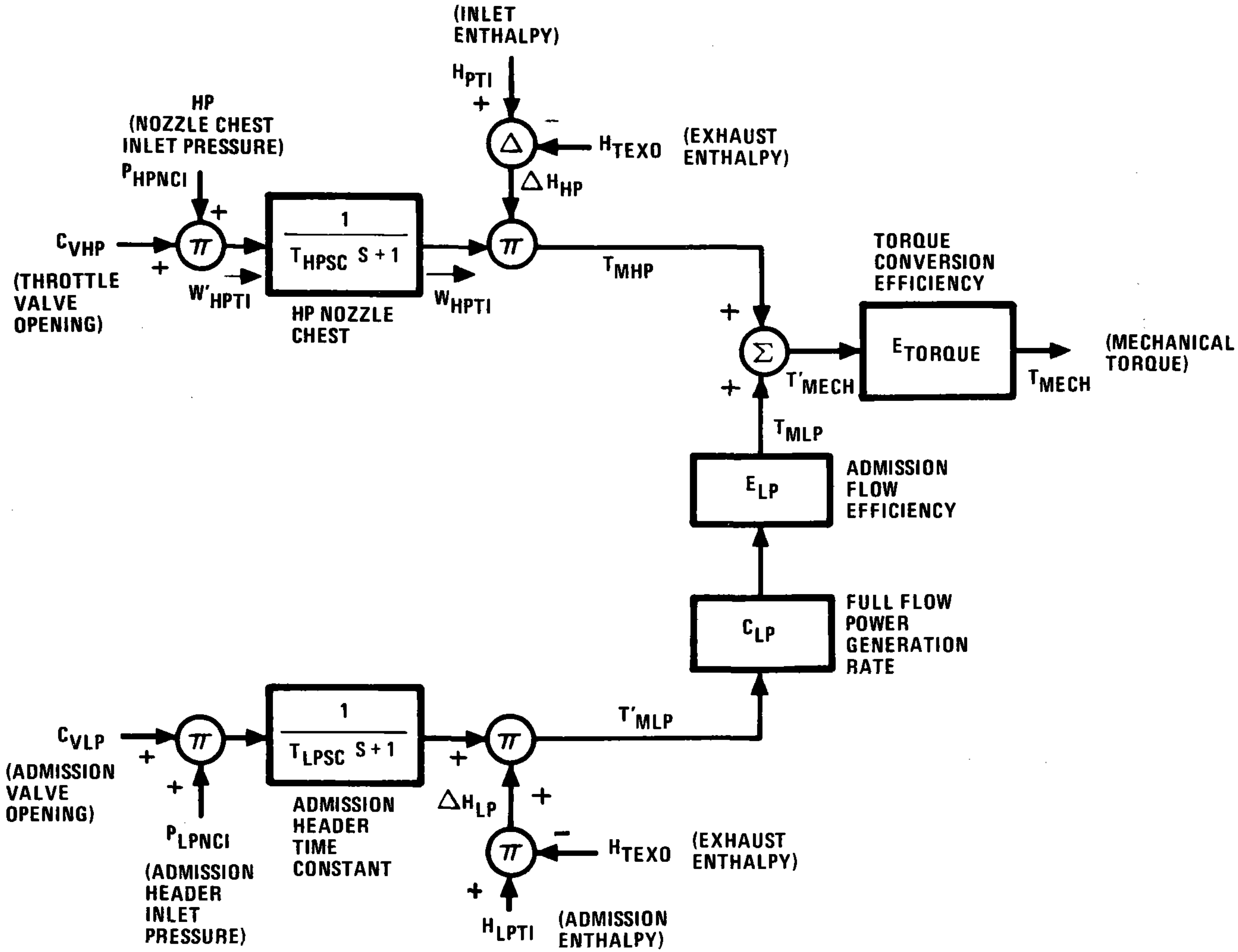


Figure 2-9. Mechanical Torque Generation Block Diagram For EGS

Reference 3 provides typical values of T_{HPNC} as 0.2 to 0.5 sec for a non-reheat turbine. In view of the relatively small size of the SPP turbine, a value of 0.2 sec was arbitrarily selected.

Mechanical torque from the HP inlet steam is a relatively complex formulation if all stage-to-stage efficiencies, extraction flows, and frictional loss terms are to be included. For the dynamic simulation model, the torque is assumed to be related to mass flow (W_{HPTi}) and enthalpy difference across the turbine (ΔH_{HP}) by the relationship

$$T_{MHP} = W_{HPTi}\,\Delta H_{HP}$$

$$= W_{HPTi}\,(H_{HPTi} - H_{TEXO})$$

where

H_{HPTi} = inlet enthalpy

H_{TEXO} = exhaust enthalpy

As discussed later, a mechanical torque generation efficiency expression, computed from empirical data, will correct the above expression for inaccuracies due to extraction flows, etc.

The mass flow term (W_{HPTi}) has already been described as the mass flow exiting the steam chest. Inlet enthalpy represents the enthalpy at the nozzle chest exit (same as at the inlet, assuming an adiabatic process within the nozzle chest). Computation of this enthalpy term will be discussed later.

Turbine exhaust enthalpy was derived from empirical data generated for the preliminary design steady-state heat balances. Table 2-4 lists the 12 heat balance cases (4 each for steam from SGS, from TSS, and from SGS/TSS). Exhaust enthalpy is tabulated against several other variables for

Table 2-4. EGS Cycle Heat Rate and Energy Data for SPP Dynamic Simulation

		W_{in}		P_{ELEC}		GCHR*	THR**	1/THR	T_{HPFW}	H_{TEXO}	$W_{in}\Delta H$		$P_{Elec}/W_{in}\Delta H$
		(Inlet Steam Flow)		(Gross Generator Output)		$\frac{KWt}{KWe}$	$\frac{KWt}{KWe}$		HP FW Temperature	Exhaust Enthalpy	(Turbine Heat Flow)		
Steam Source	Case No.	Kg/hr (lb/hr)	P. U.	KWe	P. U.	$(\frac{Btu}{KW\text{-}hr})$	$(\frac{Btu}{KW\text{-}hr})$	P. U.	(deg-C) (deg-F)	$\frac{MJ}{Kg}$ (Btu/lb)	$\frac{gJ}{hr}$ (Btu/hr)	P. U.	P. U.
SGS	S-1	60,999	1.0	14,633	1.0	2.8624	1.2331	1.0	215.0	2.33139	64.59	1.0	1.0
		(134,479)				(9,775)	(4,211)		(419.0)	(1002.99)	(61.26 (10^6))		
	S-2	49,592	0.813	12,000	0.820	2.8943	1.2208	1.010	203.9	2.33295	52.75	0.812	1.01
		(109,332)				(9,884)	(4,169)		(399.1)	(1003.66)	(50.03 (10^6))		
	S-3	24,796	0.406	5,446	0.372	3.3660	1.2249	1.007	171.9	2.42774	24.02	0.370	1.01
		(54,665)				(11,495)	(4,183)		(341.4)	(1044.44)	(22.78 (10^6))		
	S-4	12,398	0.203	2,171	0.148	4.4202	1.2902	0.956	142.7	2.58294	10.09	0.155	0.955
		(27,333)				(15,095)	(4,406)		(288.8)	(1111.21)	(9.57 (10^6))		
TSS	T-1	58,430	0.958	10,616	0.725	3.4788	1.3253	0.930	215.3	2.33086	50.66	0.780	0.929
		(128,817)				(11,880)	(4,526)		(419.5)	(1002.76)	(48.05 (10^6))		
	T-2	49,024	0.804	9,000	0.615	3.5095	1.3168	0.936	205.6	2.32739	42.67	0.657	0.936
		(108,080)				(11,985)	(4,497)		(402.0)	(1001.27)	(40.47 (10^6))		
	T-3	24,512	0.402	3,955	0.270	4.2513	1.3857	0.890	171.7	2.39282	19.74	0.304	0.888
		(54,040)				(14,518)	(4,372)		(341.0)	(1029.42)	(18.72 (10^6))		
	T-4	12,256	0.201	1,398	0.096	6.3420	1.6867	0.731	140.3	2.50516	8.49	0.131	0.733
		(27,020)				(21,658)	(5,760)		(284.6)	(1077.75)	(8.05 (10^6))		
SGS/ TSS	ST-1	23,587/ 23,587	0.387/ 0.387	10,019	0.685	3.1707	1.2413	0.993	203.4	2.34799	44.78	0.689	0.994
		(52,000/ 52,000)	(0.773)			(10,828)	(4,239)		(398.1)	(1010.13)	(42.47 (10^6))		
	ST-2	12,973/ 12,973	0.213/ 0.213	5,021	0.343	3.6586	1.2556	0.982	175.0	2.42214	27.70	0.349	0.983
		(28,600/ 28,600)	(0.425)			(12,494)	(4,288)		(347.0)	(1042.03)	(21.53 (10^6))		
	ST-3	33,203/ 11,068	0.544/ 0.181	10,010	0.684	3.0615	1.2272	1.005	199.3	2.34778	44.23	0.681	1.004
		(73,200/ 24,400)	(0.726)			(10,455)	(4,191)		(390.8)	(1010.04)	(41.95 (10^6))		
	ST-4	8,074/ 37,830	0.207/ 0.620	10,020	0.685	3.2952	1.2594	0.979	206.9	2.34650	45.44	0.699	0.980
		(27,800/ 83,400)	(0.827)			(11,253)	(4,301)		(404.4)	(1009.49)	(43.10 (10^6))		

*GCHR = Gross Cycle Heat Rate
**THR = Turbine (only) Heat Rate

these 12 cases, including inlet steam flow. Figure 2-10 illustrates these exhaust enthalpies (H_{TEXO}) plotted against inlet steam flow. A best-fit expression using the SGS and SGS/TSS steam cases (Cases S-1 through S-4, ST-1 through ST-4) produced the desired expression for exhaust enthalpy as

$$H_{TEXO} = 0.97 + 0.028/W_{IN} \text{ (pu values)}$$

where

W_{IN} represents total (HP + LP) flow into the turbine.

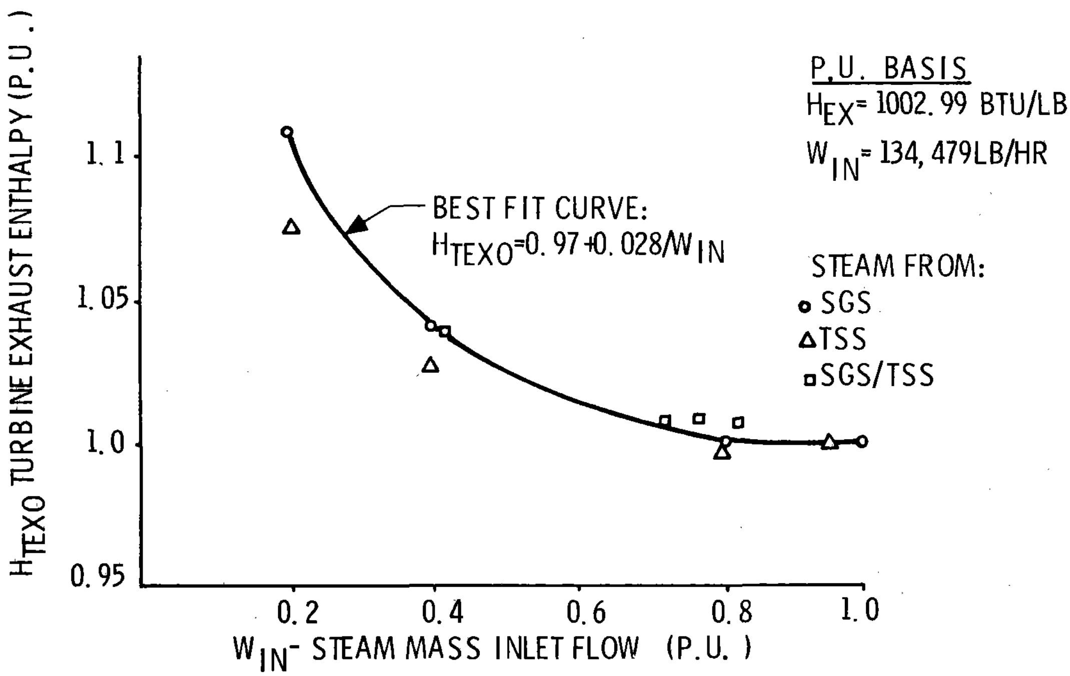


Figure 2-10. Steady-State Turbine Exhaust Enthalpy vs. Total Steam Mass Flow

Since the primary differences between the best fit curve and the TSS inlet flow cases (cases T-1 through T-4) occur at low flow conditions, it was concluded that the single expression above for exhaust enthalpy was sufficiently accurable for all combinations of steam inlet flow.

Once the HP mechanical torque term (T_{MHP}) is computed as described above, a correction for various efficiency factors within the turbine must be applied. Table 2-4 lists the net generator output (P_{ELEC}) versus inlet heat flow ($W_{in} \Delta H$) for the 12 heat balance cases. Figure 2-11 is a subsequent plot of these various data points. A best-fit relationship between these points was found to be

$$P_{ELEC} = -0.005 + 1.01 (W_{in} \Delta H) \quad \text{(p.u. values)}$$

In this case, P_{ELEC} represents net generator output after generator losses.

Since in steady-state pu terms $P_{ELEC} = T_{MECH}$ the above expression is therefore satisfactory to provide an efficiency correction (E_{TORQUE}) for generated torques as

$$T_{MECH} = -0.005 + 1.01 \, T_{MHP} \quad \text{(p.u. values)}$$

when only HP steam flow is involved.

Note that the factor of 1.01 in the above expressions does not imply an efficiency factor larger than 1.0 (or 100%) since the expression is in p.u. terms. Using the p.u. basis factors of 18.06 Mwt (61.62 (10^6) Btu/hr) (for $W_{in} \Delta H = 1.0$) and 14,633 Kwe (for $P_{ELEC} = 1.0$), the actual efficiency of the turbine-generator unit is about 81% at maximum flow (61,000 Kg/hr, or 134,479 lb/hr) through the HP inlet port.

Mechanical torque (T_{MLP}) generated by LP admission steam is computed in a manner analogous to the HP torque term described above (Figure 2-9). In this case, an efficiency correction is applied to the LP torque term (T_{MLP}) prior to summation with the term T_{MHP}. This efficiency factor is based on the plot of P_{ELEC} vs. $W_{in} \Delta H$ for TSS admission steam shown in Figure 2-11 (data as taken from Table 2-4). In this case, the best fit curve is

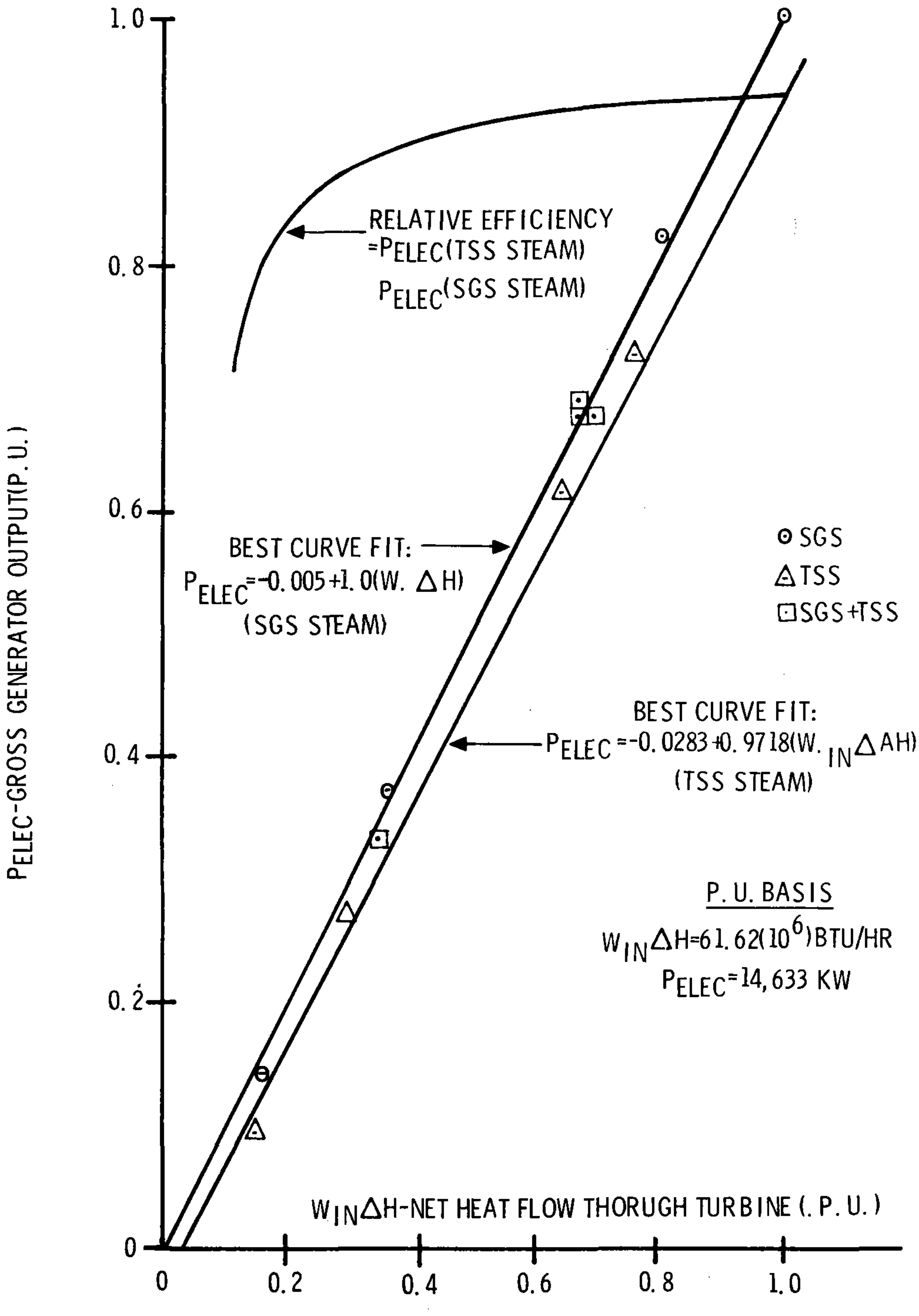


Figure 2-11. Generator Gross Electrical Output Versus Net Turbine Heat Flow

Figure 2-12 illustrates the method of net torque generation utilized in the SPP Dynamic simulation. This method follows the modeling techniques just described. A method is employed to adjust the efficiency of LP steam torque generation. Whenever the HP main stop valve is closed, the LP mechanical torque generation relative efficiency is adjusted by the expression

$$\frac{-0.0283 + 0.9718\ T_{MLP}}{-0.005 + 1.01\ T_{MLP}}$$

When the main stop valve is opened, the relative efficiency is increased to a value of unity. A 5-second lag is employed for this switchover to minimize switchover transients.

Load Torque -- The computation of a time-varying load torque is complicated by several factors at this time. First, the electrical grid network characteristics are not defined. Second, very little detail exists relative to the turbine generator characteristics such as reactances, voltage regulation characteristics, etc. Third the relatively small amount of power which the SPP can ultimately generate would likely cause the SPP turbine generator to operate as a motor if attempting to lose synchronization. In view of this dilemma, a rather simplified approach using basic synchronous motor equations was taken. This approach is explained as follows.

The electrical back torque required to generate electrical power is established by the basic load power equation

$$P_L = P_{SYNCH}\ \delta_L$$

where

P_L = load power, or synchronizing power

P_{SYNCH} = power synchronizing coefficient

$$P_{ELEC} = -0.0283 + 0.9718 (W_{in} \Delta H) (p.u.)$$

(Note that at maximum admission flow of 58, 431 Kg/hr (128, 817 lb/hr) (0. 958 p. u.), admission steam can only generate 10, 616 kW net electrical power (0. 725 pu) compared to about 14, 139 kWe (33% more) for the same mass flow at the HP inlet port. On an input energy basis full admission inlet steam flow corresponds to 14. 08 MWt (48. 05 (10^6) Btu/hr), generating 10, 616 kWe electrical power. The same energy flow into the HP inlet port would generate 11, 525 kWe, or 8. 50% more.)

Based upon the P_{ELEC} versus $W_{in} \Delta H$ empirical curves (Figure 2-11), the relative efficiency between the two inlet flow conditions is therefore computed to be

$$\epsilon_{LP} = \frac{-0.0283 + 0.9718 T'_{MLP}}{-0.005 + 1.01 T'_{MLP}}$$

When multiplied by the mechanical torque term T'_{MLP}, the total LP admission steam torque is computed as

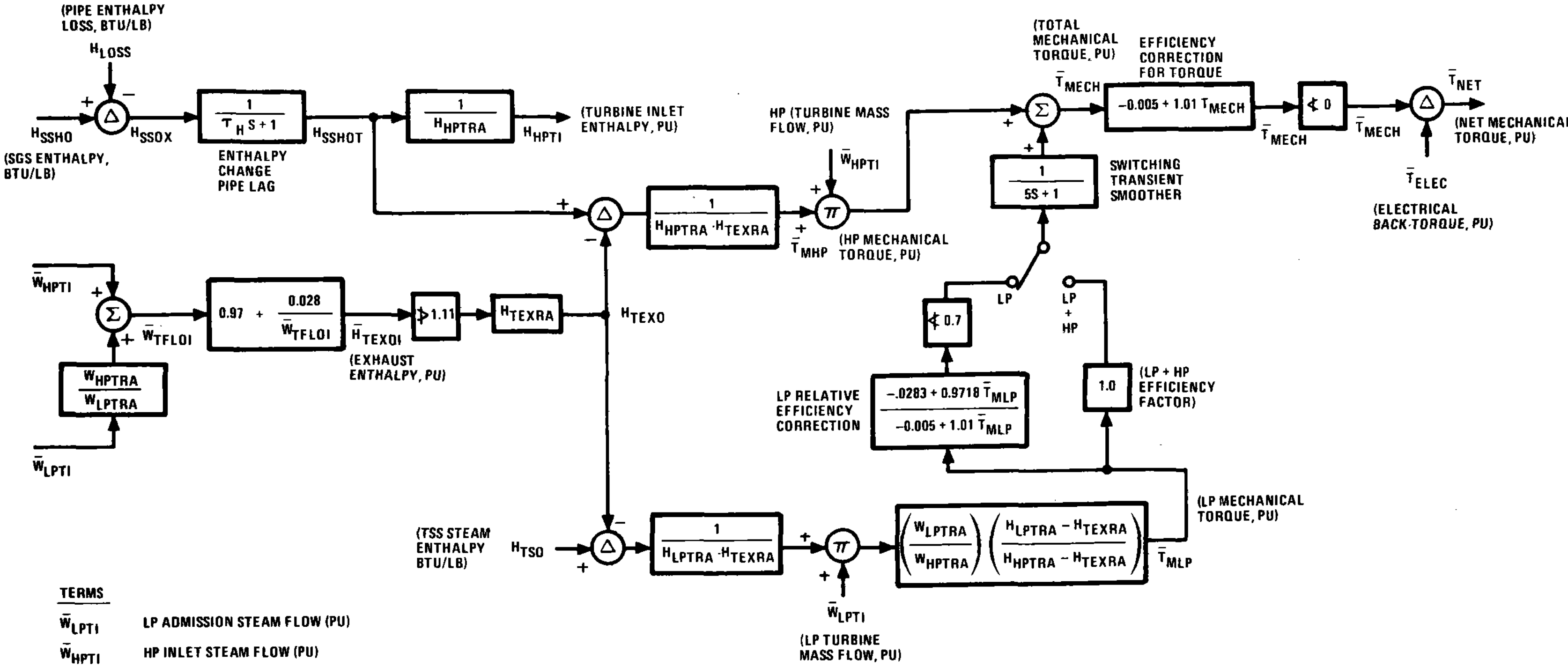
$$T_{MLP} = T'_{MLP} \, \epsilon_{LP}$$

The total mechanical torque is then

$$T_{MECH} = T_{MECH} \, \epsilon_{TORQUE}$$

$$= (T_{MLP} + T_{MHP}) \, \epsilon_{TORQUE}$$

where ϵ_{TORQUE} is the total torque efficiency factor previously defined.



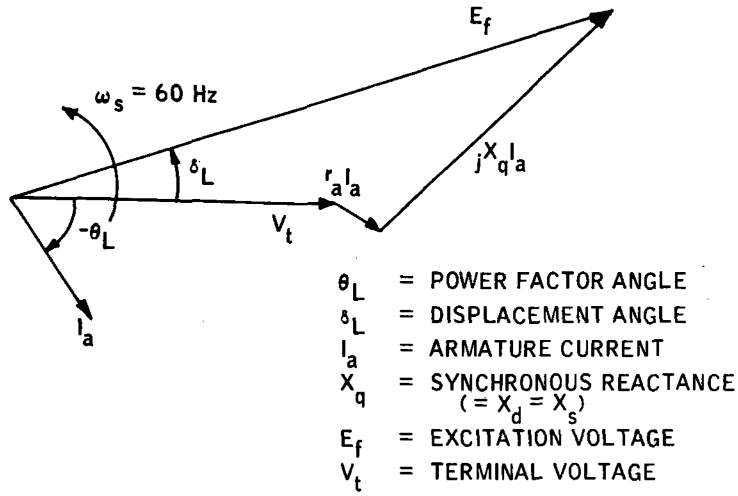
TERMS

$\bar{W}_{LPTI}$	LP ADMISSION STEAM FLOW (PU)
$\bar{W}_{HPTI}$	HP INLET STEAM FLOW (PU)
W_{HPTRA}	MAXIMUM RATED SGS STEAM FLOW (LB/HR)
W_{LPTRA}	MAXIMUM RATED TSS STEAM FLOW (LB/HR)
H_{TEXRA}	RATED TURBINE EXHAUST ENTHALPY AT DESIGN POINT CONDITION
H_{LPTRA}	RATED ADMISSION STEAM ENTHALPY
H_{HPTRA}	RATED INLET STEAM ENTHALPY

Figure 2-12. Overall Turbine Torque Generation Model for SPP Dynamic Simulation

δ_L = displacement angle of rotor relative to terminal voltage under load referred to the no-load position (i.e., zero displacement angle at no load).

The parameter δ_L is related to the electrical characteristics as shown in the illustration below.



The synchronizing power term (P_L) is therefore the power at synchronous speed corresponding to the torque developed in the generator air gap between the armature and field. This torque tends to restore the rotor to the no-load position relative to line voltage.

The synchronizing coefficient, P_{SYNCH}, is determined by dividing the rated shaft power by the corresponding angular displacement of the rotor.

In p.u. measurement units, a close approximation for the synchronizing coefficient is

$$P_{SYNCH} = \frac{1}{\tan^{-1}\left(\dfrac{X_q \cos\theta}{X_q \sin\theta + 1}\right)} \text{ rad}^{-1}$$

where

θ = angle between voltage and current at generator terminals (negative = lagging)

X_q = p. u. quadrature – axis synchronous reactance of generator

For the SPP turbine generator, the following ratings were assumed in selecting typical generator characteristics:

	3-Phase	Per Phase
Voltage:	13.8 Kv	7967 v (to neutral, Y-con.)
Power:	15,000 Kwe	
VA:	17,600 KVA	5867 KVA/phase
PF:	0.85	

For those parameters, Reference 4 gives typical values as

Short Circuit Ratio: 0.8

X_q = synchronous reactance: 1.1 (p. u.)

The displacement angle (δ_L) under load can be determined by the relationship

$$\delta_L = \tan^{-1}\left[\frac{\cos\theta_L}{\frac{1}{X_q P_L} - \sin\theta_L}\right] \text{rad}$$

where

θ_L = voltage-to-current angle under load

P_L = load power (p. u.)

The value of δ_L at rated load can be determined from the above expression by setting $P_L = 1.0$. Then for $X_q = 1.1$ and a 0.85 power factor (θ_L = -31.79 deg),

$$(\delta_L)_{\text{Full Load}} = 0.592 \text{ rad}$$
$$= 33.92 \text{ deg}$$

The inverse of this expression is then equivalent to the synchronizing coefficient, or

$$P_{SYNCH} = 1/(\delta_L)_{\text{Full load}}$$
$$= 1.689 \text{ rad}^{-1}$$
$$= 0.0295 \text{ deg}^{-1}$$

Electrical load torque is found from the expression

$$T_{ELEC} = P_L/\omega_R$$

where

ω_R = rotor speed

Rotor Speed -- Turbine rotor speed and associated parameters are determined from a set of swing equations as

$$\frac{d\omega}{dt} = (T_{MECH} - T_{ELEC})/I_{ROT} - D\omega$$

$$\omega = \omega_R - \omega_S$$

$$\frac{d\theta_L}{dt} = \omega$$

where

ω = difference between actual, synchronous frequencies

ω_R = generator frequency

ω_S = generator synchronous frequency

= 120π rad/sec (1.0 p.u.)

θ_L = rotor angle

I_{ROT} = generator inertia

D = damping factor

T_{MECH} = mechanical torque

T_{ELEC} = electrical torque

For the SPP turbine-generator, a value of I_{ROT} = 6 sec was selected based upon Reference 2. A value of D = 0.2 was selected to give reasonably fast response with some damping.

Turbine Flow Dynamics (To/From Turbine/Generator)

Steam Flow to Turbine from Receiver -- To account for steam mass storage in the piping from the receiver outlet to the turbine inlet, and the friction pressure drop in the piping, the following equations (in Laplace variables) are written in a manner similar to Profos (Reference 2)

$W'_{HPTi} = C_{VHP} P_{HPNCi}$ (HP inlet steam nozzle chest flow)

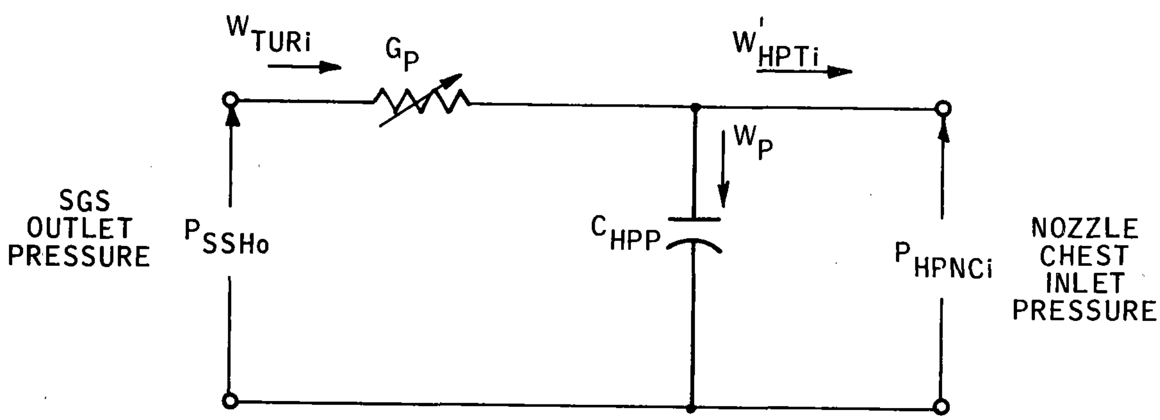
$W_{TURi} = W_P + W'_{HPTi}$ (Steam flow to turbine from SGS)

$W_P = C_{HPP} S P_{HPNCi}$ (Pipe storage effect)

$P_{HPNCE} = P_{SSHO} - K_{HPPD} W^2_{TURi}$ (HP nozzle chest pressure)

where C_{VHP} is the HP governor valve opening area.

These equations describe an RC analog circuit as shown below, where C_{HPP} is an energy storage reservoir and G_P represents a nonlinear conductance term.



The value of energy storage term, C_{HPP}, is determined as follows. From the previous set of equations, the term C_{HPP} is

$$C_{HPP} = \frac{W_P}{S\, P_{HPNCi}}$$

$$= \frac{W_P}{\dot{P}_{HPNCi}}$$

The mass continuity equation for the piping is

$$\dot{\rho}_P = \frac{W_{TURi} - W'_{HPTi}}{3600\, V_T}$$

$$= \frac{W_P}{3600\, V_T}$$

where

V_T = Total pipe volume (ft^3)

W_P = Pipe storage flow (lb/hr)

$\dot{\rho}_P$ = Average pipe fluid density rate of change $(\frac{lb/ft^3}{sec})$

We also know, using Callendar's relationship (Ref. 1), that

$$P_P = \rho_P (K_1 H_P - K_2)$$

where P_P, ρ_P, H_P are average pipe pressure (PSIA), density (lb/ft^3), and enthalpy (Btu/lb). Assuming enthalpy is essentially constant during a period of pressure change, we can then write that

$$\dot{P}_P = \dot{\rho}_P \, (K_1 H_P - K_2)$$

The expression for C_{HPP} can then be written as

$$C_{HPP} = \frac{W_P}{\dot{P}_{HPNCi}}$$

$$= \frac{W_P}{\dot{\rho}_P (K_1 H - K_2)}$$

$$= \frac{3600 \, V_T}{K_1 H - K_2}$$

For the receiver to turbine, the following characteristics apply

d	=	17.78 cm (7.001 inches)	(inside pipe diameter)
L	=	221m (725 ft)	(pipe length)
H	=	$3.4 \, (10^6 \, \frac{\text{joules}}{\text{Kg}}$ (1462.5 Btu/lb)	(average pipe design enthalpy)

Thus, the value of the storage term, C_{HPP}, is

$$C_{HPP} = 58846 \, \frac{\text{Kg/hr}}{\text{MPa/sec}} \left(894.5 \, \frac{\text{lb/hr}}{\text{psia/sec}} \right)$$

$$= 9.74 \text{ (for p. u. flow, pressure)}$$

The value of the pipe drop friction term, K_{HPPD}, is determined from EGS design data. At receiver design flow conditions (49, 593 Kg/hr or 109, 332 lbs/hr), the nominal pressure drop from the SGS outlet to the HP inlet port is 517 kPa (75 psia). Therefore, we can write that

$$P_{HPNCi} = P_{SSHO} - K_{HPPD} W^2_{HPTi}$$

where

P_{SSHO} = SGS SSH outlet steam design point pressure (10. 62 MPa = 1540 psia)

W_{HPTi} = HP turbine inlet design point flow condition (49, 593 Kg/hr = 109, 332 lbs/hr)

P_{HPNCi} = HP turbine inlet design point pressure (10. 1 MPa = 1465 psia)

Solving for K_{HPPD}, we obtain

$$K_{HPPD} = \frac{P_{SSHO} - P_{HPNCi}}{W^2_{TURi}}$$

$$= 6.2743\ (10^{-9})\ \frac{\text{psia}}{(\text{lb/hr})^2}$$

$$= 0.05119 \text{ p. u.}$$

Enthalpy changes from the receiver outlet to the turbine will also be characterized by a time delay effect and a decrease in value corresponding to a temperature drop. The delay effect may be represented by a first-order time delay

$$\tau_H = L_P/V_F$$

where

L_P = pipe length

V_F = flow velocity

The velocity term may be computed from

$$V_F = \frac{W_F}{3600\ A_P\ \rho_F}$$

where

W_F = Fluid velocity (lb/hr)

A_P = pipe flow area (0.02483 cm^2 = 0.02673 ft^2)

ρ_F = average density of fluid (30.355 Kg/m^3 = 1.8936 lb/ft^3)

The enthalpy change will correspond to the expected 10 degree F temperature decrease. The corresponding enthalpy change is approximately -13952.4 J/Kg (-6 Btu/lb).

Steam Flow to Storage from Receiver -- A set of equations analogous to those for the receiver to turbine may be written for the receiver to TSS dynamic effects. In this case, the corresponding terms are

C_{HPS} (HP energy storage term)

K_{HPPDS} (Pipe friction term)

Values for these terms may be determined in a similar manner as previously. Using the following pipe data, the values for these two terms above are

L_P = 219.5m (720 ft) (pipe length)

d_P = 17.78 cm (7.001 inches) (pipe ID)

C_{HPS} = 9.74

$$K_{HPPDS} = 6.2743\,(10^{-9})\ \frac{\text{psia}}{(\text{lb/hr})^2}$$

$$= 0.05119 \text{ p.u.}$$

Steam Flow from Storage to Turbine -- In a similar manner, the values for C_{LPP} (pipe energy storage) and K_{LPPD} (pipe friction drop coefficient) are

$$C_{LPP} = \frac{3600\ V_T}{K_1\ H - K_2}$$

$$= \frac{(3600)\,(118.9)}{673.61}$$

$$= 635.4\ \frac{\text{lb/hr}}{\text{psia/sec}}$$

$$= 6.92 \text{ (pu)}$$

$$K_{LPPD} = \frac{525-475}{(108{,}080)^2}$$

$$= 4.28035\,(10^{-9})\ \frac{\text{psia}}{(\text{lb/hr})^2}$$

$$= 0.10526 \text{ p.u.}$$

where the following pipe data is assumed

L_P = 114.3m (375 ft) (pipe length)

d_P = 19.37 cm (7.625 inches) (pipe ID)

Exhaust Flow Dynamics from Turbine Exhaust to SGS and/or TSSL -- Exhaust steam from the turbine is first condensed to feedwater then pumped (by condensate pump initially, then boiler feed pump) through a series of heat exchanger back to the SGS and/or TSS. The sequence is shown in the overall SPP model schematic (Figure 2-1). The following discussion provides the basis for the dynamics of the returning feedwater flow.

All of the return flow devices shown in Figure 2-1 (i.e., low and high pressure feedwater heaters, dearator, and condenser) are heat exchangers for varying purposes.

Most heat exchangers are distributed parameter systems, and often highly nonlinear. As a result, the complete transfer function describing its input/output thermodynamic relationship can be rather complex. Thermodynamic performance for heat exchangers may be detailed quite rigorously (References 5, 6). Reference 7 provides a relatively simple method to employ "time-lumping" techniques to model heat exchangers.

Steady-state performance of heat exchangers can be predicted quite accurately, with the results most commonly available in cycle heat balance diagrams. The transient dynamics are much more complex, however.

Generally, the differential equations describing transient performance have exponential and sinusoidal solution forms. As a result, the transfer function solutions are pseudo-periodic and periodic functions. Consequently, the frequency-response method of analysis is most commonly employed to examine heat exchanger dynamics. Frequency response data for widely varying types of heat exchanger systems show that heat energy is transferred at rates which primarily vary exponentially, with time constants determined by the design physical and fluid properties.

The most common approach for power plant simulations to heat exchanger model representation are lumped, first-order approximations to the actual complex dynamics (References 1 and 2). These low-order models are less costly to develop and exercise for information, and are regarded as adequate to provide reasonable simulation accuracy.

Extensive property changes, such as pressure and velocity changes will be transmitted nearly instantaneously for virtually incompressible fluids (e. g. feedwater). Therefore, no significant transient dynamics are necessary in the SPP model for these parameters.

Intensive property changes, such as enthalpy and temperature variations, will be transmitted with a finite deadband time plus some "time-lag", exponential decay type of dynamics. Heaters, on one hand, can be expected to have little deadband time and relatively small exponential time constants. On the other hand, bulk-mixing equipment, such as deaerators and condensors, may be expected to exhibit relatively long time constants and delay times.

The approach taken in the SPP Dynamic Simulation is to employ both a time delay term ($T_{D\,sec}$) and a first order time-constant term (τ sec) to model the heat exchanger dynamics.

Basic data for the LP and HP heaters is shown in Table 2-5. The primary variable of interest for the simulation is the tube side residence time. This parameter is determined by dividing the total tube length by the fluid velocity, and adding an incremental amount of extra time to account for headers and/or plenums associated with the heater.

Table 2-5. Hp and LP Heater Model Data for SPP Dynamic Simulation

Parameter	LP Heater	HP Heater
Type	4 pass	2 pass
Tube diameter	1.59 cm (0.625 in) O.D. (22 B.W.G.)	1.59 cm (0.625 in) O.D. (16 B.W.G.)
Tube length	5.94 m/tube (19.5 ft/tube)	5.67 m/tube (18.6 ft/tube)
No. tubes	128	116
Tube side flow area	0.00525 m^2 (0.0565 ft^2)	0.0072 m^2 (0.0775 ft^2)
Total heat transfer surface	27,8 m^2 (407 ft^2)	32.7 m^2 (352 ft^2)
Tube side residence time(1)	12 sec	7.0 sec
Tube side mass flow(1)	40,936 kg/hr (90,246 lb/hr)	41,593 kg/hr (109,332 lb/hr)
Average tube fluid density(1)	996.3 kg/m^3 (62.19 lb/ft^3)	884.94 kg/m^3 (55.24 lb/ft^3)

(1) at 49,593 kg/hr (109,332 lb/hr) receiver steam flow

The first-order time constant for the SPP simulation to be associated with each of the two heaters is equal to this residence time. Since this is a function of velocity, or mass flow (approximately, assuming near constant density), the expression utilized in the plant model for the time constant is

$$\tau_{LPH} = T_{LPH}/W_{FLO} \text{ (seconds)}$$

where

τ_{LPH} = LP heater first-order time constant

W_{FLO} = pu flow, normalized to the conditions for T_{LPH} determination

T_{LPH} = tube side residence time

An analogous expression for the HP heater is

$$\tau_{HPH} = T_{HPH}/W_{FLO}$$

These time constants are then utilized as first order lag functions of the Laplace form

$$\frac{H_o}{H_i} = \frac{1}{\tau S+1}$$

where H_i, H_o are input and output enthalpies respectively.

A suggested value (Reference 5) for delay time effect is $\tau_{LPH}/4$ (or $\tau_{HPH}/4$) seconds.

The deaerator and condensor represent bulk storage and mixing elements. Their characteristics are described in Table 2-6.

For the deaerator model, the SPP simulation uses a time-constant value of

$$\tau_{DEA} = T_{DEA}/W_{FLO} \text{ (seconds)}$$

Table 2-6. Deaerator and Condenser Model Data for SPP Dynamic Simulation

Condenser	
Tube diameter	2.18 cm (0.86 in) O.D. (22 B.W.G.)
Tube length	7.77 m (25.5 ft)
No. tubes	2170 (2 pass)
Total tube side flow area	0.369m^2 (3.97 ft^2)
Total heat transfer surface	1170.6m^2 (12,600 ft^2)
Shell side mass flow[(1)]	37,422 kg/hr (82,500 lb/hr)
Hot well residence time[(1)]	5 min
Tube side fluid velocity	2.13 m/sec (7 ft/sec)
Tube material	304SS
Deaerator	
Type	Direct contact
Average fluid density[(1)]	939.6 kg/m^3 (58.65 lb/ft^3)
Storage capacity	8164.8 kg (18,000 lb)
Storage residence time[(1)]	10 min

[(1)]at receiver design point of 49,593 kg/hr (109,332 lb/hr)

where

τ_{DEA} = time constant value

T_{DEA} = time constant at design flow condition

W_{FLO} = per flow, normalized to the design point flow condition

A time delay value of 1 minute is also incorporated on enthalpy changes.

A similar expression for the condenser time constant value is

$$\tau_{CON} = T_{CON}/W_{FLO} \quad \text{(seconds)}$$

However, no dynamics were imposed in the simulation for the condenser since the incoming (exhaust steam) flow is essentially at constant enthalpy.

The steady state value of feedwater temperature at the HP heater outlet to inlet steam mass flow is shown in Figure 2-13. This figure is plotted from data shown in Table 2-4, for the cycle heat balance cases. A steady-state curve fit to this data is

$$T_{HPFW} = 422.53 W_{in}^{0.2399} \quad \text{(deg-F)}$$

where

T_{HPFW} = HP heater feedwater outlet temperature (°F)

W_{in} = total inlet steam flow (pu)

In addition to time delay dynamics described above for the heat exchangers, the effects of enthalpy change transit delay times in the piping must be considered. The effects of feedwater enthalpy changes transported from the HP heater outlet to the SGS are especially significant in view of the relatively long travel distance (198.1m = 650 ft).

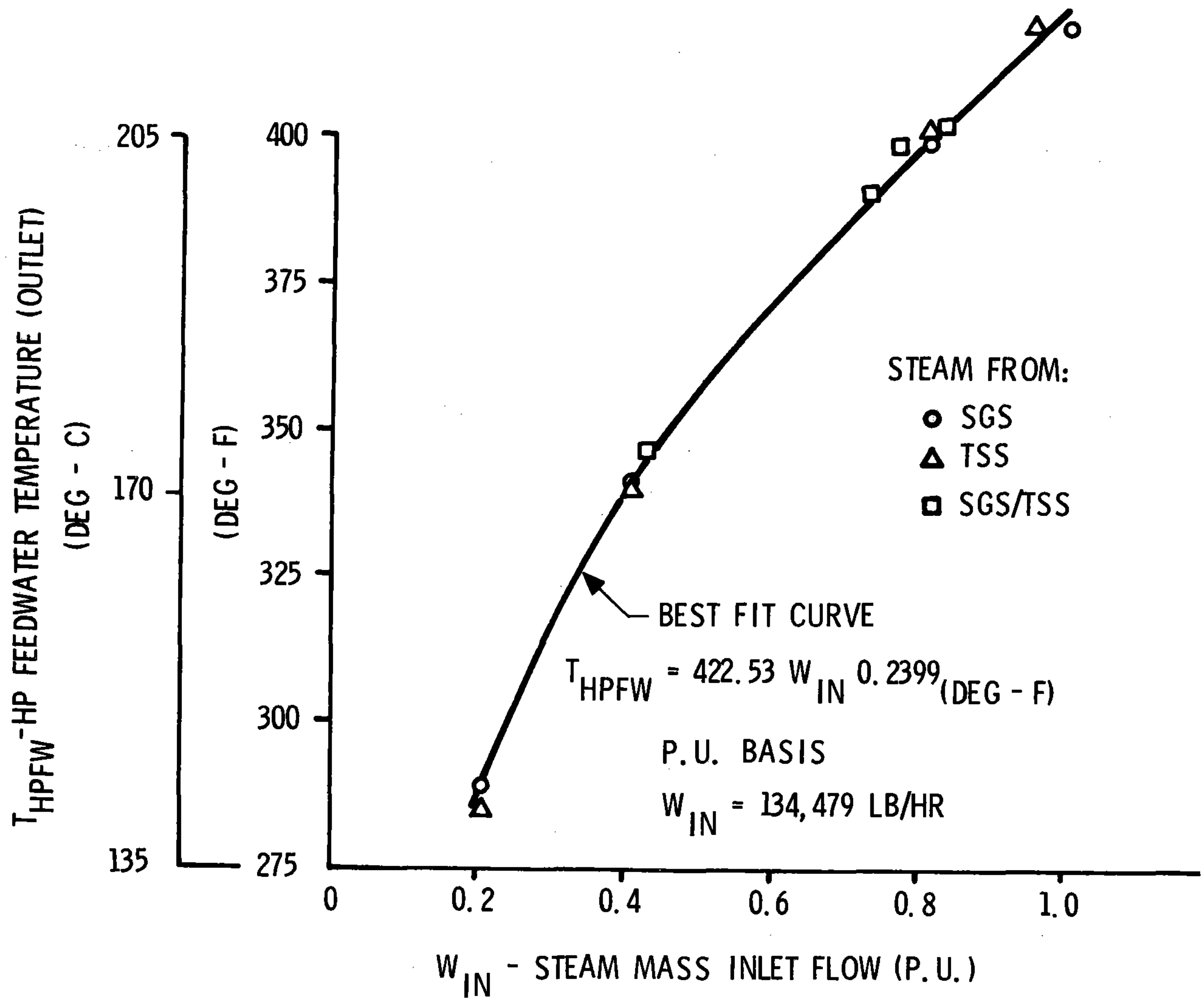


Figure 2-13. Steady State Feedwater Temperature (At HP Heater Exit) Flow

Ideally, this pipe time delay effect more of a pure time delay phenomonon. However, since the delay time varies with flow velocity, it was found to be more convenient to express this time delay as a first-order lag with time constant equal to the transit time.

Data relative to the piping from the HP heater outlet to the SGS inlet has been determined to be as follows:

Pipeline Transport Delay Data – HP Heater to SGS

Length of pipe	198.1m (650 ft)
Pipe diameter	9.205 cm (3.624 inches) I. D.
Flow area	0.00665m^2 (0.0716 ft^2)
Fluid density(1)	860.27 kg/m^3 (53.7 lb/ft^3)
Fluid velocity(1)	2.41 m/sec (7.9 ft/sec)
Transit time(1)	82.3 sec
Pressure drop(1)	1.9 kPa/100m (8.4 psia/100 ft)

Figure 2-14 shows the composite dynamics from turbine exhaust flow to the SGS or TSS feedwater inlet valves. This represents the model employed in the SPP dynamic simulation.

THERMAL STORAGE SUBSYSTEM (TSS) MODEL DESCRIPTION

Two different models for the TSS were developed for use in the SPP Dynamic Simulation. At first, simplified models were employed as a convenience to checking out the entire simulation. These simplified charge and discharge models were basically first-order lag functions modulating charge or discharge flow in response to the respective commands from the master controller. Pressure and temperature variations with flow were not taken into account for these simplified models.

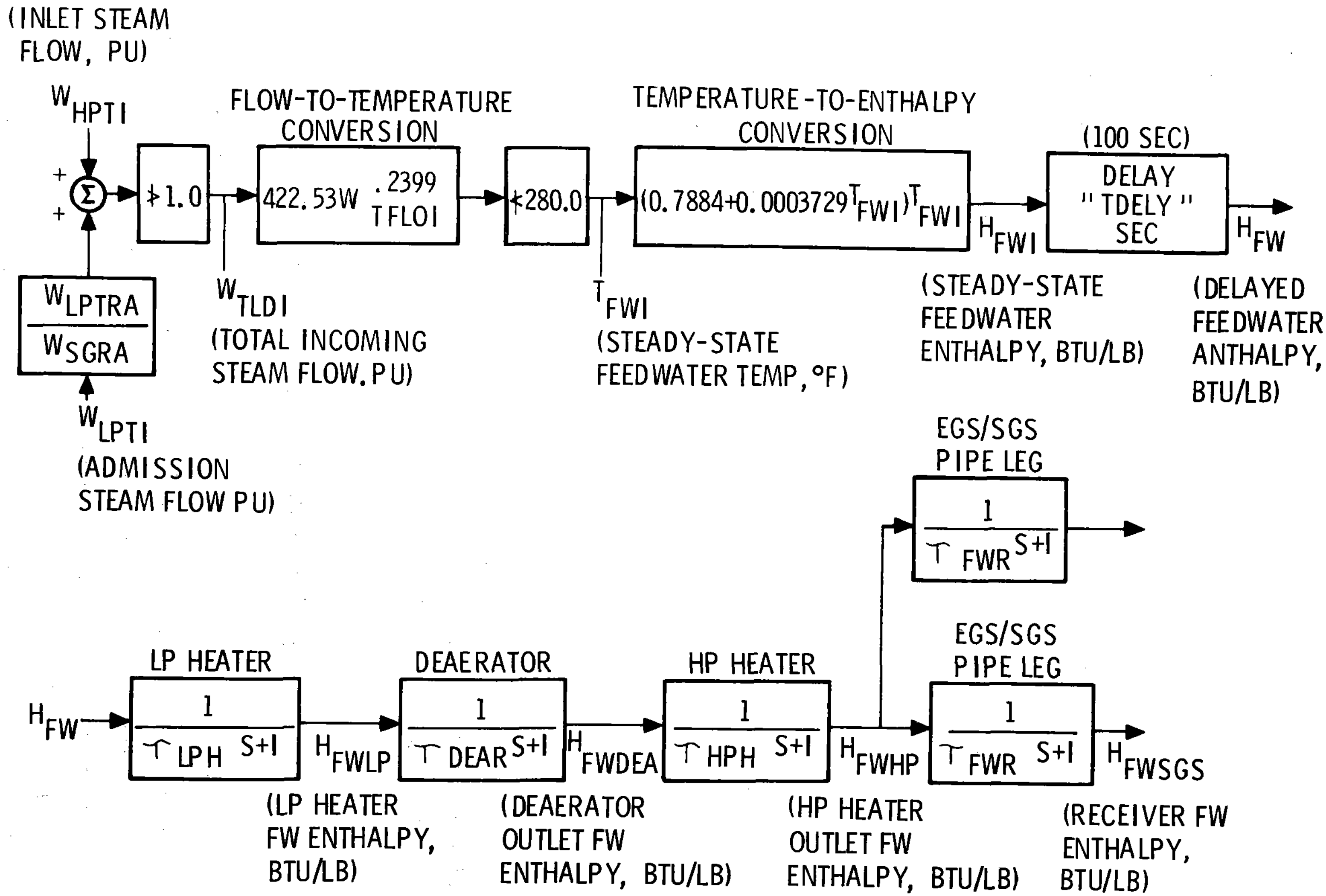


Figure 2-14. Enthalpy/Temperature Feedwater Dynamics from Turbine Exhaust to SGS or TSS

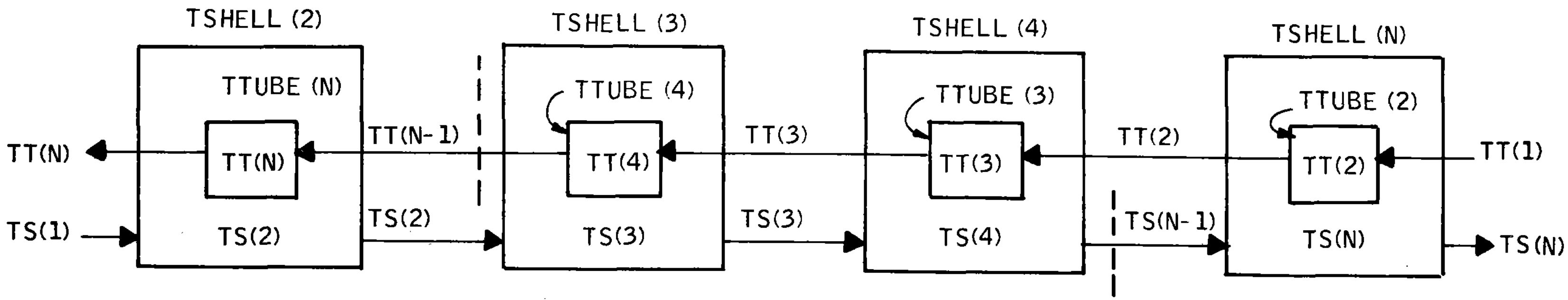
Late in the development of the total SPP Dynamic Simulation development, a detailed discharge model TSS was developed and incorporated. This discharge model was based upon a multiple node representation of the heat carrying fluid, tube metal, shell metal, and steam/water. A corresponding detailed model of the charge side of the TSS was not developed however, due to lack of time.

For the majority of the simulation run results presented in this report, the detailed discharge model was used along with a simplified charge side model. The detailed discharge model was found to consume considerable computer processor time however, and in cases where the primary concern was not on thermal storage interactions with the rest of the pilot plant (e.g., morning startup), the simplified TSS model was employed for economical reasons. The run results contained in the last section of this report indicate which of these two different sets of TSS models was used for the respective computer runs.

Detailed TSS Discharge Model Description

The TSS discharge heat exchanger model is based on dividing each of the heat exchangers into a series of counterflowing well-mixed tanks. Each of the tanks is divided into four temperature nodes; 1) the fluid inside the tubes, 2) the tube metal, 3) the fluid outside the tubes and inside the shell; and 4) the shell metal temperature.

The nodes are numbered by starting at node one as the inlet temperature of the fluid to the heat exchanger independent of whether the shell side or the tube side fluid is being considered. Tube metal temperatures are numbered along with the fluid inside the tubes, and shell metal temperatures are numbered with the fluid inside the shell. Figure 2-15 illustrates the physical model schematically.



TSHELL (I) = TEMPERATURE OF THE METAL SHELL OF SHELL NODE I

TTUBE (I) = TEMPERATURE OF THE METAL TUBES OF TUBE NODE I

TT(I) = TEMPERATURE OF THE FLUID INSIDE TUBE NODE I

TS(I) = TEMPERATURE OF THE FLUID INSIDE SHELL NODE I

Figure 2-15. Schematic of Heat Exchanger Nodes for the TSS Discharge Heat Exchanger Model

A differential heat balance expression can be written for each node in the heat exchanger. The heat balance can be expressed in a fundamental work equation as:

$$\begin{bmatrix}\text{Rate of Energy}\\ \text{Accumulation}\end{bmatrix} = \begin{bmatrix}\text{Net Rate of Energy}\\ \text{Exchange of the System}\\ \text{Due to Fluid Flow}\end{bmatrix} + \begin{bmatrix}\text{Net Rate of Energy}\\ \text{Exchange of the}\\ \text{System Due to}\\ \text{Heat Transfer}\end{bmatrix} \quad (2\text{-}66)$$

This heat balance can be written algebraically for each of the four types of heat exchanger nodes. Doing this for the shell node (refer to Figure 1 for node numbering strategy) gives:

$$\frac{d}{dt}\left\{m_{sh}\, C_{p_{sh}} \left[\text{TSHELL (I)} - T_r\right]\right. = h_{sh}\, A_{sh}\,(\text{I}) \left[\text{TS(I)} - \text{TSHELL (I)}\right] \quad (2\text{-}67)$$

where:

m_{sh}	=	metal mass of the shell of node I
$C_{p_{sh}}$	=	heat capacity of the steel metal
TSHELL(I)	=	shell temperature of node I
T_r	=	reference shell temperature
h_{sh}	=	heat transfer coefficient between the shell metal and the shell side fluid
TS (I)	=	shell side fluid temperature of node I and temperature of shell side fluid leaving node I
A_{sh}(I)	=	area of the shell node

Since T_r is a constant, $d/dt\,(-m_{sh}C_{p_{sh}}\,T_r) = 0$, and Equation (-267) can be rewritten as;

$$d/dt \left\{ m_{sh} C_{p_{sh}} \text{ TSHELL(I)} \right\} = h_s \, A_{sh}(I) \left[TS(I) - TSHELL(I) \right] \qquad (2\text{-}67a)$$

For the shell side fluid Equation (2-66) becomes:

$$d/dt \left[m_s \, C_{ps} \, TS(I) \right] - W_s \, C_{ps} \left[TS\,(I-1) - TS(I) \right] + h_{sh} A_{sh}(I) \qquad (2\text{-}68)$$

$$\left[TSHELL(I) - TS(I) \right] + h_{st} A_t(I) \left[TTUBE\,(N+2-I) - TS(I) \right]$$

where

m_s = mass of the fluid in the shell in node I

C_{ps} = heat capacity of the shell side fluid

W_s = mass flow of the fluid on the shell side into node I

TS (I-1) = temperature of shell side fluid which is flowing into node I

h_{st} = heat transfer coefficient between the shell fluid and the tube metal

$A_t(I)$ = area of the tube metal of tube node N+2-I

TTUBE (N+2-I) = tube metal temperature of node N+2-I

For the tube metal Equation (2-66) will become:

$$d/dt \left[m_{tu} \, C_{p_{tu}} \, TTUBE(I) \right] = h_{st} \, A_t(I) \left[TS\,(N+2-I) - TTUBE(I) \right] \qquad (2\text{-}69)$$

$$h_{tt} \, A_t \,(I) \left[TT(I) - TTUBE(I) \right]$$

where;

m_{tu}	=	tube mass of node I
$C_{p_{tu}}$	=	heat capacity of the tubes
TTUBE(I)	=	tube temperature of node I
h_{tt}	=	heat transfer coefficient between the metal tubes and the fluid inside the tubes
TT(I)	=	temperature of the fluid in node I and the temperature of the fluid leaving node I.

Finally, for the fluid inside of the tubes Equation (2-66) will become;

$$d/dt \left[m_t \, C_{pt} \, TT(I)\right] \, W_t \left[TT(I-1) - TT(I)\right] \, h_{tt} \, A_t \left[TTUBE(I) - TT(I)\right] \qquad (2\text{-}70)$$

where:

m_t	=	mass of the fluid in the tube in node I
C_{pt}	=	specific heat of the fluid in the tube in node I
W_t	=	mass flow rate of fluid through the node I
TT(I-1)	=	temperature of the fluid entering node I.

Starting from a set of initial values, this set of equations can be numerically integrated to give the conditions of any node at any point in time. The time derivative of temperature is calculated for all of the nodes at time (t) based on corresponding conditions in the heat exchanger. These values are then used to calculate the heat exchanger conditions at time $(t + \Delta t)$.

A relationship exists between the required number of nodes for the heat exchanger model, the integration time step size, and the maximum flow rate of fluid throughout any node. The integration process will be meaningful only if the flow rate is such that less than one node is swept out in any given time interval. In other words, a fluid element cannot pass through an entire node in one integration time, since the equations developed above assume the state of a given fluid node is influenced only by the fluid node directly upstream from it in any given time interval, and not by fluid nodes further upstream than one node. This restriction can be expressed numerically as;

$$(6) \quad N \leq \frac{V\rho_f}{W_f \Delta t}$$

where:

N	=	number of nodes in the heat exchanger
V	=	holding volume of the exchanger for the fluid under question
ρ_f	=	density of the fluid
W_f	=	maximum mass flow rate of the fluid
Δt	=	integration time of the equation set

The node number analysis must be performed for the fluid on both sides of the heat exchanger for a given integration time. The maximum number of nodes to be used in a given heat exchanger at a given integration time is then chosen to be less than the smallest value calculated for either of the two fluids in the exchanger.

The entire discharge system model is a combination of the storage tank model, the heat exchanger model, the boiler model, and the control system model.

The storage tank model treats both the superheat system and the boiler-preheater system as two tanks: a hot tank and a cold tank. The model assumes the oil taken from the hot tanks is at a constant temperature. The model uses a thermal averaging technique to calculate the temperature of the oil in the cold tanks at any time point in the run. A warning message is printed out when one of the storage tanks is depleted.

The basic heat exchanger model is similar to that used for the SGS model. Experience with running this model has shown that an acceptable integration time for good results and minimal costs to be 0. 2 second. The node numbers are set at the maximum possible number of nodes which give meaningful results as explained in the heat exchanger model.

The model used for the boiler is similar to that used for the steam generator boiler model. The change in average density of the fluid in the boiler drum with respect to time can be written as

$$\frac{d}{dt}(\rho_B) = (W_F - W_S)/V_B \tag{2-71}$$

where:

ρ_B = average density of the steam water mixture in the boiler

W_F = feedwater flow rate into the boiler

W_S = steam flow rate out of the boiler

V_B = boiler volume

The rate of change of the boiler enthalpy with respect to time can be written as

$$\frac{d}{dt}(H_B) = W_F(H_F - H_B) - W_S(H_G - H_B) + Q_B - Q_C$$

where

H_B = average enthalpy of the steam water mixture in the boiler

H_F = enthalpy of the feedwater to the boiler

H_G = enthalpy of the steam leaving the boiler

Q_B = heat transfer rate to the boiler steam from the boiler tubes

Q_C = heat transfer rate from the boiler steam to the boiler shell

The values of H_B and ρ_B are updated from their previous values at the end of each timepoint by numerical integration of the above two equations. The values of H_B and ρ_B are then used to calculate the other thermodynamic variables of the steam. The states of the oil flow and metal parts of the boiler are treated by use of the heat exchanger model.

The control system model can be divided into two different parts — the controller itself, and the control valves. The controller itself consists of three separate sections — the HITEC flow control, the oil flow control, and the feedwater flow control.

The HITEC flow control has only one input — the outlet steam temperature from the storage system. It controls the HITEC flow to keep this temperature constant at the set point. Figure 2-16 illustrates the control scheme used.

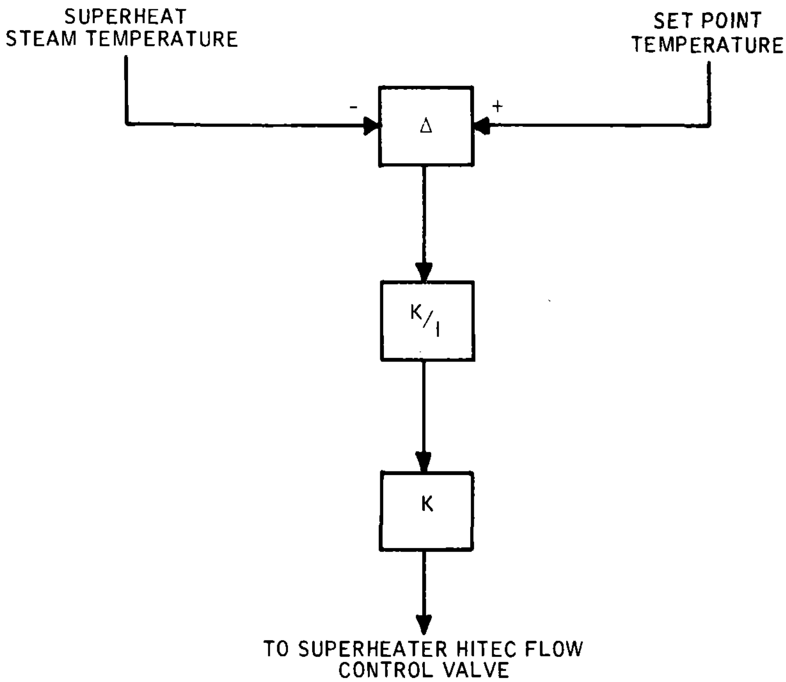


Figure 2-16. HITEC Flow Control for TSS Discharge Model

The oil flow control has six inputs – the feedwater inlet temperature to the boiler, the steam temperature out of the boiler, the oil temperature into the boiler, the oil temperature out of the boiler, the oil flowrate, and the boiler pressure. The purpose of the boiler oil flow controller is twofold – 1) to ensure that the net rate that energy is leaving the boiler is the same as the net rate that energy is entering the boiler, and 2) to control the boiler pressure to the set point valve. The control logic to accomplish this is shown in Figure 2-17.

The feedwater control has three inputs – the steam flow, the feedwater flow, and the boiler level. The feedwater flow is controlled to maintain inlet and outlet flowrates for the boiler constant and equal, and to maintain a constant fluid level in the boiler drum. Figure 2-18 illustrates the control logic.

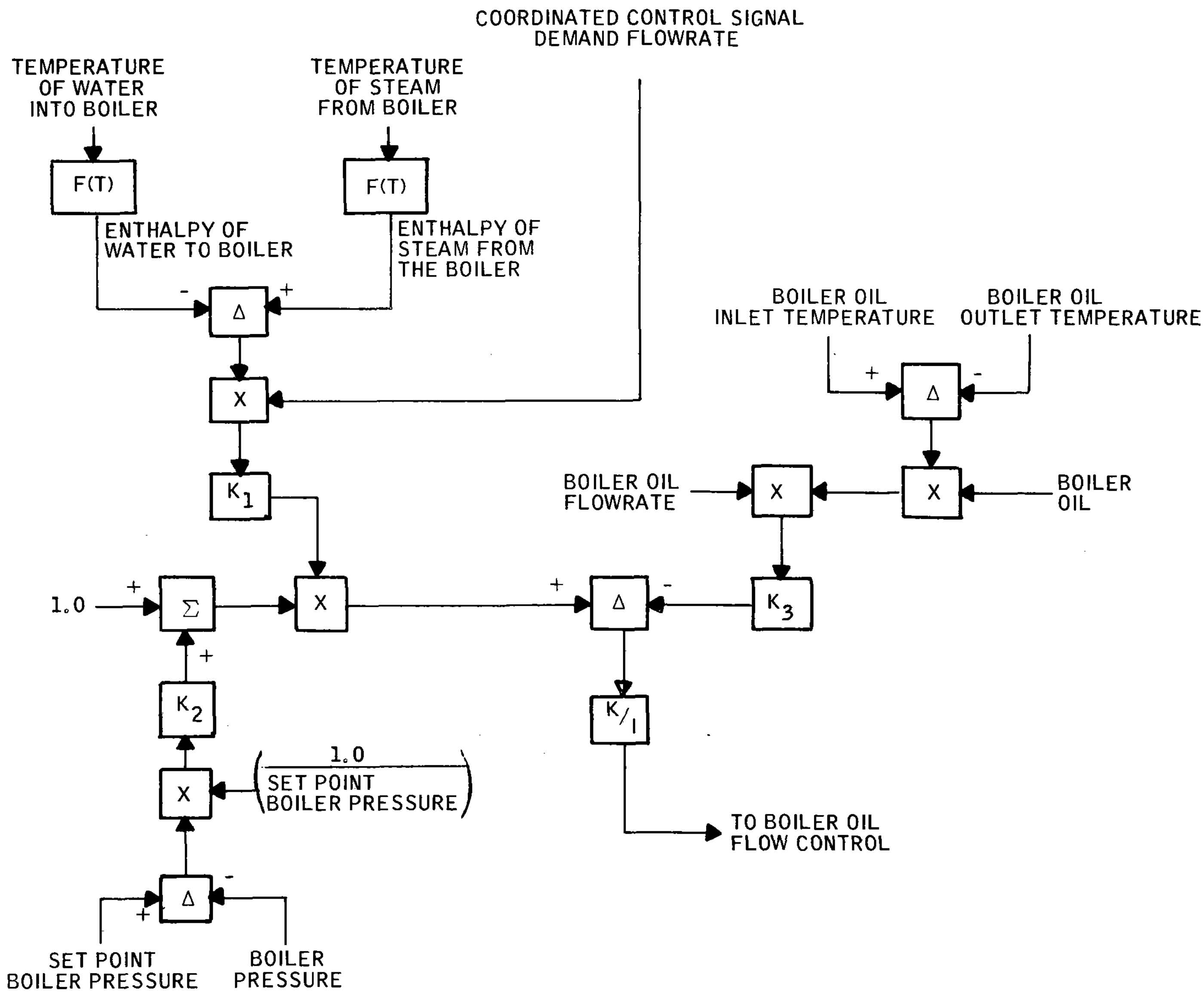


Figure 2-17. Boiler Oil Flow Control for TSS Discharge Model

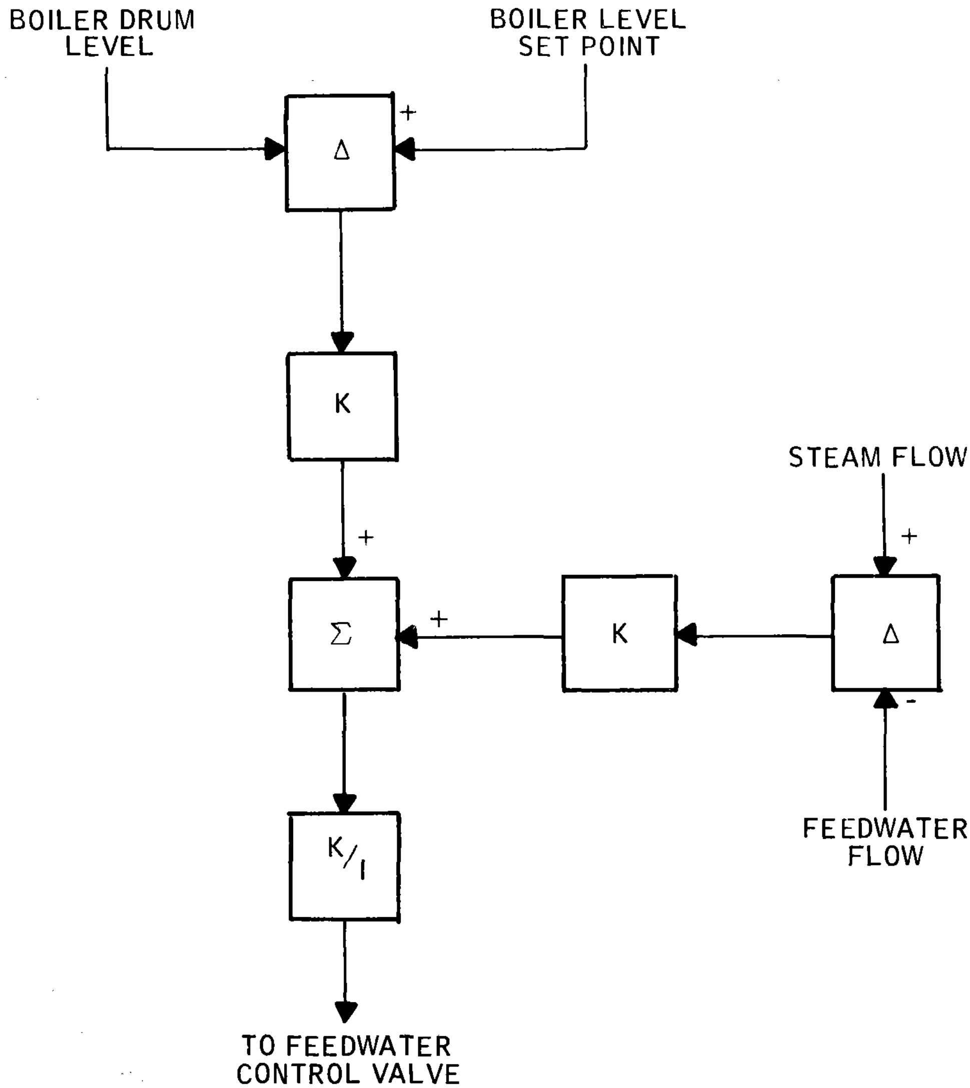


Figure 2-18. Feedwater Flow Control for TSS Discharge Model

The control valves used in the storage system are similar to those used in the rest of the SPP Dynamic Simulation. All valves in the storage system require twenty seconds to go from full closed to full open.

The program operates by first initializing the state of the system at time zero. The time derivatives of all of the system parameters at time t=0 are then calculated, and the system status is updated as time progresses.

Simplified Charge and Discharge Models

Simplified TSS charge and discharge models for the TSS were defined as

$$\frac{W_o}{W_{COM}} = \frac{1}{\tau s+1}$$

where:

W_o = flow out

W_{COM} = commanded flow

τ = flow constant

A value of τ=30 seconds was utilized for both the charge and discharge portions of this model. The flow command term originates from the master controller as either a "storage-in" or "storage-out" signal.

CS (COLLECTOR SUBSYSTEM) MODEL DESCRIPTION

The output response of the SGS is heavily dependent upon the time-varying radiant heat input characteristics. As the radiant heat input is a function of both the reradiated and incident solar power, an accurate means to model these characteristics is essential to the overall accuracy of the simulation. This requirement, in turn, means that an accurate representation of the collector field, which redirects the incident solar power, must be modeled.

The collector field is comprised of approximately 1598 individually controlled heliostats with each heliostat a four-facet device. One alternative to modeling this field is to incorporate models for each of the 1598 heliostats, position each in the field according to the preliminary design layout location, and command each to track the sun such that the redirected power focuses upon the appropriate SGS active surface. Obviously, this approach is the most straightforward at the expense of somewhat unwieldly complexity.

A preferred alternative, selected for the SPP Dynamic Simulation, is to develop a simplified collector field model based upon averaging the effects of many heliostats into a single representation. This has the effect of reducing the model complexity significantly, with little consequential degradation in the redirected solar power calculations.

The collector model incorporated into the SPP Dynamic Simulation is capable of tracking sun movement during the day, and superimposing the effects of cloud transients upon the sun's direct normal intensity. Cloud size, speed, and direction of approach may be varied. In addition, the degree to which the cloud covers the collector field may be varied.

The following discussion describes the entire collector subsystem model under these topics:

- Field model
- Receiver (or cavity) Incident power model

- Transient receiver reradiation model
- Cloud model
- Model verification

Field Model

The heliostat field is modeled by dividing the field into a square grid of field cells. Figure 2-19 shows the cell division and the actual heliostat field boundaries. The grid may contain any number of field cells up to a maximum of 400 (a 20 x 20 matrix). The number of heliostats in each cell is an input parameter required by the computer program.

The tracking efficiency of all heliostats in a cell is assumed equivalent to the tracking efficiency of the heliostat at the cell center. Here, tracking efficiency is defined as the power redirected into the cavity from a single heliostat divided by the total maximum incident power upon the heliostat. In this case, the total maximum incident power is simply the mirror area times the available direct normal intensity.

Clearly, the tracking efficiency of a cell is a function of the cell's field position and the sun position. Consider a field cell with center defined by coordinates (X_{ij}, Y_{ij}) where the coordinate system is centered at the tower location ($X = Y = 0$). Figure 2-20 shows the cell center location relative to the tower as well as a unit sun vector, defined by the sun azimuth and elevation angles, and a local orthonormal vector triad centered at the tower location.

Using the nomenclature of Figure 2-20, the unit sun vector can be written as

$$\vec{UR} = (\sin\theta_{az}\,\hat{i} - \cos\theta_{az}\,\hat{j})\cos\theta_{el} + \sin\theta_{el}\,\hat{k}$$

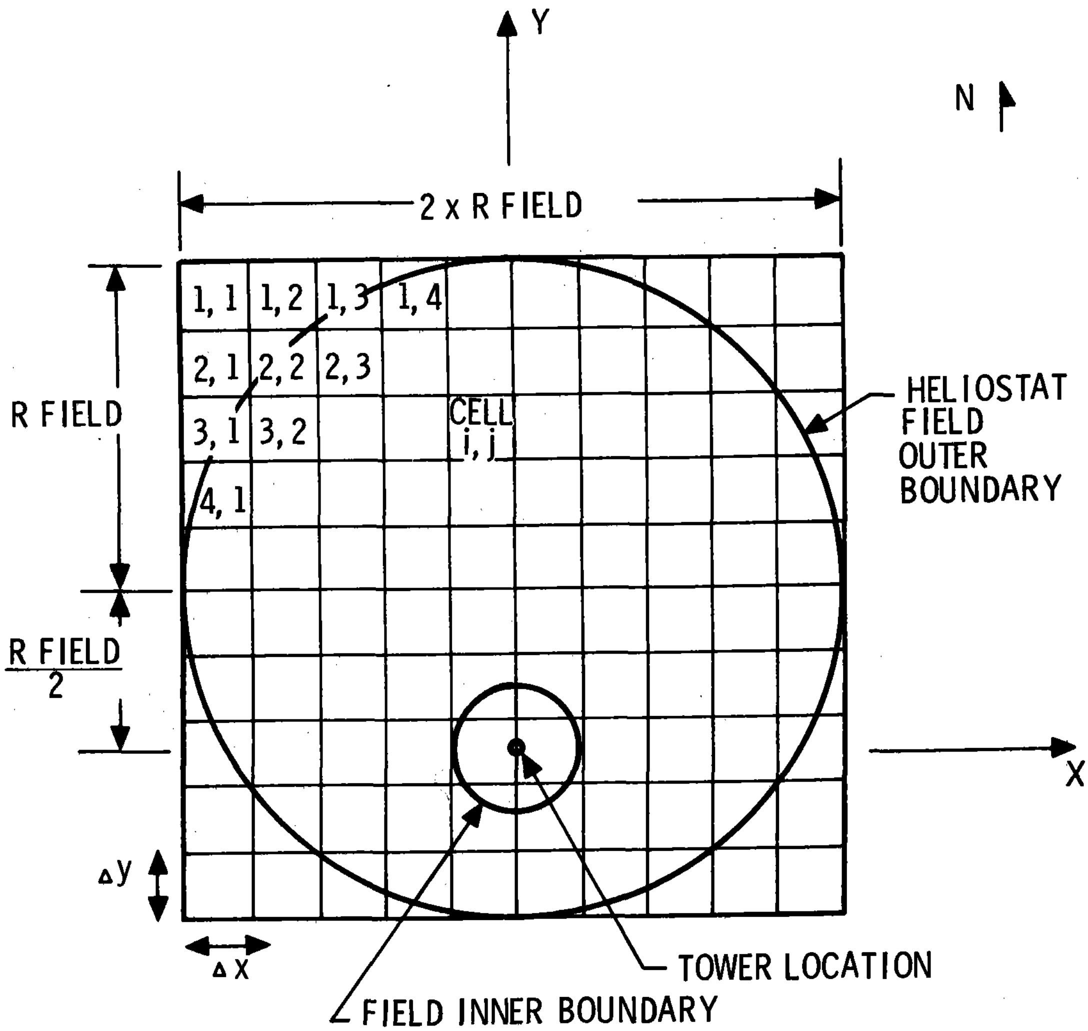


Figure 2-19. Heliostat Field Cells for CS Model

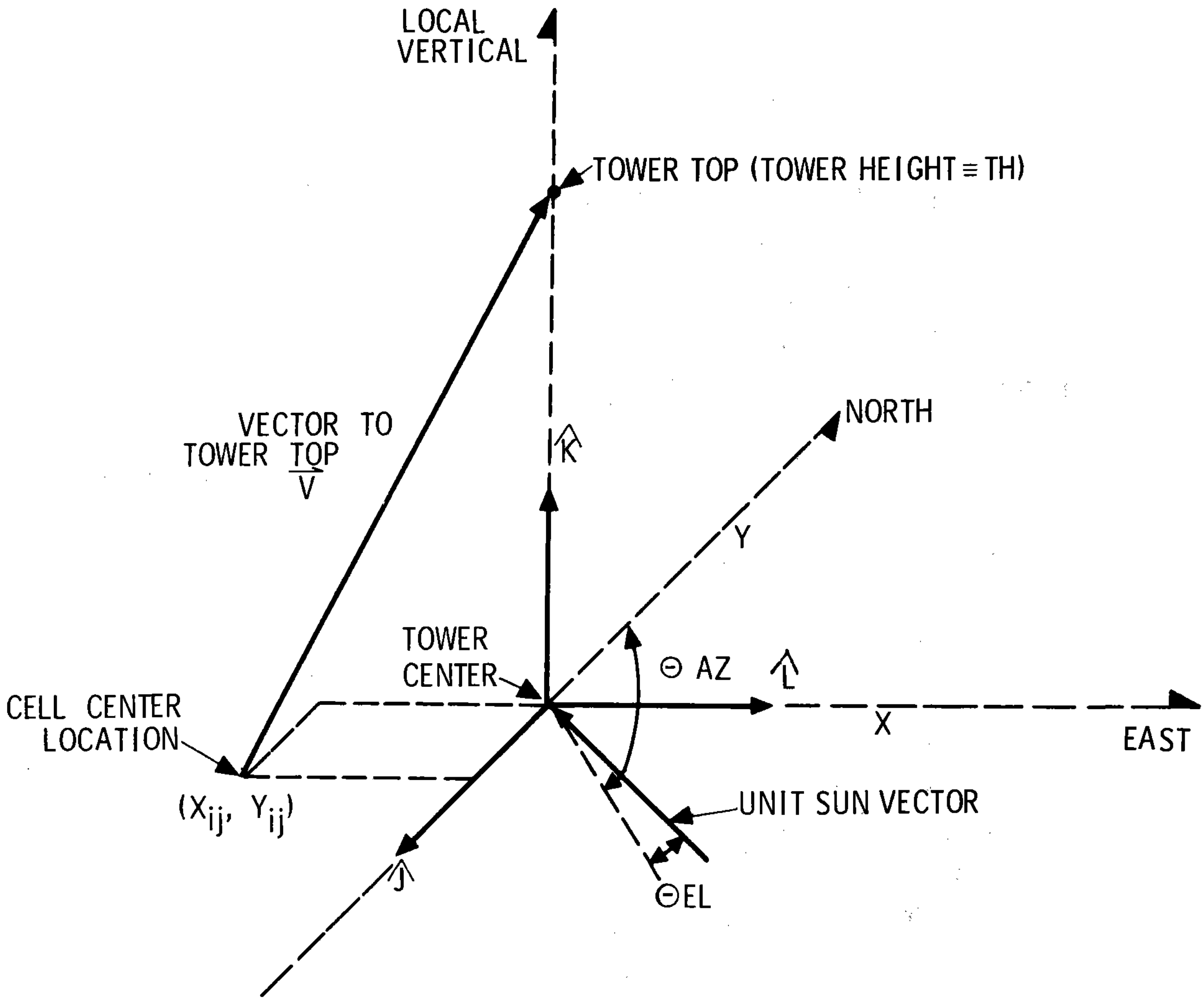


Figure 2-20. Vector Notations for CS Cell Center Cosine Tracking Efficiency

A vector from the cell center to the tower top (nominally assumed to be the aim point of the cell) is:

$$\vec{V} = -X_{ij}\,\hat{i} + Y_{ij}\,\hat{j} + (TH)\,\hat{k}$$

and the magnitude of this vector is simply

$$|\vec{V}| = D = \sqrt{X^2_{ij} + Y^2_{ij} + (TH)^2}$$

such that a unit vector along $\vec{V}$ is

$$\vec{UV} = \vec{V} / D$$

The mirror normal at the cell center is constructed to redirect the sun's rays in a direction defined by UV. The unit mirror normal vector is

$$\vec{UMN} = (\vec{UV} - \vec{UR}) \; / \quad (\vec{UV} - \vec{UR})$$

By substituting the previous expressions for $\vec{UV}$ and $\vec{UR}$ into this equation, the unit mirror normal vector is determined as a function of the cell center position, the tower height and the sun's position.

Knowing the mirror normal and the sun vector, the cosine of the angle between the two vectors is the unshadowed, unblocked tracking efficiency of the heliostat determined by the expression

$$\cos \alpha = \vec{UR} \cdot \vec{UMN}$$

Substituting from the previous equations, the final expression for the cosine is

$$\cos \alpha_{i,j} = \sqrt{\frac{1 - \cos\theta_{el}\sin\theta_{az}X_{ij}/D - \cos\theta_{el}\cos\theta_{az}Y_{ij}/D + \sin\theta_{el}\,TH/D}{2}}$$

The effects of shading and blocking on the cell tracking efficiency may be included by taking advantage of previously generated detailed ray trace code data. This data shows that for the pilot plant central receiver configuration, using four facet tilt-tilt heliostats, the total shading and blocking efficiency is a function of the sun's elevation angle only.

Figure 2-21 shows the fraction of the total power which is not lost due to heliostat shading and blocking as a function of the cosine of the sun's elevation angle. This relationship can be thought of as the shading and blocking field efficiency.

The data in Figure 2-21 represents the average shading and blocking efficiency as integrated over the field. This efficiency is modified for each field cell as a function of the cell position relative to the sun's azimuth position. Since the baseline heliostat is a four-facet tilt-tilt configuration aligned such that the outer rotation axis is normal to a line-

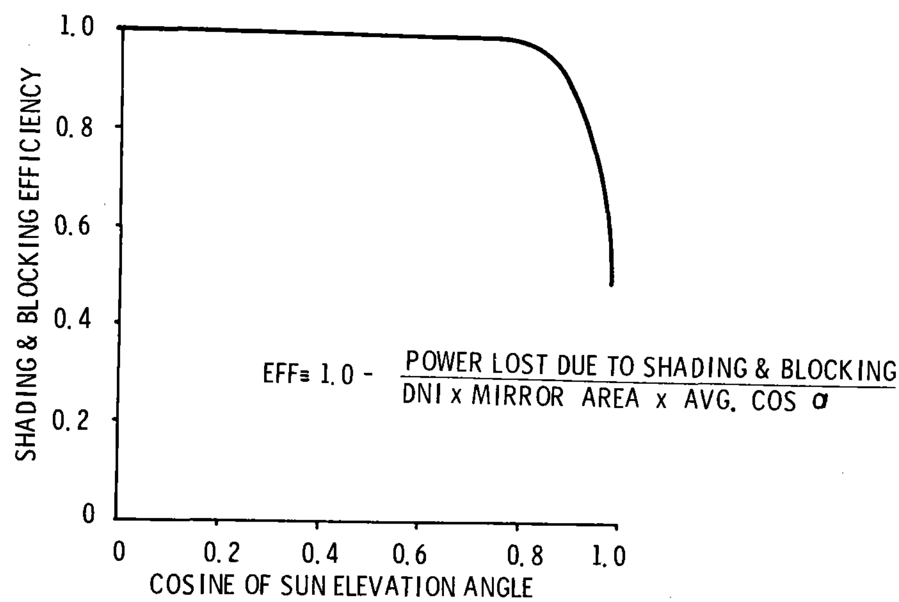


Figure 2-21. Shading and Blocking Efficiency for the Pilot Plant Heliostat Field

of-sight to the tower, the facet-to-facet shading must be a maximum for those heliostats which are positioned 90 degrees from the sun position.

This can be more clearly seen by referring to Figure 2-22, which shows several representative heliostats (not to scale) in the field and an arbitrary sun azimuth position. From detail ray trace simulation results, it is known that nearly all shading losses are due to facet-to-facet shading rather than heliostat-to-heliostat shadows. Consequently, the losses will be greatest on heliostats where the outer rotation axis is aligned with the sun vector. When the sun vector is normal to the heliostat outer axis no shading losses will occur.

To model this situation, it is assumed that the shading and blocking loss is distributed over two 120-degree field angles with the center of the shading zone at an angle perpendicular to the sun vector. Figure 2-22 shows that the assumed variation of shading losses is linear from zero loss at the zone boundaries to a maximum at the zone center. The maximum loss is calculated such that the total integrated loss over the field cells is approximately equal to the total loss as determined by the data in Figure 2-21.

The cell tracking efficiency must be further modified by the mirror reflectance (assumed = 0.9) and the fraction of the power redirected which enters the cavity. Based on the ray trace simulation results, the fraction of the redirected power which enters the cavity can be taken as a constant for all field cells and sun positions. Therefore, the total overall tracking efficiency for any field cell (TE_{ij}) is written as

$$TE_{ij} = (\cos \alpha_{ij}) \times (\eta SAB_{ij}) \times (REFL) \times (CAV)$$

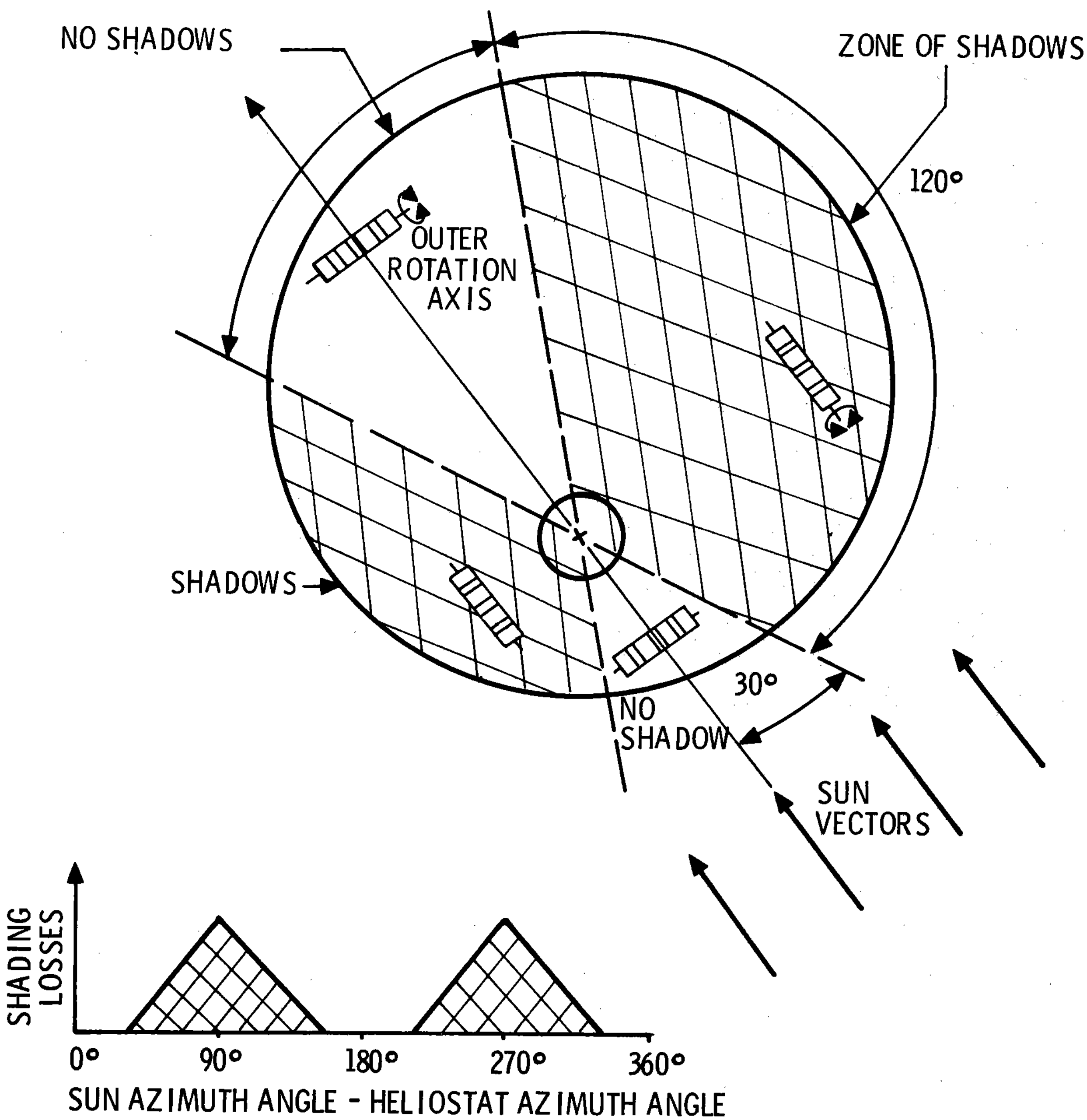


Figure 2-22. Shadowing in the Heliostat Field

where

$\cos \alpha_{ij}$ = cell (i, j) cosine-only tracking efficiency

ηSAB_{ij} = cell (i, j) shading and blocking efficiency

REFL = Mirror reflectance

CAV = Fraction of redirected power which enters cavity

Finally, the redirected power which enters the cavity from any cell is simply

$$P_{ij} = (\text{Area Mirror})_{ij} \times (\text{DNI}) \times (\text{TE}_{ij})$$

where

$P_{i,j}$ = Power into cavity from cell (i, j)

$(\text{Area Mirror})_{ij}$ = Heliostat mirror area in cell (i, j)

DNI = Direct normal intensity

Receiver Incident Power Model

The purpose of the receiver (or cavity) incident power model portion of the CS is to determine where the redirected power from any field cell will be incident upon the steam generator or cavity ceiling. Figure 2-23 illustrates a typical field cell and the external paths from the cell boundaries into the aperture, and then from the aperture to the steam generator or ceiling surfaces.

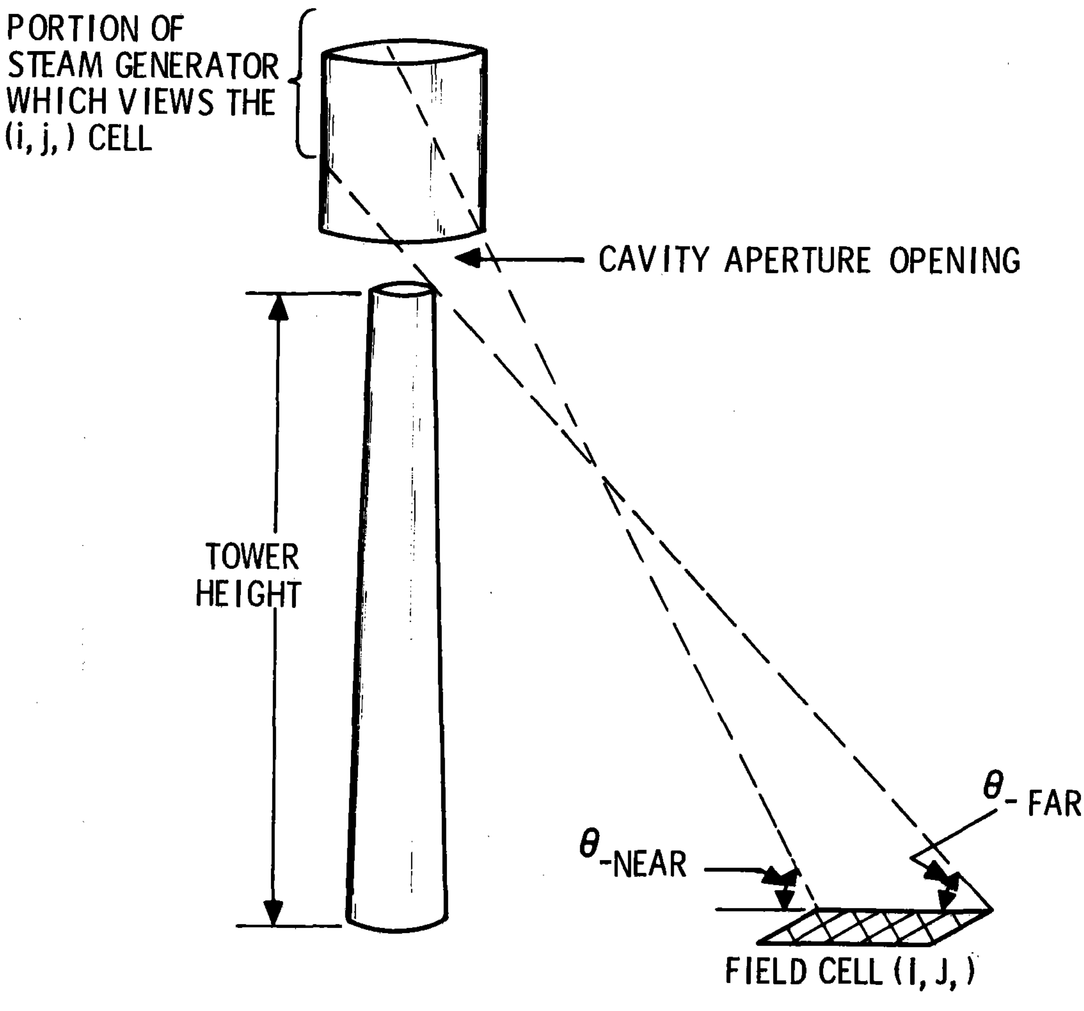


Figure 2-23. Field Cell View of Steam Generator

The portion of the internal cavity which can be seen from the field cell is determined by the two angles measured from horizontal (θ_{near} and θ_{far}) shown in Figure 2-23. As shown, the angle to the path determined by the near edge cell boundary and the upper aperture boundary is defined as θ_{near}, while the angle to the path determined by the far edge cell boundary and the lower aperture boundary is defined as θ_{far}. These angles are subsequently used to determine the steam generator segment intercepted by any field cell.

Figure 2-24 shows the tower ceiling, cavity geometry, and a typical field cell with redirected energy paths to the internal cavity surfaces. For determining incident solar power, the cavity has been modeled using four nodes: the boiler (B), the primary superheater (PSH), the secondary superheater (SSH), and the ceiling (C). This method of modeling is consistent with the SGS model, and is adequate for addressing control and stability issues associated with the energy balance between the boiler and superheater.

As shown in Figure 2-24 the points of intersection of the possible ray paths with the internal cavity can be quite easily calculated given the cavity geometry. The lower and upper intersections are given by

$$h_{\ell} = \left(\frac{DD3}{2} + \frac{DD1}{2}\right) (\tan \theta_{far})$$

$$h_u = h_a + (DD3)(\tan \theta_{near})$$

where

h_{ℓ} = height from tower top to lower path intersection

h_u = height from tower top to upper path intersection

DD1 = tower top diameter

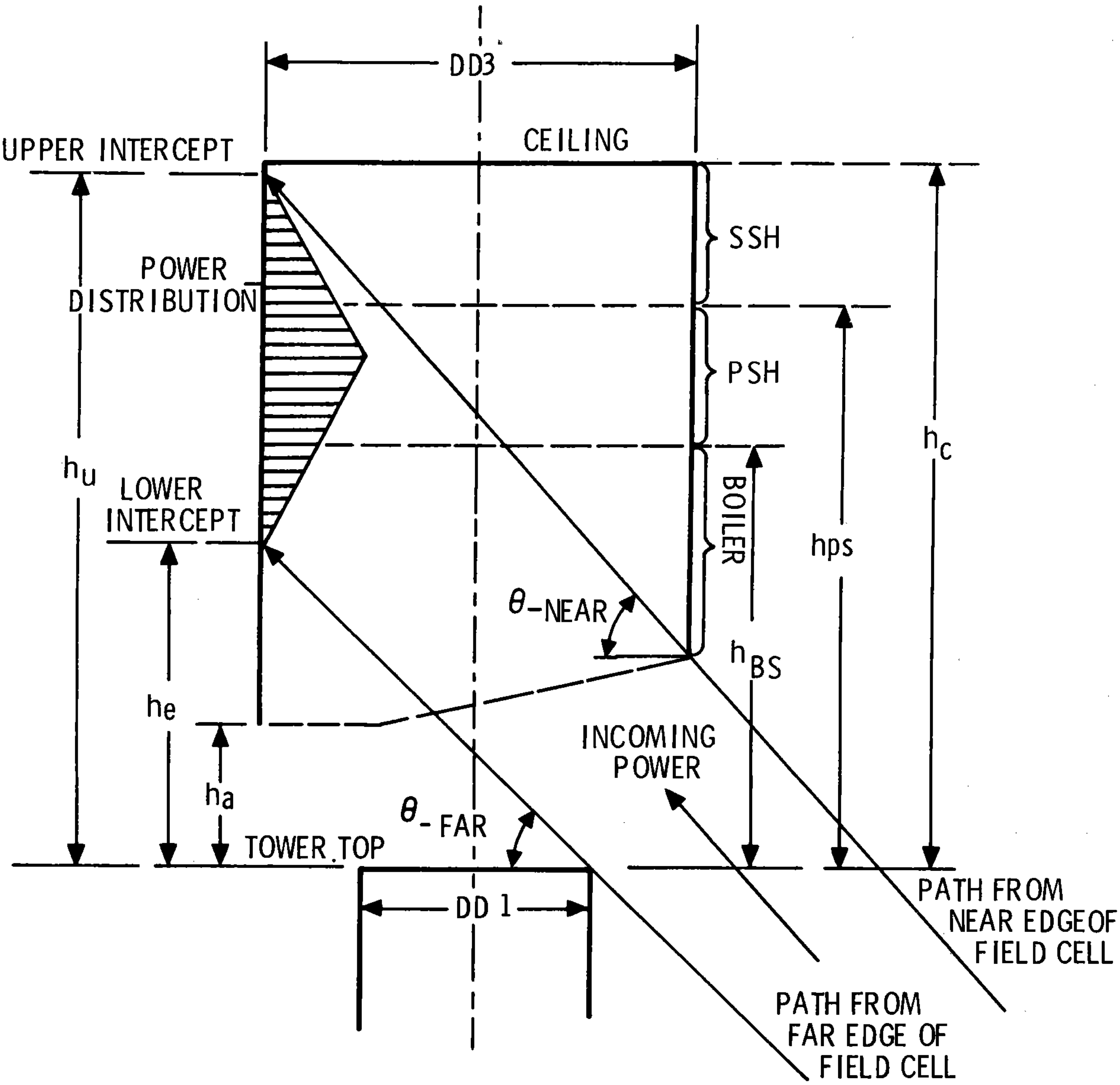


Figure 2-24. Power Directed into Cavity for a Typical Field Cell

DD3	=	internal cavity diameter
h_a	=	height from tower top to upper aperture minimum boundary

The power distribution over the portion of the steam generator which can be seen from the field was assumed to take the shape of an isoceles triangle with zero power at the intercept points and a peak midway between the points. The fraction of the cell power into the cavity which is incident on each cavity node can then be computed using the assumed distribution. For the example shown in Figure 2-24, the fractional power ratios are

$$F_B = 2 \times \frac{(h_{BS} - h_\ell)^2}{(h_u - h_\ell)^2}$$

$$F_{psh} = 1 - 2 \times \left[\frac{(h_{BS} - h_\ell)^2 + (hu - hps)^2}{(hu - h_\ell)^2} \right]$$

$$F_{ssh} = 2 \times \frac{(hu - hps)^2}{(hu - h_\ell)^2}$$

$$F_c = O$$

where

F_B	=	fraction of cell power on boiler
F_{psh}	=	fraction of cell power on primary superheater
F_{ssh}	=	fraction of cell power on secondary superheater
F_c	=	fraction of cell power on ceiling

h_{BS}	height from tower top to boiler/superheater interface
h_{ps}	height from tower top to primary/secondary superheater interface

For each field cell the fractional power ratios are calculated and stored in an array. The power on any cavity node from any one cell (i, j) is simply found by multiplying the cell power into the cavity by the appropriate fraction. The total power onto any node is the sum of the power from each field cell; or,

$$P_B = \sum^{ij} F_{B_{ij}} P_{ij}$$

$$Ppsh = \sum^{i,j} F_{psh_{ij}} P_{ij}$$

$$Pssh = \sum^{i,j} F_{ssh_{ij}} P_{ij}$$

$$Pc = \sum^{i,j} F_{c_{ij}} P_{ij}$$

Where P_B, P_{psh}, P_{ssh} and P_c are the total integrated powers on the boiler, primary superheater, secondary superheater and ceiling respectively.

<u>Transient Receiver Reradiation Model</u>

Considerable efforts on the SPP Program have been devoted to development of a sophisticated reradiation model for the receiver cavity. Using Monte Carlo techniques, redirected solar power onto the various cavity surfaces has been statistically determined. A high degree of confidence in this technique exists.

The requirements for a reradiation model for the SPP Dynamic Simulation are somewhat different than this Monte Carlo technique, however. The primary requisites are a set of algorithms which give an accurate representation of the physical reradiation phenonemona, at minimum computer run time and memory space requirements. Consequently, a transient receiver reradiation model was developed.

The transient reradiation model utilizes a six-node representation of the receiver cavity as shown in Figure 2-25. Redirected solar power on each node is determined from the receiver incident power model previously described. Surface temperatures for each node are determined from the SGS model. The transient reradiation model then calculates net solar and IR power contributed to each cavity surface. The total of net solar and IR power than provides the absorbed power required as inputs to the nodal temperature rate of change equations. At this time, convection losses have not been incorporated into the model.

The total reradiation model consists of seven subroutines, as listed in Table 2-7. The first six of these subroutines are called only once at the time of SPP Dynamic Simulation initialization. Thereafter, only the last subroutine (CAVHEAT) needs to be called at each time point.

Table 2-8 lists the initialization data contained in the initialization program CAVINIT. This data characterizes the cavity physical size and radiation properties for each of the nodes identified in Figure 2-25.

Following initialization, the subroutine CAVHEAT is called periodically whenever updated values of absorbed power are required. The input to this routine consists of two 1 x 6 vectors, as shown in Table 2-9: 1) a surface

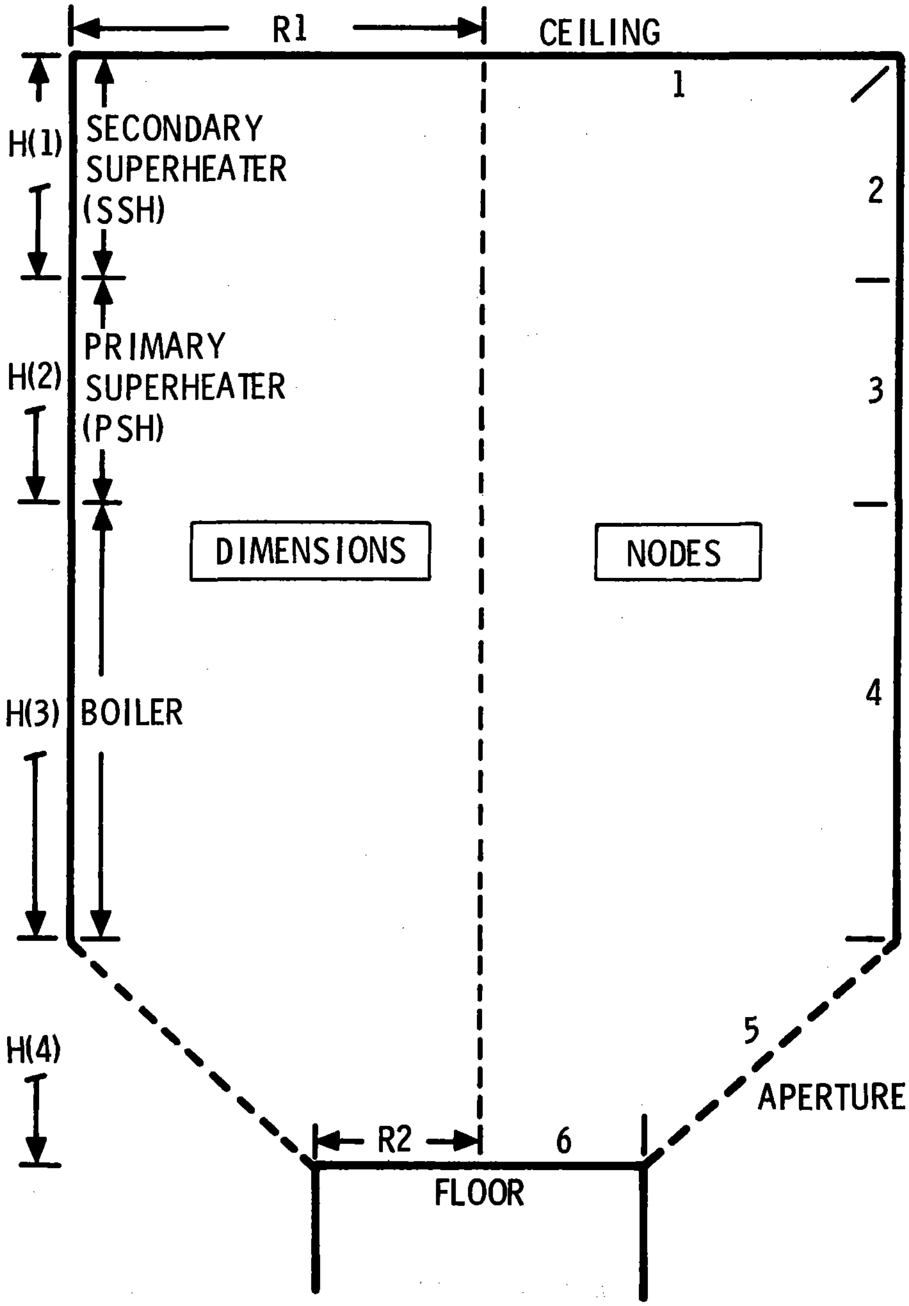


Figure 2-25. Receiver Cavity Dimensions and Nodal Numbering System

Table 2-7. Receiver Reradiation Model Subroutines

Subroutine	Function
1. CAVINIT	Initializes the cavity physical parameters and cavity radiation properties. It controls the call to all of the other initialization routines below (nos. 2 through 6).
2. VIEWFAC	Calculates all of the viewfactors between the nodes.
3. FACTOR	Calculates the viewfactor between the two coaxial discs.
4. TRANS	Calculates the transfer matrices for IR and solar heat transfer given the nodal view factors and radiation properties.
5. SCRPTF	Calculates the Hottel Script F matrice for radiant heat transfer.
6. DINRT	Calculates the inverse of a matrice.
7. CAVHEAT	Calculates the net IR and solar heat transfer rates for each of the cavity nodes given incident solar power and nodal surface temperatures.

temperature vector for each node, and 2) an incident solar power vector. The routine, in turn, calculates three 1 x 6 vectors: 1) net solar power; 2) net IR power; and 3) absorbed power.

The accuracy of the transient reradiation model has been verified by stimulating it with metal surface temperature profile curves and incident power distributions identical to those employed with the Rerad rubber model. Comparative results are shown in Table 2-10 for two different time points: 3/21, 7 a.m., and 3/21, noon.

Table 2-8. Initial Data Needed in CAVINIT

Variable	Preliminary Design Value	Definition
R1	7.46 (24.5)	Cavity top radius in m (ft)
R2	3.96 (13.0)	Tower top radius in m (ft)
H(1)	4.78 (15.67)	Distance from the cavity ceiling to the bottom of superheater one in m (ft)
H(2)	8.0 (26.25)	Distance from the cavity ceiling to the bottom of superheater two in m (ft)
H(3)	15.85 (52.0)	Average distance from the cavity ceiling to the bottom of the boiler in m (ft)
H(4)	21.34 (70.0)	Distance from the cavity ceiling to the toper top in m (ft)
ESOL (I)	0.9 (ESOL(5) = 1.0)	Solar emmisivity of Node I – aperture emmisivity is 1.
EIR (I)	0.9 (EIR (5) = 1.0)	IR emmisivity of Node I – aperture emmisivity is 1.

Table 2-10 shows the absorbed energy balance results between the two different models for the three SGS nodal surfaces. Reradiated solar and IR power comparisons are also shown.

As the table shows, the transient receiver reradiation model agrees well with the rubber model, with typical accuracies of 1-2 percent. The largest differences (5-10 percent low) occur for the reradiated IR power

Table 2-9. Variables Used for Receiver Transient Reradiation Model

Variable Vectors (1 x 6)	Definition
TCAV (I)	Temperature of node I in degrees F. The temperature of the aperture node is the outside temperature.
SI (I)	Incident solar power on node I in BTU/hr. Include only "whistle thrus" in the incident power on the aperture.
QSOL (I)	Net rate of solar input into node I in BTU/hr. Negative values correspond to power into a node, positive values correspond to power out of a node.
QIR (I)	Net rate of IR input into node I in BTU/hr. Negative values correspond to power into a node, positive values correspond to power out of a node.
QNET (I)	Absorbed power into node I in BTU/hr. Positive values correspond to power into a node; negative values correspond to power out of a node.

runs. The major reason for this slight discrepancy is believed to be the improper accounting for the inactive surface at the bottom of the boiler section.

Cloud Model

No definitive data on cloud size, shape or cloud cover was available for the cloud modeling exercise. Although a thorough literature search was not performed it was not expected that a definitive data exists because of site-dependent variations in meterological conditions. Several sources of cloud

Table 2-10. Verification Results of the Receiver Transient Reradiation Model

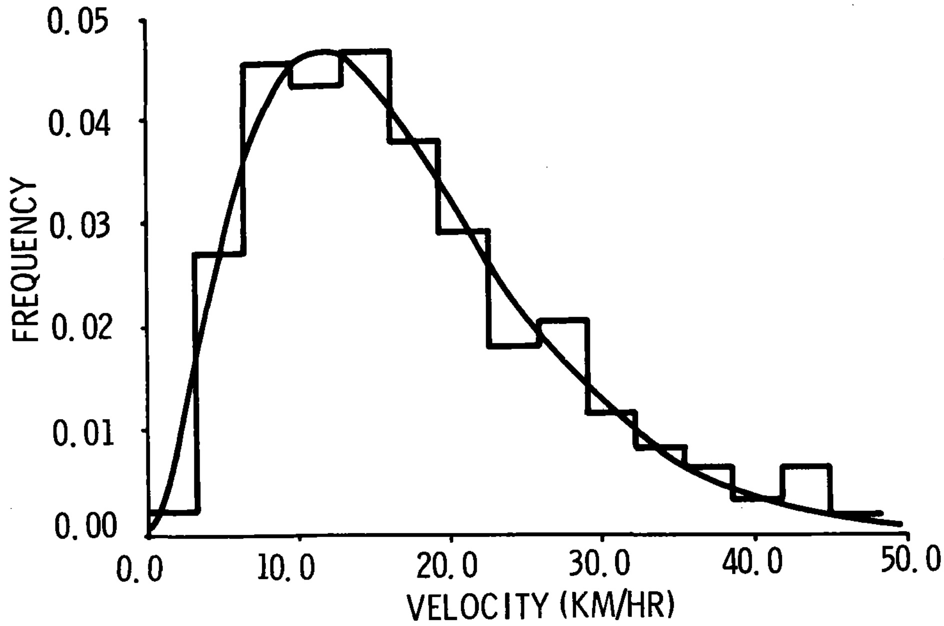
Variable Definition	3/21 7 am		3/21 Noon	
	Transient Model	Rubber Model	Transient Model	Rubber Model
Solar Power Reradiated	.286 MW	.287 MW	1.03 MW	1.04 MW
IR Power Reradiated	1.702 MW	1.792 MW	2.42 MW	2.68 MW
Absorbed Boiler Power	8.614 MW	8.648 MW	30.72 MW	30.35 MW
Superheater One Absorbed Power	2.530 MW	2.483 MW	9.69 MW	9.66 MW
Superheater Two Absorbed Power	.493 MW	.510 MW	5.53 MW	5.52 MW

data are available, however, and the cloud model was developed to be compatible with available data.

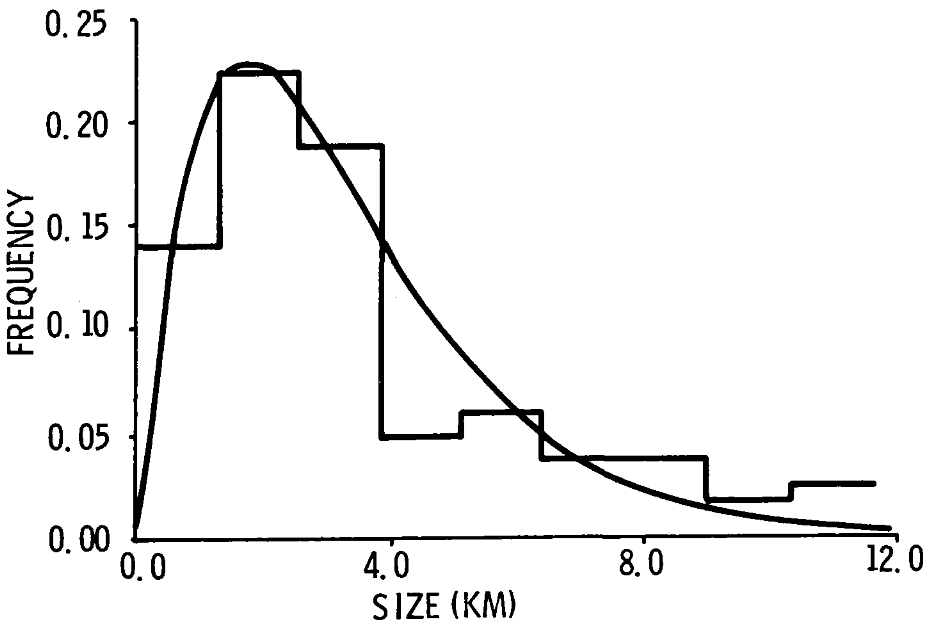
One source of data is the information contained in Reference 8. This report contains cloud speed and cloud size frequency distributions are for cloud observations in Tucson, Arizona, taken over an eight month period. They are reproduced in Figure 2-26.

The data taken during the cource of the study cited in Reference 8 was fitted to a gamma probability density function of the form

$$f_x(x) = \begin{cases} \dfrac{x^a \, e^{-x/b}}{a! \; b^{a+1}} & , x > 0 \\ o & , x \leq 0 \end{cases}$$



(a) CLOUD SPEED



(b) CLOUD SIZE

Figure 2-26. Representative Cloud Speed and Size Probability Density Functions (Gamma-Functions)

For the gamma distributions, the following parameters were determined in Reference 8:

Cloud Size (Km)	Cloud Speed (Km/hr)
a = 1.1519	a = 1.9619
b = 1.5152	b = 5.7974

Referring to Figure 2-26 it appears that clouds larger than the pilot plant heliostat field are quite likely. The pilot plant heliostat field is approximately 0.54 km in diameter and it can be estimated that over 95 percent of all clouds will be larger than this.

Further information on cloud sizes, speeds and cloud cover is reported in Reference 9. In this report a cloud model was constructed based on several references concerning cloud statistics as determined from U-2 photographs. A cloud shadow field was modeled with the cloud shadows being represented as rectangles, where the ratio of the rectangle length to width was based on the cloud data. The frequency distribution of cloud sizes was taken from Reference 10, and is reproduced in Figure 2-27. It is interesting to note that clouds smaller than 0.35 km^2 (0.135 sq. mi) in area are not on the frequency data curve reported. However, the frequency of smaller clouds does seem higher than seen in the curve of Figure 2-26. The cloud types of Figure 2-27 are all limited-extent water clouds, with bases generally below 1524m (5000 feet). These types will cast quite sharp shadows and probably represent worst-case conditions for the heliostat field.

From available data it therefore seems most probable that clouds will be as large or larger than the pilot plant heliostat field. This information was used to simplify the cloud modeling effort for the pilot plant field by assuming a single cloud moving over the field is an adequate representation of actual expected conditions. The length of the cloud, the cloud speed, the cloud direction and the cloud center relative to the field center can be varied within the computer program.

Figure 2-28 shows the heliostat field cell grid and a sample cloud moving over the field from the north. Time increments for the simulation are chosen such that one cell at a time is covered in the direction of the cloud movement. For each time increment, the field cells which are covered by the cloud are assumed to be totally blacked out. That is, the power redirected by the cell is set to zero and the total redirected power, as well as the power to each cavity node, is then computed.

Collector Model Verification

To test the field and receiver models, a series of runs were made with the computer program of the cloud model. The runs were identical to runs made previously with the detailed ray trace code and results were compared.

Figures 2-29 and 2-30 show the comparisons for sunrise to noon on an equinox day. No clouds are present in the data. For all times, the simple model redirected power and power on each of the cavity nodes is within 1 MW of the detail ray trace results. Percentage differences between the two sets of results is always within 10 percent. These differences are considered negligible for the purpose of simulating the system transient characteristics.

In addition, the model was checked for one case of cloud cover. The ray trace code and the simple model were both run with a cloud covering the north half of the field. The total power and the power on each cavity node is shown in the following table (MWt):

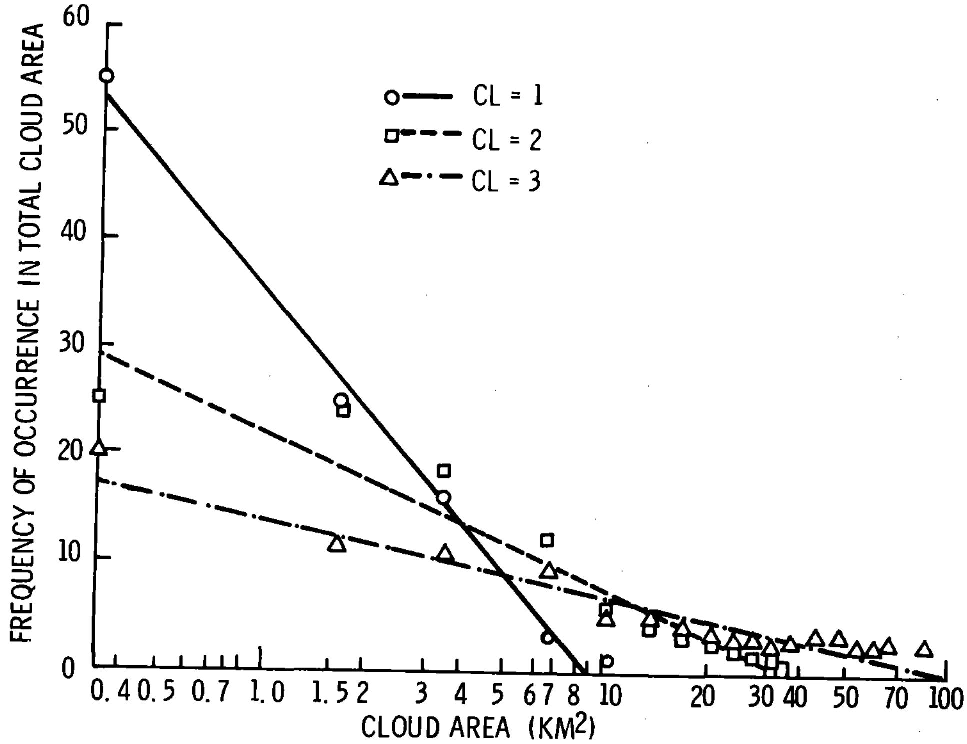


Figure 2-27. Frequencies of Cloud Areas for Three Cumuliform Cloud Types

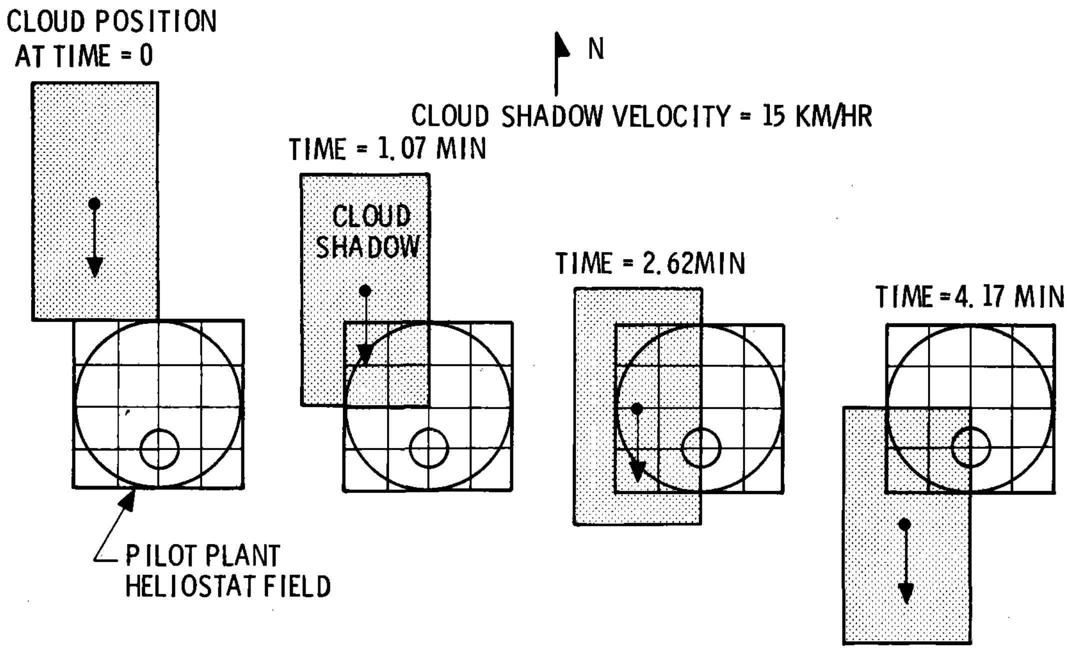


Figure 2-28. Example of Cloud Moving over Heliostat Field

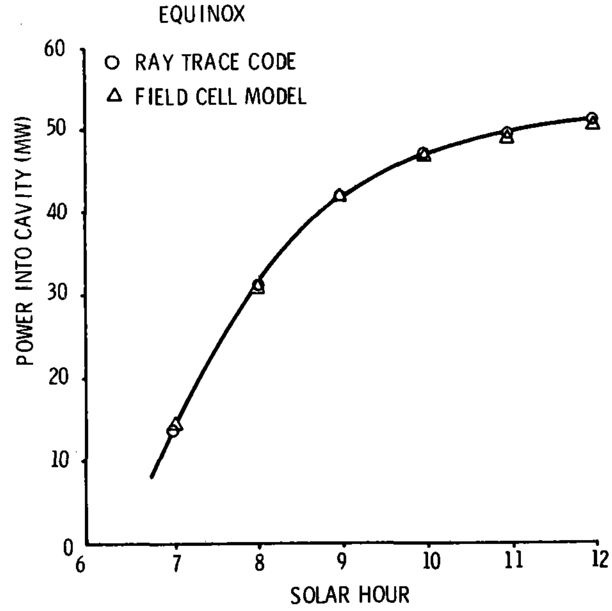


Figure 2-29. Comparative Model Results Total Redirected Power versus Time of Day

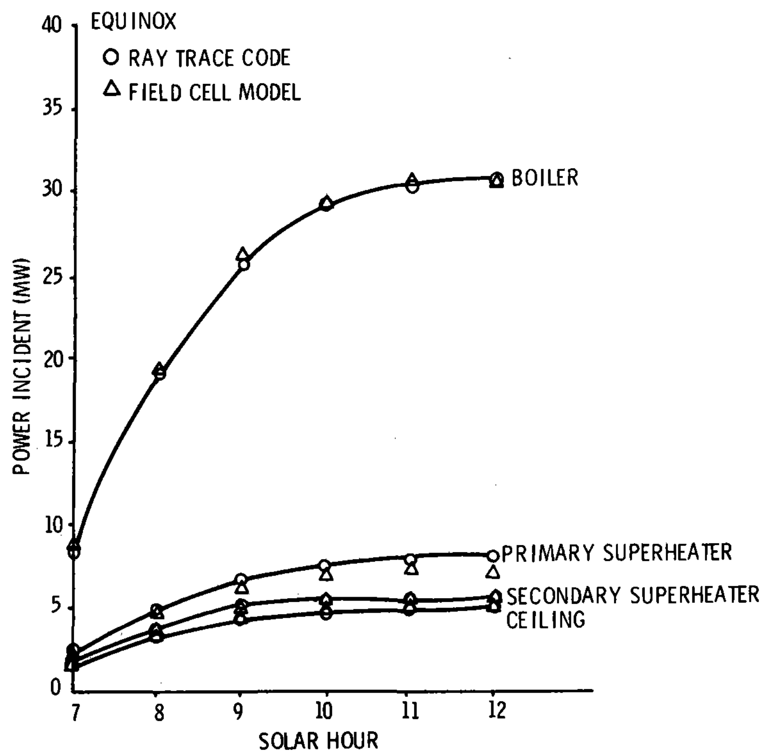


Figure 2-30. Comparative Model Results Incident Power on the Cavity Nodes versus Time

	Ray Trace	Field Cell Model
Redirected Power	27.4	26.5
Power on Boiler	10.8	10.1
Power on PSH	5.9	5.7
Power on SSH	5.8	5.5
Power on ceiling	4.9	5.2

Again, agreement between the two sources of data is within 10 percent for every power comparison. This is judged to be excellent correlation of analytical results.

Once the field cell model was verified, some selected sample cases were run. Cloud speed, cloud direction, and cloud field covering were varied. Example results are shown in Figures 2-31 through 2-34. Some selected results were then transferred to the SPP Dynamic Simulation programs to characterize the plant behavior during cloud transients.

Figure 2-31 shows the change in direct solar power stimulating the four cavity nodes as a function of time. The figure is for a cloud passing over the field from the north. The cloud eventually covers the entire field and then moves off the field.

For a cloud coming from the north, the first cavity section to be affected is the boiler since the heliostats in the north can see only the boiler section. As the cloud moves south and covers more and more of the field, the incoming power on all sections is reduced in the sequence of boiler, primary superheater, secondary superheater and then ceiling.

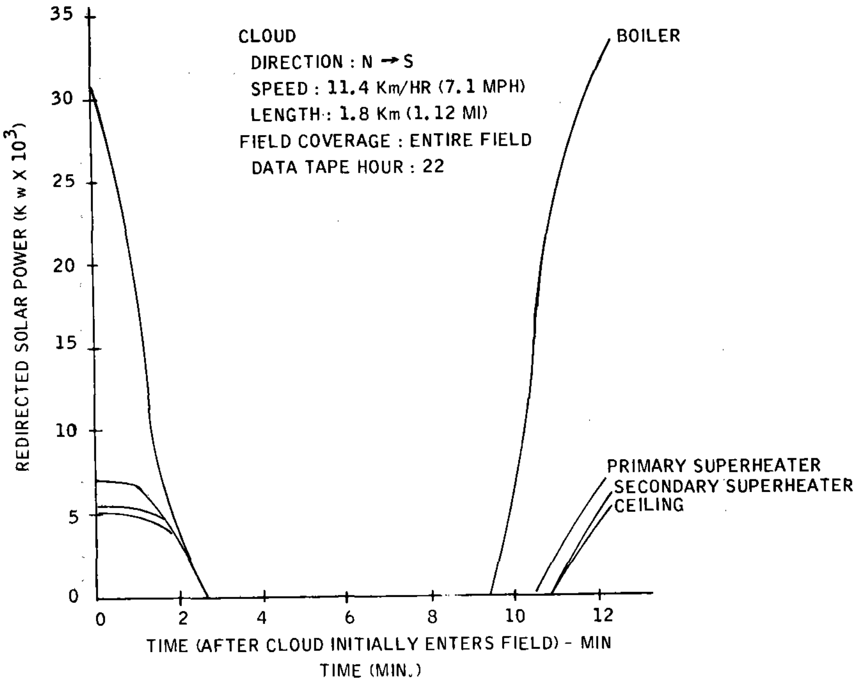


Figure 2-31. Cavity Power versus Time, North Approaching Cloud Covering Whole Field

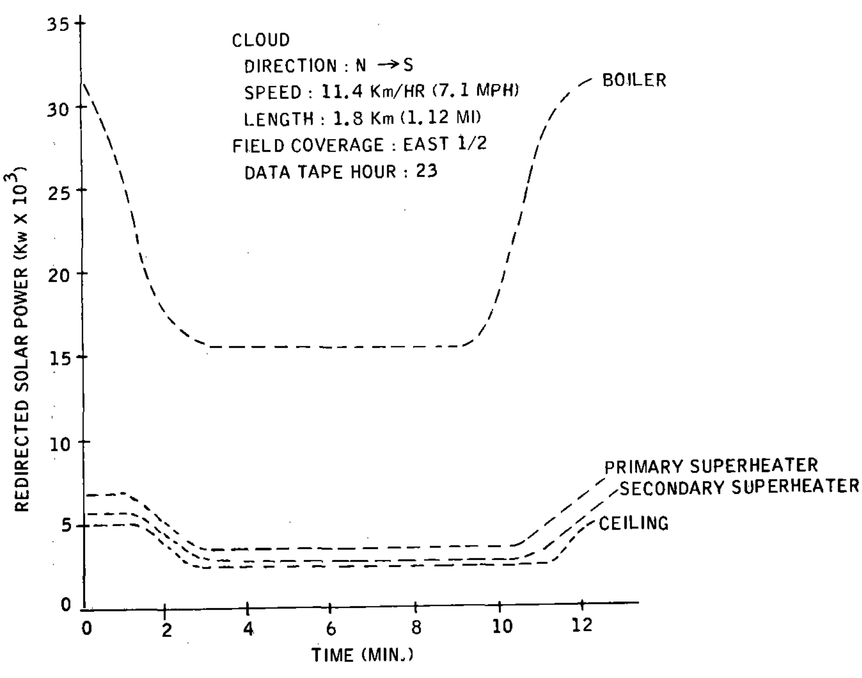


Figure 2-32. Cavity Power versus Time, North Approaching Cloud Covering East Half

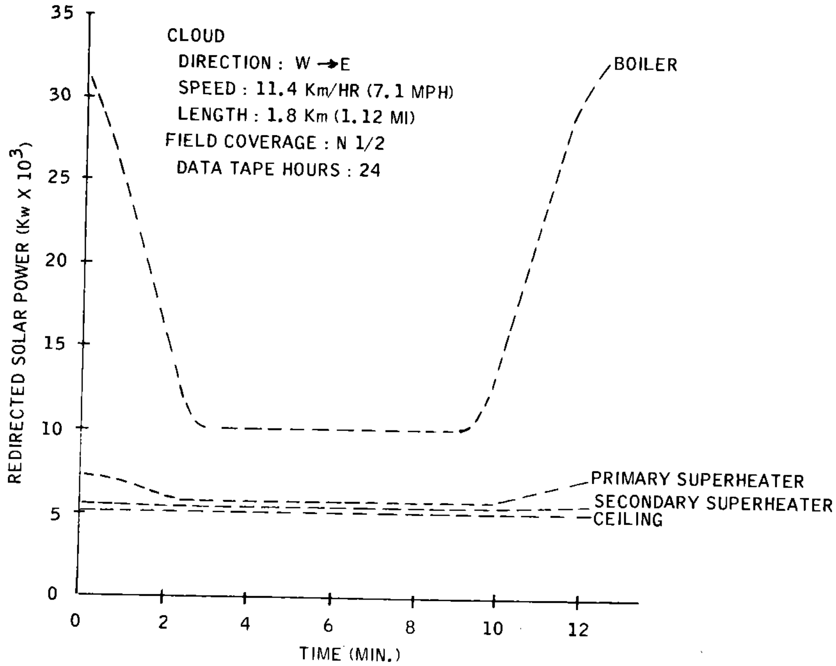


Figure 2-33. Cavity Power versus Time, Westerly Approaching Cloud Covering North Half

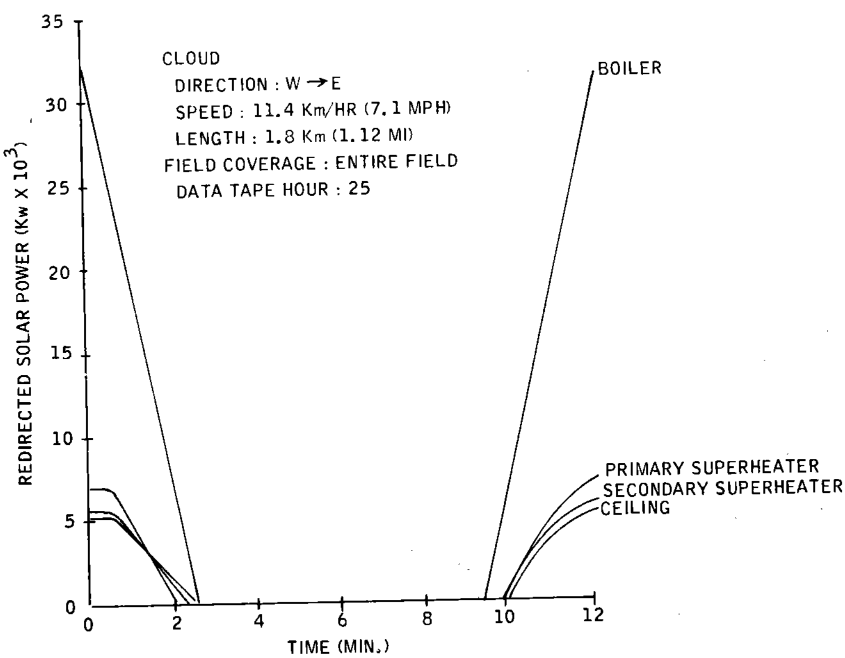


Figure 2-34. Cavity Power versus Time, Westerly Approaching Cloud Covering Whole Field

Depending upon the cloud direction and size, the cavity nodes affected can be deduced from knowledge of the parts of the heliostat field which direct power onto the different cavity sections. Figure 2-35 shows the heliostat field divided into zones of different cavity views. The figure shows that far north field heliostats see only the boiler node, while heliostats close in can see only the ceiling.

Figure 2-33 shows the results of a cloud coming from the west and covering the entire field. Note that the power on all sections is decreased nearly uniformly as the cloud passes. A worse case may be for a cloud coming from the west, but covering only the north half of the field. Figure 2-34 shows this case. It is seen that the superheater and ceiling powers are nearly unaffected by the cloud but the boiler power is reduced to one-third its original value as the cloud covers the field. This may potentially create serious imbalance problems in the steam generator.

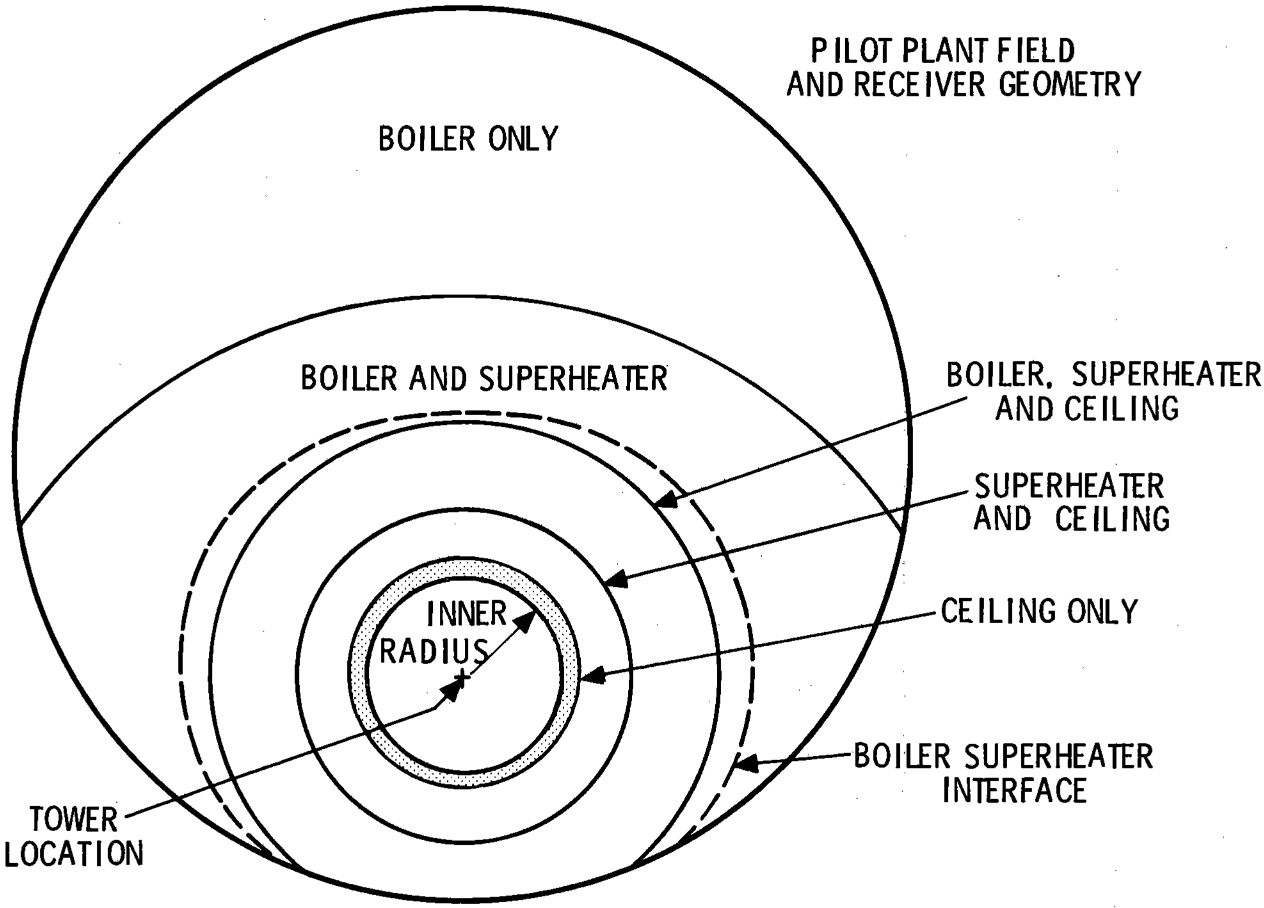


Figure 2-35. Heliostat Field-Cavity Viewing Zones

SECTION 3
COMPUTER PROGRAM DESCRIPTION

Figure 3-1 illustrates the basic top-level flow chart of the dynamic simulation computer program.

Prior to beginning the iterative computational sequence, the following operations take place:

1. Input data from the SPP data file is read in. Table 3-1 lists the data file parameters, order, and formats utilized. Basically, the input data consists of overall program data (time step sizes, final time, print times, mode switches, etc.), initial thermodynamic states (pressures, temperatures, enthalpies, flows, levels), initial valve openings, control system gains, and initial SGS radiant heat inputs. The data file input is printed out again to verify the proper data was entered.

2. Subroutines are individually initialized.

3. Initial condition parameters are printed out.

The program then enters the basic low-speed iteration loop, which steps through the program in time steps of size ΔT. A high-speed loop within this low-speed loop is utilized for computational sequences requiring smaller time step changes (for accuracy and/or numerical stability). Printout of selected parameters at preselected time intervals is permitted. Plot points, if automatic output plotting is desired, are also sampled at the same time.

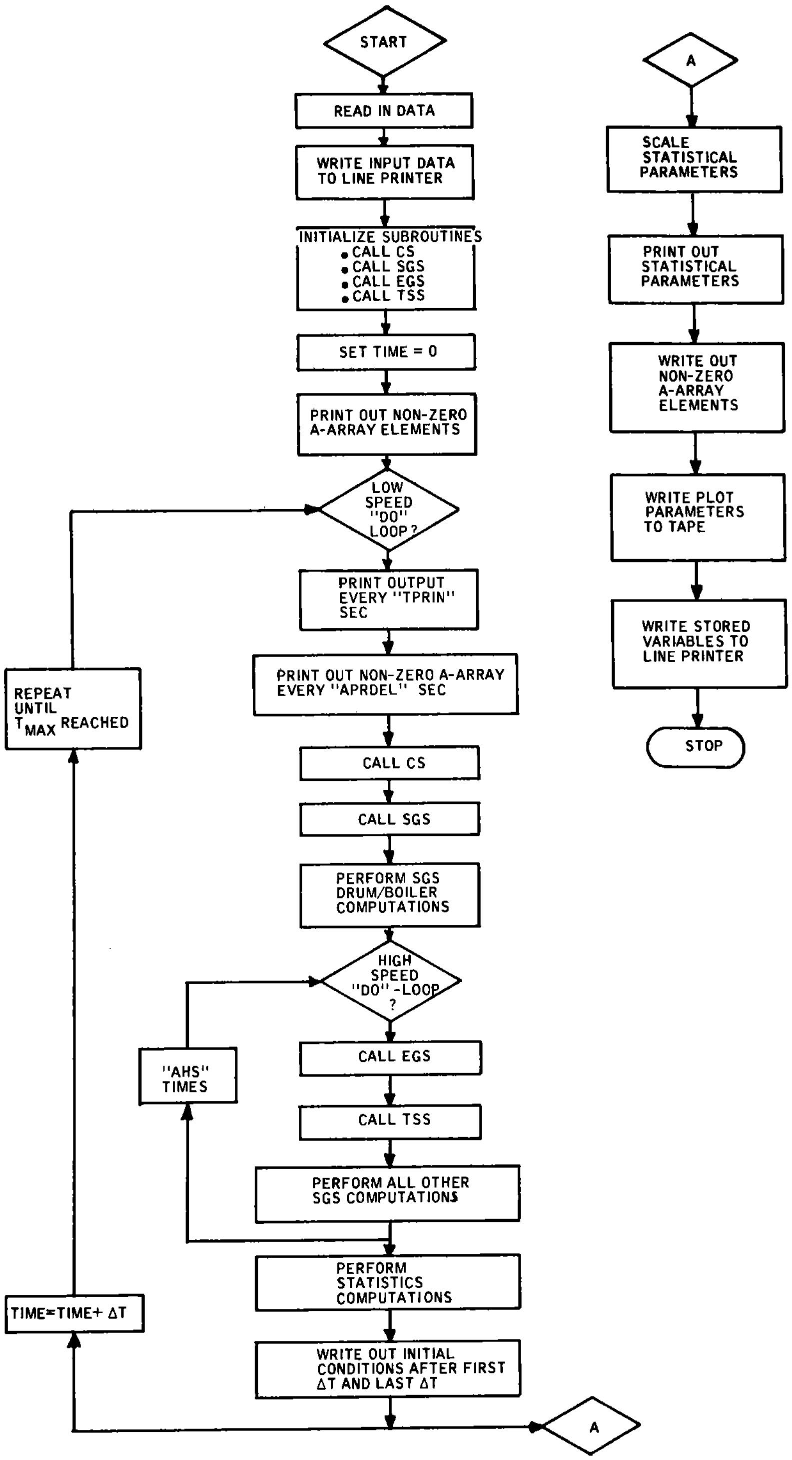


Figure 3-1. Dynamic Simulation Computer Program

Table 3-1. SSP Dynamic Simulation Input Data Format

Line No.	Parameters								Read Formats	Subsystem	Parameter Descriptions
	P1	P2	P3	P4	P5	P6	P7	P8			
1	RUNND								I8, F8.0	Program	Run Number
2	ICSET	IDPMOD	JCS	INP					5I8		Flags for submode, operating mode, collector, No. printout parameters
3	TPRDEL	APRDEL	TMAX	DELT	TSTRT				I8, 5F8.2		Time printout ΔT, A-array ΔT, max. time, step size, DNI read start
4	QBTD	QPSHTD	QSSHTD						I8, 3F8.2	CS	Initial boiler, PSH, SSH, Heat ratios (% of full load)
5	QBTF	QPSHTF	QSSHTF	TI	QRATE				I8, 5F8.4		Final heat ratios, time to change, rate of change
6	KCSBP	KCSBI	KCSPSP	KCSPSI	KCSSSI				I8, 6F8.4		CS controller gains (Unused)
7	LSET	PSGSET	TSGSET						I8, 3F8.2	SGS	Drum level, pressure, temperature set points
8	HFW	HA	H2	HPSHO	HSSHO				I8, 5F8.2		Enthalpies (initial)
9	RHDF	PFW	WSSHO	WATTSP	TPSHM	TSSHM			I8, 6F8.1		Density, pressure, temp., flow conditions
10	KAVP	KAVI	KFWP	KFWI	KSVP	KSVI			I8, 6F8.4		Controller gains
11	XFWA	XSCV	XAVA						I8, 3F8.4		Valve openings
12	T2	DEMAND	DEMHP	PLOADO	DEMNDF				I8, 5F8.3	EGS	Load, load demand
13	PTSO	WTSO	HTSO						I8, 3F8.2	TSS	Pressure, flow, enthalpy out (discharge)
14	WTSI								I8, F8.0		Flow in (charge)
15	PTSSET	TTSET							I8, 2F8.2		Set points
16	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	9I8		Line printer parameters A ( )
17	LP9	LP10	LP11	LP12	LP13	LP14	LP15	LP16	9I8		

After completing the number of time step iterations to reach the selected maximum true (T_{MAX}), final summarizing information is printed out.

A "common" block of data (i. e., data utilized by more than one subroutine or data desired to be periodically outputted) is stored in an "A"-array. Dimensioned at 600 variables, this array contains the value of any constant or variable which the user may wish to preserve. A periodic printout of all non-zero values of this array is optional. Tables 3-2 through 3-5 list a dictionary of A-array elements utilized in the simulation. Basically, the A-array is structured in the following order:

A(0) - A (99)	Program data
A(100) - A (299)	SGS and CS data
A(300) - A (599)	EGS and MC data

Statistical parameters are computed every ΔT seconds by the subroutine SGS. These statistics provide a summary of principal parameter changes during the course of the program execution.

Table 3-6 illustrates an example of the type of statistical data printed out at the conclusion of each run. As shown, the statistics are divided into three major categories:

- SPP Power levels (power and energy statistics for the SPP)
- SGS Performance (statistics concerning temperatures, pressures, levels, etc.) within the SGS
- TSS Performance (statistics concerning temperatures, pressures, levels, etc.) within the TSS

Table 3-7 summarizes the meanings of the statistical data parameters of Table 3-6.

Table 3-2. A-Array Variables for SPP Program Variables (0-99 Series)

A ( )	Mnemonic	Parameter Description	Value	Units
1	TIME	t - instantaneous time of run		sec
2	RIPDEL	ΔP_R - printout interval value		-
3	TMAX	T_{MAX} - maximum time to run completion		sec
4	DELT	Δt - basic program time step size		sec
5	-			-
6	-			-
7	RIADEL	ΔP_A - A-array printout interval variable		-
8	TIMEM	t_M - instantaneous time of run		min

Table 3-3. A-Array Variables for SGS (100, 200 Series)

A ( )	Mnemonic	Parameter Description	Value	Units
100	WFW	W_{FW} - Feedwater flow	-	lb/hr
	WO	W_O - Steam flow out of drum	-	lb/hr
	WBD	W_{BD} - Blowdown flow	-	lb/hr
	WRC	W_{RC} - Recirculating flow in boiler circuit	160, 640	lb/hr
	PFW	P_{FW} - Feedwater pressure	1, 915	psia
105	HFW	H_{FW} - Feedwater enthalpy		Btu/lb
	HA	H_A - Average boiler/drum enthalpy	-	Btu/lb
	HF	H_F - Saturation enthalpy, boiler circuit	-	Btu/lb
	HD	H_D - Drum vapor enthalpy	-	Btu/lb
	H2	H_2 - Downcover exit enthalpy	-	Btu/lb

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
110	RHOSSI	ρ_{SSI} - Initial value of SSH steam density	-	lb/ft^3
	WSSHO	W_{SSHO} - Exit steam flow of SSH	-	lb/hr
	HSSHO	H_{SSHO} - Exit steam enthalpy of SSH	-	Btu/lb
	TSSHM	T_{SSHM} - Average SSH metal temperature	-	°F
	PSGO	P_{SGO} - SGS outlet steam pressure	-	psia
115	RHOF	ρ_F - Average boiler/drum circuit density	-	lb/ft^3
	RHO2	ρ_2 - Downcover fluid density at exit	-	lb/ft^3
	WATTSO	W_{ATTSO} - Attemperator outlet flow	-	lb/hr
	WATTSP	W_{ATTSP} - Attemperator feedwater spray flow	-	lb/hr
	PSSHO	P_{SSHO} - Steam pressure at SSH exit	-	psia
120	QB	Q_B - Boiler section absorbed power	-	Btu/hr
	QPSH	Q_{PSH} - PSH section absorbed power	-	Btu/hr
	QSSH	Q_{SSH} - SSH section absorbed power	-	Btu/hr
	QR	Q_R - Total SGS absorbed power	-	Btu/hr
	TATTO	T_{ATTO} - Attemperator steam exit temperature	-	°F
125	RHOPSI	$_{PSI}$ - Initial value, PSH density of steam	-	lb/ft^3
	WPSHO	W_{PSHO} - PSH steam flow at exit	-	lb/hr
	HPSHO	H_{PSHO} - Steam enthalpy at PSH exit	-	Btu/lb
	TPSHM	T_{PSHM} - Average metal temperature, PSH metal	-	°F

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	RHOPSH	ρ_{PSH} - Steam density of PSH	-	lb/ft^3
130	EFW	ϵ_{FW} - Total feedwater controller error signal	-	pu
	EP	ϵ_P - Total pressure controller error signal	-	pu
	ET	ϵ_T - Total temperature controller error signal	-	pu
	TPSMDT	$\dot{T}_{PSM}$ - PSH average metal temperature time rate of change	-	°F/sec
	TSSMDT	$\dot{T}_{SSM}$ - SSH average metal temperature time rate of change	-	°F/sec
135	TPSHO	T_{PSHO} - PSH steam temperature at exit	-	°F
	TSSHO	T_{SSHO} - SSH steam temperature at exit	-	°F
	P_{PSHO}	P_{PSHO} - Exit pressure of steam from PSH	-	psia
	PD	P_D - Drum pressure	-	psia
	MT	M_T - Total fluid mass in drum/boiler circuit	-	lb
140	EFWI	ϵ_{FWI} - Feedwater controller integral output error	-	pu
	EPI	ϵ_{PI} - Pressure controller integral output error	-	pu
	ETI	ϵ_{TI} - Temperature controller integral output error	-	pu
	RHOR	ρ_R - Riser fluid density	-	lb/ft^3
	L	ℓ - Drum level (from bottom)	-	ft

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
145	XFWA	X_{FWA} - Feedwater actuator stem position	-	pu
	XSCV	X_{SCV} - Steam control valve actuator stem position	-	pu
	XBDA	X_{BDA} - Blowdown actuator valve stem position	-	pu
	XAVA	X_{AVA} - Attemperator actuator valve stem position	-	pu
	RHOSSH	ρ_{SSH} - Steam density in SSH	-	lb/ft^3
150	VT	V_T - Total boiler/drum circuit fluid volume	-	ft^3
	KMB	K_{MB} - Factor accounting for boiler/drum metal energy storage	-	-
	QRC	Q_{RC} - Heat added by recirculating pump	-	Btu/lb
	VDC	V_{DC} - Downcover fluid volume	-	ft^3
	V4	V_4 - Riser fluid volume	-	ft^3
155	AD	A_D - Drum cross-sectional area	-	ft^2
	LD	L_D - Drum height	-	ft
	LSET	L_{SET} - Drum luquid level set point	-	ft
	PSGSET	P_{SGSET} - Steam SSH exit pressure (or throttle pressure) set point	-	psia
	TSGSET	T_{SGSET} - Steam SSH exit temperature set point	-	°F
160	VPSHO	V_{PSH} - PSH fluid volume	-	ft^3
	KFRPSH	K_{FRPSH} - Friction coefficient, PSH steam flow	-	$\frac{hr^2}{in^2\text{-}ft^3}$

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	KMSPSH	K_{MSPSH} - PSH metal to steam heat transfer coefficient	-	Btu/lb-°F
	MMPSH	M_{MPSH} - PSH metal mass	-	lb
	CMPSH	C_{MPSH} - PSH metal specific heat	-	$\frac{Btu}{lb\text{-}°F}$
165	VSSHO	V_{SSH} - SSH fluid volume	-	ft^3
	KFRSSH	K_{FRSSH} - Friction coefficient, SSH steam flow	-	$\frac{hr^2}{in^2\text{-}ft^3}$
	KMSSSH	K_{MSSSH} - SSH metal to steam heat transfer coefficient	-	$\frac{Btu}{lb\text{-}°F}$
	MMSSH	M_{MSSH} - SSH metal mass	-	lb
	CMSSH	C_{MSSH} - SSH metal specific heat	-	$\frac{Btu}{lb\text{-}°F}$
170	CFWA	C_{FWA} - Feedwater valve time constant (inverse)	-	sec^{-1}
	CFWV	C_{FWV} - Feedwater valve flow characteristic	-	$\frac{pu}{(psia)^{1/2}}$
	CSCVA	C_{SCVA} - Steam valve time constant (inverse)	-	sec^{-1}
	CSCV	C_{SCV} - Steam valve flow characteristic	-	$\frac{pu}{psia\text{-}lb/ft^3}$
	CBDA	C_{BDA} - Blowdown valve time constant (inverse)	-	sec^{-1}
175	CAVA	C_{AVA} - Attemperator valve time constant (inverse)	-	sec^{-1}
	CVAT	C_{VAT} - Attemperator valve flow characteristic	-	$\frac{pu}{(psia)^{1/2}}$

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	CVBD	C_{VBD} - Blowdown valve flow characteristic	-	pu (psia)$^{1/2}$
	KAVP	K_{AVP} - Proportional gain, attemperator controller	-	pu
	KAVI	K_{AVI} - Integral gain, attemperator controller	-	pu
180	KDRUM	K_{DRUM} - Proportional gain, drum level controller	-	pu
	KFWP	K_{FWP} - Proportional gain, feedwater controller	-	pu
	KFWI	K_{FWI} - Integral gain, feedwater controller	-	pu
	KSVP	K_{SVP} - Proportional gain, pressure controller	-	pu
	KSVI	K_{SVI} - Integral gain, pressure controller	-	pu
185	TSSHI	T_{SSHI} - Outlet steam temperature (TSSET)	-	pu
	XAVDOT	$\dot{X}_{AV}$ - Attemperator actuator rate limit	-	pu/sec
	XBDDOT	$\dot{X}_{BD}$ - Blowdown actuator rate limit	-	pu/sec
	XBDH	X_{BDH} - Blowdown valve full open position limit	-	pu
	XBDL	X_{BDL} - Blowdown valve full close position limit	-	pu
190	XFWL	X_{FWL} - Feedwater controller command closed position limit	-	pu

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	XFWH	X_{FWH} - Feedwater controller command open position limit	-	pu
	XFWDOT	$\dot{X}_{FW}$ - Feedwater valve rate limit	-	pu/sec
	XFWAH	X_{FWAH} - Feedwater valve fully open position limit	-	pu
	XFWAL	X_{FWAL} - Feedwater valve fully closed position limit	-	pu
195	XSCVH	X_{SCVH} - Steam valve controller full open position limit	-	pu
	XSCVL	X_{SCVL} - Steam valve controller full closed position limit	-	pu
	XSCDOT	$\dot{X}_{SCV}$ - Steam valve rate limit	-	pu/sec
	XAVAH	X_{AVAH} - Attemperator controller full open position limit	-	pu
	XAVAL	X_{AVAL} - Attemperator controller full closed position limit	-	pu
200	TD1	T_{D1} - Drum saturation temperature polynomial value, $T_D > 250$	-	°F
	TD2	T_{D2} - Drum saturation temperature polynomial value, $T_D \leq 250$	-	°F
	TD	T_D - Saturation temperature in drum/boiler circuit	-	°F
205	-			
	HFG	h_{fg} - Fluid to vapor transition drum fluid enthalpy	-	Btu/lb
	HG	h_g - Vapor enthalpy of drum fluid	-	Btu/lb
	VF	v_f - Specific fluid volume in drum	-	ft^3/lb
	VFG	v_{fg} - Specific volume, fluid/vapor mixture, in drum	-	ft^3/lb

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
210	VG	v_g - Specific volume of drum vapor	-	ft^3/lb
	HDC	h_{DC} - Downcover fluid enthalpy	-	Btu/lb
	X2	X_2 - Downcover fluid quality	-	-
	V2	v_2 - Specific volume of downcover fluid	-	ft^3/lb
	M2	m_2 - Downcover fluid mass	-	lb
215	M3	m_3 - Boiler fluid mass	-	lb
	M4	m_4 - Riser fluid mass	-	lb
	WPSHI	W_{PSHi} - Steam flow into PSH	-	lb/hr
220	BPSH	B_{PSH} - Heat removal rate from PSH metal by steam flow	-	Btu/hr
	HPSODT	$\dot{H}_{PSH}$ - PSH steam enthalpy time rate of change	-	Btu/lb sec
	TPO1	T_{PO1} - PSH temperature polynomial expression value	-	°F
	TPO2	T_{PO2} - PSH temperature polynomial expression value	-	°F
	HATTSO	H_{ATTSO} - Attemperator outlet steam enthalpy	-	Btu/lb
225				
	WSSHI	W_{SSHi} - SSH inlet steam flow	-	lb/hr
	BSSH	B_{SSH} - Heat removal rate from SSH metal by steam flow	-	Btu/hr
	HSSODT	H_{SSO} - SSH steam enthalpy time rate of change	-	Btu/lb sec
230	TSO1	T_{SO1} - SSH outlet temperature polynomial expression value	-	°F

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	TSO2	T_{SO2} - SSH outlet temperature polynomial expression value	-	°F
	XFWAC	X_{FWAC} - Feedwater valve actuator command	-	pu
	XSCVC	X_{SCVC} - Steam control valve actuator command	-	pu
	XAVAC	X_{AVAC} - Attemperator valve actuator command	-	pu
235	QBTO	Q_{BTO} - Initial boiler section heat input	-	%
	QPSHTO	Q_{PSHTO} - Initial PSH section heat input	-	%
	QSSHTO	Q_{SSHTO} - Initial SSH section heat input	-	%
	QBT1	Q_{BT1} - Final boiler section heat input	-	%
	QPSHT1	Q_{PSHT1} - Final PSH section heat input	-	%
240	QSSHT1	Q_{SSGT1} - Final SSH section heat input	-	%
	T1	t_1 - Time to impose change in SGS heat inputs	-	sec
	DPSCV	ΔP_{SCV} - Pressure difference across steam control valve	-	psia
	PSCRAT	P_{RATIO} - Ratio of SCV pressure differential to inlet pressure	-	-
	ZSCV	Z_{SCV} - SCV expansion factor	-	-

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
245	VSCV	v_{SCV} - Steam valve specific volume	-	ft^3/lb
	QRATE	Q_{RATE} - Rate of change of SGS heat input	-	%/min
	QRTO	Q_{RTO} - Total initial heat input to SGS (% full load)	-	%
	TPSMDT	$\dot{T}_{PSHM}$ - PSH metal temperature rate of change	-	°F/hr
	TSSMDT	$\dot{T}_{SSHM}$ - SSH metal temperature rate of change	-	°F/hr
250	RUNNO	RUN NO. - Run number	-	-
	QBPFL	Q_{BFL} - Boiler section heat input	-	%
	QPSPFL	Q_{PSHFL} - PSH section heat input	-	%
	QSSPFL	Q_{SSHPL} - SSH section heat input	-	%
	QTPFL	Q_{TFL} - Total SGS heat input	-	%
255	WTURI	W_{TURi} - SGS steam flow to HP turbine inlet	-	lb/hr
	WTSI	W_{TSi} - SGS steam flow to TSS inlet	-	lb/hr
	PSSH1	P_{SSH} - SSH steam outlet pressure	-	pu
	WSSH1	W_{SSH} - SSH steam outlet flow	-	pu
	ATTS	High speed loop iteration ratio	-	-
260	AR1	α - Boiler density distribution parameter	-	$Btu\text{-}ft^3$ lb^2
	BR1	β - Boiler density distribution parameter	-	$Btu\text{-}ft^3$ lb^2
	KCSBP	K_{CSBP} - CS proportional gain, boiler control	-	pu
	KCSBI	K_{CSBI} - CS integral gain, boiler control	-	pu

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	KCSPSP	K_{CSPSHP} - CS proportional gain, PSH control	-	pu
265	KCSPSI	K_{CSPSHI} - CS integral gain, PSH control	-	pu
	KCSSSP	K_{CSSHP} - CS proportional gain, SSH control	-	pu
	KCSSSI	K_{CSSHI} - CS integral gain, SSH control	-	pu
	QR1	Q_{R1} - Scaled SGS heat input value	-	Btu/hr
	EBUS	E_{BUS} - Total busbar energy delivered	-	MWe
270	PAUX	P_{AUX} - Auxiliary plant power	-	MWe
	ETSST	E_{TSST} - Total change in TSS energy stored	-	Kwe-hr
	PNSGS	P_{NSGS} - Net SGS power delivered	-	Btu/hr
	ESGST	E_{SGST} - Net total SGS energy delivered	-	Kwe-hrs
	TCAV(1)	T_{CAV1} - Receiver cavity (Node 1) ceiling temperature	-	°F
275	TCAV(5)	T_{CAV5} - Receiver cavity (Node 5) aperature temperature	-	°F
	TCAV(6)	T_{CAV6} - Receiver cavity (Node 6) floor temperature	-	°F
	TSTRT	T_{START} - Start true for incident flux reading	-	hrs
	DNI	DNI - Direct Normal Intensity		kw/m^2
	QREDIR	Q_{RED} - Redirected solar power from heliostats	-	Btu/hr

Table 3-3. A-Array Variables for SGS (100, 200 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
280	QBINC	Q_{BINC} - Boiler Incident Power	-	Btu/hr
	QPSINC	Q_{PINC} - PSH incident power	-	Btu/hr
	QSSINC	Q_{SINC} - SSH incident power	-	Btu/hr
	QCINC	Q_{CINC} - Ceiling incident power	-	Btu/hr
	QRFL	Q_{RFL} - SRE SGS rated heat input	-	Btu/hr
285	QRFLPP	Q_{RFLPP} - SPP SGS rated heat input	-	Btu/hr
	PKWSCL	P_{KWSCL} - Kwe scaling of generator	-	Kw

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series)

A ( )	Mnemonic	Parameter Description	Value	Units
300	PLOAD	P_{LOAD} - Full load gross generator output	-	MWe
	PFLOAD	PF_{LOAD} - Power factor of electrical load	-	-
	T2	t_2 - Time of load change	-	sec
	DEMAND	D_{LO} - Initial load demand	-	pu
305				
310	PHPTRA	P_{HPTRA} - Rated (HP) throttle pressure	-	psia
	WHPTRA	W_{HPTRA} - Rated (HP) throttle flow	-	lb/hr
	HHPTRA	H_{HPTRA} - Rated (HP) throttle inlet enthalpy	-	Btu/lb
	P_{LPTRA}	P_{LPTRA} - Rated (LP) admission pressure	-	psia

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	WLPTRA	W_{LPTRA} - Rated (LP) admission steam flow	-	lb/hr
315	HLPTRA	H_{LPTRA} - Rated (LP) admission steam enthalpy	-	Btu/lb
	CVLPOP	C_{VLPOP} - Turbine admission valve full open position limit	-	pu
	CVLPCL	C_{VLPCL} - Turbine admission valve full close position limit	-	pu
	THPSC	τ_{HPSC} - HP steam chest flow true constant	-	sec
320	TSMHPI	τ_{SMHP} - HP throttle valve motor time constant (inverse)	-	sec^{-1}
	CHPPI	C_{HPPI} - HP steam flow mass storage coefficient	-	pu/sec
	CDVHPO	$\dot{C}_{VHPO}$ - Throttle value (HP) opening rate limit	-	pu/sec
	CDVHPC	$\dot{C}_{VHPCL}$ - Throttle value (HP) closing rate limit	-	pu/sec
	CVHPOP	C_{VHPOP} - Turbine throttle value full open position limit	-	pu
325	CVHPCL	C_{VHPCL} - Turbine throttle value full close position limit	-	pu
	CLPPI	C_{LPPI} - LP steam flow mass storage coefficient	-	pu/sec
	CDVLPO	$\dot{C}_{VLPO}$ - Admission value opening rate limit	-	pu/sec
	CDVLPC	C_{VLPCL} - Admission value closing rate limit	-	pu/sec

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	DEMNDF	D_{LF} - Final load demand	-	pu
330	VERHP	V_{ERHP} - Valve error, HP governor motor	-	pu
	CVHP	C_{VHP} - Throttle valve opening area	-	pu
		P_{HPSVi} - Inlet pressure to throttle valve	-	pu
	PHPNCI	P_{HPNCi} - HP nozzle chest inlet pressure	-	pu
335	WHPTI	W_{HPTi} - HP steam flow out of nozzle chest	-	pu
	TMHP	T_{MHP} - Mechanical torque due to HP steam flow	-	pu
	TELEC	T_{ELEC} - Electrical back torque of turbine-generator	-	pu
	TNET	T_{NET} - Net torque (mechanical less electrical)	-	pu
	WR	W_R - Rotor speed, turbine-generator	-	pu
340	PELEC	P_{ELEC} - Generator gross electrical output	-	pu
	DELLOD	S_{LOAD} - Load torque angle	-	rad
	TFWHP	T_{FWHP} - Feedwater temperature HP heater exit	-	°F
	WTFLOI	W_{TFLOi} - Total flow through turbine	-	pu
345	IROT	I_{ROT} - Rotor inertia	-	sec
350	KGOVH	K_{GOVH} - HP governor speed error gain	-	pu

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	KPHP	K_{PHP} - HP governor mass flow feedback gain	-	pu
	KHPPD	K_{HPPD} - HP pipe drop friction coefficient	-	pu
	KPLP	K_{PLP} - LP governor mass flow feedback gain	-	pu
	KLPPD	K_{LPPD} - LP pipe drop friction coefficient	-	pu
355	TDELY	T_{DELY} - Time delay, feedwater enthalpy change	-	sec
	TCON	T_{CON} - Condenser enthalpy change true constant factor	-	sec
	TLPH	T_{LPH} - LP heater enthalpy change true constant factor	-	sec
	TDEAR	T_{DEAR} - Deaerator enthalpy change true constant factor	-	sec
	THPH	T_{HPH} - HP heater enthalpy change true constant factor	-	sec
360	WERHP	W_{ERHP} - Speed error, HP governor	-	pu
	VCOMHP	V_{COMHP} - Valve command, HP governor motor	-	pu
	HHPTI	H_{HPTi} - HP inlet enthalpy	-	pu
365	TMECH	T_{MECH} - Mechanical torque, total	-	pu
	THETRA	θ_{RAT} - Rated load power factor angle	-	rad
	DELRAT	δ_{RAT} - Rated generator torque angle	-	rad

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	PSYNCH	P_{SYNCH} - Synchronizing torque coefficient	-	rad^{-1}
	HTEXO	H_{TEXO} - Exhaust enthalpy	-	Btu/lb
370	THETLD	θ_{LOAD} - Load power factor angle	-	rad
	HSSHOT	H_{SSHOT} - Total HP inlet enthalpy	-	pu
	WERLP	W_{ERLP} - Speed error, LP governor	-	pu
	VCOMLP	V_{COMLP} - Valve command, LP governor motor	-	pu
	VERLP	V_{ERLP} - Valve error, LP governor motor	-	pu
375	CVLP	C_{VLP} - LP admission valve area	-	pu
380				
	PLPNCI	P_{LPNCi} - LP admission chest inlet pressure	-	pu
	WLPTI	W_{LPTi} - Admission inlet steam flow	-	pu
	TMLP	T_{MLP} - Mechanical torque due to LP steam flow	-	pu
385				
	HFW1	H_{FW1} - Undelayed feedwater enthalpy	-	Btu/lb
	HFWP	H_{FWP} - Delayed feedwater enthalpy	-	Btu/lb
	HFWHP	H_{FWHP} - HP feedwater enthalpy	-	Btu/lb
390	HFWLP	H_{FWLP} - LP feedwater enthalpy	-	Btu/lb
	HFWDEA	H_{FWDEA} - Deaerator feedwater enthalpy	-	Btu/lb
	HFWSGS	H_{FWSGS} - Feedwater enthalpy to SGS	-	Btu/lb

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Continued)

A ( )	Mnemonic	Parameter Description	Value	Units
	MWER	MW_{ER} - MWe error (MCS)	-	pu
	MWERI	MW_{ERI} - MWe integral output (MCS)	-	pu
395	MWERT	MW_{ERT} - Total MWe error signal (MCS)	-	pu
	MWERTL	MW_{ERTL} - Total MWe error signal, logged (MCS)	-	pu
	PER	P_{ER} - Pressure error (MCS)	-	pu
	PERI	P_{ERI} - Pressure error integral output (MCS)	-	pu
	PERT	P_{ERT} - Total pressure error signal (MCS)	-	pu
400	PERTL	P_{ERTL} - Total pressure error signal, logged (MCS)	-	pu
	TGPER	TG_{PER} - Pressure error signal contribution to governor	-	pu
	TGMWER	TG_{MWER} - MWe error signal to TG (MCS)	-	pu
	TGCOM	TG_{COM} - Turbine governor command (MCS)	-	pu
405				
	MWELIM	MW_{ELIM} - MWe error limit (MCS)	-	pu
	MWILIM	MW_{ILIM} - MWe integral limit (MCS)	-	pu
	MWETLM	MW_{ETLIM} - Total MWe signal limit (MCS)	-	pu
	PERLIM	P_{ERLIM} - Pressure error signal limit (MCS)	-	pu

Table 3-4. A-Array Variables for EGS, MCS (300, 400 Series) (Concluded)

A ( )	Mnemonic	Parameter Description	Value	Units
410	PILIM	PI_{LIM} - Integral limit, pressure error (MCS)	-	pu
	PETLIM	P_{ETLIM} - Total pressure signal limit (MCS)	-	pu
	SICOML	SI_{COML} - Limit on SI_{COM} (MCS)	-	pu
	TGCOML	TG_{COML} - Limit on TG_{COM} (MCS)	-	pu
	SOCOML	SO_{COML} - Limit on SO_{COM} (MCS)	-	pu
415	KMWP	K_{MWP} - Proportional gain, MWe signal	-	pu
	KMWI	K_{MWI} - Integral gain, MWe signal	-	pu
	KPP	K_{PP} - Proportional gain, pressure error	-	pu
	KPI	K_{PI} - Integral gain, pressure error	-	pu
	FLOEFF	ϵ_{FLO} - Flow efficiency term, mechanical torque	-	-

Table 3-5. A-Array Variables for TSS (500 Series)

A ( )	Mnemonic	Parameter Description	Value	Units
500	PTSO	P_{TSO} - Steam outlet pressure, discharge mode	-	psia
	WTSO	W_{TSO} - Superheater outlet steam flow	-	lb/hr
	HTSO	H_{TSO} - Superheater outlet steam enthalpy	-	Btu/lb
	PTSSET	P_{TSSET} - Superheater outlet pressure setpoint	-	psia
	PTSI	P_{TSi} - Steam inlet pressure to TSS system	-	psia
505	TTSSET	T_{TSSET} - Superheater outlet steam temp. setpoint	-	°F
	HTSI	H_{TSi} - Inlet steam enthalpy	-	Btu/lb
	SICOM	SI_{COM} - "Storage-in" command from MCS	-	pu
	SOCOM	SO_{COM} - "Storage-out" command from MCS	-	pu
	WOILCO	W_{OILCO} - Cold oil flow	-	lb/hr
510	WOILHO	W_{OILHO} - Hot oil flow	-	lb/hr
	WHITEX	W_{HITECX} - HITEC flow into desuperheater	-	lb/hr
	WHITST	$W_{HITECST}$ - HITEC flow into storage	-	lb/hr
	TTSO	T_{TSO} - Superheater steam outlet temperature	-	°F
	WFWTS	W_{FWTS} - Feedwater flow to storage	-	lb/hr

Table 3-5. A-Array Variables for TSS (500 Series) (Concluded)

A ( )	Mnemonic	Parameter Description	Value	Units
515	WATTTS	W_{ATTTS} - Attemperator spray flow (total 1 and 2)	-	lb/hr
	DLTS	d_{TS} - Drum level of liquid in boiler (main set point)	-	in
	TSCHRG	TS_{CHRGE} - TSS charge state	-	%
	THHTC	T_{HHTC} - Hot HITEC temperature	-	°F
	TCHTC	T_{CHTC} - Cold HITEC temperature	-	°F
520	TOIL	T_{OIL} - Oil in storage temperature	-	°F
	PDRUM	P_{DRUM} - Drum pressure	-	psia
	TPREH	T_{PREH} - Preheater exit fluid temperature	-	°F
	TDSHO	T_{DSHO} - Desuperheater exit steam temperature	-	°F

Table 3-6. Example of SPP Dynamic Simulation Summary Printout

SPP POWER LEVELS — SUMMARY OF SPP PERFORMANCE (RUN NO 308.)

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	117.270	146.738	0.	34.37	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	107.433	141.535	-4.472	31.49	41.48	-1.31
EGS	80.223	97.518	-0.000	23.51	28.58	-0.00
TSS	26.117	40.412	0.001	7.65	11.84	0.00
NET TSS POWER TO EGS	13.551	89.263	-0.006	3.97	26.16	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.96	9.98	7.36
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				12355555.	14853.	8.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 6857.6 TO TSS 2232.5 FROM TSS

TOTAL RADIANT ENERGY IN= 10024.4KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9062

NET CHANGE IN TSS ENERGY 1025.82(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.03(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	378.6	394.2	371.9
TD-DRUM TEMP	604.6	612.3	583.3
TPSHO-PSH TEMP OUT	783.3	802.1	751.7
TSSHO-SSH TEMP OUT	957.2	970.0	931.0
TPSHM-PSH METAL TEMP	824.7	849.5	779.6
TSSHM-SSH METAL TEMP	991.0	1010.5	953.6
PSH METAL TEMP RATE	72.3	3107.6	-2246.7
SSH METAL TEMP RATE	64.5	3221.5	-1985.3
PPSHO-PSH PRES.OUT	1536.7	1601.4	1359.6
PSSHO-SSH PRES.OUT	1476.1	1522.5	1359.6
PD-DRUM PRES	1597.0	1685.0	1359.6
DELTA DRUM LEVEL	0.77	4.37	-0.78
PHPNCI-HP NOZ PRES	1451.3	1490.1	1359.6
TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEMP	569.9	570.0	569.9
TOIL-MAIN OIL TEMP	479.9	480.0	479.9
DDRUM-DELTA DRUM LEV	0.2	0.4	-0.2
PDRUM-DRUM PRESSURE	587.5	600.5	560.5
TPREH-PREHEATER TEMP	480.9	484.1	472.2
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.7838	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	50.0979	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	25.1866	31.5154	0.
QRDP-REDIRECTED POWER TO PSH(MWT)	5.7496	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	4.5314	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	4.1801	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	39.6476	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	23.9519	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	5.7923	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	4.6277	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	4.3024	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1497	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	38.8240	48.5795	0.
QABPEB-BOILER ABSORBED POWER(% OF DESIGN MAX)	52.0453	65.1230	0.
QABPEP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5861	15.7487	0.
QABPES-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	10.0556	12.5823	0.
QABPET-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	74.687	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.759	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.743	0.776	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.939	0.980	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.000	31.495	-31.496
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.000	12.180	-12.179
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	11.625	-11.625
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.000	49.637	-49.636
TCAV1-CEILING TEMPERATURE(DEG-F)	1181.4	1445.1	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.2	652.6	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 14.626

REDIRECTED ENERGY(MWT-HRS),TOTAL= 11.57BOILER= 7.35PSH= 1.68SSH= 1.32CEILING= 1.22

ABSORBED ENERGY(MWT-HRS),BOILER= 6.99PSH= 1.69SSH= 1.35CEILING= 1.26FLOOR= 0.04TOTAL= 11.33

Table 3-7. Summary Description of Statistical Parameters Computed

	SPP Power Levels	
1.	Gross SGS Input Power	Absorbed power input to SGS
2.	Net output power of SGS	Net thermodynamic power (ΔWH) of SGS (total, to EGS, to TSS)
3.	Net TSS power to EGS	Net thermodynamic power (ΔWH) of TSS to EGS
4.	EGS Generator output	Gross generator electrical power output
5.	Gross Cycle Heat rate	Sum of power delivered by TSS and SGS, divided by gross generator power
6.	Total net energy delivered	Total net thermodynamic energy delivered from a) SGS to EGS, b) SGS to TSS, c) TSS to EGS
7.	Total radiant energy in	Total absorbed power of SGS (Efficiency = thermodynamic energy delivered by TSS and SGS to EGS, less piping losses, divided by SGS absorbed energy)
8.	Net Change in TSS Energy	Net change in thermodynamic energy of TSS
9.	Total electrical energy generated	Time integral of busbar power delivered by plant
	SGS Performance	
	(Self Explanatory)	
	TSS Performance	
	(Self Explanatory)	
	Miscellaneous Receiver Cavity Terms	
1.	DNI - Direct normal intensity	Available direct normal intensity entering heliostat mirrors
2.	QINC - Incident available power	Available direct normal power (DNI x Mirror area)
3.	Redirected power	Solar power incident on receiver after tracking reflectance, etc., losses
4.	Absorbed power	Total absorbed power on receiver surfaces
5.	Absorbed power percentages	Absorbed powers as percentages of SGS design maximum
6.	Absorbed power rates of change	Rate of change of absorbed power or surfaces, based upon maximum design value
7.	Cavity ceiling, floor temperatures	Temperatures of materials at cavity ceiling, floor
8.	Available direct normal energy	Time integral of direct normal available power (No. 2 above)
9.	Redirected energy	Time integral of redirected power to various receiver surfaces
10.	Absorbed energy	Time integral of receiver absorbed powers

Up to 14 plots may be selected for automatic (CALCOMP) plotting of each run's results. Table 3-8 lists these parameters, their respective measurement units, and the computer variable. These same parameters may also be listed on the line printer output at the user's option.

Table 3-8. SPP Dynamic Simulation Plot Parameters

Plot No.	Computer Mnemonic	Parameter	Subsystem	Units	Computer Equation
1	PDA	P_D - Drum Pressure	SGS	MPa	[A(138)] (0.006895)
	WDA	W_D - Drum Steam Flow	SGS	Kg/hr	[A(101)] (0.4536)
	WFWA	W_{FW} - Feedwater Flow into drum	SGS	Kg/hr	[A(100)] (0.4536)
	WATTSA	W_{ATTSP} - Attemperator spray flow	SGS	Kg/hr	[A(118)]·(0.4536)
2	TPSHMA	T_{PSHM} - PSH Metal Temperature	SGS	Deg-C	[A(128)-32.0](5/9)
	TPSHOA	T_{PSHO} - PSH outlet steam temperature	SGS	Deg-C	[A(135)-32.0](5/9)
	TSSHMA	T_{SSHM} - SSH Metal Temperature	SGS	Deg-C	[A(113)-32.0)] (5/9)
	TSSHOA	T_{SSHO} - SSH outlet steam temperature	SGS	Deg-C	[A(136)-32.0)] (5/9)
3	QRA	Q_R - Total absorbed power input (5)	CS	MWt	[A(268)] (0.05862) (10^{-6})
	MWEA	MWe - Net busbar electrical power	EGS	MWe	[A(340)] (14.633)- [A(270)]
	EGENA	E_{GEN} - Net generat ed electrical energy	EGS	MWe-hrs	A(269)
	ETSSAA	E_{TSS} - Net change in TSS stored energy	TSS	MWt-hrs	[A(271)]/1000
4	CVHPA	C_{VHP} - HP governor throttle valve position	EGS	pu	A(331)
	CVLPA	C_{VLP} - LP governor valve position	EGS	pu	A(375)
	WHPTIA	W_{HPTi} - HP turbine inlet flow	EGS	Kg/hr	[A(335)] [A(311)][(0.4536)]
	WLPTIA	W_{LPTi} - LP turbine inlet flow	EGS	Kg/hr	[A(383)] [A(311)][(0.4536)]
5	QBA	Q_B - Boiler absorbed heat input	CS	% (of total)	A(251)
	QPSHA	Q_{PSH} - PSH absorbed heat input	CS	% (of total)	A(252)
	QSSHA	Q_{SSH} - SSH absorbed heat input	CS	% (of total)	A(253)
	QTA	Q_R - Total absorbed heat input	CS	% (of design max)	A(254)
6	TPSMDA	T_{PSHM} - PSH metal temperature rate of change	SGS	deg-C/hr	[A(248)-32.0](5/9)
	TSSMDA	T_{SSHM} - SSH metal temperature rate of change	SGS	deg-C/hr	[A(249)-32.0] (5/9)
	LA	Δ - SGS drum level deviation from set point	SGS	cm	[A(144)-A(157)] (30.48)
7	WSGOA	W_{SGO} - Outlet steam flow	SGS	Kg/hr	[A(111)] (0.4536)
	PSGOA	P_{SGO} - Outlet steam pressure	SGS	Mpa	[A(119)] (0.006895)
	TSGOA	T_{SGO} - Outlet steam temperature	SGS	deg-C	[A(136)-32.0] (5/9)
	PHPNCA	P_{HPNCi} - Throttle pressure	EGS	MPa	[A(333)] [A(310)] (0.006895)
8	THPFWA	T_{HPFW} - HP heater outlet feedwater temperature	EGS	deg-C	[A(342)-32.0](5/9)
	DLTSA	Δd - Drum level deviation drum setpoint	TSS	cm	[A(516)] (2.54)
	WFWTSA	W_{FWTSS} - Feedwater flow into TSS preheater	TSS	Kg/hr	[A(514)] (0.4536)
	WATTTSA	W_{ATTS} - Total attemperator spray flow	TSS	Kg/hr	[A(515)] (0.4536)
9	PTSOA	P_{TSO} - Outlet steam pressure	TSS	MPa	[A(500)] (0.006895)
	TTSOA	T_{TSO} - Outlet steam temperature	TSS	deg-C	[A(513)-32.0](5/9)
	WTSOA	W_{TSO} - Outlet steam flow	TSS	Kg/hr	[A(501)] (0.4536)
	WTSIA	W_{TSi} - Charge steam flow in	TSS	Kg/hr	[A(256)] (0.4536)
10	WOILCA	W_{OILC} - Cold oil flow	TSS	% (of design)	[A(509)] (7.77) (10^{-5})
	WOILHA	T_{OILC} - Oil temperature, cold side	TSS	% (of design)	[A(520)] (0.17301)
	WHITEA	W_{HS} - HITEC flow	TSS	% (of design)	[A(511)] (0.000602)
	WHITSA	T_{HIT} - Hot HITEC temperature	TSS	% (of design)	[A(518)] (0.117647)

Table 3-8. SPP Dynamic Simulation Plot Parameters (Concluded)

Plot No.	Computer Mnemonic	Parameter	Subsystem	Units	Computer Equation
11	MWERTA	MW_{ERTL} - Integrated megawatt error	MCS	pu	A(396)
	PERTLA	P_{ERTL} - Integrated pressure error	MCS	pu	A(400)
	SOCOMA	SO_{COM} - "Storage-out" command	MCS	pu	A(508)
	SICOMA	SI_{COM} - "Storage-in" command	MCS	pu	A(507)
	DEMHPA	TG_{COM} - Turbine governor command	MCS	pu	A(404)
12	MWDEMA	MW_{DEM} - Megawatt demand (gross)	MCS	pu	A(303)
	PSGSTA	P_{SGST} - SGS net power delivered	SGS	MWt	[A(272)] (0.2931) (10^{-6})
	ESGSTA	E_{SGST} - Net SGS energy delivered	SGS	MWt-hrs	A(273)
13	QINCA	Q_{INC} - Available incident solar power	CS	MWt	[A(278)] (63.92)
	QRDAA	Q_{REDIR} - Redirected solar power into cavity	CS	MWt	[A(279)] (0.2931) (10^{-6})
	QRABA	Q_R - SGS absorbed power	CS	MWt	[A(268)] (0.2931) (10^{-6})
	QRABPA	Q_{RP} - SGS absorbed power to incident power ratio	CS	%	[A(268)] (4.5854) (10^{-7})/ [A(278)]
14	QRDA	Q_{REDIR} - Redirected/incident power ratio	CS	%	[A(279)] (0.02931)/ [A(278)]
	QBINCA	Q_{BINC} - Boiler absorbed/cavity incident power ratio	CS	%	[A(280)] (100)/[A(279)]
	QPINCA	Q_{PINC} - PSH absorbed/cavity incident power ratio	CS	%	[A(281)] (100)/[A(279)]
	QSINCA	Q_{SINC} - SSH absorbed/cavity incident power ratio	CS	%	[A(283)](100)/ [A(279)]
	QCINCA	Q_{CINC} - Ceiling absorbed/cavity incident power ratio	CS	%	[A(283)](100)/ [A(279)]

SECTION 4
COMPUTER RUN RESULTS

A series of computer simulation runs were made to examine overall pilot plant performance. These performance results are summarized at the completion of each run by various optimal usages of line printer outputs and computer generated (CALCOMP) plots. Selected results of the various runs are contained in this section. Section 4 of Book 1 of this Volume provides analysis of these results and also presents some summarizing results data.

Table 4-1 is a summary of computer runs made using the SPP Dynamic Simulation. Initial conditions for these runs are shown in Table 4-2. Run results are contained in increasing order of run numbers. For each run, the results include:

- Statistical Summary Printout
- CALCOMP plots

Table 4-1. Run Schedule for SPP Dynamic Simulation Computer Results

Run No.	Run Type	Run Time	Run Description	Speed Km/hr (mph)	Length Km (mi)	Approach Direction	Field Coverage	Data Tape Hour (Hrs)
300	Plant Startup	200 min	Variable pressure startup from 1379 (200 psia)/ 193°C (380°F)	←	NA			→
302	Cloud Transient	18 min	Cloud from West, entering	11.4 (7.1)	1.8 (1.12)	W	All	25.2
303		18 min		11.4 (7.1)	1.8 (1.12)	W	N-1/2	24.2
304		18 min		11.4 (7.1)	1.8 (1.12)	W	S-1/2	26.2
305		18 min	(Varying cloud speeds, lengths, field coverages)	21.9 (13.6)	1.8 (1.12)	W	N-1/2	31.2
306		12 min		21.9 (13.6)	1.8 (1.12)	W	S-1/2	33.2
307		12 min		32.9 (20.4)	1.8 (1.12)	W	All	39.2
308		18 min		11.4 (7.1)	0.67 (0.42)	W	All	4.2
309		14 min		32.9 (20.4)	0.67 (0.42)	W	All	18.2
311		18 min	Cloud from North, entering field at t=3 min	11.4 (7.1)	1.8 (1.12)	N	All	22.2
312		18 min	Cloud from South, entering field at t=3 min	11.4 (7.1)	1.8 (1.12)	S	All	28.2
313	Load Demand Changes	35 min	Starting at t=2 min, ramp demand up at 4%/min from 7 to 12 MWe; ramp back down starting at t=18 min	←	NA			→
314	Failure Effects	7 min	Recirculating pump flow rate in SGS reduced 50% at t=2 min	←	NA			→
315		7 min	HP heater failure; feed-water temperature goes to 149 deg-C (300 deg-F) at t=2 min	←	NA			→
316		7 min	Collector field failure - solar incident power on boiler only reduced by 20% at t=2 min	←	NA			→
317	Cloud Transient	138 min	Plant operation for cloud corrupted day starting at hour 4643.3 on Sandia data tape	←	NA			→

Table 4-2. Initial Parameter Data for SPP Dynamic Simulation Computer Run Results

Parameter	Units		Parameter Values	
	SI	English	Run 300	All Others
Program Data				
ΔT - Basic Iteration Step Size	Sec		1.0	
ΔHS - High Speed Iteration Rate	-		X15	
SGS				
L_{SET} - Drum Level Set point*	m	(ft)	1.52 (5.0)	
P_{SGSET} - Throttle pressure set point	Mpa	(psia)	1.38 (200)	10.1 (1465.0)
T_{SGSET} - Temperature set point, steam outlet	deg-C	(deg-F)	513 (955)	
H_{FW} - Feedwater enthalpy*	Kjoules/Kg	(Btu/lb)	930.2 (400.0)	888.8 (382.2)
H_A - Average drum/boiler enthalpy*	Kjoules/Kg	(Btu/lb)	852.0 (366.4)	1517.3 (652.5)
H_2 - Downcover enthalpy*	Kjoules/Kg	(Btu/lb)	844.6 (363.2)	1414.8 (608.4)
H_{PSHO} - PSH outlet enthalpy*	Kjoules/Kg	(Btu/lb)	2790.5 (1200.0)	3104.4 (1335.0)
H_{SSHO} - SSH outlet enthalpy*	Kjoules/Kg	(Btu/lb)	2790.5 (1200.0)	3362.5 (1446.0)
$_F$ - Average drum/boiler density*	Kg/M^3	(lb/ft^3)	560.7 (35.0)	464.6 (29.0)
P_{FW} - Feedwater pressure*	MPa	(psia)	13.2 (1915.0)	
W_{SSHO} - Steam flow*	Kg/hr	(lb/hr)	0 (0)	5661.0 (12,480)
W_{ATTSP} - Attemperator Flow*	Kg/hr	(lb/hr)	0 (0)	110.2 (243.0)
T_{PSHM} - PSH Metal temperature*	deg-C	(deg-F)	193.3 (380.0)	432.8 (811.0)
T_{SSHM} - SSH Metal temperature*	deg-C	(deg-F)	139.3 (380.0)	518.7 (965.7)
K_{AVP} - Attemperator controller proportional gain*	-	-	20.0	
K_{AVI} - Attemperator controller integral gain*	-	-	0.08	
K_{FWP} - Feedwater controller proportional gain*	-	-	5.0	
K_{FWI} - Feedwater controller integral gain*	-	-	0.05	
X_{FWA} - Feedwater valve opening*	pu	-	0	0.677
X_{AVA} - Attemperator valve opening*	pu	-	0	0.1
EGS				
Demand for load	pu			0.62
Load	pu			0.62
TSS				
P_{TSO} - TSS outlet steam pressure	MPa	(psia)	3.41 (495.0)	
W_{TSO} - Outlet steam flow	Kg/hr	(lb/hr)	0 (0)	
H_{TSO} - Outlet steam enthalpy	Kjoules/Kg	(Btu/lb)	3204.4 (1378.0)	
W_{TSi} - Inlet steam flow	Kg/hr	(lb/hr)	0 (0)	2116.0 (4665.0)
P_{TSSET} - Pressure set point	MPa	(psia)	3.62 (525.0)	
T_{TSET} - Temperature set point	deg-C	(deg-F)	387.8 (730.0)	

Run No.	300
Type of Run	Morning Plant Start-up
Run Length	200 min
Run Description	Variable pressure startup from "hot" conditions (1.38MPa (200 psia)/139°C (380°F)) condition

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	66.872	115.119	0.253	19.60	33.74	0.07
NET OUTPUT POWER OF SGS TO-						
TOTAL	61.134	109.060	-1.403	17.92	31.97	-0.41
EGS	59.567	106.292	0.021	17.46	31.15	0.01
TSS	0.	0.	0.	0.	0.	0.
NET TSS POWER TO EGS	0.000	3.256	0.	0.00	0.95	0.
EGS GROSS GENERATOR OUTPUT(MWE)=				5.37	10.47	0.00
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				88582596.	13336.	9869.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 57997.3 TO TSS 0. FROM TSS

TOTAL RADIANT ENERGY IN= 65109.7KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.8902

NET CHANGE IN TSS ENERGY -0.28(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 11.21(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	320.1	382.1	261.6
TD-DRUM TEMP	482.4	567.4	352.5
TPSHO-PSH TEMP OUT	792.8	921.2	379.0
TSSHO-SSH TEMP OUT	886.8	980.4	379.0
TPSHM-PSH METAL TEMP	834.2	973.1	380.0
TSSHM-SSH METAL TEMP	917.9	1019.5	379.2
PSH METAL TEMP RATE	148.8	3048.5	-167.0
SSH METAL TEMP RATE	192.5	1479.9	-50.2
PPSHO-PSH PRES.OUT	634.4	1137.6	141.7
PSSHO-SSH PRES.OUT	595.1	1069.5	141.1
PD-DRUM PRES	671.8	1203.3	142.3
DELTA DRUM LEVEL	-0.18	7.58	-4.63
PHPNCI-HP NOZ PRES	580.8	1034.1	141.1

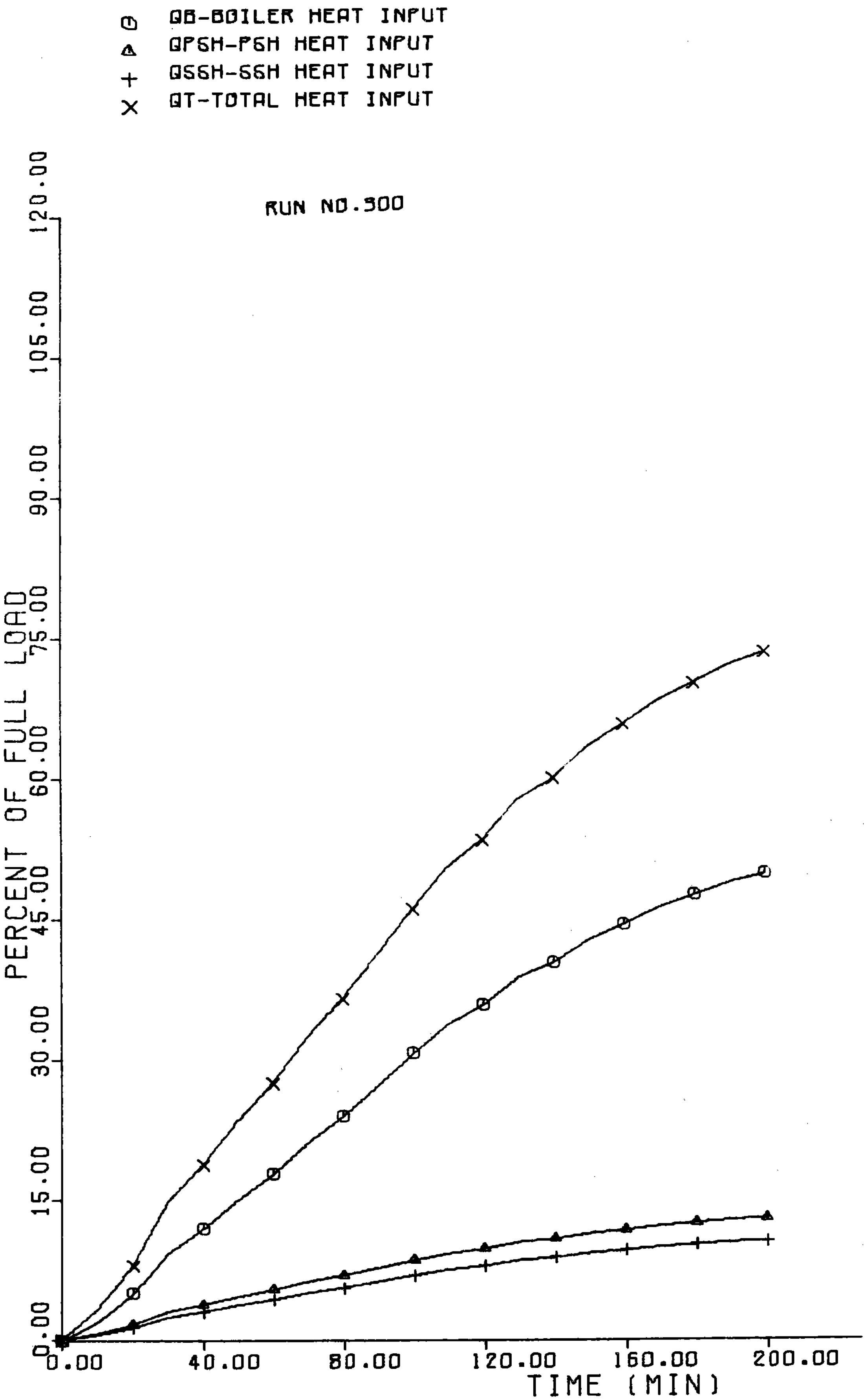
TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

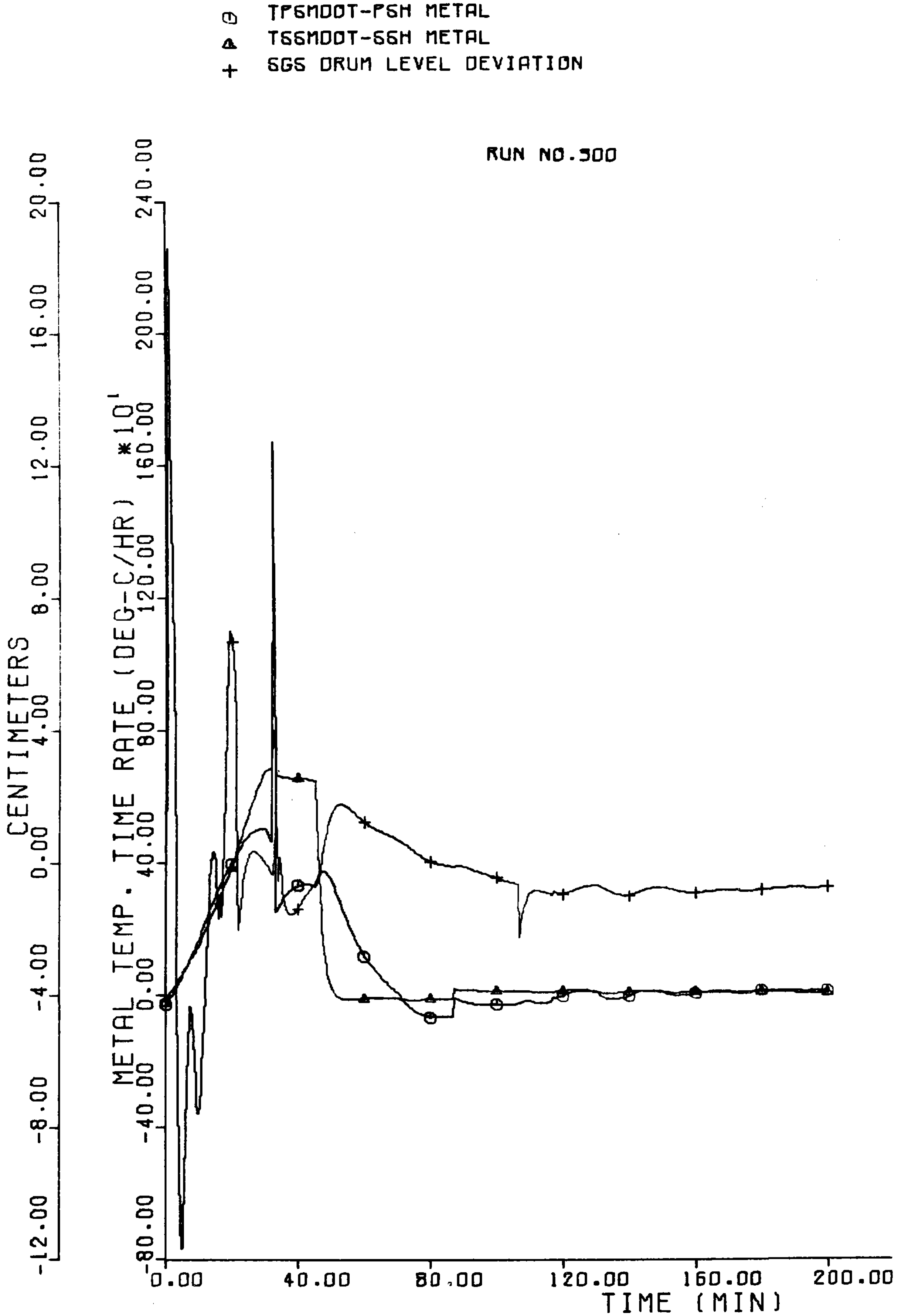
MISCELLANEOUS RECEIVER CAVITY TERMS

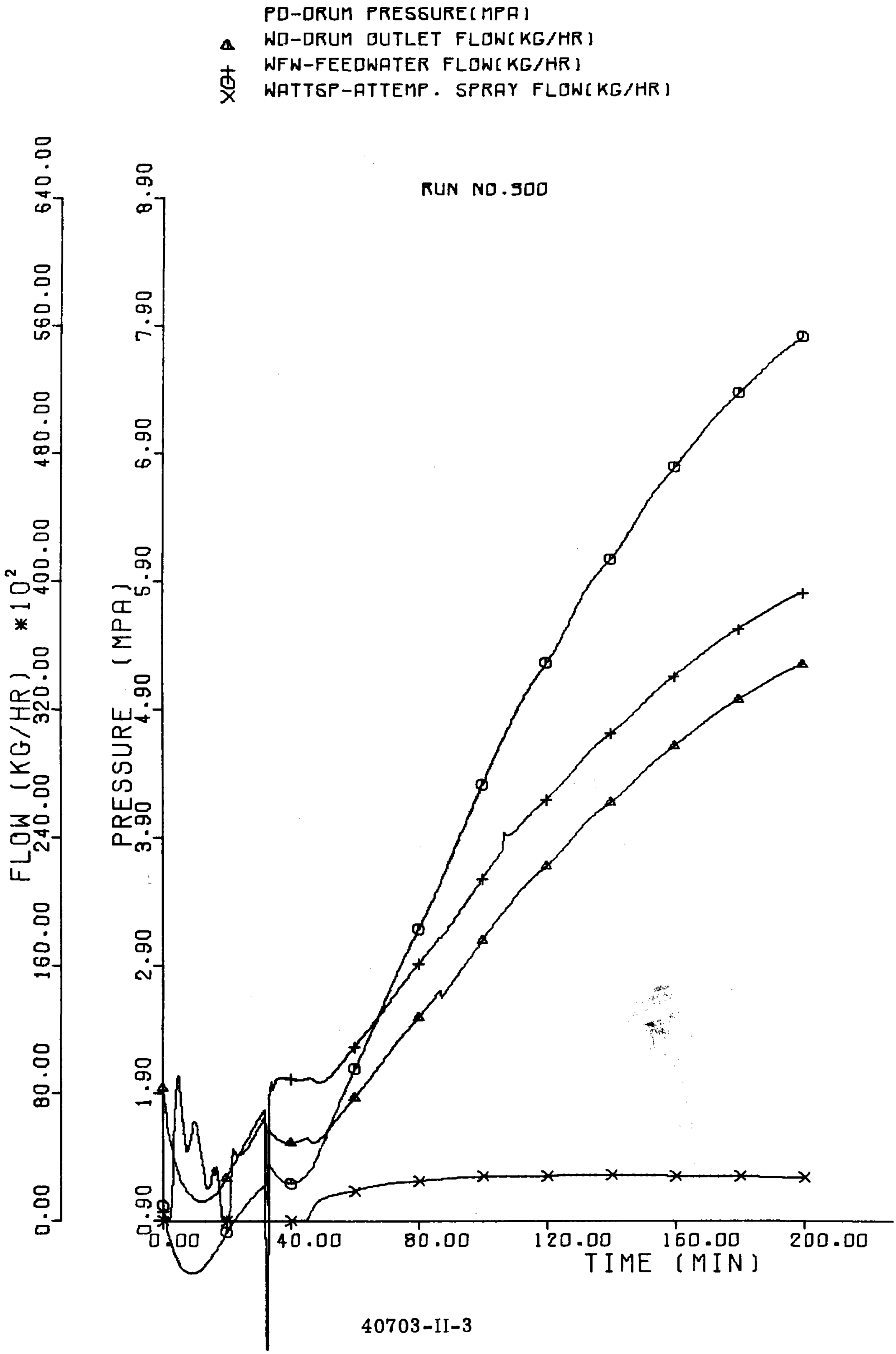
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.6167	0.8583	0.0085
QINC-INCIDENT AVAILABLE POWER(MWT)	39.4186	54.8611	0.5456
QRDB-REDIRECTED POWER TO BOILER(MWT)	13.7589	24.0669	0.0489
QBDP-REDIRECTED POWER TO PSH(MWT)	3.5751	5.9453	0.0153
QRDS-REDIRECTED POWER TO SSH(MWT)	2.8675	4.7776	0.0121
QRDC-REDIRECTED POWER TO CEILING(MWT)	2.6518	4.4170	0.0112
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	22.8534	39.2068	0.0874
QABB-ABSORBED POWER ON BOILER(MWT)	13.1098	22.9149	0.0467
QABP-ABSORBED POWER ON PSH(MWT)	3.5794	5.9679	0.0151
QABS-ABSORBED POWER ON SSH(MWT)	2.9111	4.8587	0.0122
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	2.7059	4.5182	0.0113
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.0842	0.1457	0.0003
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	22.3904	38.4054	0.0857
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	28.4863	49.7918	0.1015
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.7776	12.9676	0.0329
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	6.3256	10.5575	0.0266
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	42.590	73.317	0.161
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.523	0.715	0.160
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.513	0.700	0.157
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.980	0.980	0.980
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.249	0.479	0.092
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.065	0.151	0.021
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.053	0.121	0.017
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.367	0.752	0.131
TCAV1-CEILING TEMPEPATURE(DEG-F)	1563.8	3695.6	380.0
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	385.6	396.0	380.0

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 131.078
REDIRECTED ENERGY(MWT-HRS),TOTAL= 75.993OILER= 45.75PSH= 11.89SSH= 9.54CEILING= 8.82
ABSORBED ENERGY(MWT-HRS),BOILER= 43.59PSH= 11.90SSH= 9.68CEILING= 9.00FLOOR= 0.28TOTAL= 74.45

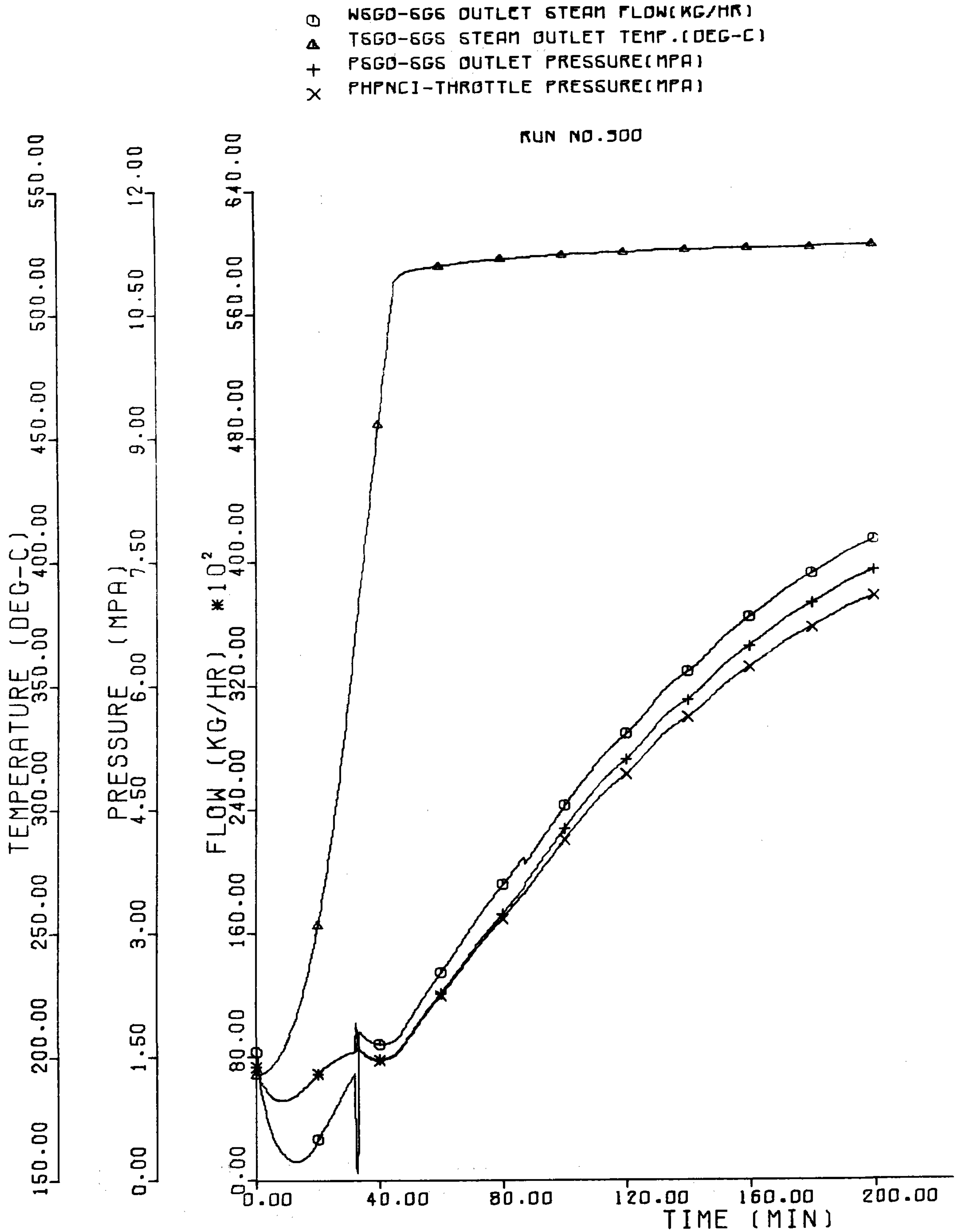
407D-11-3

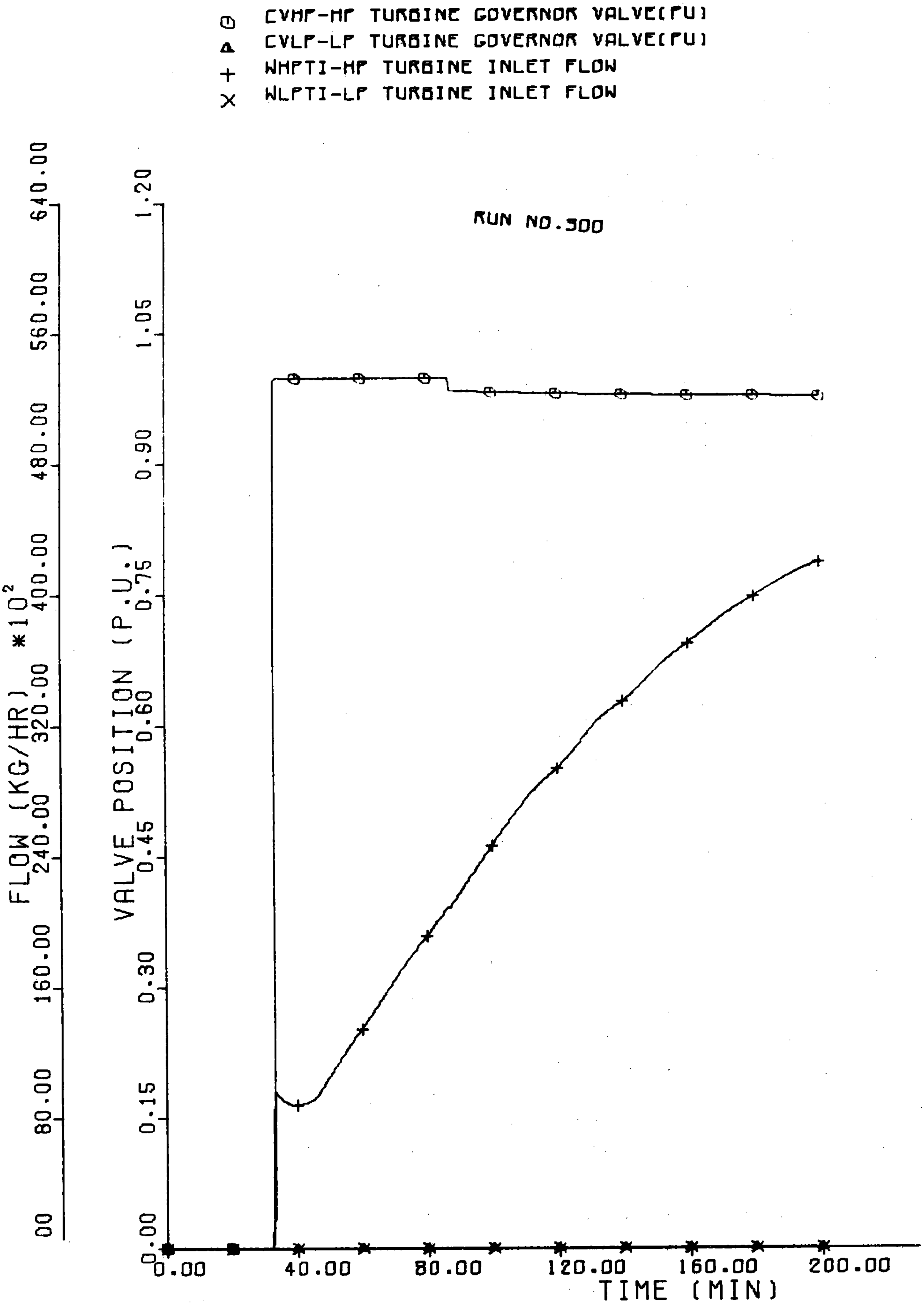

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.300
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
40.00
80.00
120.00
160.00
200.00
TIME (MIN)

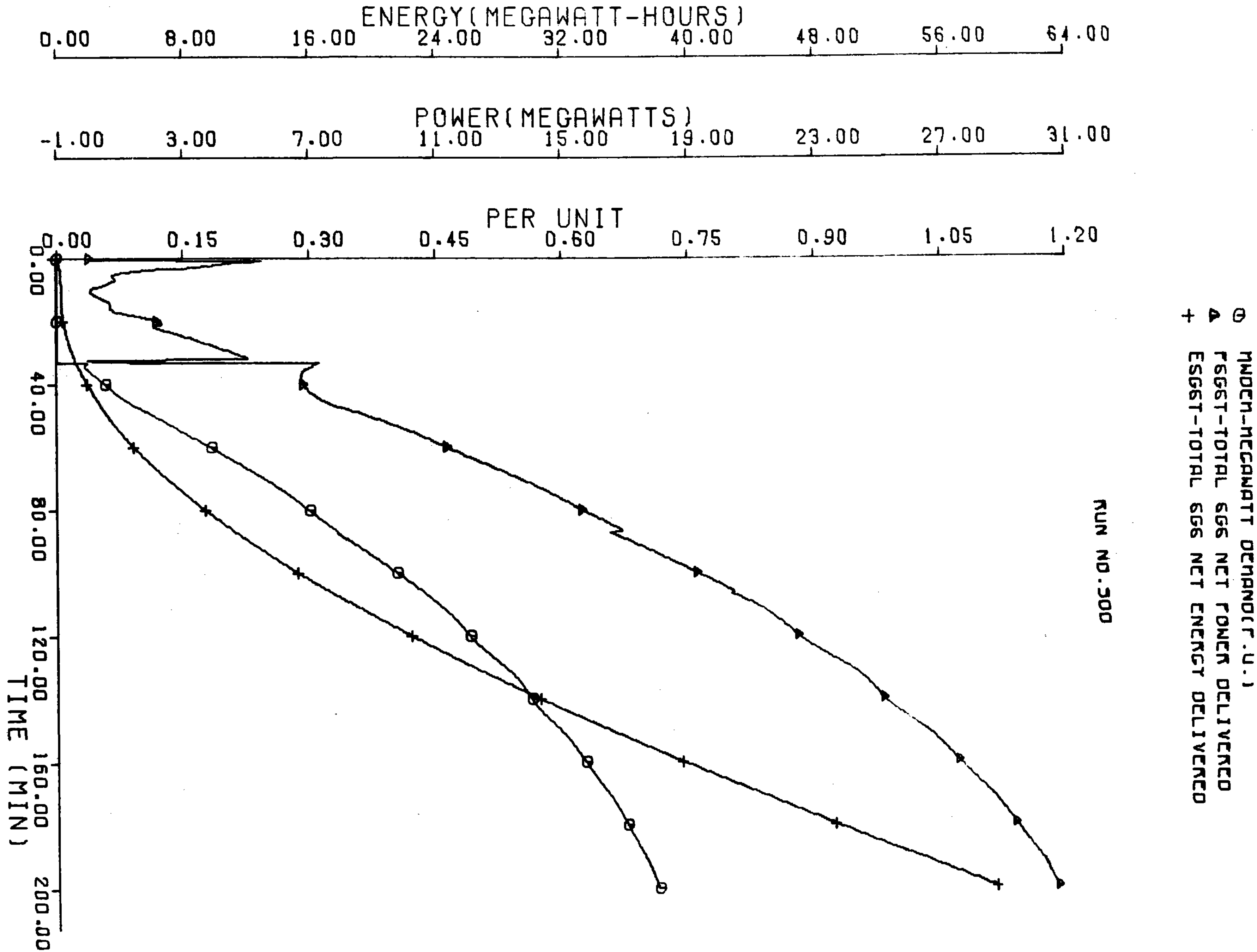

TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.300
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00
-80.00
-40.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
0.00
40.00
80.00
120.00
160.00
200.00


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.500
FLOW (KG/HR) *10²
PRESSURE (MPA)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.90
1.90
2.90
3.90
4.90
5.90
6.90
7.90
8.90
0.00
40.00
80.00
120.00
160.00
200.00

40703-II-3

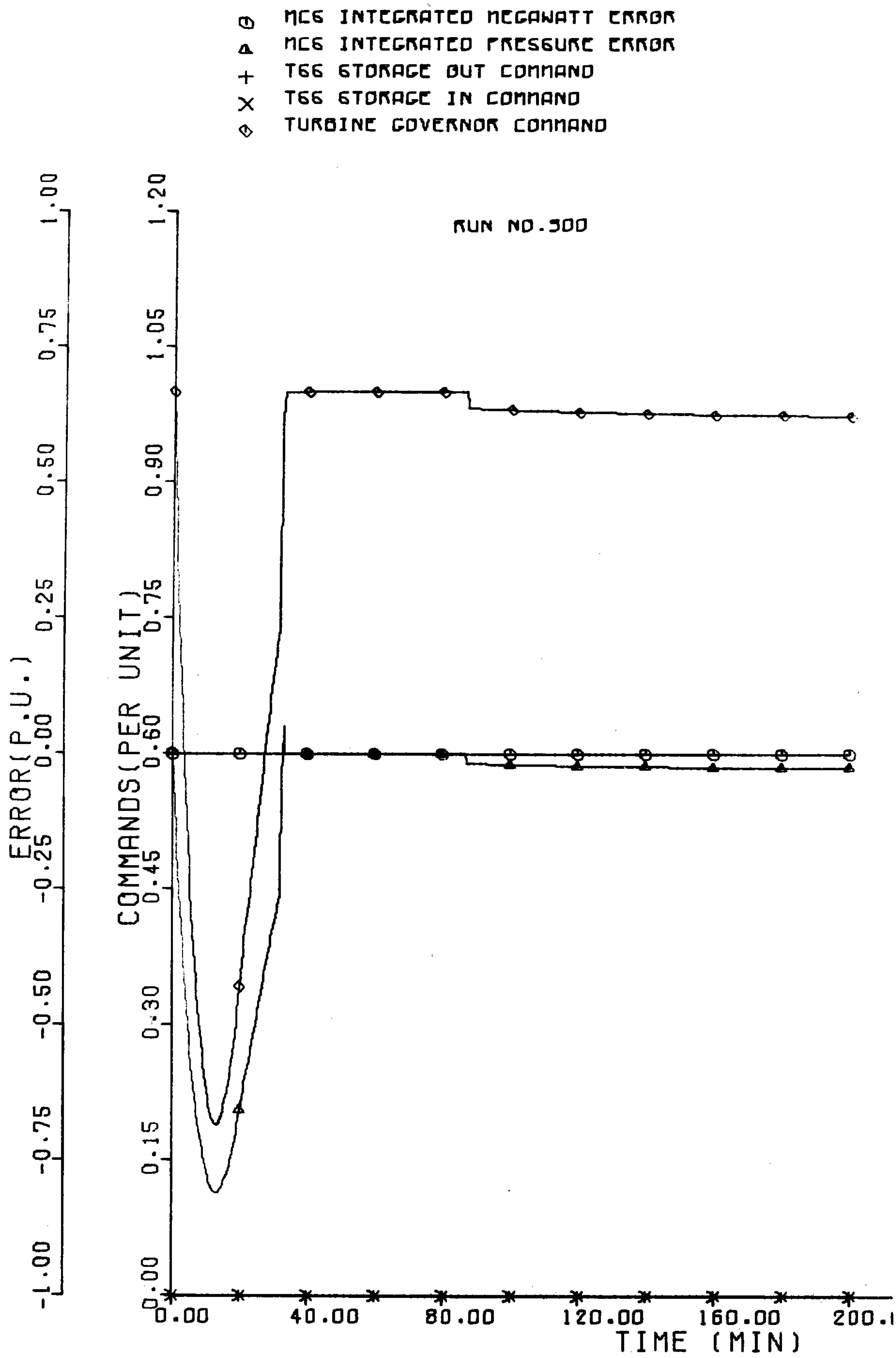

W6GO-6G6 OUTLET STEAM FLOW(KG/HR)
T6GO-6GS STEAM OUTLET TEMP.(DEG-C)
P6GO-6GS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.300
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10²
TIME (MIN)
150.00
200.00
250.00
300.00
350.00
400.00
450.00
500.00
550.00
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
40.00
80.00
120.00
160.00
200.00

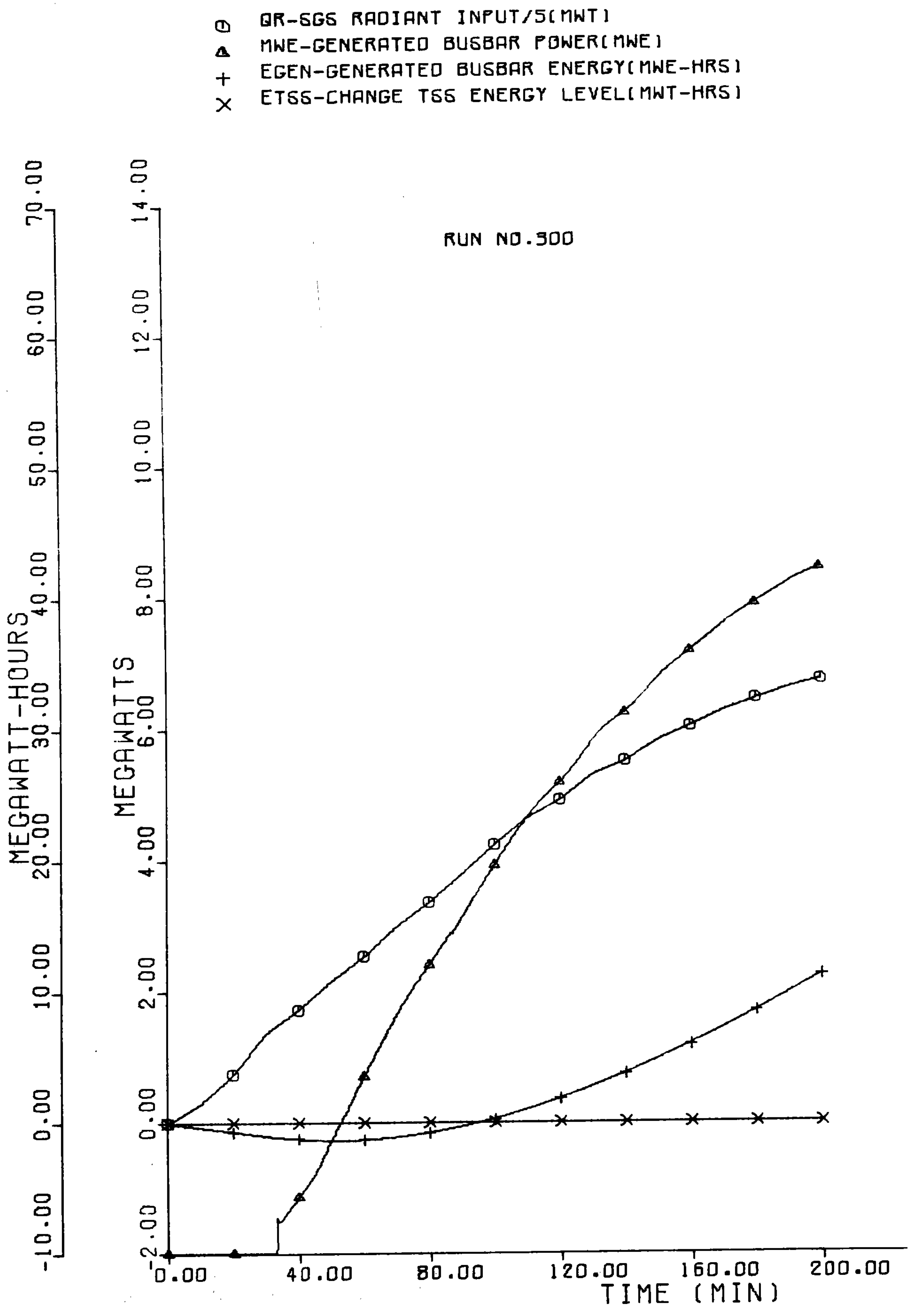

CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.300
FLOW (KG/HR) *10^2
VALVE POSITION (P.U.)
TIME (MIN)
0.00
40.00
80.00
120.00
160.00
200.00
00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20

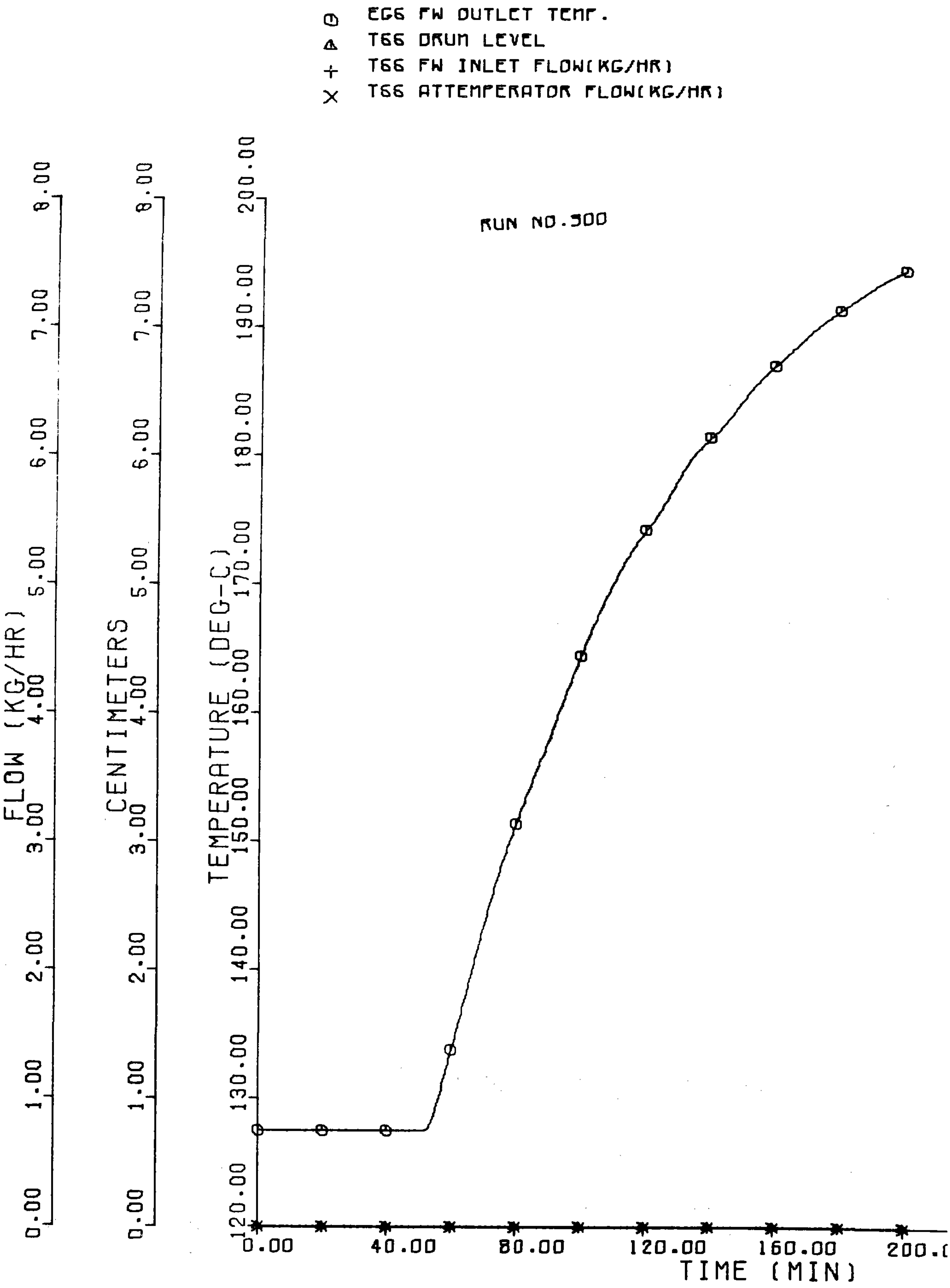


ENERGY(MEGAWATT-HOURS)
0.00 8.00 16.00 24.00 32.00 40.00 48.00 56.00 64.00
POWER(MEGAWATTS)
-1.00 3.00 7.00 11.00 15.00 19.00 23.00 27.00 31.00
PER UNIT
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20
TIME (MIN)
0.00 40.00 80.00 120.00 160.00 200.00
RUN NO.300
Θ MWDEM-MEGAWATT DEMAND(P.U.)
▲ PSGST-TOTAL SGS NET POWER DELIVERED
+ ESGST-TOTAL SGS NET ENERGY DELIVERED

40703-II-3


MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.300
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
40.00
80.00
120.00
160.00
200.


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.300
MEGAWATT-HOURS
MEGAWATTS
TIME (MIN)
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
-2.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
40.00
80.00
120.00
160.00
200.00


EGG FW OUTLET TEMP.
TGG DRUM LEVEL
TGG FW INLET FLOW(KG/HR)
TGG ATTEMPERATOR FLOW(KG/HR)
RUN NO.300
FLOW (KG/HR)
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
120.00
130.00
140.00
150.00
160.00
170.00
180.00
190.00
200.00
40.00
80.00
120.00
160.00

Run No.	302
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Westernly approaching cloud entering field at t=3 min: Speed = 11.4 Km/hr (7.1 mph) Length = 1.8 Km (1.12 mi) Field Coverage: Entire field

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	67.765	146.738	0.	19.86	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	62.436	141.627	-4.295	18.30	41.51	-1.26
EGS	48.735	99.727	-0.000	14.28	29.23	-0.00
TSS	12.933	39.034	0.000	3.79	11.44	0.00
NET TSS POWER TO EGS	43.825	90.225	-0.009	12.85	26.45	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.90	10.22	7.38
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				7126751.	14914.	0.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 4166.0 TO TSS 1105.5 FROM TSS

TOTAL RADIANT ENERGY IN= 5792.7KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9094

NET CHANGE IN TSS ENERGY -2659.46(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.02(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

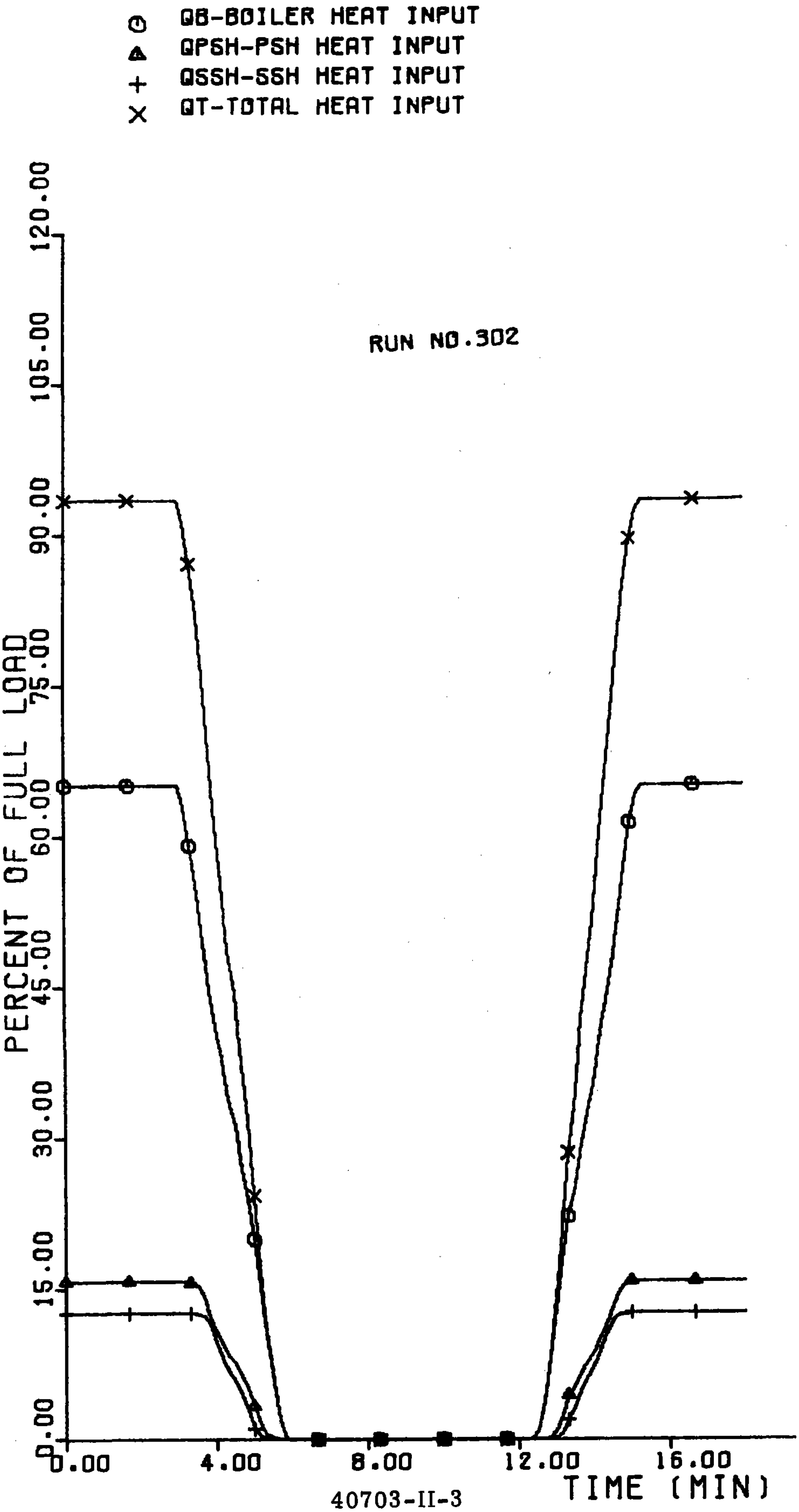
SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	387.0	399.3	371.3
TD-DRUM TEMP	596.9	614.6	583.4
TPSHO-PSH TEMP OUT	775.6	798.3	750.4
TSSHO-SSH TEMP OUT	952.4	970.2	927.6
TPSHM-PSH METAL TEMP	806.1	845.3	778.5
TSSHM-SSH METAL TEMP	976.6	1009.7	950.5
PSH METAL TEMP RATE	61.8	3011.0	-2283.9
SSH METAL TEMP RATE	76.7	3392.6	-1984.3
PPSHO-PSH PRES.OUT	1476.4	1630.6	1360.7
PSSHO-SSH PRES.OUT	1443.2	1554.5	1360.7
PD-DRUM PRES	1509.7	1713.1	1360.7
DELTA DRUM LEVEL	2.29	5.61	-1.58
PHPNCI-HP NOZ PRES	1428.6	1520.4	1360.7

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.1	570.2	569.9
TOIL-MAIN OIL TEMP	479.9	480.0	479.8
DDRUM-DELTA DRUM LEV	0.1	0.4	-0.2
PDRUM-DRUM PRESSURE	575.5	611.8	560.3
TPREH-PREHEATER TEMP	477.5	485.5	472.5
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ)	0.4529	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	28.9494	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	14.5542	31.5154	0.
QRDP-REDIRECTED POWER TO PSH(MWT)	3.3224	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	2.6185	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	2.4155	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	22.9106	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	13.8408	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	3.3471	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	2.6741	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	2.4861	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.0865	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	22.4347	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	30.0746	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.2729	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	5.8107	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	43.158	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.492	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.482	0.776	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.609	0.980	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	31.515	-31.515
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	-0.000	12.187	-12.187
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.000	11.633	-11.633
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	-0.000	49.626	-49.669
TCAV1-CEILING MPERATURE(DEG-F)	1113.8	1249.7	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.8	651.5	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 8.452
REDIRECTED ENERGY(MWT-HRS),TOTAL= 6.69BOILER= 4.25PSH= 0.97SSH= 0.76CEILING= 0.71
ABSORBED ENERGY(MWT-HRS),BOILER= 4.04PSH= 0.98SSH= 0.78CEILING= 0.73FLOOR= 0.03TOTAL= 6.55


QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.302
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

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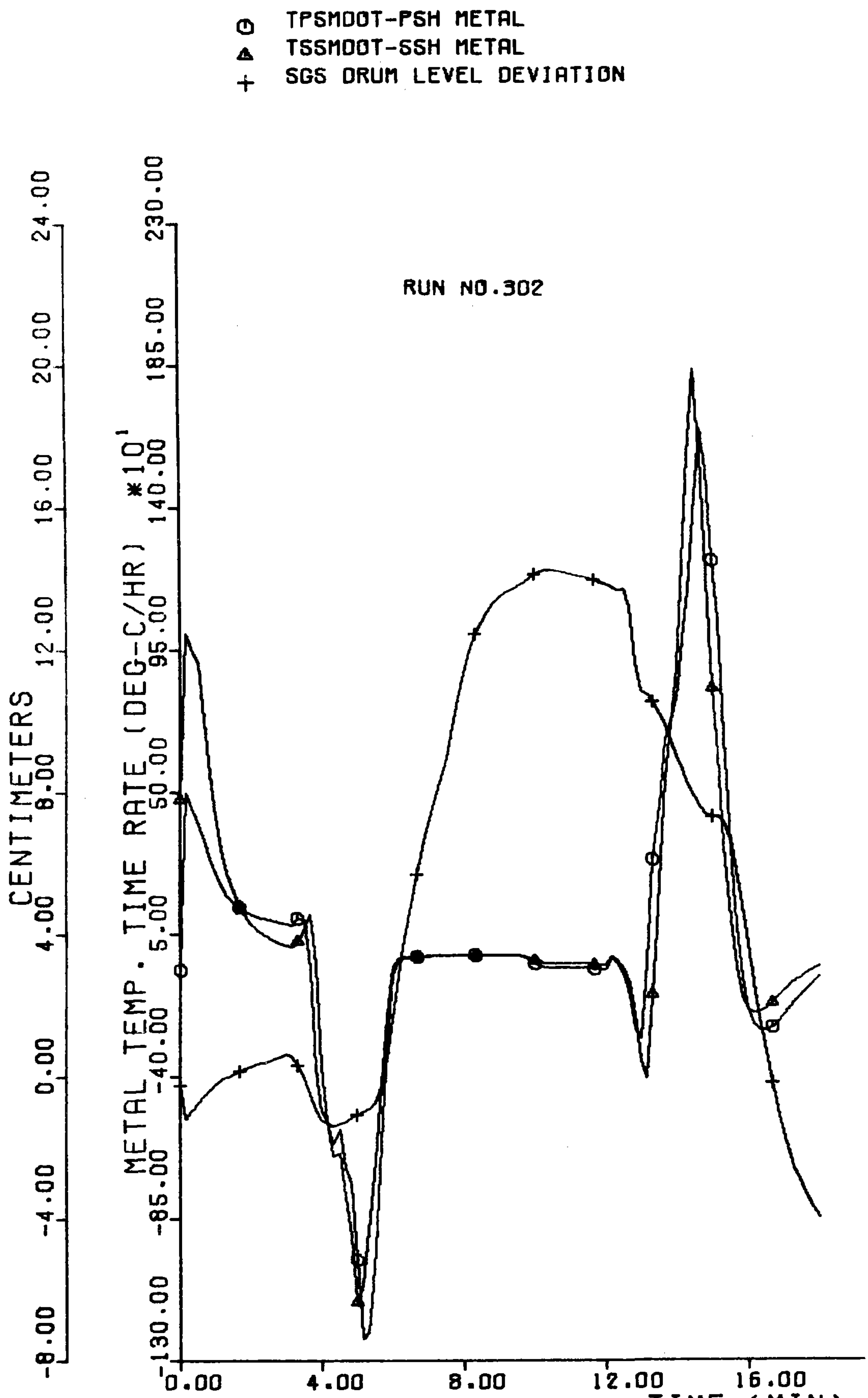
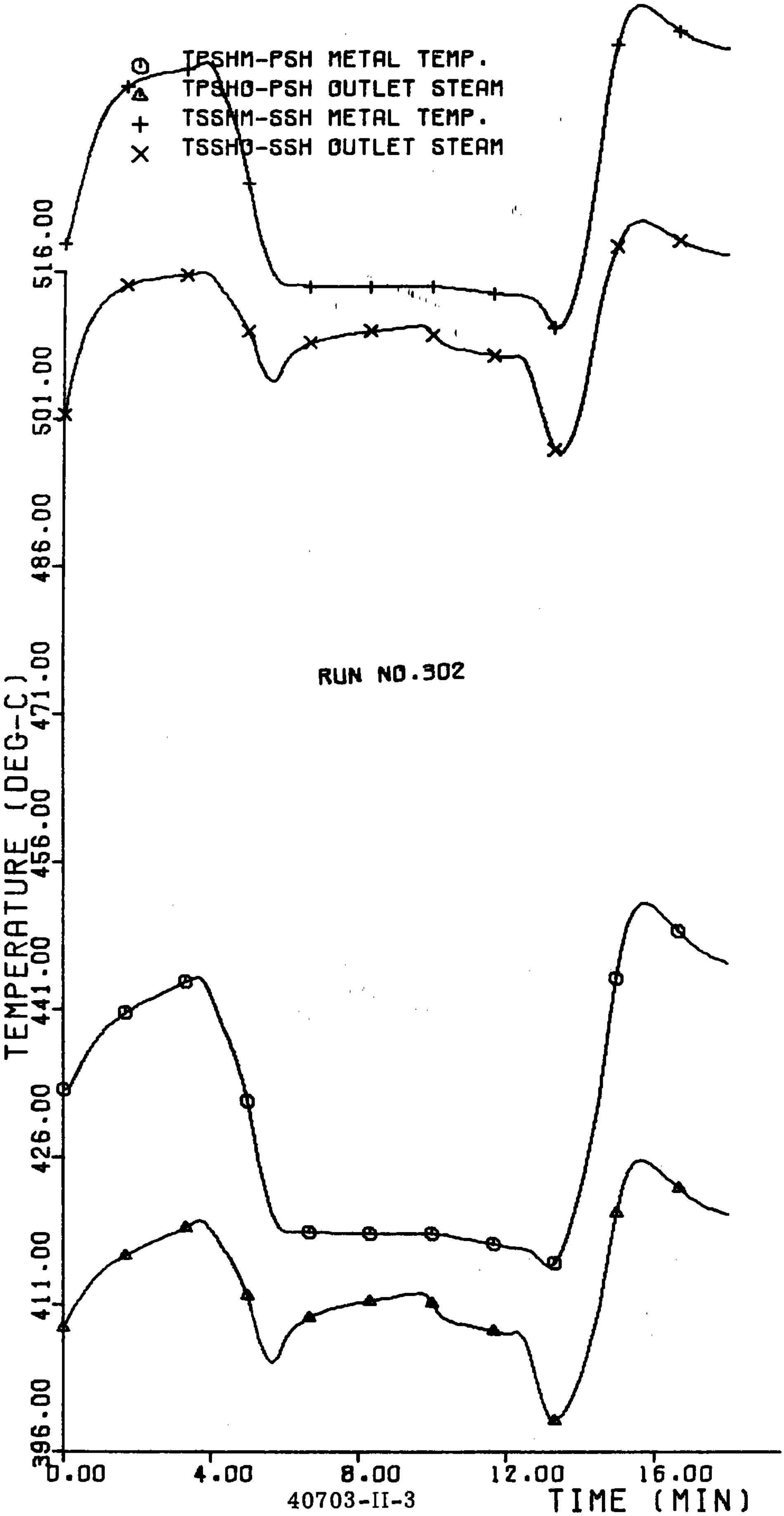
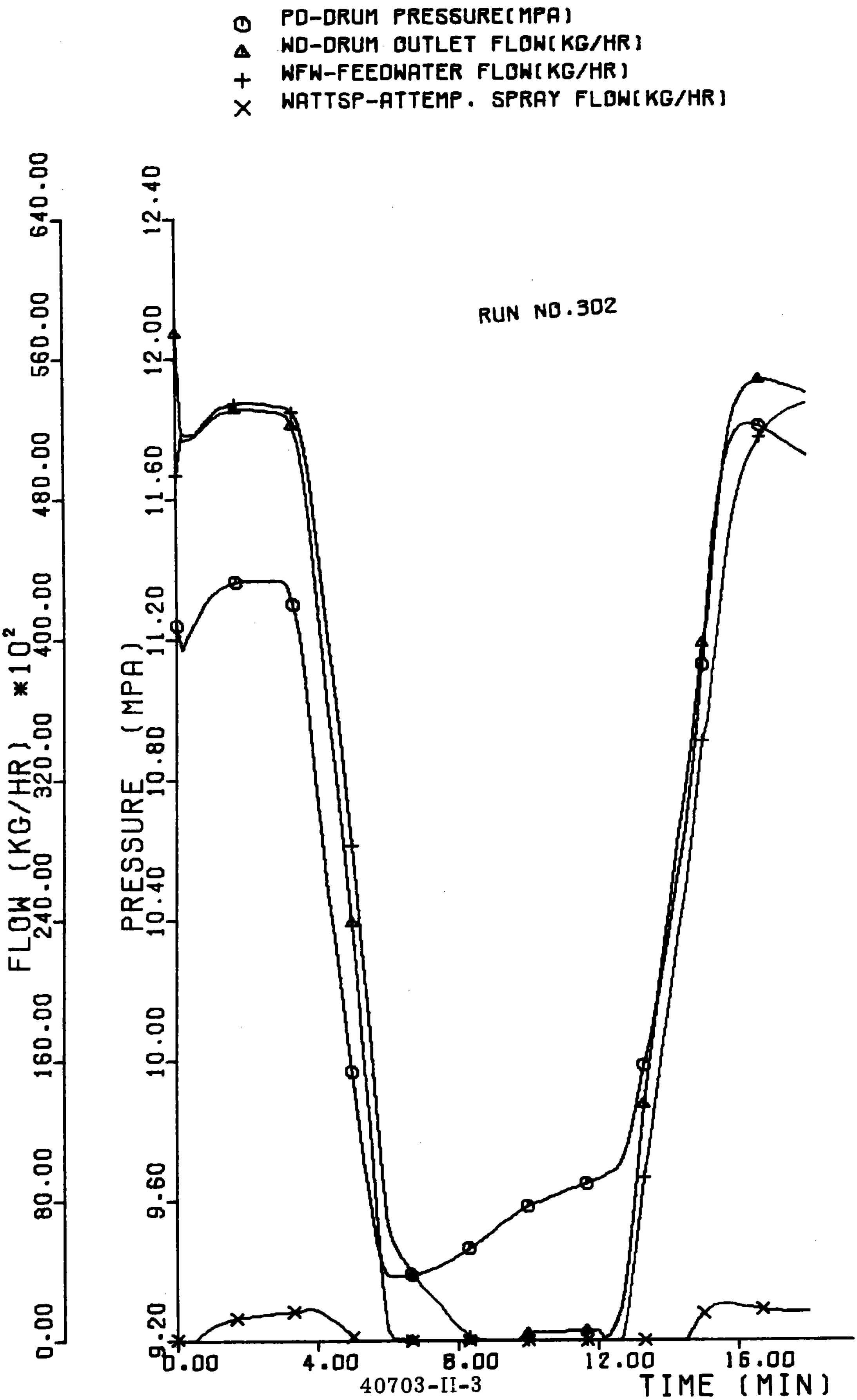

TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.302
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10[1]
TIME (MIN)
24.00
20.00
16.00
12.00
8.00
4.00
0.00
-4.00
-8.00
230.00
185.00
140.00
95.00
50.00
5.00
-40.00
-85.00
-130.00
0.00
4.00
8.00
12.00
16.00

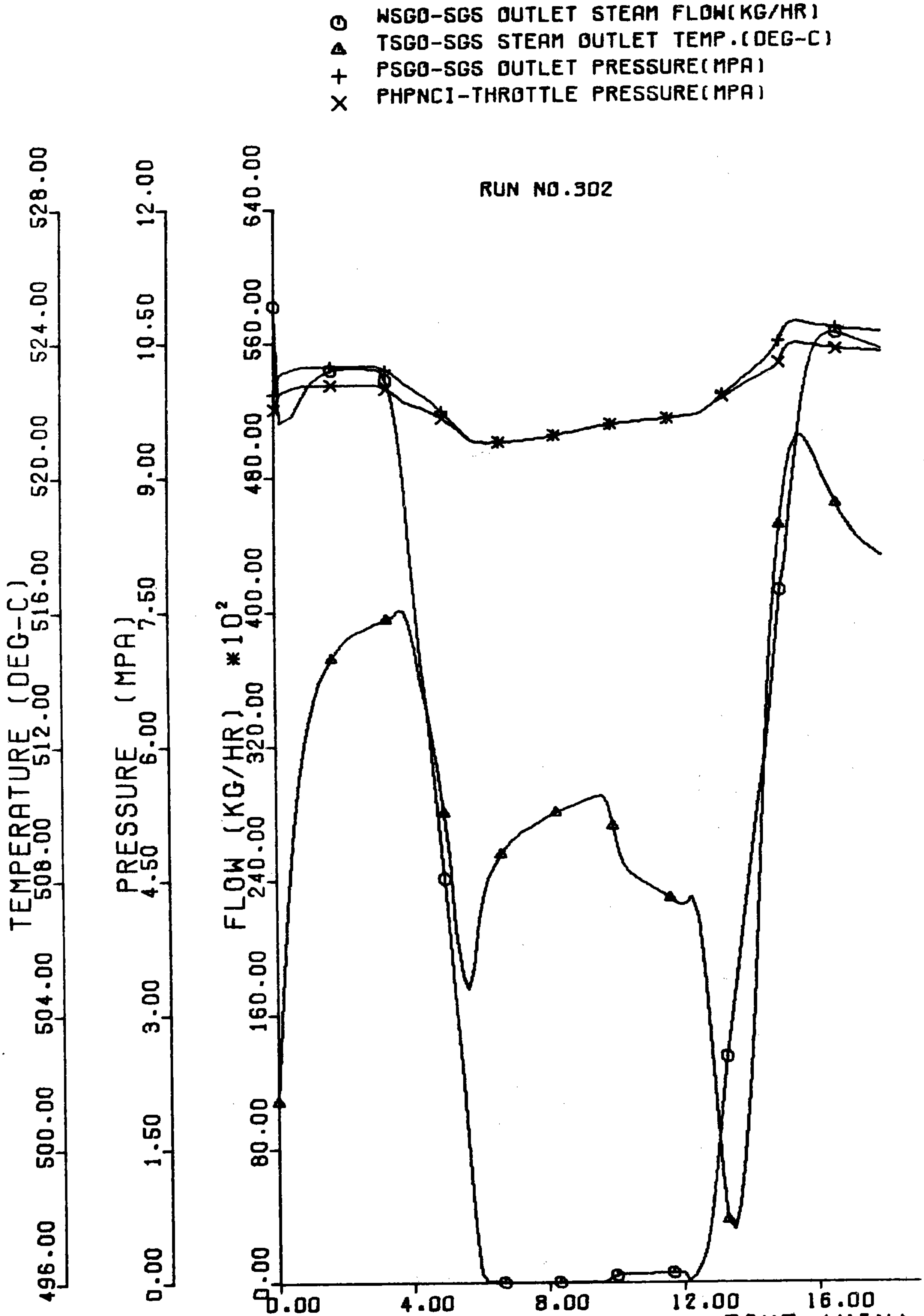
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.302
TEMPERATURE (DEG-C)
396.00
411.00
426.00
441.00
456.00
471.00
486.00
501.00
516.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.302
FLOW (KG/HR) *10²
PRESSURE (MPA)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
12.40
4.00
8.00
12.00
16.00

40703-II-3


WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.302
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10^2
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
496.00
500.00
504.00
508.00
512.00
516.00
520.00
524.00
528.00
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00

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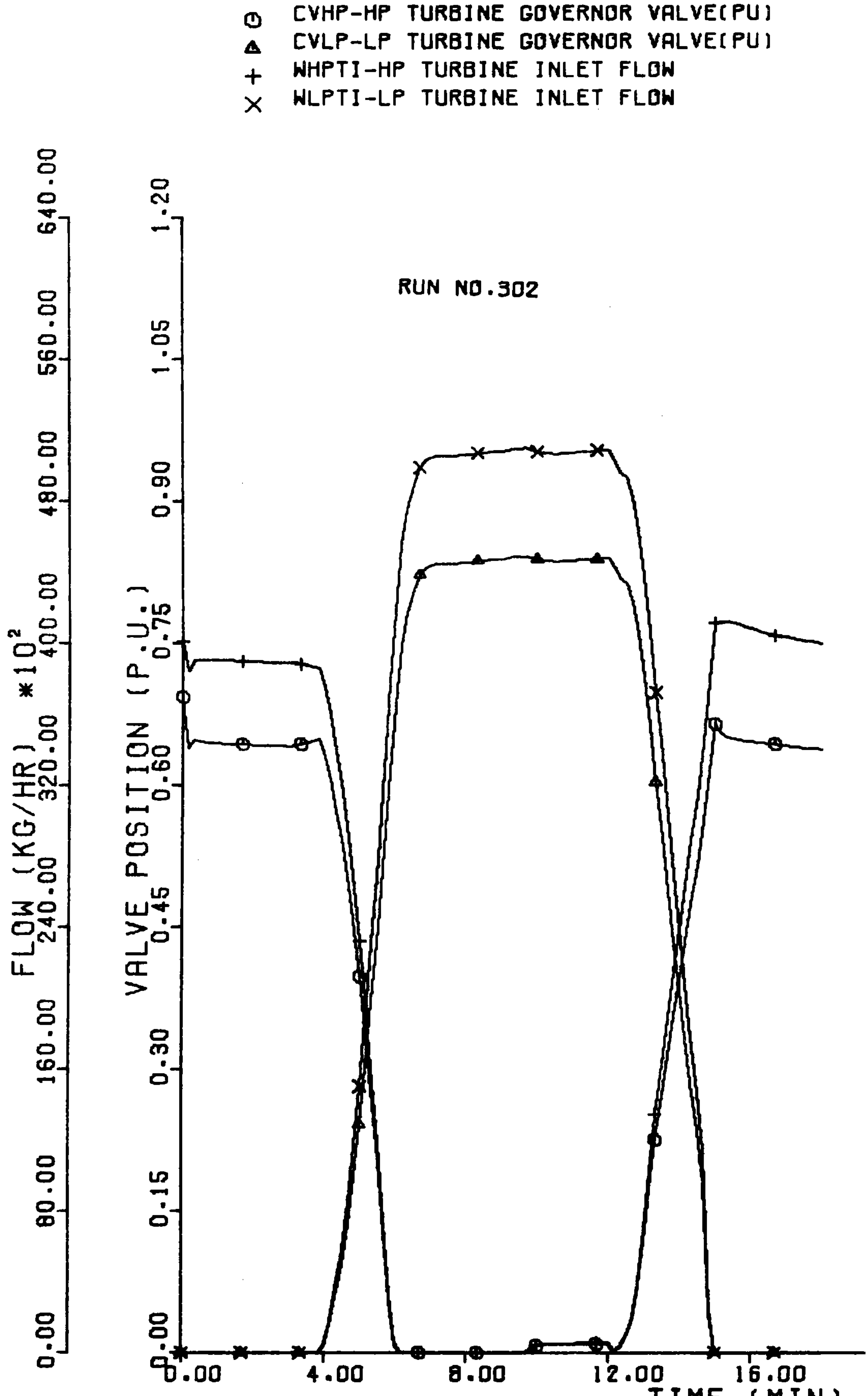
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.302
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
VALVE POSITION (P.U.)
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

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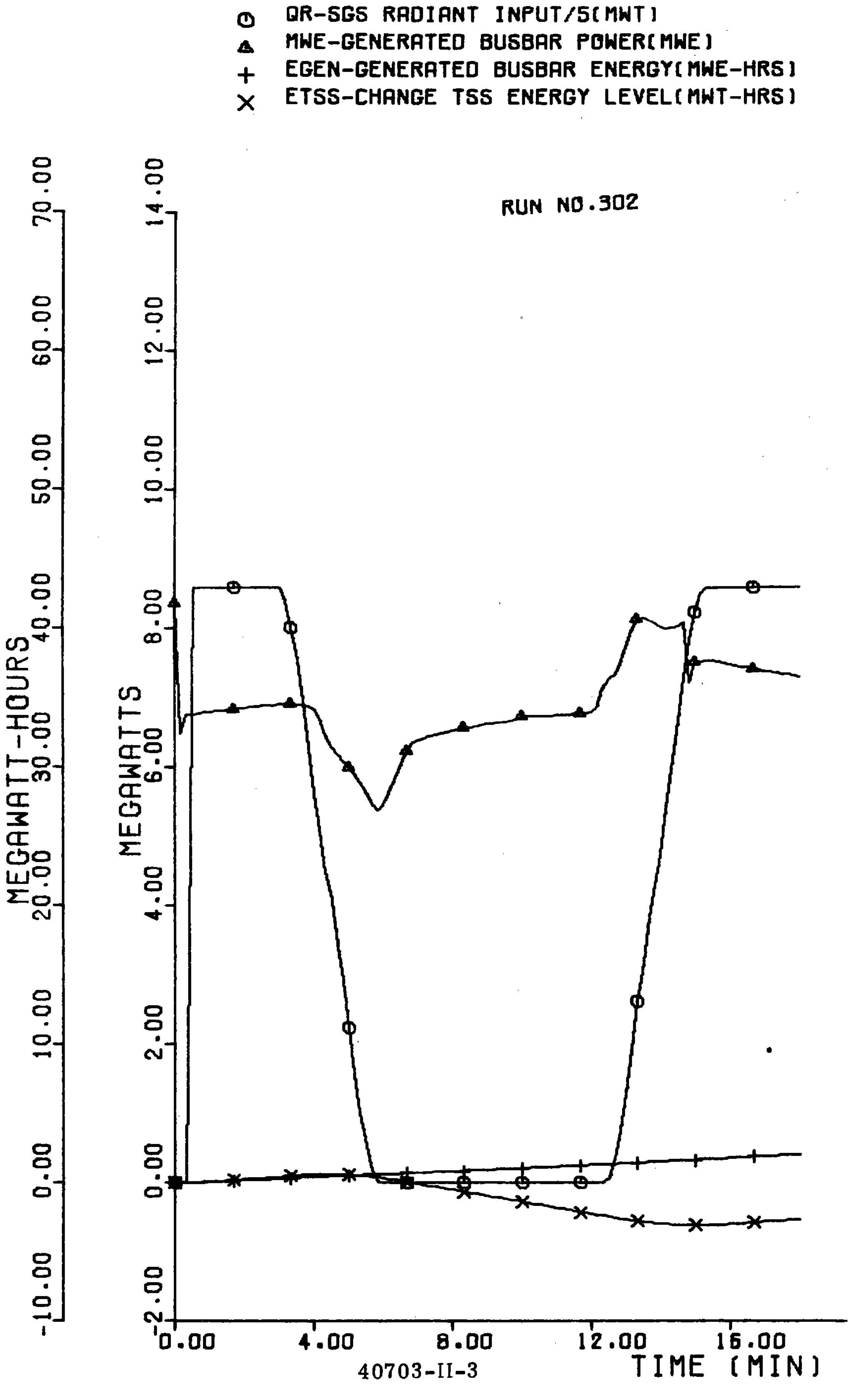
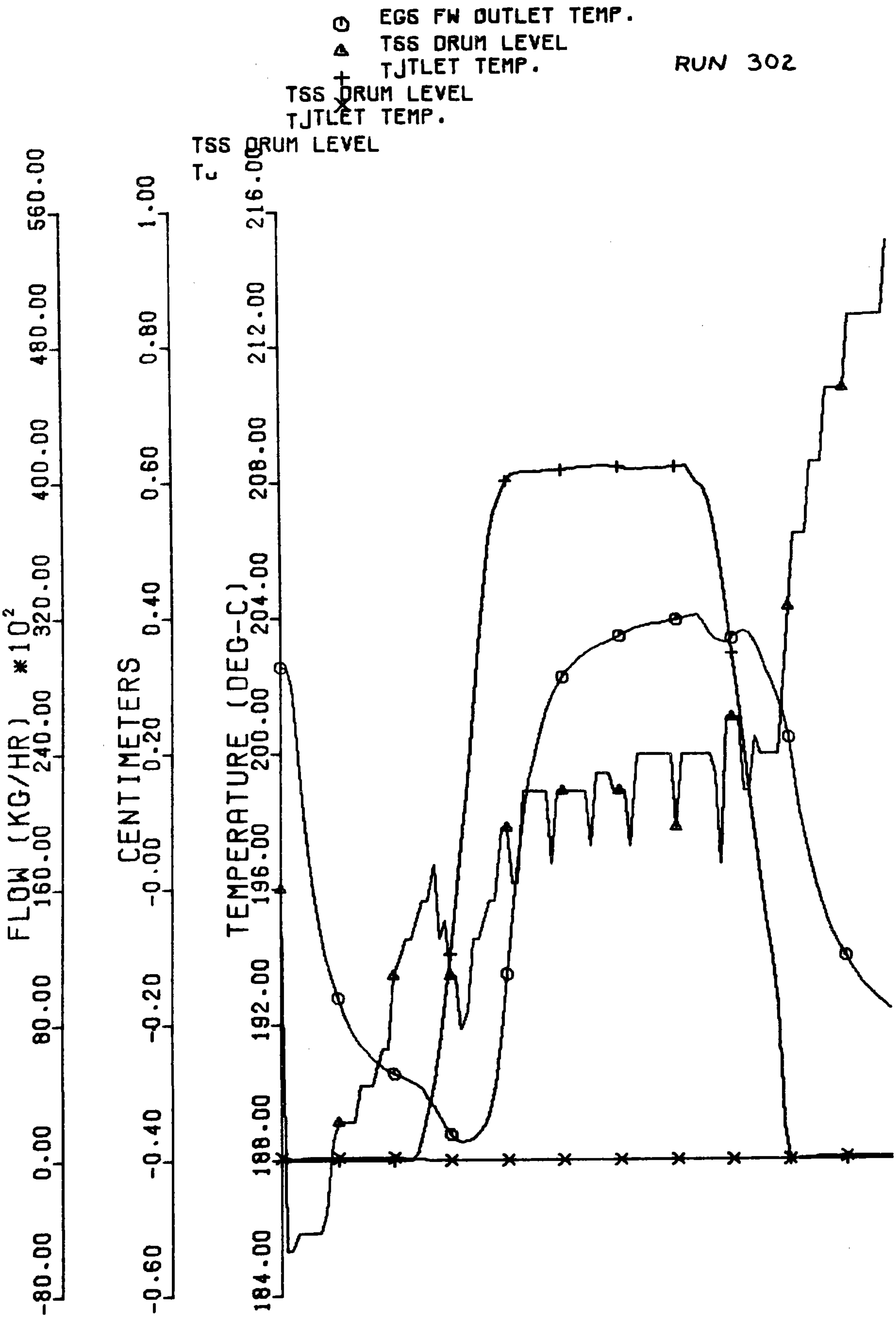

QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.302
MEGAWATT-HOURS
MEGAWATTS
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3


EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TJTLET TEMP.
RUN 302
TSS DRUM LEVEL
TJTLET TEMP.
TSS DRUM LEVEL
FLOW (KG/HR) *10²
CENTIMETERS
TEMPERATURE (DEG-C)
-80.00
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
-0.60
-0.40
-0.20
-0.00
0.20
0.40
0.60
0.80
1.00
184.00
188.00
192.00
196.00
200.00
204.00
208.00
212.00
216.00

Run No.	303
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Cloud from West entering field at t=3 min:

Speed = 11.4 Km/hr (7.1 mph)
Length = 1.8 Km (1.12 mi)

Field Coverage: North 1/2

SUMMARY OF SPP PERFORMANCE (RUN NO 303.)

SPP POWER LEVELS

	BTU/HR X 10#6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	106.068	146.738	71.170	31.09	43.01	20.86
NET OUTPUT POWER OF SGS TO-						
TOTAL	99.825	160.426	53.452	29.26	47.02	15.67
EGS	77.596	95.847	52.924	22.74	28.09	15.51
TSS	17.985	56.235	0.000	5.27	16.48	0.00
NET TSS POWER TO EGS	15.375	37.707	-0.000	4.51	11.05	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.97	9.71	8.27
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				11172273.	16373.	6048.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 6633.0 TO TSS 1537.3 FROM TSS

TOTAL RADIANT ENERGY IN= 9066.8KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9006

NET CHANGE IN TSS ENERGY 190.39(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.04(MW-HRSE)

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4-28

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	377.6	391.9	371.8
TD-DRUM TEMP	601.4	615.8	590.5
TPSHO-PSH TEMP OUT	919.9	1076.0	773.3
TSSHO-SSH TEMP OUT	973.6	993.8	949.2
TPSHM-PSH METAL TEMP	977.7	1149.4	816.2
TSSHM-SSH METAL TEMP	1026.0	1051.2	979.4
PSH METAL TEMP RATE	286.4	3303.3	-5267.3
SSH METAL TEMP RATE	44.8	1661.8	-1165.8
PPSHO-PSH PRES.OUT	1513.8	1630.9	1425.5
PSSHO-SSH PRES.OUT	1465.5	1533.0	1411.8
PD-DRUM PRES	1558.7	1728.1	1435.6
DELTA DRUM LEVEL	3.09	6.33	-0.45
PHPNCI-HP NOZ PRES	1444.3	1503.0	1402.4

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	569.8	570.0	569.5
TOIL-MAIN OIL TEMP	479.9	480.0	479.8
DDRUM-DELTA DRUM LEV	0.0	0.1	-0.2
PDRUM-DRUM PRESSURE	573.1	583.8	565.1
TPREH-PREHEATER TEMP	478.6	481.2	475.7
TDSH-DESUPER-TEMP	0.	0.	0.

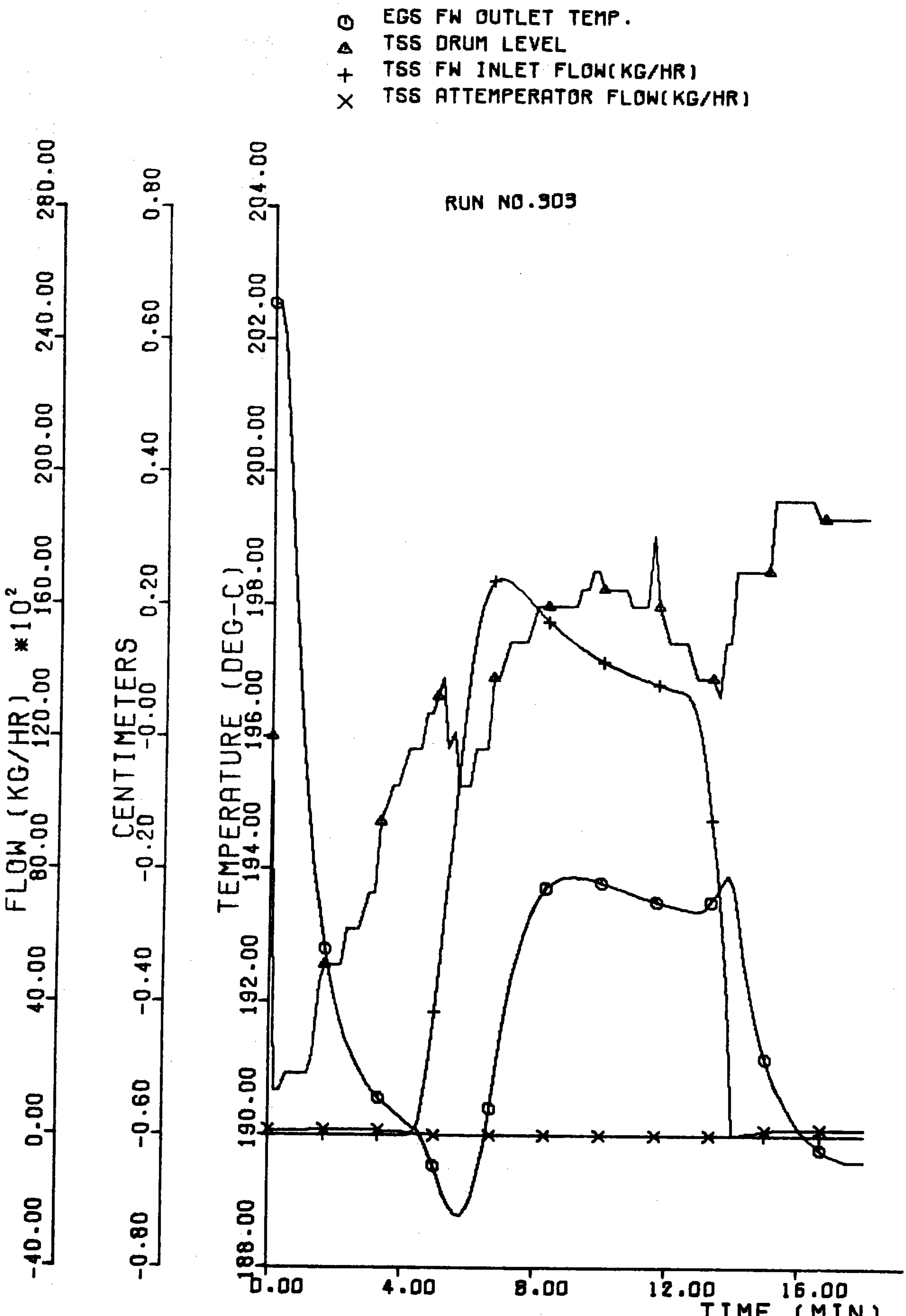
MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.7351	0.9807	0.5243
QINC-INCIDENT AVAILABLE POWER(MWT)	46.9867	62.6863	33.5150
QRDB-REDIRECTED POWER TO BOILER(MWT)	19.9739	31.5154	10.0702
QRDP-REDIRECTED POWER TO PSH(MWT)	6.4086	7.1943	5.7344
QRDS-REDIRECTED POWER TO SSH(MWT)	5.5725	5.6700	5.4888
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	37.1854	49.6101	26.5239
QABB-ABSORBED POWER ON BOILER(MWT)	19.1147	29.9705	9.7995
QABP-ABSORBED POWER ON PSH(MWT)	6.3741	7.2478	5.6244
QABS-ABSORBED POWER ON SSH(MWT)	5.5997	5.7905	5.4360
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.2508	5.3834	5.1369
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1305	0.1873	0.0818
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	36.4698	48.5795	26.0786
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	41.5344	65.1230	21.2933
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	13.8503	15.7487	12.2213
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.1676	12.5823	11.8118
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	67.552	93.454	45.326
QRDINC-RATIO.REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO.ABSORBED TO INCIDENT POWER TOTALS)	0.777	0.778	0.775
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.981	0.983	0.979
QABBRA-RATE OF CHANGE.BOILER ABSORBED POWER(%/MIN)	0.000	28.630	-28.654
QABPRA-RATE OF CHANGE.PSH ABSORBED POWER(%/MIN)	-0.000	4.324	-4.328
QABSRA-RATE OF CHANGE.SSH ABSORBED POWER(%/MIN)	-0.000	0.974	-0.975
QABTRA-RATE OF CHANGE.TOTAL ABSORBED POWER(%/MIN)	0.000	33.929	-33.958
TCAV1-CEILING TEMPERATURE(DEG-F)	1264.8	1547.1	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.2	652.3	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 13.718

REDIRECTED ENERGY(MWT-HRS),TOTAL= 10.86BOILER= 5.83PSH= 1.87SSH= 1.63CEILING= 1.53

ABSORBED ENERGY(MWT-HRS),BOILER= 5.58PSH= 1.86SSH= 1.63CEILING= 1.53FLOOR= 0.04TOTAL= 10.65



EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.303
FLOW (KG/HR) *10²
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
0.00
4.00
8.00
12.00
16.00

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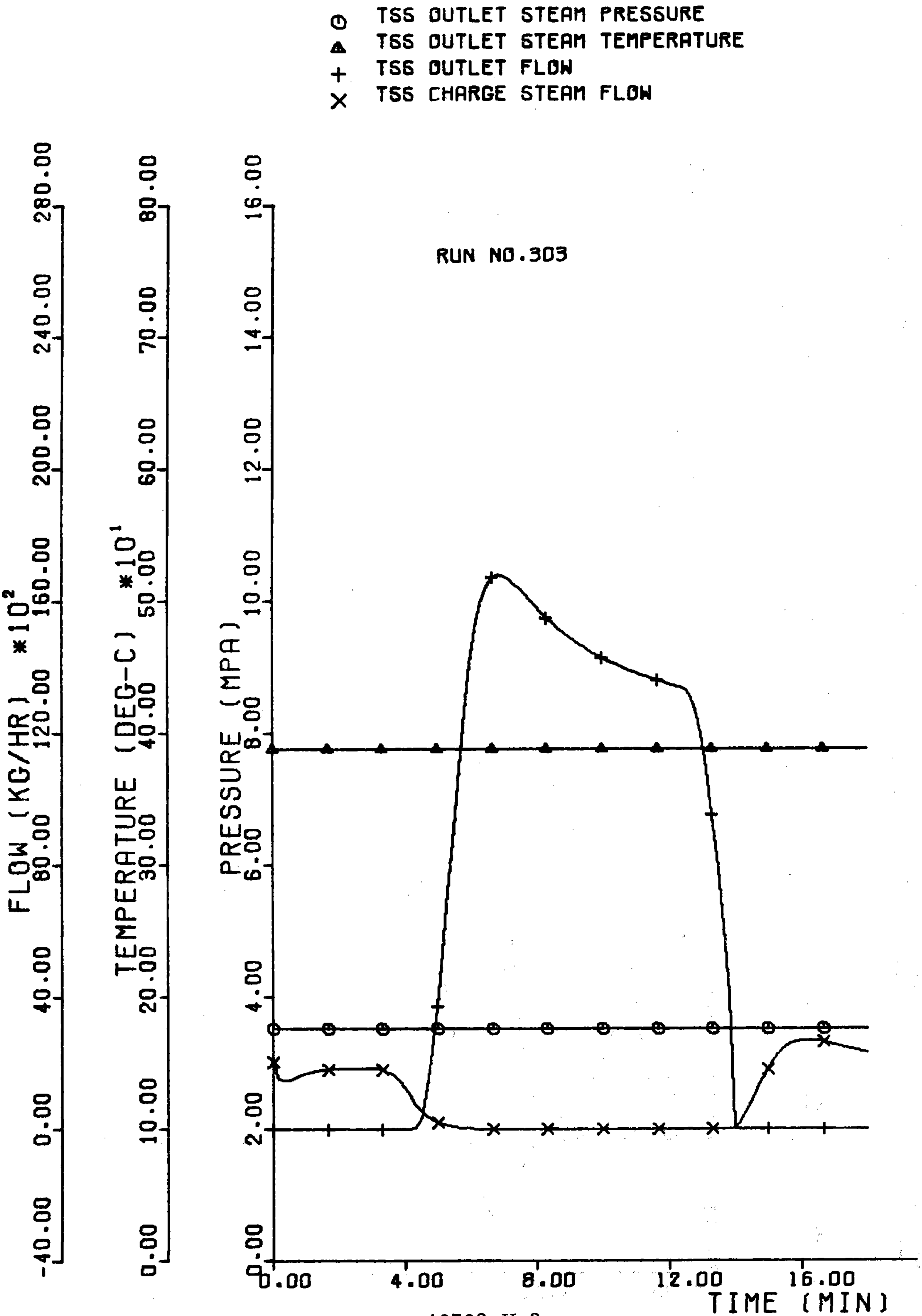

TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
RUN NO.303
FLOW (KG/HR) *10²
TEMPERATURE (DEG-C) *10¹
PRESSURE (MPA)
TIME (MIN)
-40.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
0.00
4.00
8.00
12.00
16.00

40703-II-3

Run No.	304
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Cloud approaching from West entering field at t=3 min: Speed = 11.4 Km/hr (7.1 mph) Length = 1.8 Km (1.12 mi) Field Coverage: South 1/2

SUMMARY OF SPP PERFORMANCE (RUN NO 304.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	108.435	146.738	75.568	31.78	43.01	22.15
NET OUTPUT POWER OF SGS TO-						
TOTAL	98.927	130.920	72.519	29.00	38.37	21.26
EGS	90.287	114.636	72.313	26.46	33.60	21.20
TSS	8.369	36.287	0.000	2.45	10.64	0.00
NET TSS POWER TO EGS	9.381	25.398	-0.001	2.75	7.44	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.76	9.48	8.44
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				11769924.	14761.	8567.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 7717.9 TO TSS 715.4 FROM TSS

TOTAL RADIANT ENERGY IN= 9269.2KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9092

NET CHANGE IN TSS ENERGY -93.42(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 1.97(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	390.8	410.0	374.3
TD-DRUM TEMP	603.9	612.4	597.7
TPSHO-PSH TEMP OUT	705.8	781.3	633.1
TSSHO-SSH TEMP OUT	823.3	959.1	676.8
TPSHM-PSH METAL TEMP	735.5	825.5	648.6
TSSHM-SSH METAL TEMP	844.8	996.3	685.6
PSH METAL TEMP RATE	2.8	3938.3	-3467.2
SSH METAL TEMP RATE	23.6	5016.3	-3952.0
PPSHO-PSH PRES.OUT	1532.7	1605.0	1482.2
PSSHO-SSH PRES.OUT	1484.0	1535.9	1451.3
PD-DRUM PRES	1586.3	1686.3	1515.0
DELTA DRUM LEVEL	0.36	1.30	-1.13
PHPNCI-HP NOZ PRES	1450.0	1482.1	1426.0

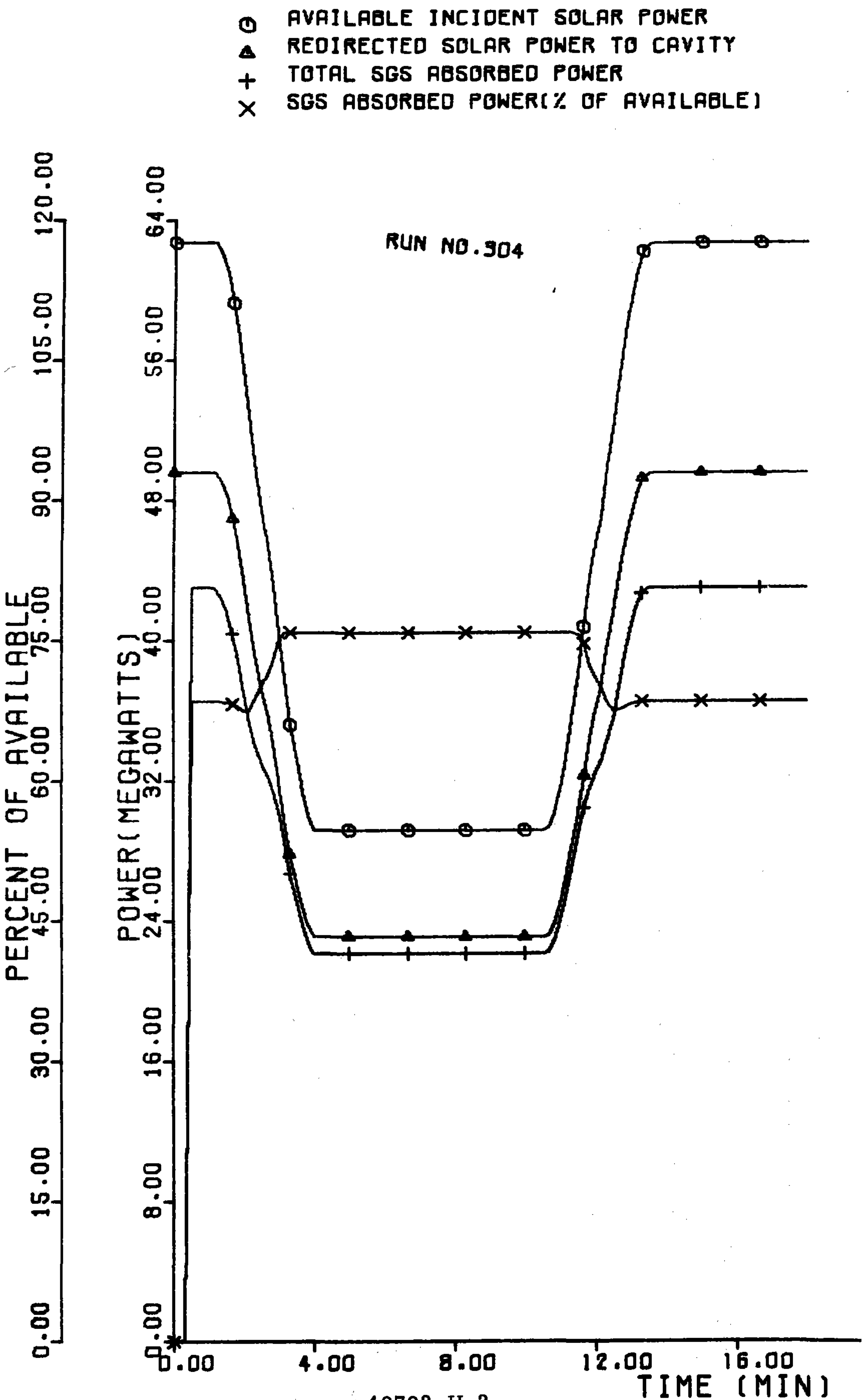
TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	569.9	570.0	569.7
TOIL-MAIN OIL TEMP	479.9	480.0	479.9
DDRUM-DELTA DRUM LEV	0.0	0.1	-0.2
PDRUM-DRUM PRESSURE	572.6	583.6	564.7
TPREH-PREHEATER TEMP	479.4	481.0	477.4
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS

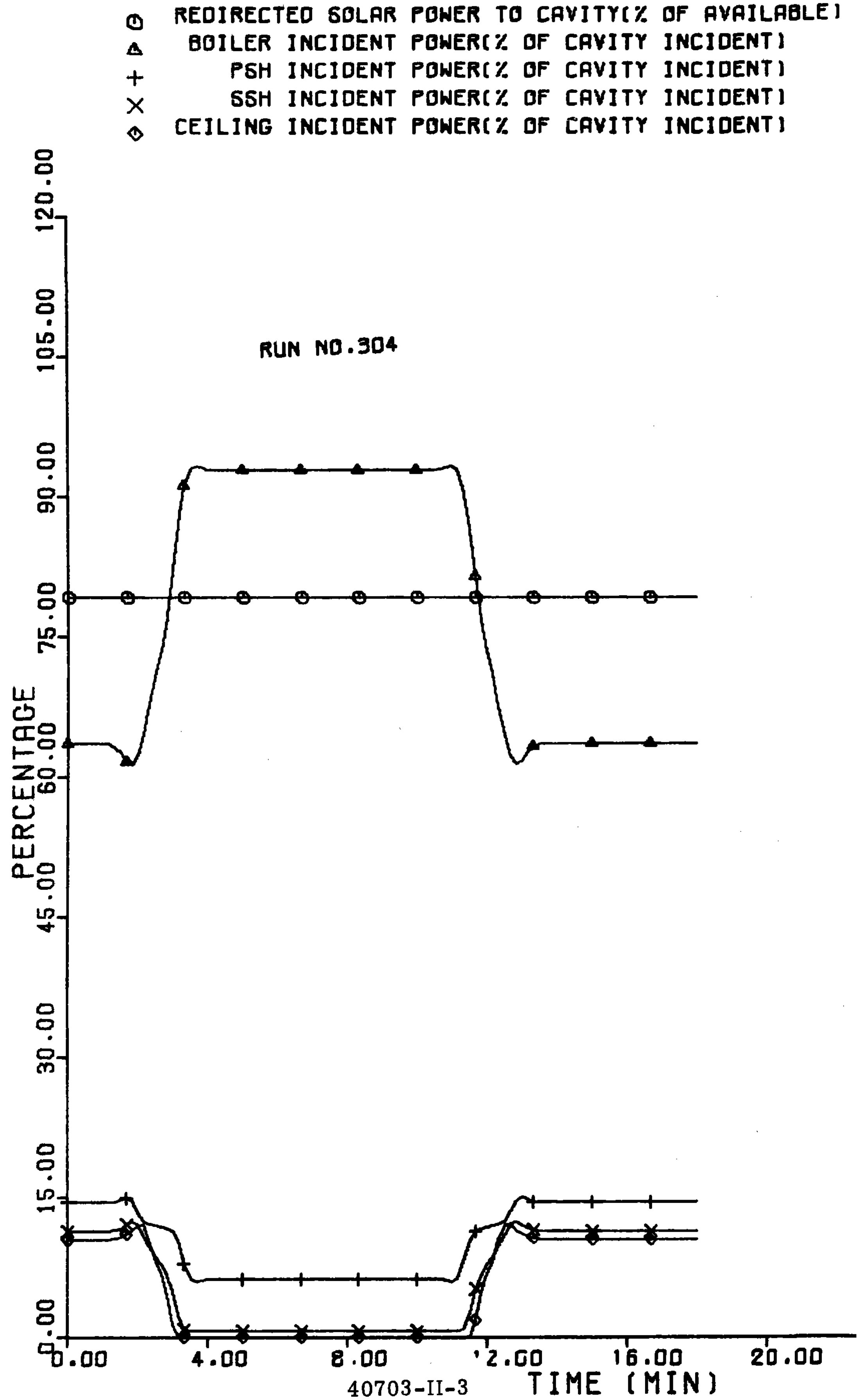
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ)	0.6985	0.9807	0.4564
QINC-INCIDENT AVAILABLE POWER(MWT)	44.6490	62.6863	29.1713
QRDB-REDIRECTED POWER TO BOILER(MWT)	26.0958	31.5154	21.4452
QBDP-REDIRECTED POWER TO PSH(MWT)	4.1081	7.1943	1.4599
QRDS-REDIRECTED POWER TO SSH(MWT)	2.7159	5.6700	0.1811
QRDC-REDIRECTED POWER TO CEILING(MWT)	2.4155	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	35.3353	49.6101	23.0863
QABB-ABSORBED POWER ON BOILER(MWT)	24.6965	29.9705	20.1710
QABP-ABSORBED POWER ON PSH(MWT)	4.2208	7.2478	1.6233
QABS-ABSORBED POWER ON SSH(MWT)	2.8650	5.7905	0.3546
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	2.6188	5.3834	0.2465
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1432	0.1873	0.1054
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	34.5443	48.5795	22.5009
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	53.6632	65.1230	43.8297
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	9.1713	15.7487	3.5273
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	6.2253	12.5823	0.7705
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	69.060	93.454	48.127
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.773	0.775	0.771
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.977	0.980	0.975
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	14.984	-14.984
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.000	11.176	-11.176
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	11.385	-11.385
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.000	25.729	-25.729
TCAV1-CEILING TEMPERATURE(DEG-F)	1090.5	1264.0	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.2	652.5	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 13.035
REDIRECTED ENERGY(MWT-HRS),TOTAL= 10.32BOILER= 7.62PSH= 1.20SSH= 0.79CEILING= 0.71
ABSORBED ENERGY(MWT-HRS),BOILER= 7.21PSH= 1.23SSH= 0.84CEILING= 0.76FLOOR= 0.04TOTAL= 10.09

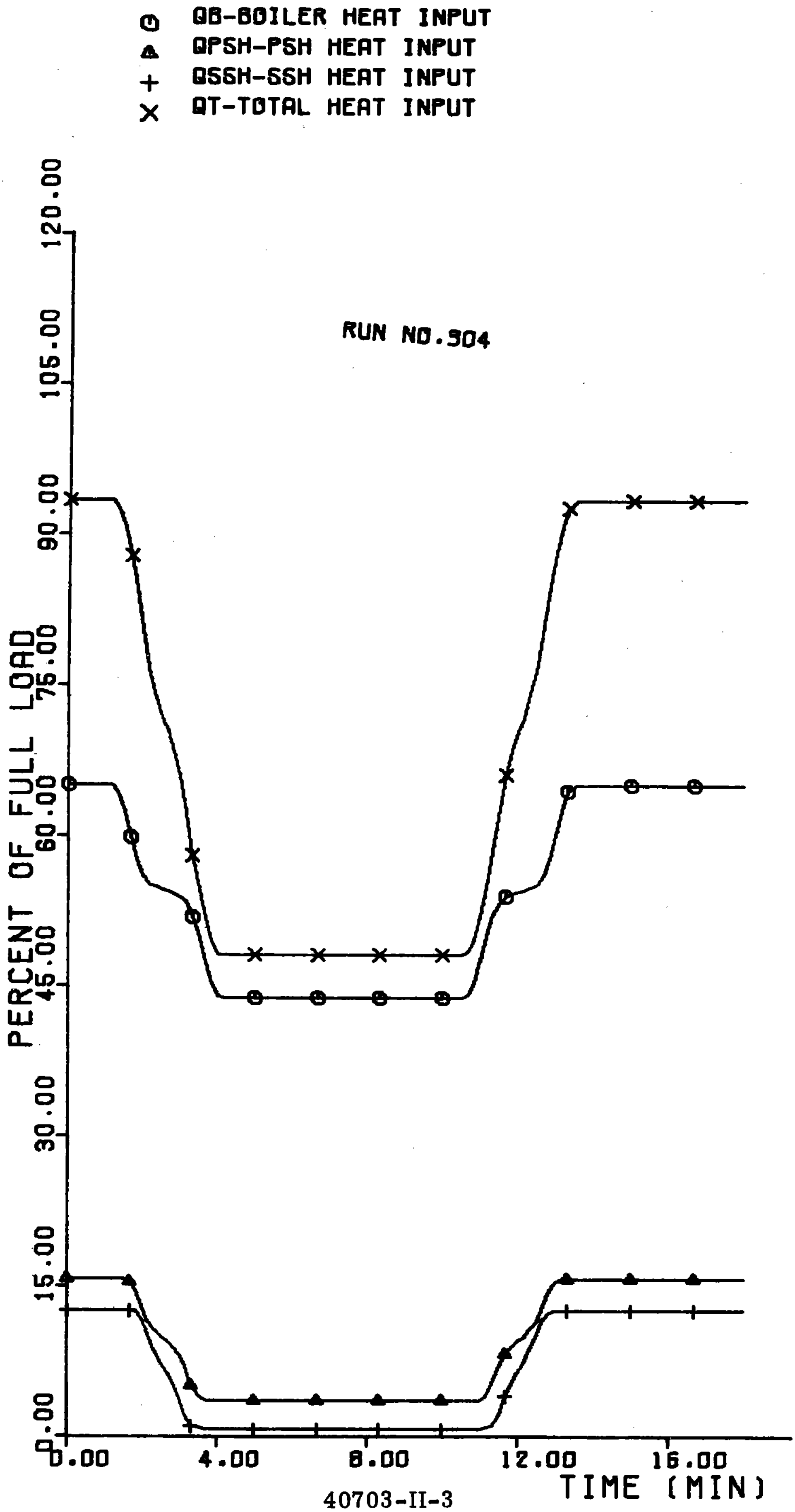
40703-11-3


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.304
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
4.00
12.00

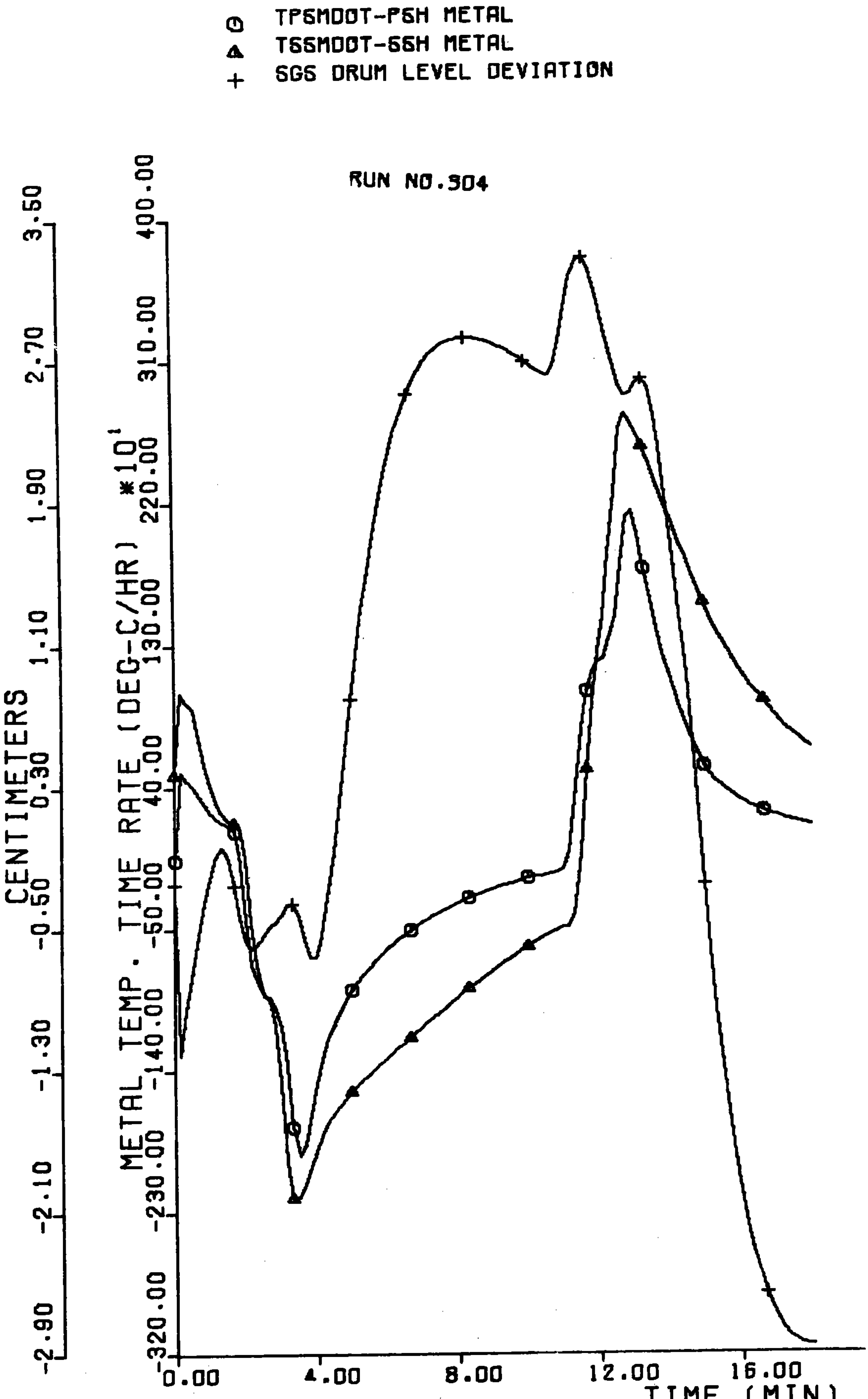
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.304
PERCENTAGE
120.00
105.00
90.00
75.00
60.00
45.00
30.00
15.00
0.00
0.00
4.00
8.00
12.00
16.00
20.00
TIME (MIN)

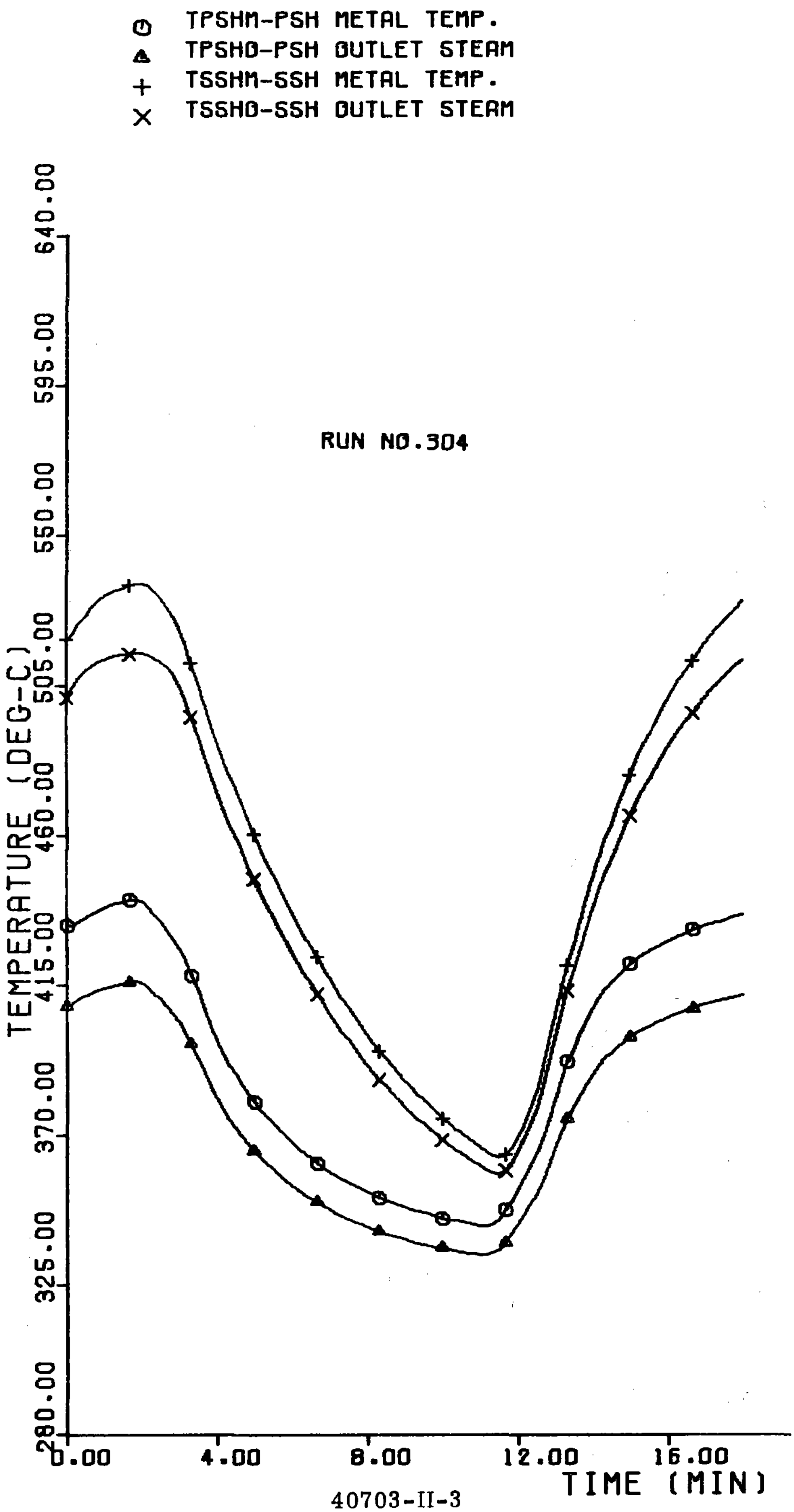
40703-II-3

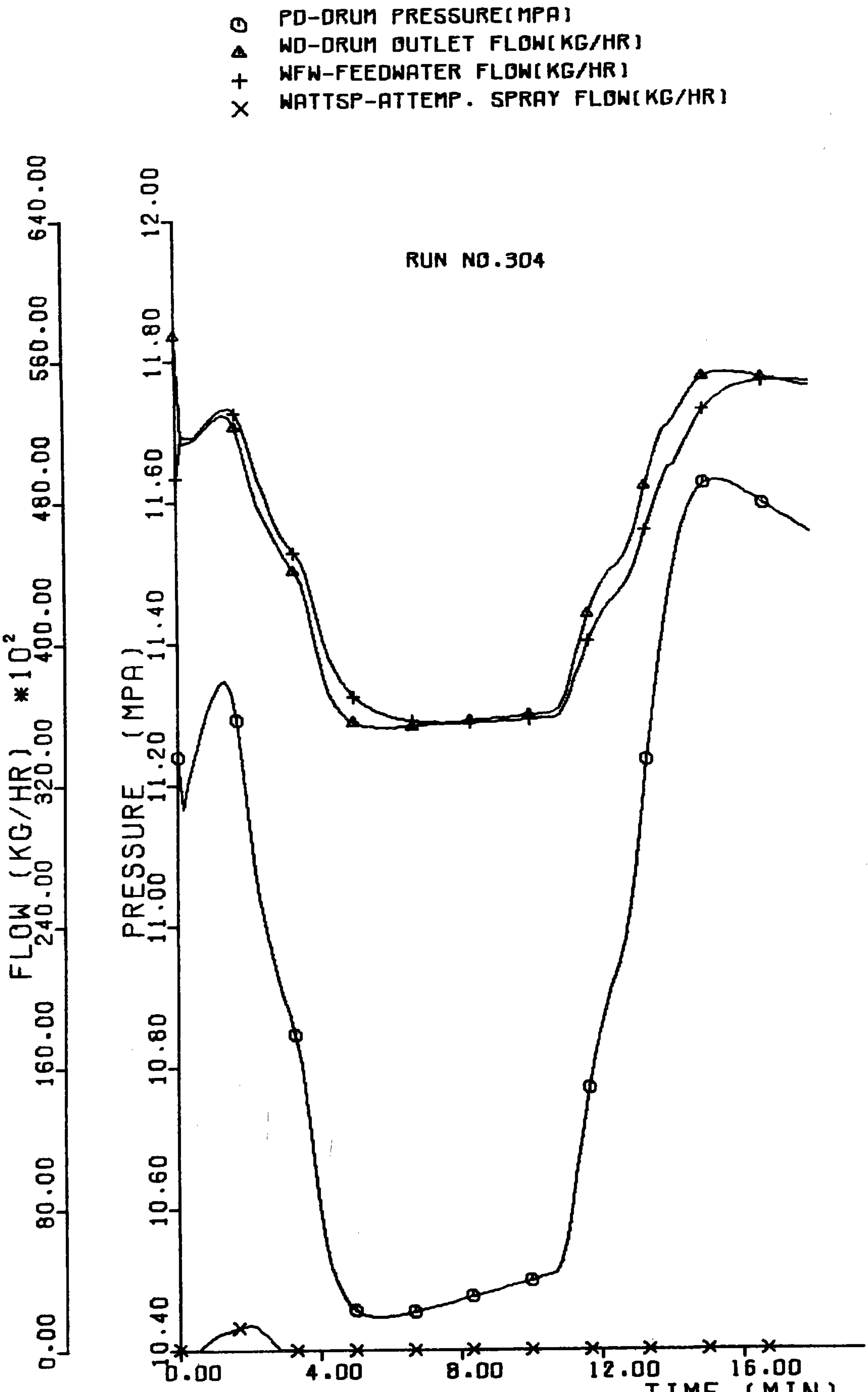

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.304
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3

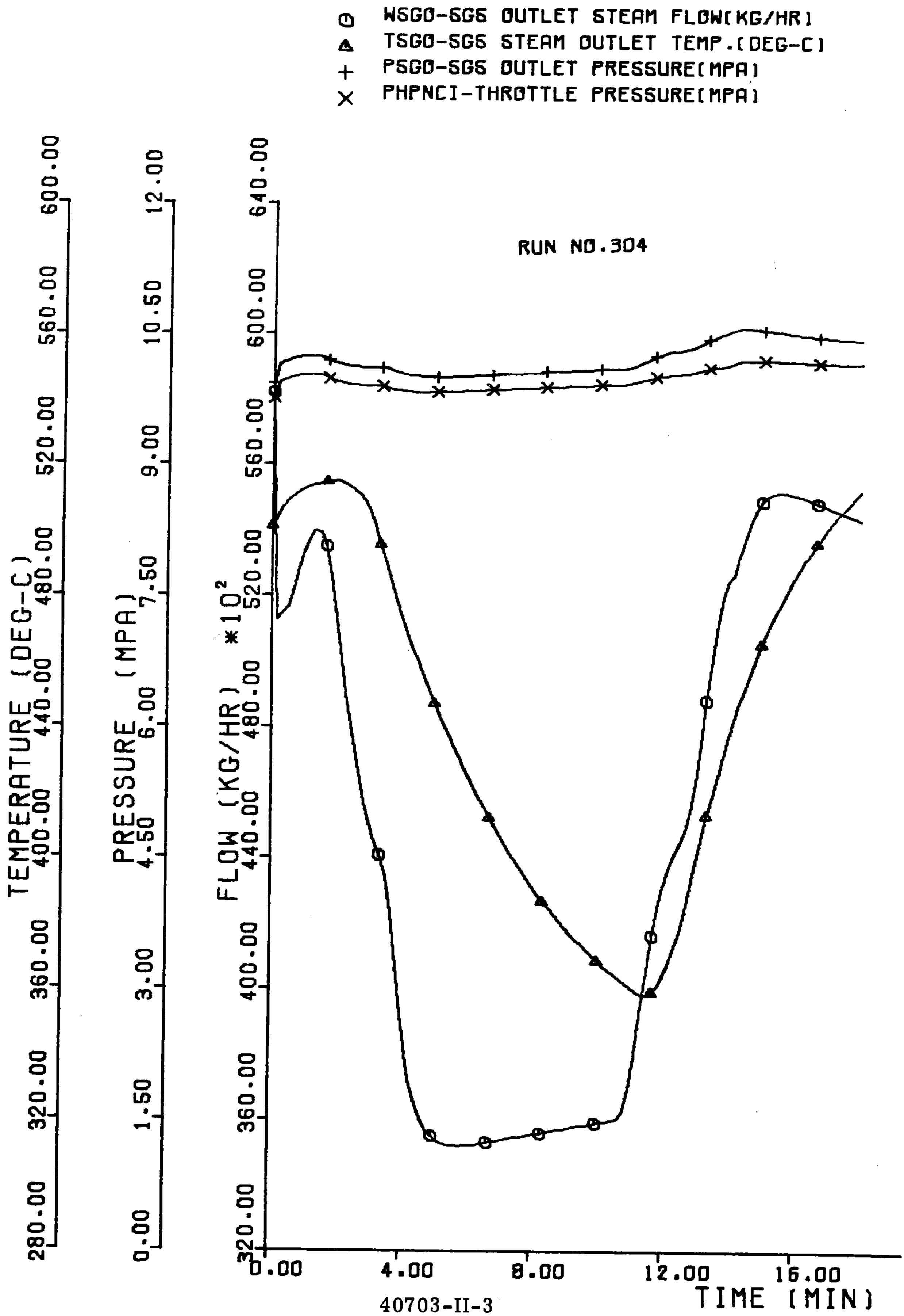

TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.304
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
3.50
2.70
1.90
1.10
0.30
-0.50
-1.30
-2.10
-2.90
400.00
310.00
220.00
130.00
40.00
-50.00
-140.00
-230.00
-320.00
0.00
4.00
8.00
12.00
16.00

40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.304
TEMPERATURE (DEG-C)
640.00
595.00
550.00
505.00
460.00
415.00
370.00
325.00
280.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

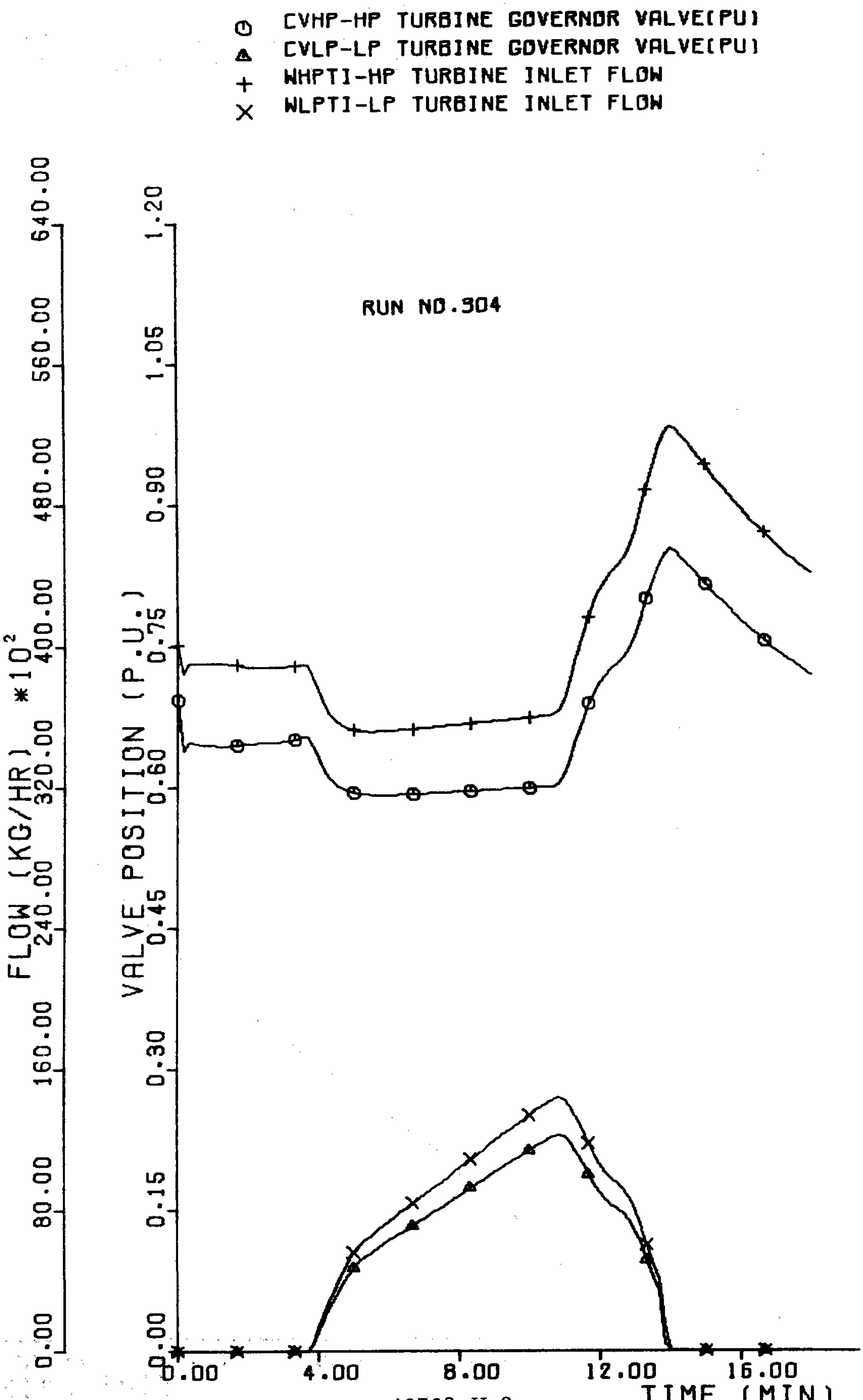

PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.304
FLOW (KG/HR) *10^2
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
PRESSURE (MPA)
10.40
10.60
10.80
11.00
11.20
11.40
11.60
11.80
12.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3

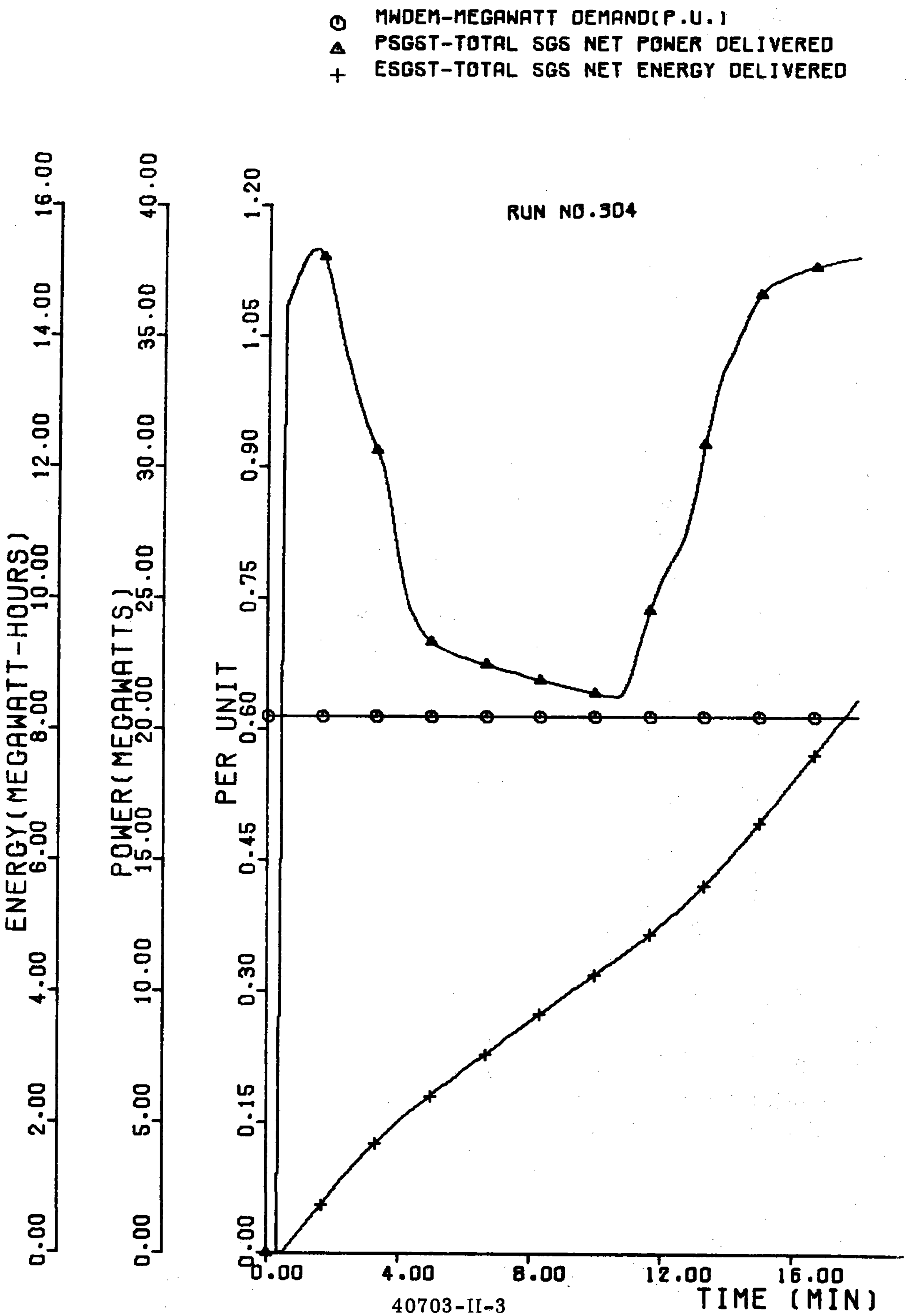


WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.304
TEMPERATURE (DEG-C)
280.00
320.00
360.00
400.00
440.00
480.00
520.00
560.00
600.00
PRESSURE (MPA)
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
FLOW (KG/HR) *10²
320.00
360.00
400.00
440.00
480.00
520.00
560.00
600.00
640.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

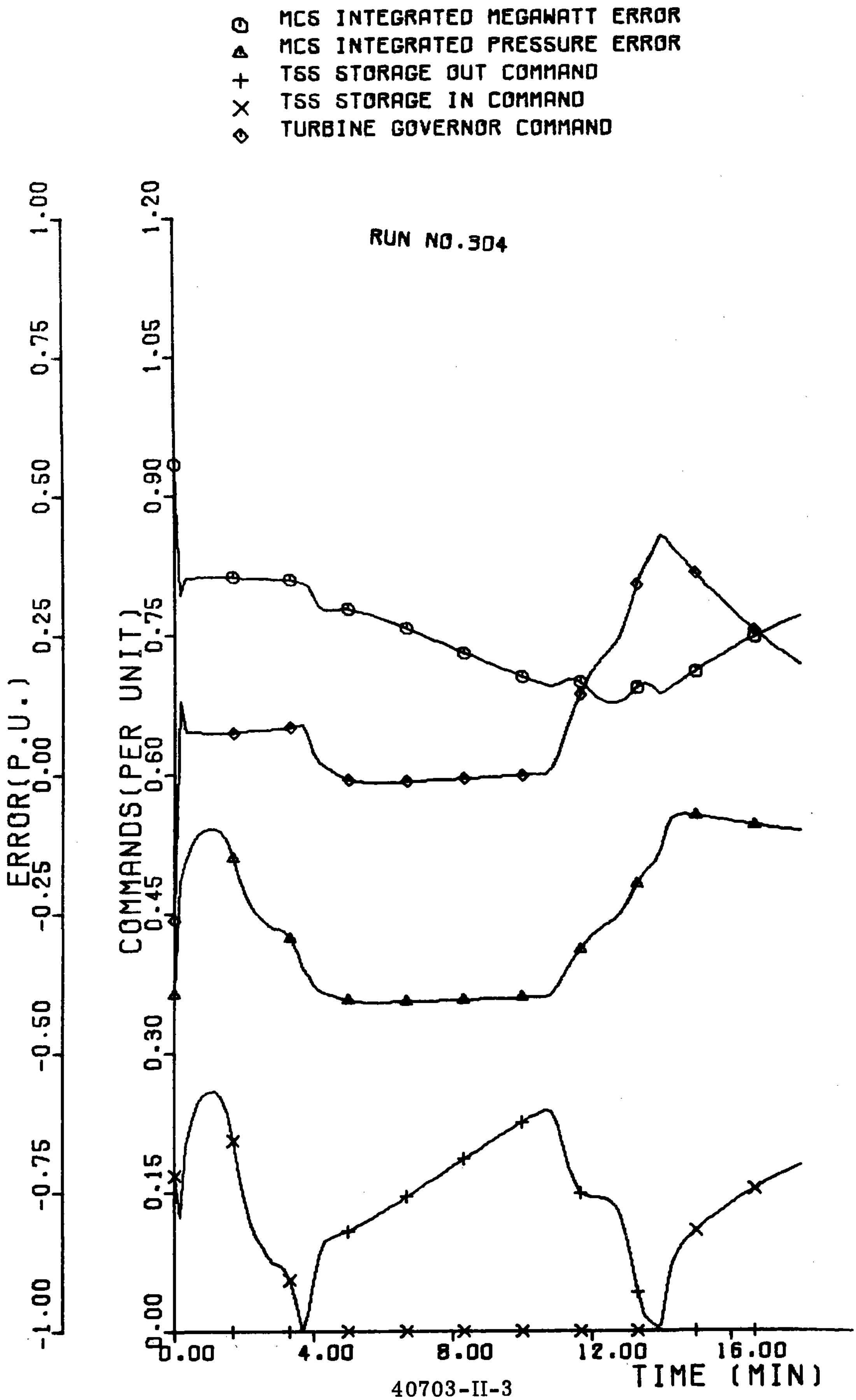
40703-II-3


CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.304
FLOW (KG/HR) *10²
VALVE POSITION (P.U.)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

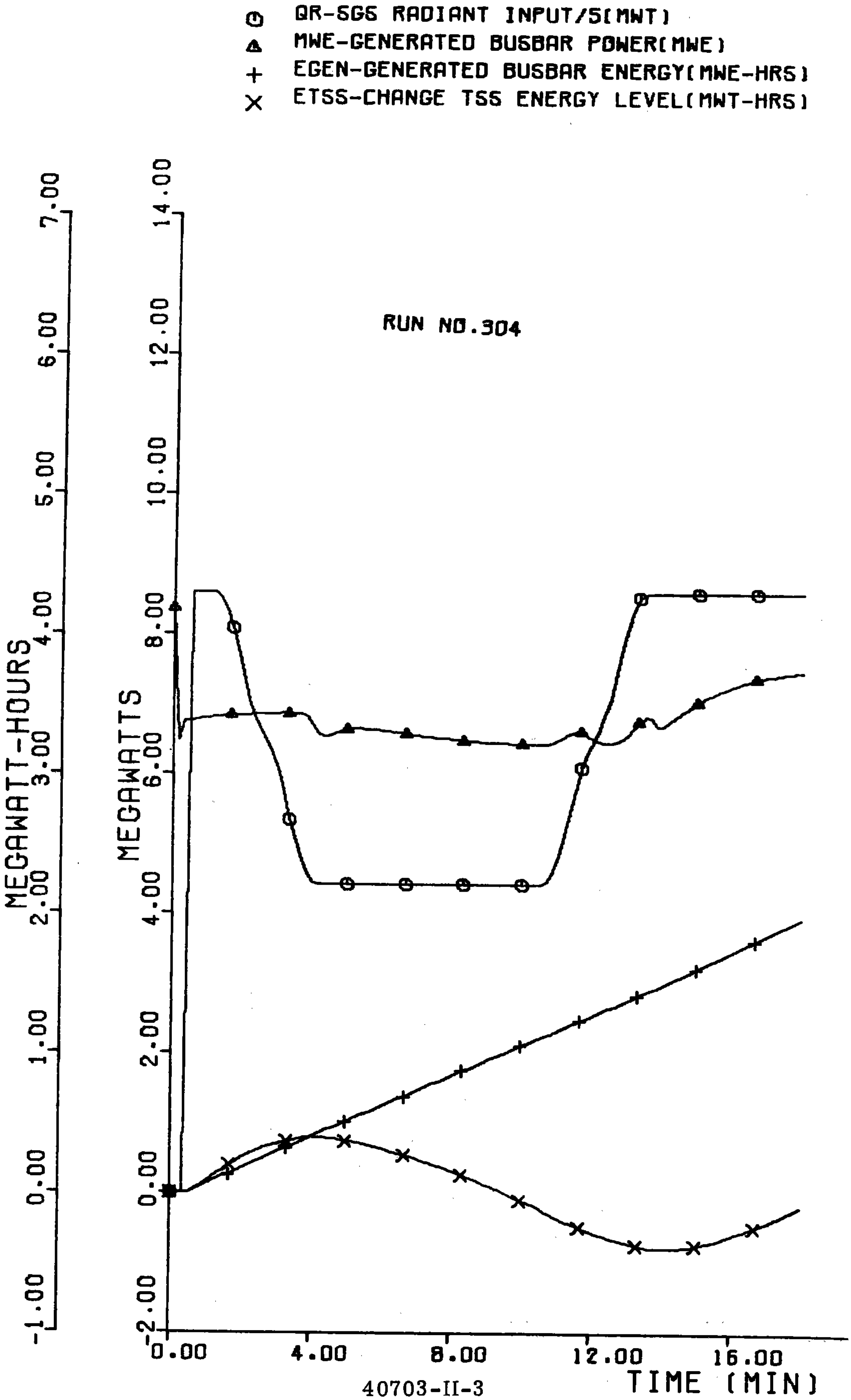
40703-II-3


MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.304
ENERGY(MEGAWATT-HOURS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
POWER(MEGAWATTS)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
PER UNIT
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

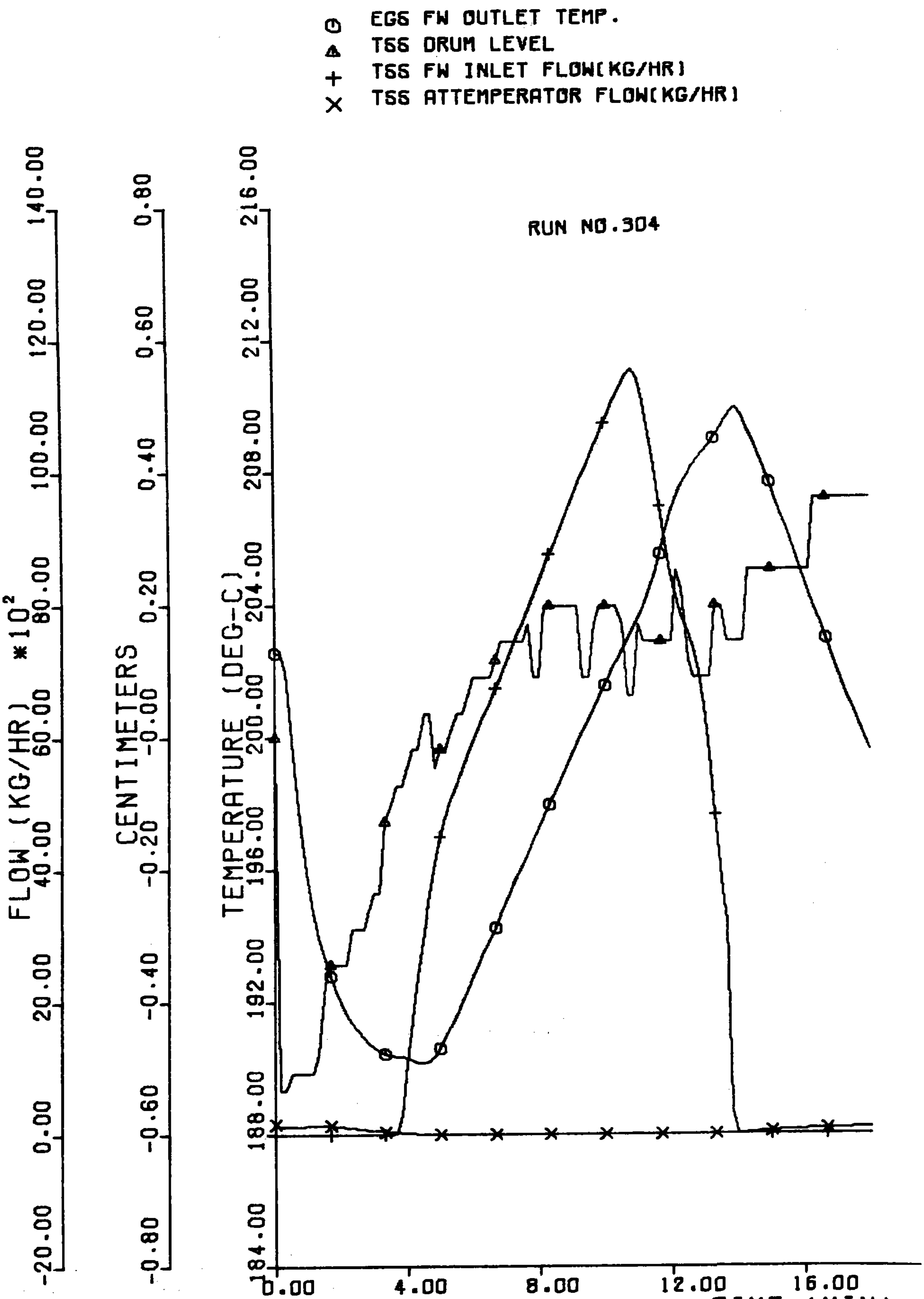
40703-II-3

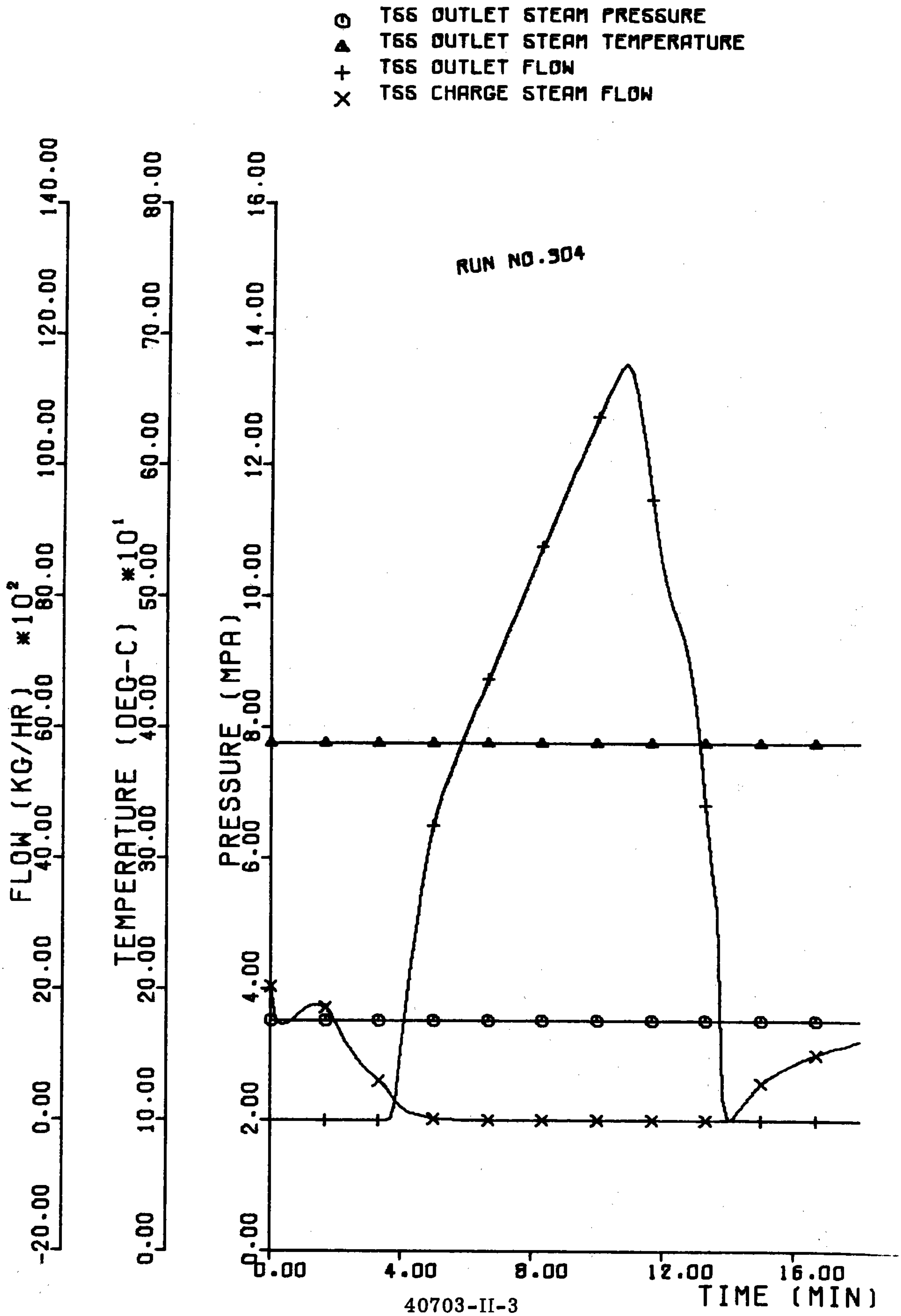

MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.304
ERROR(P.U.)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
COMMANDS(PER UNIT)
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.304
MEGAWATT-HOURS
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
MEGAWATTS
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3


EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.304
FLOW (KG/HR) *10²
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
-0.80
-0.60
-0.40
-0.20
-0.00
0.20
0.40
0.60
0.80
184.00
188.00
192.00
196.00
200.00
204.00
208.00
212.00
216.00
0.00
4.00
8.00
12.00
16.00


TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
RUN NO.304
FLOW (KG/HR) *10²
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
TEMPERATURE (DEG-C) *10¹
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
PRESSURE (MPA)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3

Run No.	305
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Cloud approaching from West entering field at t=3 min:

Speed = 21.9 Km/hr (13.6 mph)
Length = 1.8 Km (1.12 mi)

Field Coverage: North 1/2

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	125.589	146.738	71.170	36.81	43.01	20.86
NET OUTPUT POWER OF SGS TO-						
TOTAL	116.918	157.610	49.869	34.27	46.20	14.62
EGS	85.000	96.688	50.318	24.91	28.34	14.75
TSS	28.918	53.051	0.001	8.48	15.55	0.00
NET TSS POWER TO EGS	8.697	39.748	-0.009	2.55	11.65	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.97	9.90	7.85
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				13303710.	16053.	5863.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 7265.9 TO TSS 2472.0 FROM TSS

TOTAL RADIANT ENERGY IN= 10735.6KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9065

NET CHANGE IN TSS ENERGY 1670.94(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.03(MW-HRSE)

40703-11-3

4-49

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	376.5	391.9	371.7
TD-DRUM TEMP	605.5	614.4	589.8
TPSHO-PSH TEMP OUT	845.6	978.2	773.3
TSSHO-SSH TEMP OUT	964.8	993.0	949.2
TPSHM-PSH METAL TEMP	896.8	1045.1	816.2
TSSHM-SSH METAL TEMP	1010.2	1052.4	979.4
PSH METAL TEMP RATE	79.1	3548.0	-4115.7
SSH METAL TEMP RATE	33.7	1732.1	-1119.9
PPSHO-PSH PRES.OUT	1544.0	1616.2	1418.5
PSSHO-SSH PRES.OUT	1479.2	1523.3	1405.6
PD-DRUM PRES	1606.7	1711.3	1428.3
DELTA DRUM LEVEL	1.53	7.58	-1.03
PHPNCI-HP NOZ PRES	1453.9	1492.6	1397.1

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	569.9	570.0	569.8
TOIL-MAIN OIL TEMP	479.9	480.0	479.9
DDRUM-DELTA DRUM LEV	0.1	0.3	-0.2
PDRUM-DRUM PRESSURE	581.3	589.6	560.6
TPREH-PREHEATER TEMP	479.7	481.6	475.0
TDSH-DESUPER-TEMP	0.	0.	0.

305-2

MISCELLANEOUS RECEIVER CAVITY TERMS

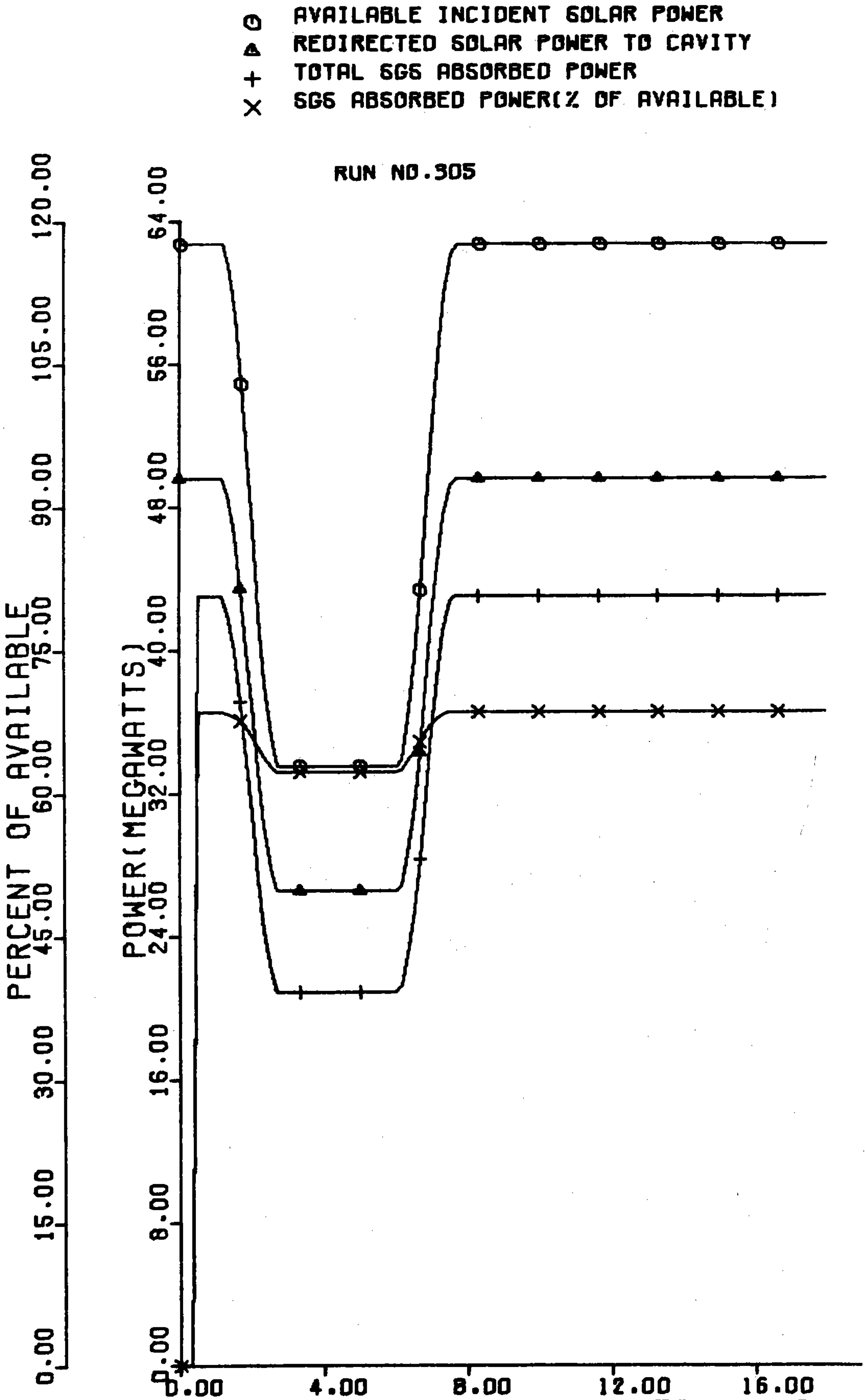
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.8530	0.9807	0.5243
QINC-INCIDENT AVAILABLE POWER(MWT)	54.5226	62.6863	33.5150
QRDB-REDIRECTED POWER TO BOILER(MWT)	25.5138	31.5154	10.0702
QBDP-REDIRECTED POWER TO PSH(MWT)	6.7858	7.1943	5.7344
QRDS-REDIRECTED POWER TO SSH(MWT)	5.6193	5.6700	5.4888
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	43.1494	49.6101	26.5239
QABB-ABSORBED POWER ON BOILER(MWT)	24.3255	29.9705	9.7995
QABP-ABSORBED POWER ON PSH(MWT)	6.7934	7.2478	5.6244
QABS-ABSORBED POWER ON SSH(MWT)	5.6913	5.7905	5.4360
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.3145	5.3834	5.1369
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1578	0.1873	0.0818
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	42.2826	48.5795	26.0786
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	52.8570	65.1230	21.2933
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	14.7615	15.7487	12.2213
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.3667	12.5823	11.8118
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	79.985	93.454	45.326
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.776	0.778	0.775
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.980	0.983	0.979
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	55.054	-55.065
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	-0.000	8.316	-8.317
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	1.874	-1.874
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	-0.000	65.244	-65.257
TCAV1-CEILING TEMPERATURE(DEG-F)	1266.3	1554.0	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.3	652.7	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 15.918

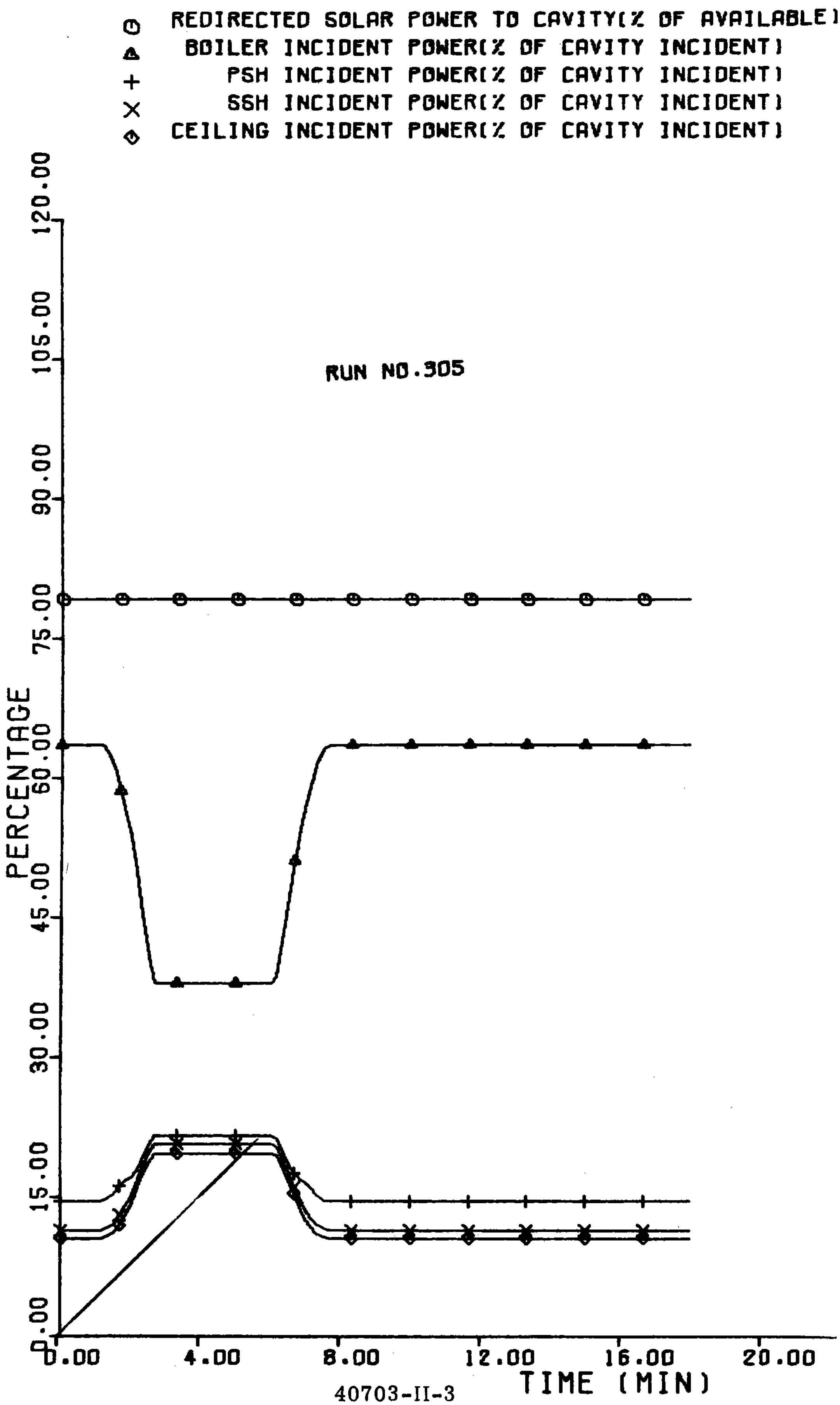
REDIRECTED ENERGY(MWT-HRS),TOTAL= 12.60BOILER= 7.45PSH= 1.98SSH= 1.64CEILING= 1.53

ABSORBED ENERGY(MWT-HRS),BOILER= 7.10PSH= 1.98SSH= 1.66CEILING= 1.55FLOOR= 0.05TOTAL= 12.34

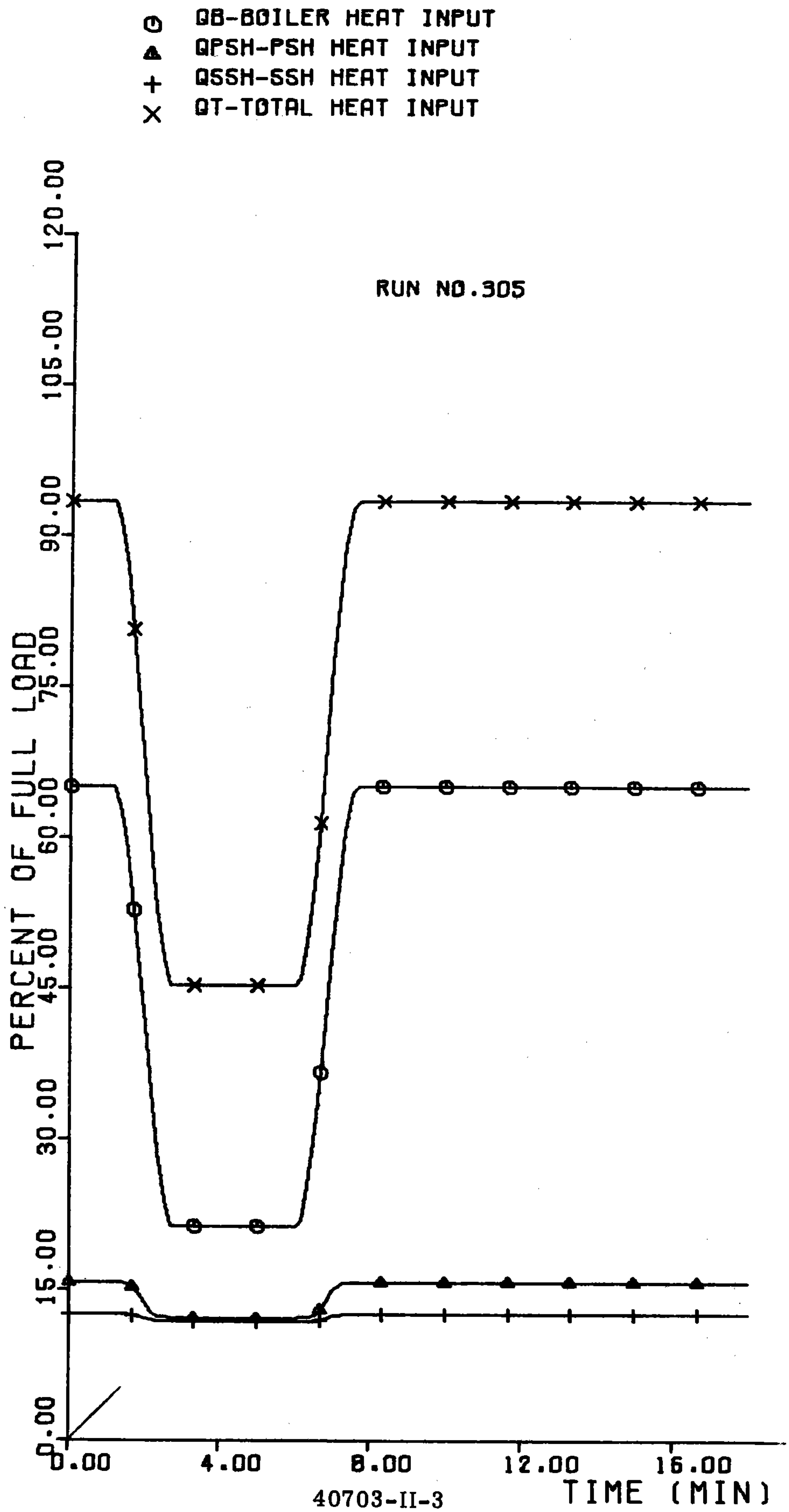
40703-II-3


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.305
PERCENT OF AVAILABLE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
POWER(MEGAWATTS)
0.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

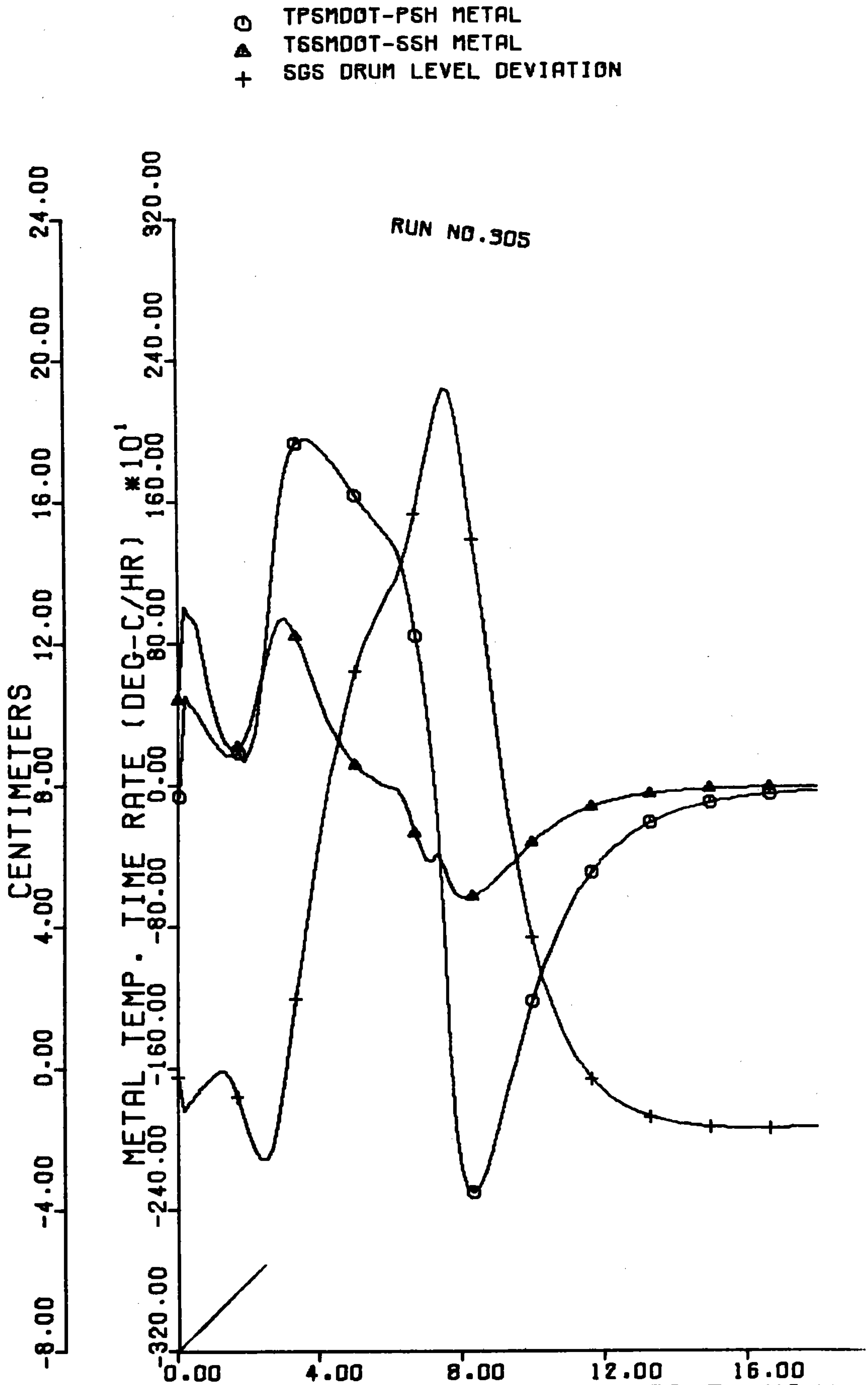
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.305
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
20.00
TIME (MIN)

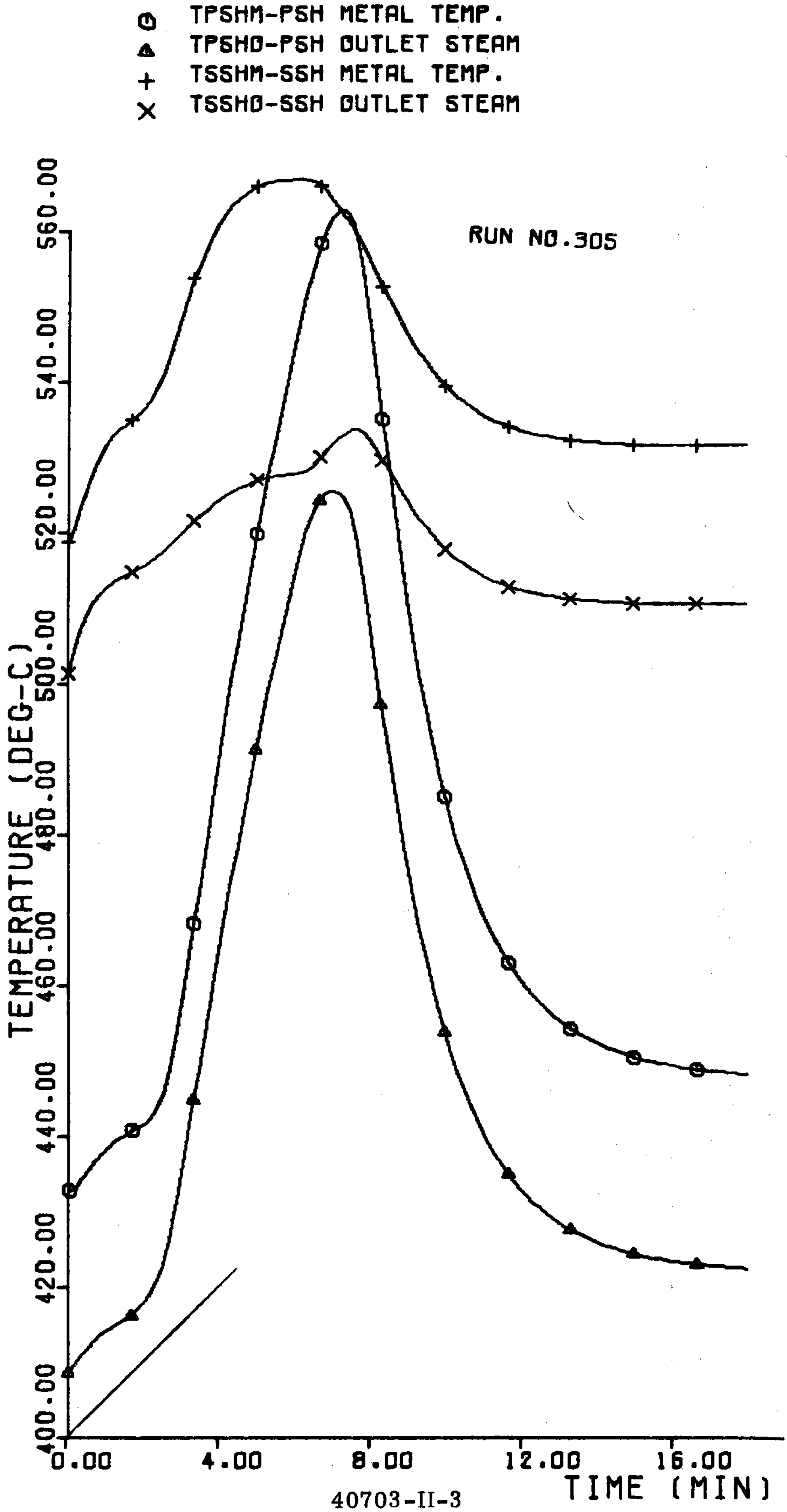
40703-II-3


QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.305
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3

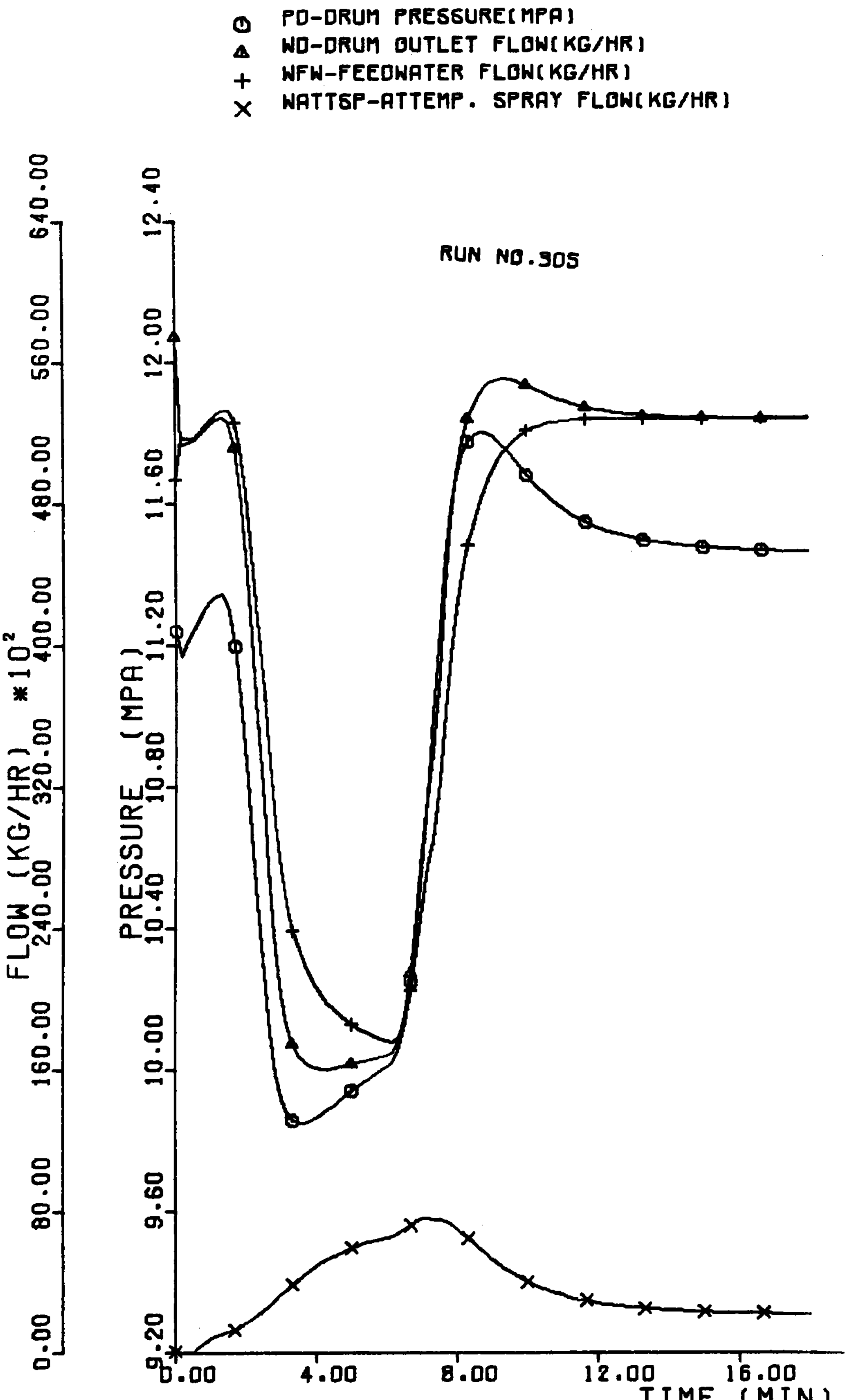

TPSMDOT-PSH METAL
T6SMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.305
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10[1]
24.00
20.00
16.00
12.00
8.00
4.00
0.00
-4.00
-8.00
320.00
240.00
160.00
80.00
0.00
-80.00
-160.00
-240.00
-320.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3

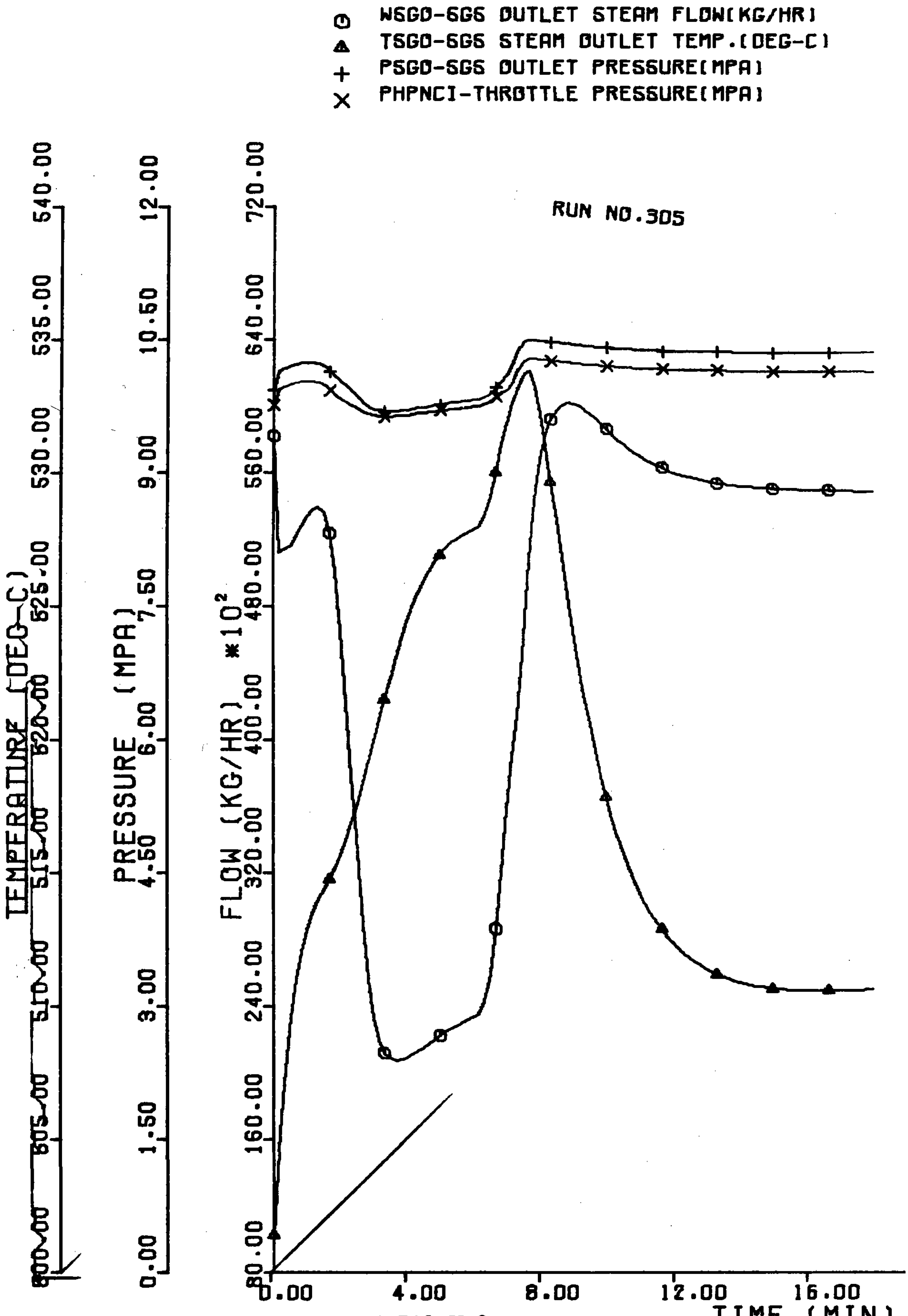


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.305
TEMPERATURE (DEG-C)
400.00
420.00
440.00
460.00
480.00
500.00
520.00
540.00
560.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

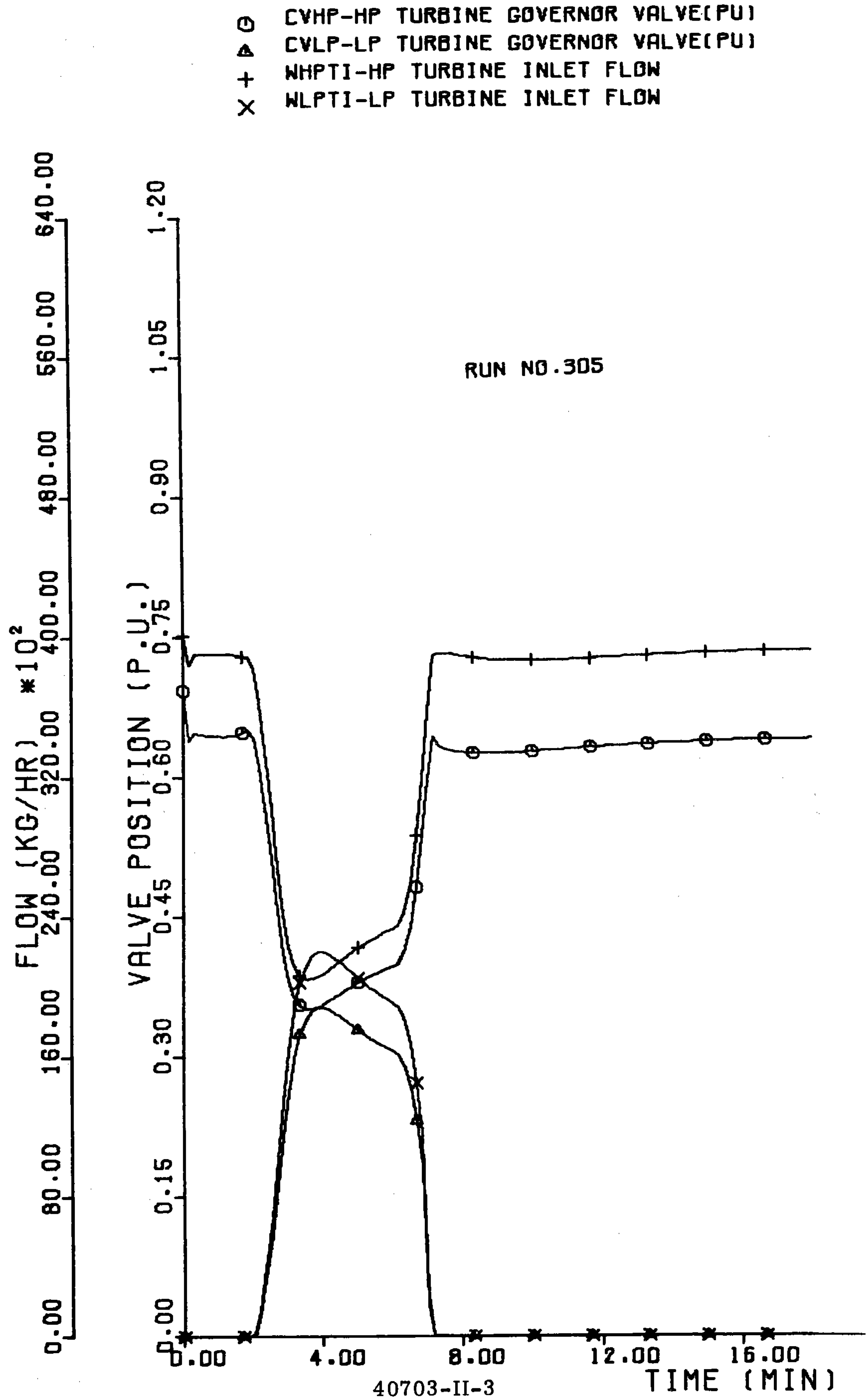
40703-II-3


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.305
FLOW (KG/HR) *10²
PRESSURE (MPA)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
12.40
0.00
4.00
8.00
12.00
16.00

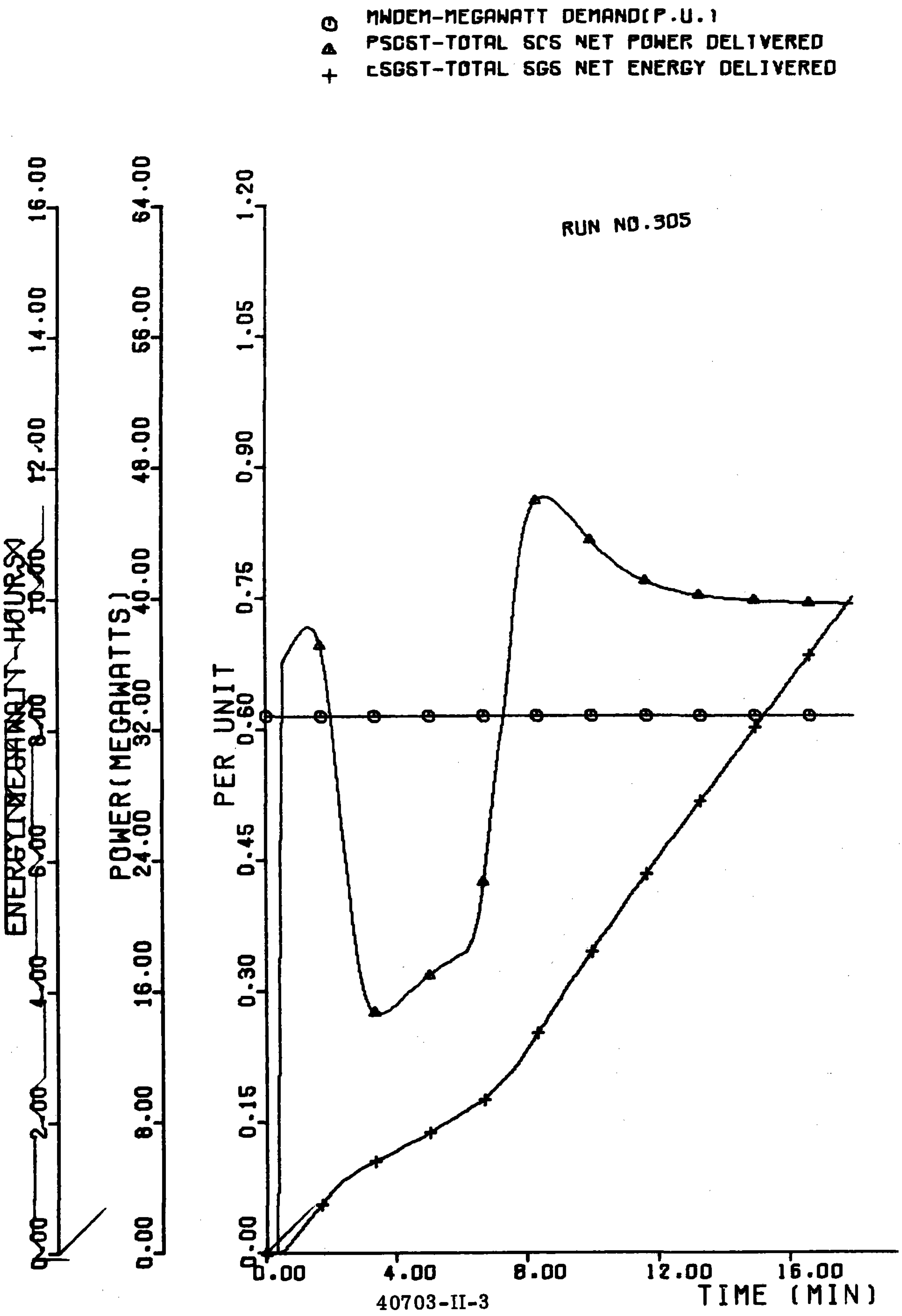
40703-II-3


WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.305
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10²
TIME (MIN)
540.00
535.00
530.00
525.00
520.00
515.00
510.00
505.00
500.00
12.00
10.50
9.00
7.50
6.00
4.50
3.00
1.50
0.00
720.00
640.00
560.00
480.00
400.00
320.00
240.00
160.00
80.00
0.00
4.00
8.00
12.00
16.00

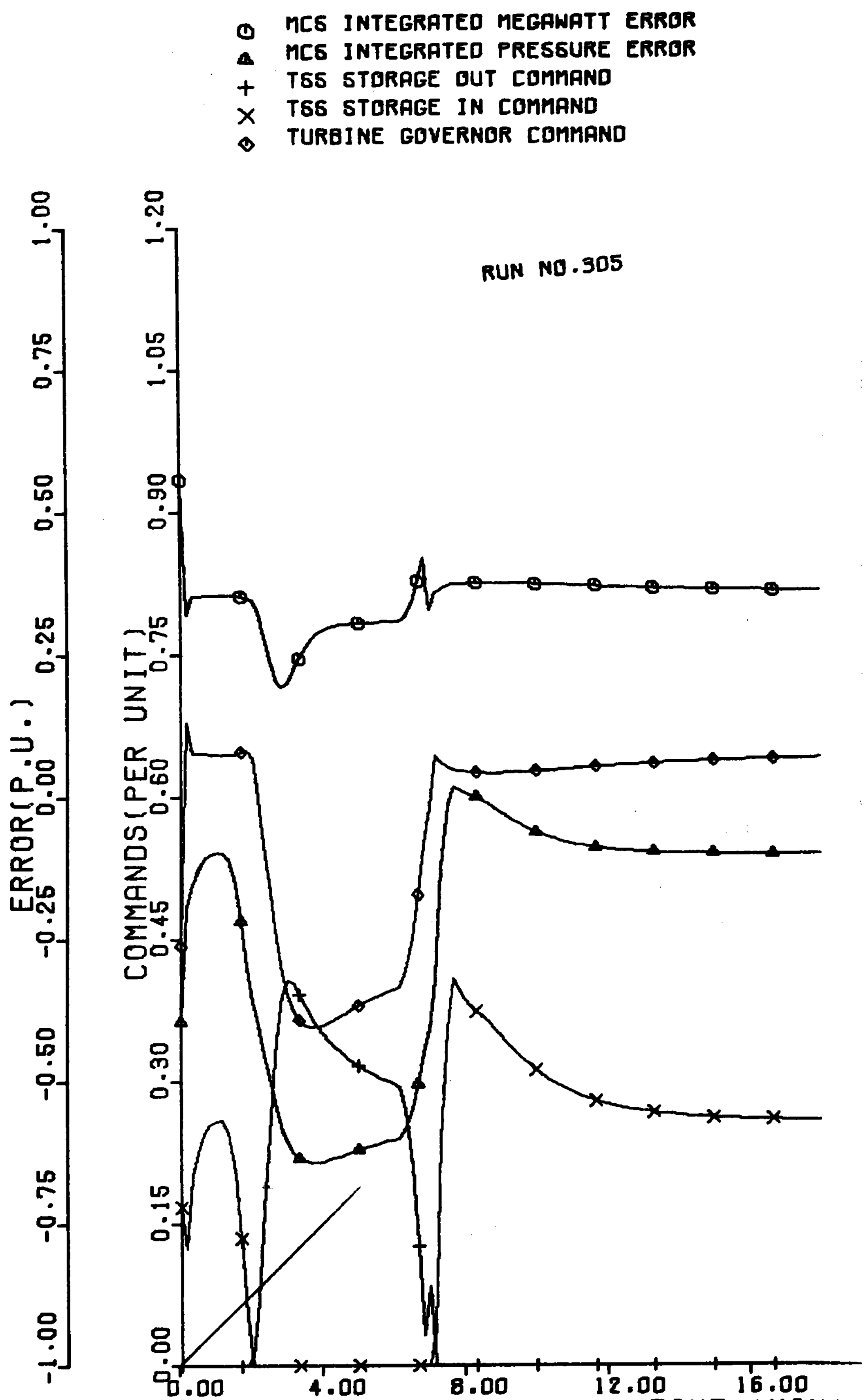
40703-II-3


CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.305
FLOW (KG/HR) *10²
VALVE POSITION (P.U.)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00

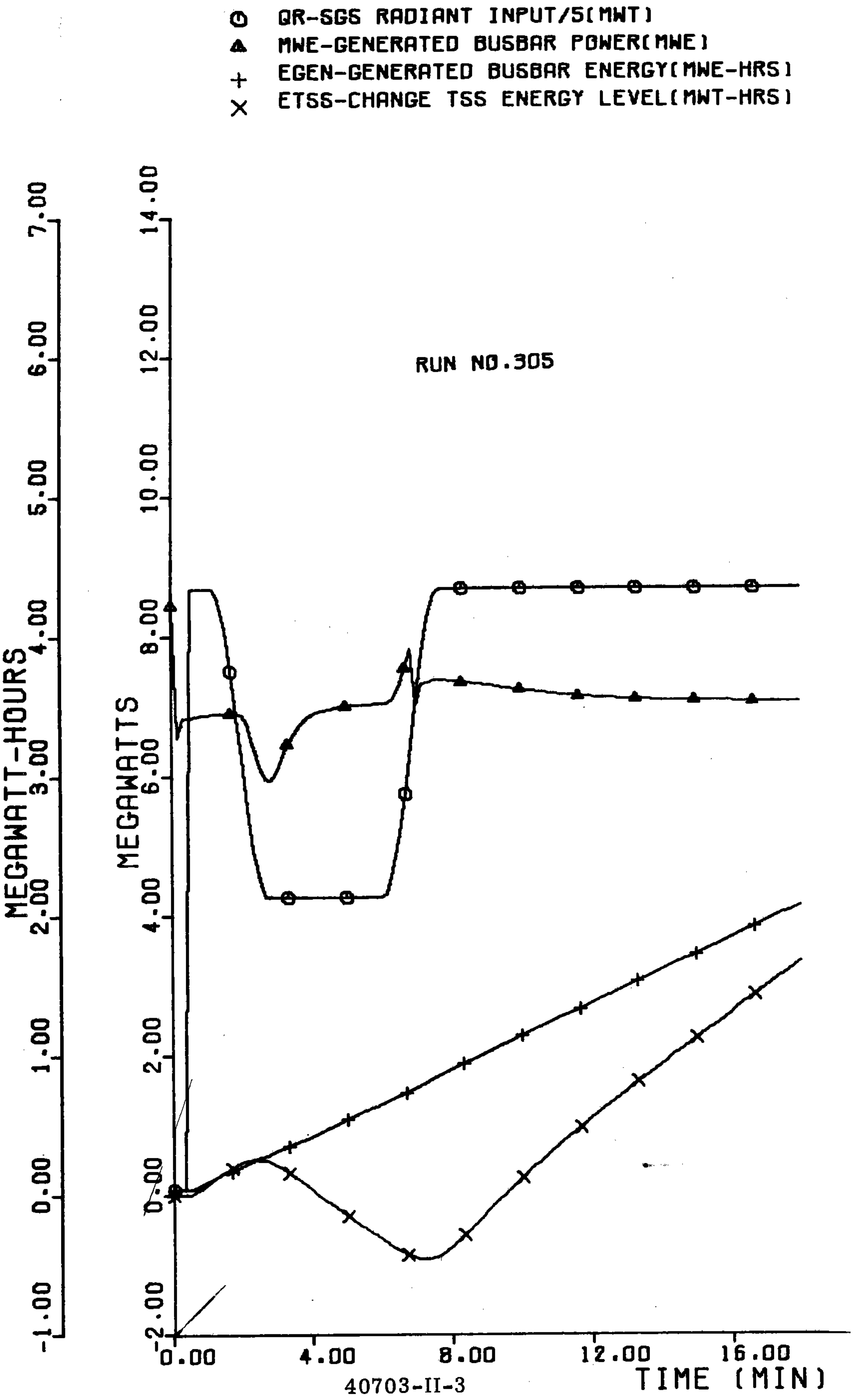
40703-II-3


MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.305
ENERGY(MEGAWATT-HOURS)
POWER(MEGAWATTS)
PER UNIT
TIME (MIN)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20

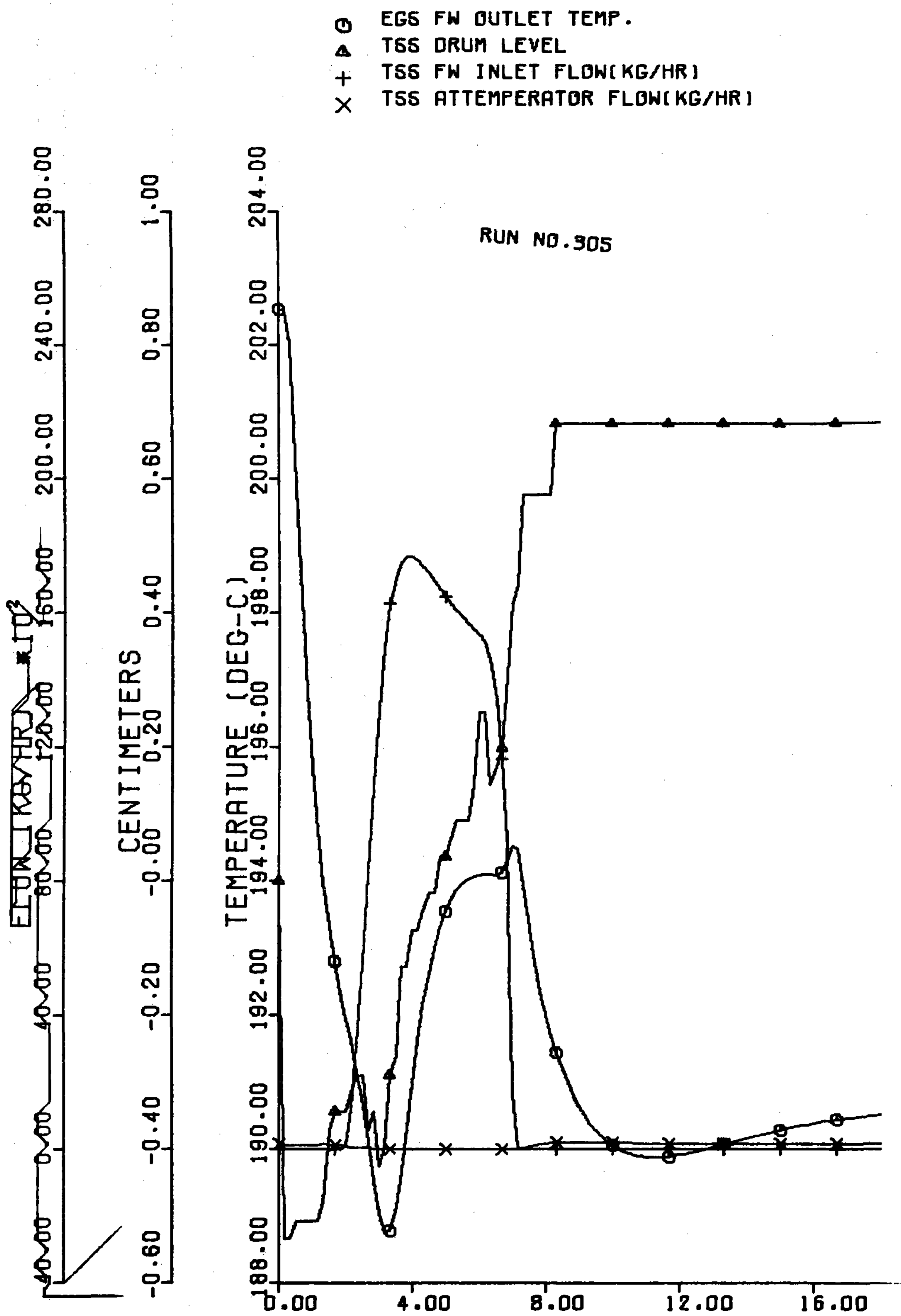
40703-II-3


MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.305
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
-1.00 -0.75 -0.50 -0.25 0.00 0.25 0.50 0.75 1.00
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20
0.00 4.00 8.00 12.00 16.00

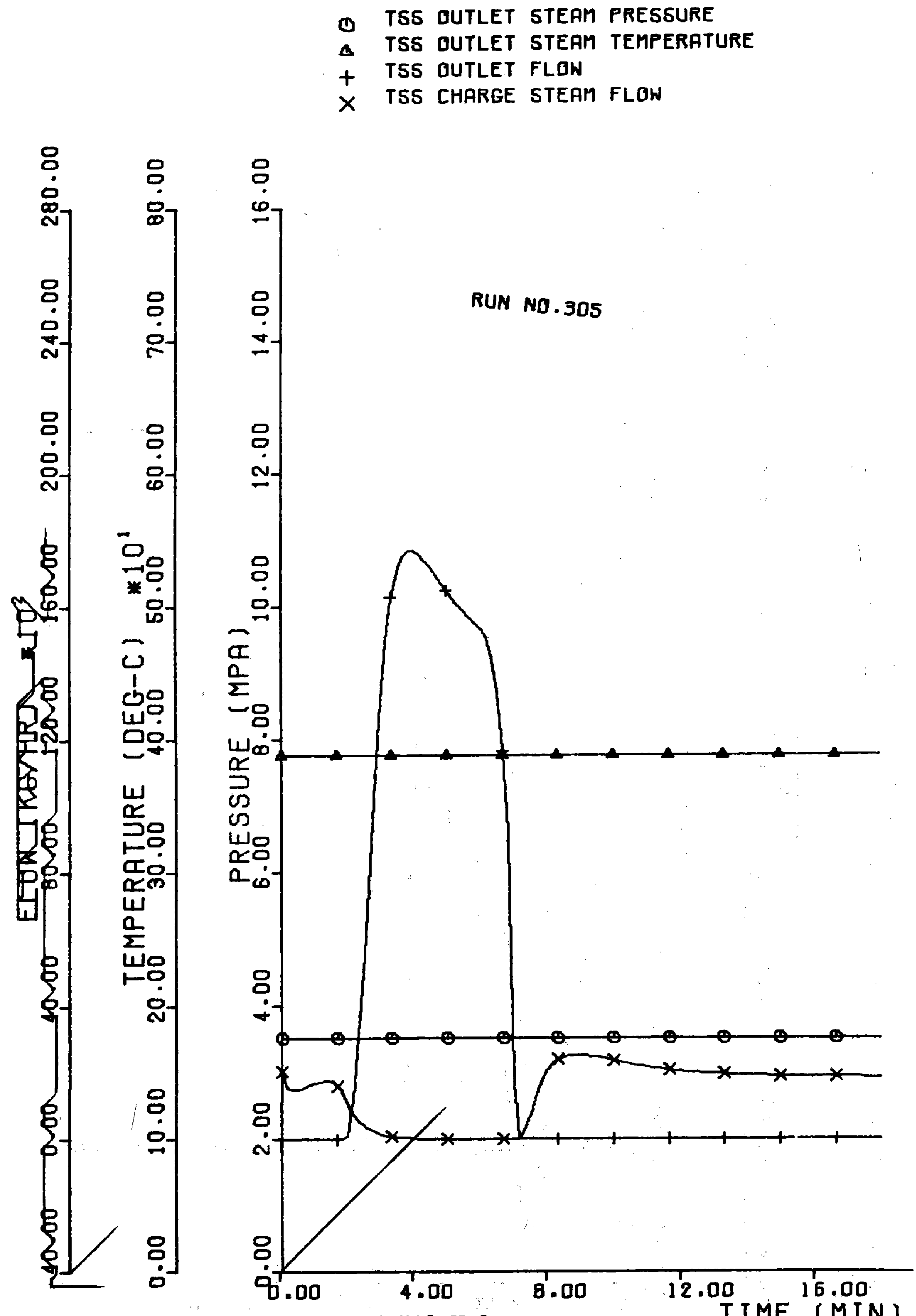
40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.305
MEGAWATT-HOURS
MEGAWATTS
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
0.00
4.00
8.00
12.00
16.00
TIME (MIN)

40703-II-3


EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.305
FLOW (KG/HR) ×10³
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
204.00
202.00
200.00
198.00
196.00
194.00
192.00
190.00
188.00
1.00
0.80
0.60
0.40
0.20
-0.00
-0.20
-0.40
-0.60
280.00
240.00
200.00
160.00
120.00
80.00
40.00
0.00
-40.00

40703-II-3


TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
RUN NO.305
PRESSURE (MPA)
TEMPERATURE (DEG-C) *10[1]
FLOW (KG/HR) *10[3]
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00

Run No.	306
Type of Run	Cloud Transient
Run Length	12 min
Run Description	Cloud approaching from West entering field at t=3 min: Speed = 21.9 Km/hr (13.6 mph) Length = 1.8 Km (1.12 mi) Field Coverage: South 1/2

SUMMARY OF SPP PERFORMANCE (RUN NO 306.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	116.444	146.738	75.568	34.13	43.01	22.15
NET OUTPUT POWER OF SGS TO-						
TOTAL	105.922	130.613	76.540	31.05	38.28	22.43
EGS	92.779	105.122	76.640	27.19	30.81	22.46
TSS	12.918	36.076	0.001	3.79	10.57	0.00
NET TSS POWER TO EGS	4.372	15.586	-0.001	1.28	4.57	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.77	9.19	8.54
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				8303710.	14740.	8954.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 5214.3 TO TSS 726.0 FROM TSS

TOTAL RADIANT ENERGY IN= 6544.3KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9071

NET CHANGE IN TSS ENERGY 470.98(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 1.30(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	384.2	392.5	374.2
TD-DRUM TEMP	604.6	610.6	597.6
TPSHO-PSH TEMP OUT	725.9	779.9	656.0
TSSHO-SSH TEMP OUT	869.9	958.0	754.0
TPSHM-PSH METAL TEMP	759.5	824.1	675.9
TSSHM-SSH METAL TEMP	895.4	994.4	771.8
PSH METAL TEMP RATE	16.1	4334.0	-4173.2
SSH METAL TEMP RATE	53.9	4132.5	-4281.7
PPSHO-PSH PRES.OUT	1535.9	1584.2	1480.5
PSSHO-SSH PRES.OUT	1481.2	1513.5	1448.7
PD-DRUM PRES	1594.7	1664.8	1513.8
DELTA DRUM LEVEL	0.32	1.72	-0.74
PHPNCI-HP NOZ PRES	1448.0	1469.9	1423.4

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.0	570.0	570.0
TOIL-MAIN OIL TEMP	480.0	480.0	480.0
DDRUM-DELTA DRUM LEV	0.0	0.2	-0.2
PDRUM-DRUM PRESSURE	573.7	579.8	566.0
TPREH-PREHEATER TEMP	479.7	480.4	478.5
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS 306-2

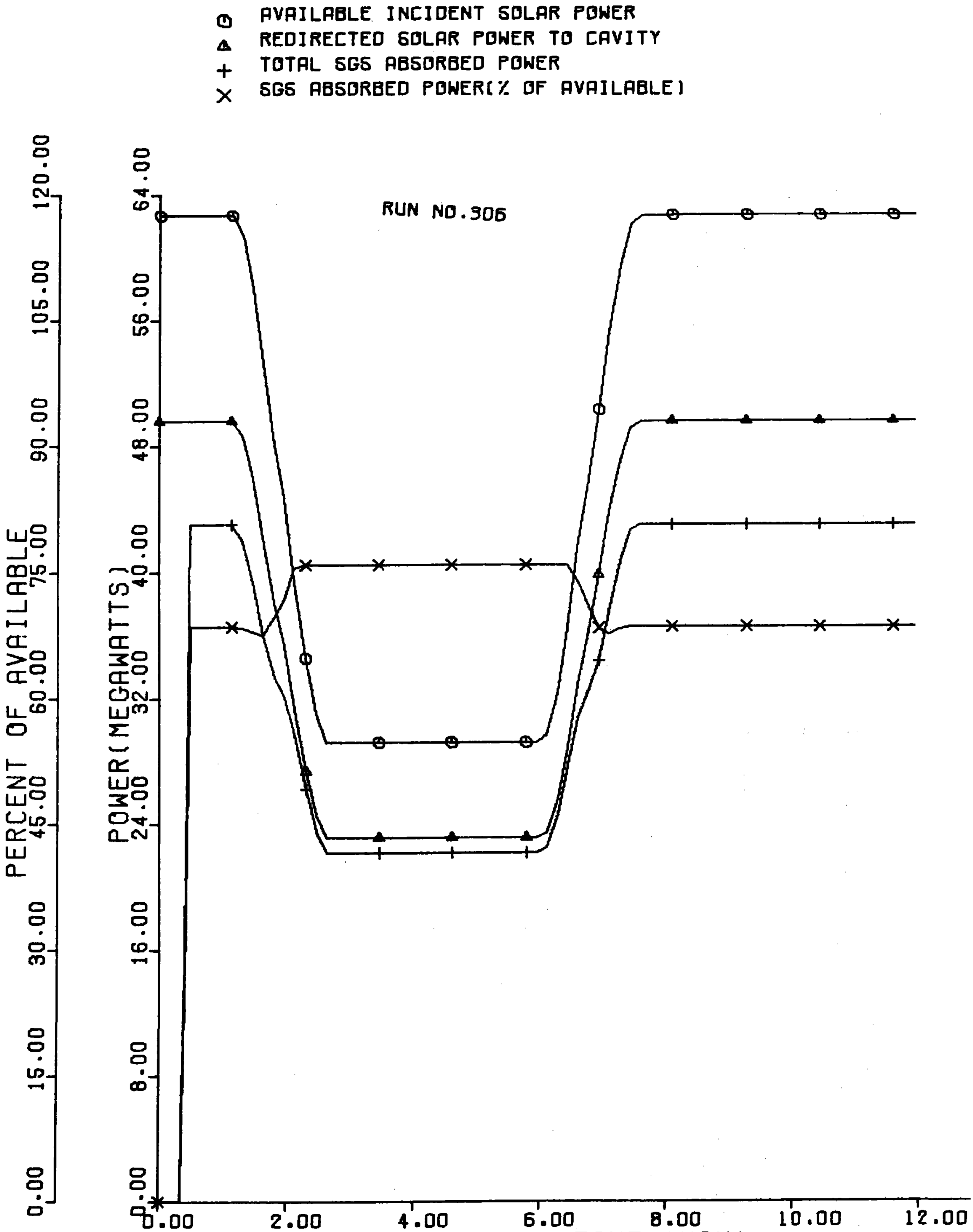
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.7575	0.9807	0.4564
QINC-INCIDENT AVAILABLE POWER(MWT)	48.4205	62.6863	29.1713
QRDB-REDIRECTED POWER TO BOILER(MWT)	27.2289	31.5154	21.4452
QBDP-REDIRECTED POWER TO PSH(MWT)	4.7534	7.1943	1.4599
QRDS-REDIRECTED POWER TO SSH(MWT)	3.3336	5.6700	0.1811
QRDC-REDIRECTED POWER TO CEILING(MWT)	3.0040	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	38.3200	49.6101	23.0863
QABB-ABSORBED POWER ON BOILER(MWT)	25.7993	29.9705	20.1710
QABP-ABSORBED POWER ON PSH(MWT)	4.8537	7.2478	1.6233
QABS-ABSORBED POWER ON SSH(MWT)	3.4767	5.7905	0.3546
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	3.1969	5.3834	0.2465
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1524	0.1873	0.1054
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	37.4790	48.5795	22.5009
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	56.0593	65.1230	43.8297
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	10.5466	15.7487	3.5273
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.5545	12.5823	0.7705
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	74.160	93.454	48.127
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.773	0.775	0.771
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.977	0.980	0.975
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.000	28.819	-28.819
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	-0.000	21.495	-21.495
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.000	21.896	-21.896
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	-0.000	49.486	-49.486
TCAV1-CEILING TEMPERATURE(DEG-F)	1070.4	1208.3	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.9	651.8	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 9.294

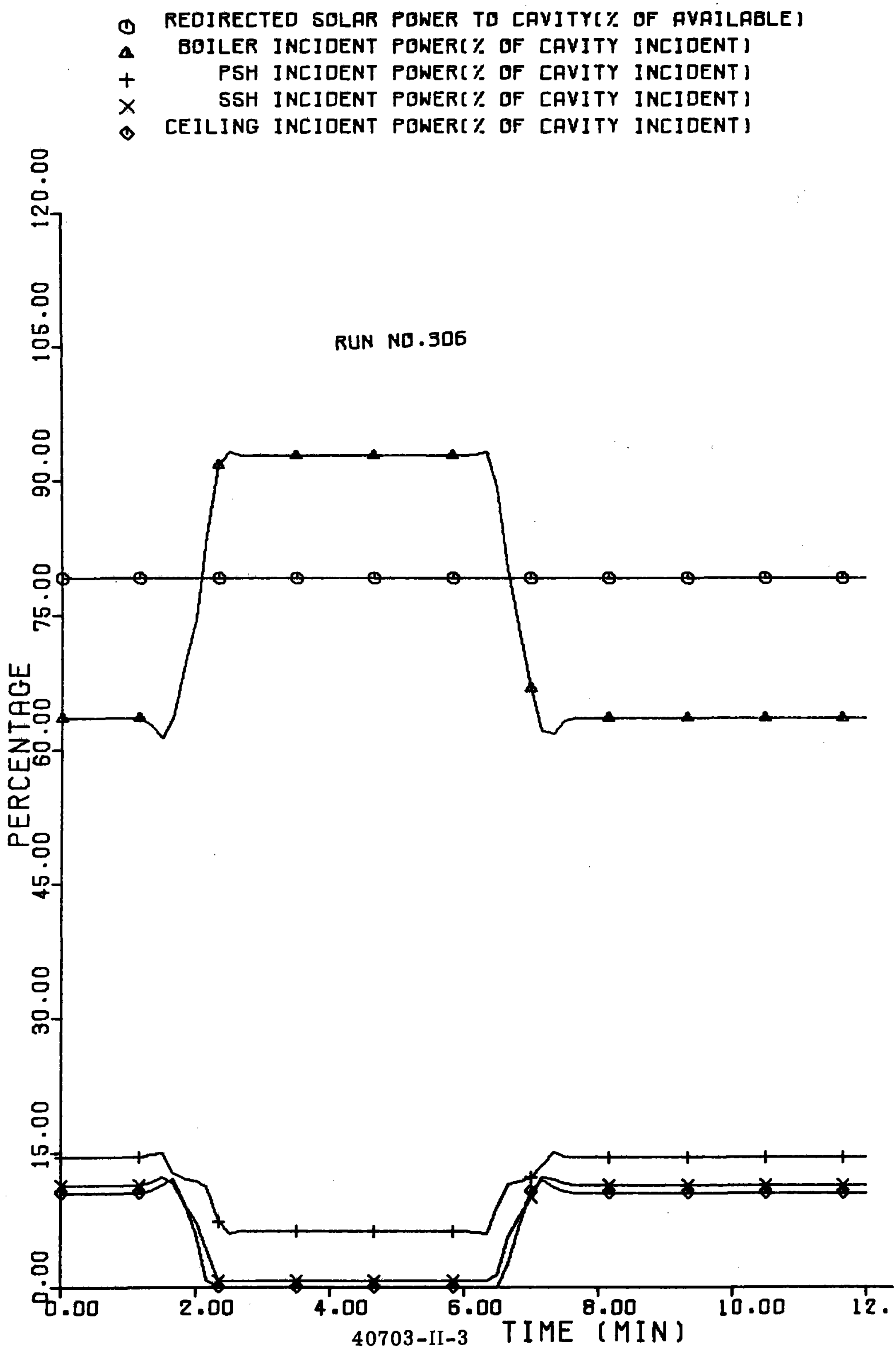
REDIRECTED ENERGY(MWT-HRS),TOTAL= 7.36BOILER= 5.23PSH= 0.91SSH= 0.64CEILING= 0.58

ABSORBED ENERGY(MWT-HRS),BOILER= 4.95PSH= 0.93SSH= 0.67CEILING= 0.61FLOOR= 0.03TOTAL= 7.19

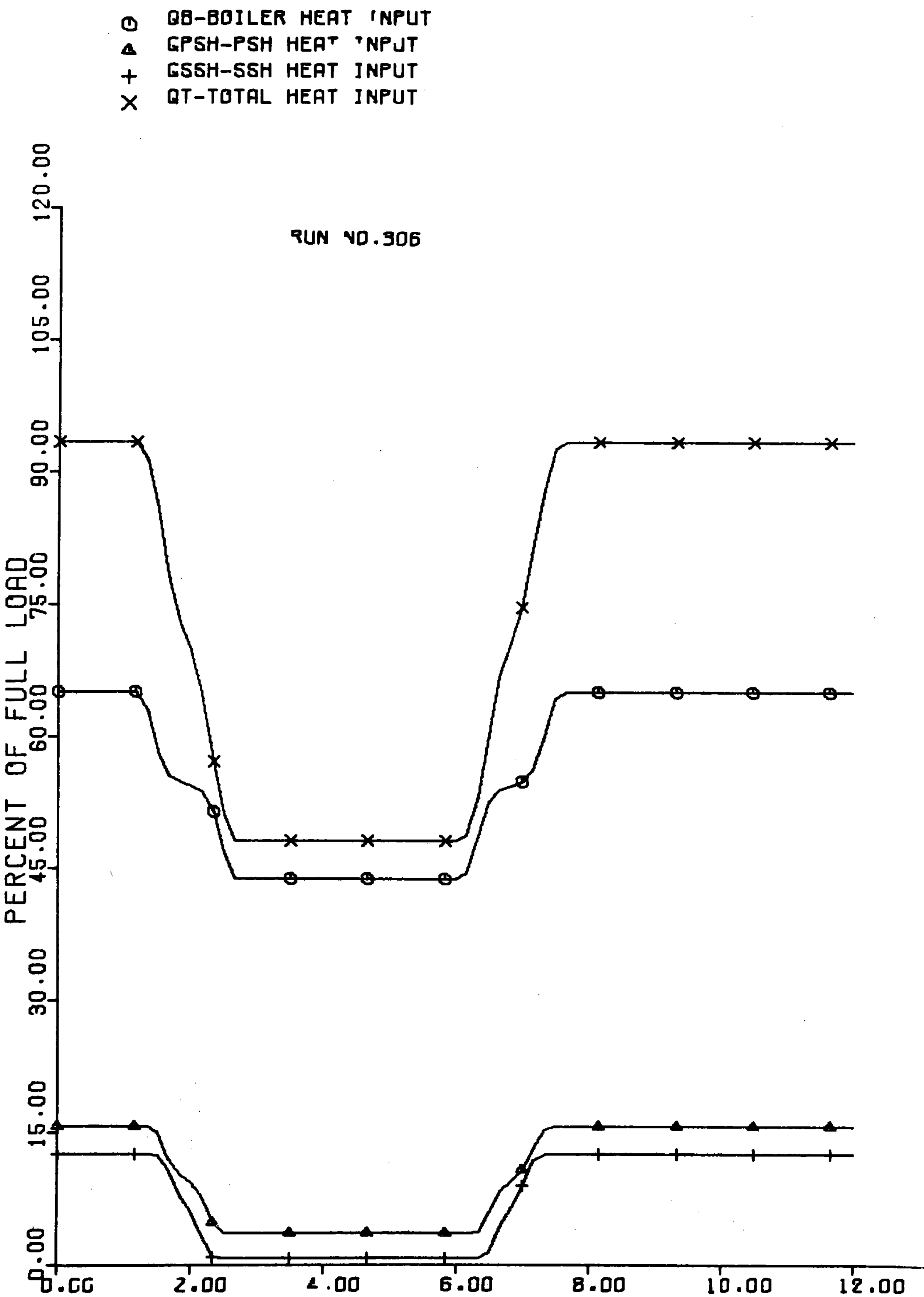
407D3-11-3


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.306
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
2.00
4.00
6.00
10.00
12.00

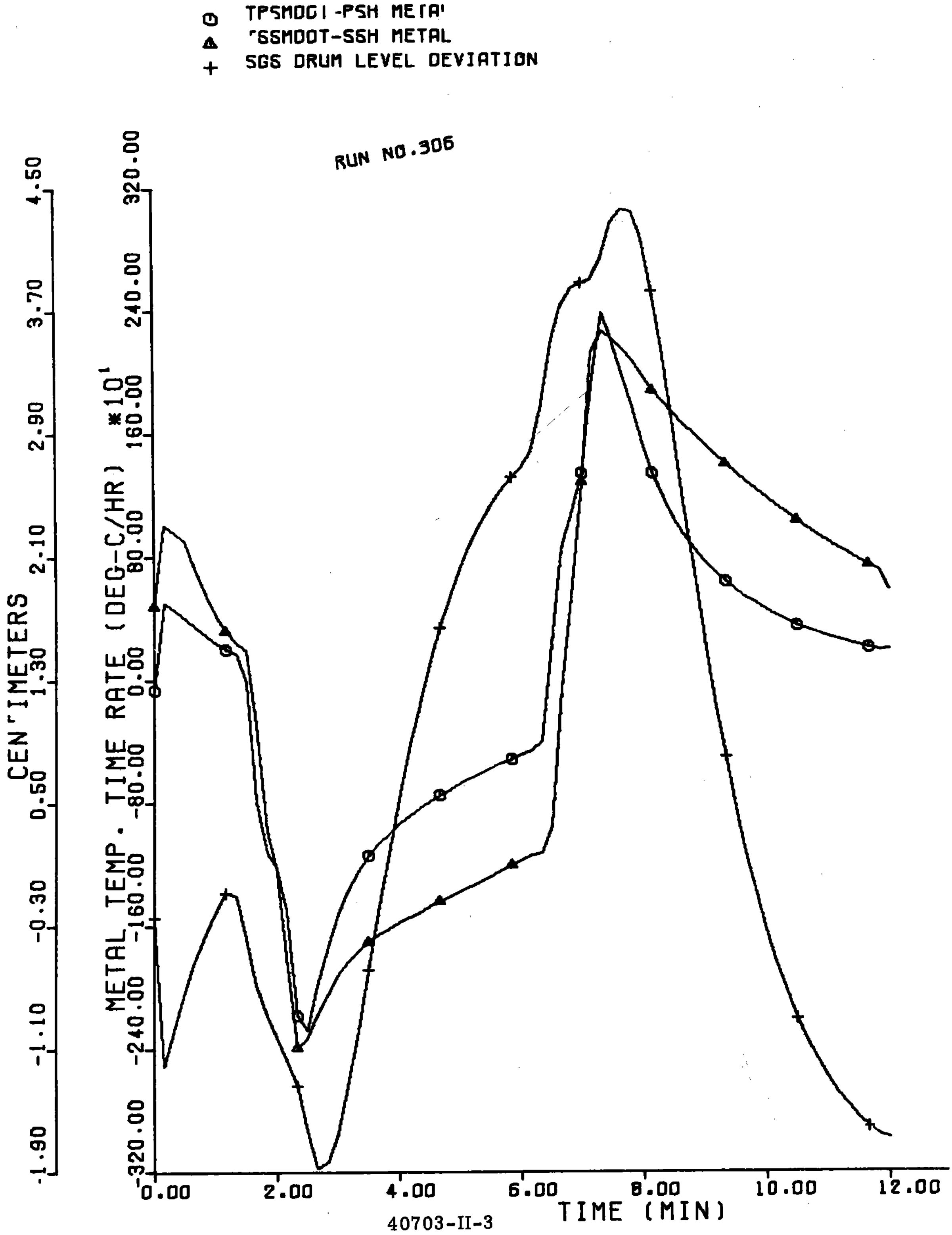
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.306
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
2.00
4.00
6.00
8.00
10.00
12.
TIME (MIN)

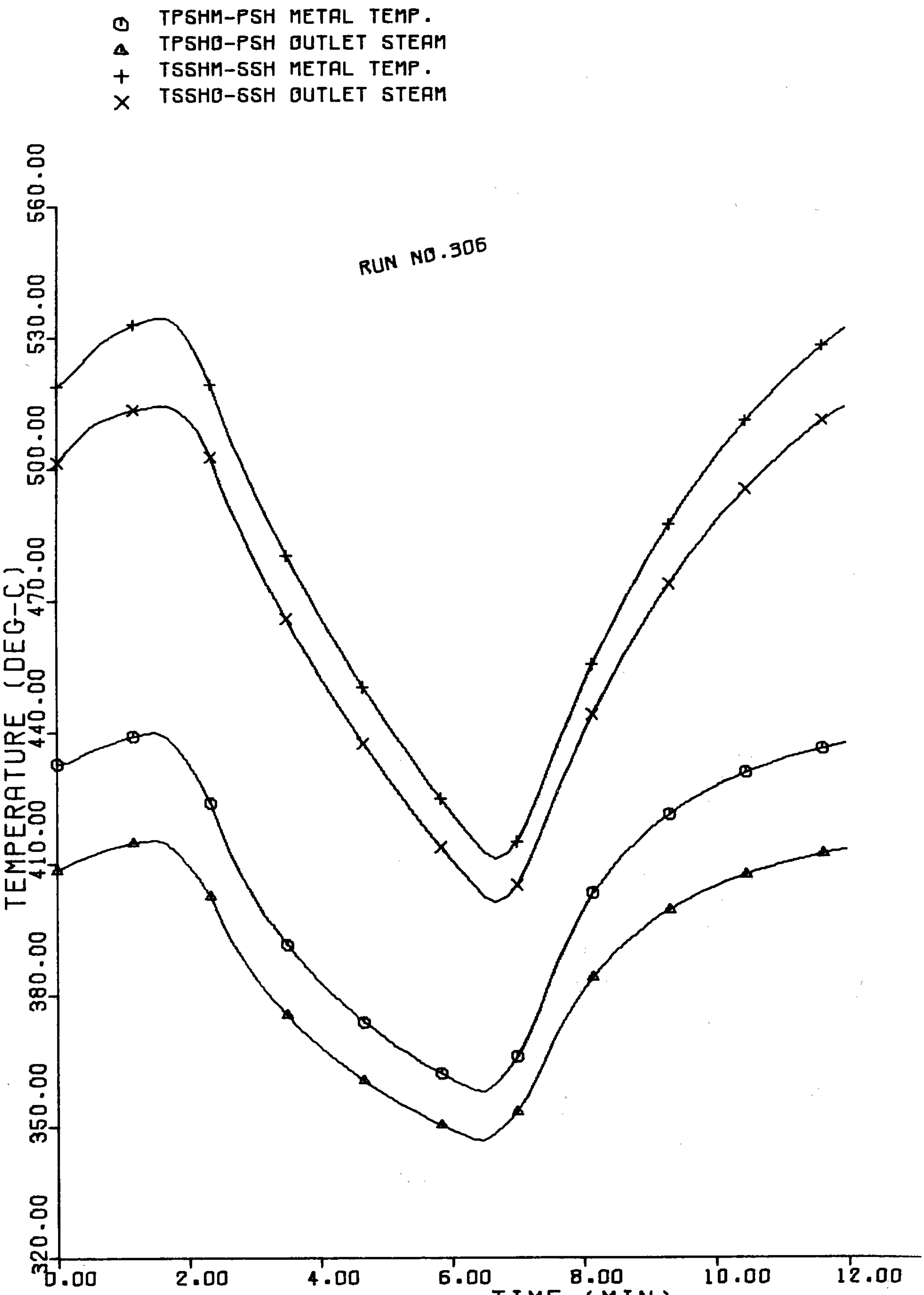
40703-II-3


QB-BOILER HEAT INPUT
GPSH-PSH HEAT INPUT
GSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.306
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

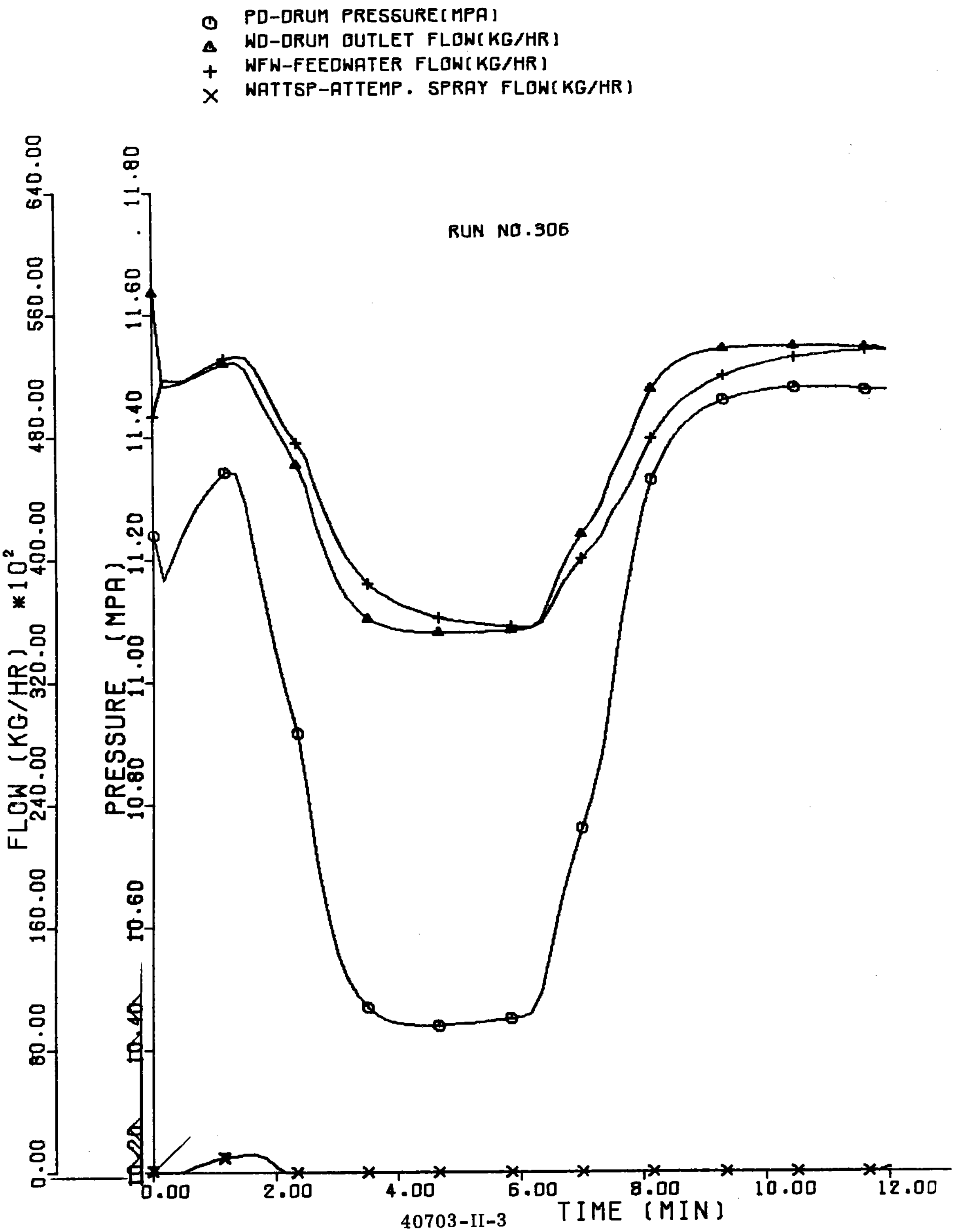
40703-II-3


TPSMDGI-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.306
CENTIMETERS
4.50
3.70
2.90
2.10
1.30
0.50
-0.30
-1.10
-1.90
METAL TEMP. TIME RATE (DEG-C/HR) *10[1]
320.00
240.00
160.00
80.00
0.00
-80.00
-160.00
-240.00
-320.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

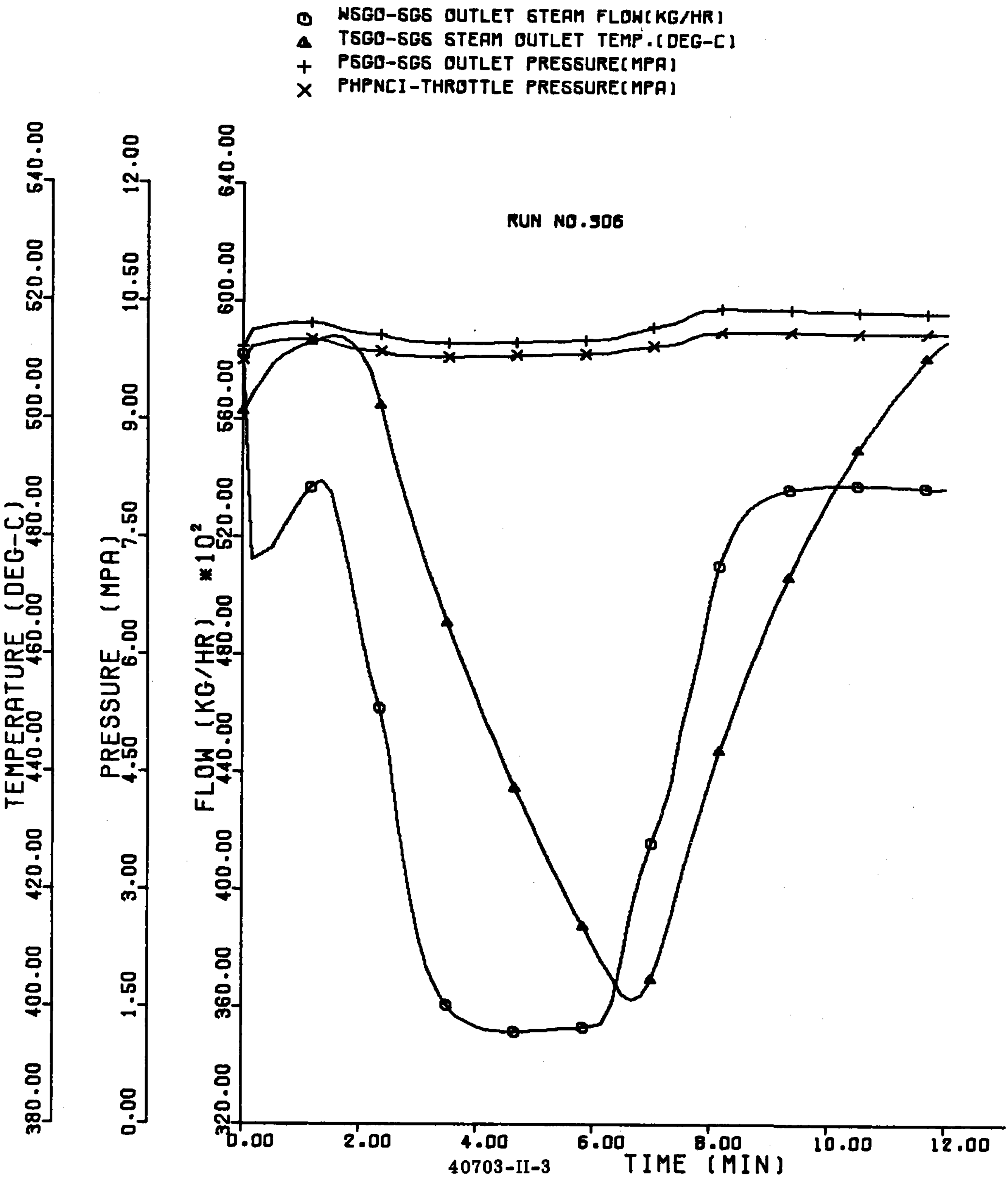
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.306
TEMPERATURE (DEG-C)
560.00
530.00
500.00
470.00
440.00
410.00
380.00
350.00
320.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

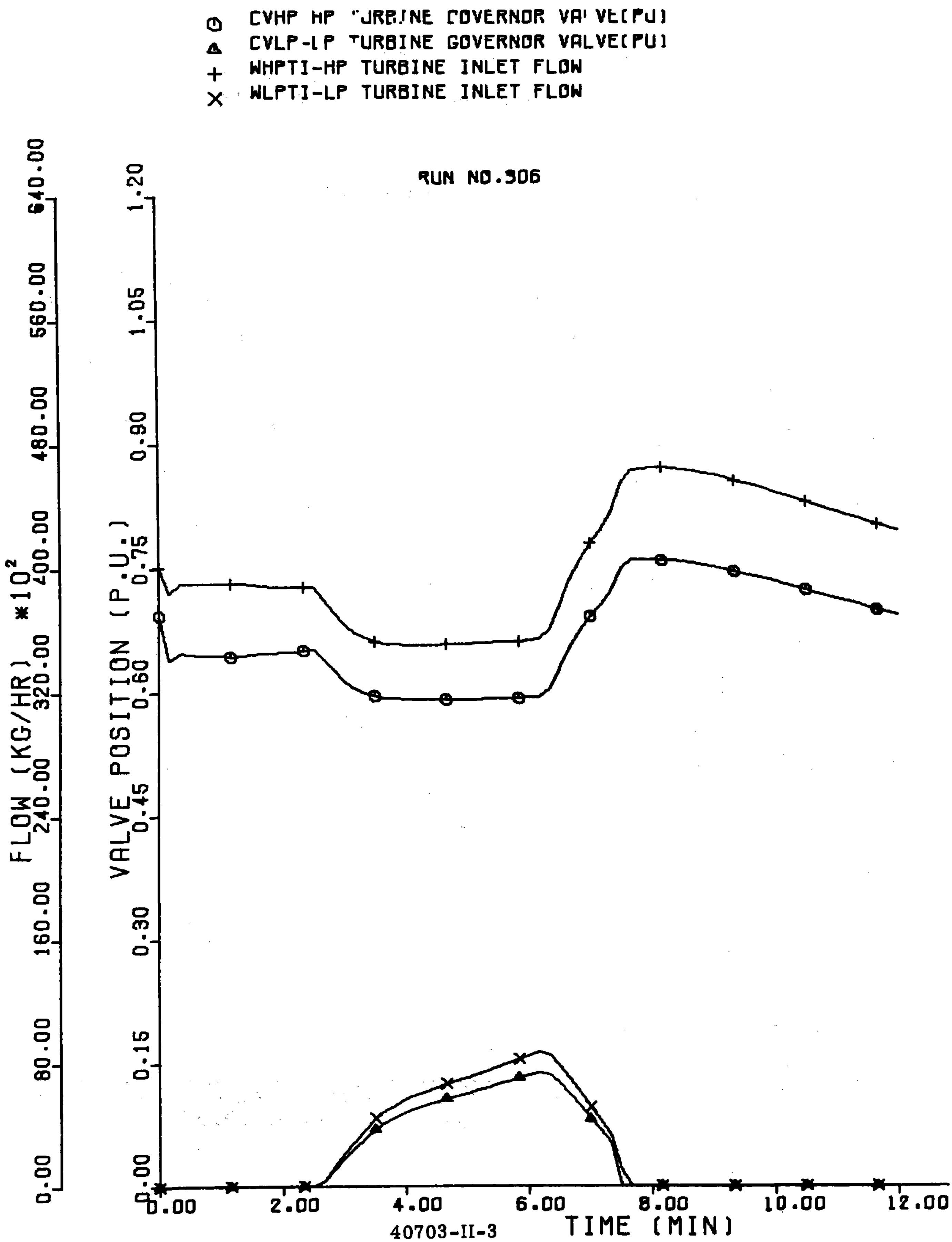
40703-II-3


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.306
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
10.40
10.60
10.80
11.00
11.20
11.40
11.60
11.80
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

40703-II-3

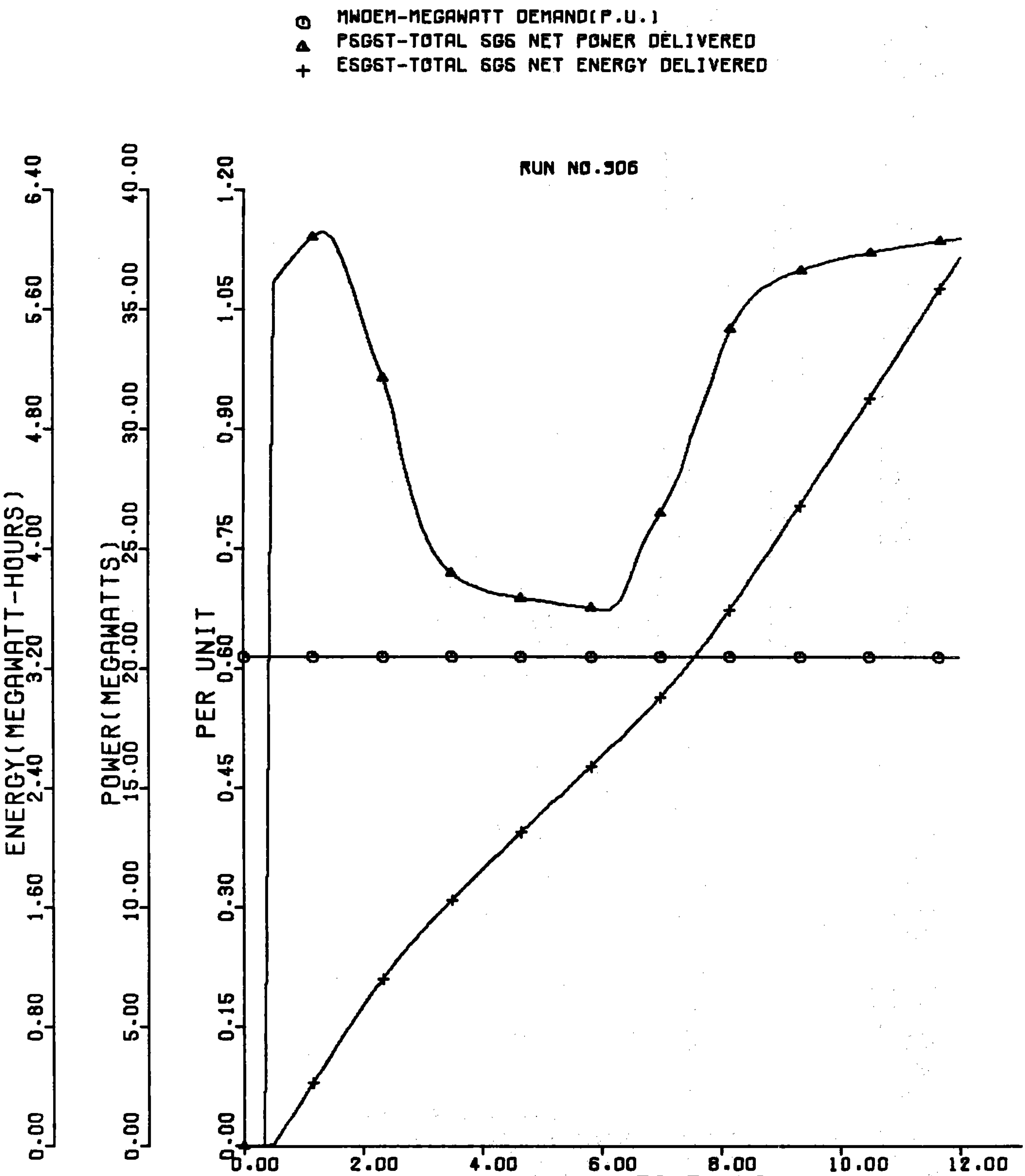

WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.306
TEMPERATURE (DEG-C)
380.00 400.00 420.00 440.00 460.00 480.00 500.00 520.00 540.00
PRESSURE (MPA)
0.00 1.50 3.00 4.50 6.00 7.50 9.00 10.50 12.00
FLOW (KG/HR) *10²
320.00 360.00 400.00 440.00 480.00 520.00 560.00 600.00 640.00
0.00 2.00 4.00 6.00 8.00 10.00 12.00
TIME (MIN)

40703-II-3



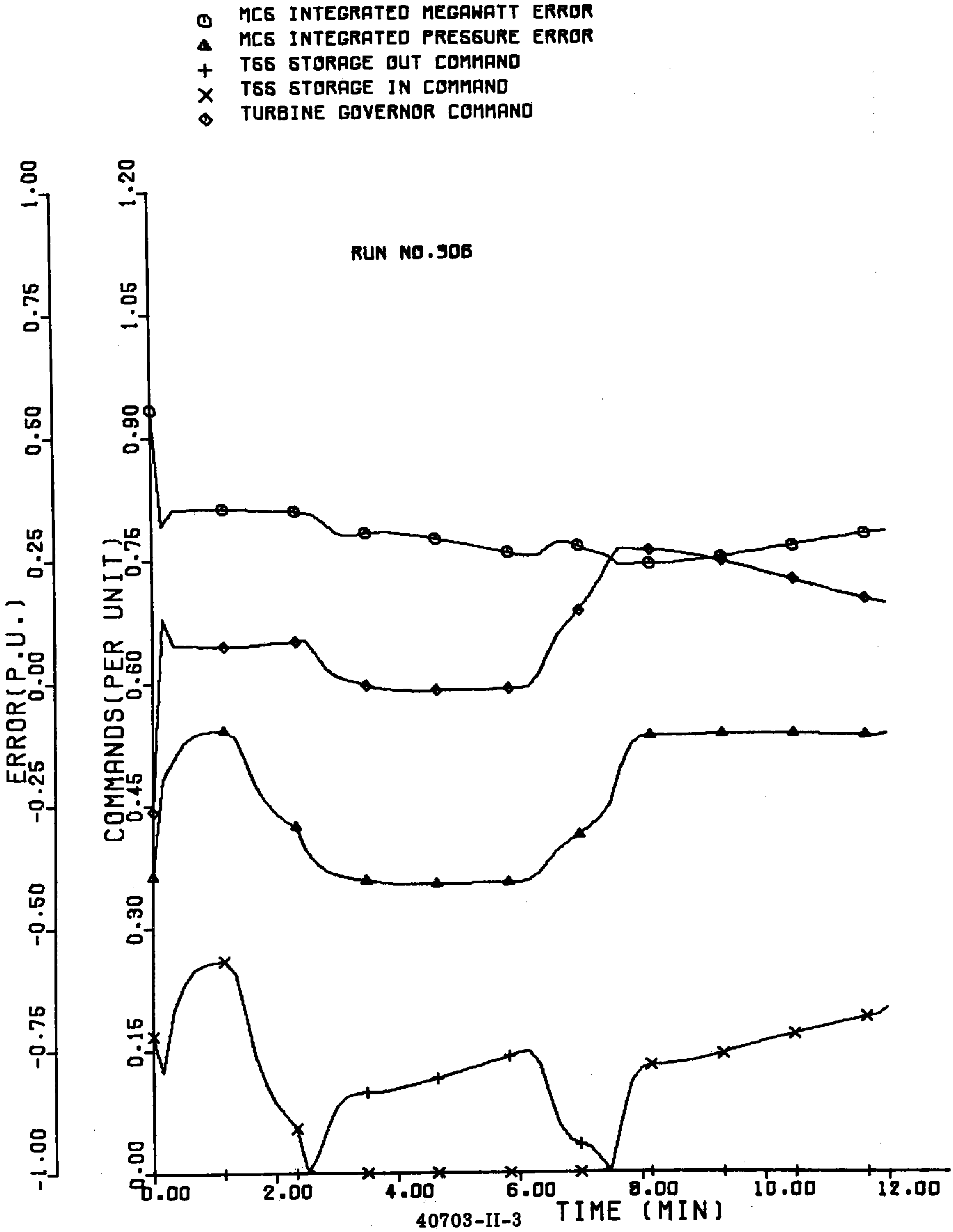
CVHP HP "JRB!NE COVERNOR VA' VE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.306
FLOW (KG/HR) *10^2
VALVE POSITION (P.U.)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
2.00
4.00
6.00
8.00
10.00
12.00

40703-II-3

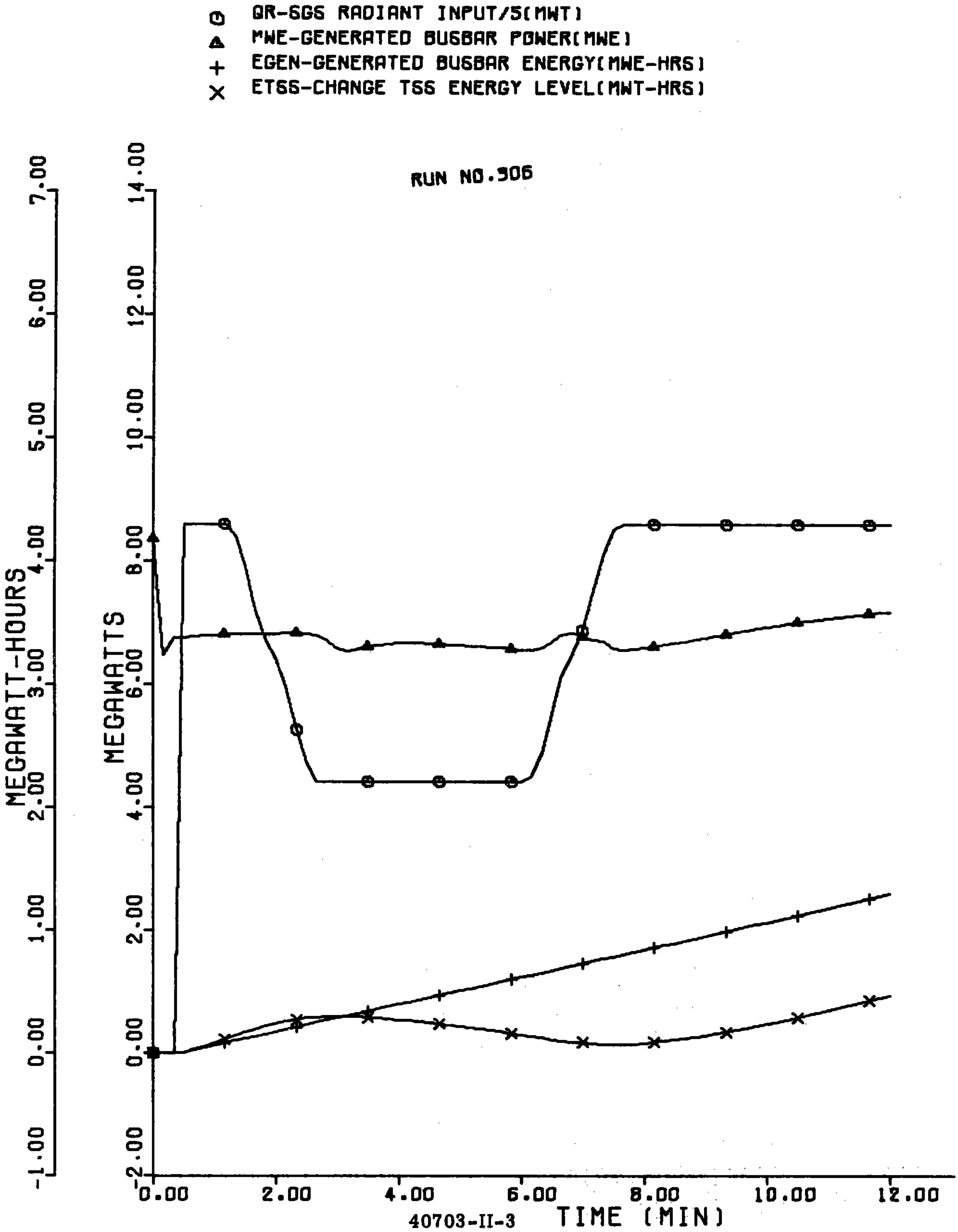


MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.306
ENERGY(MEGAWATT-HOURS)
0.00
0.80
1.60
2.40
3.20
4.00
4.80
5.60
6.40
POWER(MEGAWATTS)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
PER UNIT
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

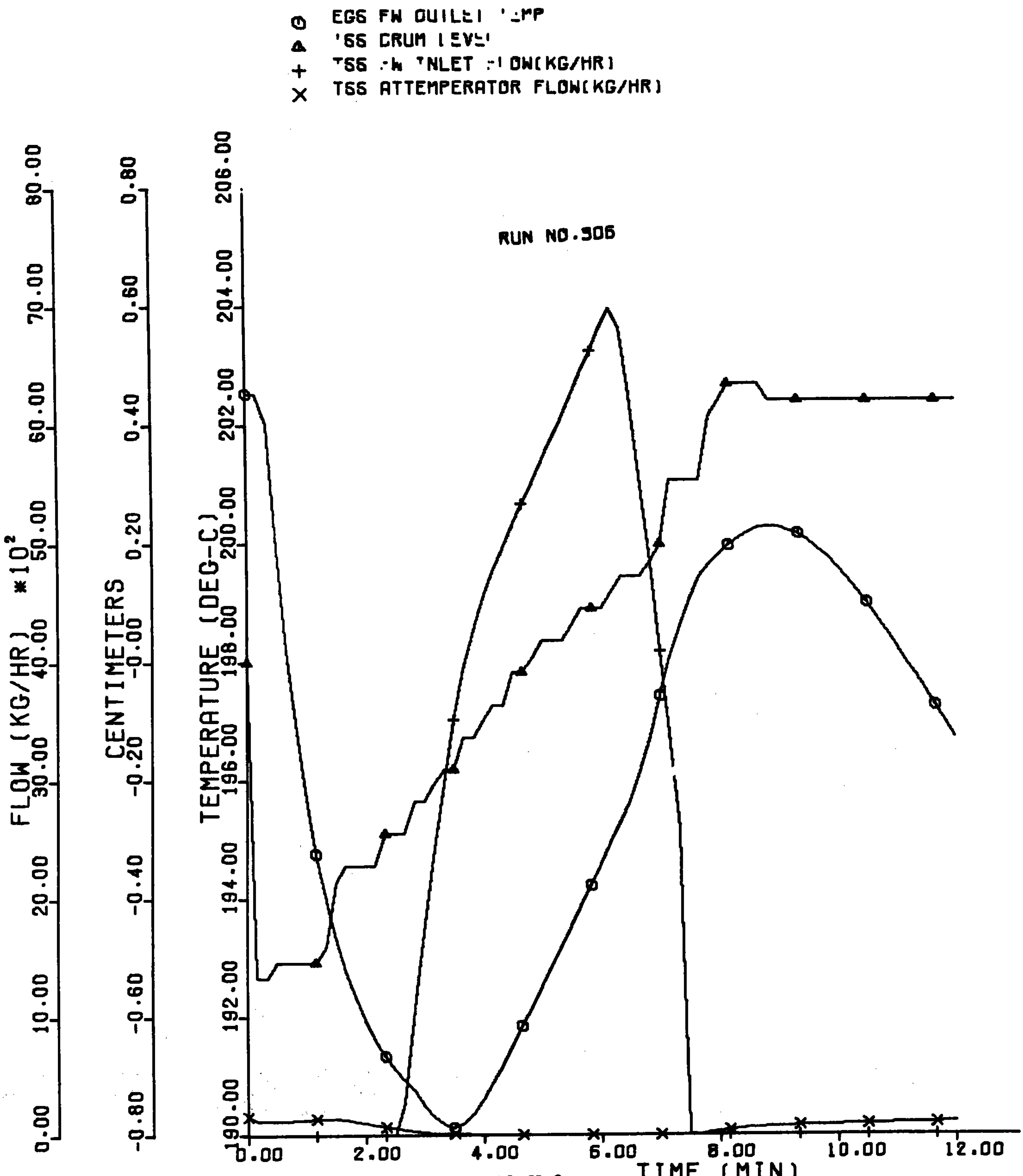
40703-II-3


MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.306
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00

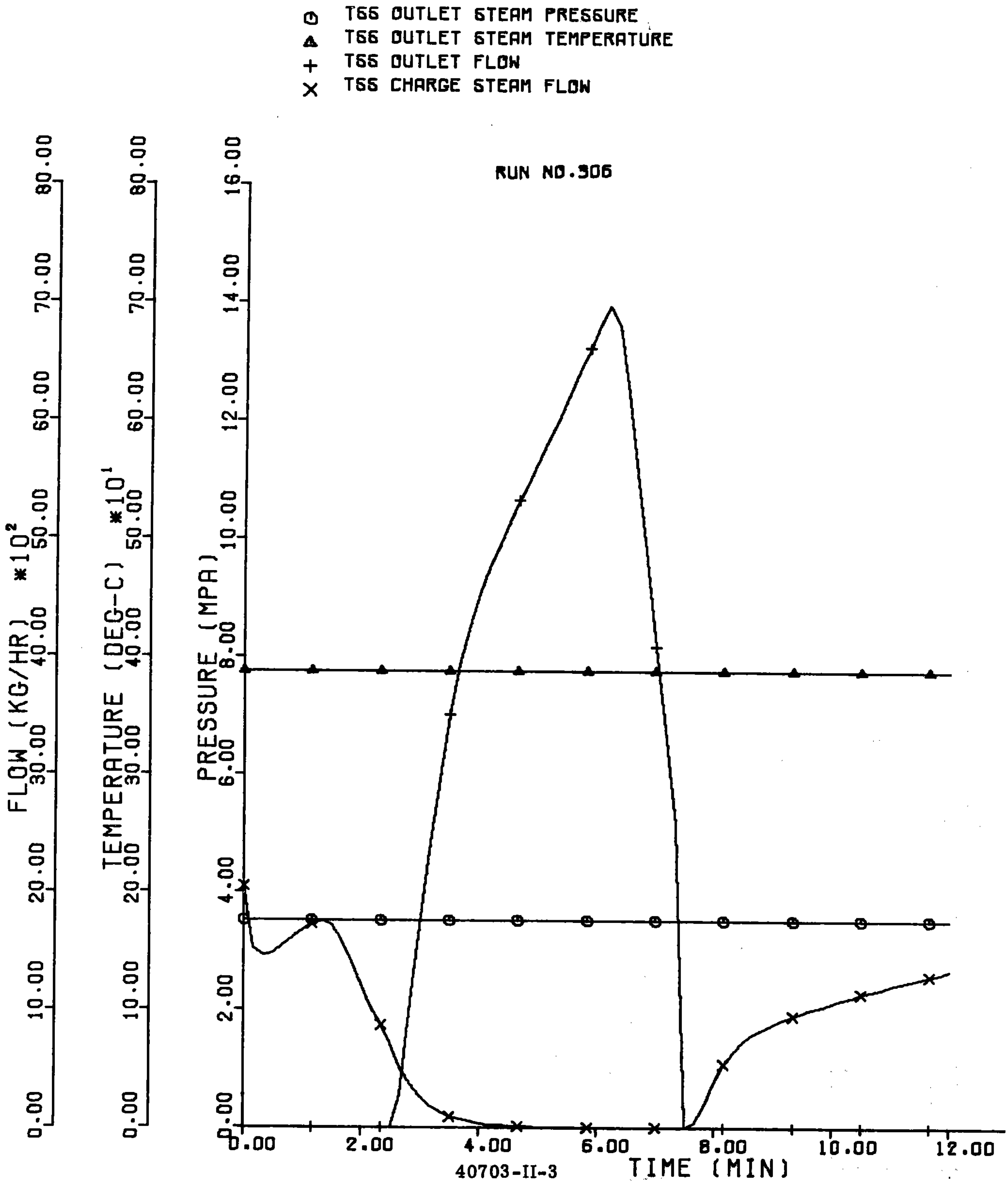
40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.306
MEGAWATT-HOURS
MEGAWATTS
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
TIME (MIN)

40703-II-3


EGS FW OUTLET TEMP
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.306
FLOW (KG/HR) *10²
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
-0.80
-0.60
-0.40
-0.20
-0.00
0.20
0.40
0.60
0.80
190.00
192.00
194.00
196.00
198.00
200.00
202.00
204.00
206.00
2.00
4.00
6.00
8.00
10.00
12.00

40703-II-3


TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
RUN NO.306
FLOW (KG/HR) *10²
TEMPERATURE (DEG-C) *10¹
PRESSURE (MPA)
TIME (MIN)
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00
0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00
0.00 2.00 4.00 6.00 8.00 10.00 12.00

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Run No.	307
Type of Run	Cloud Transient
Length of Run	12 min
Run Description	Cloud approaching from West entering field at t=3 min:

Speed = 32.9 Km/hr (20.4 mph)
Length = 1.8 Km (1.12 mi)

Field Coverage: Entire Field

SUMMARY OF SPP PERFORMANCE (RUN NO 307.)

SPP POWER LEVELS

	BTU/HR X 10*6 AVG	PEAK	MIN	MWTH AVG	PEAK	MIN
GROSS SGS INPUT POWER	105.098	146.738	0.	30.80	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	95.967	141.851	-4.272	28.13	41.58	-1.25
EGS	71.527	99.164	-0.000	20.96	29.07	-0.00
TSS	23.515	38.968	0.008	6.89	11.42	0.00
NET TSS POWER TO EGS	21.696	88.591	-0.001	6.36	25.97	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.86	11.22	6.44
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				7204045.	14720.	6.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 4019.9 TO TSS 1321.6 FROM TSS

TOTAL RADIANT ENERGY IN= 5906.6KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9037

NET CHANGE IN TSS ENERGY 77.68(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 1.32(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	381.2	397.8	368.6
TD-DRUM TEMP	602.5	612.5	582.0
TPSHO-PSH TEMP OUT	777.8	794.6	749.6
TSSHO-SSH TEMP OUT	955.9	967.1	936.7
TPSHM-PSH METAL TEMP	815.5	841.1	772.3
TSSHM-SSH METAL TEMP	986.7	1006.5	955.2
PSH METAL TEMP RATE	97.9	4666.8	-4429.5
SSH METAL TEMP RATE	105.0	4297.5	-3553.7
PPSHO-PSH PRES.OUT	1518.3	1603.1	1346.2
PSSHO-SSH PRES.OUT	1463.3	1524.4	1346.2
PD-DRUM PRES	1573.2	1686.9	1346.2
DELTA DRUM LEVEL	1.16	5.82	-2.45
PHPNCI-HP NOZ PRES	1440.5	1490.7	1346.2

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.0	570.0	570.0
TOIL-MAIN OIL TEMP	479.9	480.0	479.9
DDRUM-DELTA DRUM LEV	0.2	0.5	-0.2
PDRUM-DRUM PRESSURE	592.9	614.0	555.7
TPREH-PREHEATER TEMP	481.0	486.7	472.6
TDSH-DESUPER-TEMP	0.	0.	0.

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MISCELLANEOUS RECEIVER CAVITY TERMS 307-2

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.7024	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	44.8978	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	22.5722	31.5154	0.
QBDP-REDIRECTED POWER TO PSH(MWT)	5.1528	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	4.0610	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	3.7462	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	35.5322	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	21.4657	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	5.1910	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	4.1474	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	3.8558	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1341	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	34.7940	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	46.6430	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	11.2796	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	9.0118	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	66.934	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.633	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.620	0.776	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.783	0.980	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	90.903	-90.957
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	-0.000	35.153	-35.174
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	33.574	-33.555
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.000	143.268	-143.268
TCAV1-CEILING TEMPERATURE(DEG-F)	1091.3	1254.9	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.7	651.6	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 8.618
REDIRECTED ENERGY(MWT-HRS),TOTAL= 6.82BOILER= 4.33PSH= 0.99SSH= 0.78CEILING= 0.72
ABSORBED ENERGY(MWT-HRS),BOILER= 4.12PSH= 1.00SSH= 0.80CEILING= 0.74FLOOR= 0.03TOTAL= 6.68

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Run No.	308
Type of Run	Cloud Transient
Length of Run	18 min
Run Description	Cloud approaching from West entering field at t=3 min: Speed = 11. 4 Km/hr (7. 1 mph) Length = 0. 67 Km (0. 42 mi) Field Coverage: Entire Field
Notes	Plots were unavailable for this run.

SUMMARY OF SPP PERFORMANCE (RUN NO 308.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	117.270	146.738	0.	34.37	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	107.433	141.535	-4.472	31.49	41.48	-1.31
EGS	80.223	97.518	-0.000	23.51	28.58	-0.00
TSS	26.117	40.412	0.001	7.65	11.84	0.00
NET TSS POWER TO EGS	13.551	89.263	-0.006	3.97	26.16	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.96	9.98	7.36
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				12355555.	14853.	8.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 6857.6 TO TSS 2232.5 FROM TSS

TOTAL RADIANT ENERGY IN= 10024.4KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9062

NET CHANGE IN TSS ENERGY 1025.82(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.03(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	378.6	394.2	371.9
TD-DRUM TEMP	604.6	612.3	583.3
TPSHO-PSH TEMP OUT	783.3	802.1	751.7
TSSHO-SSH TEMP OUT	957.2	970.0	931.0
TPSHM-PSH METAL TEMP	824.7	849.5	779.6
TSSHM-SSH METAL TEMP	991.0	1010.5	953.6
PSH METAL TEMP RATE	72.3	3107.6	-2246.7
SSH METAL TEMP RATE	64.5	3221.5	-1985.3
PPSHO-PSH PRES.OUT	1536.7	1601.4	1359.6
PSSHO-SSH PRES.OUT	14[illegible].1	1522.5	1359.6
PD-DRUM PRES	1597.0	1685.0	1359.6
DELTA DRUM LEVEL	0.77	4.37	-0.78
PHPNCI-HP NOZ PRES	1451.3	1490.1	1359.6

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	569.9	570.0	569.9
TOIL-MAIN OIL TEMP	479.9	480.0	479.9
DDRUM-DELTA DRUM LEV	0.2	0.4	-0.2
PDRUM-DRUM PRESSURE	587.5	600.5	560.5
TPREH-PREHEATER TEMP	480.9	484.1	472.2
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.7838	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	50.0979	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	25.1866	31.5154	0.
QRDP-REDIRECTED POWER TO PSH(MWT)	5.7496	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	4.5314	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	4.1801	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	39.6476	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	23.9519	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	5.7923	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	4.6277	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	4.3024	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1497	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	38.8240	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	52.0453	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5861	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	10.0556	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	74.687	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.759	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.743	0.776	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.939	0.980	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.000	31.495	-31.496
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.000	12.180	-12.179
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	11.625	-11.625
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.000	49.637	-49.636
TCAV1-CEILING TEMPERATURE(DEG-F)	1181.4	1445.1	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.2	652.6	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 14.626

REDIRECTED ENERGY(MWT-HRS),TOTAL= 11.57BOILER= 7.35PSH= 1.68SSH= 1.32CEILING= 1.22

ABSORBED ENERGY(MWT-HRS),BOILER= 6.99PSH= 1.69SSH= 1.35CEILING= 1.26FLOOR= 0.04TOTAL= 11.33

Run No.	309
Type of Run	Cloud Transient
Run Length	14 min
Run Description	Cloud approaching from West entering field at t=3 min:

Speed = 32.9 Km/hr (20.4 mph)
Length = 0.67 Km (0.42 mi)

Field Coverage: Entire Field

SUMMARY OF SPP PERFORMANCE (RUN NO 309.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	133.499	146.738	0.	39.13	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	121.981	139.047	6.586	35.75	40.75	1.93
EGS	89.001	97.153	9.579	26.09	28.48	2.81
TSS	31.800	39.240	0.480	9.32	11.50	0.14
NET TSS POWER TO EGS	4.958	61.875	-0.000	1.45	18.14	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.92	10.50	6.45
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				10893792.	14848.	1969.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 5870.6 TO TSS 2097.5 FROM TSS

TOTAL RADIANT ENERGY IN= 8805.8KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9043

NET CHANGE IN TSS ENERGY 1722.61(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 1.56(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	376.1	391.9	368.8
TD-DRUM TEMP	607.0	610.7	583.8
TPSHO-PSH TEMP OUT	785.8	796.0	749.6
TSSHO-SSH TEMP OUT	958.5	966.1	935.3
TPSHM-PSH METAL TEMP	829.8	842.7	774.1
TSSHM-SSH METAL TEMP	994.7	1005.8	955.9
PSH METAL TEMP RATE	95.6	4618.4	-4429.3
SSH METAL TEMP RATE	81.4	4315.2	-3553.7
PPSHO-PSH PRES.OUT	1553.1	1582.8	1363.6
PSSHO-SSH PRES.OUT	1482.2	1503.7	1362.5
PD-DRUM PRES	1623.7	1665.3	1364.8
DELTA DRUM LEVEL	0.59	3.63	-2.45
PHPNCI-HP NOZ PRES	1454.2	1471.8	1362.1

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.0	570.0	570.0
TOIL-MAIN OIL TEMP	480.0	480.0	480.0
DDRUM-DELTA DRUM LEV	0.1	0.3	-0.2
PDRUM-DRUM PRESSURE	590.3	601.9	555.4
TPREH-PREHEATER TEMP	479.9	480.8	473.5
TDSH-DESUPER-TEMP	0.	0.	0.

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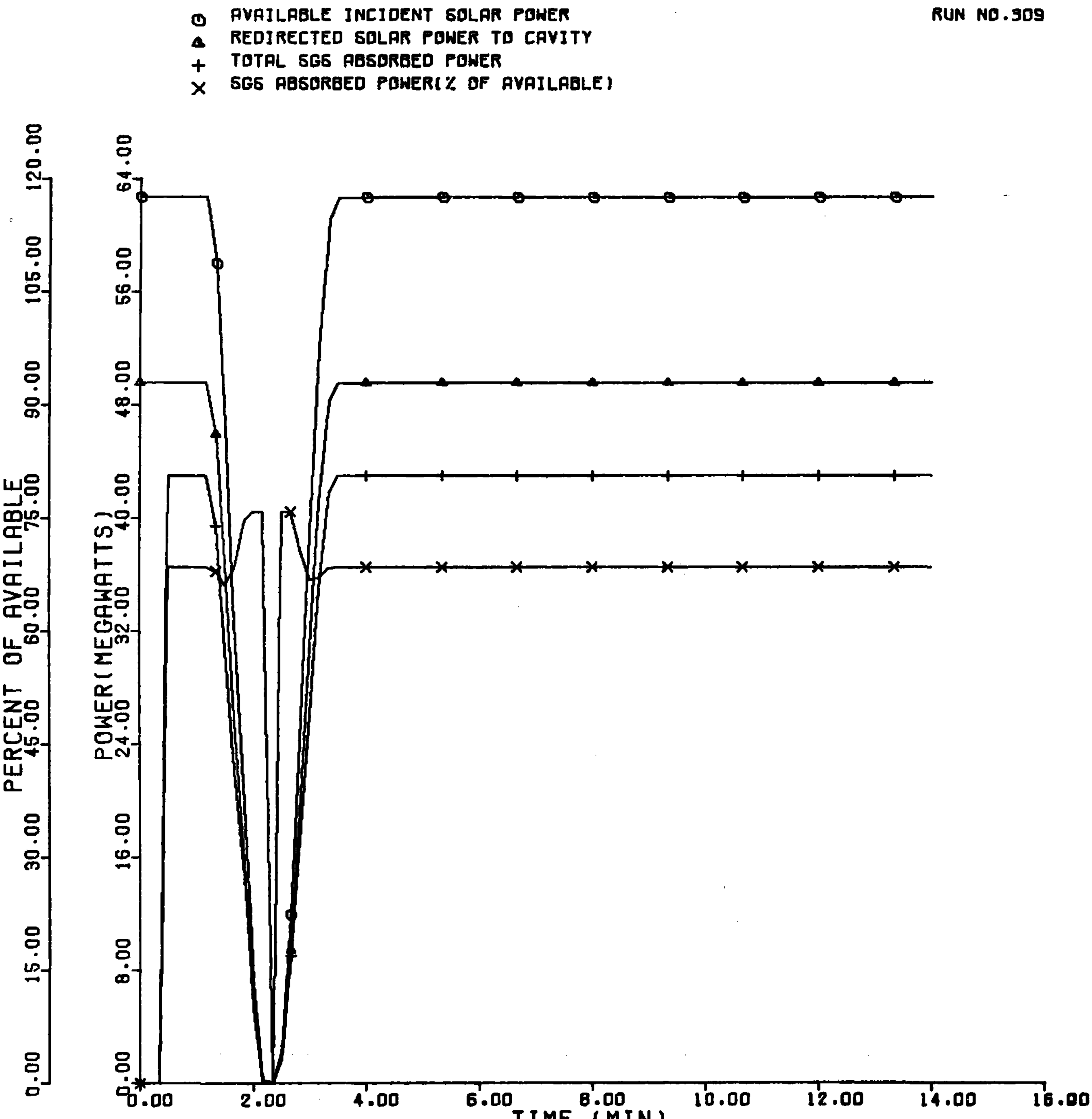
MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.8922	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	57.0309	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	28.6722	31.5154	0.
QBDP-REDIRECTED POWER TO PSH(MWT)	6.5453	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	5.1584	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	4.7585	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	45.1344	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	27.2667	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	6.5939	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	5.2681	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	4.8977	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1704	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	44.1968	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	59.2479	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	14.3279	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	11.4471	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	85.023	93.454	0.
QRDINC-RATIO.REDIRECTED TO INCIDENT POWER TOTALS)	0.777	0.791	0.
QABINC-RATIO.ABSORBED TO INCIDENT POWER TOTALS)	0.760	0.776	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.961	0.980	0.
QABBRA-RATE OF CHANGE.BOILER ABSORBED POWER(%/MIN)	-0.000	90.825	-90.825
QABPRA-RATE OF CHANGE.PSH ABSORBED POWER(%/MIN)	-0.000	35.123	-35.153
QABSRA-RATE OF CHANGE.SSH ABSORBED POWER(%/MIN)	0.000	33.526	-33.536
QABTRA-RATE OF CHANGE.TOTAL ABSORBED POWER(%/MIN)	-0.000	143.145	-143.187
TCAV1-CEILING TEMPERATURE(DEG-F)	1171.0	1388.8	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	651.1	652.3	650.1

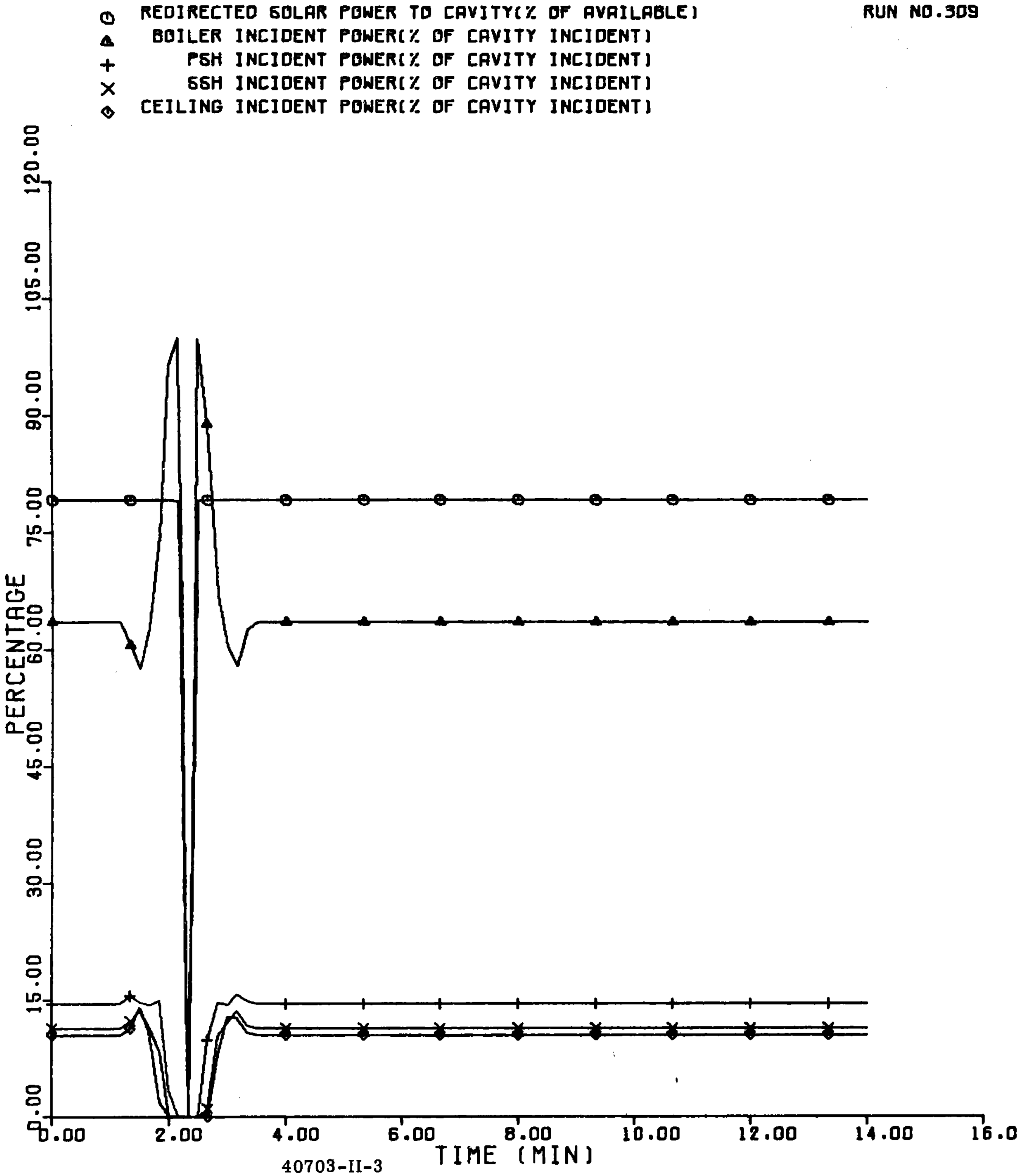
TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 12.848
REDIRECTED ENERGY(MWT-HRS).TOTAL= 10.17BOILER= 6.46PSH= 1.47SSH= 1.16CEILING= 1.07
ABSORBED ENERGY(MWT-HRS).BOILER= 6.14PSH= 1.49SSH= 1.19CEILING= 1.10FLOOR= 0.04TOTAL= 9.96

40703-11-3

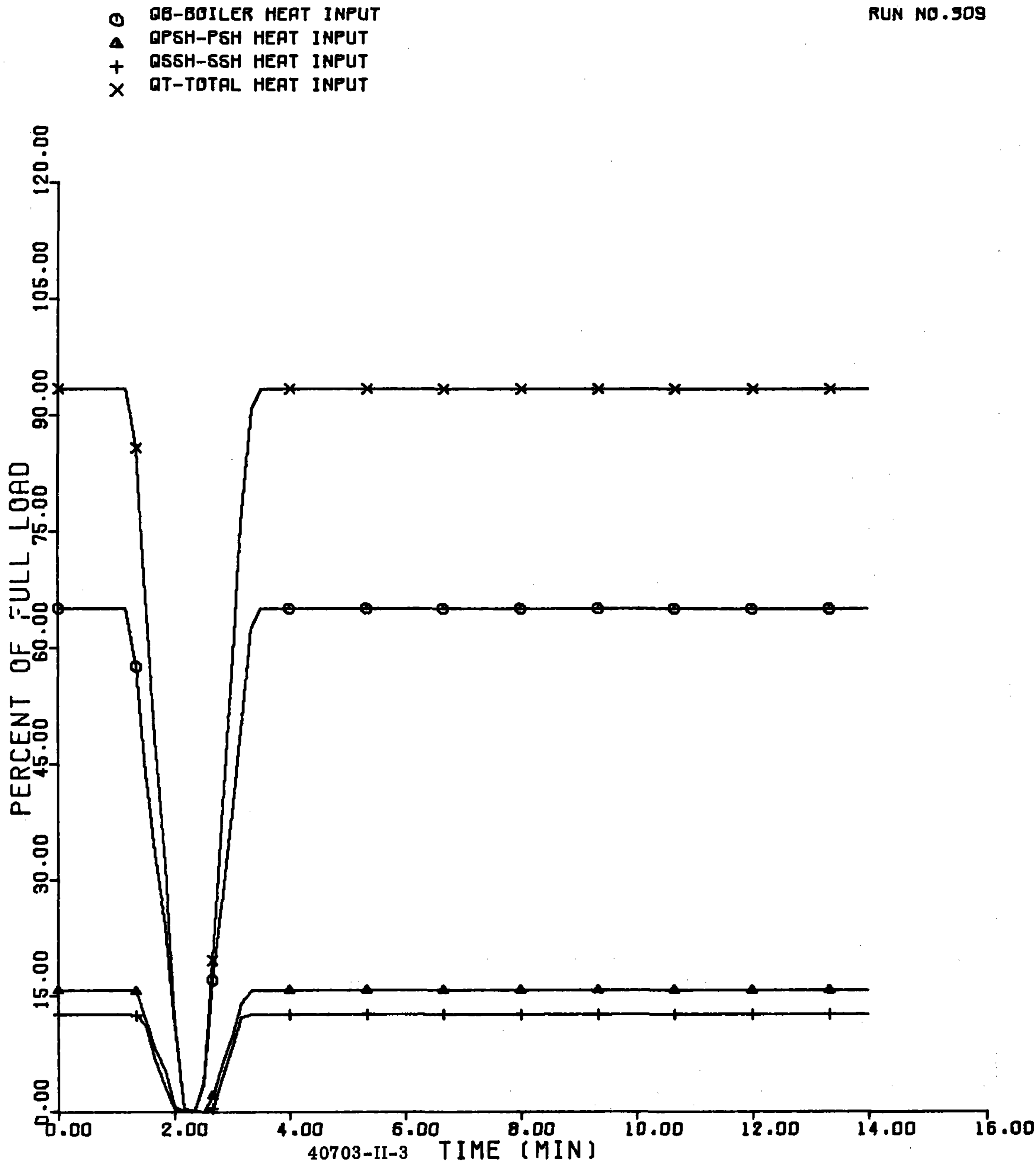


RUN NO.309
AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
PERCENT OF AVAILABLE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
POWER(MEGAWATTS)
0.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

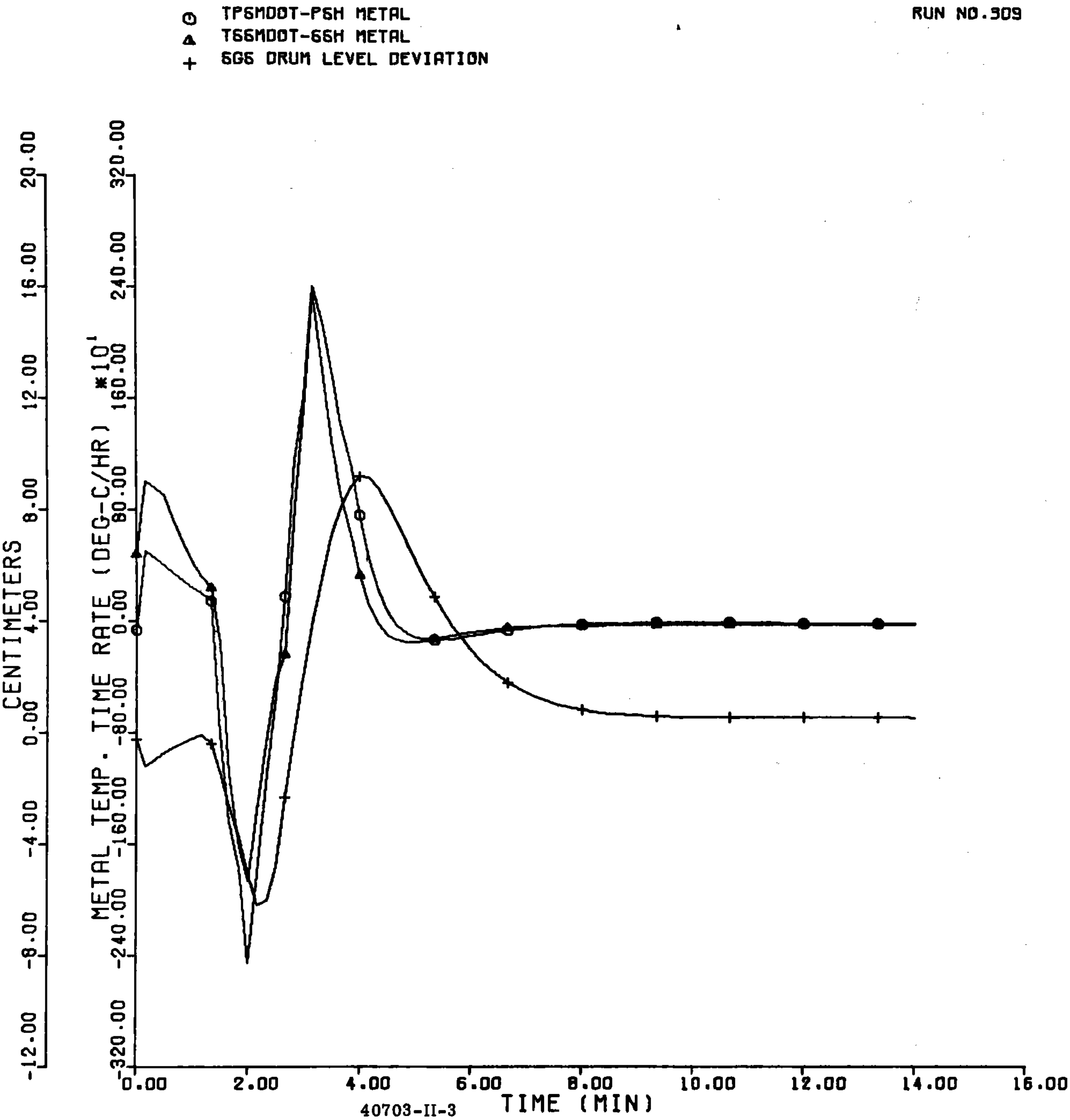
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.309
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

40703-II-3

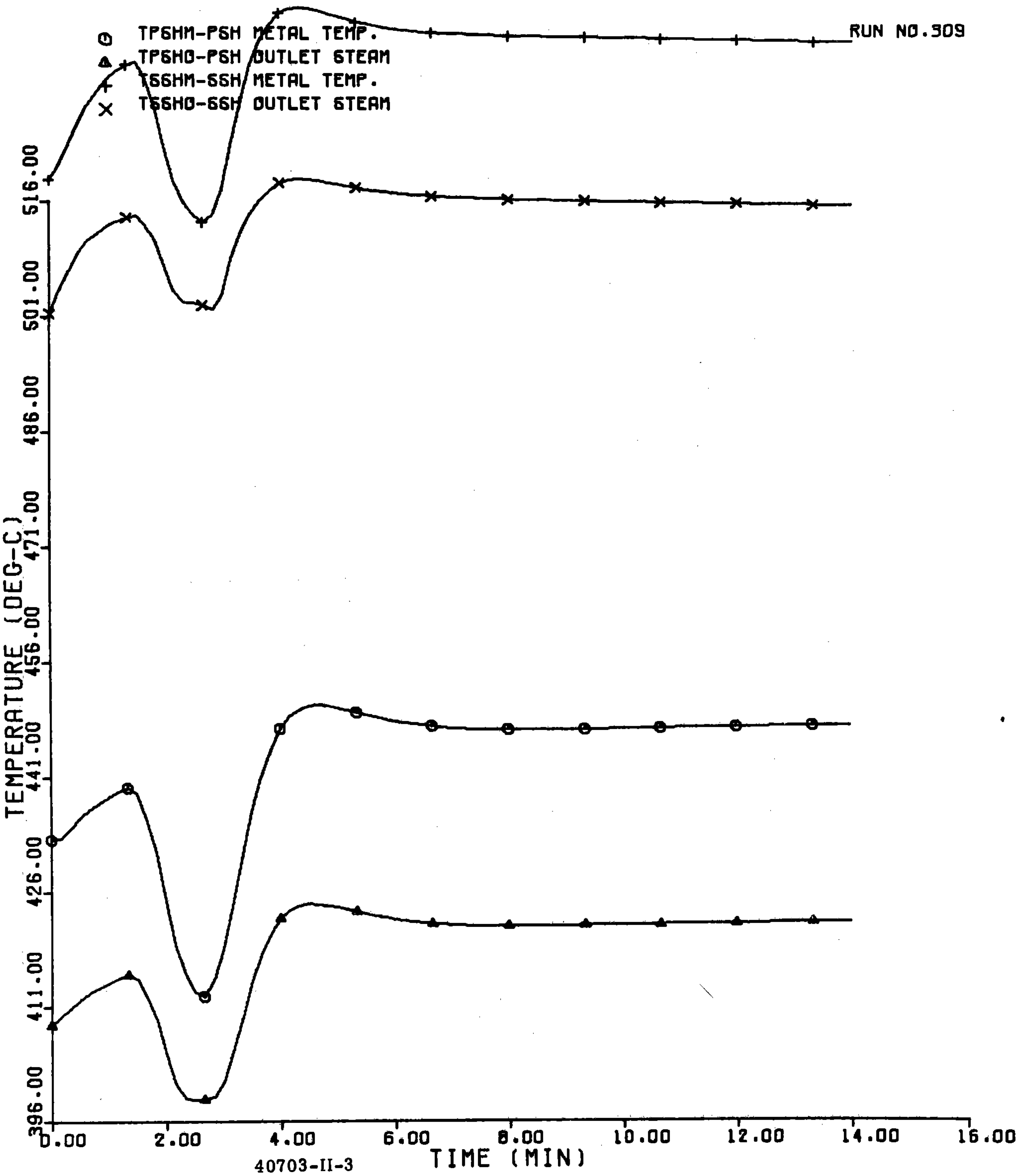

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.309
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

40703-II-3

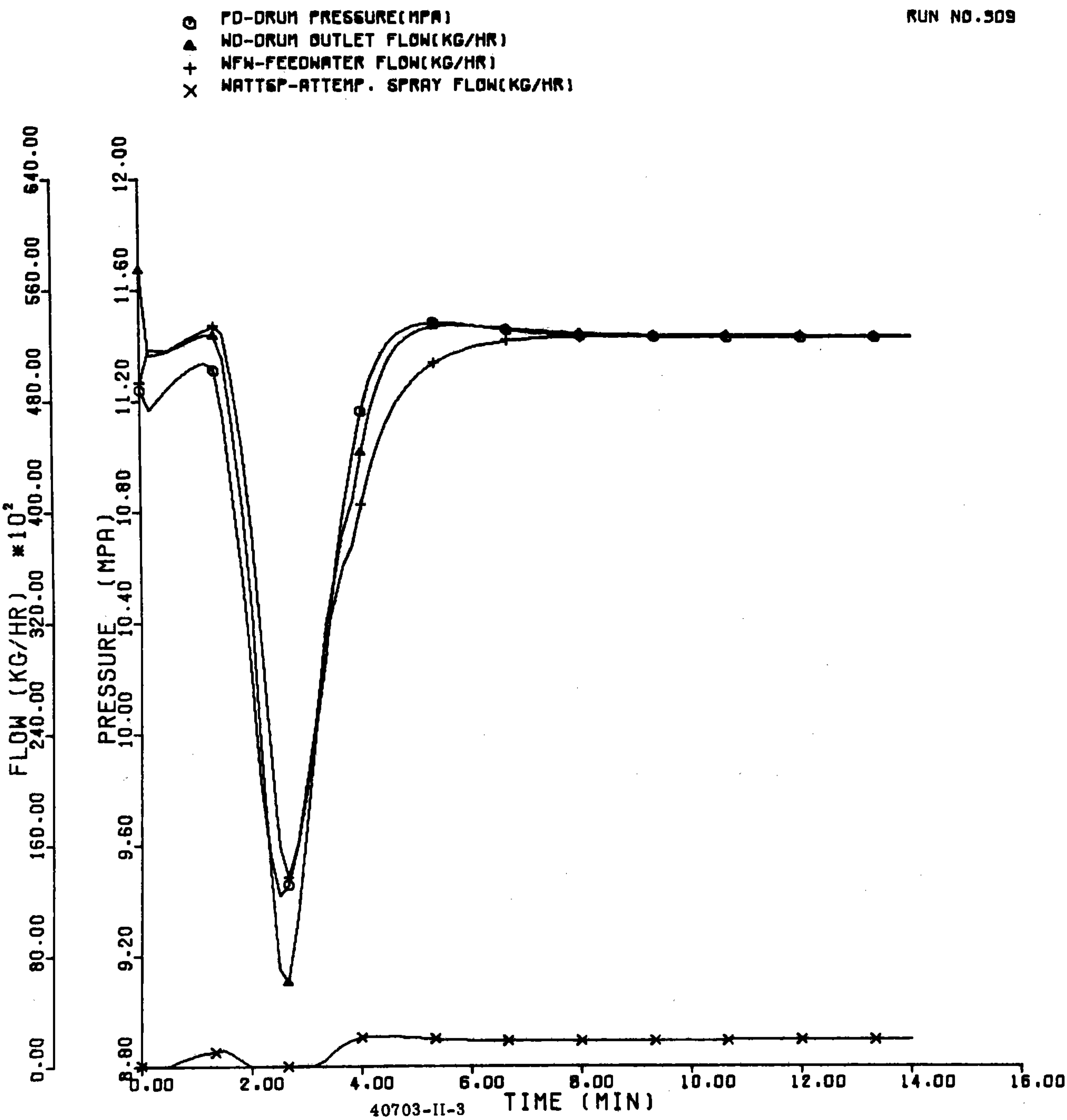


TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.309
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
20.00
16.00
12.00
8.00
4.00
0.00
-4.00
-8.00
-12.00
320.00
240.00
160.00
80.00
0.00
-80.00
-160.00
-240.00
-320.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

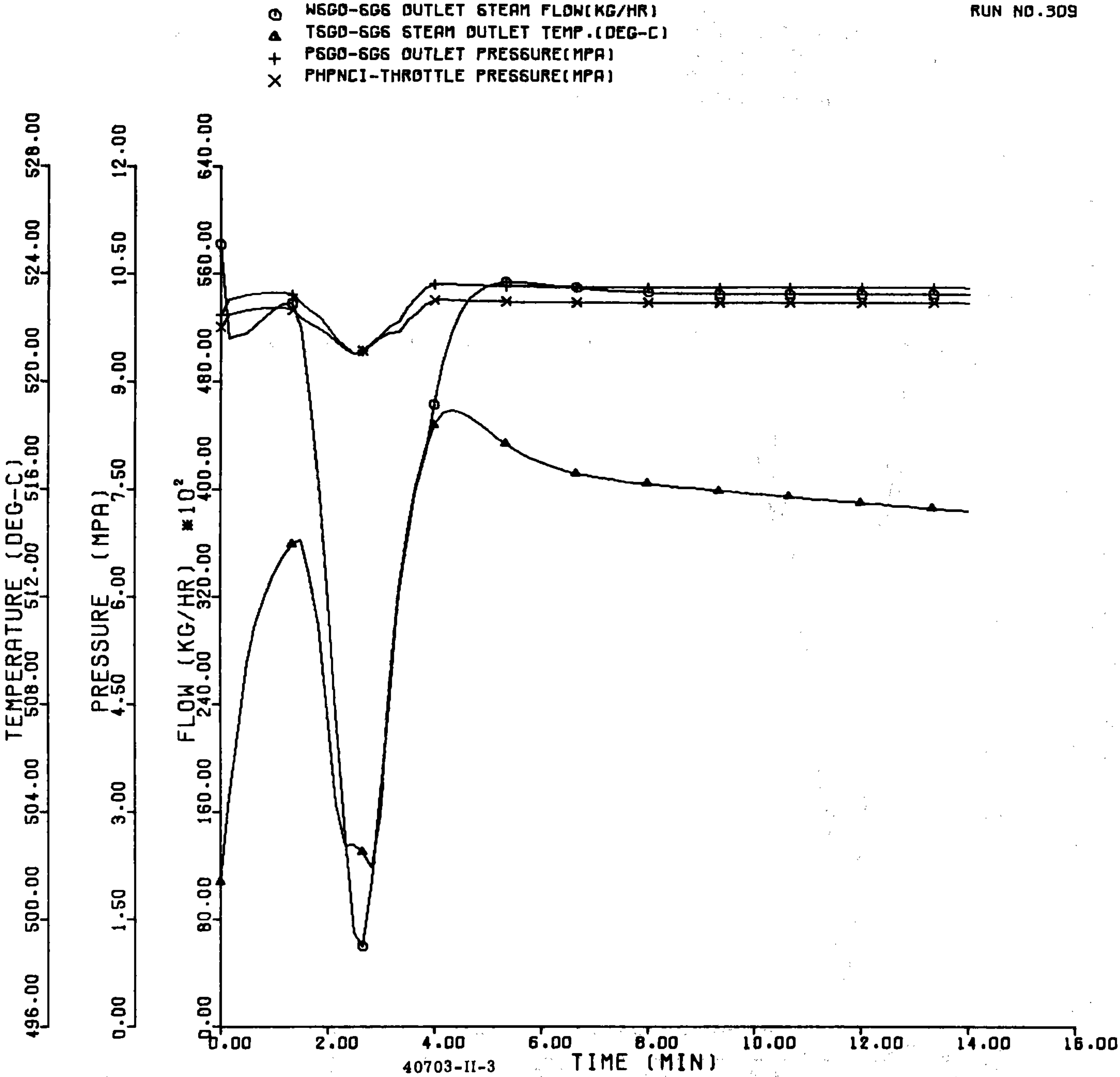
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.309
TEMPERATURE (DEG-C)
396.00
411.00
426.00
441.00
456.00
471.00
486.00
501.00
516.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

40703-II-3

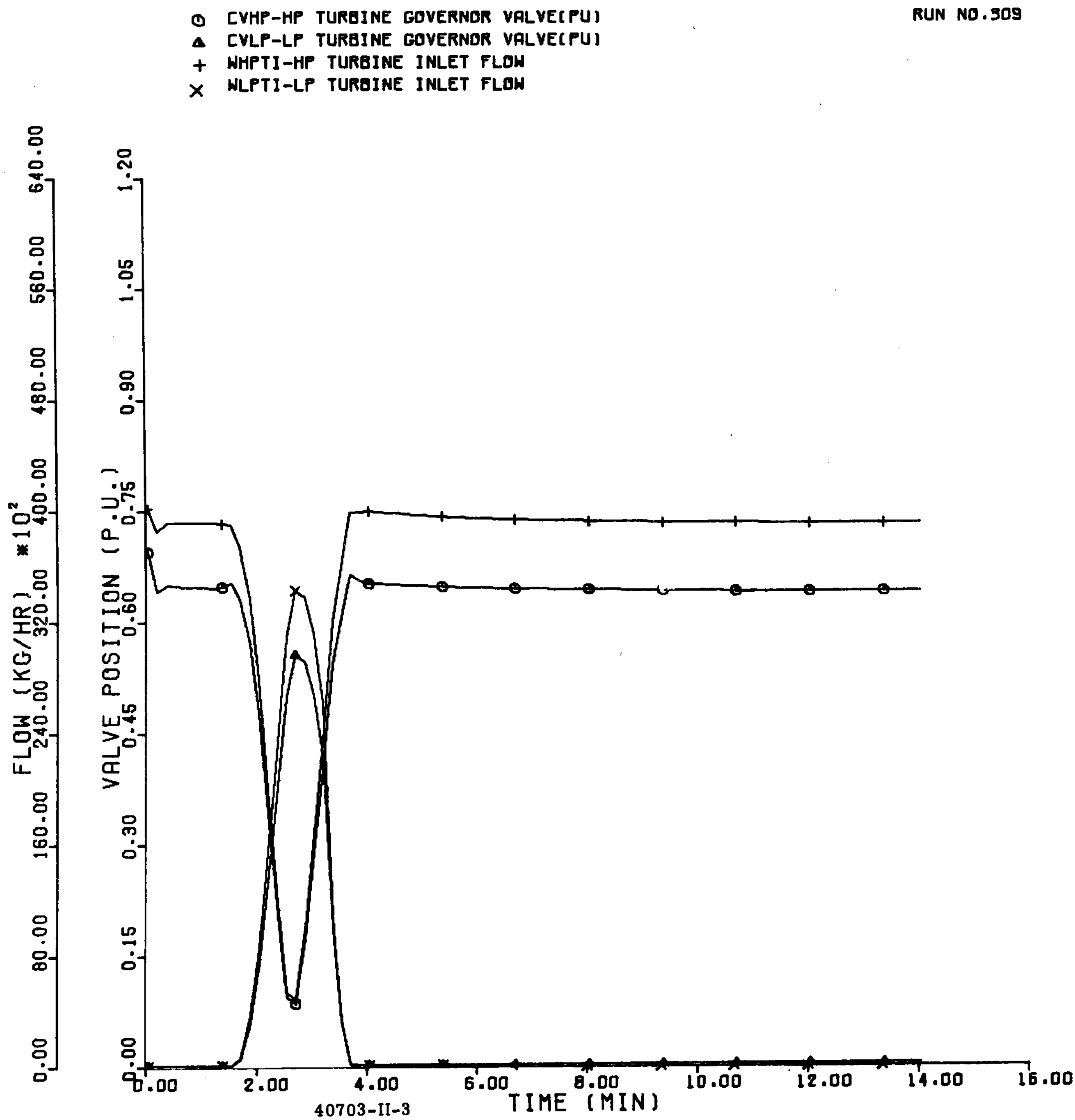

RUN NO.309
PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
8.80
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

40703-II-3

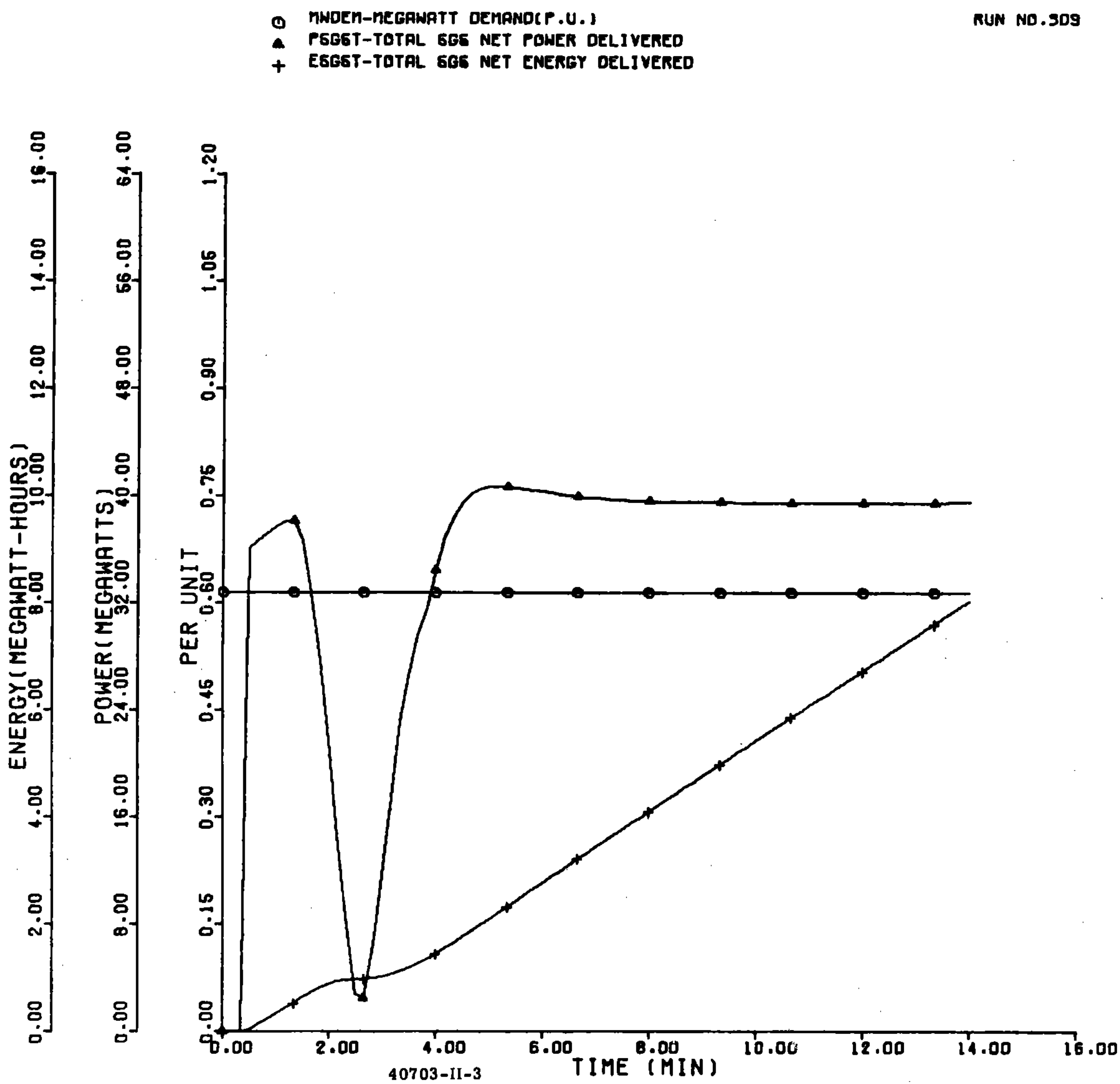


WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.309
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10^2
TIME (MIN)

40703-II-3

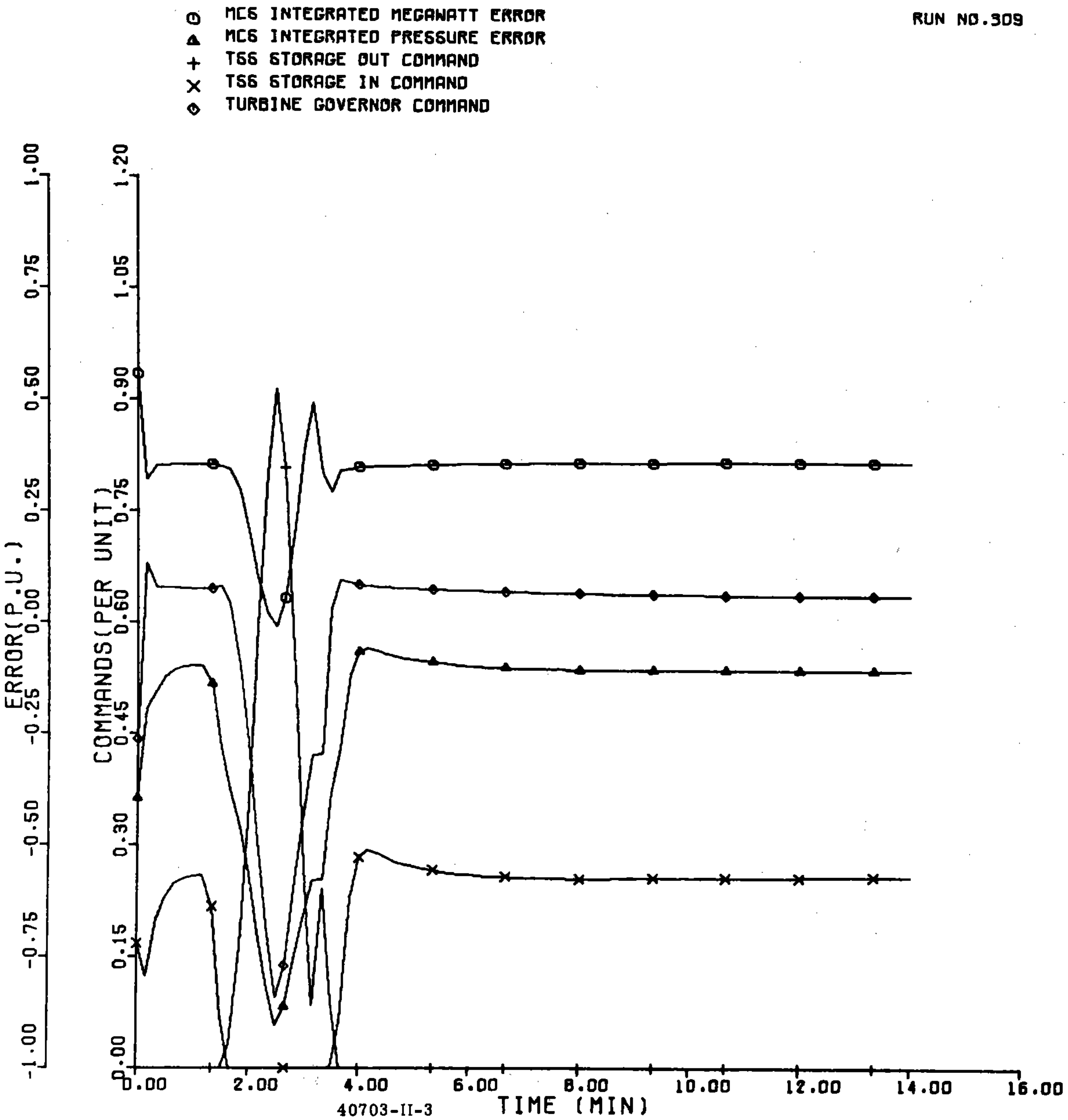

RUN NO.309
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
VALVE POSITION (P.U.)
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

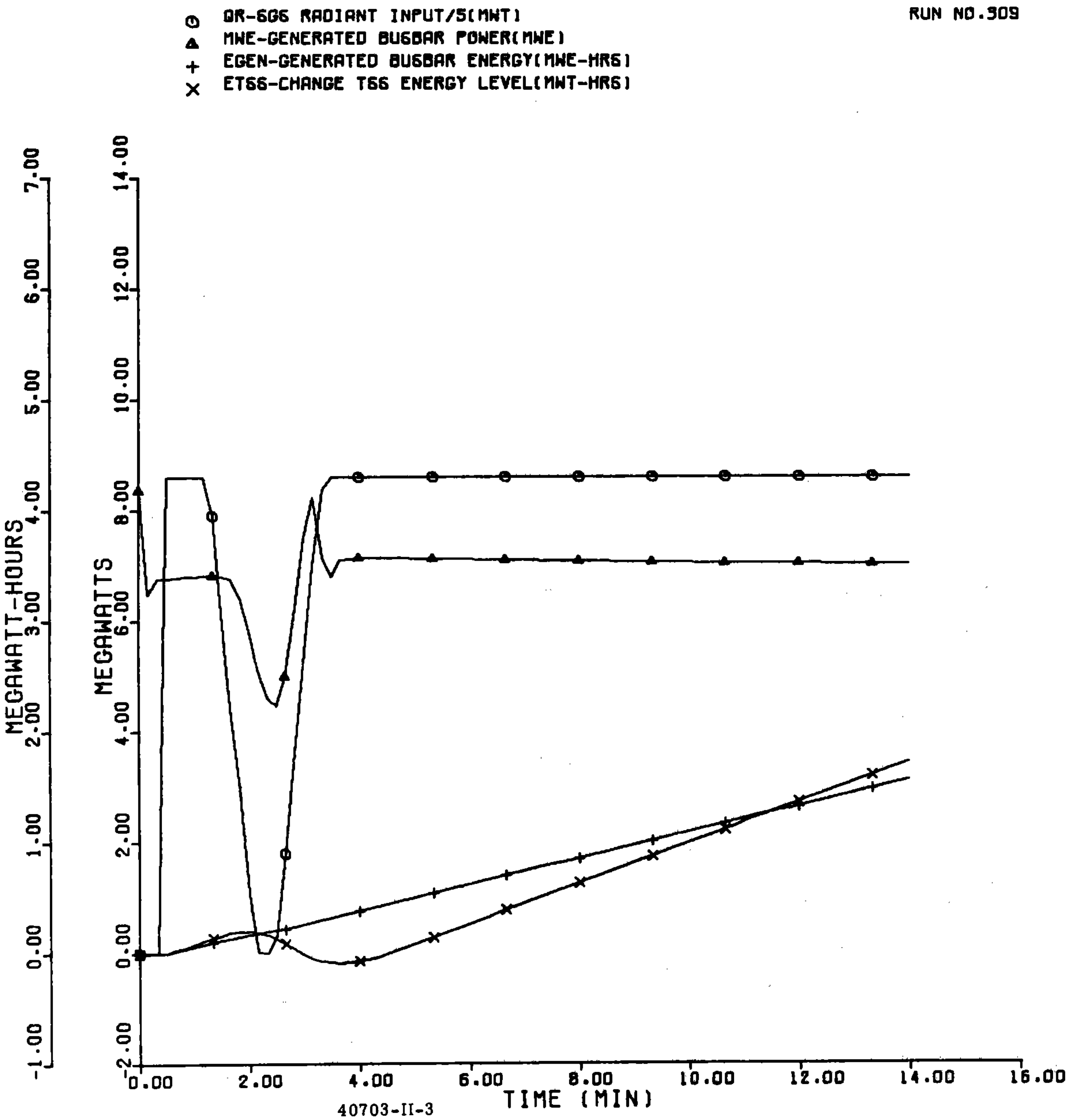
40703-II-3



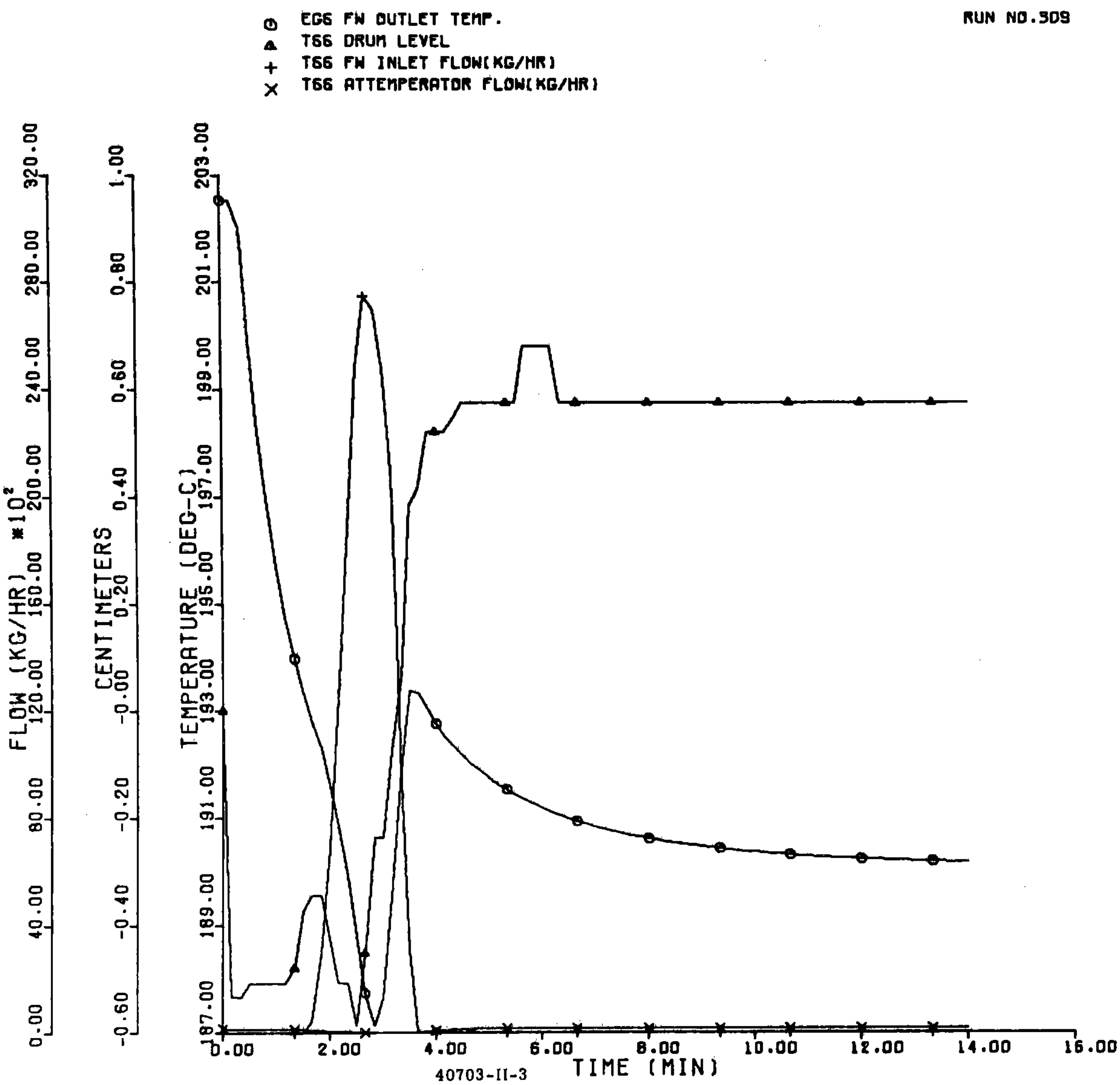
MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.309
ENERGY(MEGAWATT-HOURS)
POWER(MEGAWATTS)
PER UNIT
TIME (MIN)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20

40703-II-3

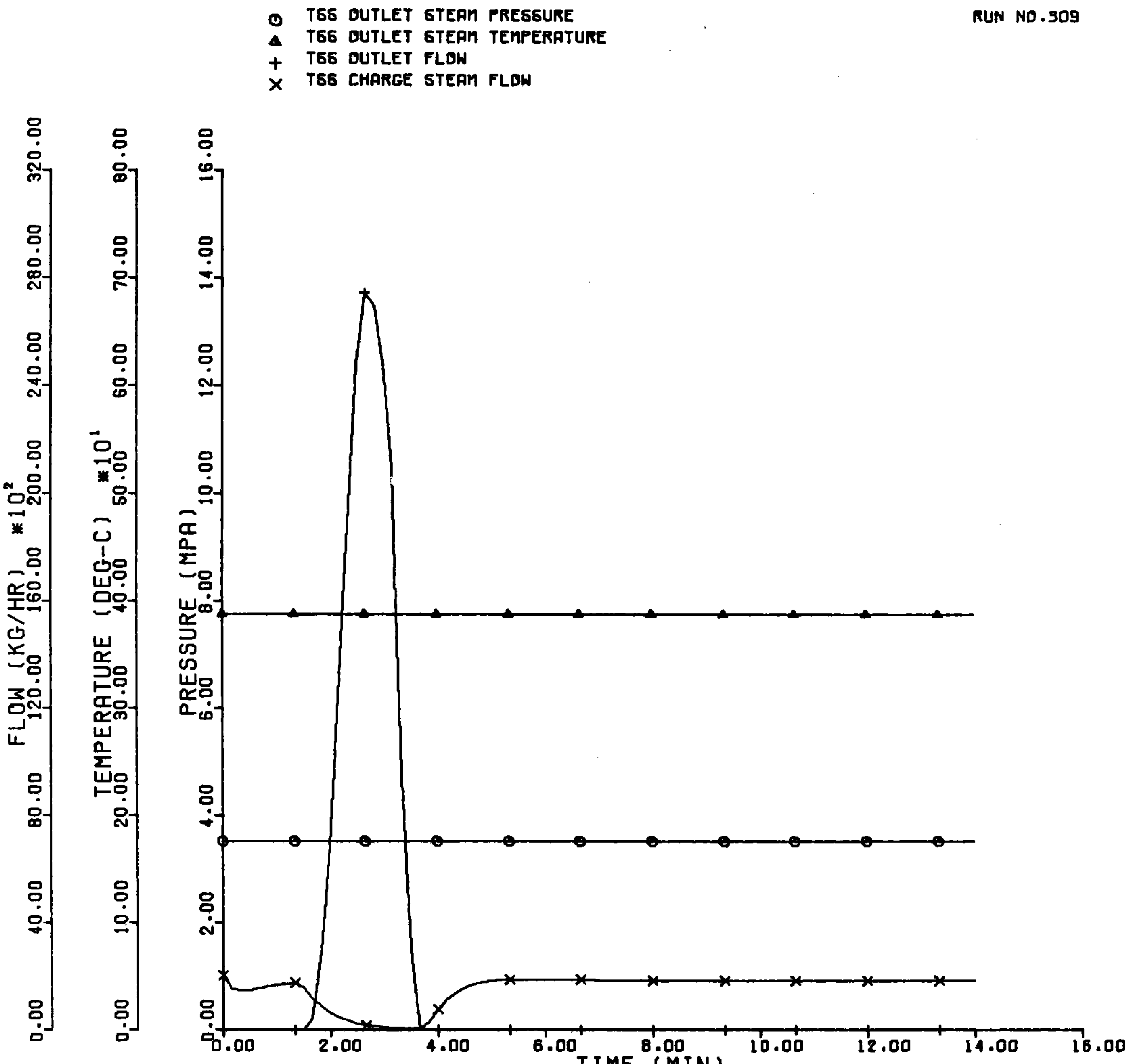

MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.309
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
40703-II-3


RUN NO.309
QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
MEGAWATT-HOURS
MEGAWATTS
TIME (MIN)

40703-II-3


RUN NO.309
EGS FW OUTLET TEMP.
TGS DRUM LEVEL
TGS FW INLET FLOW(KG/HR)
TGS ATTEMPERATOR FLOW(KG/HR)
FLOW (KG/HR) *10²
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
320.00
CENTIMETERS
-0.60
-0.40
-0.20
-0.00
0.20
0.40
0.60
0.80
1.00
TEMPERATURE (DEG-C)
187.00
189.00
191.00
193.00
195.00
197.00
199.00
201.00
203.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIME (MIN)

40703-II-3


TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
RUN NO.309
FLOW (KG/HR) *10^2
TEMPERATURE (DEG-C) *10^1
PRESSURE (MPA)
TIME (MIN)

40703-II-3

Run No.	311
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Cloud approaching from North entering field at t=3 min:

Speed = 11.4 Km/hr (7.1 mph)
Length = 1.8 Km (1.12 mi)

Field Coverage: Entire Field

SUMMARY OF SPP PERFORMANCE (RUN NO 311.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	67.765	146.738	0.	19.86	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	62.573	135.647	-2.907	18.34	39.76	-0.85
EGS	48.861	98.956	-0.000	14.32	29.00	-0.00
TSS	12.937	36.737	0.000	3.79	10.77	0.00
NET TSS POWER TO EGS	43.081	89.641	-0.003	12.63	26.27	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.93	10.69	7.47
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				7113646.	14750.	0.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 4176.7 TO TSS 1105.9 FROM TSS

TOTAL RADIANT ENERGY IN= 5792.7KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9114

NET CHANGE IN TSS ENERGY -2595.68(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.02(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	386.4	397.2	370.6
TD-DRUM TEMP	597.3	613.7	583.4
TPSHO-PSH TEMP OUT	810.6	848.5	773.0
TSSHO-SSH TEMP OUT	953.7	965.4	932.2
TPSHM-PSH METAL TEMP	843.4	864.4	813.7
TSSHM-SSH METAL TEMP	995.1	1012.2	957.4
PSH METAL TEMP RATE	51.1	1842.4	-2547.1
SSH METAL TEMP RATE	72.2	1961.3	-1780.3
PPSHO-PSH PRES.OUT	1481.5	1621.3	1360.9
PSSHO-SSH PRES.OUT	1448.2	1547.8	1360.9
PD-DRUM PRES	1515.3	1702.1	1360.9
DELTA DRUM LEVEL	2.03	5.54	-1.99
PHPNCI-HP NOZ PRES	1433.1	1513.3	1360.9

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.1	570.2	569.9
TOIL-MAIN OIL TEMP	479.9	480.0	479.8
DDRUM-DELTA DRUM LEV	0.1	0.4	-0.2
PDRUM-DRUM PRESSURE	581.5	615.3	560.6
TPREH-PREHEATER TEMP	478.4	487.3	472.2
TDSH-DESUPER-TEMP	0.	0.	0.

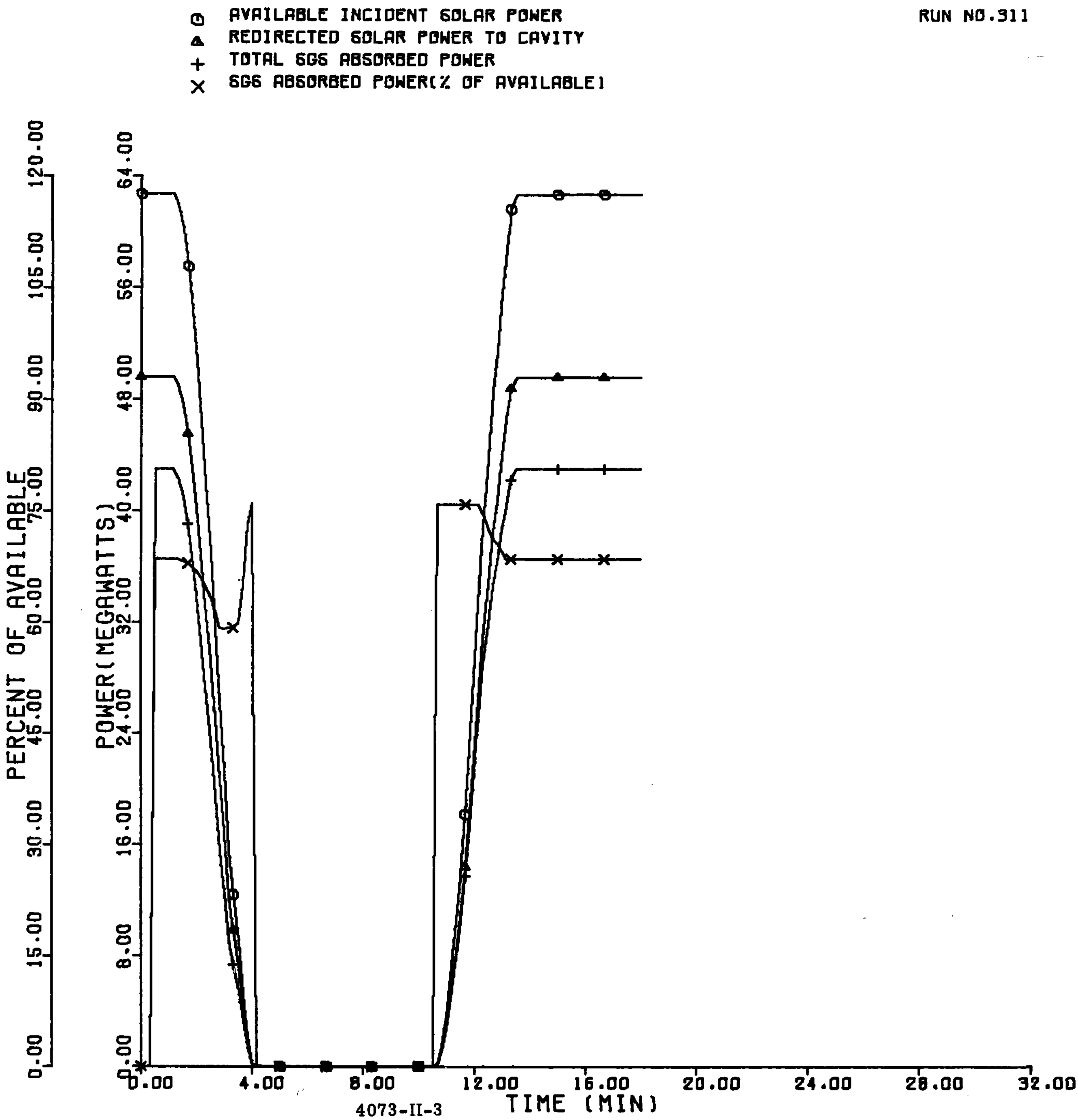
MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.4529	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	28.9494	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	14.5542	31.5154	0.
QRDP-REDIRECTED POWER TO PSH(MWT)	3.3224	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	2.6185	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	2.4155	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	22.9106	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	13.8408	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	3.3471	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	2.6742	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	2.4861	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.0865	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	22.4347	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	30.0747	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.2730	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	5.8107	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	43.158	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.492	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.482	0.781	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.609	0.987	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	41.743	-41.743
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.000	12.832	-12.832
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	-0.000	12.842	-12.853
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	-0.000	52.699	-52.699
TCAV1-CEILING TEMPERATURE(DEG-F)	1092.7	1249.7	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.6	651.5	650.1

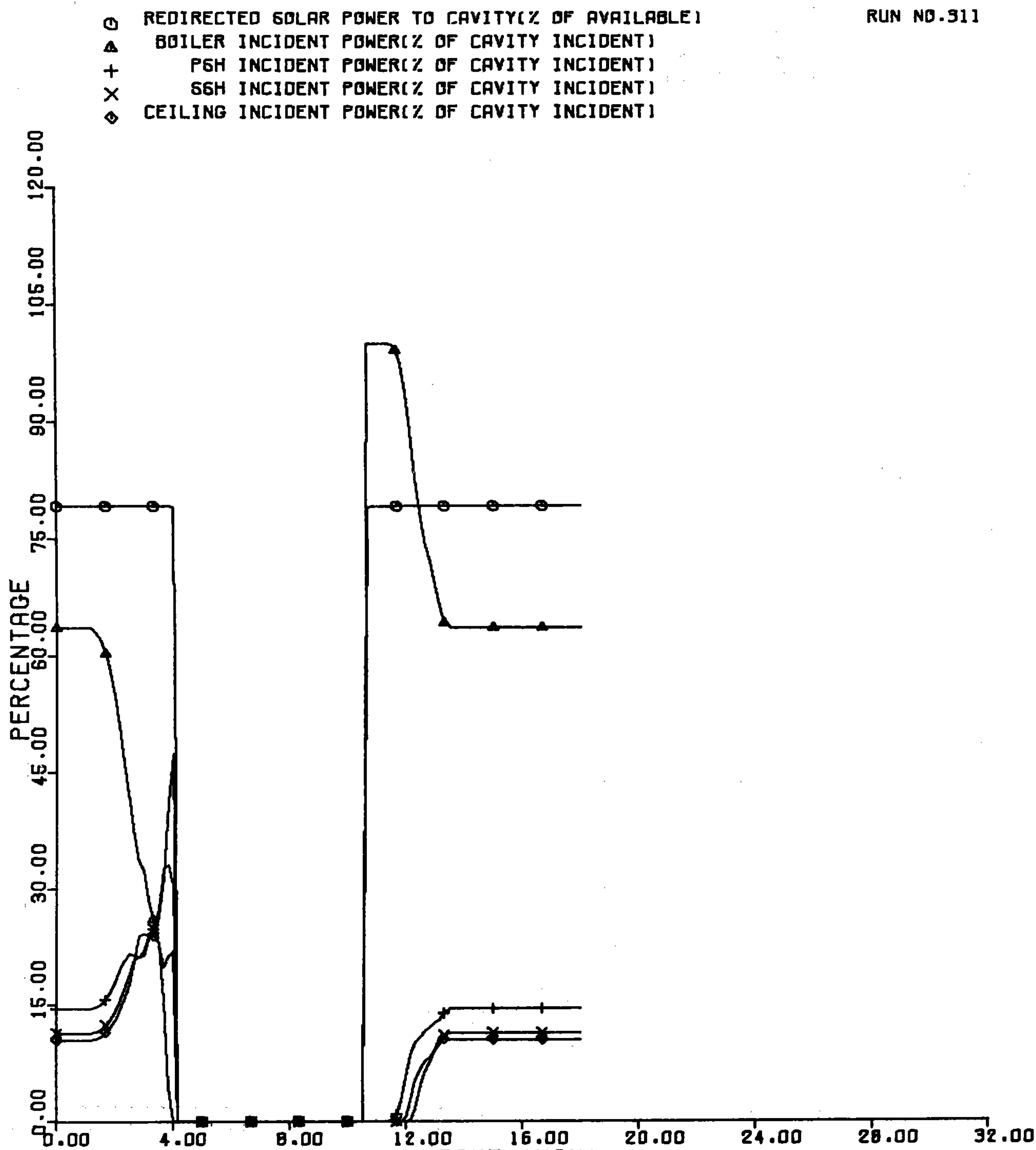
TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 8.452
REDIRECTED ENERGY(MWT-HRS),TOTAL= 6.69BOILER= 4.25PSH= 0.97SSH= 0.76CEILING= 0.71
ABSORBED ENERGY(MWT-HRS),BOILER= 4.04PSH= 0.98SSH= 0.78CEILING= 0.73FLOOR= 0.03TOTAL= 6.55

40703-II-3

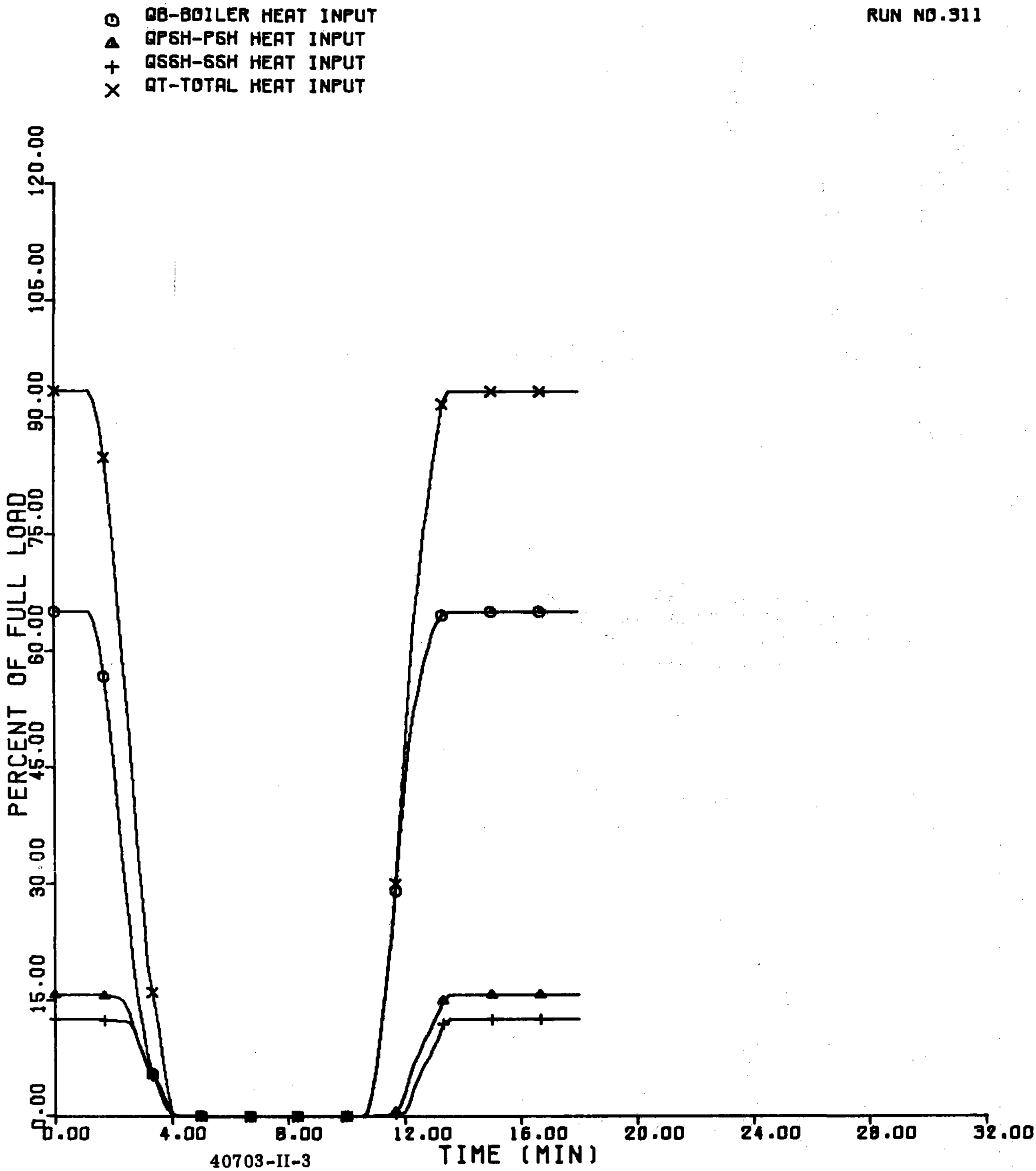
4-104


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.311
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

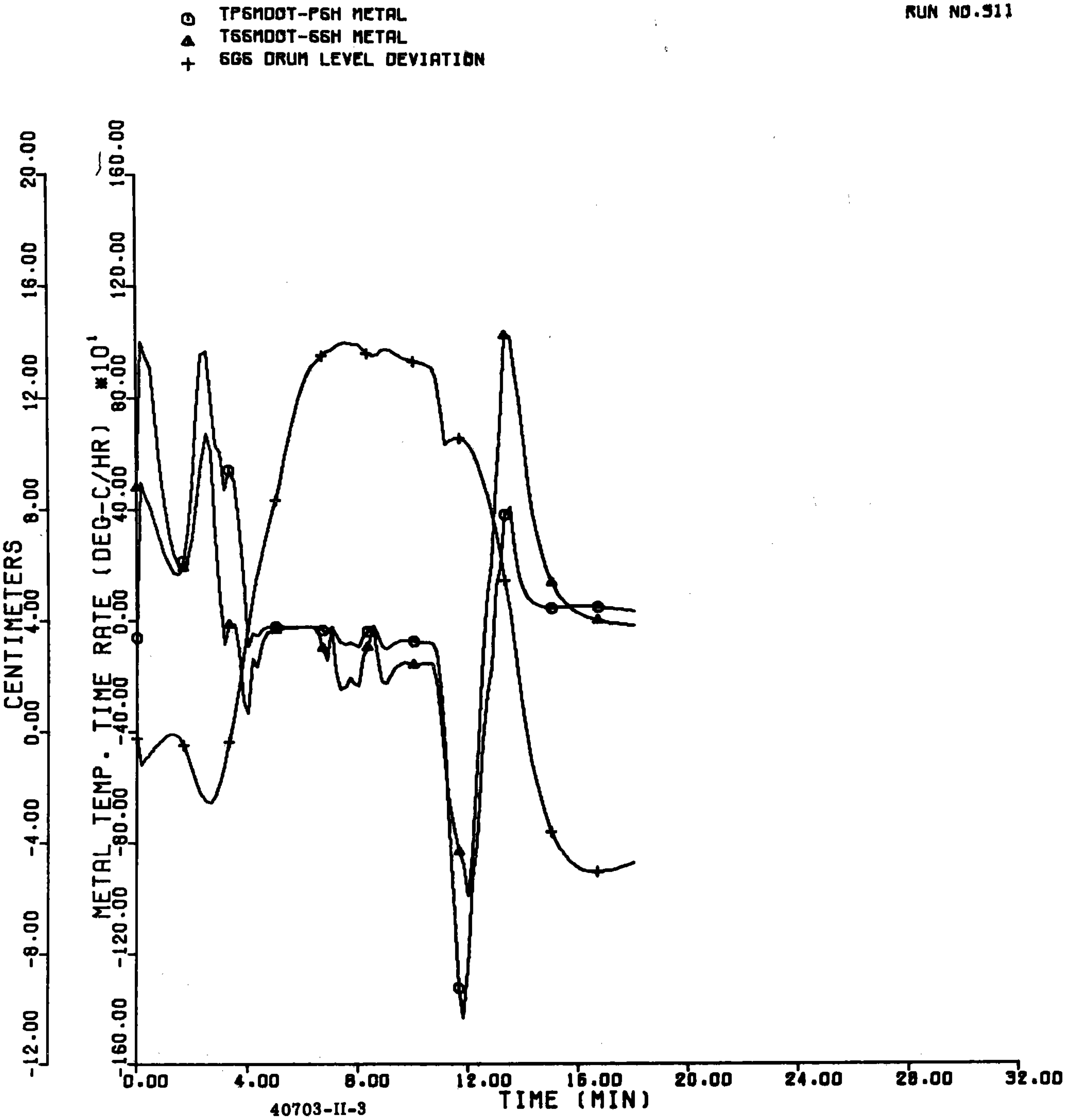
4073-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.311
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

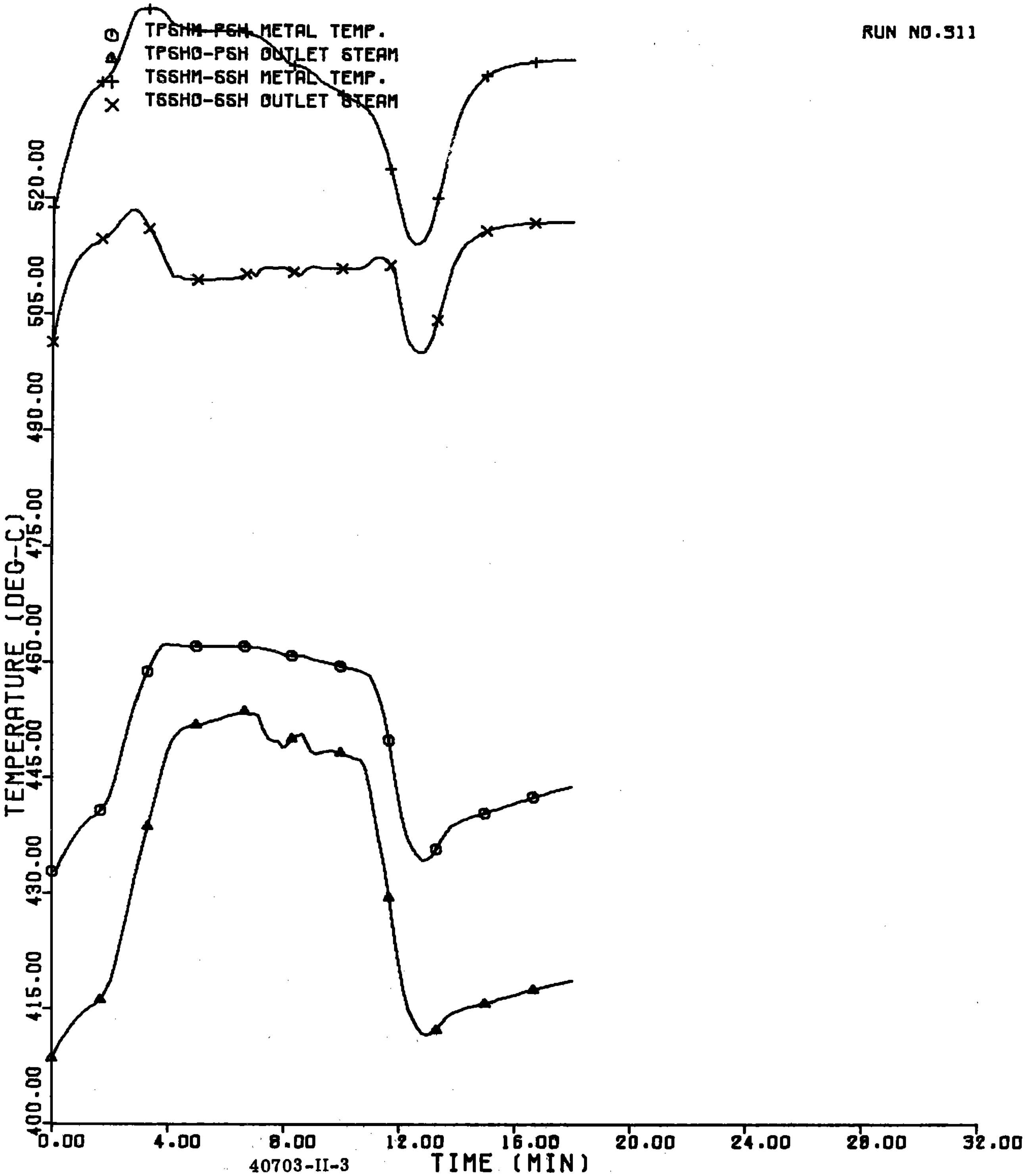
4703-II-3


QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.311
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

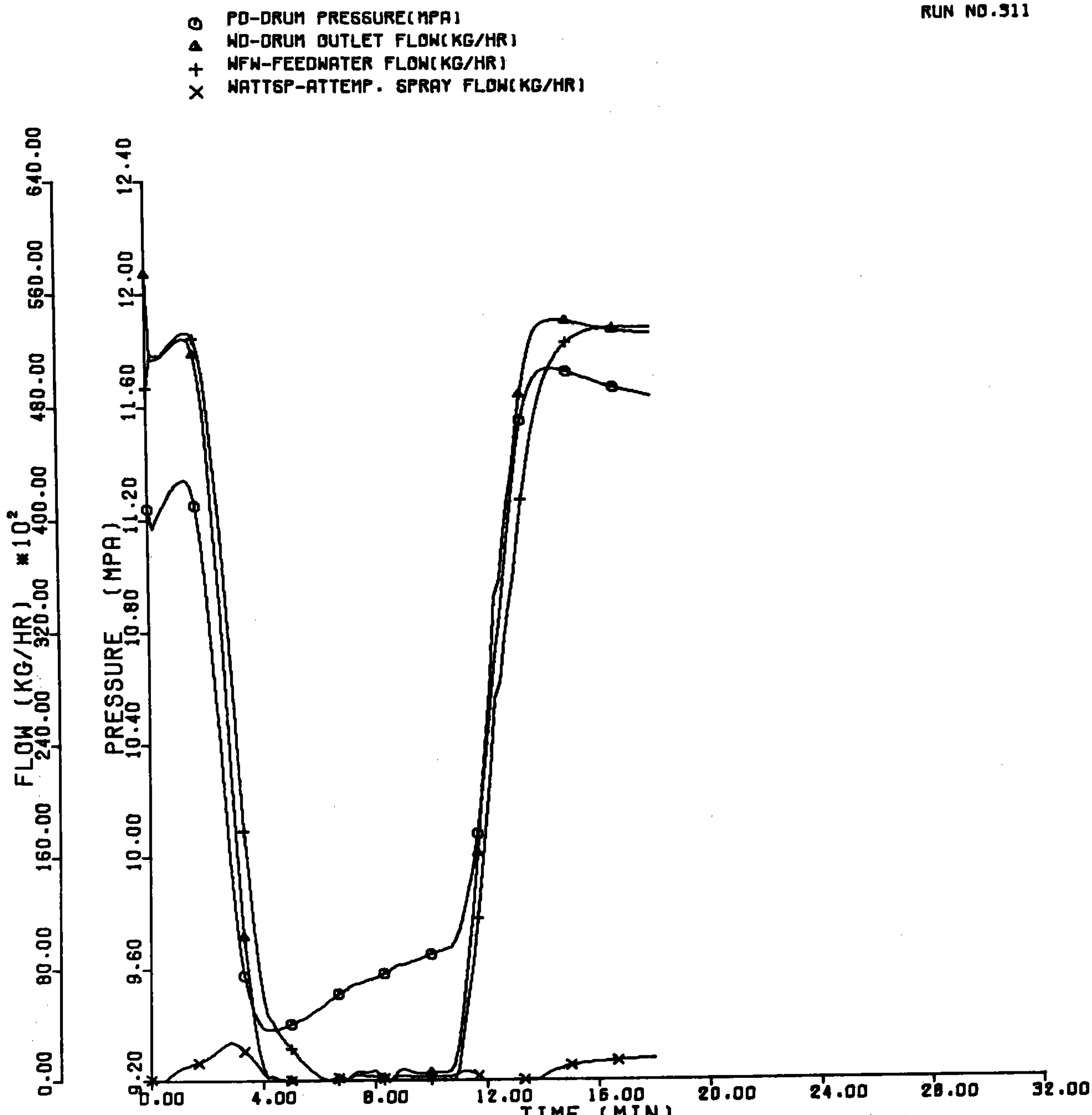
40703-II-3


TP6MDOT-P6H METAL
T66MDOT-66H METAL
6G6 DRUM LEVEL DEVIATION
RUN NO.311
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00
-160.00
-120.00
-80.00
-40.00
0.00
40.00
80.00
120.00
160.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

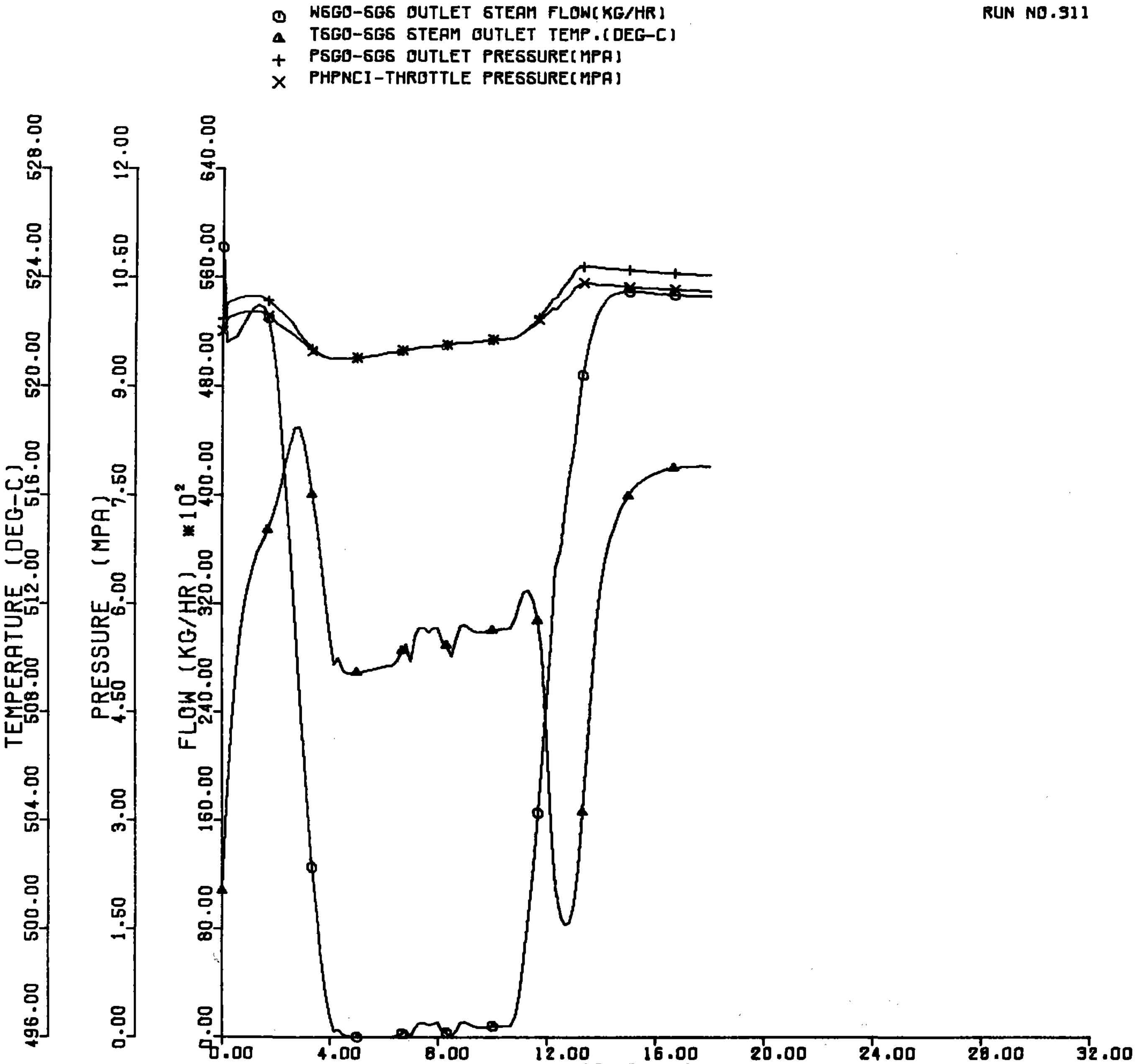
40703-II-3


RUN NO.311
TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
TEMPERATURE (DEG-C)
400.00
415.00
430.00
445.00
460.00
475.00
490.00
505.00
520.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

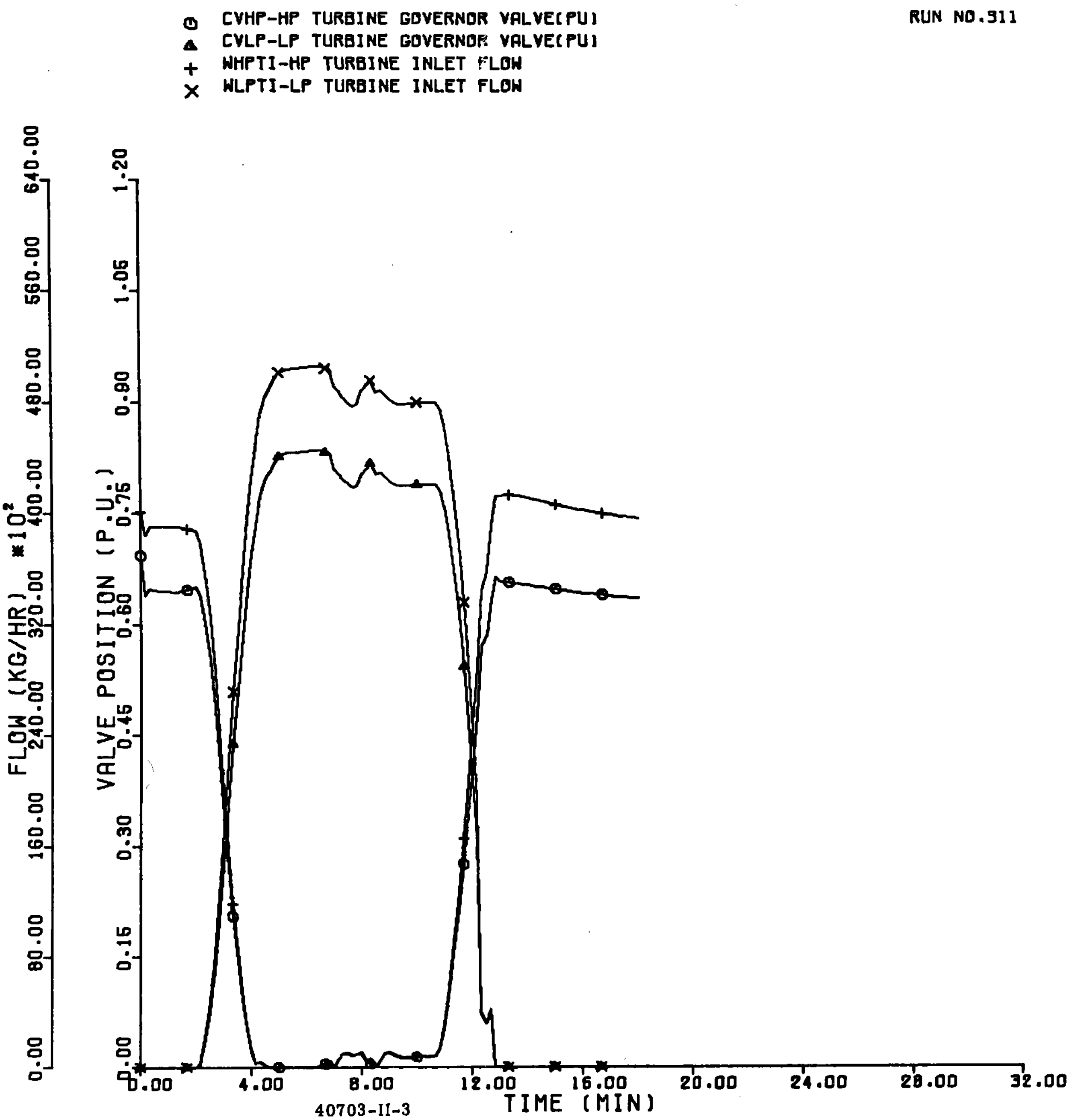
40703-II-3


RUN NO.311
PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
12.40
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3

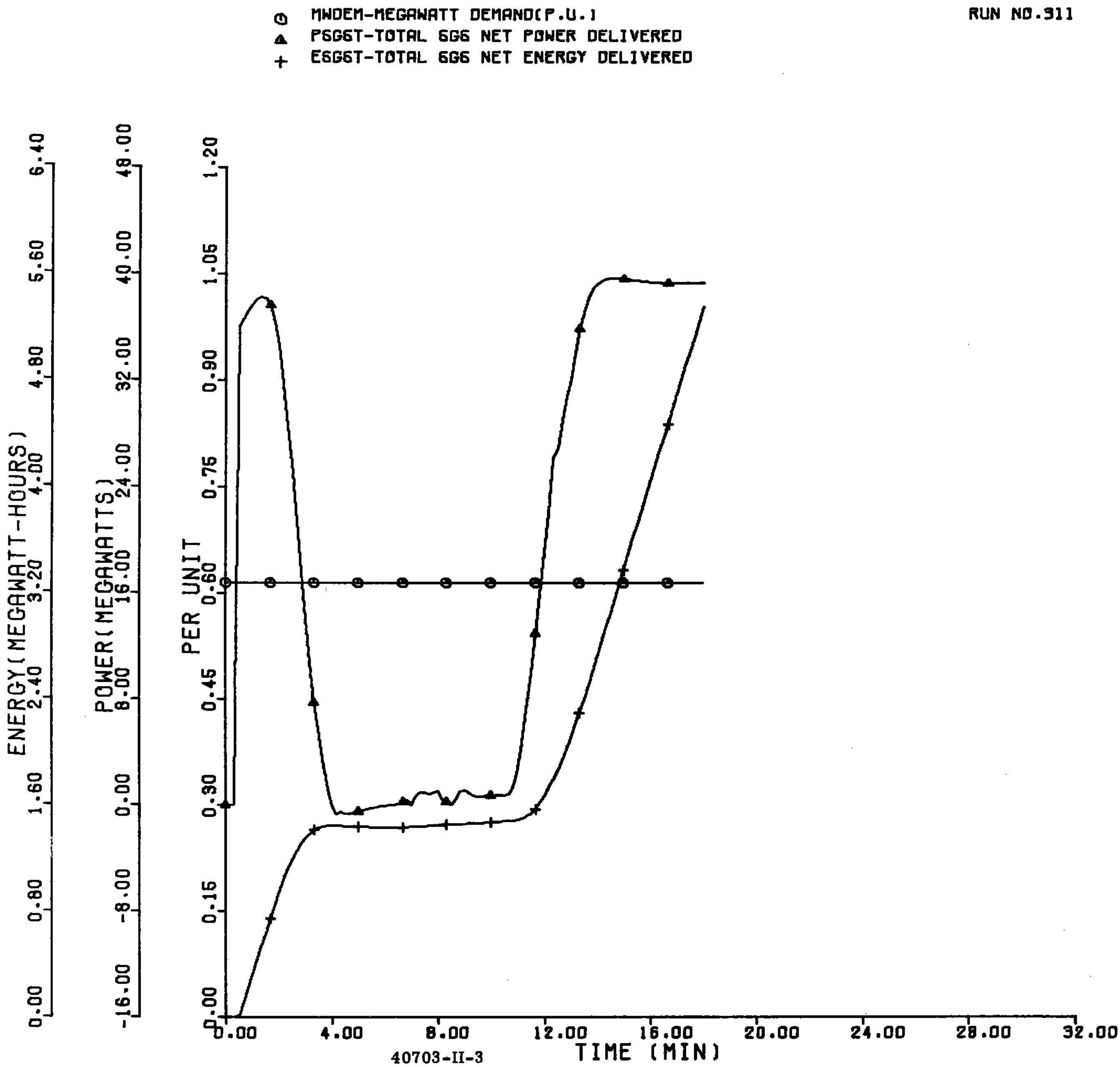

W6G0-6G6 OUTLET STEAM FLOW(KG/HR)
T6G0-6G6 STEAM OUTLET TEMP.(DEG-C)
P6G0-6G6 OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.311
TEMPERATURE (DEG-C)
496.00
500.00
504.00
508.00
512.00
516.00
520.00
524.00
528.00
PRESSURE (MPA)
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

40703-II-3

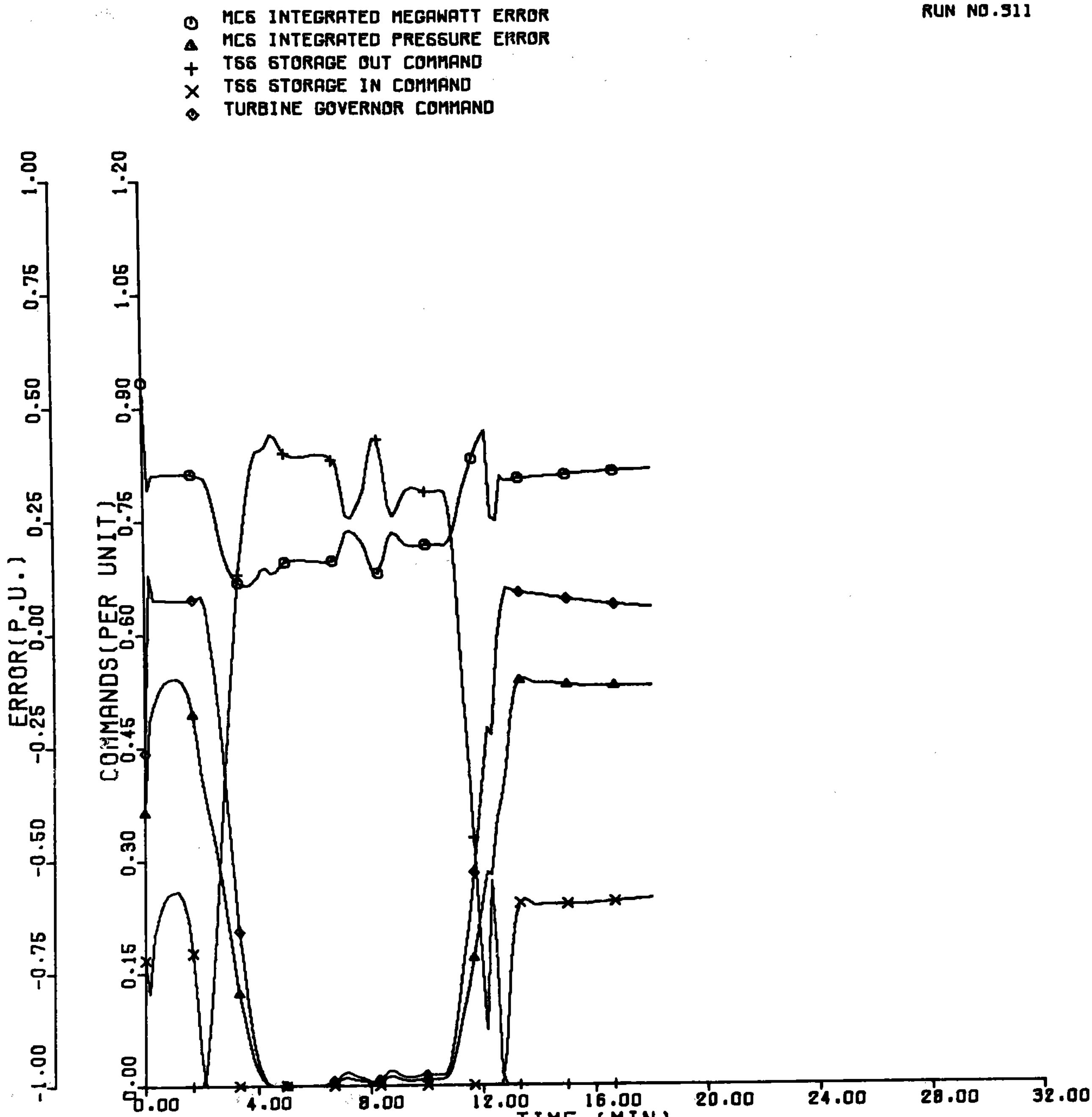


RUN NO.311
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
VALVE POSITION (P.U.)
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

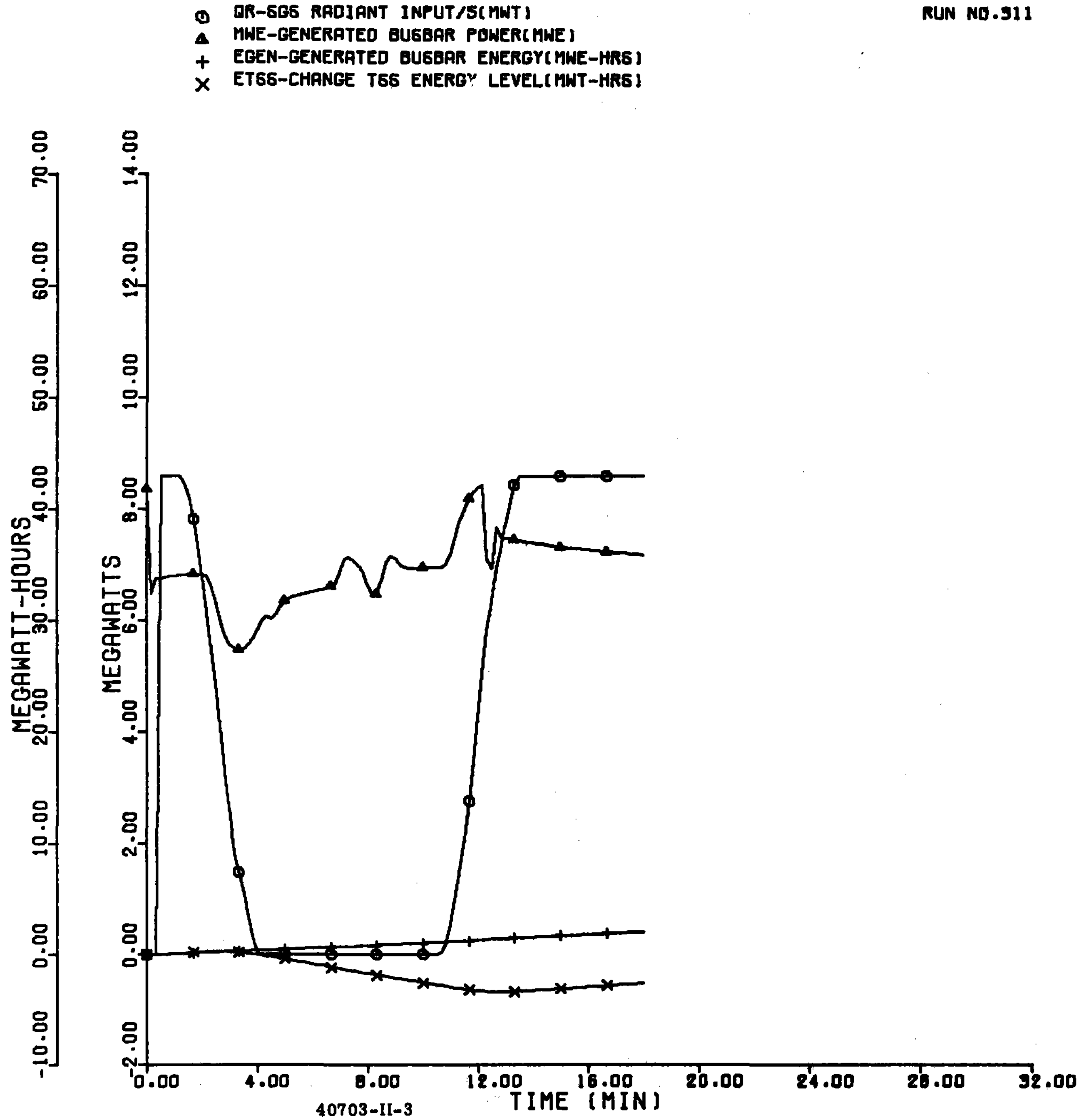
40703-II-3


MWDEM-MEGAWATT DEMAND(P.U.)
PSG6T-TOTAL 6G6 NET POWER DELIVERED
ESG6T-TOTAL 6G6 NET ENERGY DELIVERED
RUN NO.311
ENERGY(MEGAWATT-HOURS)
0.00 0.80 1.60 2.40 3.20 4.00 4.80 5.60 6.40
POWER(MEGAWATTS)
-16.00 -8.00 0.00 8.00 16.00 24.00 32.00 40.00 48.00
PER UNIT
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20
0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00
TIME (MIN)

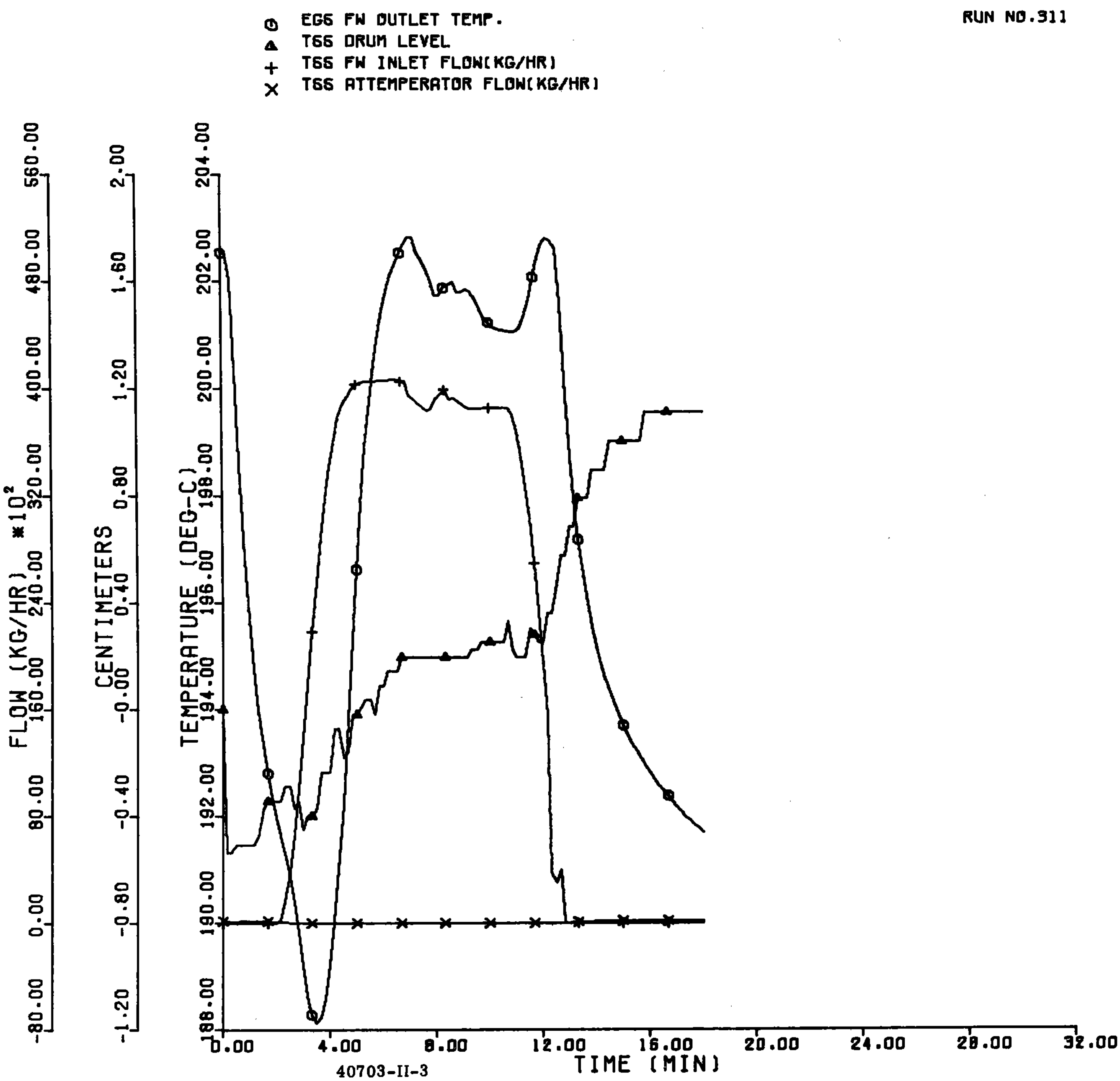
40703-II-3


RUN NO.311
MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
ERROR(P.U.)
-1.00
-0.75
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
COMMANDS(PER UNIT)
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

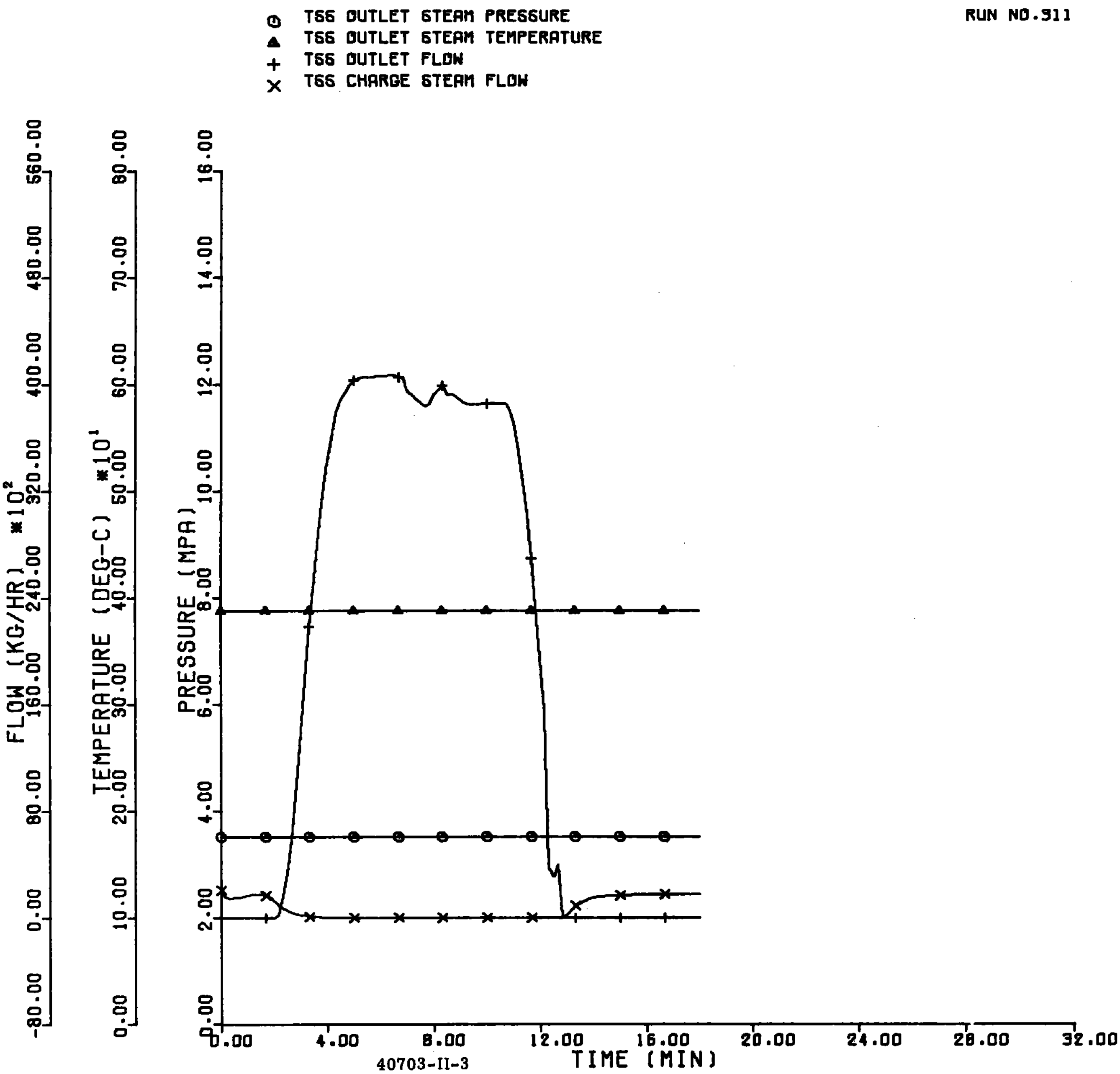
40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.311
MEGAWATT-HOURS
MEGAWATTS
TIME (MIN)
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

40703-II-3


RUN NO.311
EGS FW OUTLET TEMP.
TGS DRUM LEVEL
TGS FW INLET FLOW(KG/HR)
TGS ATTEMPERATOR FLOW(KG/HR)
FLOW (KG/HR) *10²
-80.00
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
CENTIMETERS
-1.20
-0.80
-0.40
-0.00
0.40
0.80
1.20
1.60
2.00
TEMPERATURE (DEG-C)
188.00
190.00
192.00
194.00
196.00
198.00
200.00
202.00
204.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3


RUN NO.311
TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
FLOW (KG/HR) *10²
TEMPERATURE (DEG-C) *10¹
PRESSURE (MPA)
TIME (MIN)
40703-II-3

Run No.	312
Type of Run	Cloud Transient
Run Length	18 min
Run Description	Cloud approaching from South entering field at t=3 min: Speed = 11.4 Km/hr (7.1 mph) Length = 1.8 Km (1.12 mi) Field Coverage: Entire field

SUMMARY OF SPP PERFORMANCE (RUN NO 312.)

SPP POWER LEVELS

	BTU/HR X 10*6 AVG	BTU/HR X 10*6 PEAK	BTU/HR X 10*6 MIN	MWTH AVG	MWTH PEAK	MWTH MIN
GROSS SGS INPUT POWER	67.765	146.738	0.	19.86	43.01	0.
NET OUTPUT POWER OF SGS TO-						
TOTAL	62.529	144.724	-5.091	18.33	42.42	-1.49
EGS	48.088	102.226	-0.000	14.09	29.96	-0.00
TSS	13.645	39.822	0.000	4.00	11.67	0.00
NET TSS POWER TO EGS	44.634	90.606	-0.000	13.08	26.56	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.90	10.77	7.11
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				7075156.	14764.	0.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 4110.6 TO TSS 1166.4 FROM TSS

TOTAL RADIANT ENERGY IN= 5792.7KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9104

NET CHANGE IN TSS ENERGY -2668.00(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 2.02(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	387.7	399.4	370.5
TD-DRUM TEMP	597.3	615.3	583.0
TPSHO-PSH TEMP OUT	744.5	813.7	696.5
TSSHO-SSH TEMP OUT	919.1	975.3	872.0
TPSHM-PSH METAL TEMP	772.1	862.6	713.1
TSSHM-SSH METAL TEMP	942.7	1016.8	889.1
PSH METAL TEMP RATE	64.2	5470.1	-4229.0
SSH METAL TEMP RATE	71.7	5151.9	-4193.2
PPSHO-PSH PRES.OUT	1480.9	1637.1	1356.5
PSSHO-SSH PRES.OUT	1446.8	1559.1	1356.5
PD-DRUM PRES	1515.1	1721.3	1356.5
DELTA DRUM LEVEL	2.18	5.93	-1.88
PHPNCI-HP NOZ PRES	1431.7	1523.8	1356.5

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	850.0	850.0	850.0
TCHTC-COLD HITEC TEM	570.1	570.3	570.0
TOIL-MAIN OIL TEMP	479.9	480.0	479.8
DDRUM-DELTA DRUM LEV	0.1	0.5	-0.2
PDRUM-DRUM PRESSURE	581.0	622.3	560.1
TPREH-PREHEATER TEMP	478.3	487.8	472.4
TDSH-DESUPER-TEMP	0.	0.	0.

40703-II-3

MISCELLANEOUS RECEIVER CAVITY TERMS

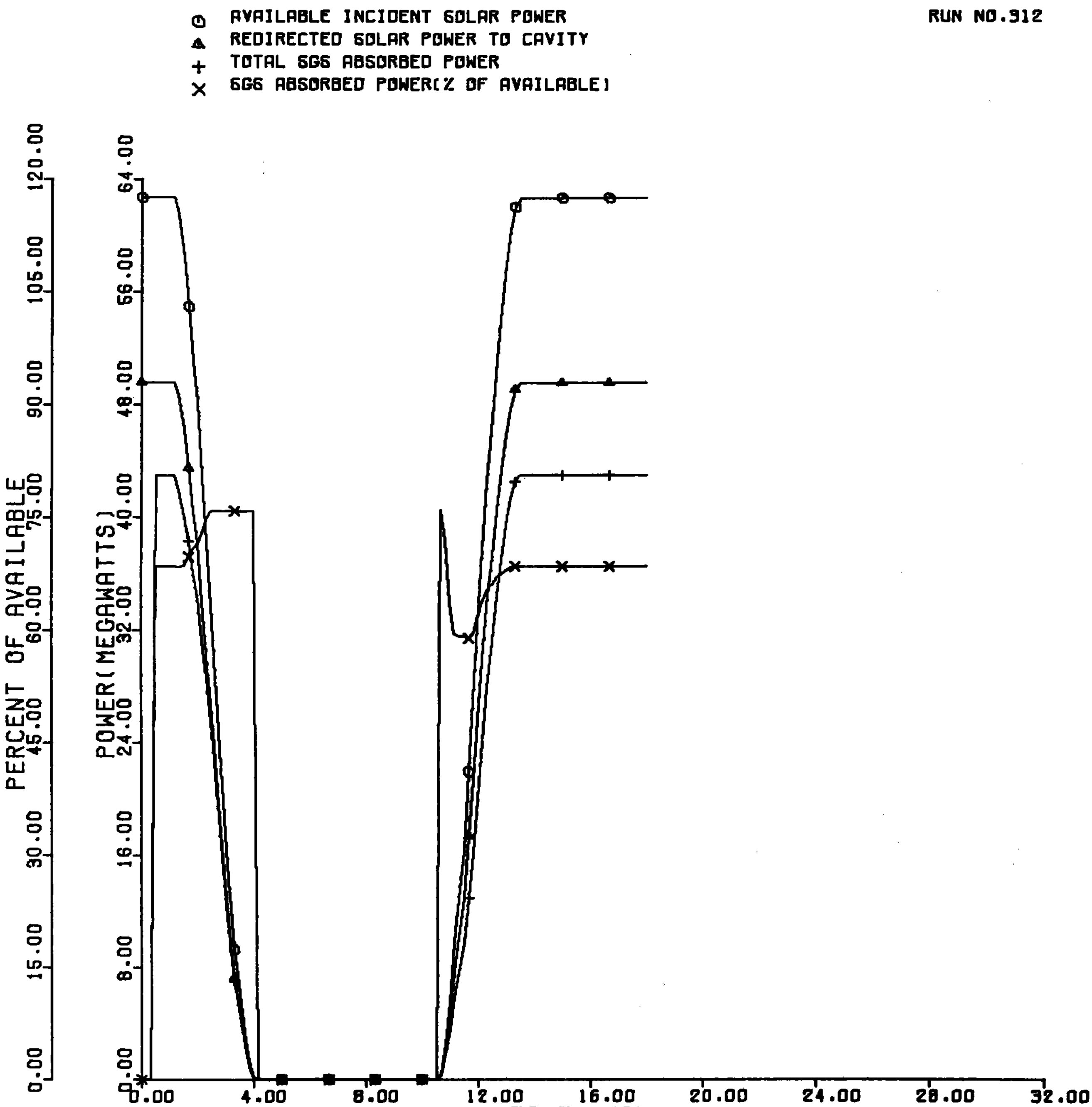
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.4529	0.9807	0.
QINC-INCIDENT AVAILABLE POWER(MWT)	28.9493	62.6863	0.
QRDB-REDIRECTED POWER TO BOILER(MWT)	14.5542	31.5154	0.
QBDP-REDIRECTED POWER TO PSH(MWT)	3.3224	7.1943	0.
QRDS-REDIRECTED POWER TO SSH(MWT)	2.6185	5.6700	0.
QRDC-REDIRECTED POWER TO CEILING(MWT)	2.4155	5.2304	0.
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	22.9106	49.6101	0.
QABB-ABSORBED POWER ON BOILER(MWT)	13.8407	29.9705	0.
QABP-ABSORBED POWER ON PSH(MWT)	3.3471	7.2478	0.
QABS-ABSORBED POWER ON SSH(MWT)	2.6741	5.7905	0.
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	2.4861	5.3834	0.
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.0865	0.1873	0.
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	22.4346	48.5795	0.
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	30.0746	65.1230	0.
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.2729	15.7487	0.
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	5.8107	12.5823	0.
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	43.158	93.454	0.
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.492	0.791	0.
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.482	0.781	0.
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.609	0.987	0.
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	-0.000	41.743	-41.707
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	-0.000	12.832	-12.832
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.000	12.842	-12.842
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.000	52.700	-52.699
TCAV1-CEILING TEMPERATURE(DEG-F)	1070.8	1249.7	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.6	651.5	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 8.452

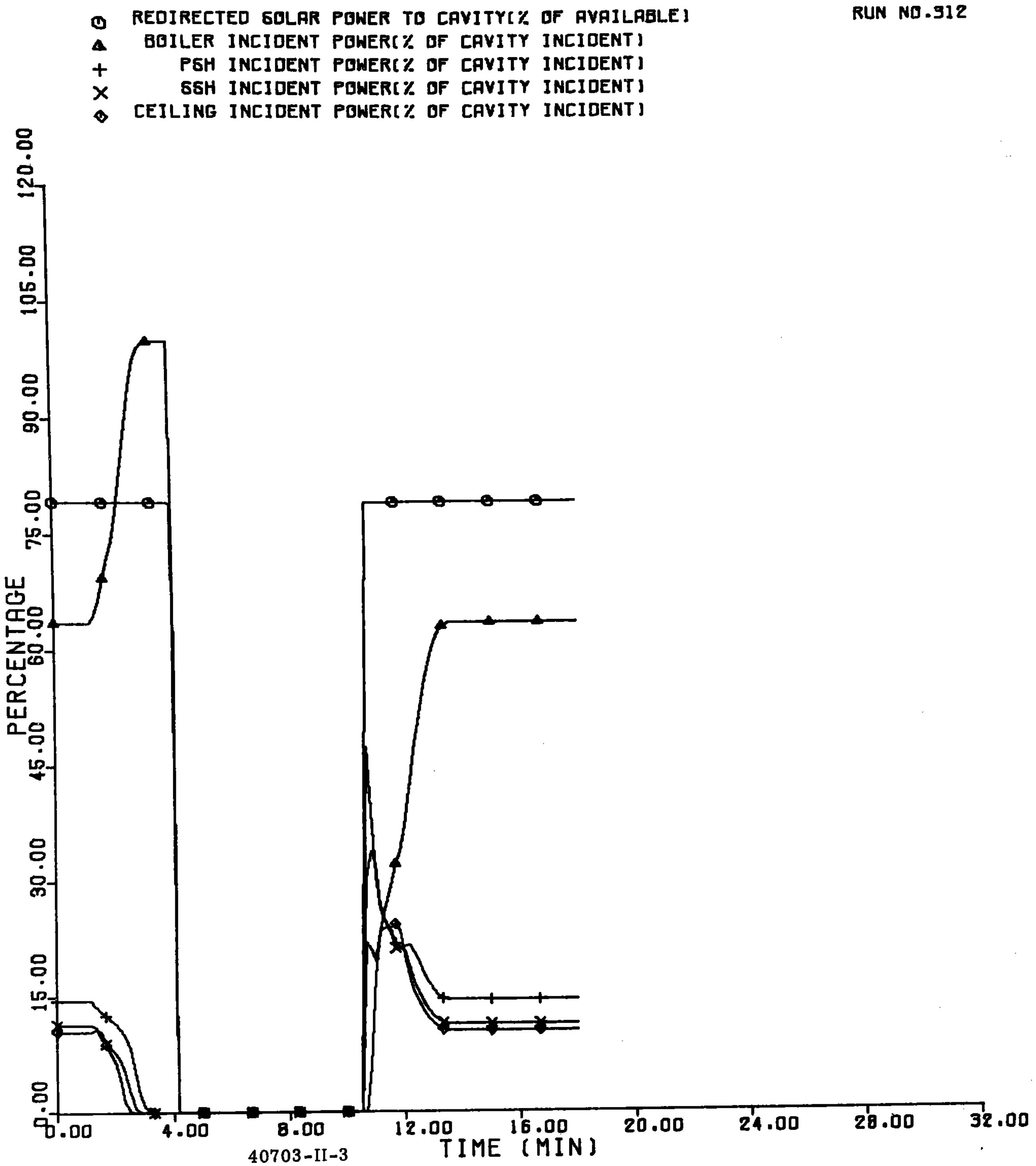
REDIRECTED ENERGY(MWT-HRS),TOTAL= 6.69BOILER= 4.25PSH= 0.97SSH= 0.76CEILING= 0.71

ABSORBED ENERGY(MWT-HRS),BOILER= 4.04PSH= 0.98SSH= 0.78CEILING= 0.73FLOOR= 0.03TOTAL= 6.55

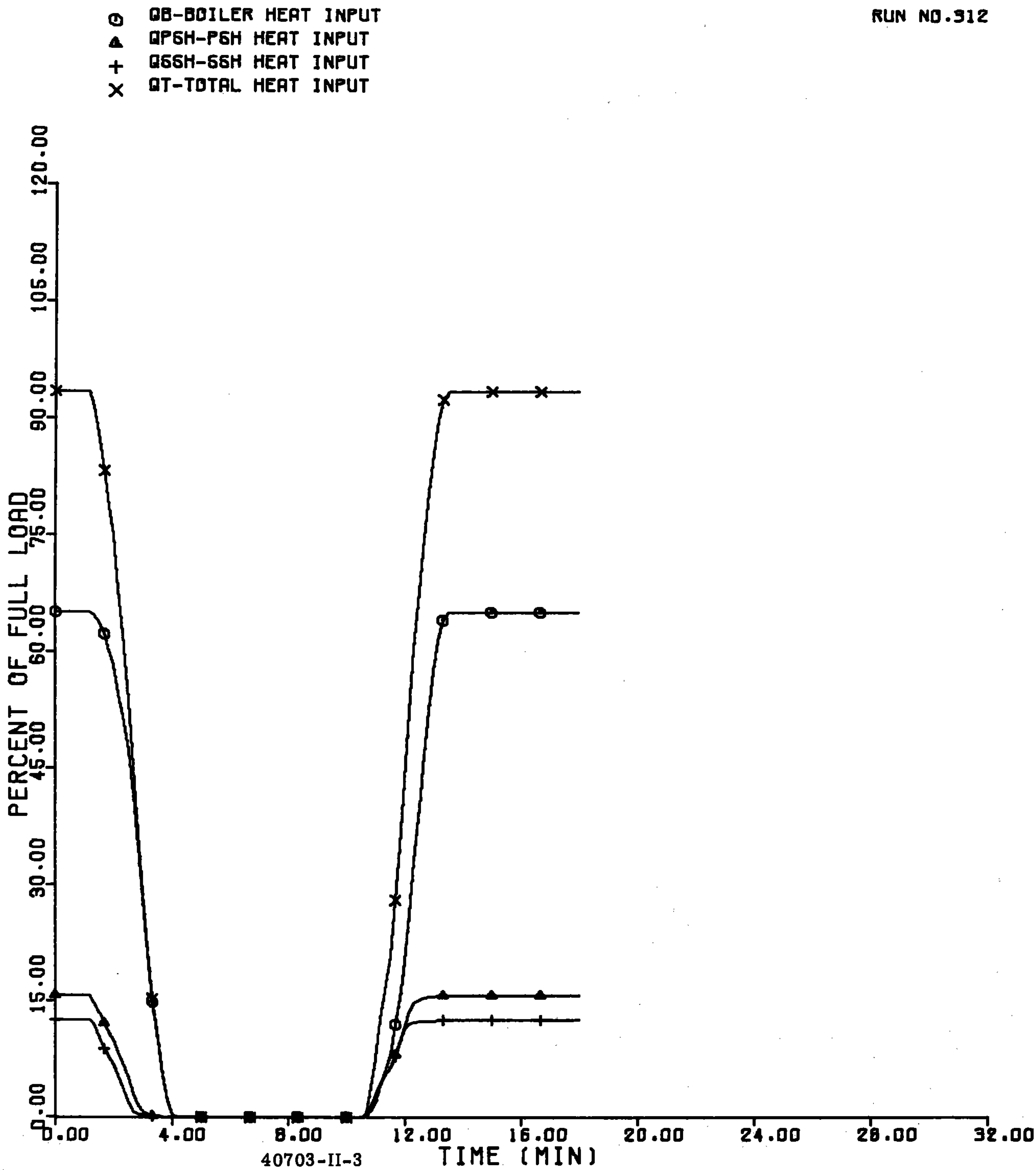
40703-II-3


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.312
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
4.00
12.00
20.00
28.00

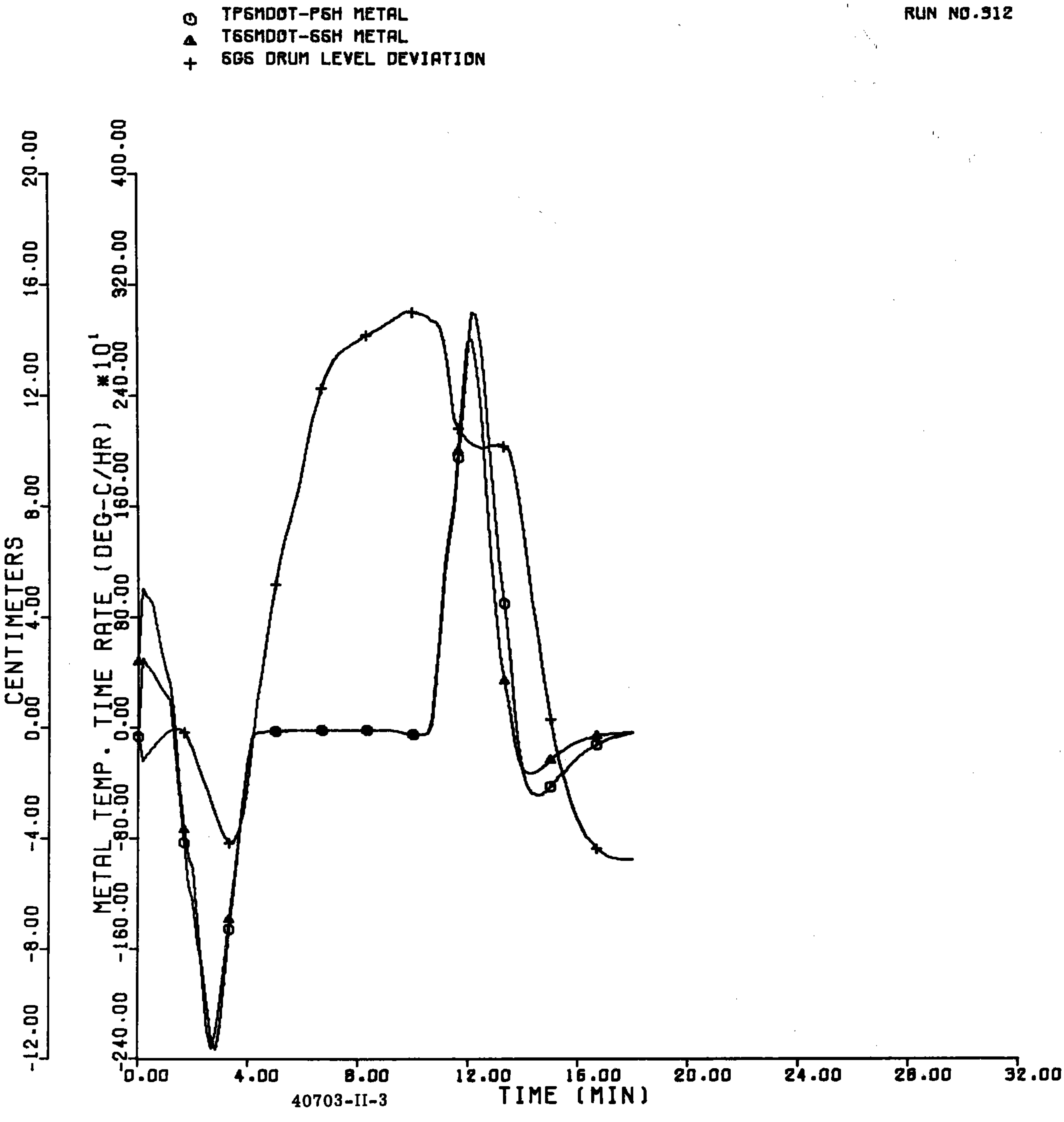
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.312
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3

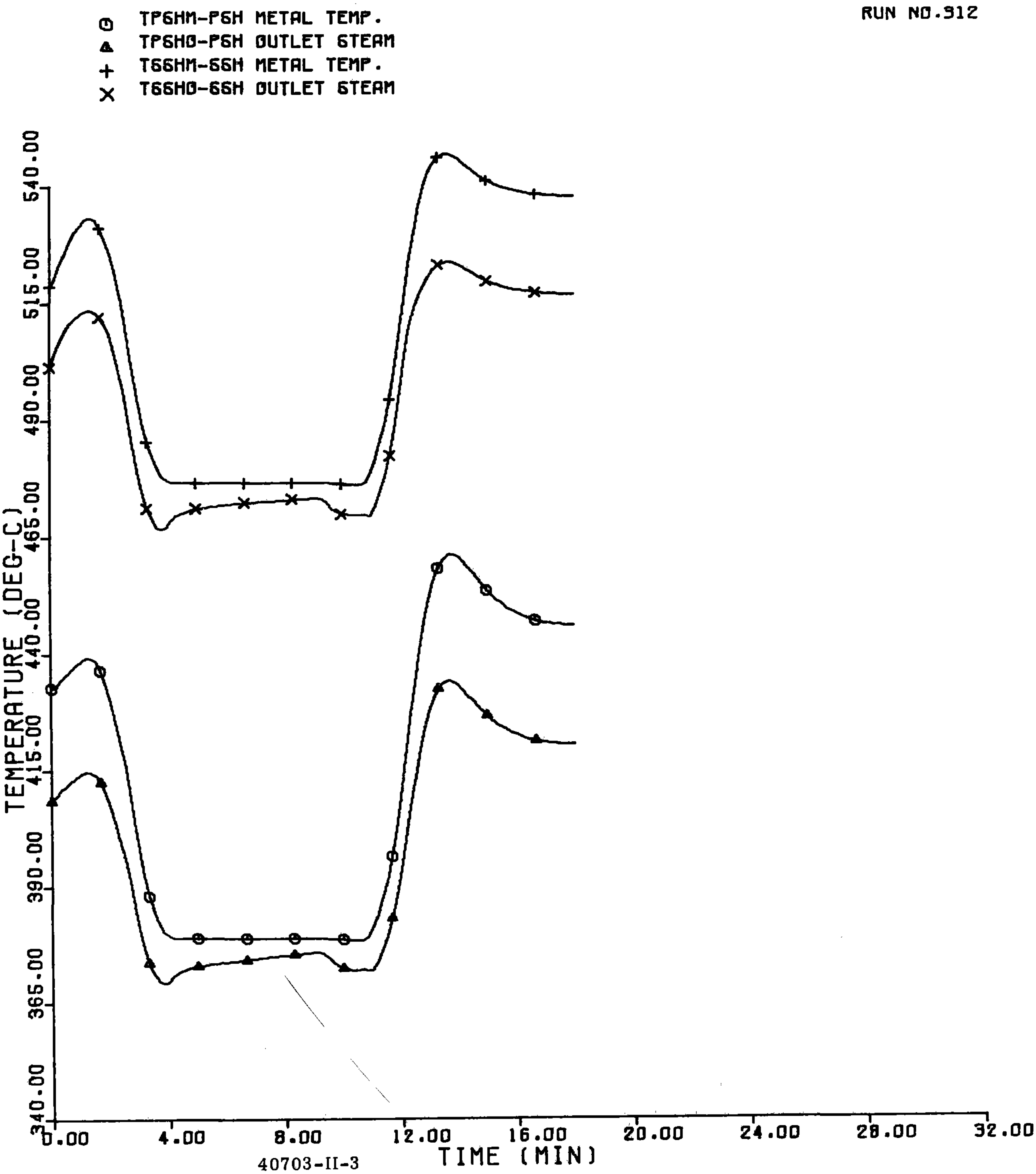

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.312
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3

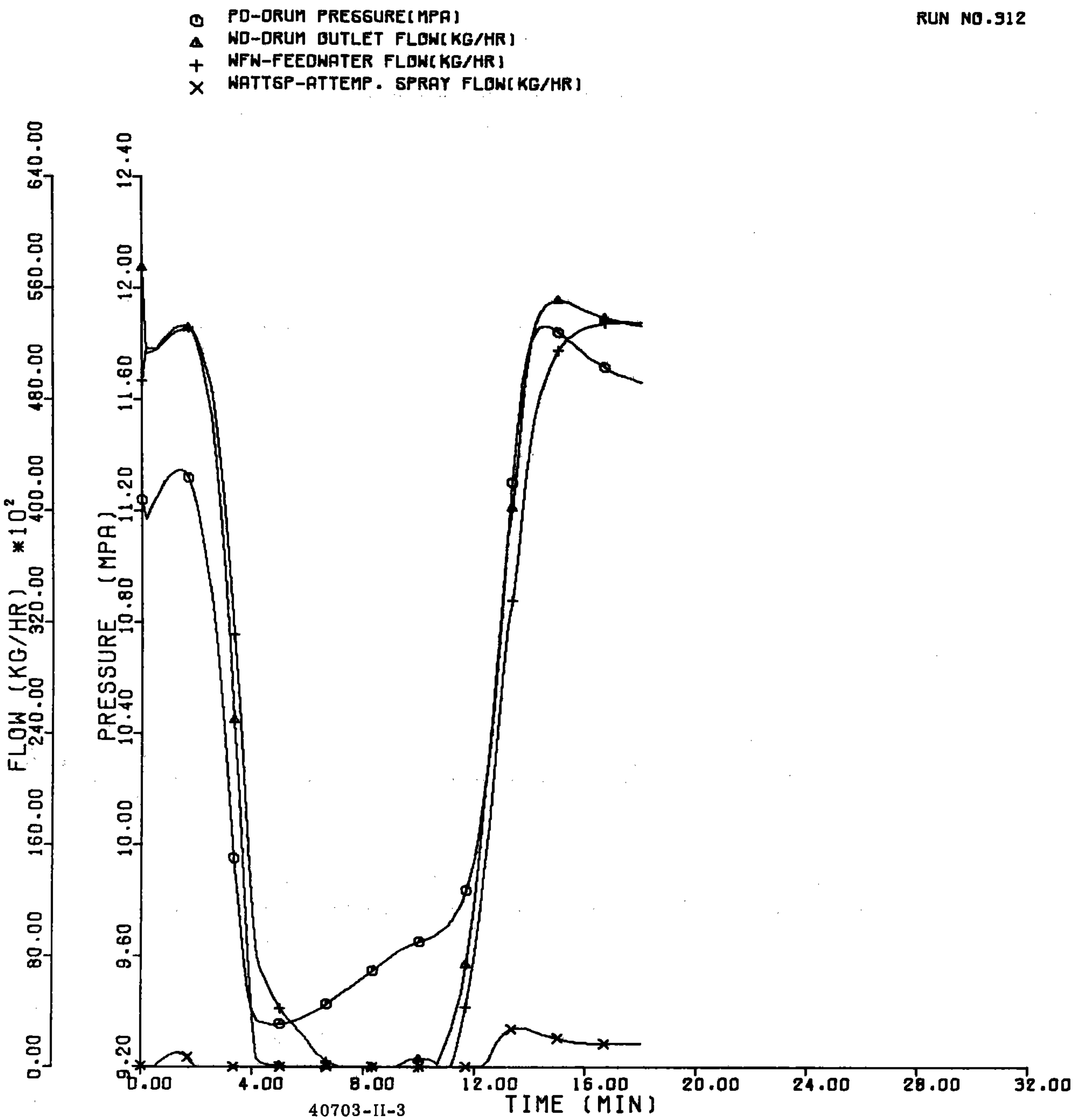


RUN NO.312
TPGMDOT-PGH METAL
TGGMDOT-GGH METAL
GDG DRUM LEVEL DEVIATION
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
-12.00
-8.00
-4.00
0.00
4.00
8.00
12.00
16.00
20.00
-240.00
-160.00
-80.00
0.00
80.00
160.00
240.00
320.00
400.00

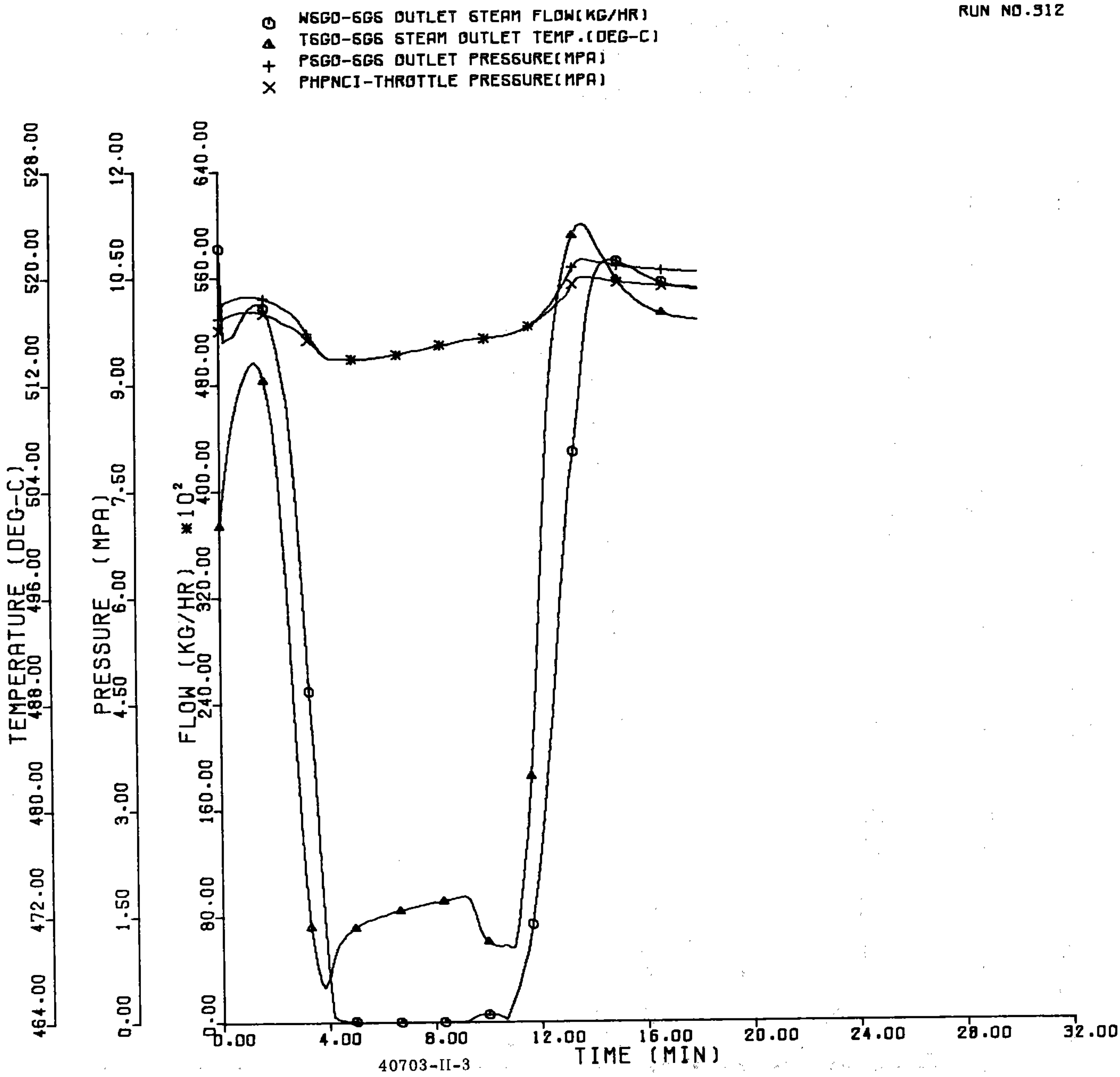
40703-II-3


RUN NO.312
TP6HM-P6H METAL TEMP.
TP6HO-P6H OUTLET STEAM
T66HM-66H METAL TEMP.
T66HO-66H OUTLET STEAM
TEMPERATURE (DEG-C)
340.00
365.00
390.00
415.00
440.00
465.00
490.00
515.00
540.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

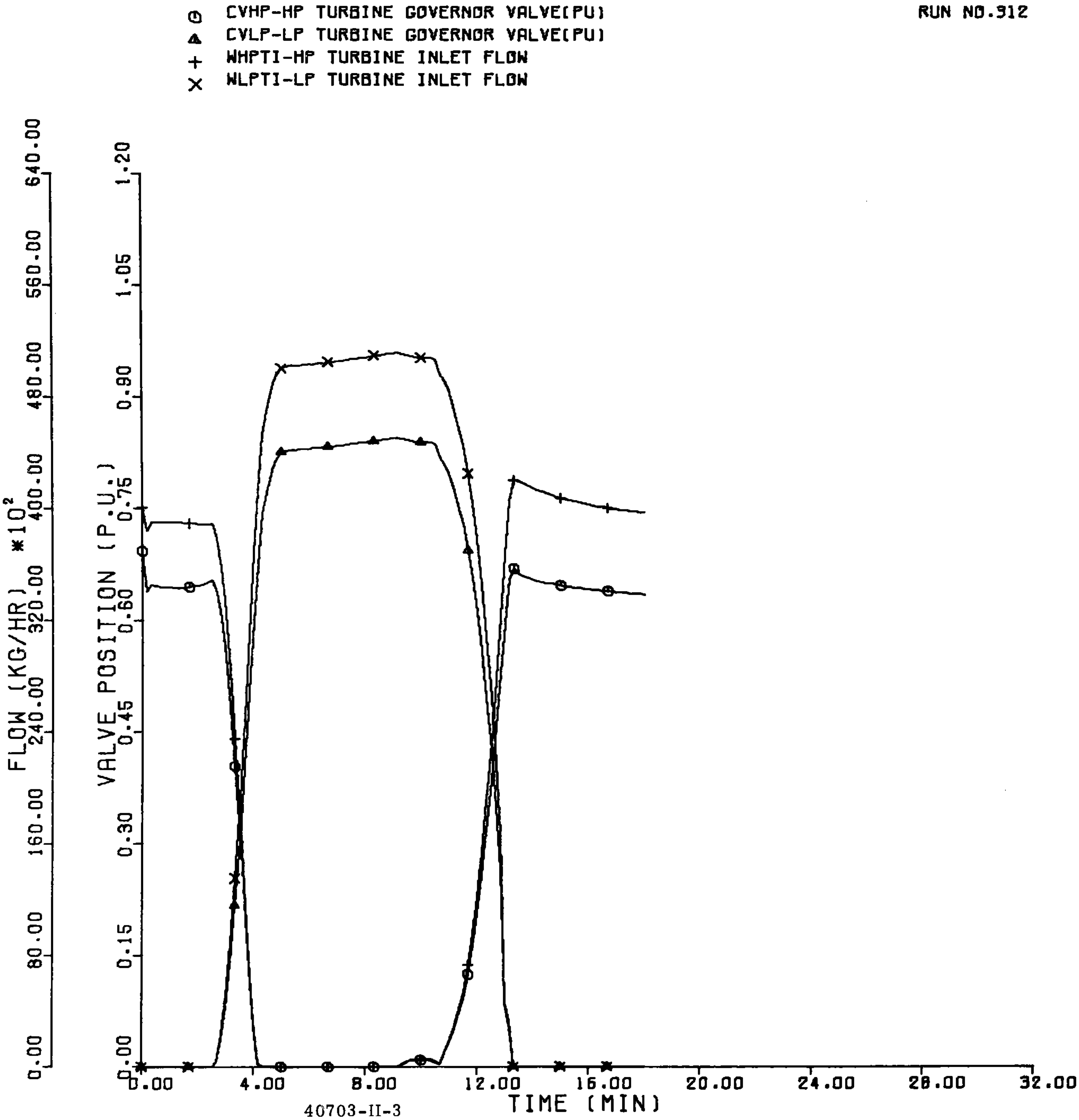
40703-II-3


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.312
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
12.40
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

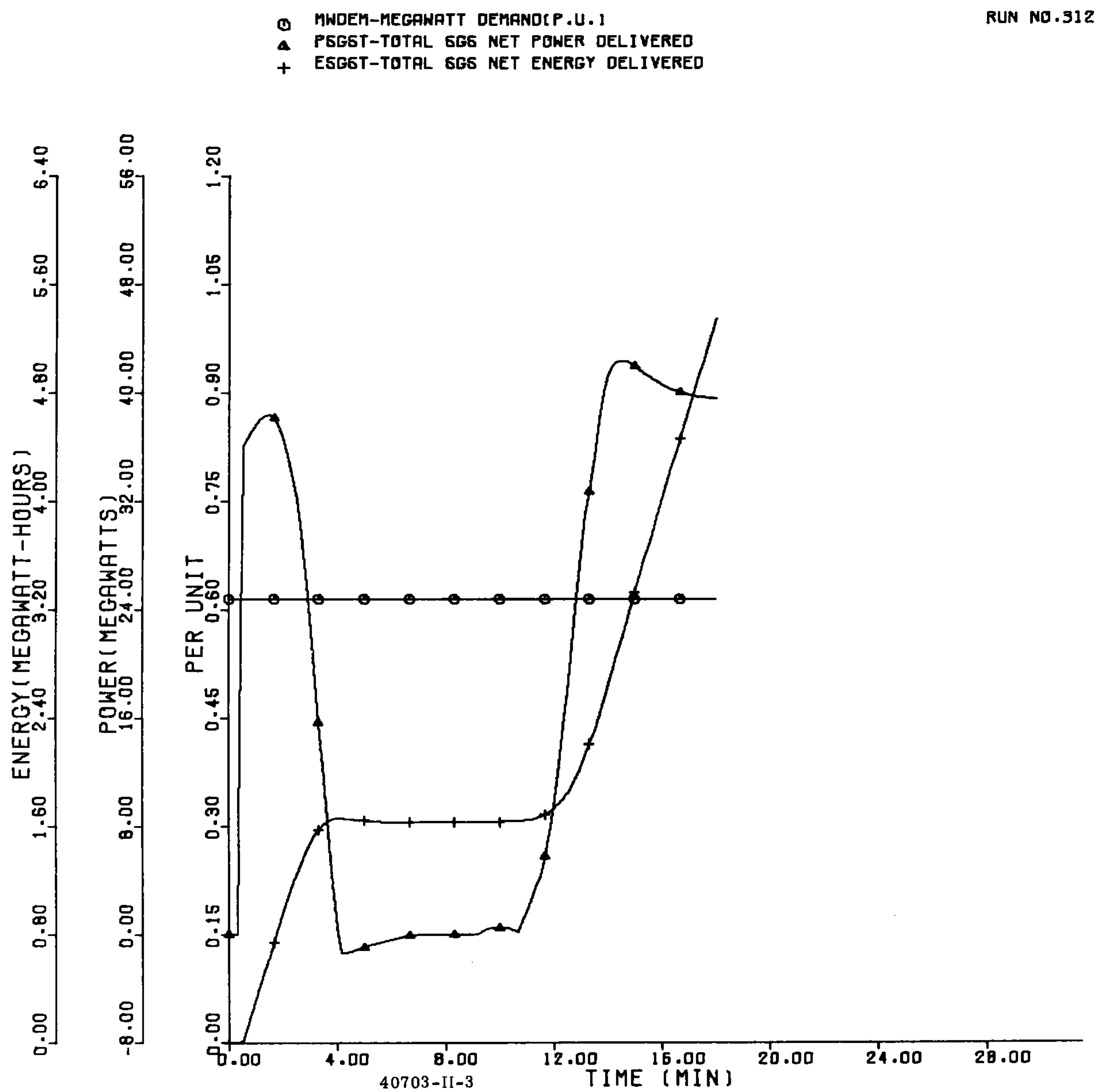
40703-II-3


RUN NO.312
WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10²
TIME (MIN)
464.00
472.00
480.00
488.00
496.00
504.00
512.00
520.00
528.00
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

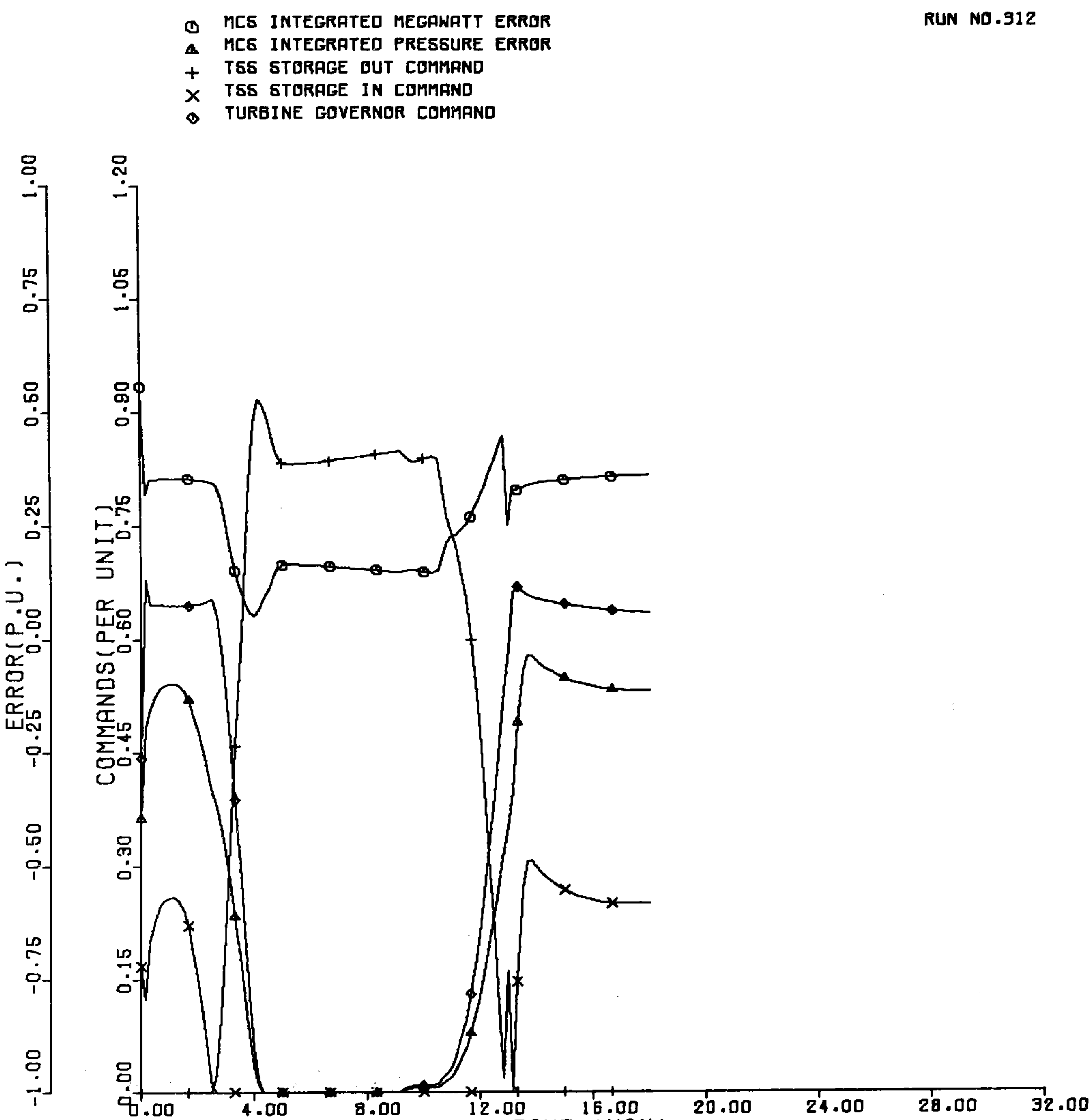
40703-II-3


RUN NO.312
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
FLOW (KG/HR) *10²
VALVE POSITION (P.U.)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

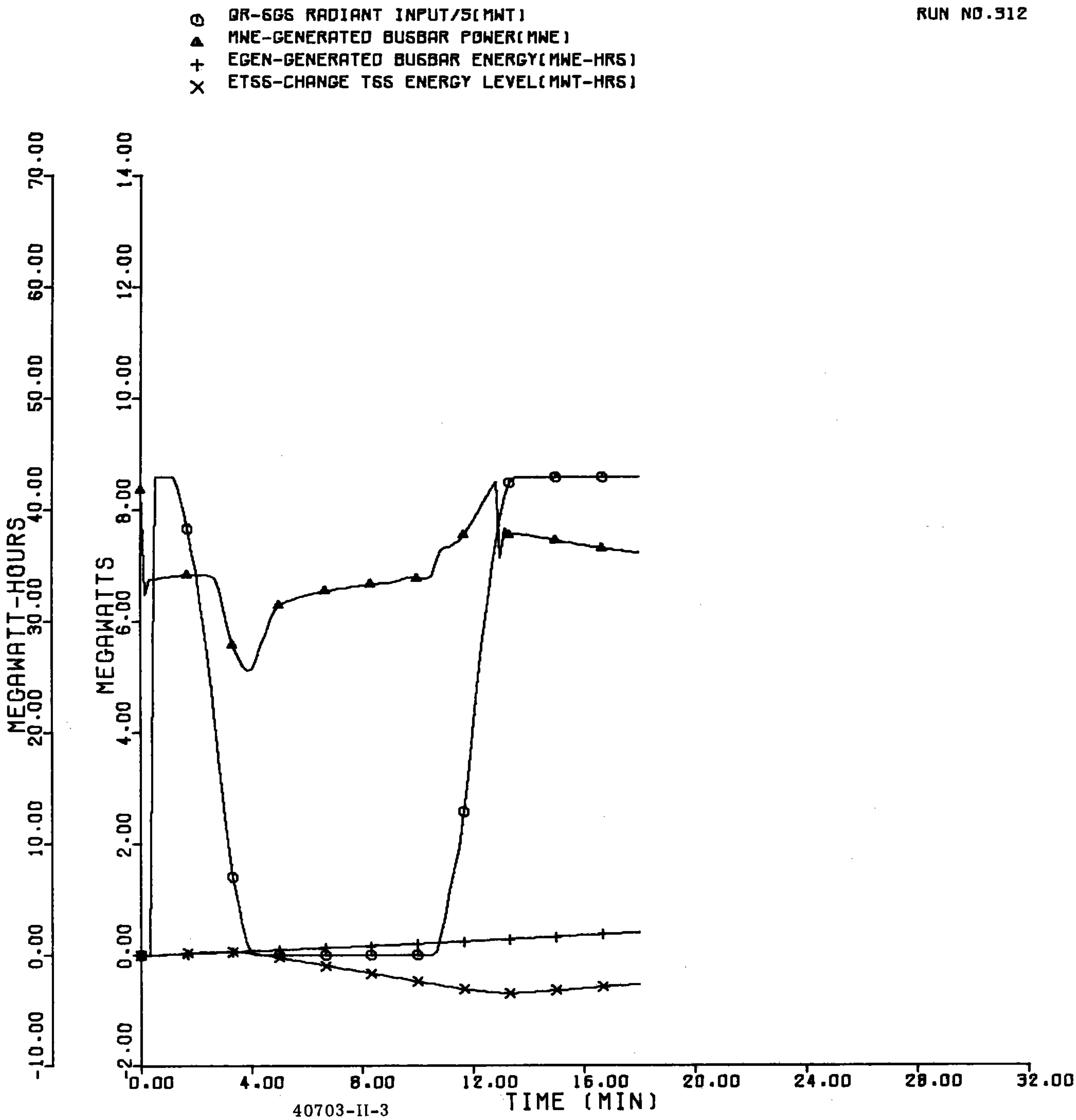
40703-II-3


MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.312
ENERGY(MEGAWATT-HOURS)
0.00
0.80
1.60
2.40
3.20
4.00
4.80
5.60
6.40
POWER(MEGAWATTS)
-8.00
0.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
PER UNIT
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
TIME (MIN)

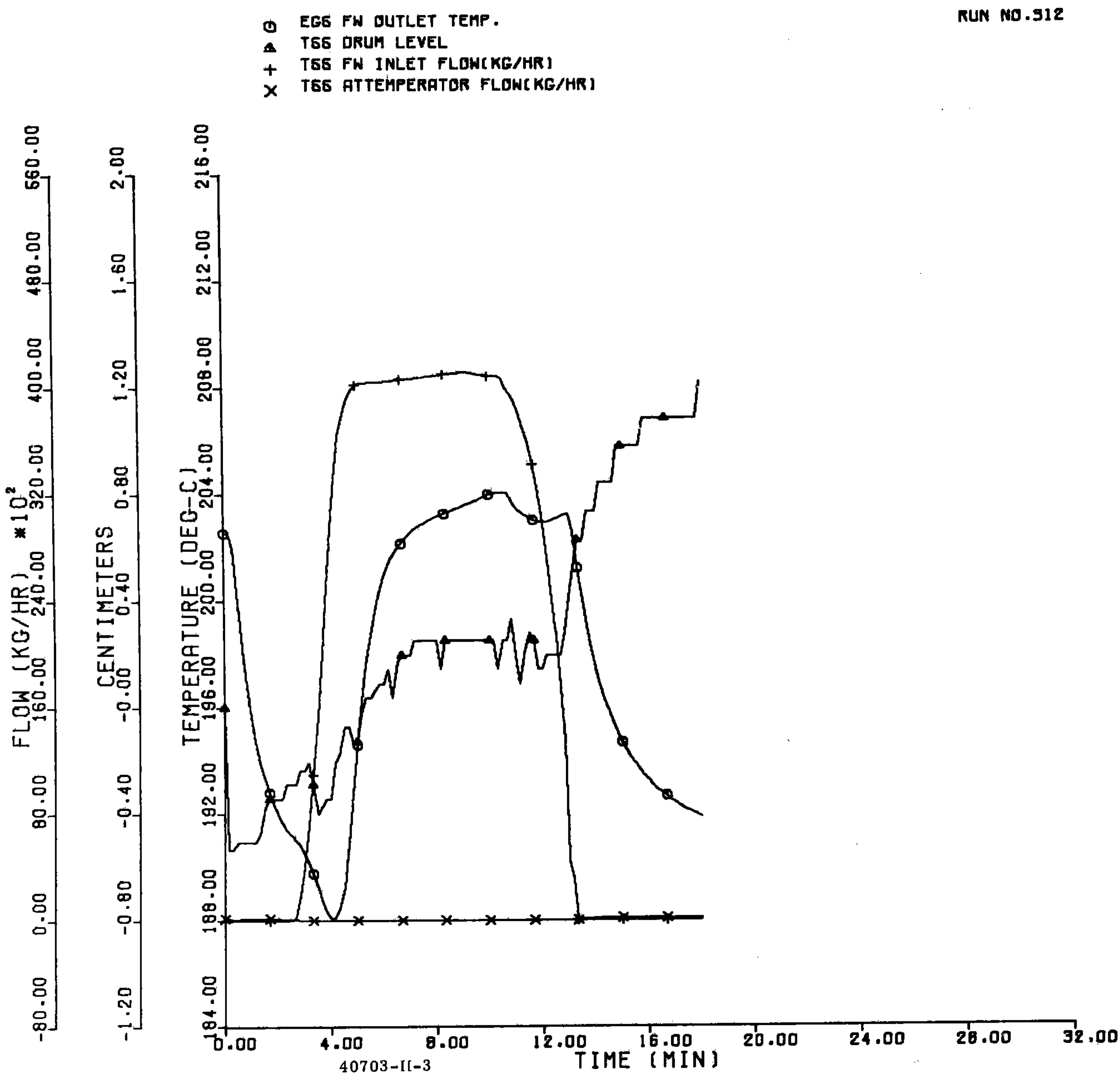
40703-II-3

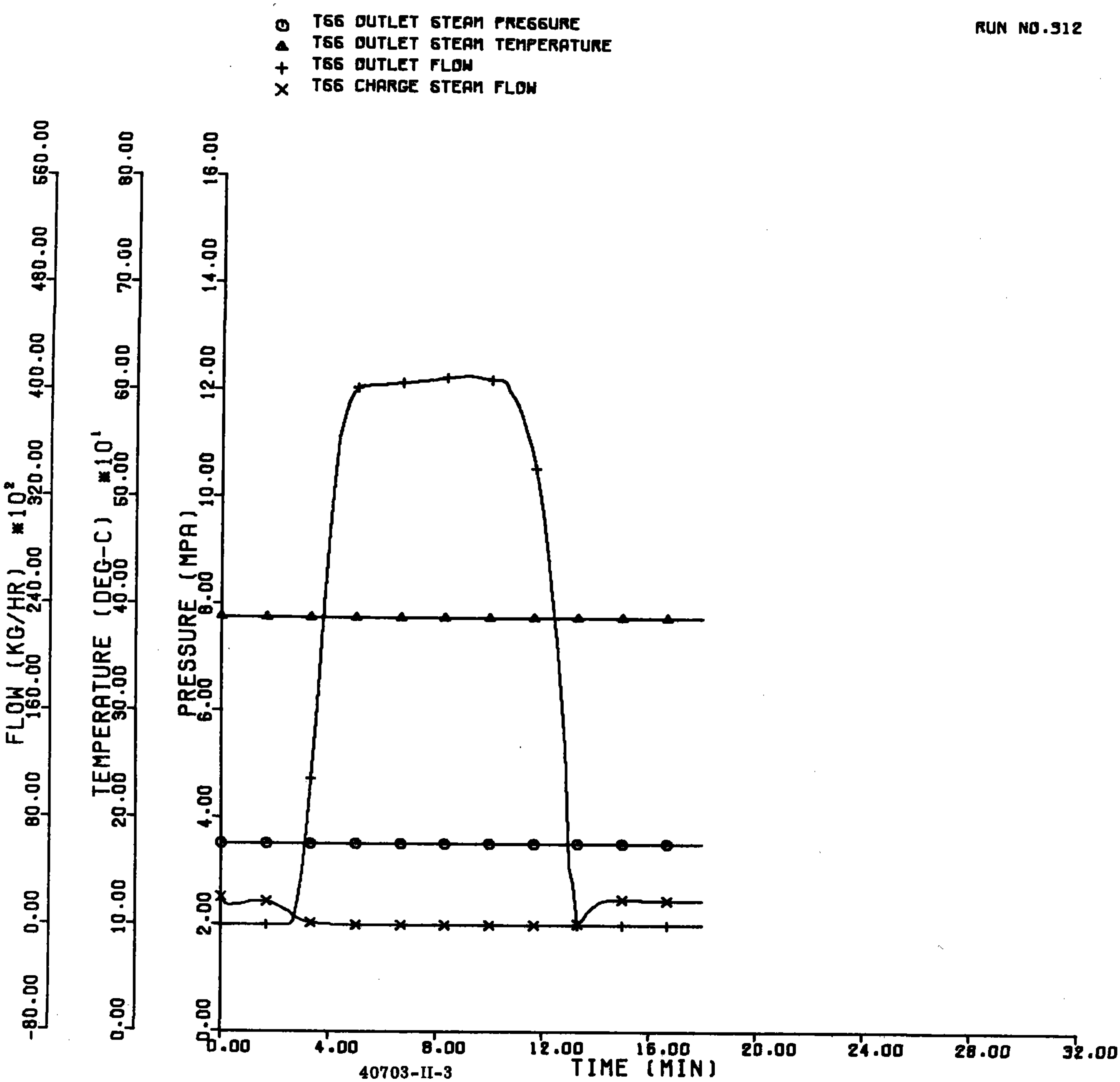

RUN NO.312
MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
ERROR(P.U.)
COMMANDS(PER UNIT)
-1.00
-0.75
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3


RUN NO.312
QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
MEGAWATT-HOURS
MEGAWATTS
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
TIME (MIN)

40703-II-3


RUN NO.312
EGG FW OUTLET TEMP.
TGG DRUM LEVEL
TGG FW INLET FLOW(KG/HR)
TGG ATTEMPERATOR FLOW(KG/HR)
FLOW (KG/HR) *10²
-80.00 0.00 80.00 160.00 240.00 320.00 400.00 480.00 560.00
CENTIMETERS
-1.20 -0.80 -0.40 -0.00 0.40 0.80 1.20 1.60 2.00
TEMPERATURE (DEG-C)
184.00 188.00 192.00 196.00 200.00 204.00 208.00 212.00 216.00
0.00 4.00 8.00 12.00 16.00 20.00 24.00 28.00 32.00
TIME (MIN)
40703-II-3


RUN NO.312
TSS OUTLET STEAM PRESSURE
TSS OUTLET STEAM TEMPERATURE
TSS OUTLET FLOW
TSS CHARGE STEAM FLOW
FLOW (KG/HR) *10²
TEMPERATURE (DEG-C) *10¹
PRESSURE (MPA)
TIME (MIN)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
40703-II-3

Run No.	313
Type of Run	Load Demand Change
Run Length	35 min
Run Description	Initial load demand of 7 MWe (net busbar). At t=2 min, ramp demand up at 4%/min to 12 MWe; at t=18 min, ramp load demand down to 7 MWe at -4%/min ramp rate.
Notes	Simplified TSS discharge storage model used.

SUMMARY OF SPP PERFORMANCE (RUN NO 313.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	146.737	146.738	146.738	43.01	43.01	43.01
NET OUTPUT POWER OF SGS TO-						
TOTAL	134.392	137.322	124.308	39.39	40.25	36.43
EGS	114.612	135.204	93.158	33.59	39.63	27.30
TSS	18.568	37.595	0.000	5.44	11.02	0.00
NET TSS POWER TO EGS	-0.000	0.000	-0.000	-0.00	0.00	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				11.28	13.55	8.75
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				25053134.	14887.	9772.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 19305.5 TO TSS 3127.7 FROM TSS

TOTAL RADIANT ENERGY IN= 24716.6KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9070

NET CHANGE IN TSS ENERGY 3080.06(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 5.34(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	396.0	415.1	376.2
TD-DRUM TEMP	611.5	613.6	608.0
TPSHO-PSH TEMP OUT	782.8	790.1	773.5
TSSHO-SSH TEMP OUT	957.0	960.8	949.3
TPSHM-PSH METAL TEMP	827.8	836.1	816.5
TSSHM-SSH METAL TEMP	994.2	998.9	979.6
PSH METAL TEMP RATE	34.3	673.6	-161.4
SSH METAL TEMP RATE	27.9	1614.0	-65.8
PPSHO-PSH PRES.OUT	1592.5	1617.5	1555.3
PSSHO-SSH PRES.OUT	1509.1	1534.1	1481.4
PD-DRUM PRES	1675.5	1701.1	1633.2
DELTA DRUM LEVEL	0.07	0.59	-0.39
PHPNCI-HP NOZ PRES	1461.8	1469.3	1450.7

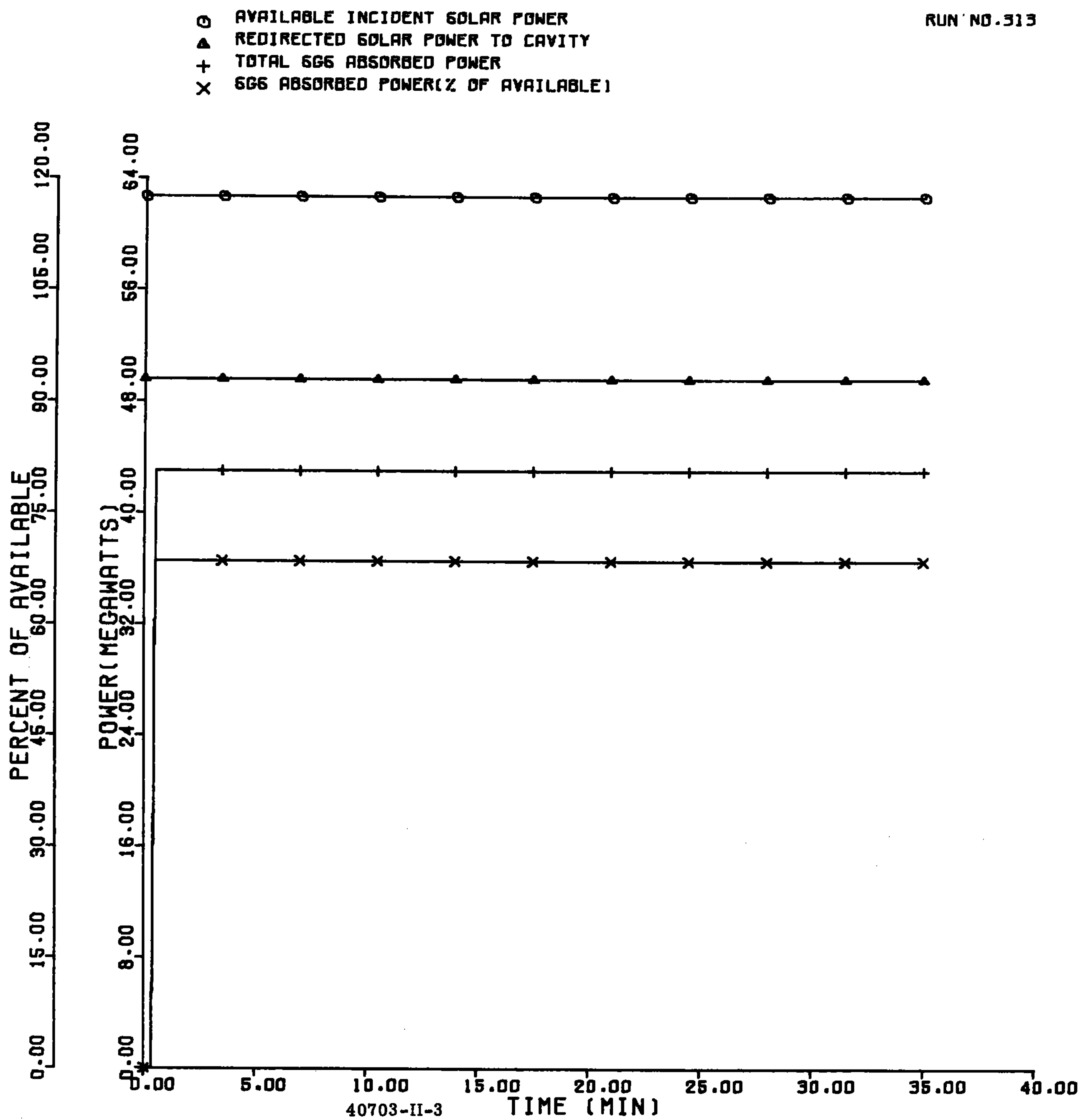
TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS 313-2

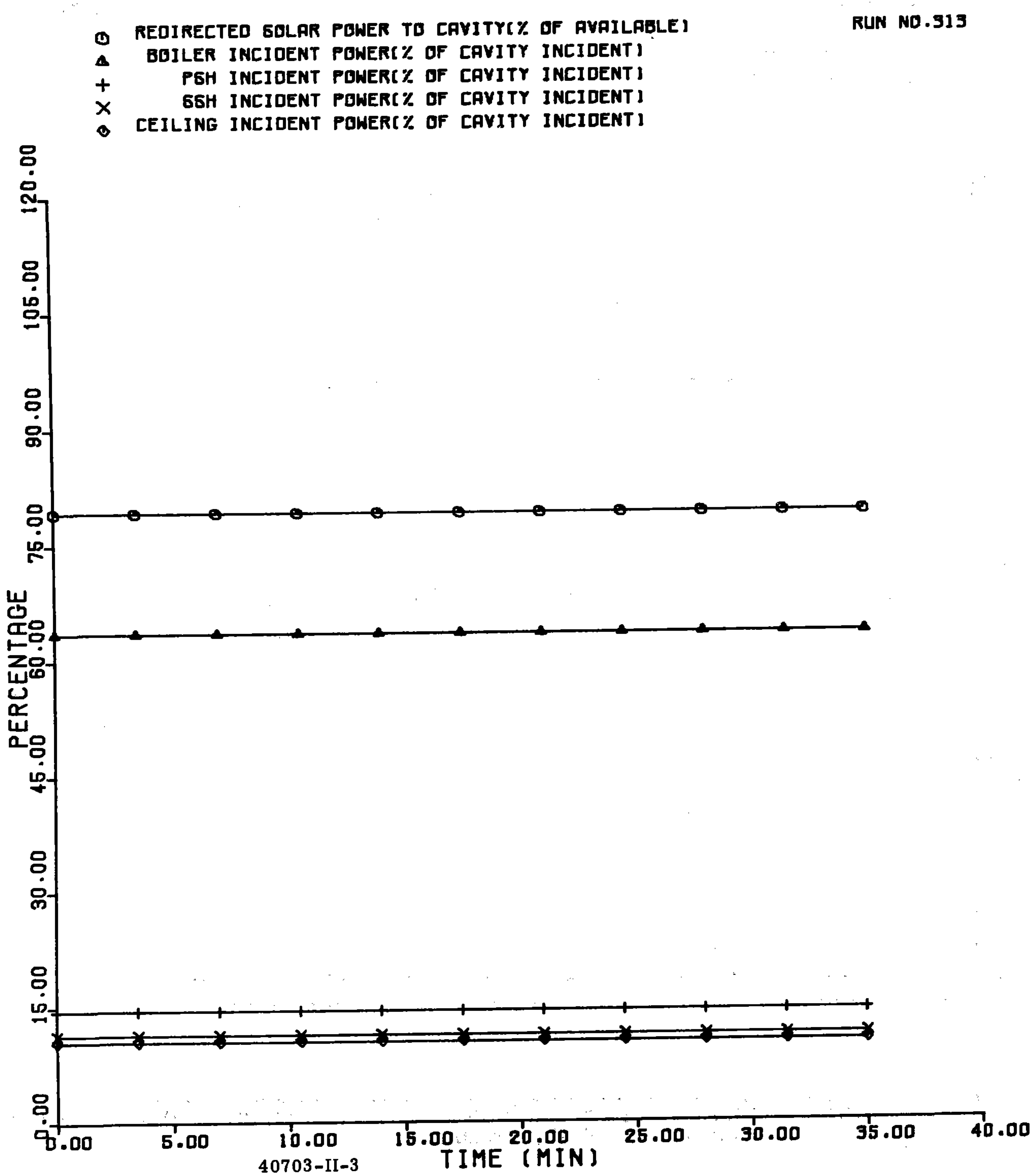
	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.9807	0.9807	0.9807
QINC-INCIDENT AVAILABLE POWER(MWT)	62.6862	62.6863	62.6863
QRDB-REDIRECTED POWER TO BOILER(MWT)	31.5155	31.5154	31.5154
QRDP-REDIRECTED POWER TO PSH(MWT)	7.1943	7.1943	7.1943
QRDS-REDIRECTED POWER TO SSH(MWT)	5.6700	5.6700	5.6700
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	49.6103	49.6101	49.6101
QABB-ABSORBED POWER ON BOILER(MWT)	29.9706	29.9705	29.9705
QABP-ABSORBED POWER ON PSH(MWT)	7.2478	7.2478	7.2478
QABS-ABSORBED POWER ON SSH(MWT)	5.7905	5.7905	5.7905
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.3834	5.3834	5.3834
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1873	0.1873	0.1873
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	48.5794	48.5795	48.5795
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	65.1230	65.1230	65.1230
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	15.7487	15.7487	15.7487
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5823	12.5823	12.5823
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	93.454	93.454	93.454
QRDINC-RATIO.REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO.ABSORBED TO INCIDENT POWER TOTALS)	0.775	0.775	0.775
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.979	0.979	0.979
QABBRA-RATE OF CHANGE.BOILER ABSORBED POWER(%/MIN)	0.	0.	0.
QABPRA-RATE OF CHANGE.PSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABSRA-RATE OF CHANGE.SSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABTRA-RATE OF CHANGE.TOTAL ABSORBED POWER(%/MIN)	0.	0.	0.
TCAV1-CEILING TEMPERATURE(DEG-F)	1553.1	2123.4	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	653.2	656.3	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 36.062
REDIRECTED ENERGY(MWT-HRS),TOTAL= 28.54BOILER= 18.13PSH= 4.14SSH= 3.26CEILING= 3.01
ABSORBED ENERGY(MWT-HRS),BOILER= 17.24PSH= 4.17SSH= 3.33CEILING= 3.10FLOOR= 0.11TOTAL= 27.95

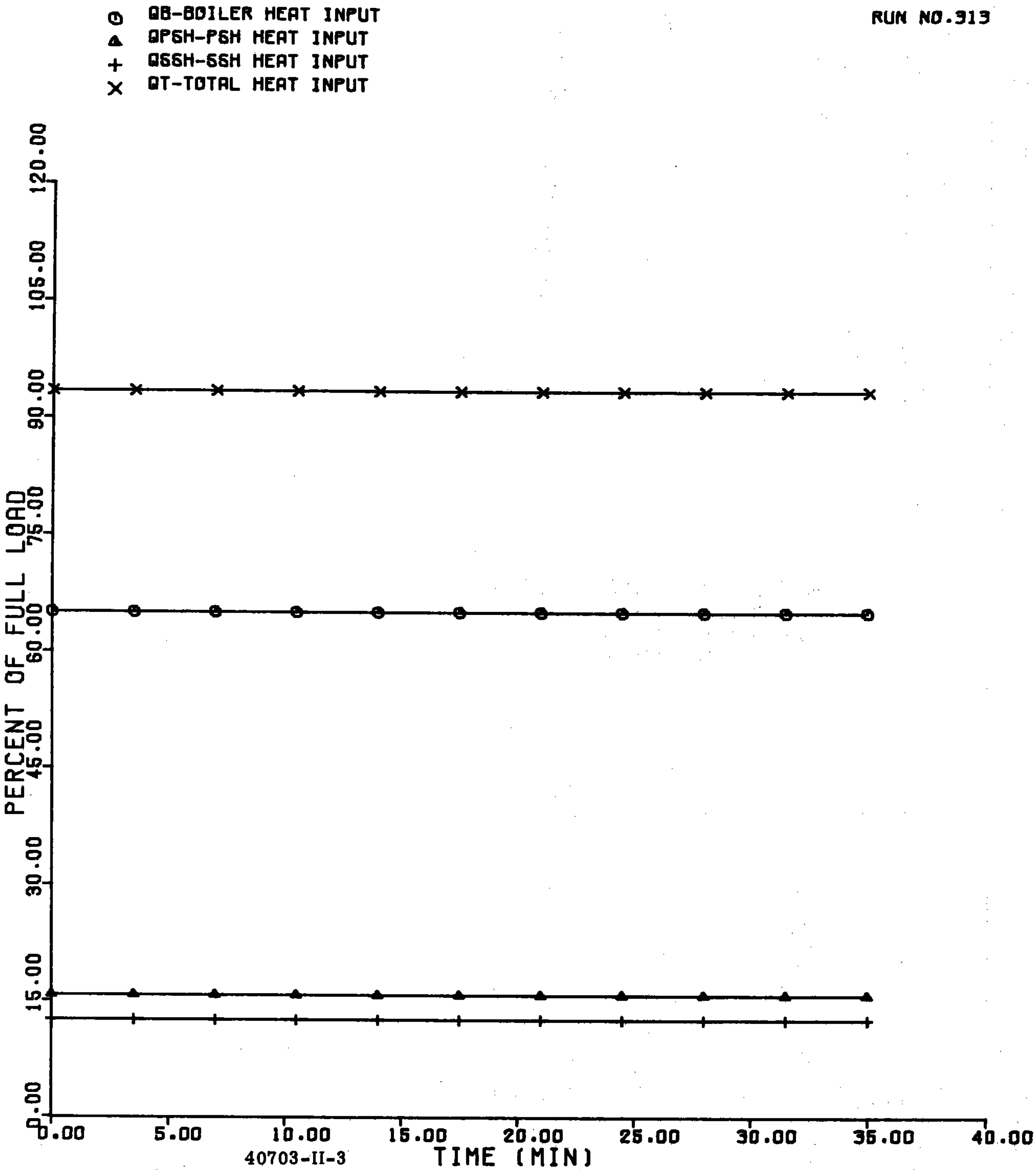
40703-11-3


AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.313
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

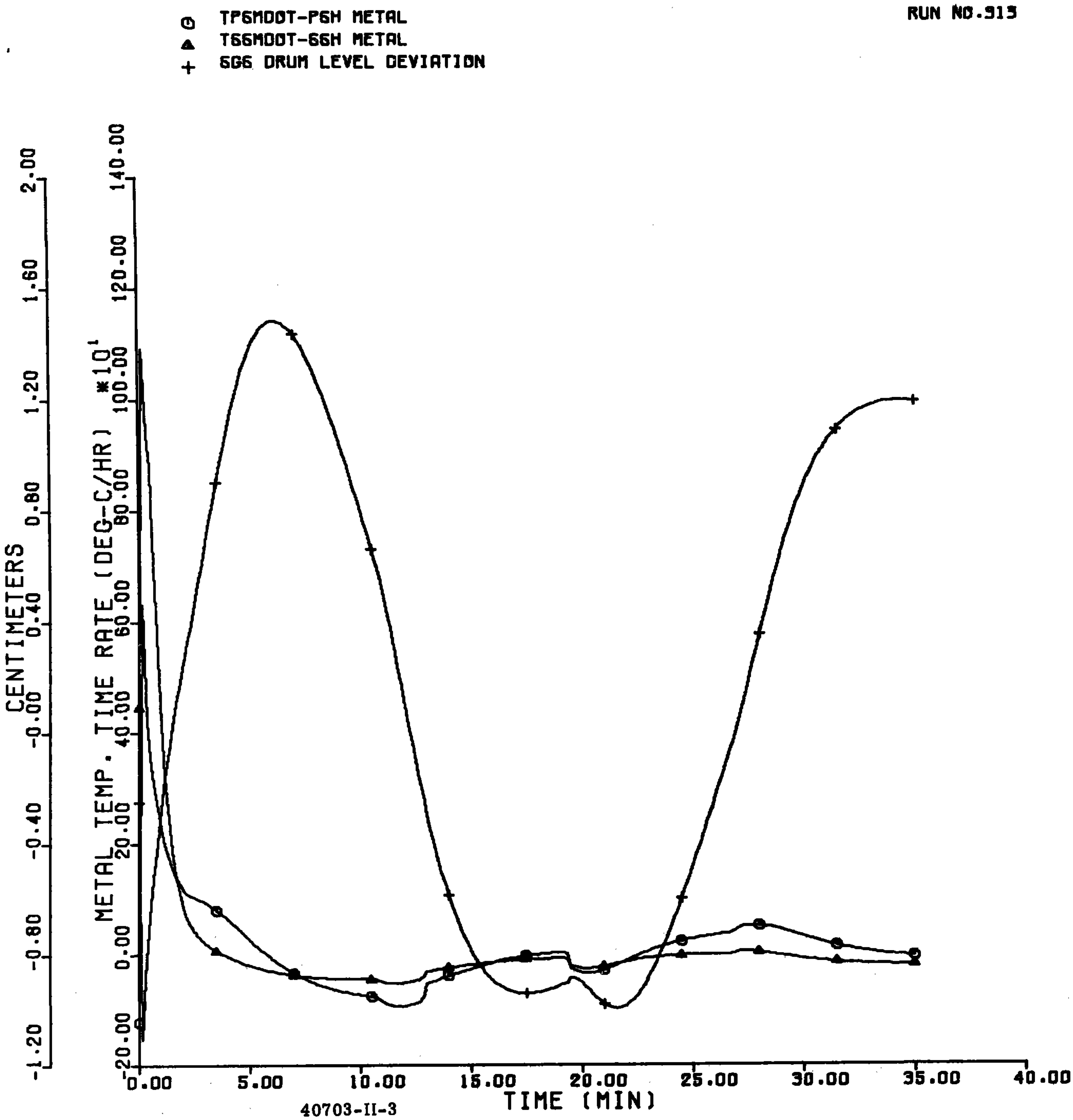
40703-II-3


RUN NO.313
REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

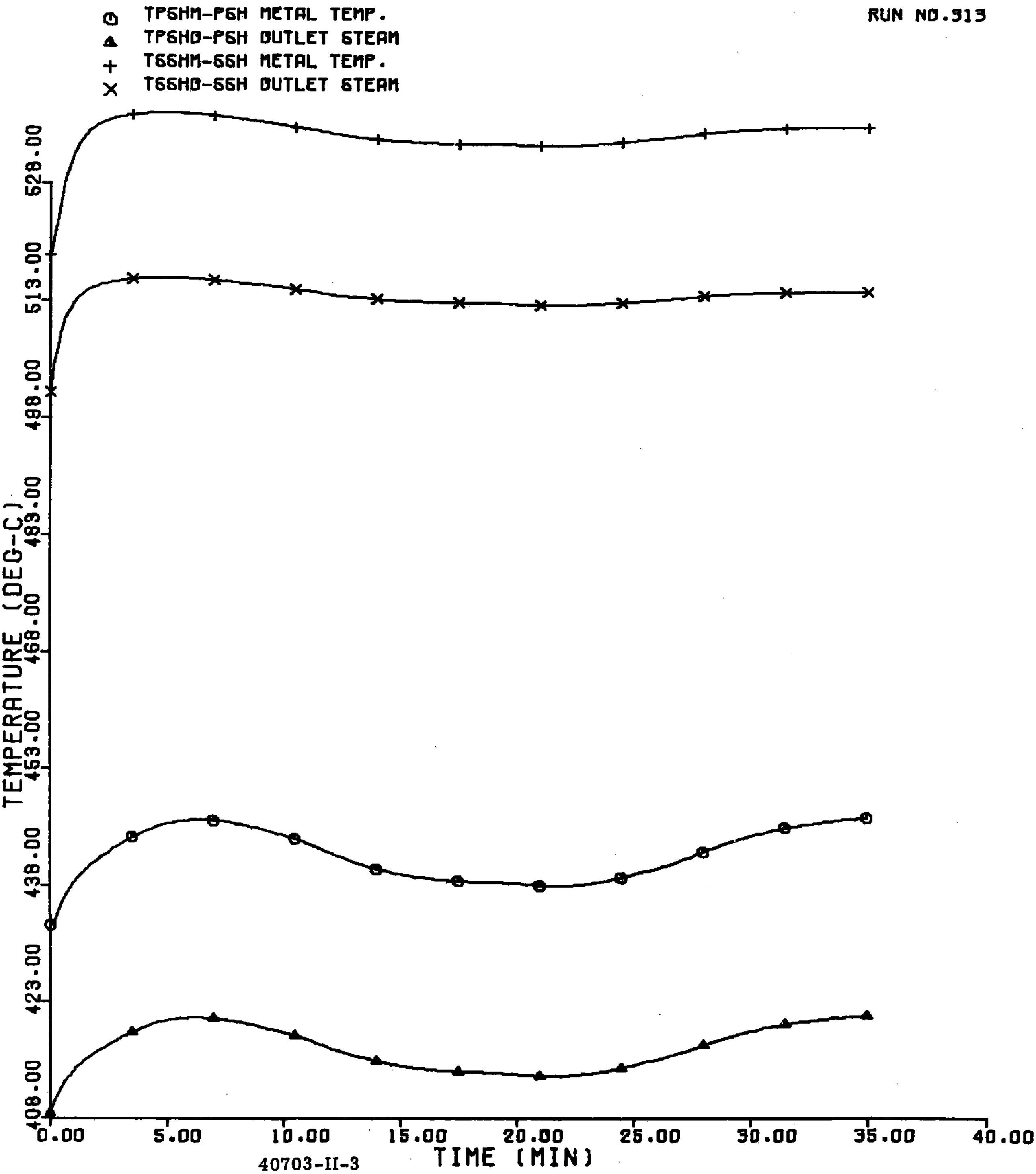
40703-II-3


QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.313
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

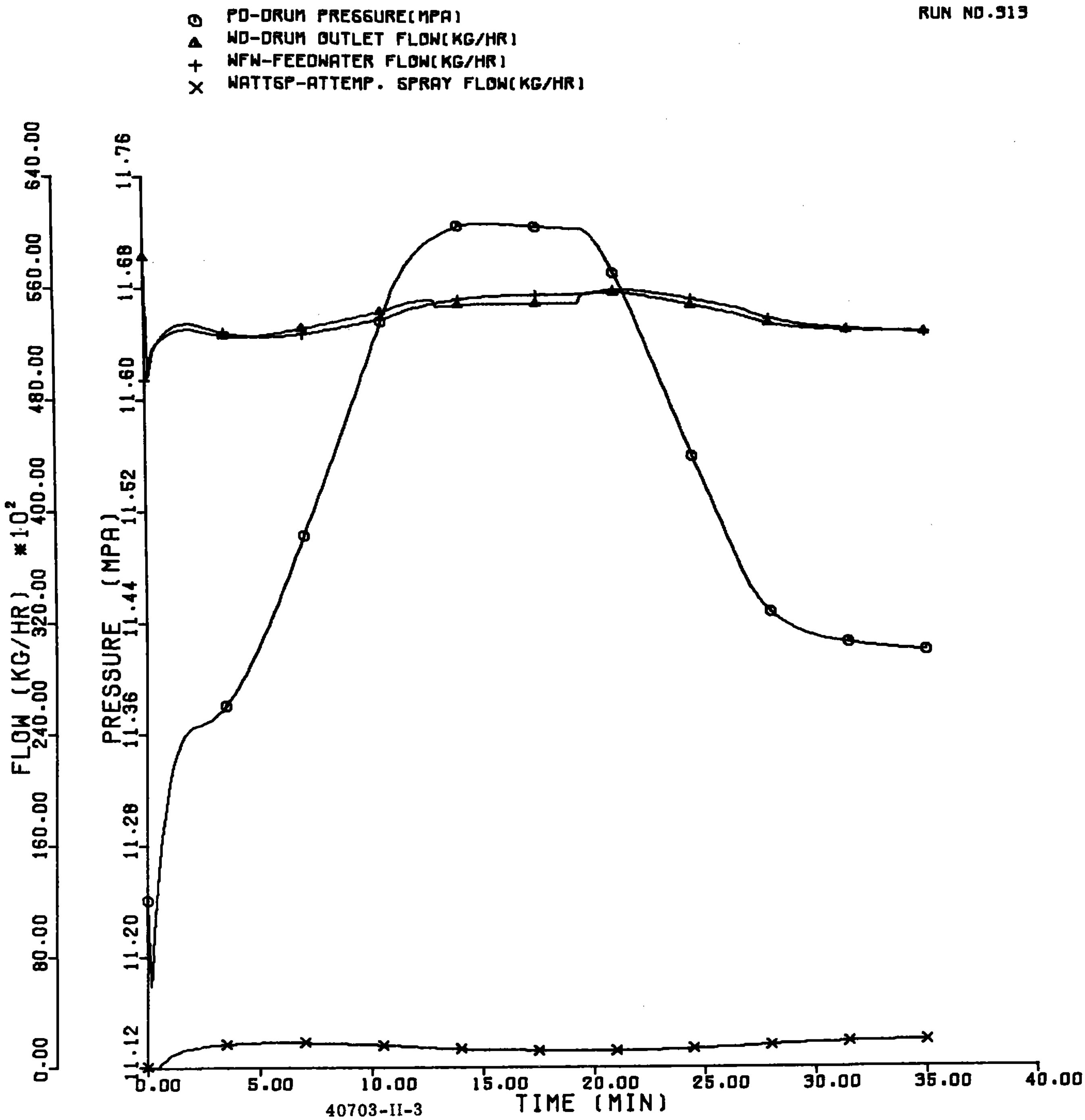
40703-II-3


RUN NO.313
TP6MDOT-P6H METAL
T66MDOT-66H METAL
6G6 DRUM LEVEL DEVIATION
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
TIME (MIN)
2.00
1.60
1.20
0.80
0.40
-0.00
-0.40
-0.80
-1.20
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

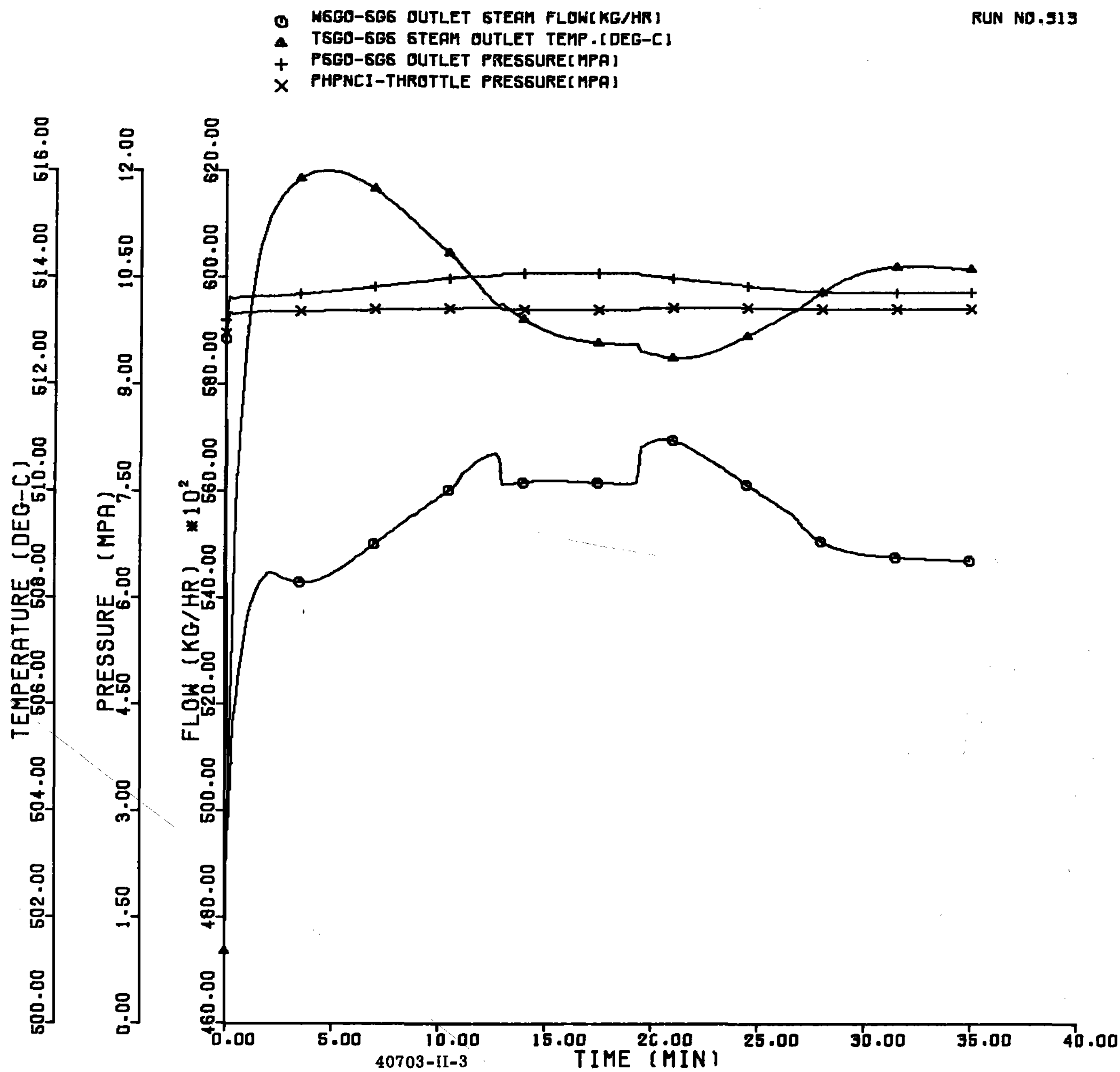
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.313
TEMPERATURE (DEG-C)
528.00
513.00
498.00
483.00
468.00
453.00
438.00
423.00
408.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

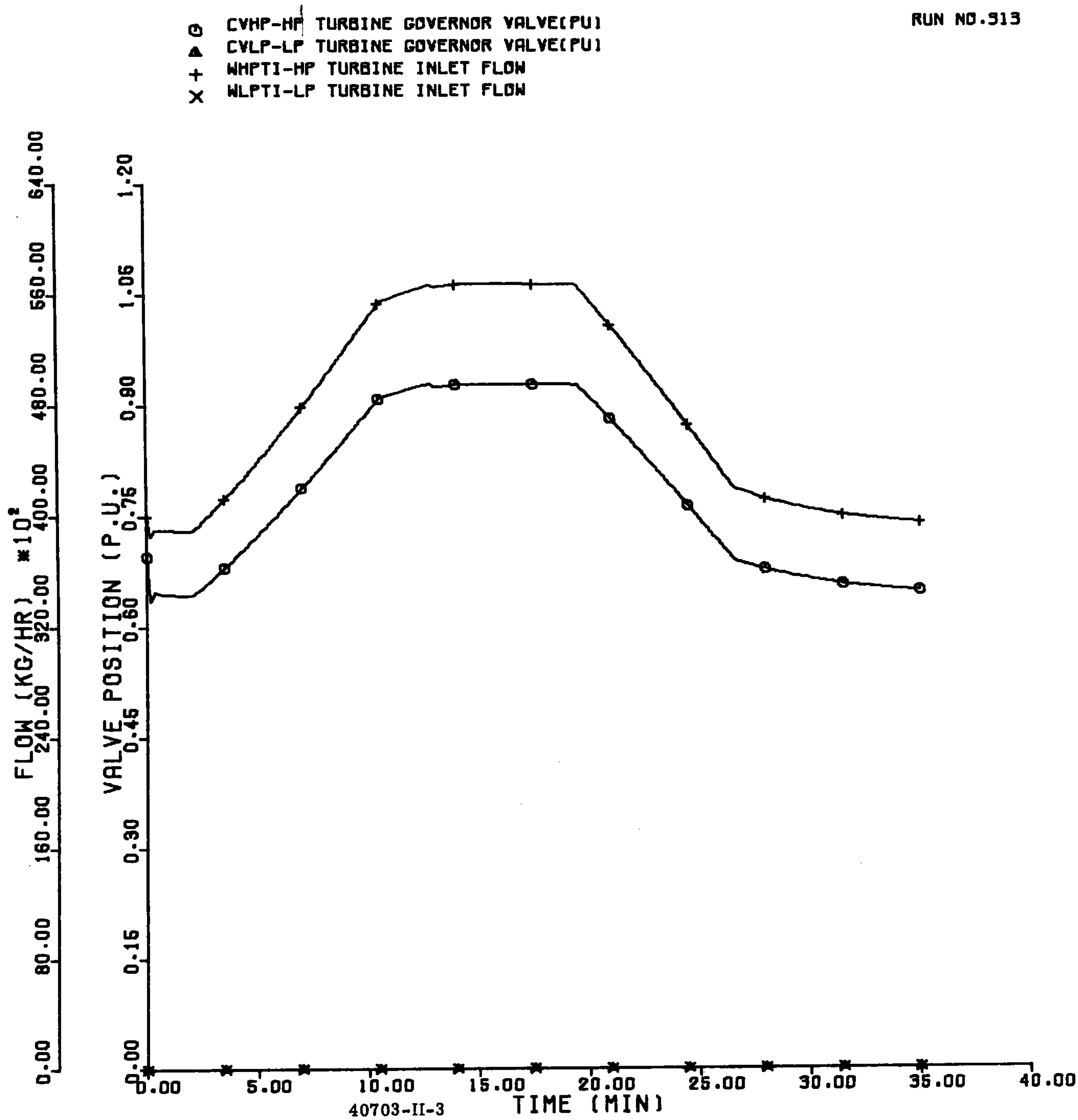
40703-II-3


PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
RUN NO.313
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
11.12
11.20
11.28
11.36
11.44
11.52
11.60
11.68
11.76
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

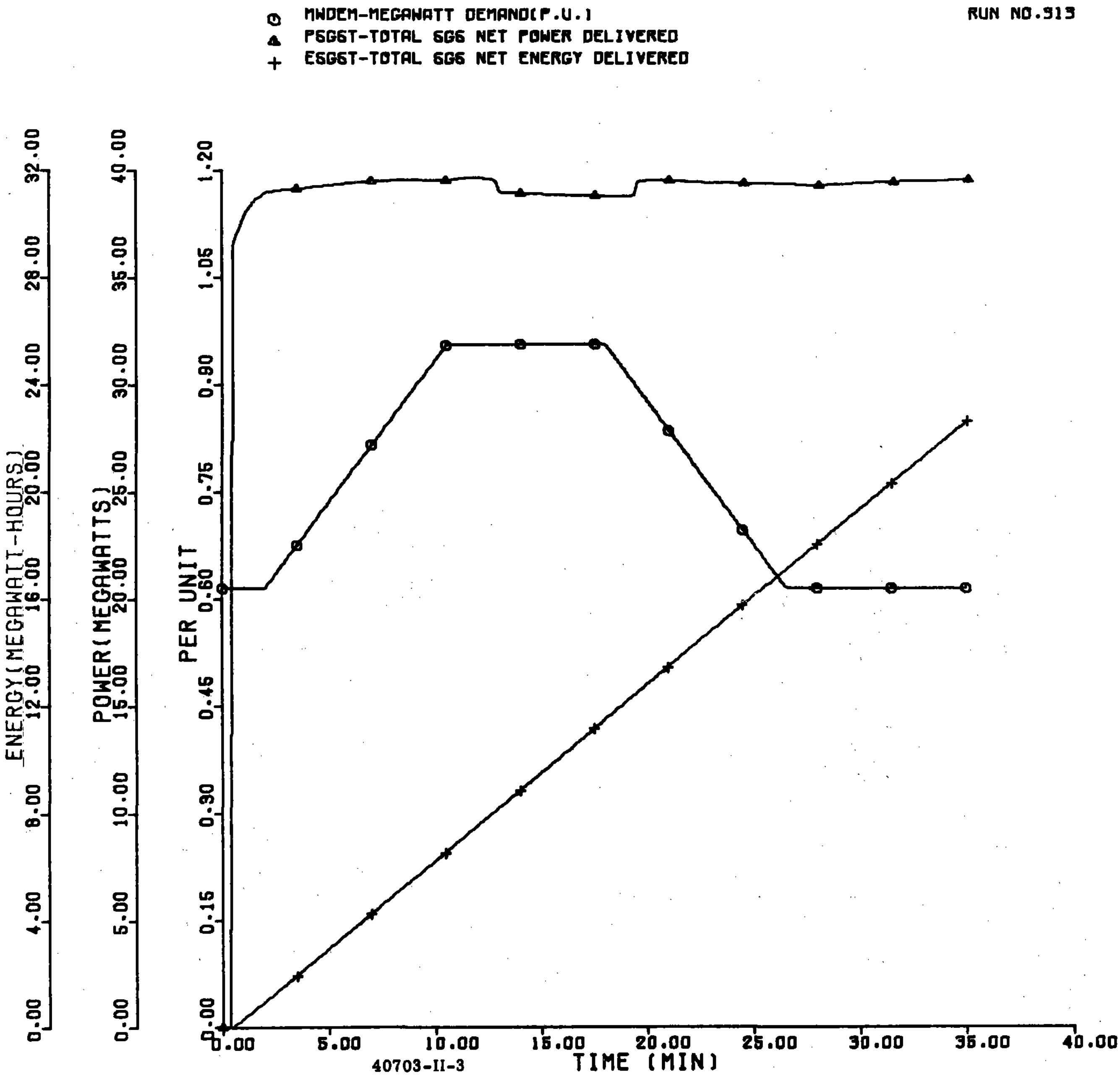
40703-II-3

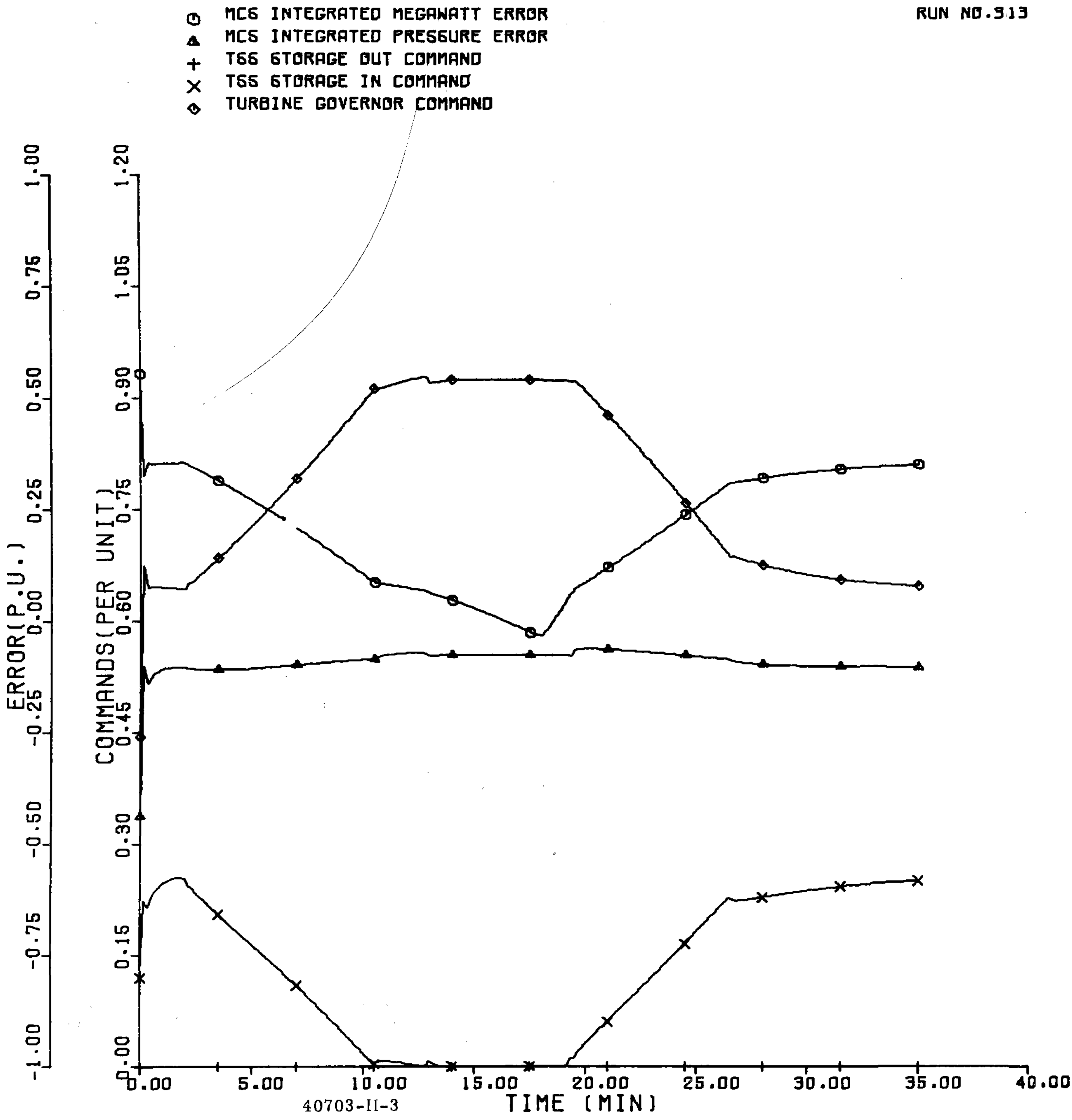

WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.313
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10²
TIME (MIN)
500.00
502.00
504.00
506.00
508.00
510.00
512.00
514.00
516.00
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
460.00
480.00
500.00
520.00
540.00
560.00
580.00
600.00
620.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

40703-II-3

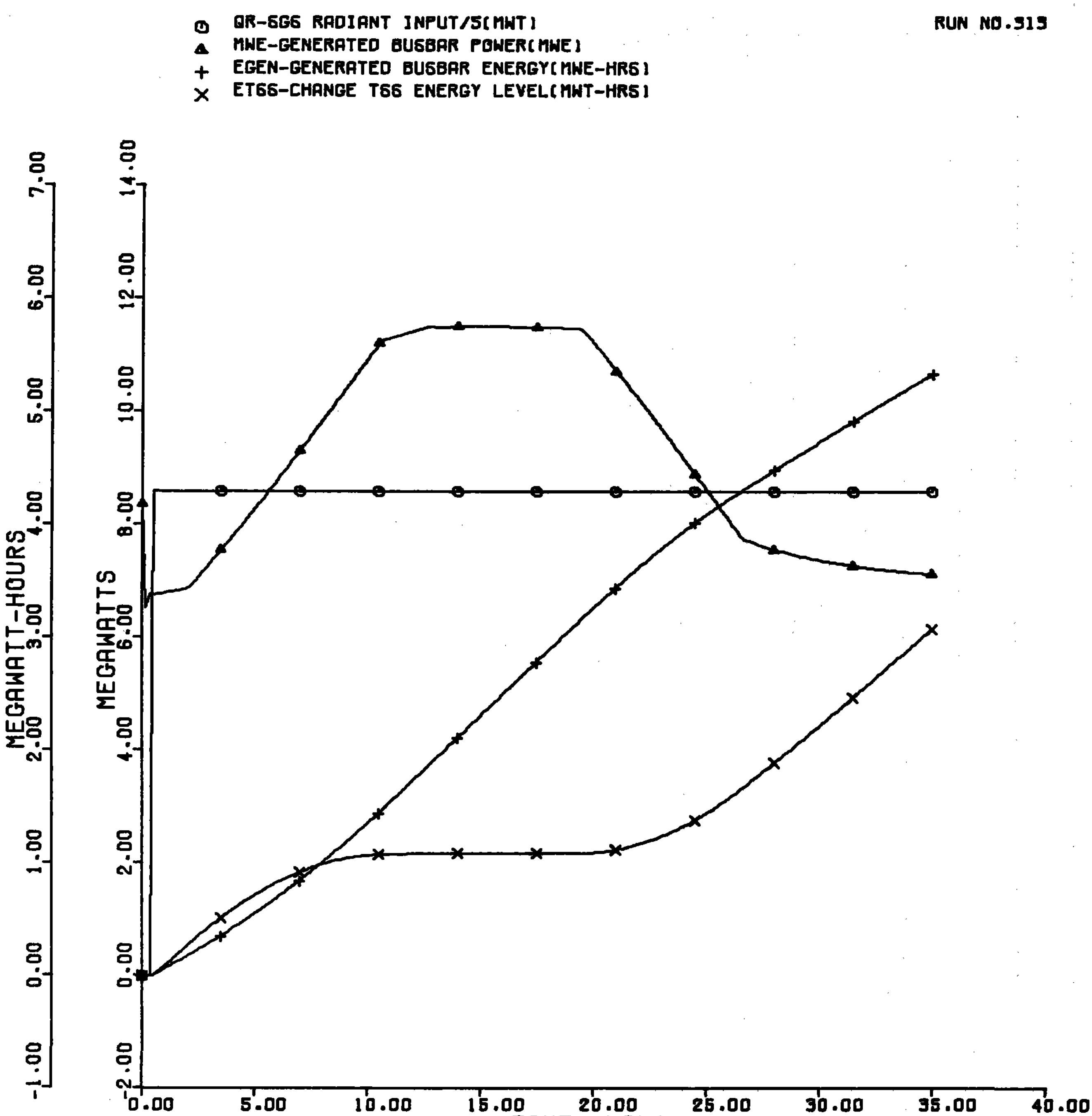

RUN NO.313
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
VALVE POSITION (P.U.)
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

40703-II-3

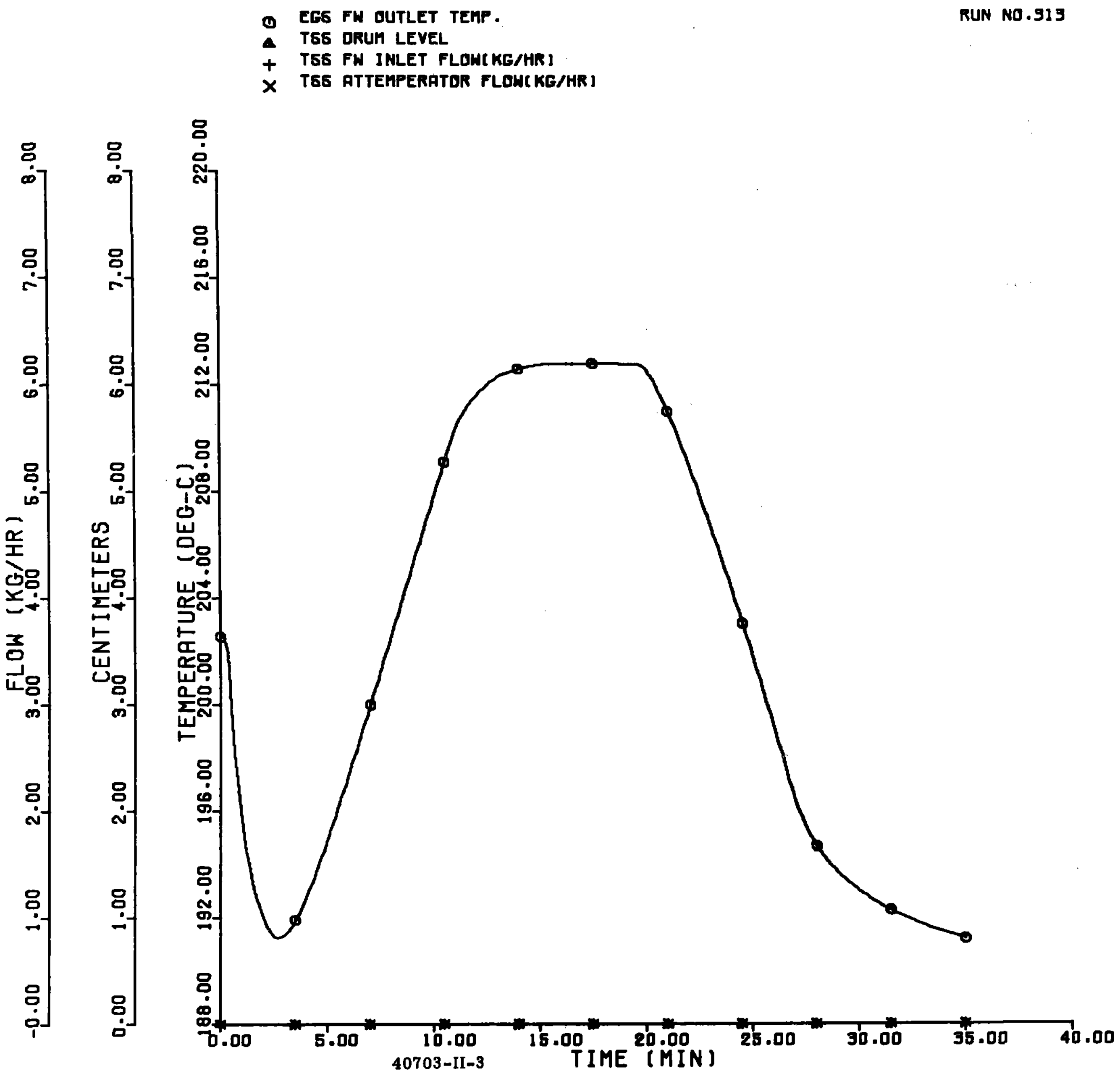

MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.313
ENERGY(MEGAWATT-HOURS)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
POWER(MEGAWATTS)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
PER UNIT
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)
40703-II-3


MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.313
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.313
MEGAWATT-HOURS
MEGAWATTS
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
-2.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
TIME (MIN)

40703-II-3


EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.313
FLOW (KG/HR)
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
-0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
0.00
188.00
192.00
196.00
200.00
204.00
208.00
212.00
216.00
220.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

40703-II-3

Run No.	314
Type of Run	Failure Effects
Run Length	7 min
Run Description	SGS recirculating pump flow rate reduced to 50 percent of nominal beginning at t=2 min.
Note	Simplified TSS discharge model used.

SUMMARY OF SPP PERFORMANCE (RUN NO 314.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	146.738	146.738	146.738	43.01	43.01	43.01
NET OUTPUT POWER OF SGS TO-						
TOTAL	132.205	134.786	124.308	38.75	39.51	36.43
EGS	94.568	94.853	93.158	27.72	27.80	27.30
TSS	37.222	38.482	31.128	10.91	11.28	9.12
NET TSS POWER TO EGS	-0.000	0.000	-0.000	-0.00	0.00	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.91	8.99	8.75
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				5780021.	14891.	14196.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 3007.4 TO TSS 1183.7 FROM TSS

TOTAL RADIANT ENERGY IN= 4666.5KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.8976

NET CHANGE IN TSS ENERGY 1158.94(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 0.75(MW-HRSE)

40703-II-3

4-150

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	376.6	391.8	374.0
TD-DRUM TEMP	609.1	609.4	608.0
TPSHO-PSH TEMP OUT	786.0	791.5	773.5
TSSHO-SSH TEMP OUT	959.5	961.0	949.3
TPSHM-PSH METAL TEMP	831.2	837.7	816.5
TSSHM-SSH METAL TEMP	996.7	999.2	979.6
PSH METAL TEMP RATE	195.7	673.6	24.4
SSH METAL TEMP RATE	177.5	1614.0	-19.8
PPSHO-PSH PRES.OUT	1566.6	1569.9	1555.3
PSSHO-SSH PRES.OUT	1486.2	1488.5	1481.4
PD-DRUM PRES	1646.8	1650.4	1633.2
DELTA DRUM LEVEL	-0.10	0.66	-1.27
PHPNCI-HP NOZ PRES	1455.8	1458.3	1450.7

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

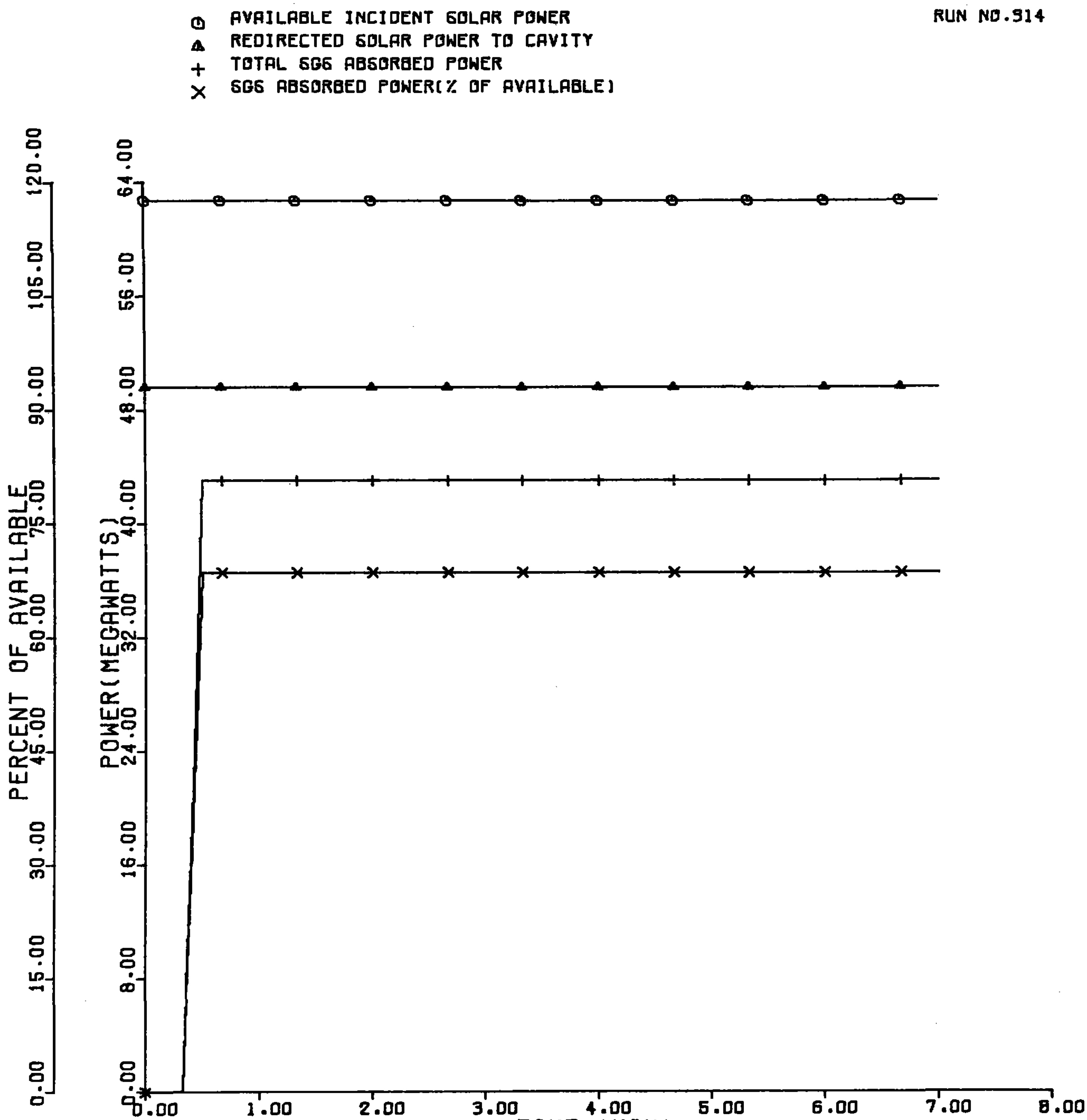
MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.9807	0.9807	0.9807
QINC-INCIDENT AVAILABLE POWER(MWT)	62.6864	62.6863	62.6863
QRDB-REDIRECTED POWER TO BOILER(MWT)	31.5154	31.5154	31.5154
QBDP-REDIRECTED POWER TO PSH(MWT)	7.1943	7.1943	7.1943
QRDS-REDIRECTED POWER TO SSH(MWT)	5.6700	5.6700	5.6700
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	49.6101	49.6101	49.6101
QABB-ABSORBED POWER ON BOILER(MWT)	29.9705	29.9705	29.9705
QABP-ABSORBED POWER ON PSH(MWT)	7.2478	7.2478	7.2478
QABS-ABSORBED POWER ON SSH(MWT)	5.7905	5.7905	5.7905
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.3835	5.3834	5.3834
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1873	0.1873	0.1873
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	48.5795	48.5795	48.5795
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	65.1230	65.1230	65.1230
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	15.7487	15.7487	15.7487
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5823	12.5823	12.5823
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	93.454	93.454	93.454
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.775	0.775	0.775
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.979	0.979	0.979
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.	0.	0.
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.	0.	0.
TCAV1-CEILING TEMPERATURE(DEG-F)	1090.2	1197.7	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.7	651.3	650.1

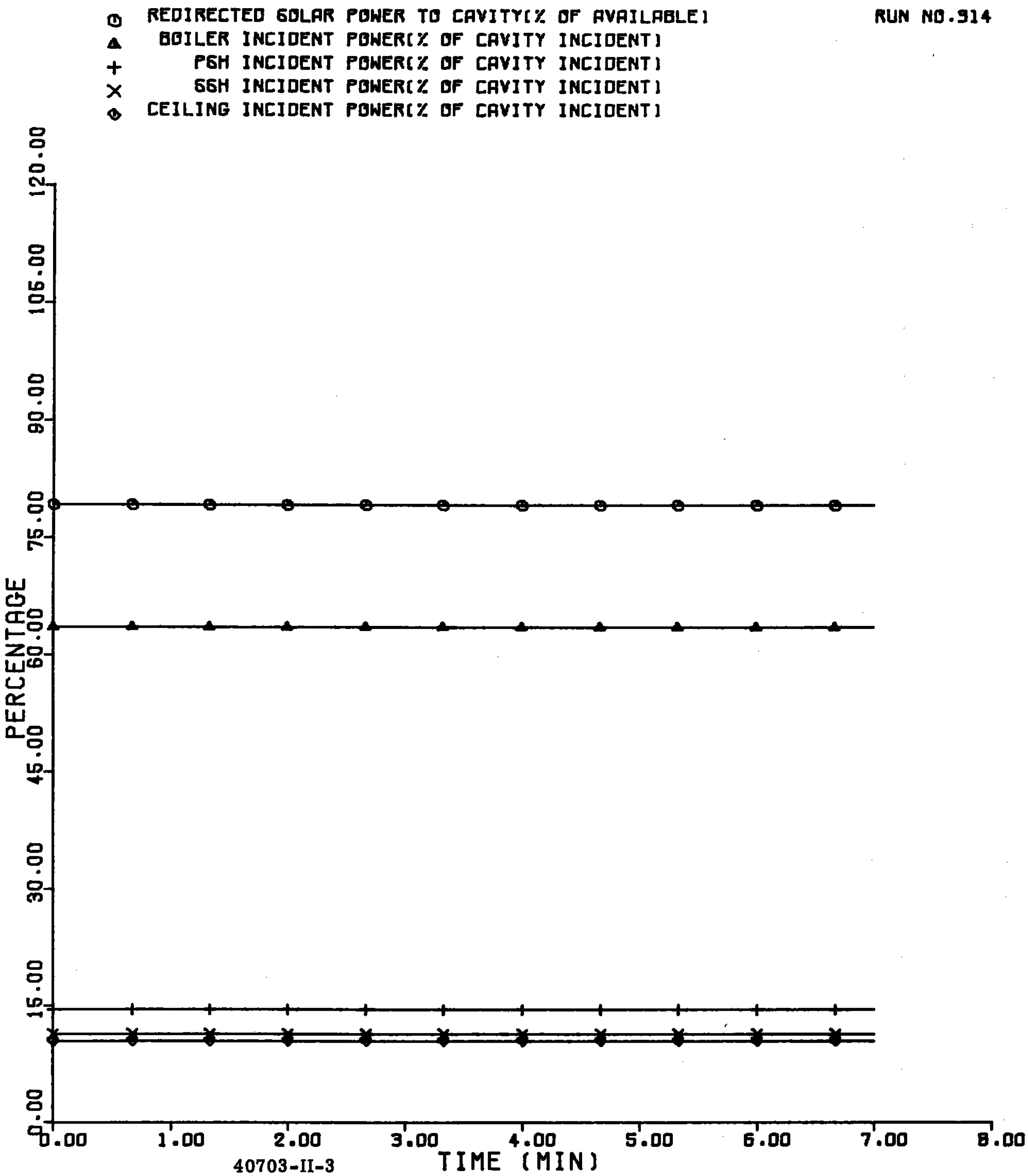
TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 6.808

REDIRECTED ENERGY(MWT-HRS),TOTAL= 5.39BOILER= 3.42PSH= 0.78SSH= 0.62CEILING= 0.57

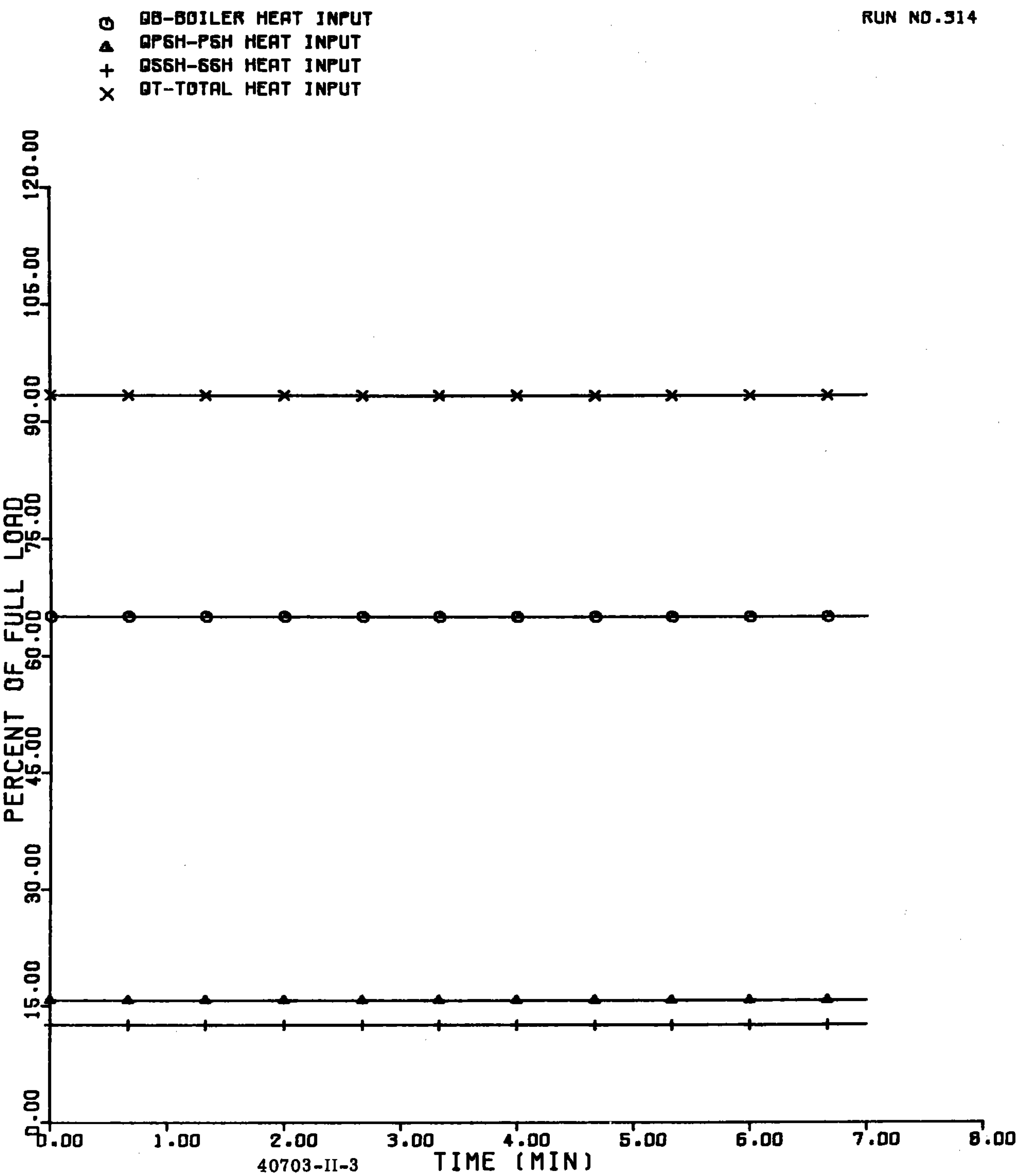
ABSORBED ENERGY(MWT-HRS),BOILER= 3.26PSH= 0.79SSH= 0.63CEILING= 0.58FLOOR= 0.02TOTAL= 5.28


RUN NO.314
AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00

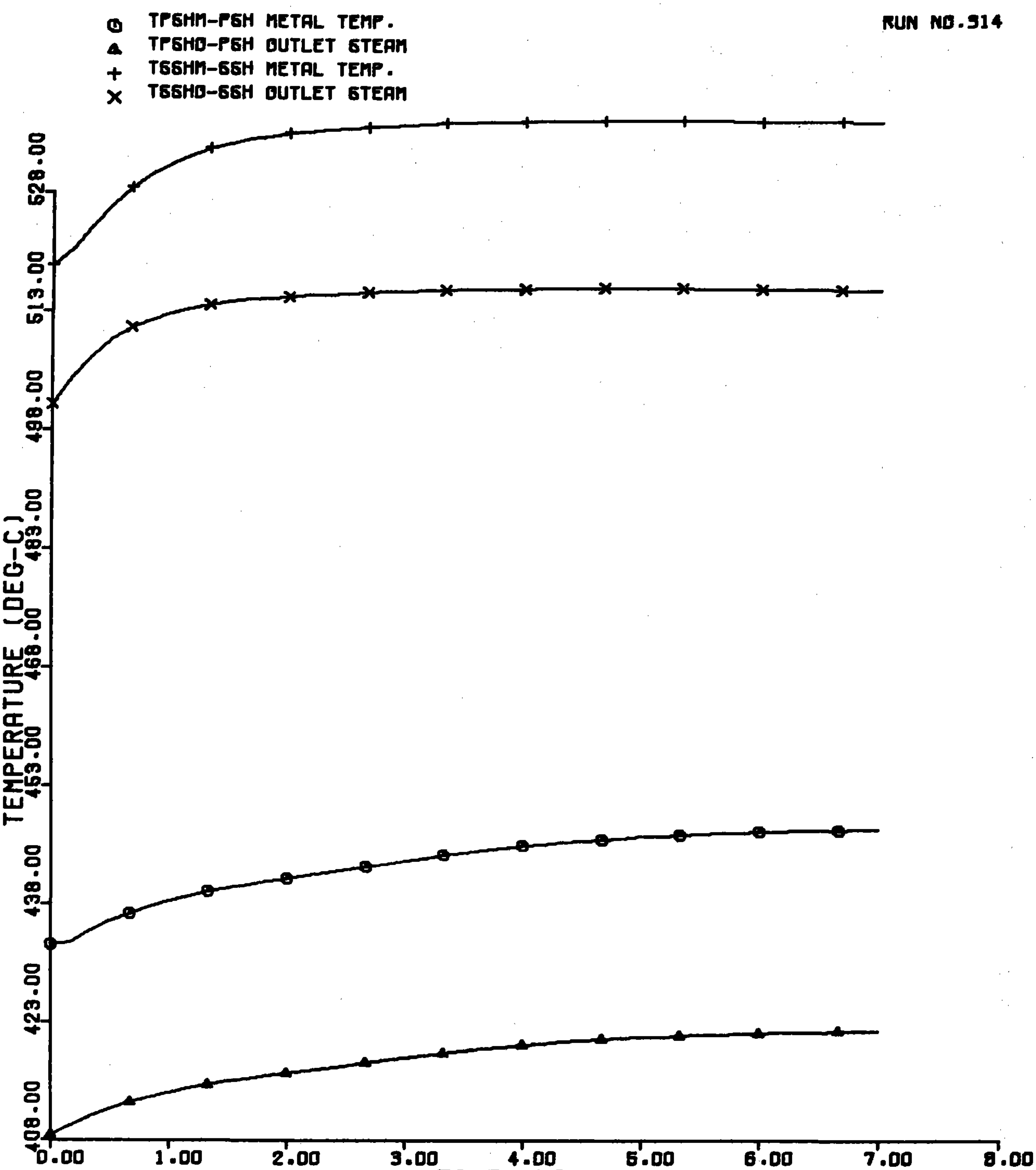
40703-II-3


REDIRECTED SOLAR POWER TO CAVITY(% OF AVAILABLE)
BOILER INCIDENT POWER(% OF CAVITY INCIDENT)
PSH INCIDENT POWER(% OF CAVITY INCIDENT)
SSH INCIDENT POWER(% OF CAVITY INCIDENT)
CEILING INCIDENT POWER(% OF CAVITY INCIDENT)
RUN NO.314
PERCENTAGE
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

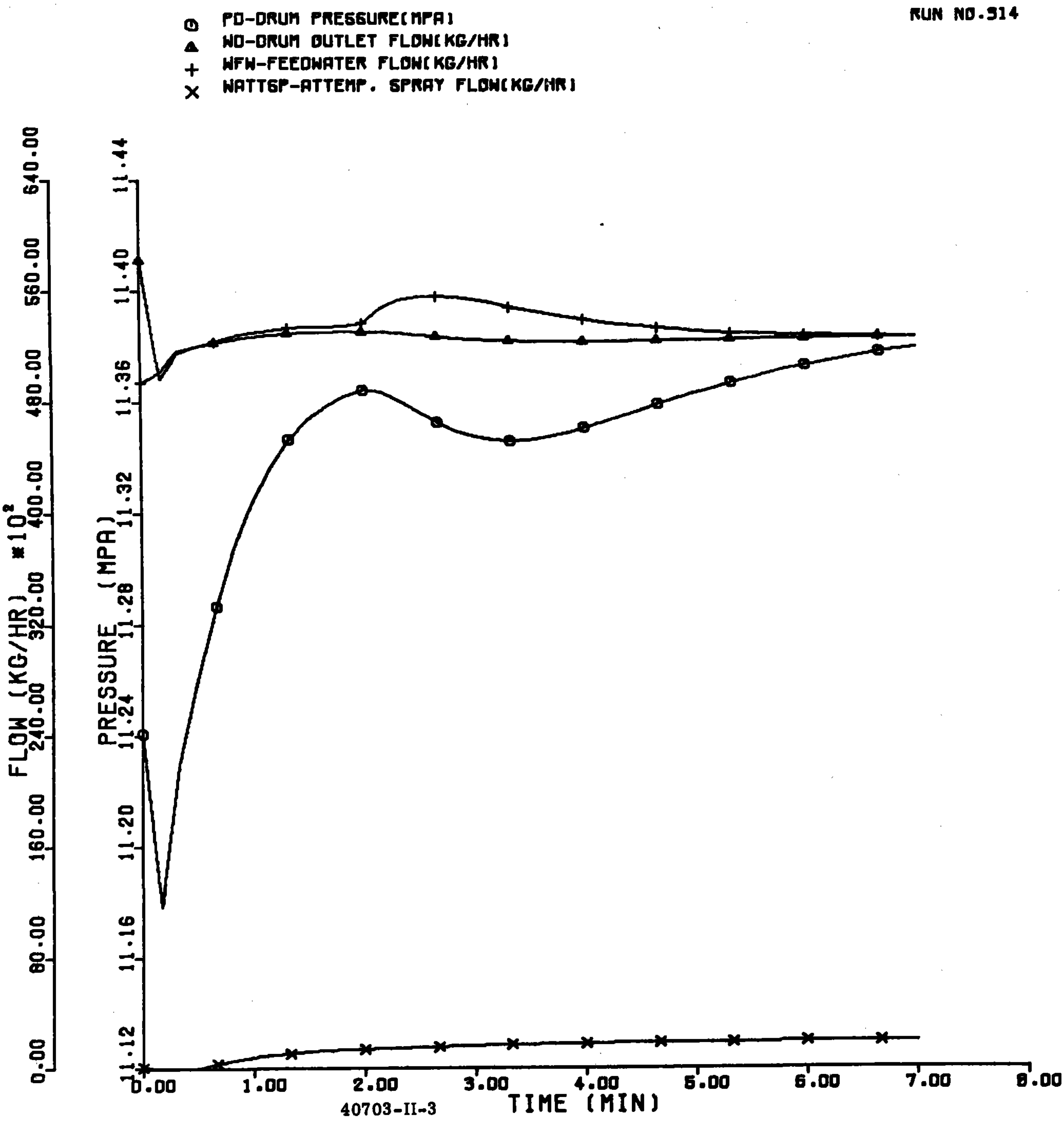
40703-II-3

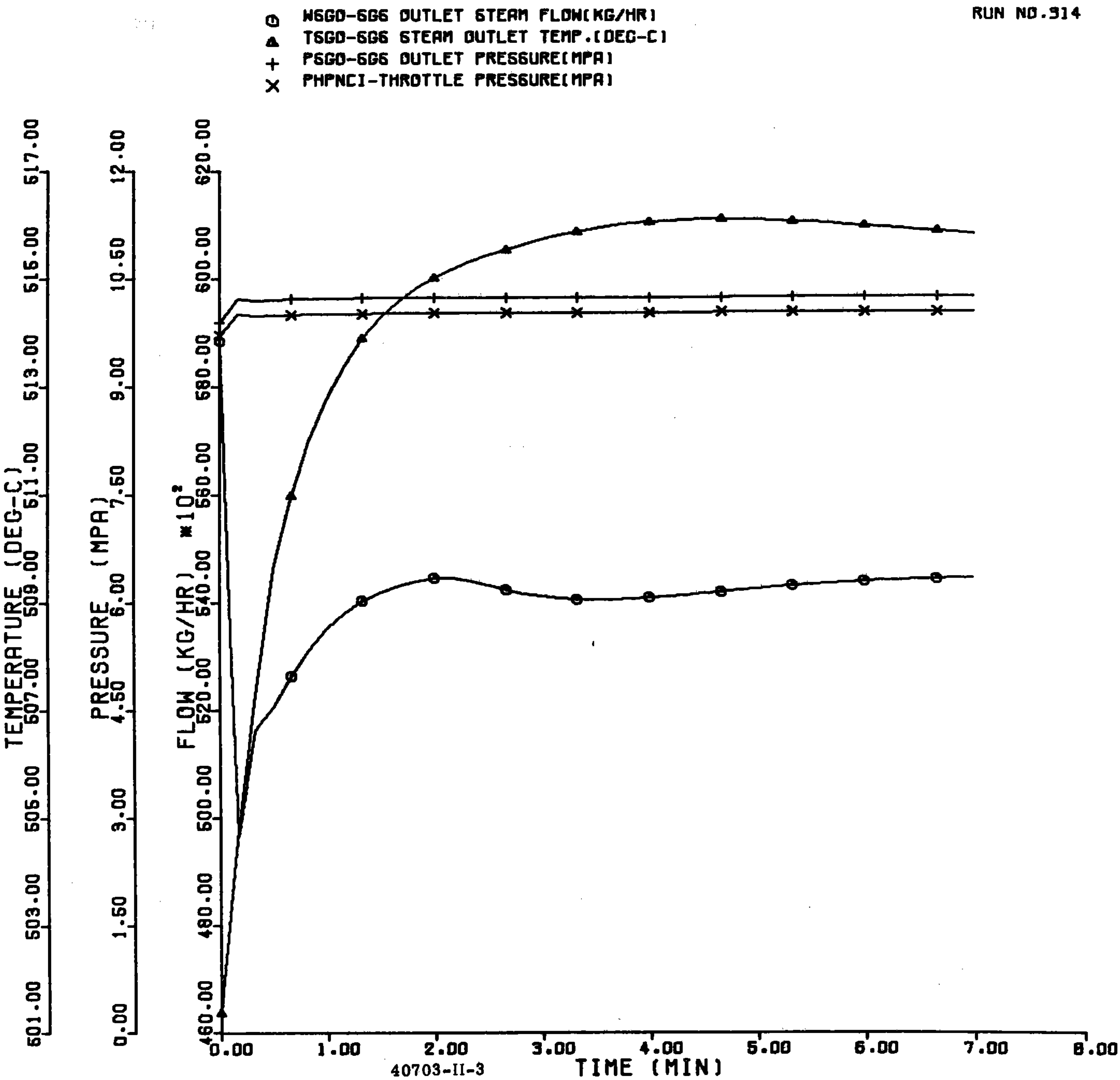

RUN NO.314
QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

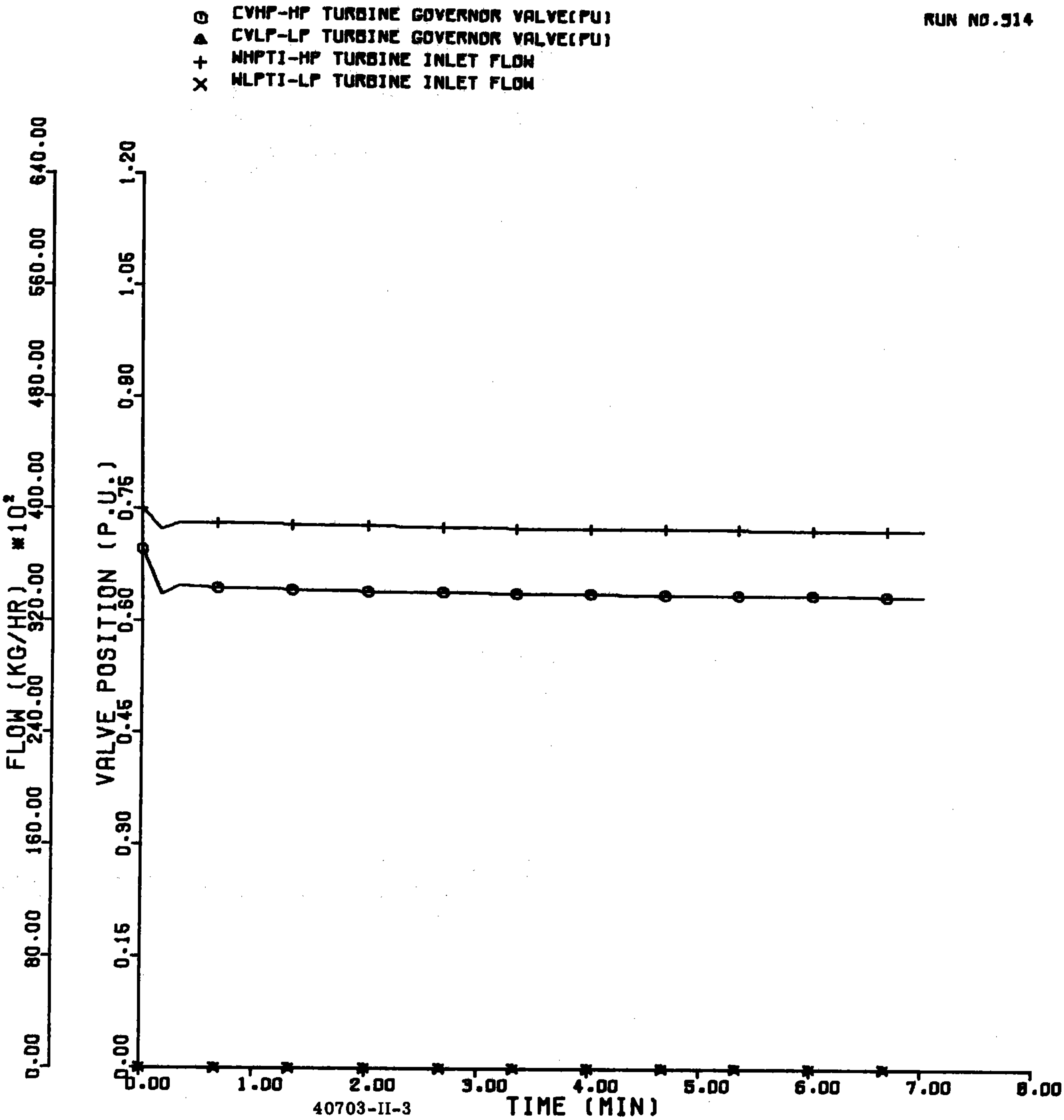
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.314
TEMPERATURE (DEG-C)
408.00
423.00
438.00
453.00
468.00
483.00
498.00
513.00
528.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

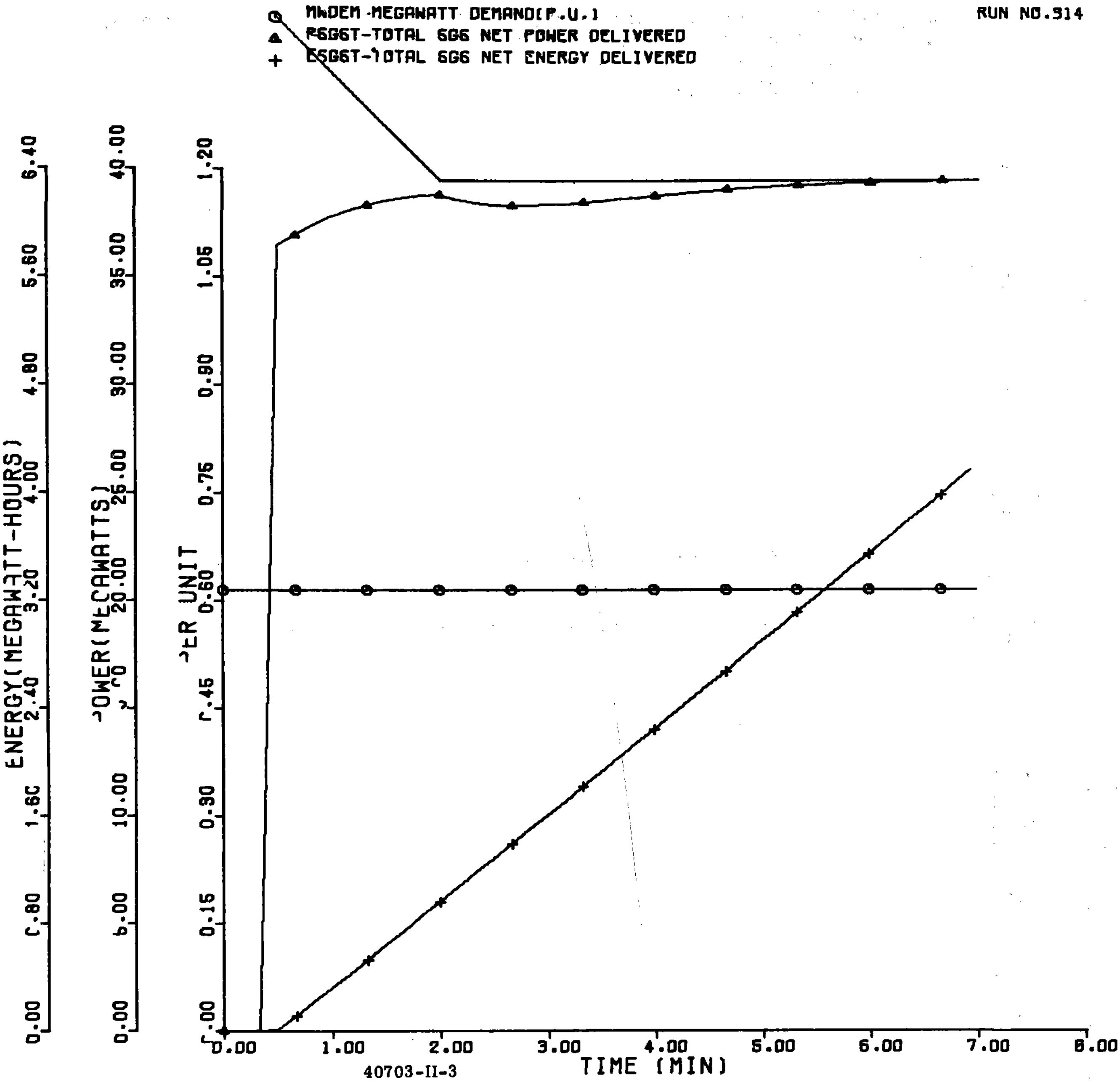
40703-II-3


RUN NO.314
PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
PRESSURE (MPA)
11.12
11.16
11.20
11.24
11.28
11.32
11.36
11.40
11.44
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)
40703-II-3

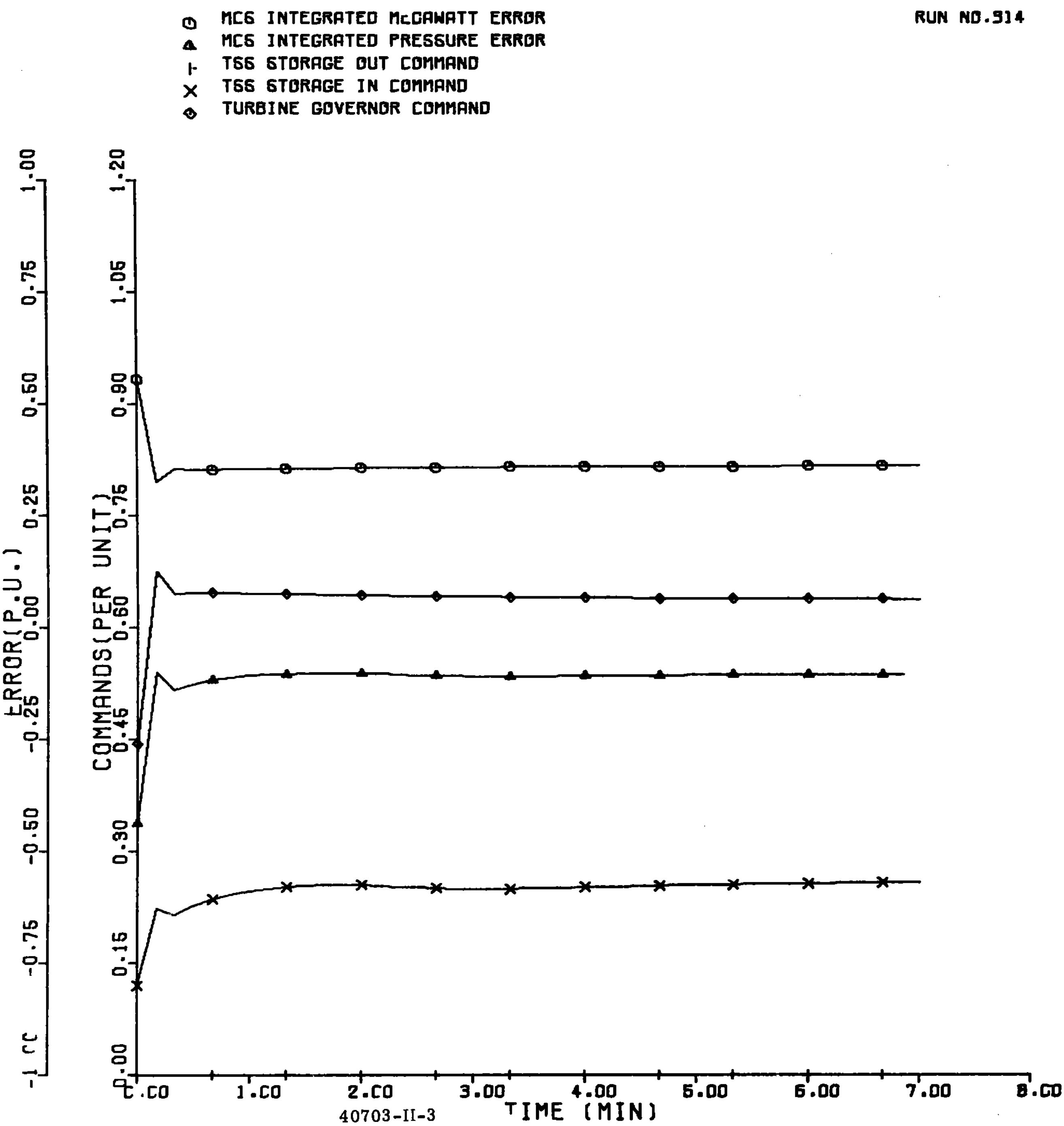

WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.314
TEMPERATURE (DEG-C)
PRESSURE (MPA)
FLOW (KG/HR) *10²
TIME (MIN)
40703-II-3


CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
RUN NO.314
FLOW (KG/HR) *10²
VALVE POSITION (P.U.)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

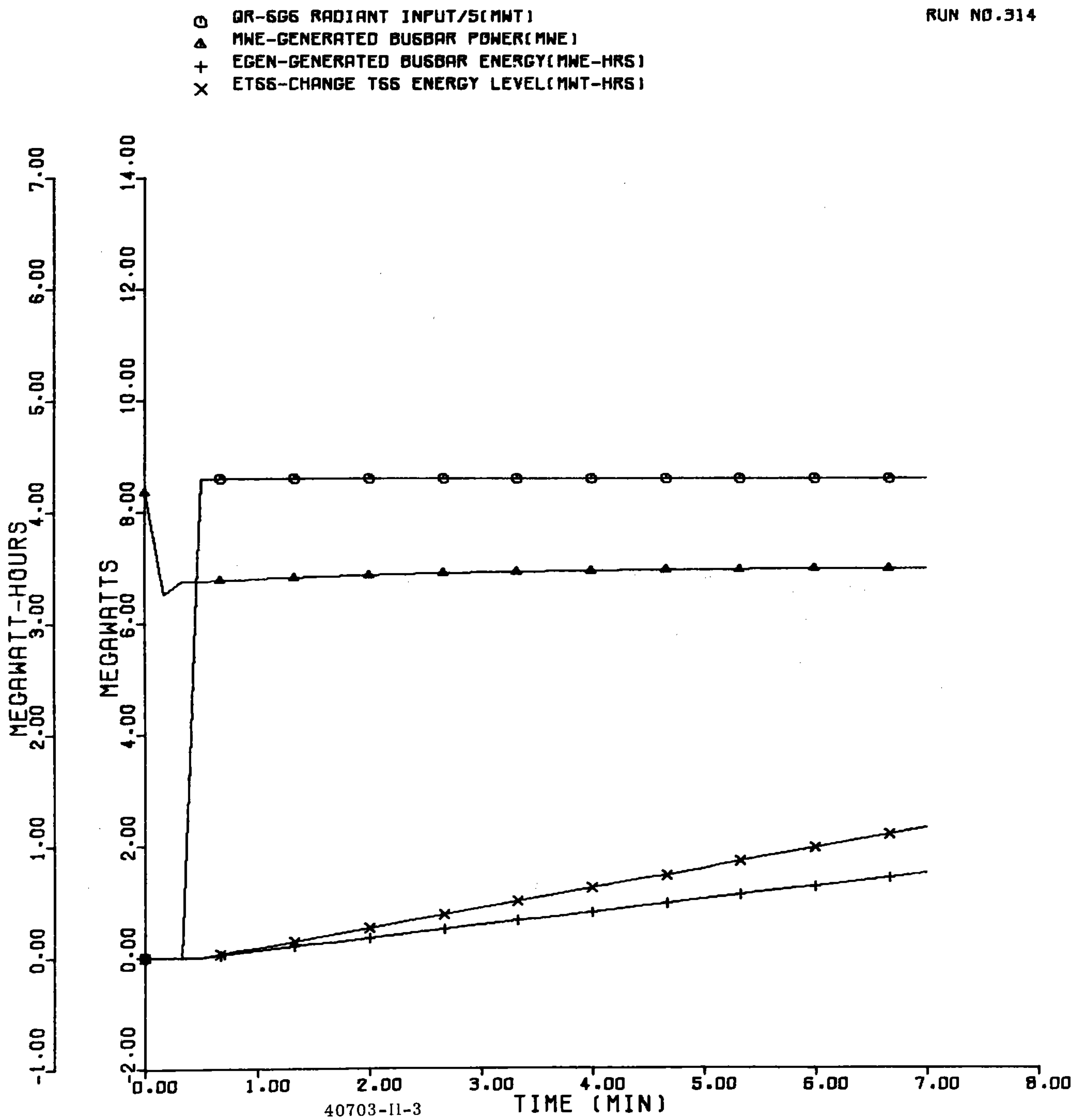
40703-II-3


MWDEM-MEGAWATT DEMAND(P.U.)
PSG6T-TOTAL SG6 NET POWER DELIVERED
ESG6T-TOTAL SG6 NET ENERGY DELIVERED
RUN NO.314
ENERGY(MEGAWATT-HOURS)
POWER(MEGAWATTS)
PER UNIT
0.00 0.80 1.60 2.40 3.20 4.00 4.80 5.60 6.40
0.00 5.00 10.00 15.00 20.00 25.00 30.00 35.00 40.00
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00
TIME (MIN)

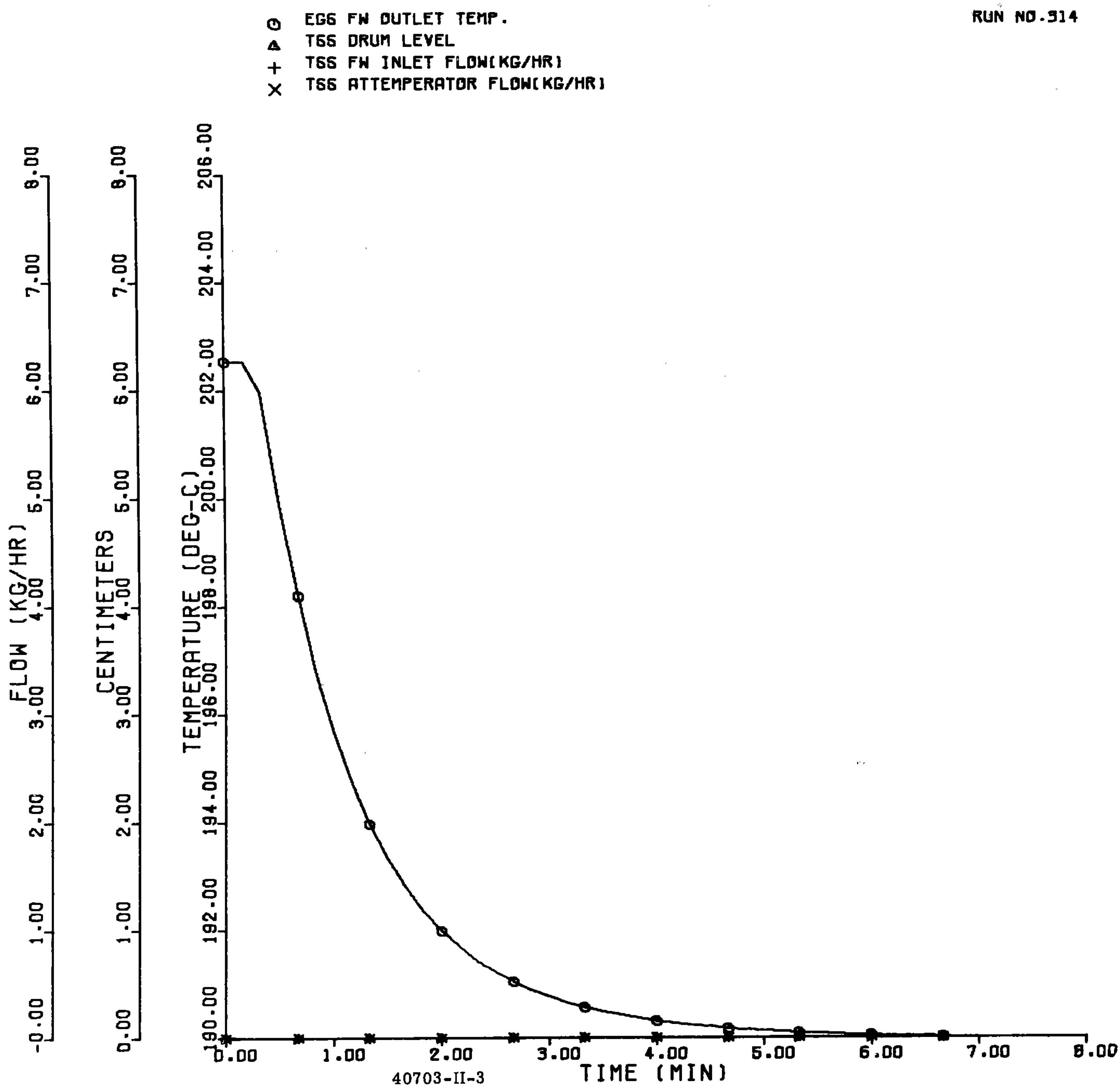
40703-II-3


RUN NO.314
MCS INTEGRATED McDAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.314
MEGAWATT-HOURS
MEGAWATTS
-1.00 0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00
-2.00 0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00
TIME (MIN)

40703-II-3



EGG FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
RUN NO.314
FLOW (KG/HR)
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
-0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
190.00
192.00
194.00
196.00
198.00
200.00
202.00
204.00
206.00

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Run No.	315
Run Type	Failure Effects
Run Length	7 min
Run Description	HP heater failure at t=2 min; outlet temperature goes to 149 deg-C (300 deg-F) in "step" fashion.
Note	Simplified TSS discharge model used.

SPP POWER LEVELS

	BTU/HR X 10*6 AVG	PEAK	MIN	MWTH AVG	PEAK	MIN
GROSS SGS INPUT POWER	146.738	146.738	146.738	43.01	43.01	43.01
NET OUTPUT POWER OF SGS TO-						
TOTAL	132.128	143.367	124.308	38.73	42.02	36.43
EGS	100.080	102.290	93.158	29.33	29.98	27.30
TSS	31.283	40.632	27.368	9.17	11.91	8.02
NET TSS POWER TO EGS	-0.000	0.000	-0.000	-0.00	0.00	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.91	8.99	8.75
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				5762853.	16122.	14196.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 3182.7 TO TSS 994.8 FROM TSS

TOTAL RADIANT ENERGY IN= 4666.5KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.8947

NET CHANGE IN TSS ENERGY 923.67(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 0.75(MW-HRSE)

40703-11-3

4-164

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	319.1	391.8	300.0
TD-DRUM TEMP	607.2	609.2	606.0
TPSHO-PSH TEMP OUT	798.7	818.2	773.5
TSSHO-SSH TEMP OUT	962.2	965.8	949.3
TPSHM-PSH METAL TEMP	845.1	867.6	816.5
TSSHM-SSH METAL TEMP	1001.0	1006.4	979.6
PSH METAL TEMP RATE	471.5	884.8	142.3
SSH METAL TEMP RATE	246.0	1614.0	-24.0
PPSHO-PSH PRES.OUT	1552.5	1567.1	1543.7
PSSHO-SSH PRES.OUT	1480.8	1485.7	1476.4
PD-DRUM PRES	1623.7	1648.2	1610.0
DELTA DRUM LEVEL	0.56	1.48	-0.64
PHPNCI-HP NOZ PRES	1450.5	1455.2	1446.0

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

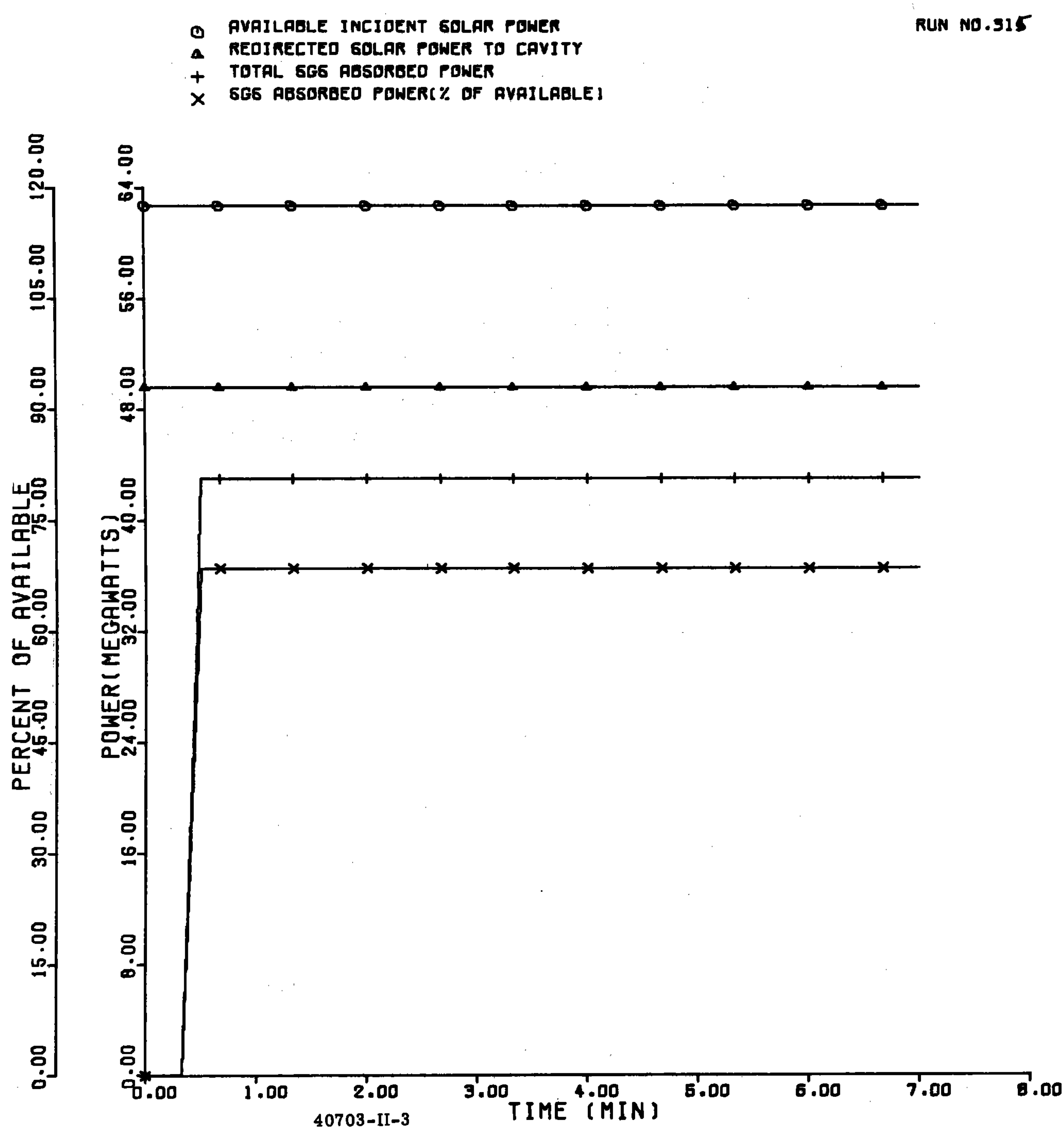
MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ),	0.9807	0.9807	0.9807
QINC-INCIDENT AVAILABLE POWER(MWT)	62.6864	62.6863	62.6863
QRDB-REDIRECTED POWER TO BOILER(MWT)	31.5154	31.5154	31.5154
QBDP-REDIRECTED POWER TO PSH(MWT)	7.1943	7.1943	7.1943
QRDS-REDIRECTED POWER TO SSH(MWT)	5.6700	5.6700	5.6700
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	49.6101	49.6101	49.6101
QABB-ABSORBED POWER ON BOILER(MWT)	29.9705	29.9705	29.9705
QABP-ABSORBED POWER ON PSH(MWT)	7.2478	7.2478	7.2478
QABS-ABSORBED POWER ON SSH(MWT)	5.7905	5.7905	5.7905
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.3835	5.3834	5.3834
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1873	0.1873	0.1873
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	48.5795	48.5795	48.5795
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	65.1230	65.1230	65.1230
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	15.7487	15.7487	15.7487
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5823	12.5823	12.5823
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	93.454	93.454	93.454
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.791	0.791	0.791
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.775	0.775	0.775
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.979	0.979	0.979
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	0.	0.	0.
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	0.	0.	0.
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	0.	0.	0.
TCAV1-CEILING TEMPERATURE(DEG-F)	1090.2	1197.7	982.8
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.7	651.3	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 6.808

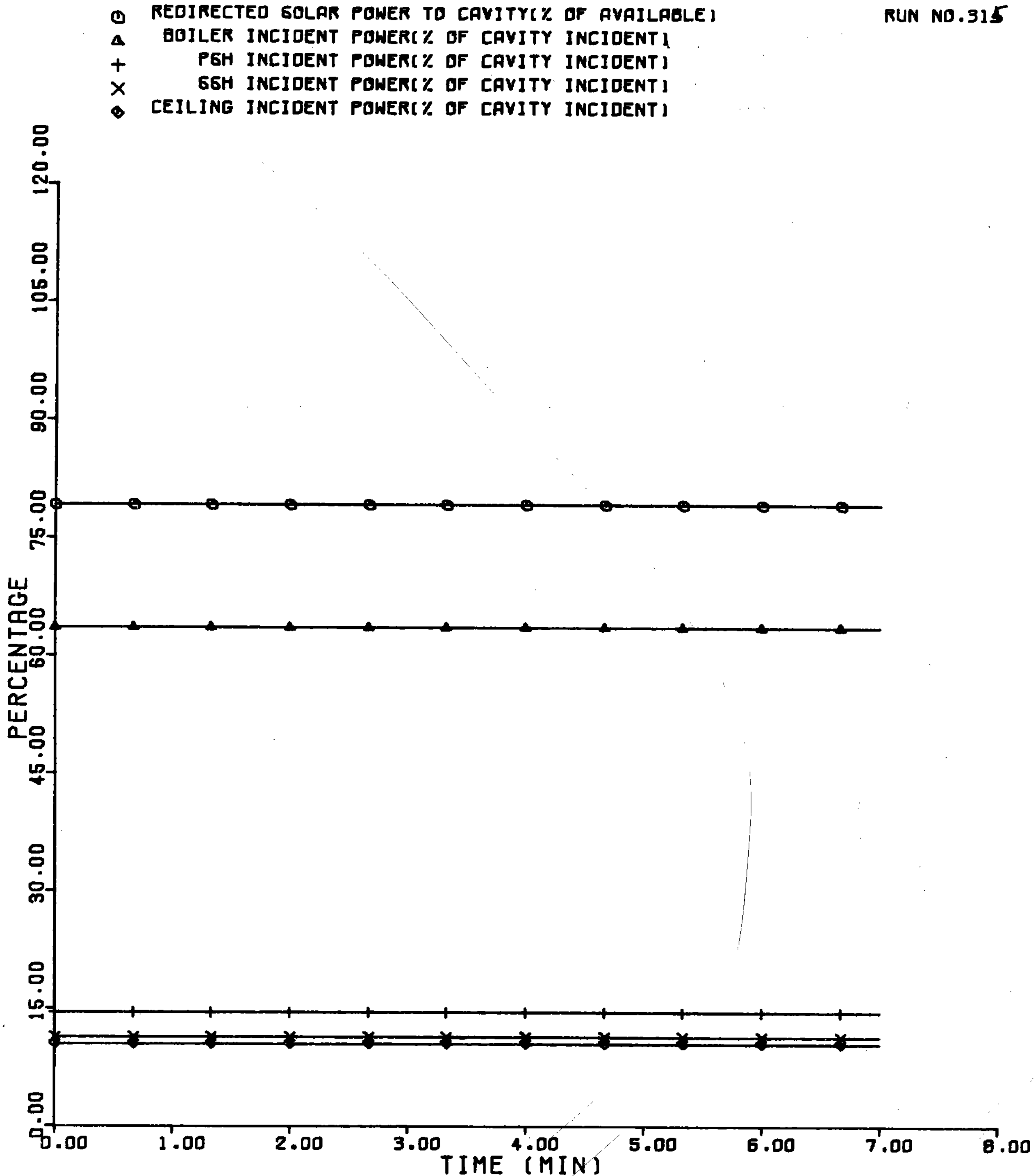
REDIRECTED ENERGY(MWT-HRS),TOTAL= 5.39BOILER= 3.42PSH= 0.78SSH= 0.62CEILING= 0.57

ABSORBED ENERGY(MWT-HRS),BOILER= 3.26PSH= 0.79SSH= 0.63CEILING= 0.58FLOOR= 0.02TOTAL= 5.28

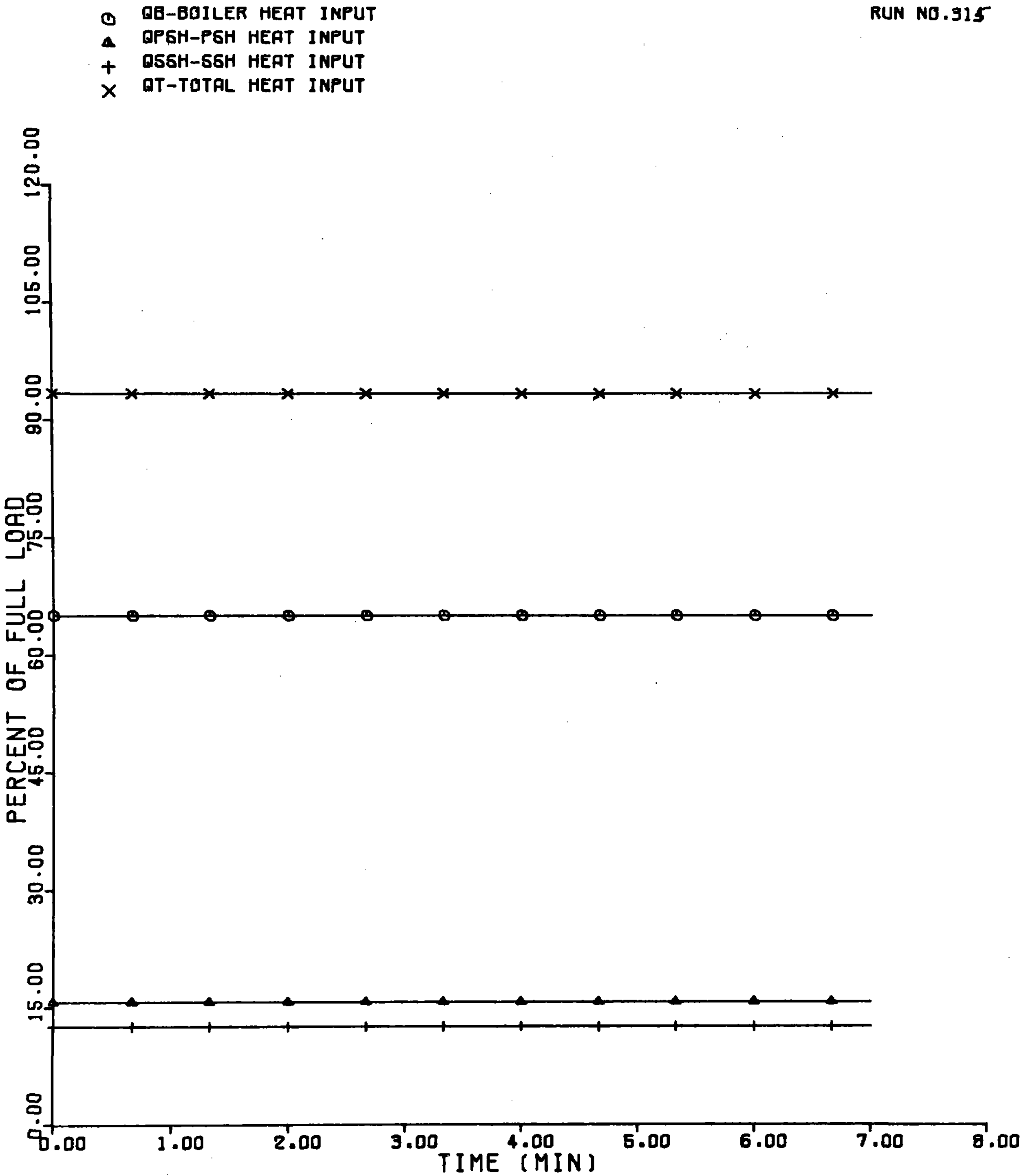

AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
RUN NO.315
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00

40703-II-3

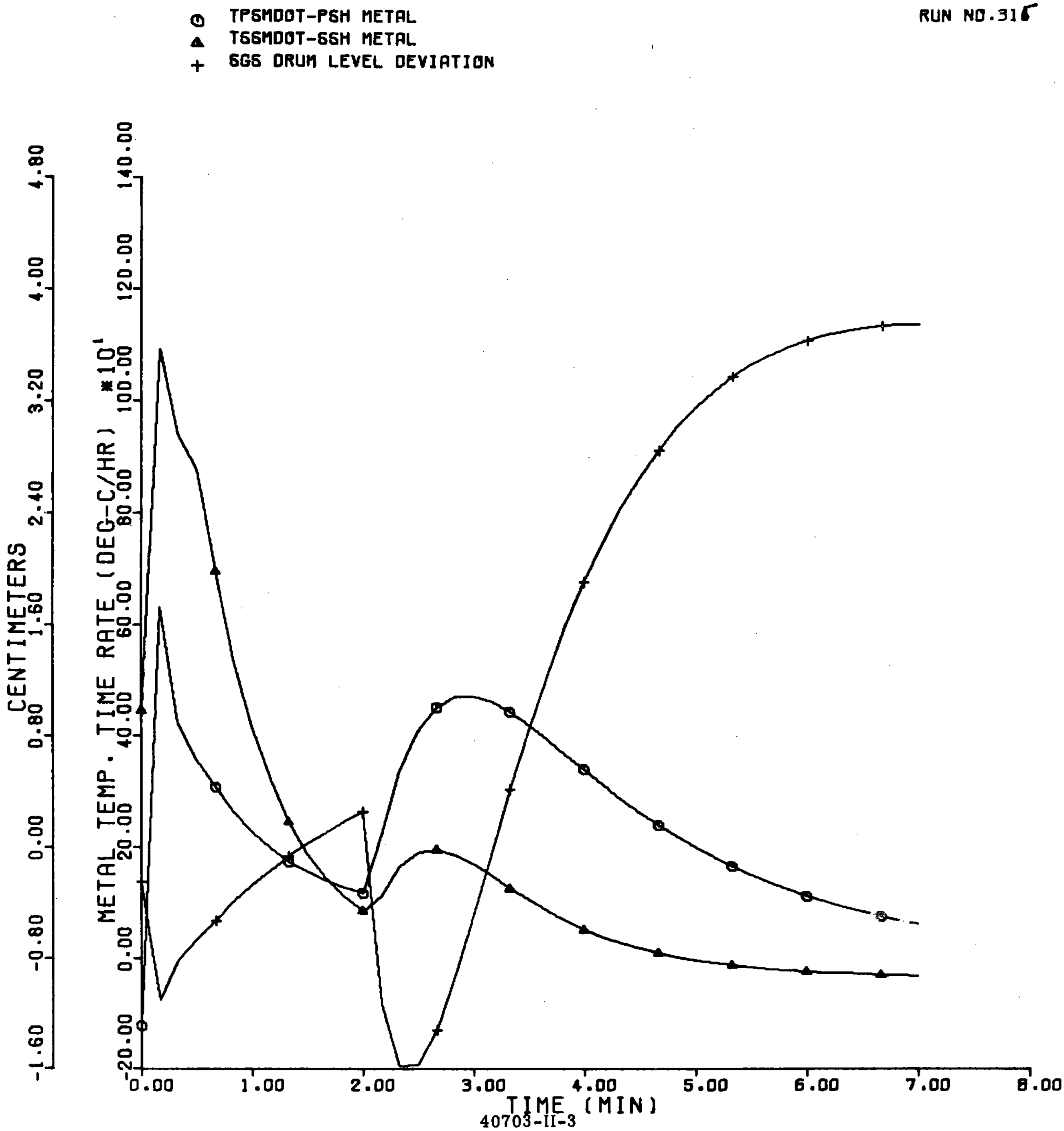
RUN NO.315



40703-II-3

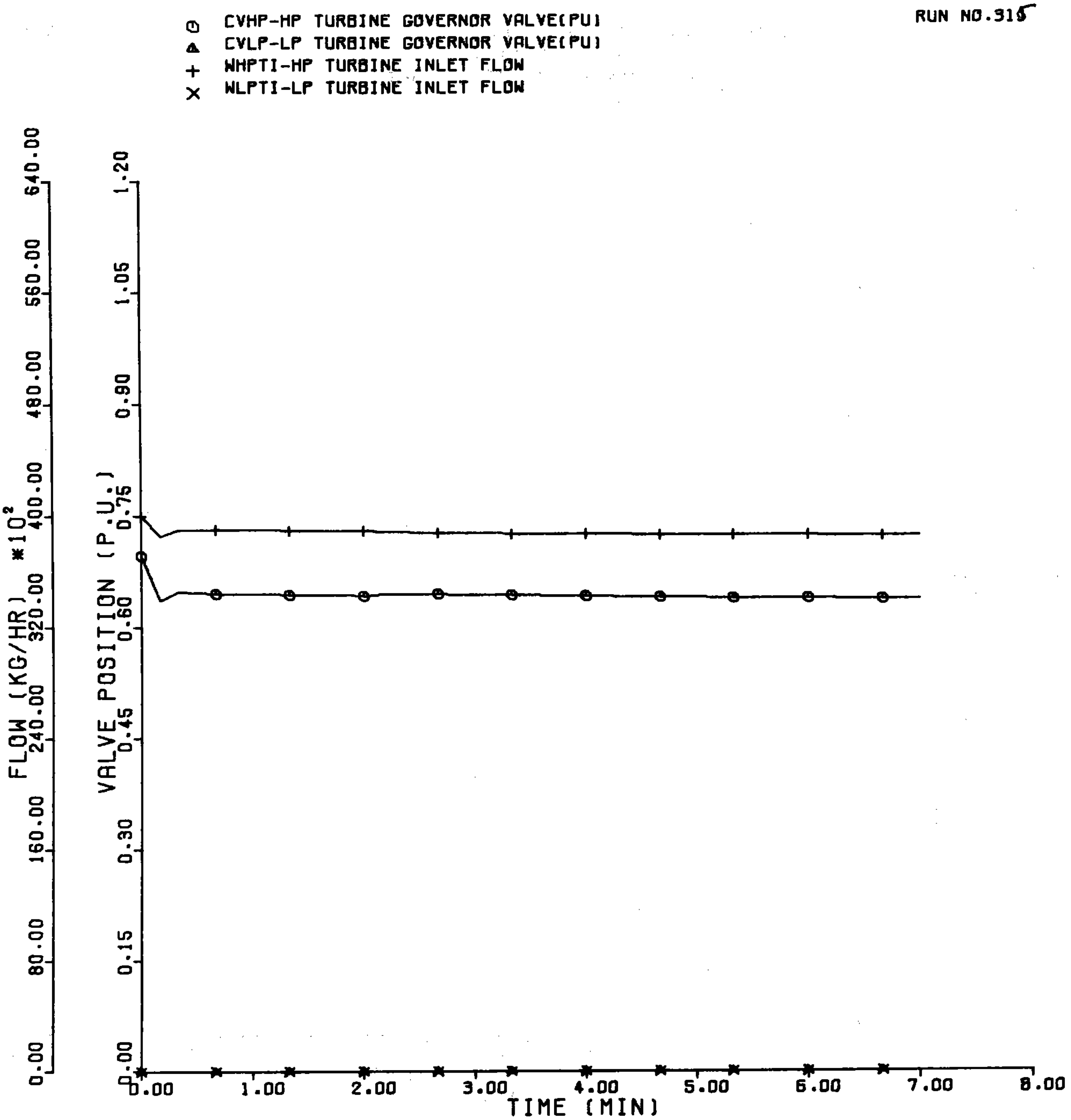

RUN NO.315
QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

40703-II-3


TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
RUN NO.315
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10¹
-1.60
-0.80
0.00
0.80
1.60
2.40
3.20
4.00
4.80
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

40703-II-3

RUN NO.315



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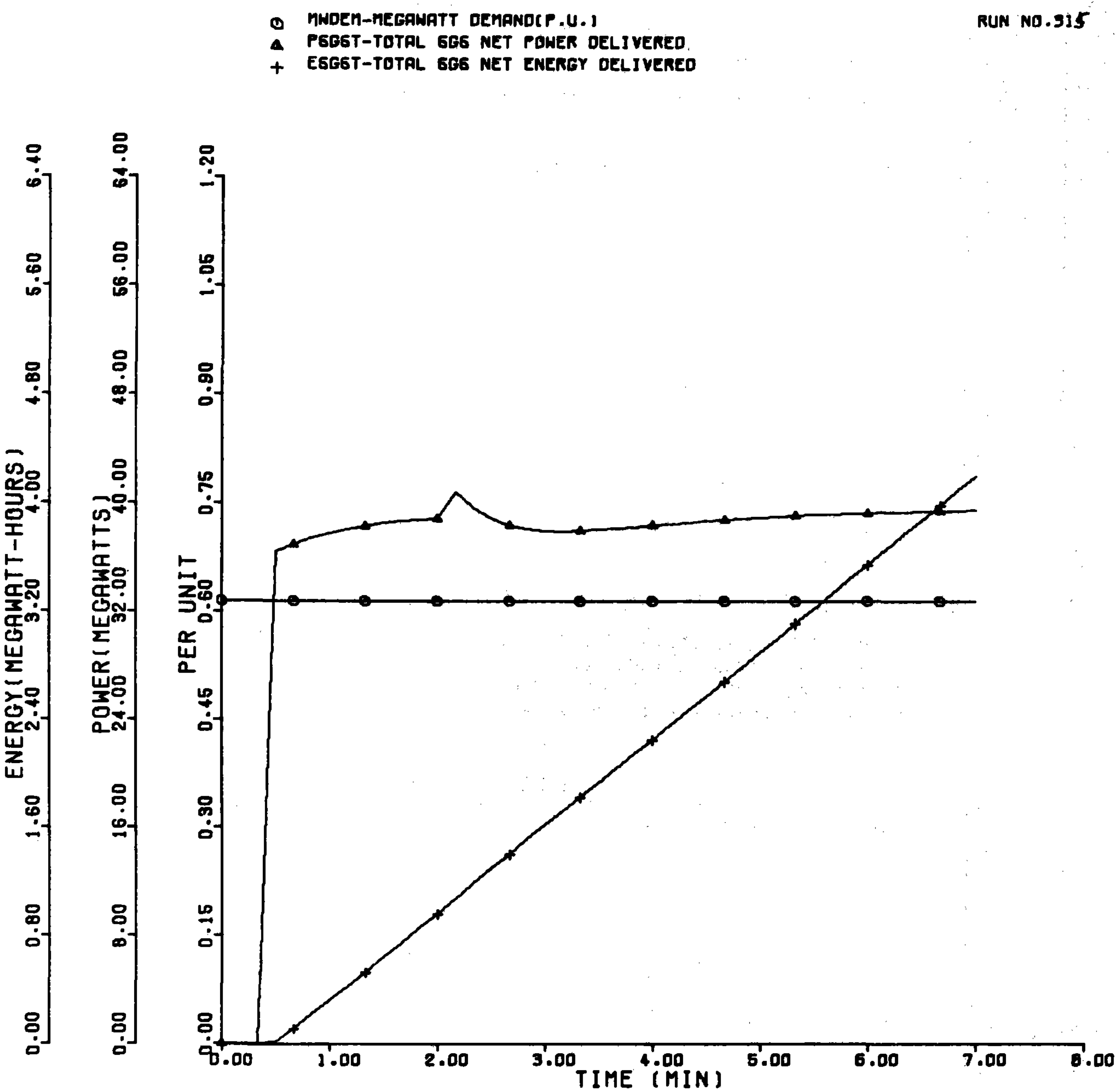
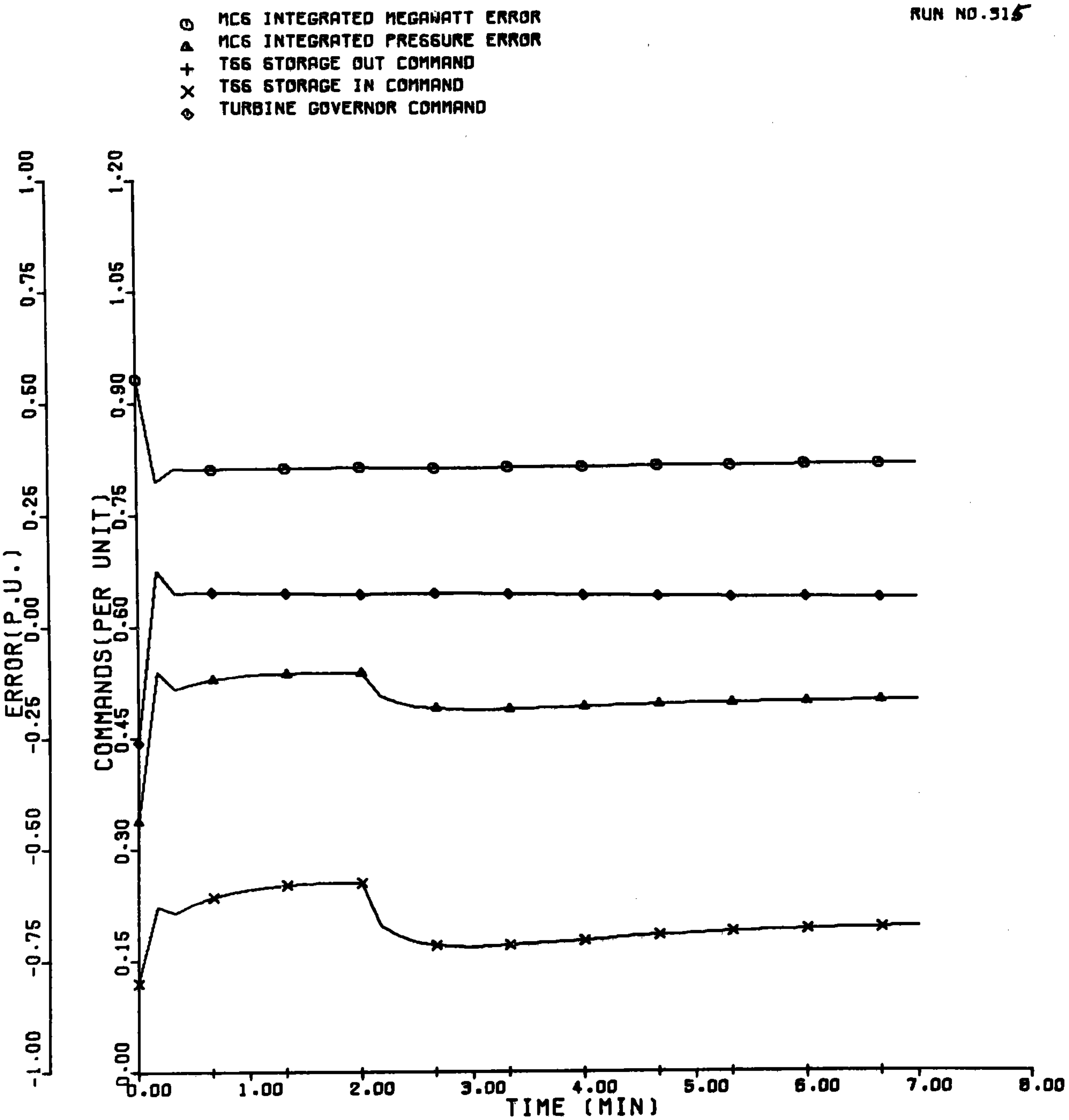
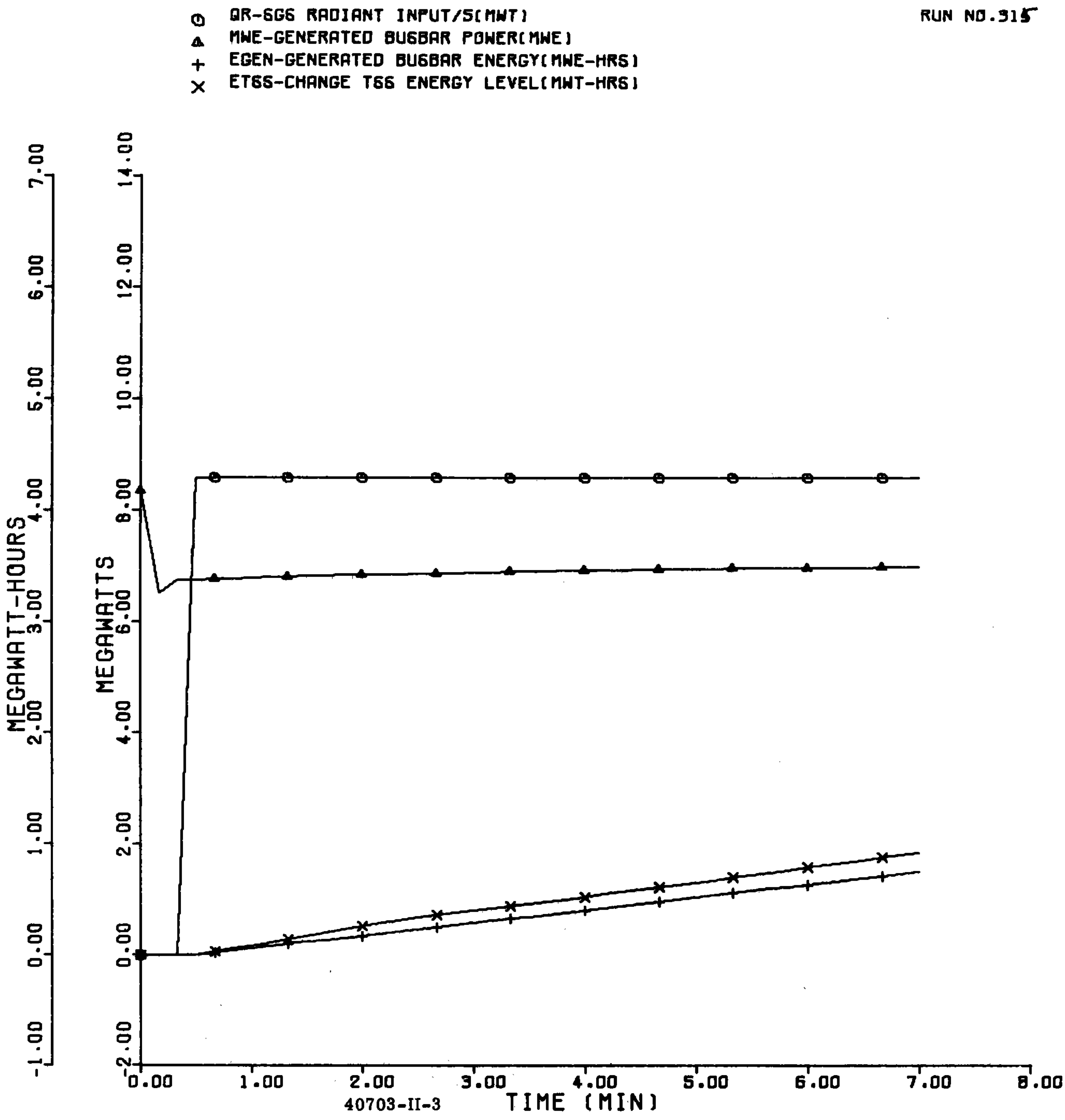

MWDEM-MEGAWATT DEMAND(P.U.)
PSGGT-TOTAL SGS NET POWER DELIVERED
ESGGT-TOTAL SGS NET ENERGY DELIVERED
RUN NO.315
ENERGY(MEGAWATT-HOURS)
POWER(MEGAWATTS)
PER UNIT
TIME (MIN)
0.00 0.80 1.60 2.40 3.20 4.00 4.80 5.60 6.40
0.00 8.00 16.00 24.00 32.00 40.00 48.00 56.00 64.00
0.00 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20
0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00

40703-II-3


RUN NO.315
MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
ERROR(P.U.)
COMMANDS(PER UNIT)
TIME (MIN)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

40703-II-3


QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
RUN NO.315
MEGAWATT-HOURS
MEGAWATTS
TIME (MIN)
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
-2.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

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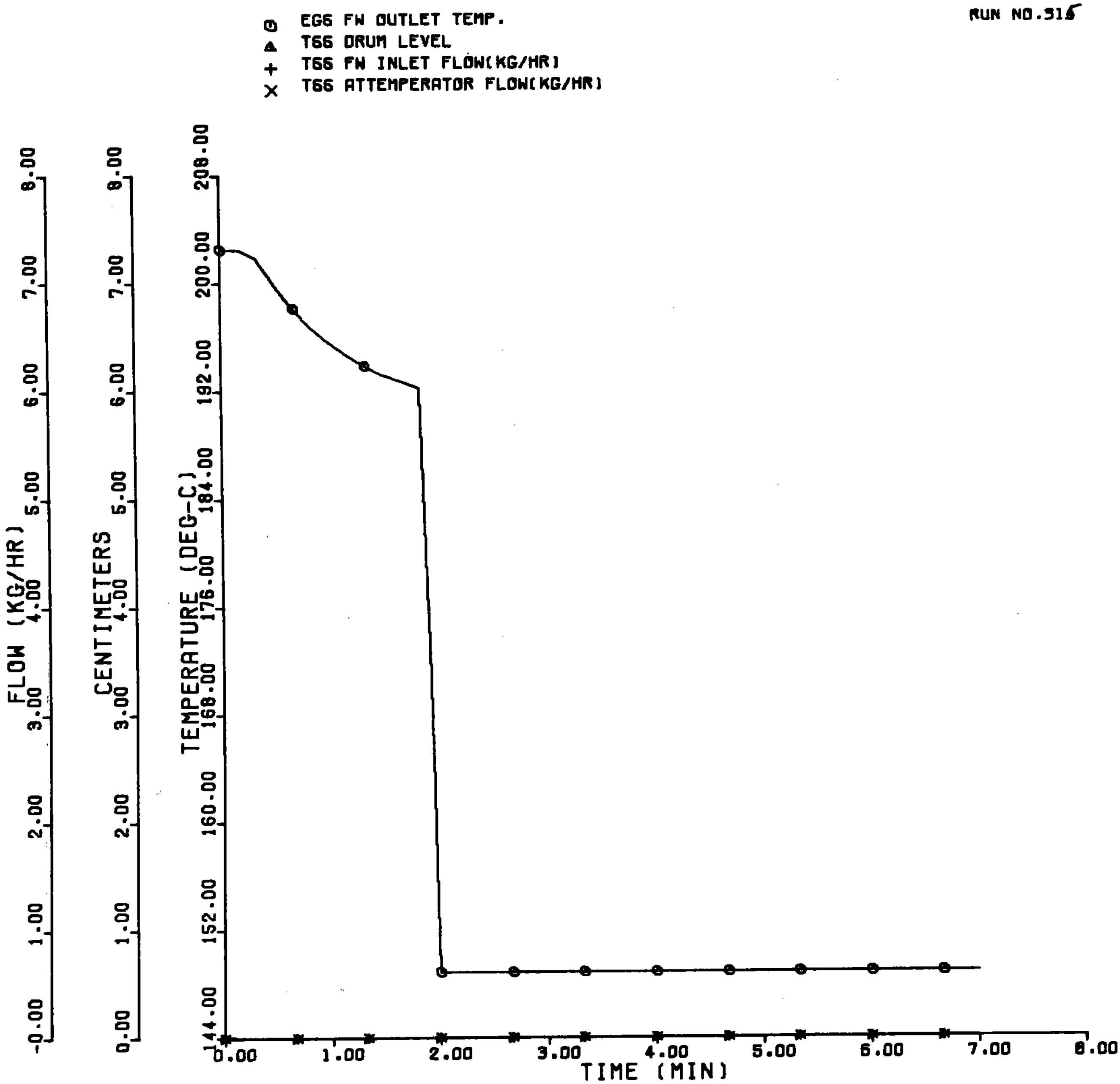
RUN NO.315



40703-II-3

Run No.	316
Run Type	Failure Effects
Run Length	7 min
Run Description	Simulated collector field failure at t=2 min; redirected power on boiler reduced by 20 percent in "step" fashion.
Note	Simplified TSS discharge model used.

SUMMARY OF SPP PERFORMANCE (RUN NO 316.)

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	131.992	146.738	126.114	38.69	43.01	36.96
NET OUTPUT POWER OF SGS TO-						
TOTAL	118.565	147.308	109.878	34.75	43.18	32.21
EGS	94.538	107.703	90.357	27.71	31.57	26.48
TSS	22.865	42.761	14.875	6.70	12.53	4.36
NET TSS POWER TO EGS	0.095	10.409	-0.001	0.03	3.05	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				8.93	11.87	8.47
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				5538062.	14886.	12244.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 3237.1 TO TSS 782.9 FROM TSS

TOTAL RADIANT ENERGY IN= 4519.6KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.8889

NET CHANGE IN TSS ENERGY 765.68(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 0.81(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F,DEG-F/HR,PSIA,IN

SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	377.6	396.6	373.1
TD-DRUM TEMP	605.4	609.2	603.4
TPSHO-PSH TEMP OUT	807.9	847.7	767.1
TSSHO-SSH TEMP OUT	963.8	971.7	934.4
TPSHM-PSH METAL TEMP	855.0	900.1	810.6
TSSHM-SSH METAL TEMP	1003.2	1014.9	965.9
PSH METAL TEMP RATE	762.0	1401.5	-553.6
SSH METAL TEMP RATE	419.6	2001.4	-17.2
PPSHO-PSH PRES.OUT	1539.7	1567.0	1513.0
PSSHO-SSH PRES.OUT	1474.9	1486.0	1406.3
PD-DRUM PRES	1603.6	1648.2	1579.4
DELTA DRUM LEVEL	0.92	2.43	-0.46
PHPNCI-HP NOZ PRES	1444.6	1456.9	1366.6

TSS PERFORMANCE	AVG	PEAK	MIN
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

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	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.9807	0.9807	0.9807
QINC-INCIDENT AVAILABLE POWER(MWT)	62.6864	62.6863	62.6863
QRDB-REDIRECTED POWER TO BOILER(MWT)	27.0089	31.5154	25.2123
QRDP-REDIRECTED POWER TO PSH(MWT)	7.1943	7.1943	7.1943
QRDS-REDIRECTED POWER TO SSH(MWT)	5.6700	5.6700	5.6700
QRDC-REDIRECTED POWER TO CEILING(MWT)	5.2304	5.2304	5.2304
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	45.1036	49.6101	43.3070
QABB-ABSORBED POWER ON BOILER(MWT)	25.7405	29.9705	24.0541
QABP-ABSORBED POWER ON PSH(MWT)	7.1902	7.2478	7.1672
QABS-ABSORBED POWER ON SSH(MWT)	5.7563	5.7905	5.7427
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	5.3395	5.3834	5.3220
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1658	0.1873	0.1572
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	44.1922	48.5795	42.4431
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	55.9315	65.1230	52.2671
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	15.6235	15.7487	15.5736
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	12.5079	12.5823	12.4783
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	84.063	93.454	80.319
QRDINC-RATIO,REDIRECTED TO INCIDENT POWER TOTALS)	0.720	0.791	0.691
QABINC-RATIO,ABSORBED TO INCIDENT POWER TOTALS)	0.705	0.775	0.677
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.980	0.980	0.979
QABBRA-RATE OF CHANGE,BOILER ABSORBED POWER(%/MIN)	7.449	3907.378	-771.349
QABPRA-RATE OF CHANGE,PSH ABSORBED POWER(%/MIN)	2.220	944.920	-10.503
QABSRA-RATE OF CHANGE,SSH ABSORBED POWER(%/MIN)	1.778	754.938	-6.242
QABTRA-RATE OF CHANGE,TOTAL ABSORBED POWER(%/MIN)	11.447	5607.235	-788.095
TCAV1-CEILING TEMPERATURE(DEG-F)	1081.3	1195.8	966.3
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	650.6	651.1	650.0

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 7.331
REDIRECTED ENERGY(MWT-HRS),TOTAL= 5.27BOILER= 3.16PSH= 0.84SSH= 0.66CEILING= 0.61
ABSORBED ENERGY(MWT-HRS),BOILER= 3.01PSH= 0.84SSH= 0.67CEILING= 0.62FLOOR= 0.02TOTAL= 5.17

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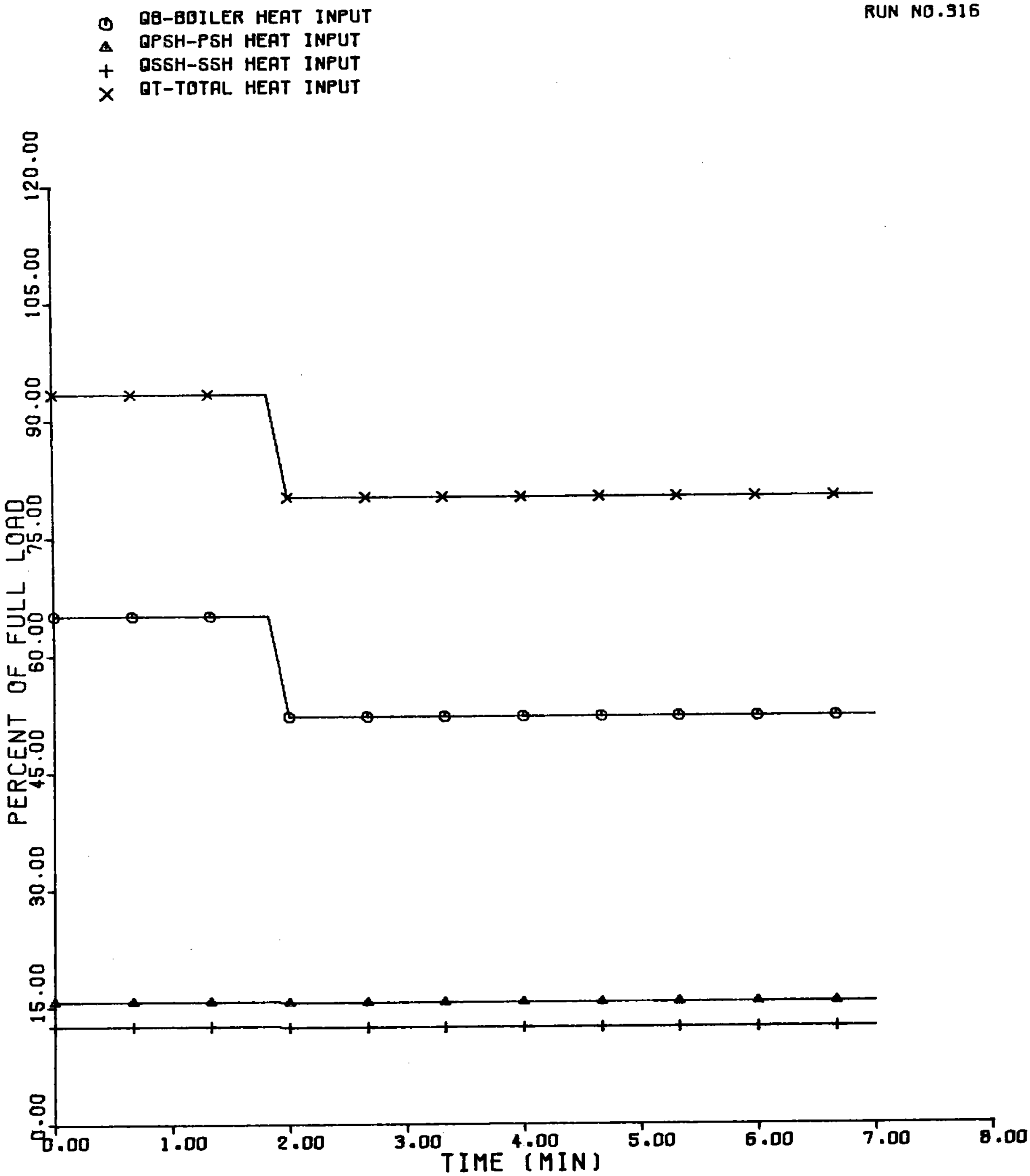
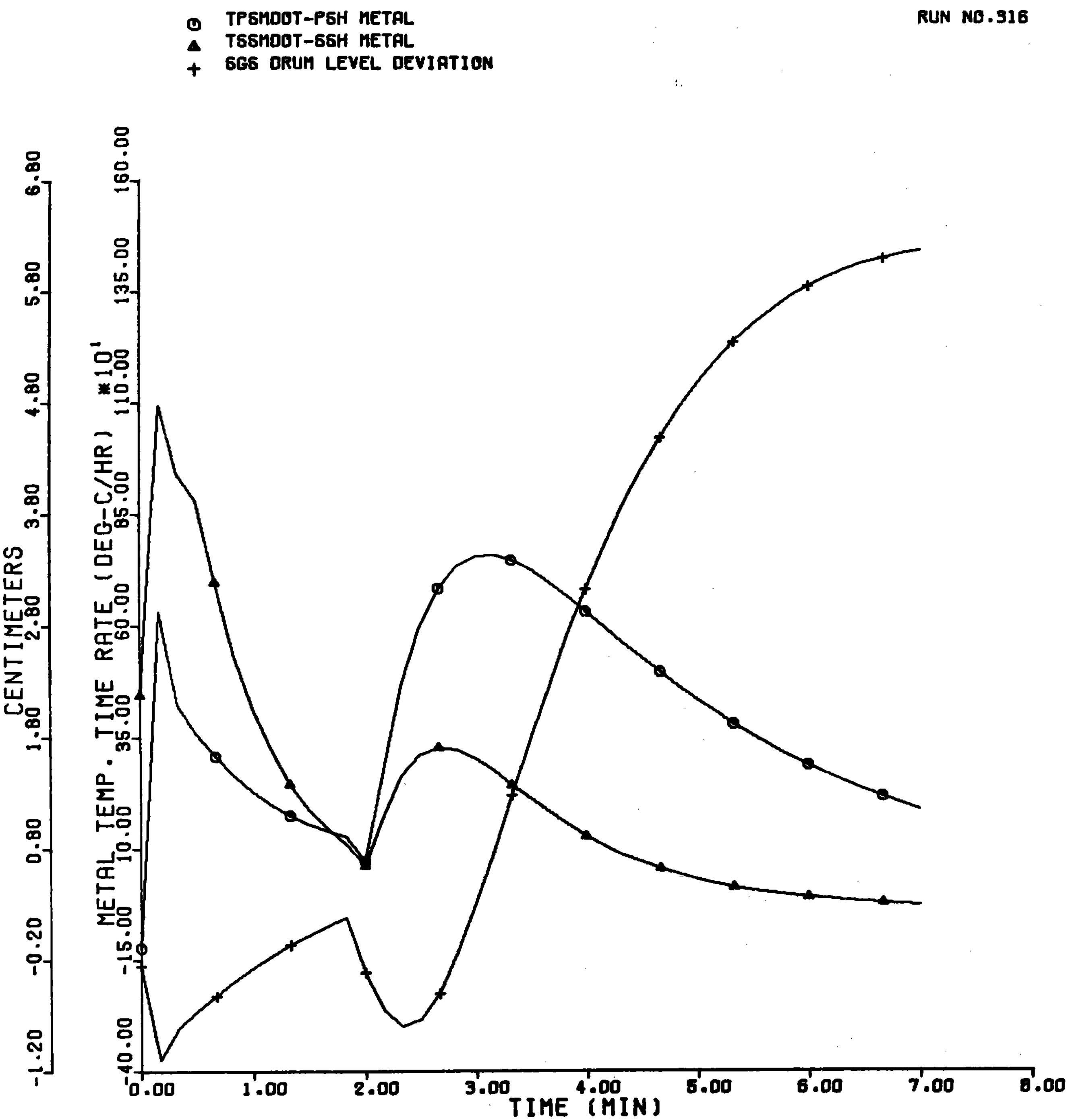
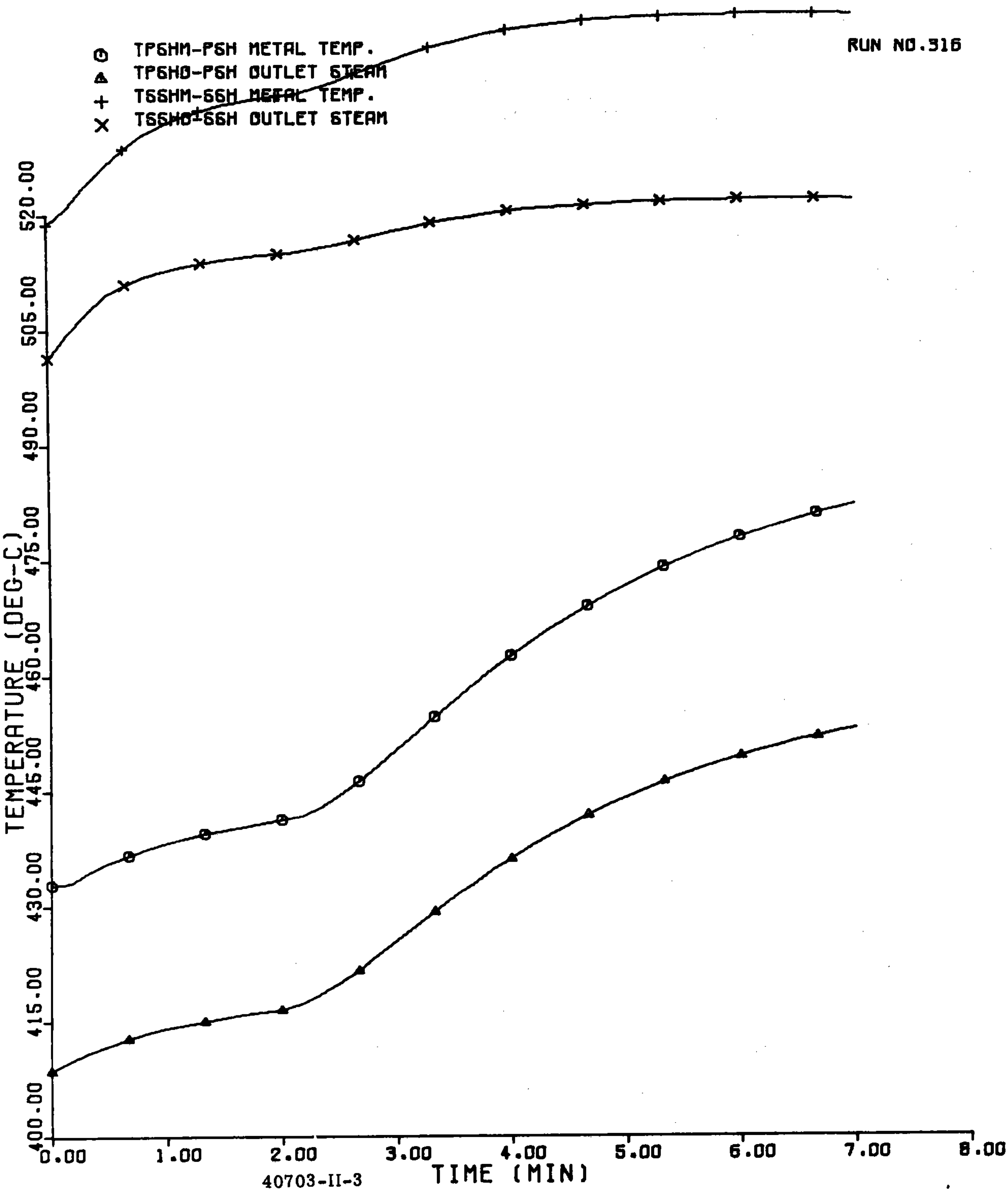
RUN NO.316

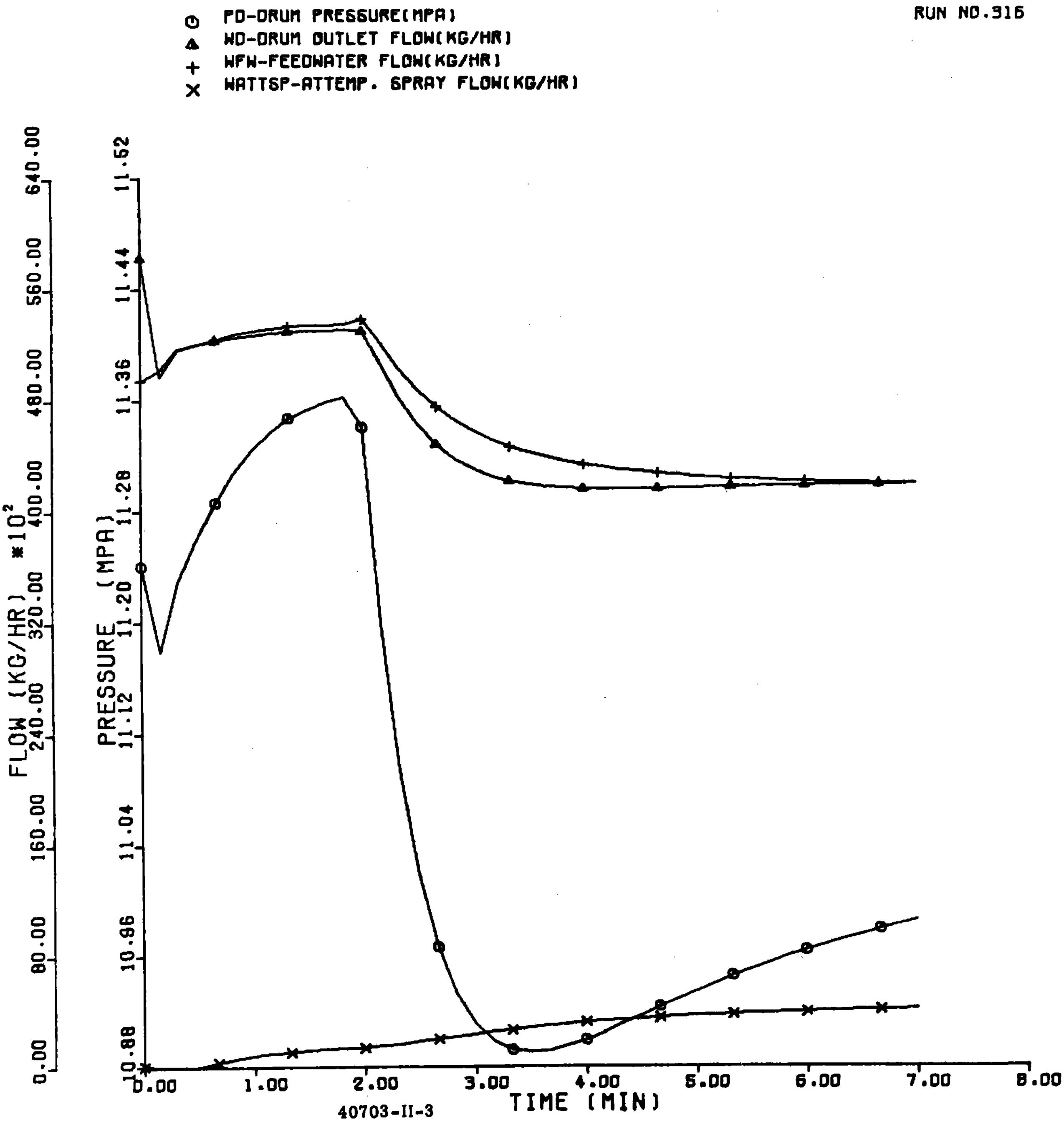

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)


RUN NO.316
TPSMDOT-PSH METAL
TSSMDOT-SSH METAL
SGS DRUM LEVEL DEVIATION
CENTIMETERS
-1.20
-0.20
0.80
1.80
2.80
3.80
4.80
5.80
6.80
METAL TEMP. TIME RATE (DEG-C/HR) *10[1]
-40.00
-15.00
10.00
35.00
60.00
85.00
110.00
135.00
160.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

40703-II-3


RUN NO.316
TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
TEMPERATURE (DEG-C)
520.00
505.00
490.00
475.00
460.00
445.00
430.00
415.00
400.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
TIME (MIN)

40703-II-3


RUN NO.316
PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
FLOW (KG/HR) *10^2
PRESSURE (MPA)
TIME (MIN)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
10.88
10.96
11.04
11.12
11.20
11.28
11.36
11.44
11.52
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00

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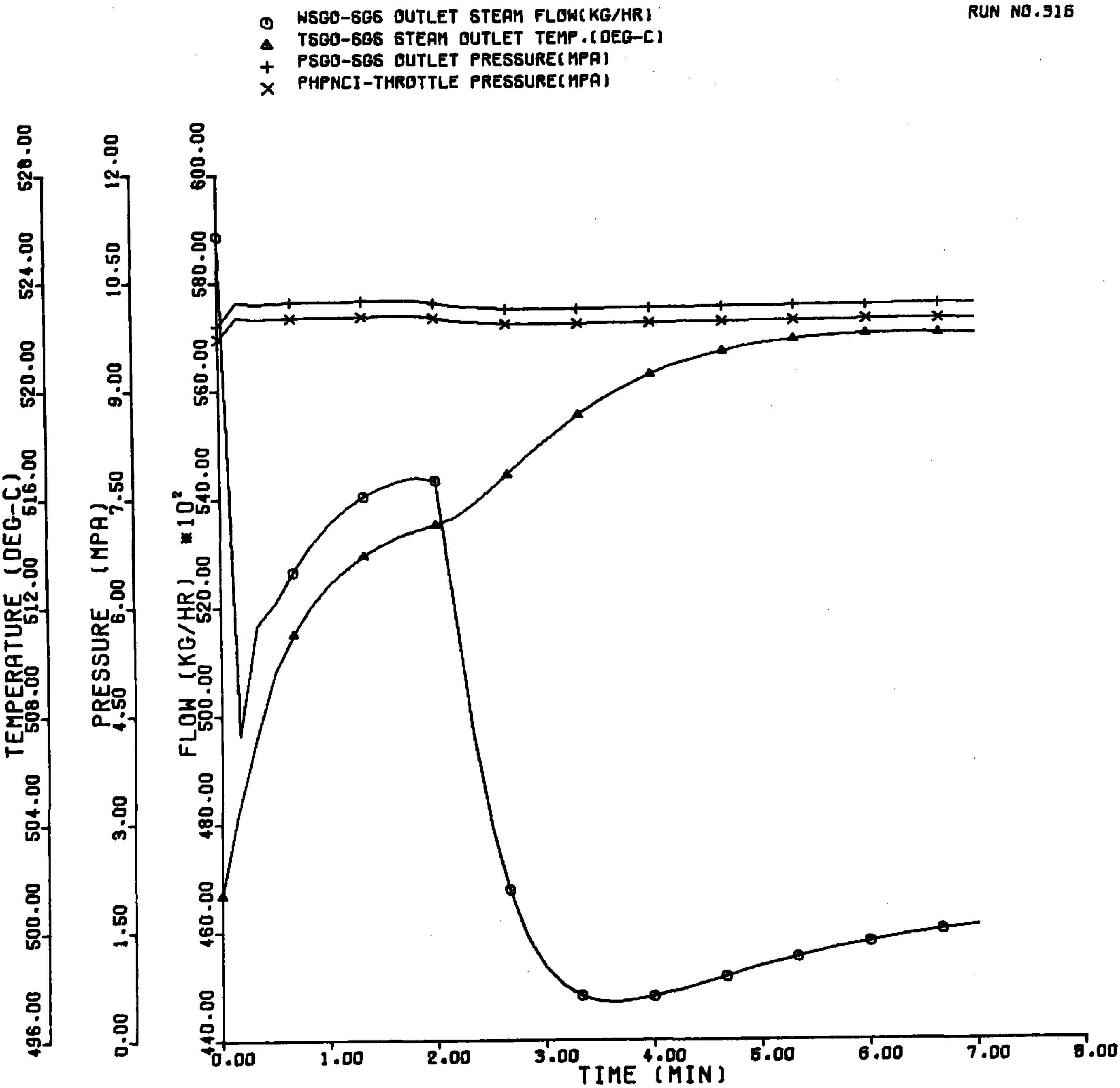
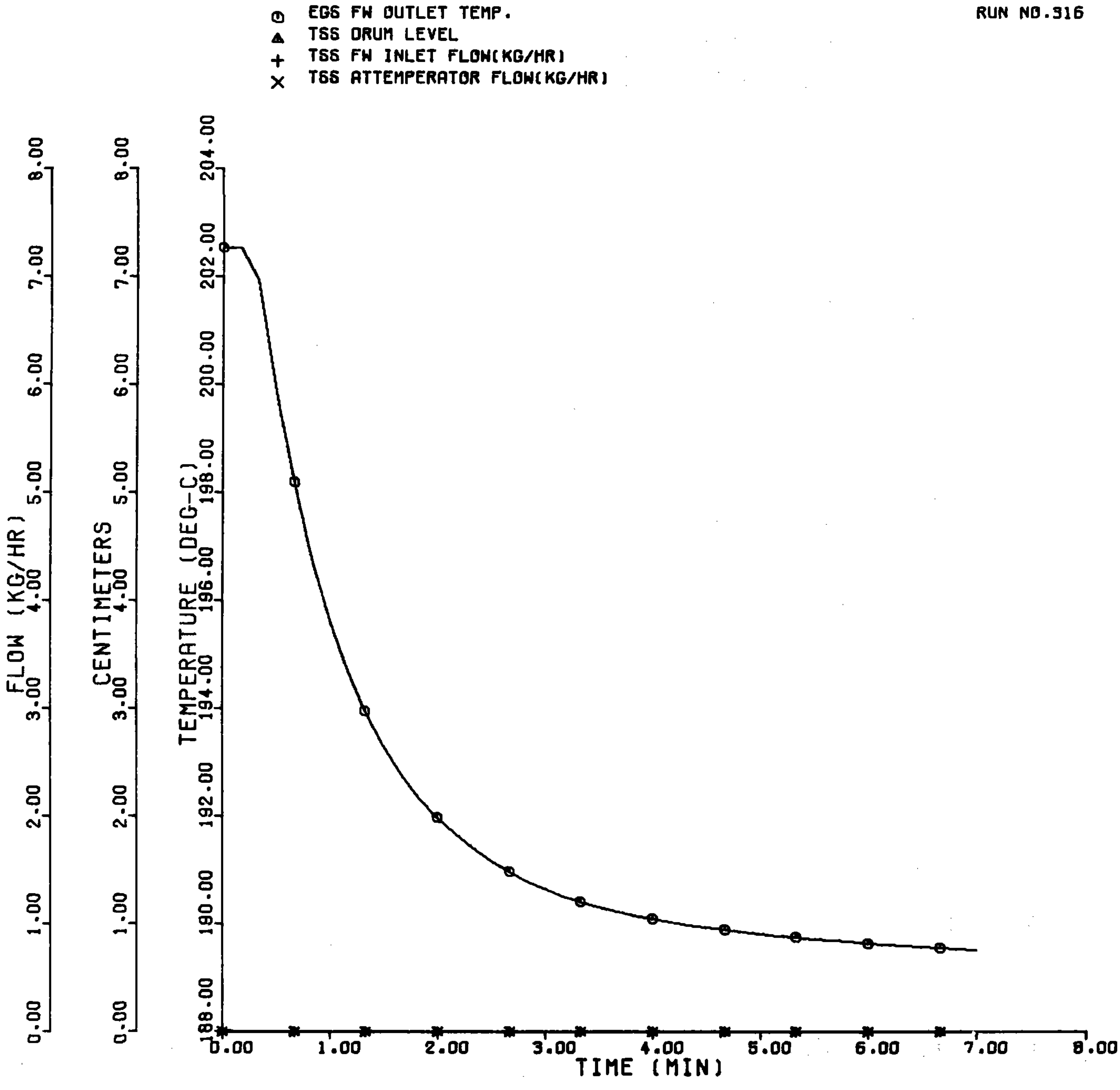
RUN NO.316

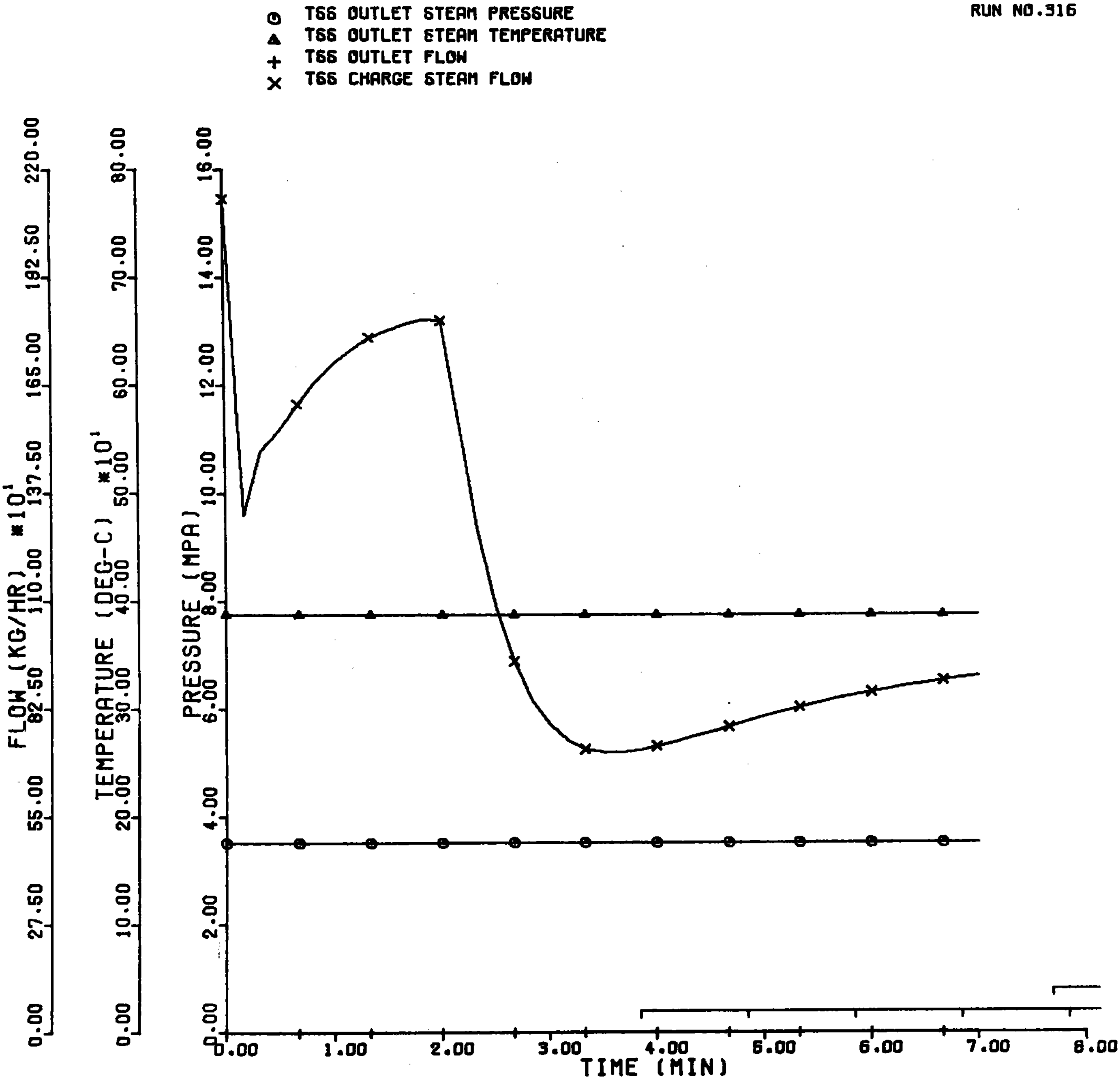


40703-II-3

RUN NO.316


EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
FLOW (KG/HR)
CENTIMETERS
TEMPERATURE (DEG-C)
TIME (MIN)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
188.00
190.00
192.00
194.00
196.00
198.00
200.00
202.00
204.00

RUN NO.316



40703-II-3

Run No.	317
Run Type	Cloud Transient
Run Length	138 min
Run Description	Plant operation using Sandia-supplied solar insolation data starting at 4643. 3 hrs.
Note	Simplified TSS discharge model employed.

SPP POWER LEVELS

	BTU/HR X 10*6			MWTH		
	AVG	PEAK	MIN	AVG	PEAK	MIN
GROSS SGS INPUT POWER	87.101	138.908	0.000	25.53	40.71	0.00
NET OUTPUT POWER OF SGS TO-						
TOTAL	81.158	129.684	1.537	23.79	38.01	0.45
EGS	65.314	98.411	1.879	19.14	28.84	0.55
TSS	14.453	30.992	0.000	4.24	9.08	0.00
NET TSS POWER TO EGS	27.250	84.854	-0.001	7.99	24.87	-0.00
EGS GROSS GENERATOR OUTPUT(MWE)=				9.01	9.48	8.61
GROSS CYCLE HEAT RATE(BTU/KW-HR)=				73098323.	14017.	209.

TOTAL NET ENERGY DELIVERED(KW-HRS) SGS/EGS 43990.4 TO TSS 9734.6 FROM TSS 1

TOTAL RADIANT ENERGY IN= 58664.3KW-HRS.EFFICIENCY(NET ENERGY OUT/TOTAL IN)=0.9152

NET CHANGE IN TSS ENERGY -8860.11(KW-HRS)

TOTAL ELEC ENERGY GENERATED= 16.13(MW-HRSE)

FOLLOWING UNITS ARE-DEG-F.DEG-F/HR.PSIA.IN

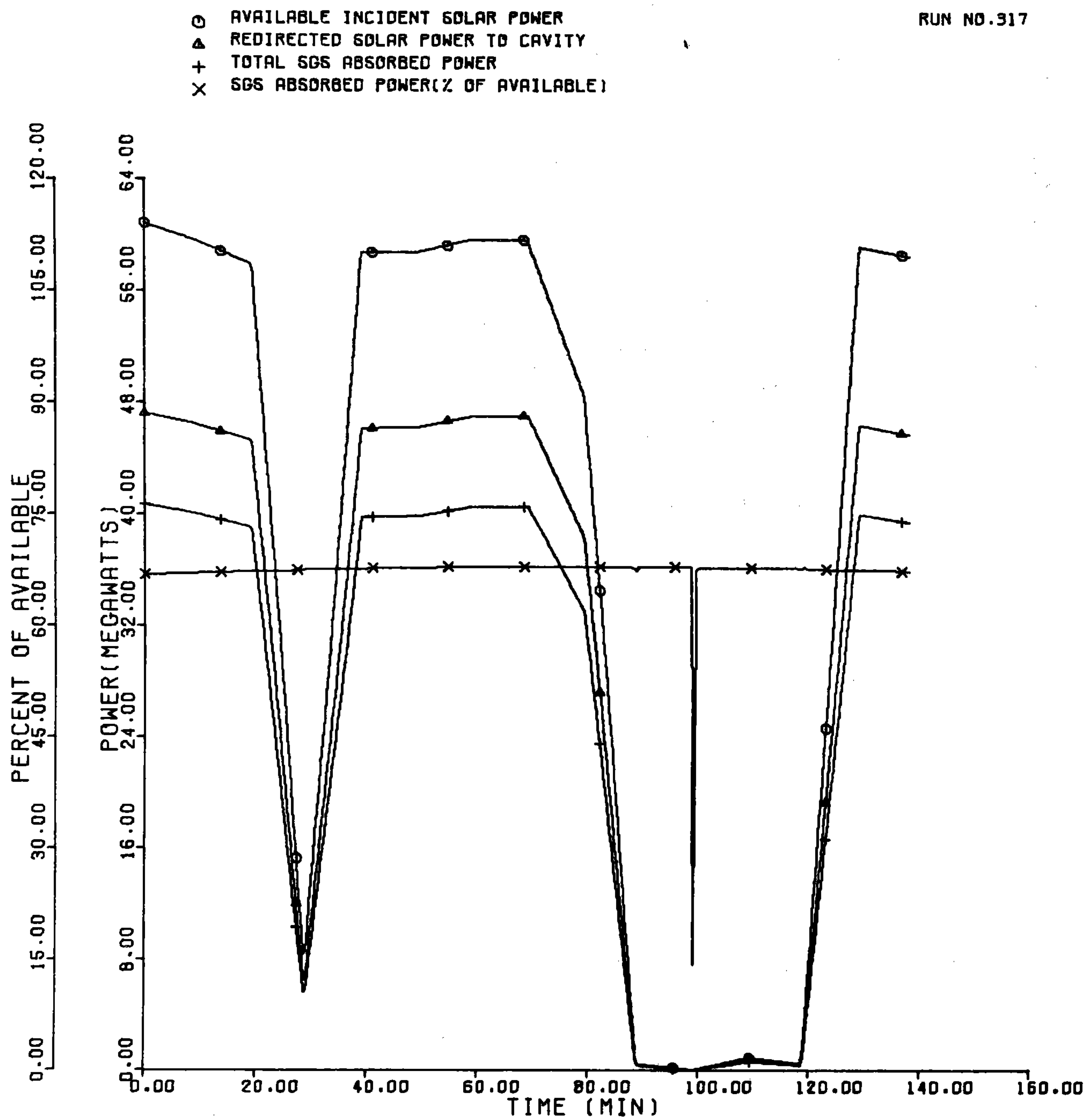
SGS PERFORMANCE	AVG	PEAK	MIN
TFW-HP FW TEMP	380.6	393.6	373.2
TD-DRUM TEMP	601.7	613.1	587.3
TPSHO-PSH TEMP OUT	797.8	816.3	750.2
TSSHO-SSH TEMP OUT	952.4	969.4	920.8
TPSHM-PSH METAL TEMP	836.7	864.5	772.4
TSSHM-SSH METAL TEMP	983.7	1009.0	936.8
PSH METAL TEMP RATE	13.4	2099.9	-250.1
SSH METAL TEMP RATE	5.9	2412.2	-212.6
PPSHO-PSH PRES.OUT	1522.2	1627.2	1401.6
PSSHO-SSH PRES.OUT	1481.6	1560.4	1401.6
PD-DRUM PRES	1562.4	1694.5	1401.7
DELTA DRUM LEVEL	0.38	4.73	-2.77
PHPNCI-HP NOZ PRES	1461.9	1528.8	1401.6

TSS PERFORMANCE			
THHTC-HOT HITEC TEMP	0.	0.	0.
TCHTC-COLD HITEC TEM	0.	0.	0.
TOIL-MAIN OIL TEMP	0.	0.	0.
DDRUM-DELTA DRUM LEV	0.	0.	0.
PDRUM-DRUM PRESSURE	0.	0.	0.
TPREH-PREHEATER TEMP	0.	0.	0.
TDSH-DESUPER-TEMP	0.	0.	0.

MISCELLANEOUS RECEIVER CAVITY TERMS

	AVG	PEAK	MIN
DNI-DIRECT NORMAL INTENSITY(KW/M-SQ).	0.5906	0.9525	0.0000
QINC-INCIDENT AVAILABLE POWER(MWT)	37.7499	60.8858	0.0001
QRDB-REDIRECTED POWER TO BOILER(MWT)	18.3599	29.2523	0.0000
QRDP-REDIRECTED POWER TO PSH(MWT)	4.4268	7.0751	-0.0000
QRDS-REDIRECTED POWER TO SSH(MWT)	3.5414	5.6597	-0.0000
QRDC-REDIRECTED POWER TO CEILING(MWT)	3.2762	5.2338	0.0000
QRDT-TOTAL REDIRECTED POWER TO CAVITY(MWT)	29.6044	47.2209	0.0000
QABB-ABSORBED POWER ON BOILER(MWT)	17.4747	27.8430	0.0000
QABP-ABSORBED POWER ON PSH(MWT)	4.4486	7.1088	-0.0000
QABS-ABSORBED POWER ON SSH(MWT)	3.6059	5.7620	-0.0000
QABC-TOTAL ABSORBED POWER ONTO CEILING(MWT)	3.3565	5.3615	0.0000
QABF-TOTAL ABSORBED POWER ONTO CAVITY FLOOR(MWT)	0.1105	0.1762	0.0000
QABT-TOTAL ABSORBED POWER INTO CAVITY(MWT)	28.9963	46.2515	0.0000
QABPFB-BOILER ABSORBED POWER(% OF DESIGN MAX)	37.9708	60.5002	0.0001
QABPFP-PSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	9.6665	15.4467	-0.0000
QABPFS-SSH ABSORBED POWER(% OF TOTAL DESIGN MAX)	7.8353	12.5203	-0.0000
QABPFT-TOTAL ABSORBED POWER(% OF TOTAL DESIGN MAX)	55.473	88.467	0.000
QRDINC-RATIO.REDIRECTED TO INCIDENT POWER TOTALS)	0.785	0.812	0.356
QABINC-RATIO.ABSORBED TO INCIDENT POWER TOTALS)	0.769	0.796	0.344
QABRD-RATIO ABSORBED TO REDIRECTED POWER TOTALS)	0.979	0.979	0.738
QABBRA-RATE OF CHANGE.BOILER ABSORBED POWER(%/MIN)	-0.014	6.364	-5.769
QABPRA-RATE OF CHANGE.PSH ABSORBED POWER(%/MIN)	-0.004	1.621	-1.471
QABSRA-RATE OF CHANGE.SSH ABSORBED POWER(%/MIN)	-0.003	1.314	-1.192
QABTRA-RATE OF CHANGE.TOTAL ABSORBED POWER(%/MIN)	-0.020	9.298	-8.431
TCAV1-CEILING TEMPERATURE(DEG-F)	2662.7	3838.2	993.7
TCAV6-CAVITY FLOOR TEMPERATURE(DEG-F)	658.7	664.7	650.1

TOTAL AVALABLE DIRECT NORMAL ENERGY(MWT-HRS)= 86.835
REDIRECTED ENERGY(MWT-HRS),TOTAL= 68.10BOILER= 42.23PSH= 10.18SSH= 8.15CEILING= 7.54
ABSORBED ENERGY(MWT-HRS),BOILER= 40.20PSH= 10.23SSH= 8.29CEILING= 7.72FLOOR= 0.25TOTAL= 66.70


RUN NO.317
AVAILABLE INCIDENT SOLAR POWER
REDIRECTED SOLAR POWER TO CAVITY
TOTAL SGS ABSORBED POWER
SGS ABSORBED POWER(% OF AVAILABLE)
PERCENT OF AVAILABLE
POWER(MEGAWATTS)
TIME (MIN)
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
8.00
16.00
24.00
32.00
40.00
48.00
56.00
64.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00

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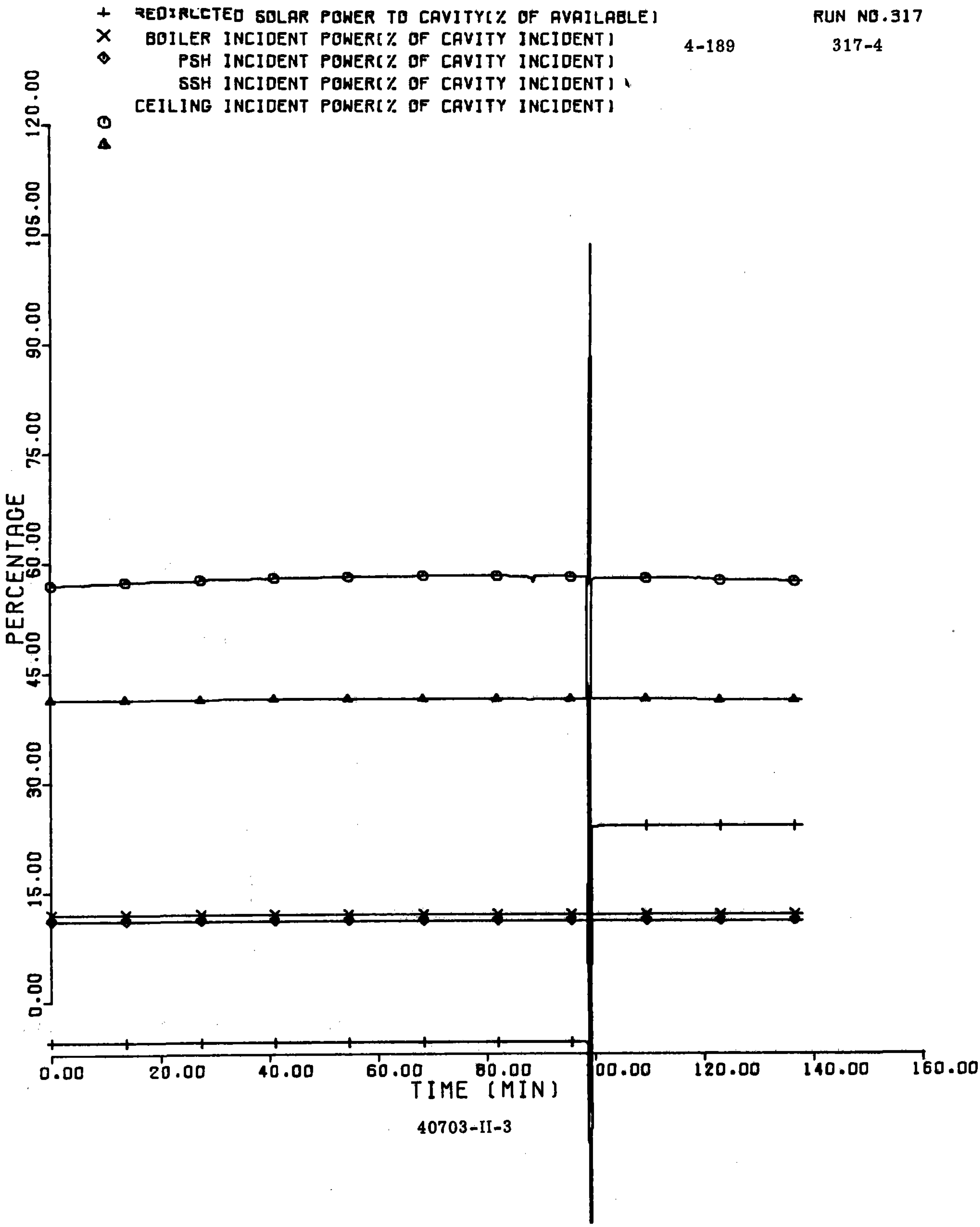
RUN NO.317

4-189

317-4



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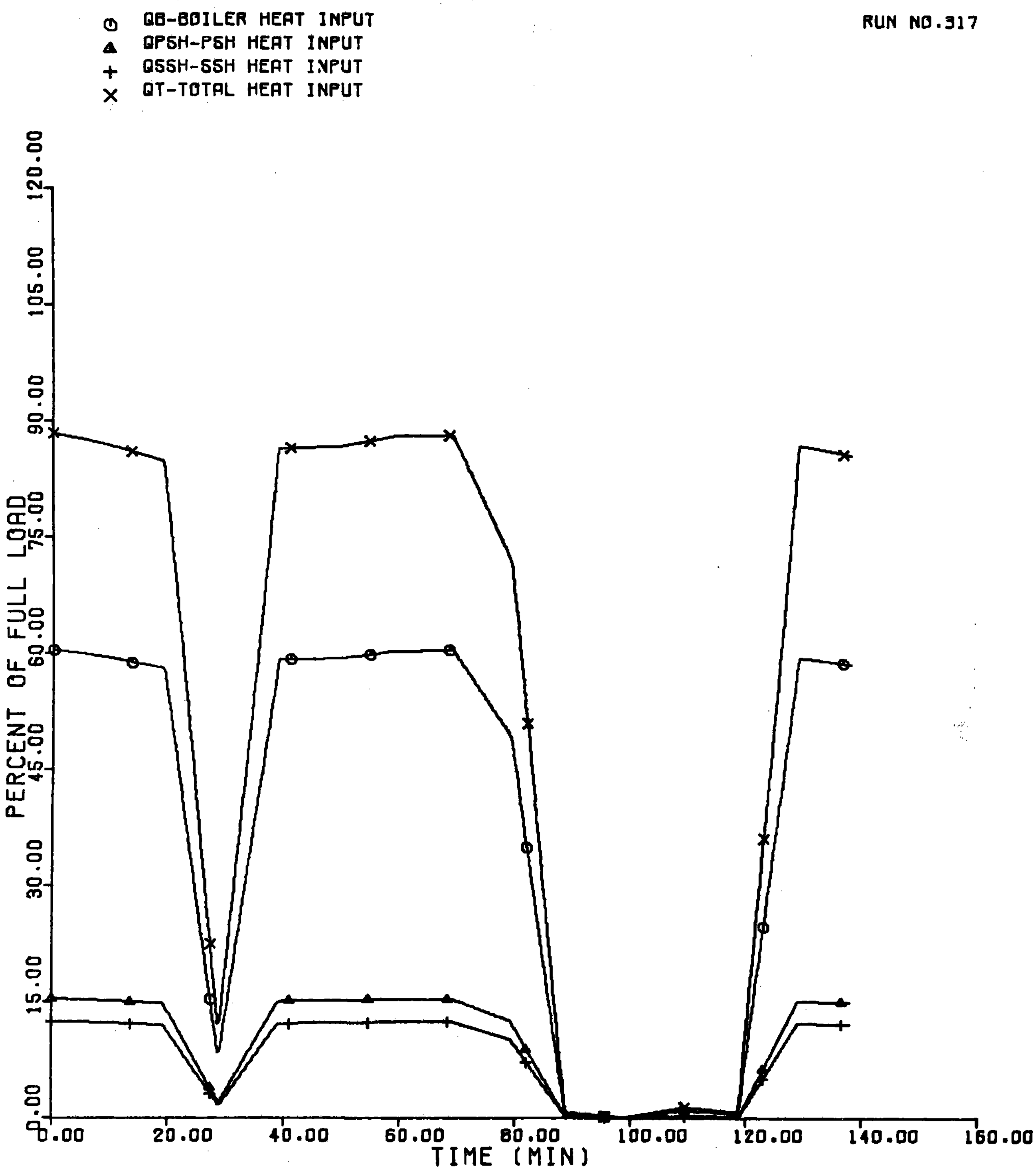
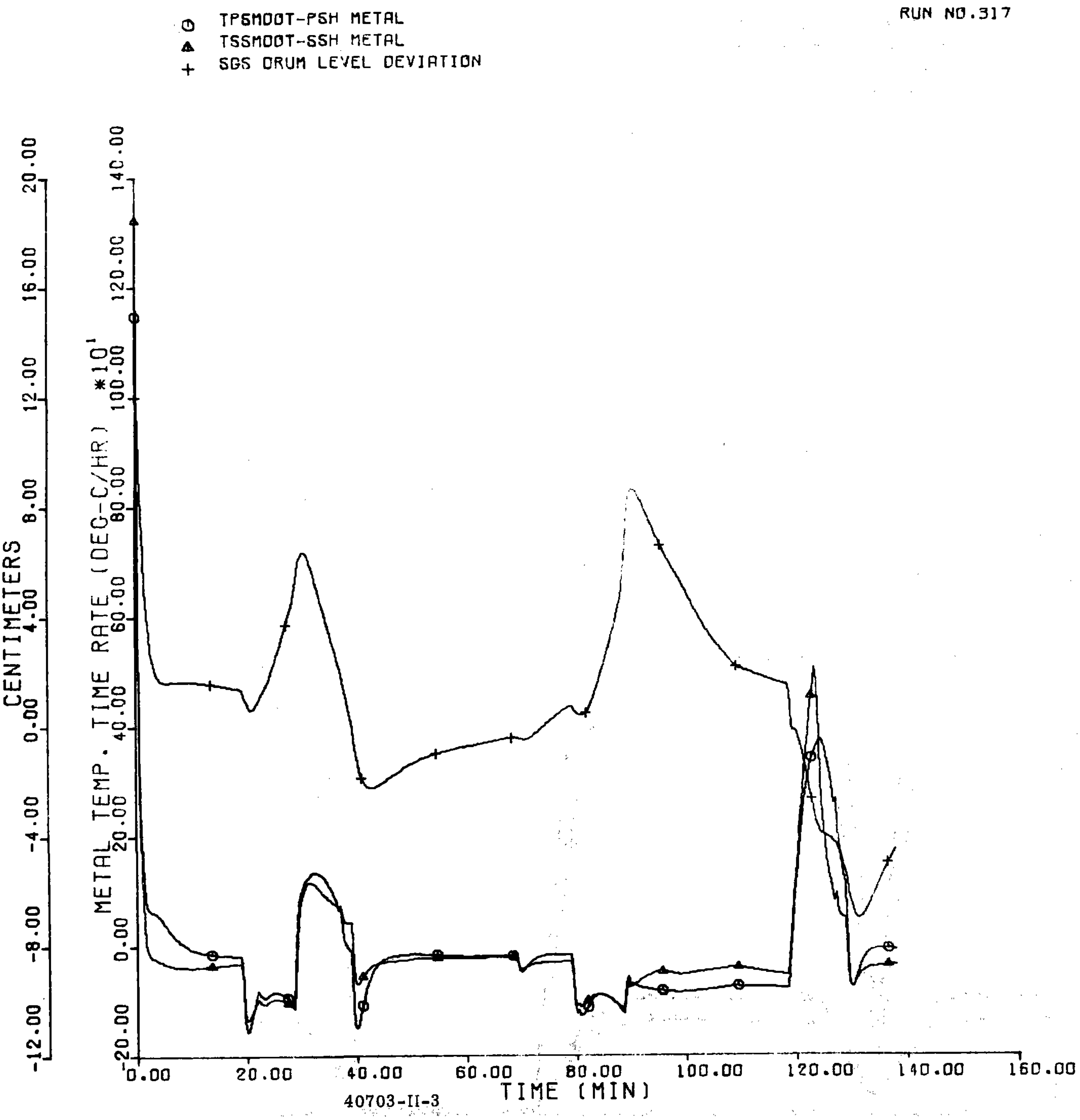
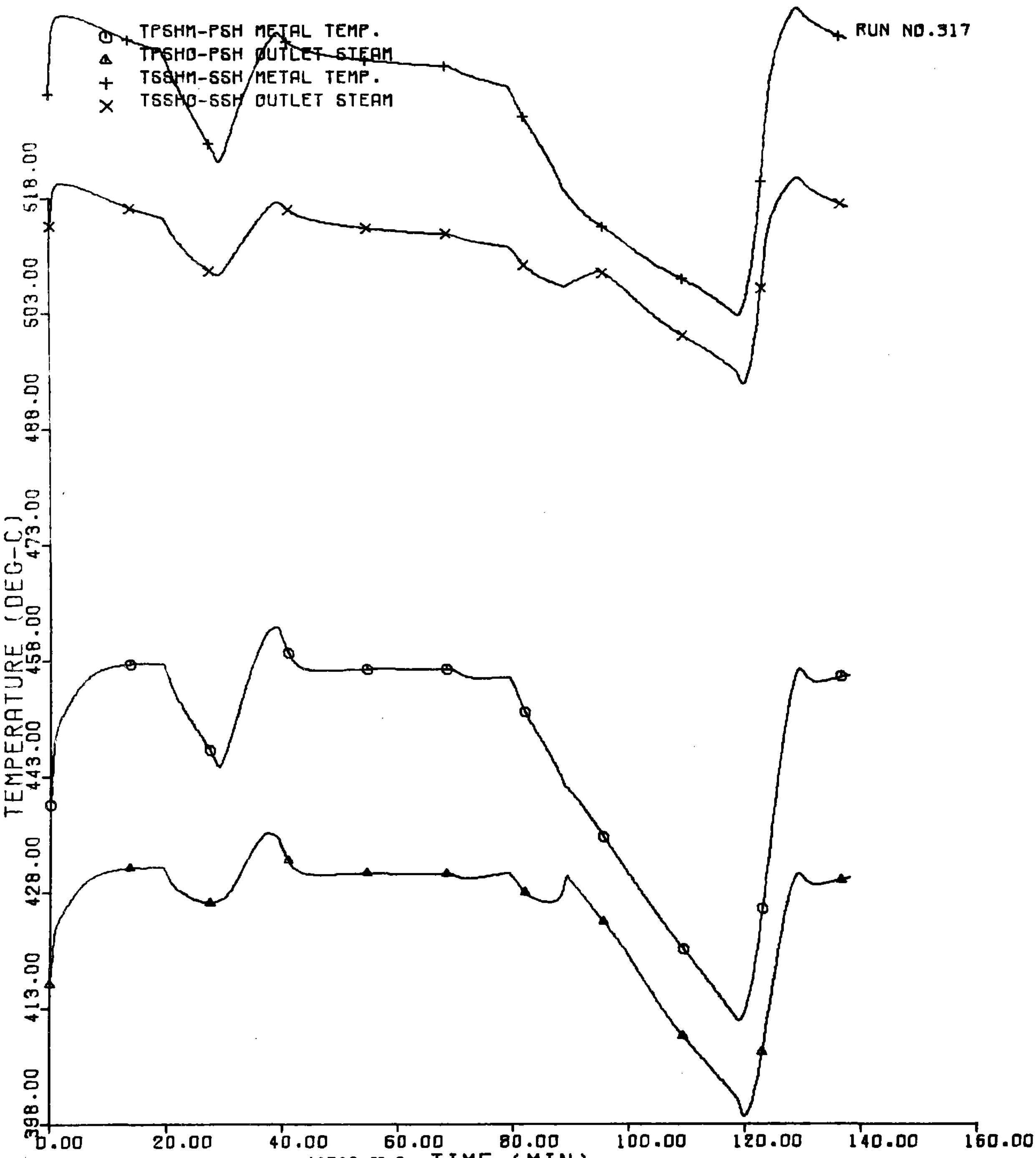

QB-BOILER HEAT INPUT
QPSH-PSH HEAT INPUT
QSSH-SSH HEAT INPUT
QT-TOTAL HEAT INPUT
RUN NO.317
PERCENT OF FULL LOAD
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

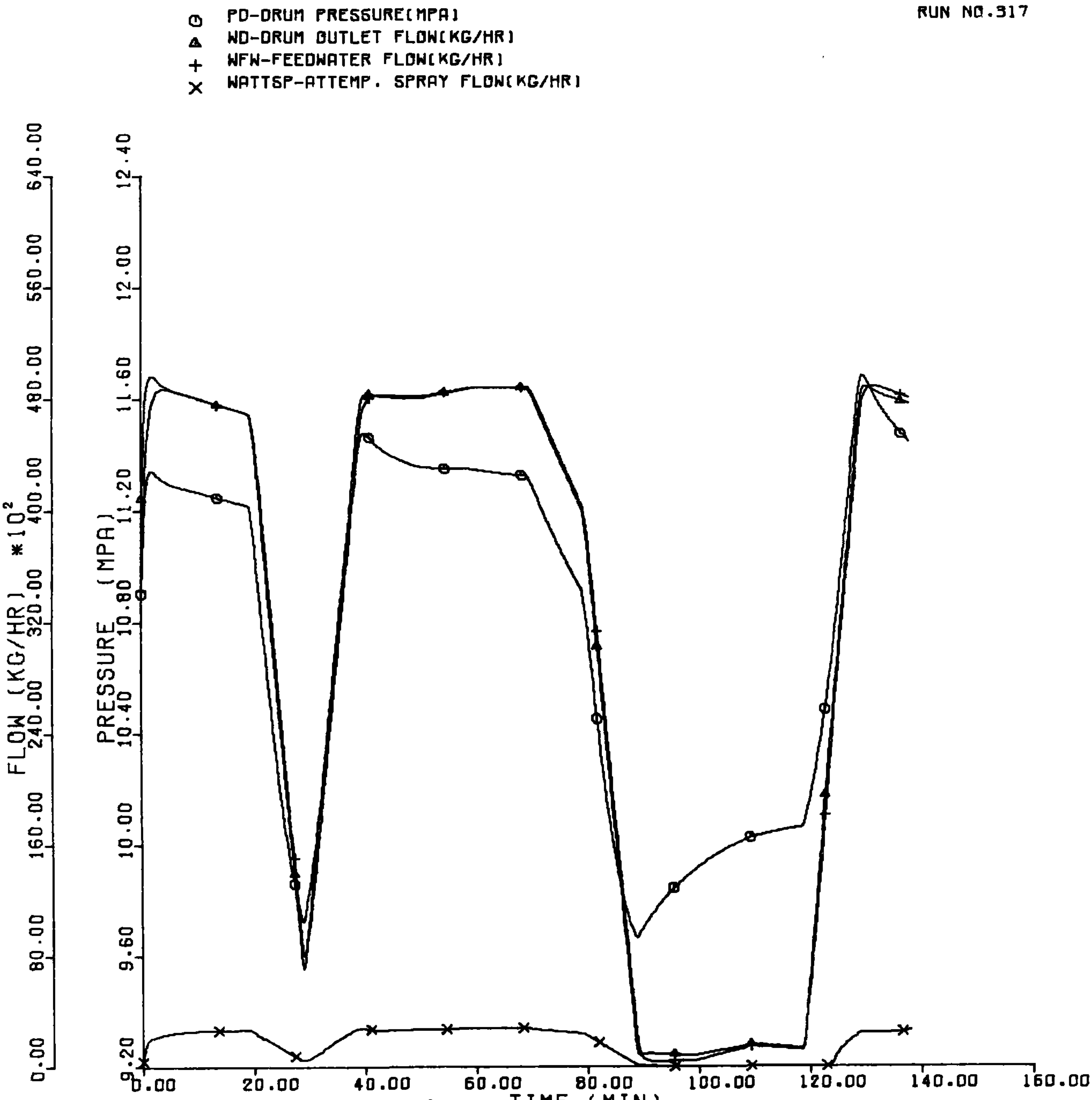
40703-II-3


RUN NO.317
TPSMOOT-PSH METAL
TSSMOOT-SSH METAL
SGS DRUM LEVEL DEVIATION
CENTIMETERS
METAL TEMP. TIME RATE (DEG-C/HR) *10[1]
TIME (MIN)
20.00
16.00
12.00
8.00
4.00
0.00
-4.00
-8.00
-12.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00

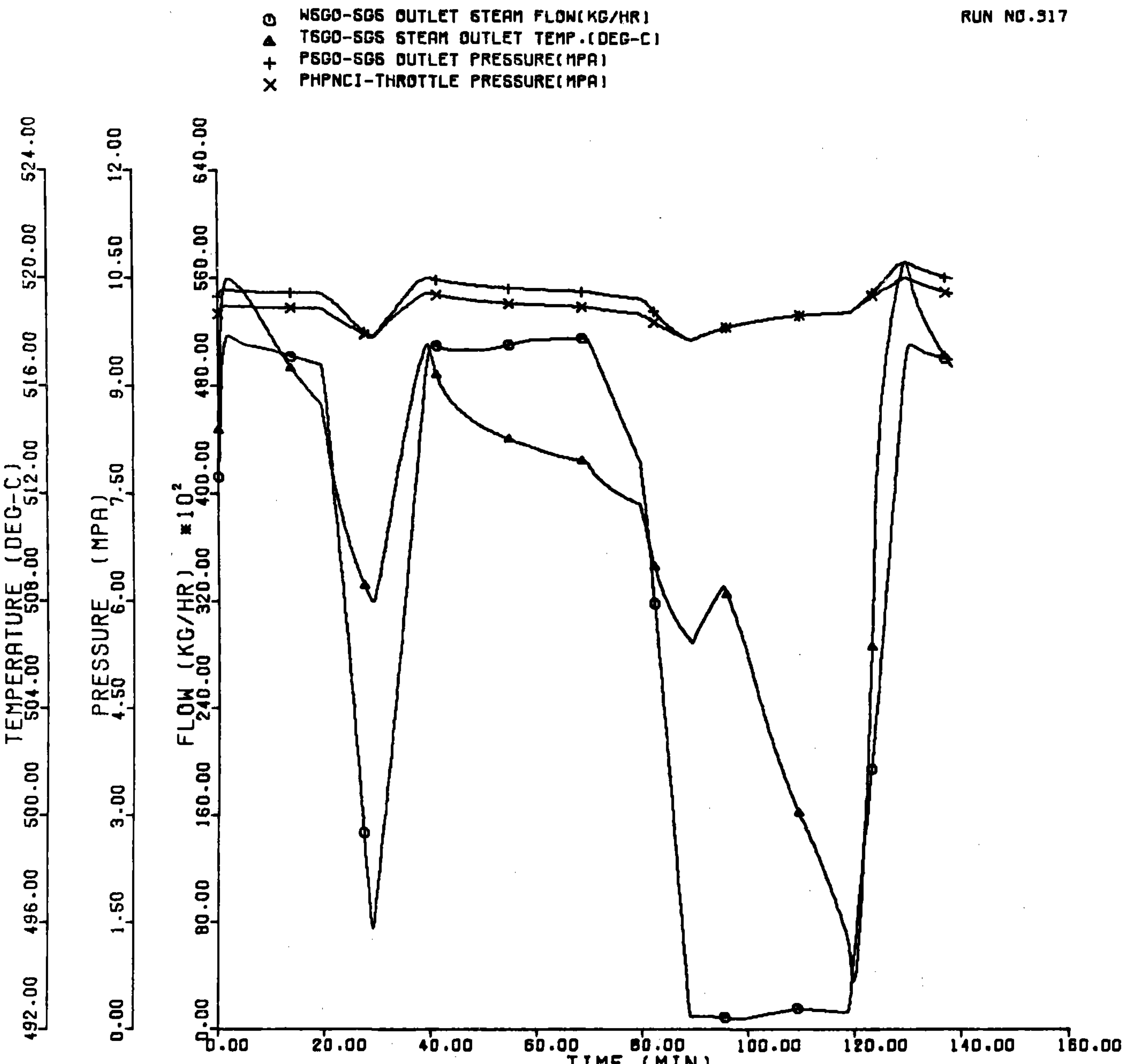
40703-II-3


TPSHM-PSH METAL TEMP.
TPSHO-PSH OUTLET STEAM
TSSHM-SSH METAL TEMP.
TSSHO-SSH OUTLET STEAM
RUN NO.317
TEMPERATURE (DEG-C)
518.00
503.00
488.00
473.00
458.00
443.00
428.00
413.00
398.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

40703-II-3

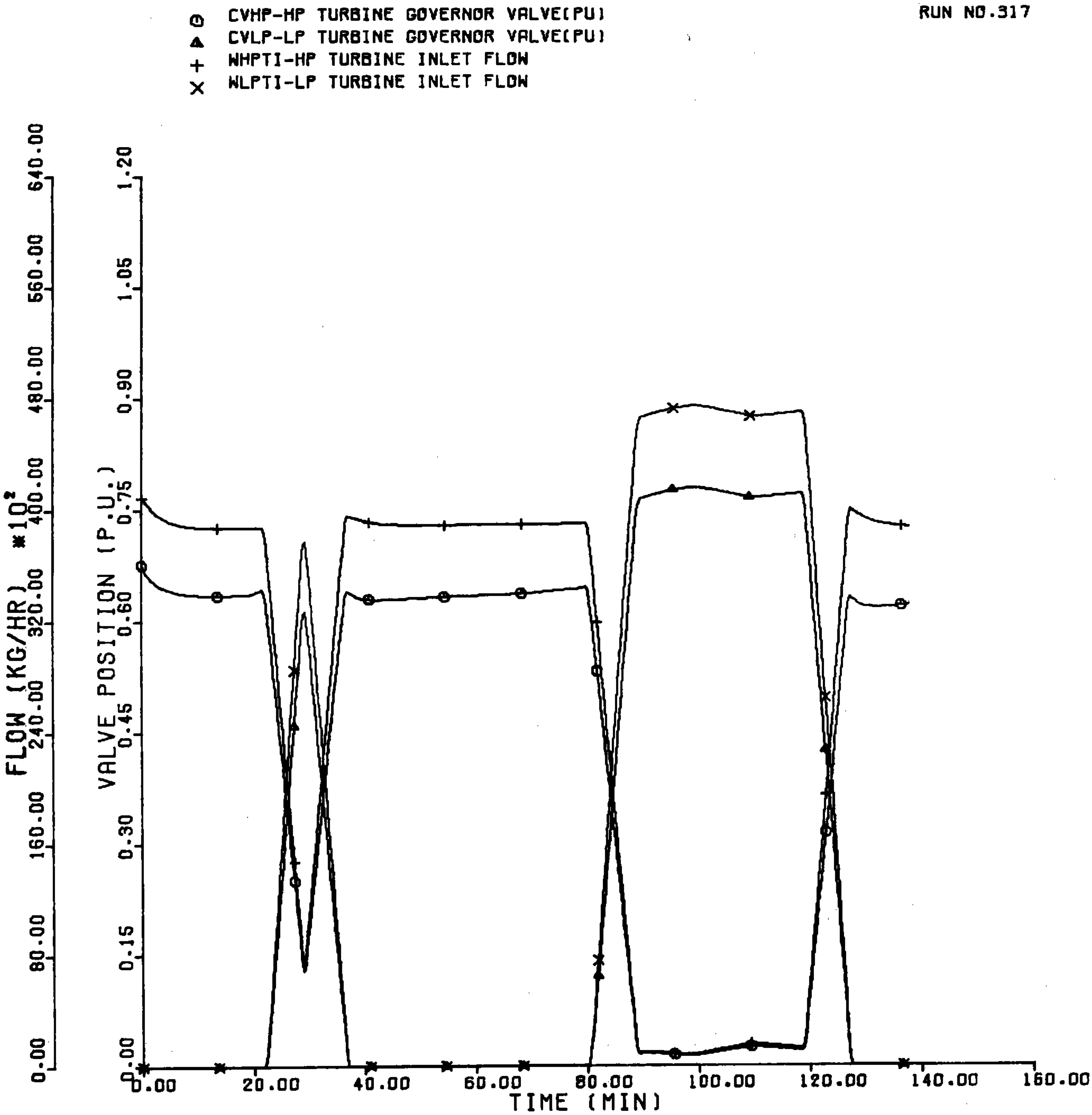

RUN NO.317
PD-DRUM PRESSURE(MPA)
WD-DRUM OUTLET FLOW(KG/HR)
WFW-FEEDWATER FLOW(KG/HR)
WATTSP-ATTEMP. SPRAY FLOW(KG/HR)
FLOW (KG/HR) *10²
PRESSURE (MPA)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
9.20
9.60
10.00
10.40
10.80
11.20
11.60
12.00
12.40
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

40703-II-3

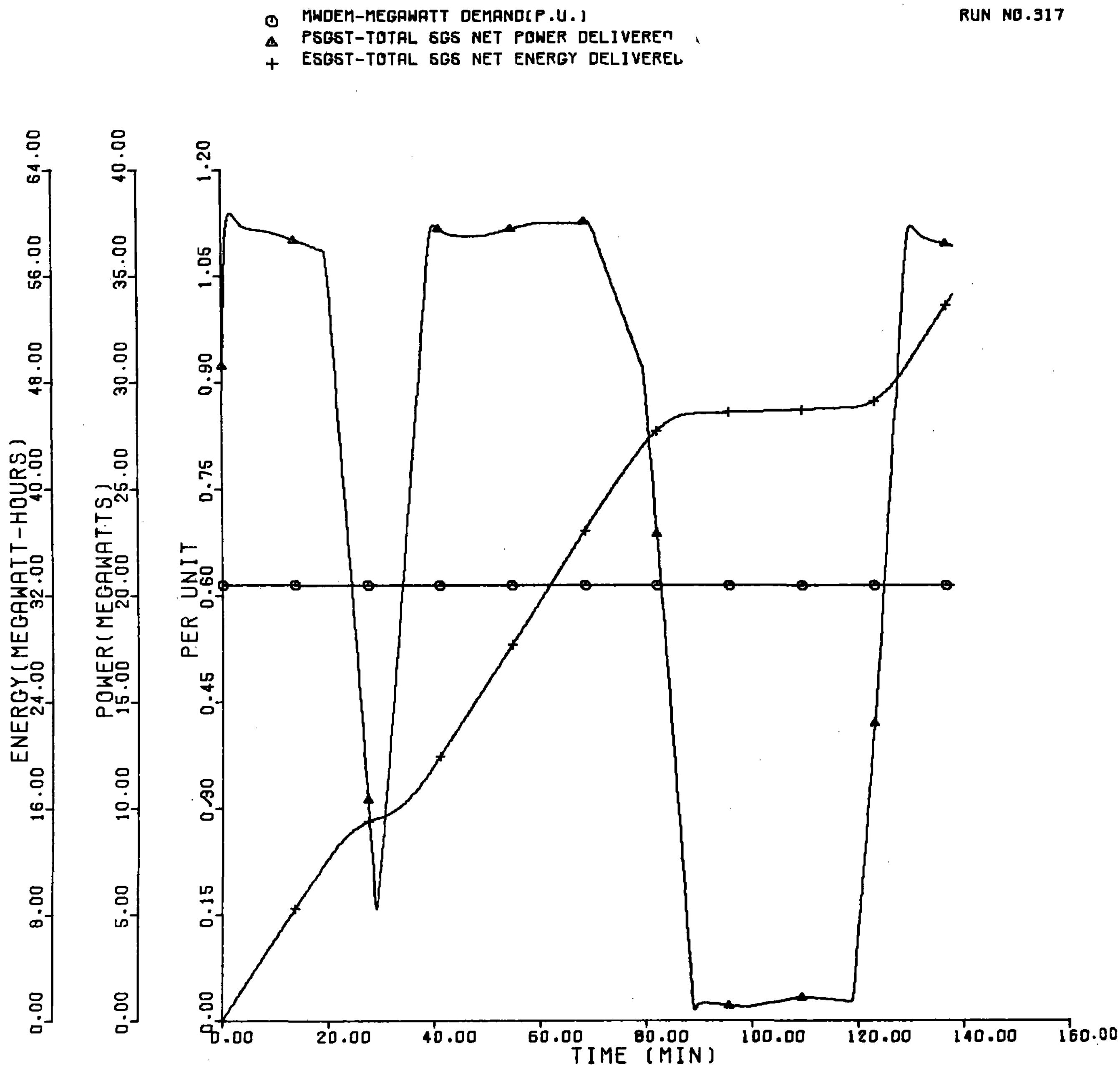


WSGO-SGS OUTLET STEAM FLOW(KG/HR)
TSGO-SGS STEAM OUTLET TEMP.(DEG-C)
PSGO-SGS OUTLET PRESSURE(MPA)
PHPNCI-THROTTLE PRESSURE(MPA)
RUN NO.317
TEMPERATURE (DEG-C)
492.00
496.00
500.00
504.00
508.00
512.00
516.00
520.00
524.00
PRESSURE (MPA)
0.00
1.50
3.00
4.50
6.00
7.50
9.00
10.50
12.00
FLOW (KG/HR) *10²
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

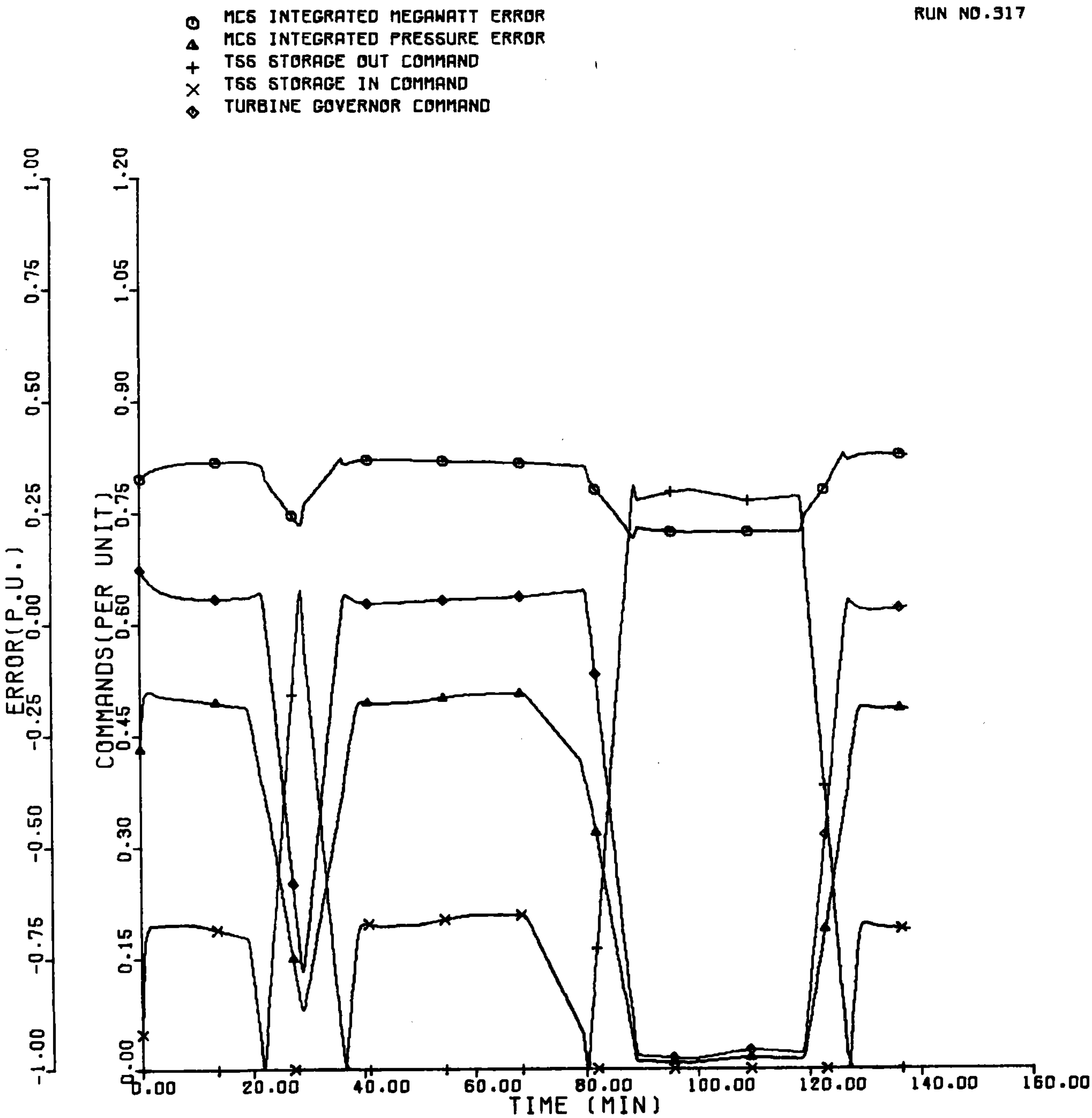
40703-II-3


RUN NO.317
CVHP-HP TURBINE GOVERNOR VALVE(PU)
CVLP-LP TURBINE GOVERNOR VALVE(PU)
WHPTI-HP TURBINE INLET FLOW
WLPTI-LP TURBINE INLET FLOW
FLOW (KG/HR) *10²
VALVE POSITION (P.U.)
0.00
80.00
160.00
240.00
320.00
400.00
480.00
560.00
640.00
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

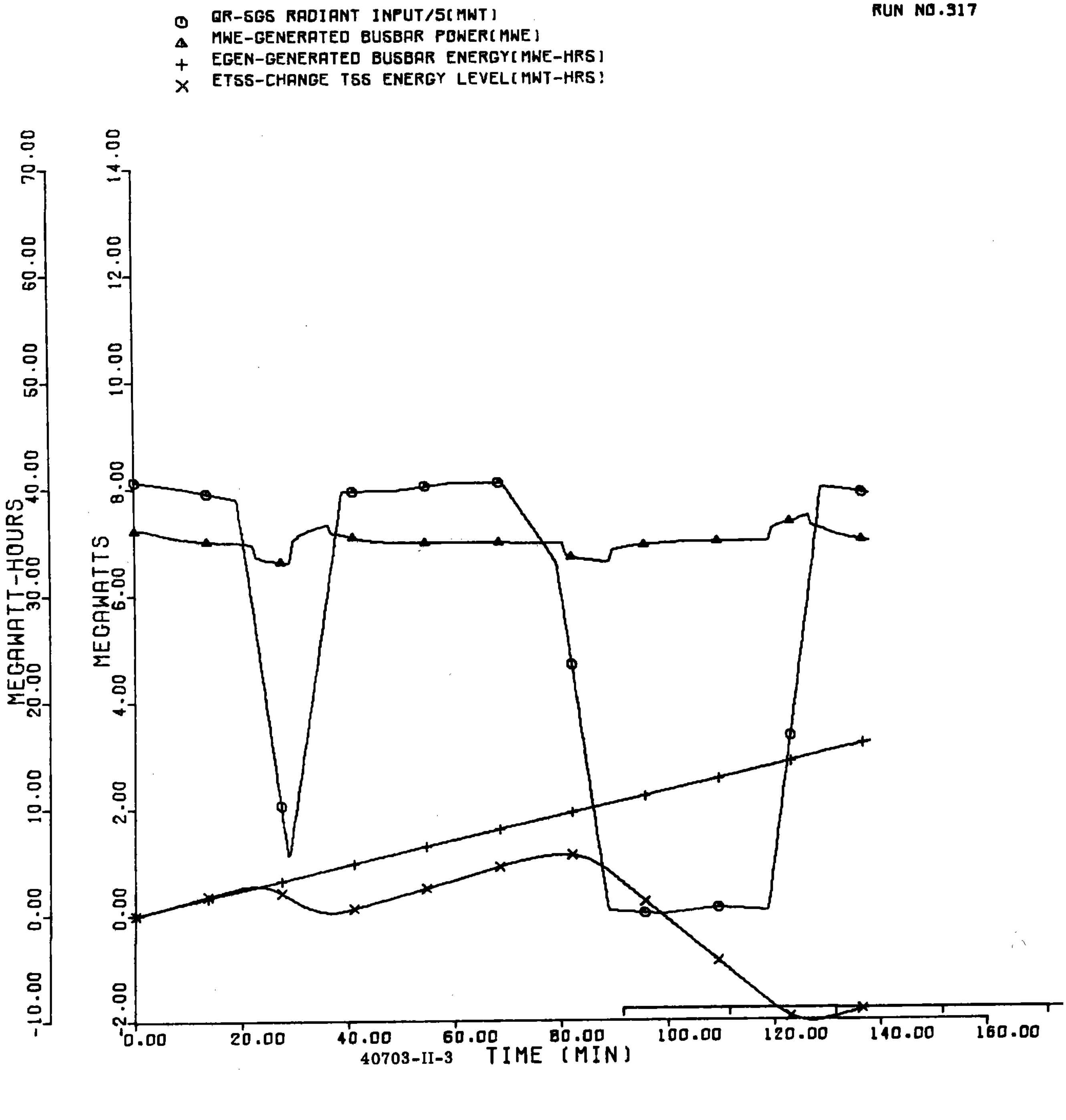
40703-II-3

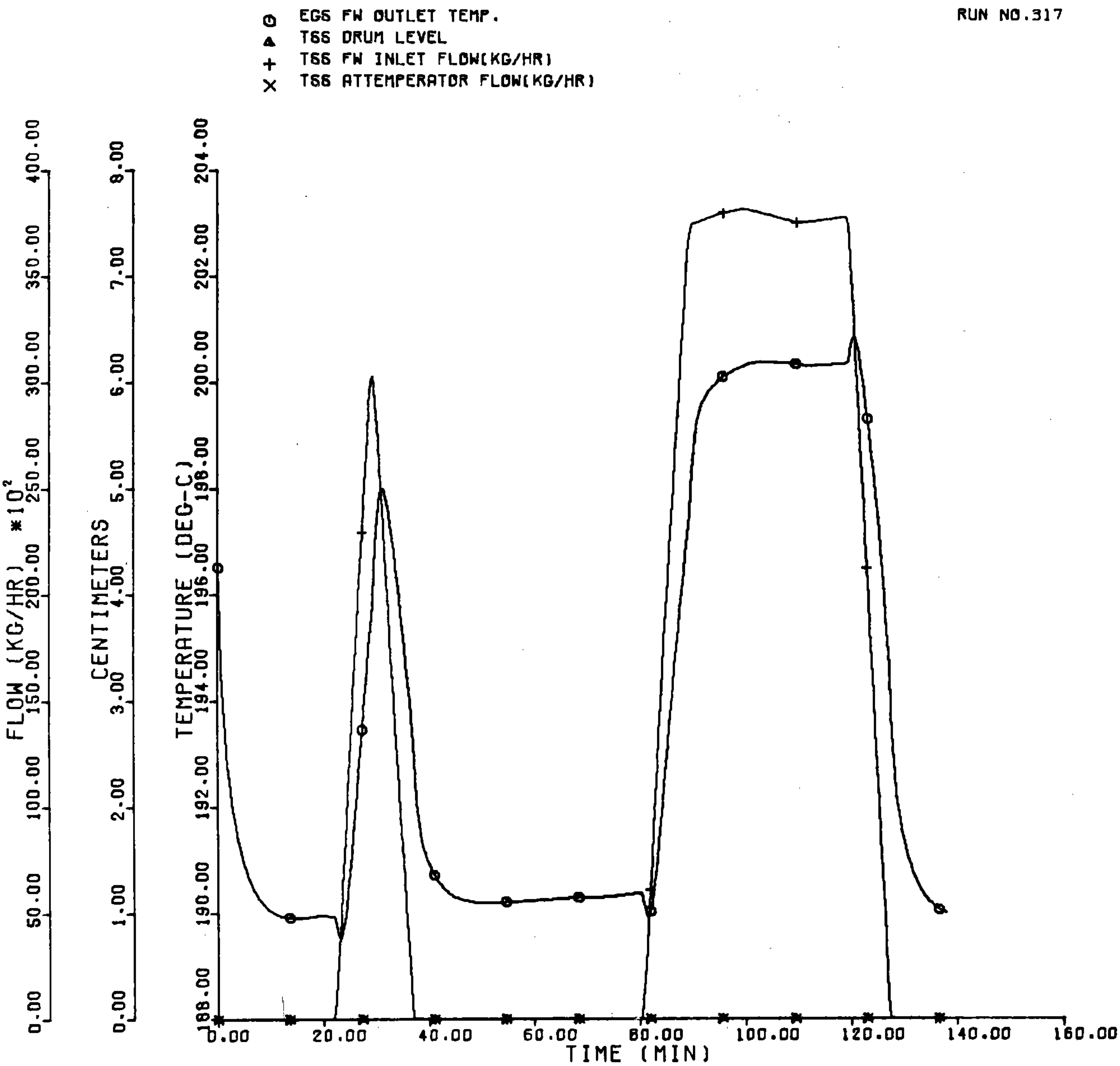

MWDEM-MEGAWATT DEMAND(P.U.)
PSGST-TOTAL SGS NET POWER DELIVERED
ESGST-TOTAL SGS NET ENERGY DELIVERED
RUN NO.317
ENERGY(MEGAWATT-HOURS)
POWER(MEGAWATTS)
PER UNIT
TIME (MIN)
0.00 20.00 40.00 60.00 80.00 100.00 120.00 140.00 160.00

40703-II-3


MCS INTEGRATED MEGAWATT ERROR
MCS INTEGRATED PRESSURE ERROR
TSS STORAGE OUT COMMAND
TSS STORAGE IN COMMAND
TURBINE GOVERNOR COMMAND
RUN NO.317
ERROR(P.U.)
COMMANDS(PER UNIT)
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
-0.75
-1.00
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

40703-II-3


RUN NO.317
QR-SGS RADIANT INPUT/5(MWT)
MWE-GENERATED BUSBAR POWER(MWE)
EGEN-GENERATED BUSBAR ENERGY(MWE-HRS)
ETSS-CHANGE TSS ENERGY LEVEL(MWT-HRS)
MEGAWATT-HOURS
MEGAWATTS
TIME (MIN)
40703-II-3


RUN NO.317
EGS FW OUTLET TEMP.
TSS DRUM LEVEL
TSS FW INLET FLOW(KG/HR)
TSS ATTEMPERATOR FLOW(KG/HR)
FLOW (KG/HR) *10²
CENTIMETERS
TEMPERATURE (DEG-C)
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
188.00
190.00
192.00
194.00
196.00
198.00
200.00
202.00
204.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
TIME (MIN)

40703-II-3

SECTION 5
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