

NUREG/IA-0120
EST-SIAN-22



International Agreement Report

Assessment of the Turbine Trip Transient in Cofrentes NPP with TRAC-BF1

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U.S. Nuclear Regulatory Commission
Washington, DC 20555

June 1993

Prepared as part of
The Agreement on Research Participation and Technical Exchange
under the International Thermal-Hydraulic Code Assessment
and Application Program (ICAP)

Published by
U.S. Nuclear Regulatory Commission

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F O R E W O R D

This report has been prepared by Hidroeléctrica Española in the framework of the ICAP-UNESA Project.

The report represents one of the application calculations submitted in fulfilment of the bilateral agreement for cooperation in thermalhydraulic activities between the Consejo de Seguridad Nuclear of Spain (CSN) and the United States Nuclear Regulatory Commission (USNRC) in the form of Spanish contribution to the International Code Assessment and Applications Program (ICAP) of the USNRC whose main purpose is the validation of the TRAC and RELAP system codes.

The Consejo de Seguridad Nuclear has promoted a coordinated Spanish Nuclear Industry effort (ICAP-SPAIN) aiming to satisfy the requirements of this agreement and to improve the quality of the technical support groups at the Spanish Utilities, Spanish Research Establishments, Regulatory Staff and Engineering Companies, for safety purposes.

This ICAP-SPAIN national program includes agreements between CSN and each of the following organizations:

- Unidad Eléctrica (UNESA)
- Unión Iberoamericana de Tecnología Eléctrica (UITESA)
- Empresa Nacional del Uranio (ENUSA)
- TECNATOM
- Empresarios Agrupados
- LOFT-ESPAÑA

The program is executed by 12 working groups and a generic code review group and is coordinated by the "Comité de Coordinación". This committee has approved the distribution of this document for ICAP purposes.

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EXECUTIVE SUMMARY.-

This report presents the results of the assessment of TRAC-BF1 (G1-J1) code with the model of C.N. Cofrentes for simulation of the transient originated by the manual trip of the main turbine.

C.N. Cofrentes is a General Electric designed BWR/6 plant, with a nominal core thermal power of 2894 Mwt, in commercial operation since 1985, owned and operated by Hidroelectrica Española S.A. The plant incorporates all the characteristics of BWR/6 reactors, with two turbine driven FW pumps

The objective of this assessment is to generate a Cofrentes model for TRAC-BF1 and compare code results with plant recorded data during the start-up test transient of "manual turbine trip" with the plant at 70% thermal power.

The model has been developed from plant drawings and documentation, and a documented and validated RETRAN model.

Principal characteristics of the model include a 4 rings-8 levels vessel, two recirculation loops and one representative steam line; control systems and trips were also modelled.

A reference/nominal steady state situation was then adjusted by connecting submodels of portions of the system (vessel, recirculation loops, steam lines) previously tuned to the desired conditions. In the same way separated models for each of the control systems (feedwater/level, recirculation, pressure) were developed.

The point kinetic option was selected for core neutronic feedback, as considered adequate enough for this kind of mild operational transients. Reactivity coefficients were obtained from perturbations on the 3D simulator, around the initial steady state situation.

The transient selected to be reproduced with TRAC-BF1 was the "MANUAL TURBINE TRIP" start-up test.

Simulation of this operational transient with TRAC-BF1 will contribute to the assessment of the performance of the code/model features related to dynamic level tracking, recirculation and jet pumps performance in normal operating conditions, and check models generated for the control systems

A 45 seconds transient was run, this time including all the important phenomena occurring in the system. The transient was initiated by the closure of the turbine stop valves, which originates the reactor trip and a rapid increase of the system pressure, further relieved by steam discharge to the main condenser through the bypass valves.

Some adjustment was made on the residual heat to be able to reproduce reactor pressure, taking into account that this test was performed in the early portion of first cycle.

Sensed level was the most critical plant variable to reproduce. Based on sensitivity analysis, volume and area fractions in the vessel model corresponding to the separator region, were tuned, as well as the pressure loss coefficient for the dryer, to get a better simulation of level behaviour

The rest of variables measured were accurately reproduced by the code.

As a result of this assessment a model of C.N. Cofrentes has been developed for TRAC-BF1 that fairly reproduces operational transient behaviour of the plant. A special purpose code was generated to obtain reactivity coefficients, as required by TRAC-BF1, from the 3D simulator.

1.- INTRODUCTION

Hidroelectrica Española (HE) joined ICAP as a member of the UNESA group in order to simulate two transients of C.N.Cofrentes with TRAC-BF1 code and compare simulation results with data recorded at the plant.

The code information package, including tape with source program of G1J1 version, was received and implemented on a SIEMENS 7590-F computer. Some adaptation was needed on the source received (CDC version) to make it compilable; test cases were run, with results slightly different to those provided as reference in some of them. Later, on August 1989, the IBM version, as converted by Pennsylvania State University, was released to HE representatives by INEL. Implementation of this version is currently in progress.

Due to the above mentioned problems, the model and cases described in this report were developed using the TRAC-BF1 G1J1 version implemented in a CONVEX computer owned by UITESA. This version has been vectorized using the proper option during the code compilation, achieving a reduction in the CPU time consumption of about 70%. The graphics option has been implemented for this computer and an interactive graphic system has been developed as a user friendly tool to plot output data

2.- PLANT DESCRIPTION

Cofrentes Nuclear Power Plant, owned and operated by Hidroeléctrica Española S.A., has a BWR/6 reactor (Mark III containment), designed by General Electric, with a rated thermal power of 2894 Mwt.

Located 50 Km from Valencia (Spain), Cofrentes commercial operation started in 1985 and is presently running its sixth cycle.

Design features of the Nuclear Steam Supply System (NSSS) include two loop recirculation system, driven by two centrifugal pumps, feeding a total of 20 jet pumps, with a flow control valve in each loop. Feed-water is supplied by two turbine-driven pumps. Four main steam lines supply the main turbine with the steam generated in the reactor, each line equipped with isolation valves (MSIV), safety/relief valves (SRV) and turbine stop and control valves (TSV and TCV). Six bypass valves blowdown steam to the condenser from a common header connected to the four steam lines, with a nominal capacity of 35% rated steam flow.

The core consists of 624 fuel elements (8x8) with an active length of 150 in. and 145 control rods. Core power is monitored by 33 vertical strings, each holding 4 Local Power Range Monitors (LPRM), arranged in a uniform pattern throughout the core, these sensors are ion chambers which measure local neutron flux. Four Average Power Range Monitors (APRM) measure bulk power, each one averaging 24 LPRM signals. APRM are calibrated based on a reactor thermal balance.

NSSS instrumentation of interest for the transients analyzed in this report and related to the Control systems and Reactor Protection System (RPS) are briefly described: Dp transducers are used to measure flow in the recirculation, steam and feedwater lines; water level in the vessel downcomer is also measured by a Dp transducer, pressure signals are available from sensors located in the steam dome and in the averaging manifold in steam lines at the entrance of TSV's

During start-up tests a special program for collecting plant signals was carried out. Prior to each significant transient test, a set of signals considered relevant for later analysis and simulation of the transient was defined. The Emergency Response and Information System (ERIS) was used as Data Acquisition System for sampling and recording selected signals.

3.- TEST DESCRIPTION.-

This transient, identified as Start-up test PPN-27/2B, was carried out on December 1984 with the plant operating at 71% thermal power and 94.5% core flow

The transient was initiated by manual trip of the main turbine, i.e.: closure of stop valves; signal from position switches on this valves produces reactor scram and recirculation pumps transfer to low speed (25% of nominal).

Pressure increase, due to the fast turbine valves closure, is sensed by the pressure control system and bypass valves are opened discharging steam to the condenser. None of the relief valves did open as their setpoints were not reached

When steam flow through the main lines reduces below 35% a low steam flow signal is generated which trips one of the two feedwater pumps.

Core void content is reduced, due to initial pressurization, and level drops reaching low level alarm (L4), then the Recirculation runback logic is activated and flow control valve closes to 26% open position. Feedwater control system speed-up the remaining pump which is later lost due to the shutoff of steam to the pump turbine.

Figures 3.1 to 3.12 present plots of measured variables for the 40 seconds of interest, including 2 seconds previous to the initiation of the transient.

MEASURED POWER (APRM)

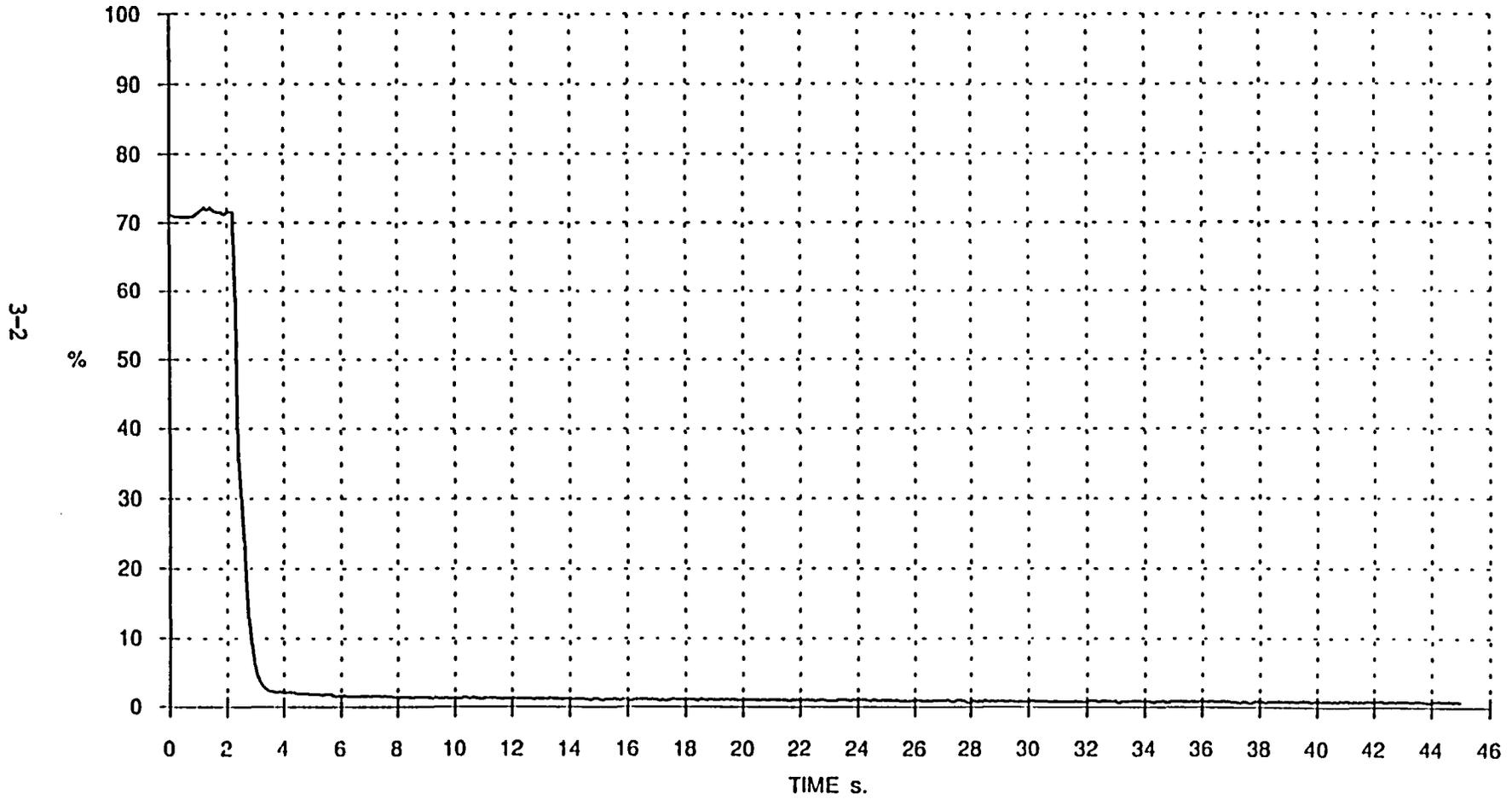


FIGURE 3.1

MEASURED DOME PRESURE

3-3

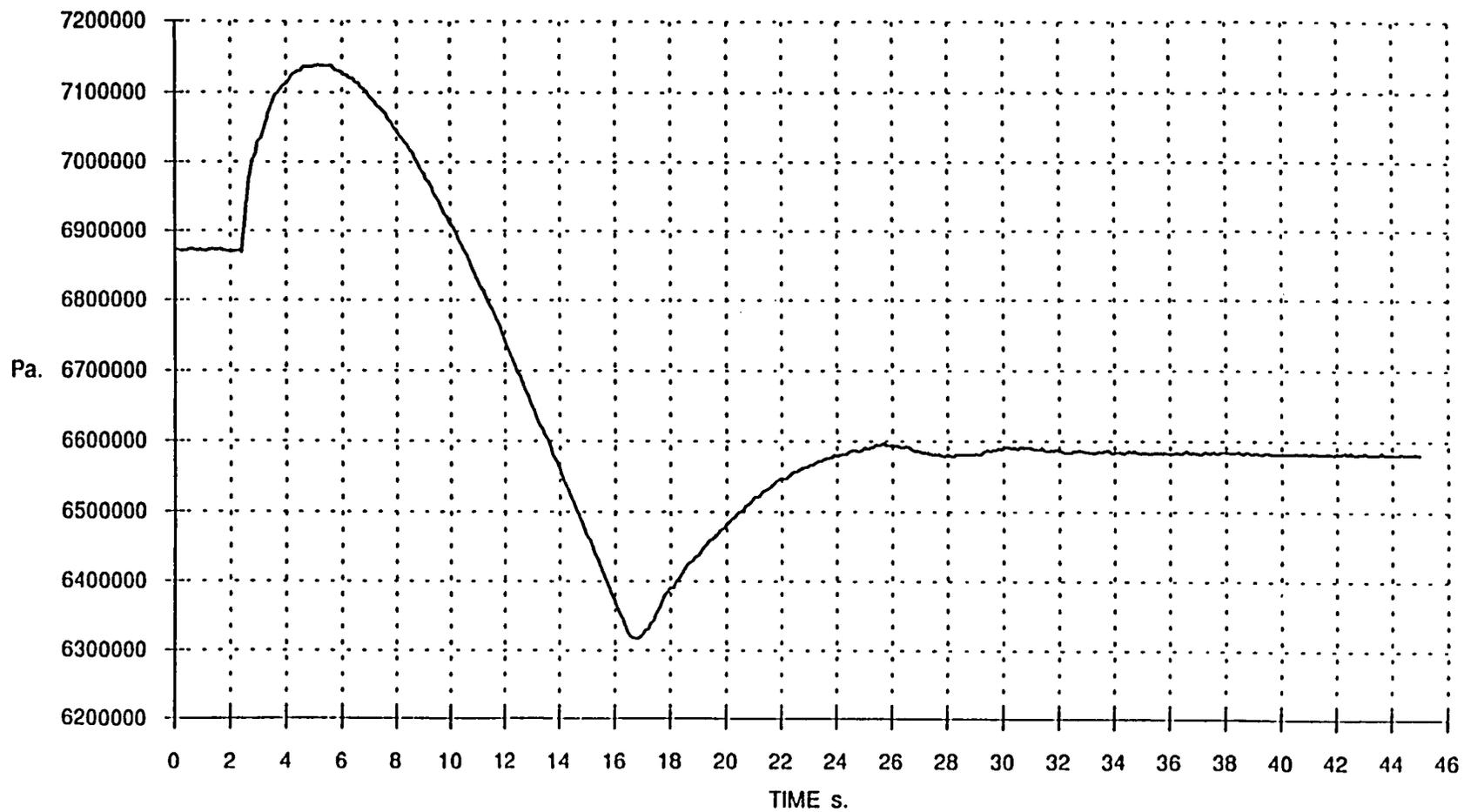


FIGURE 3.2

MEASURED PRESSURE AT STEAM COLECTOR

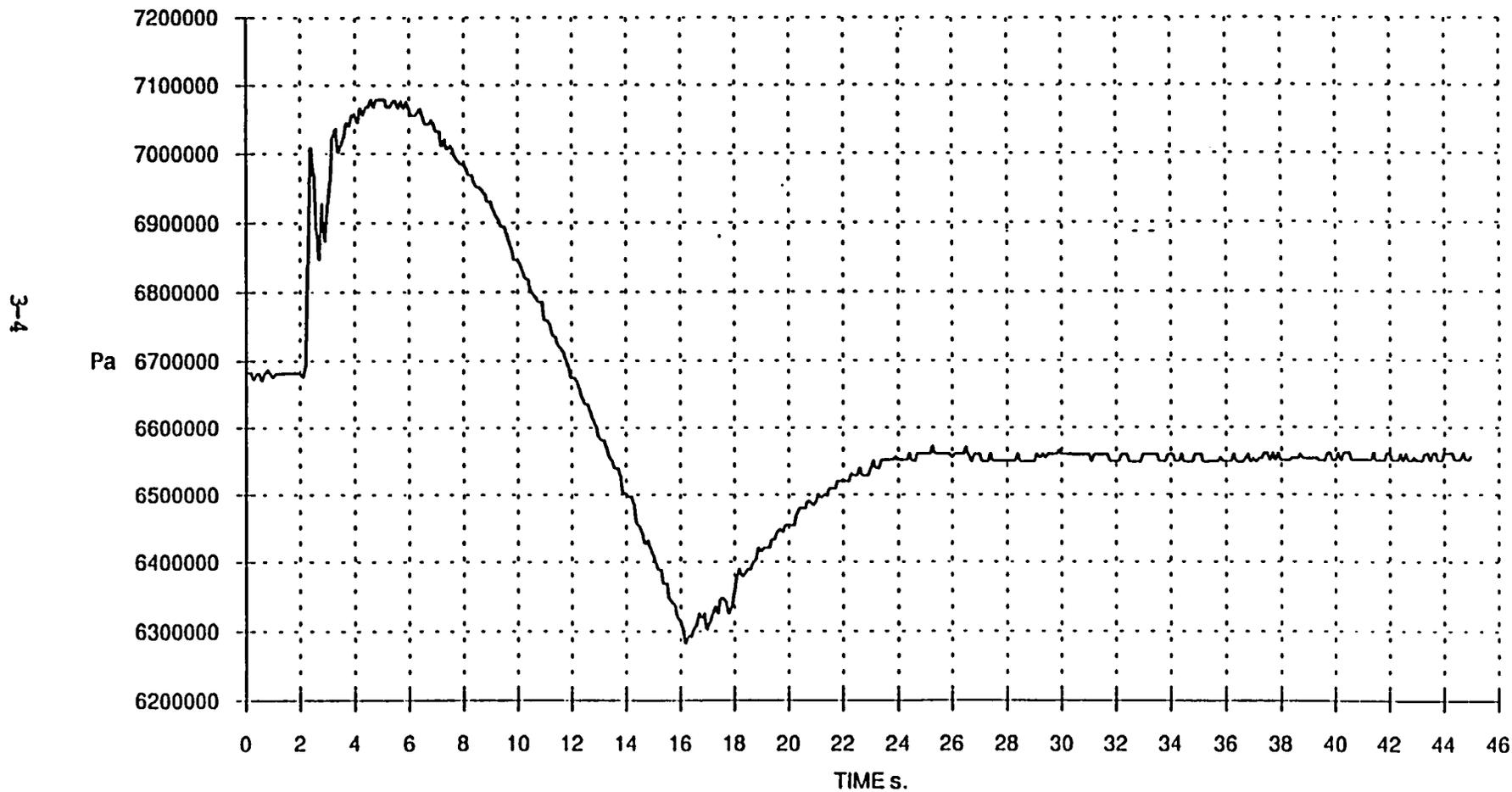
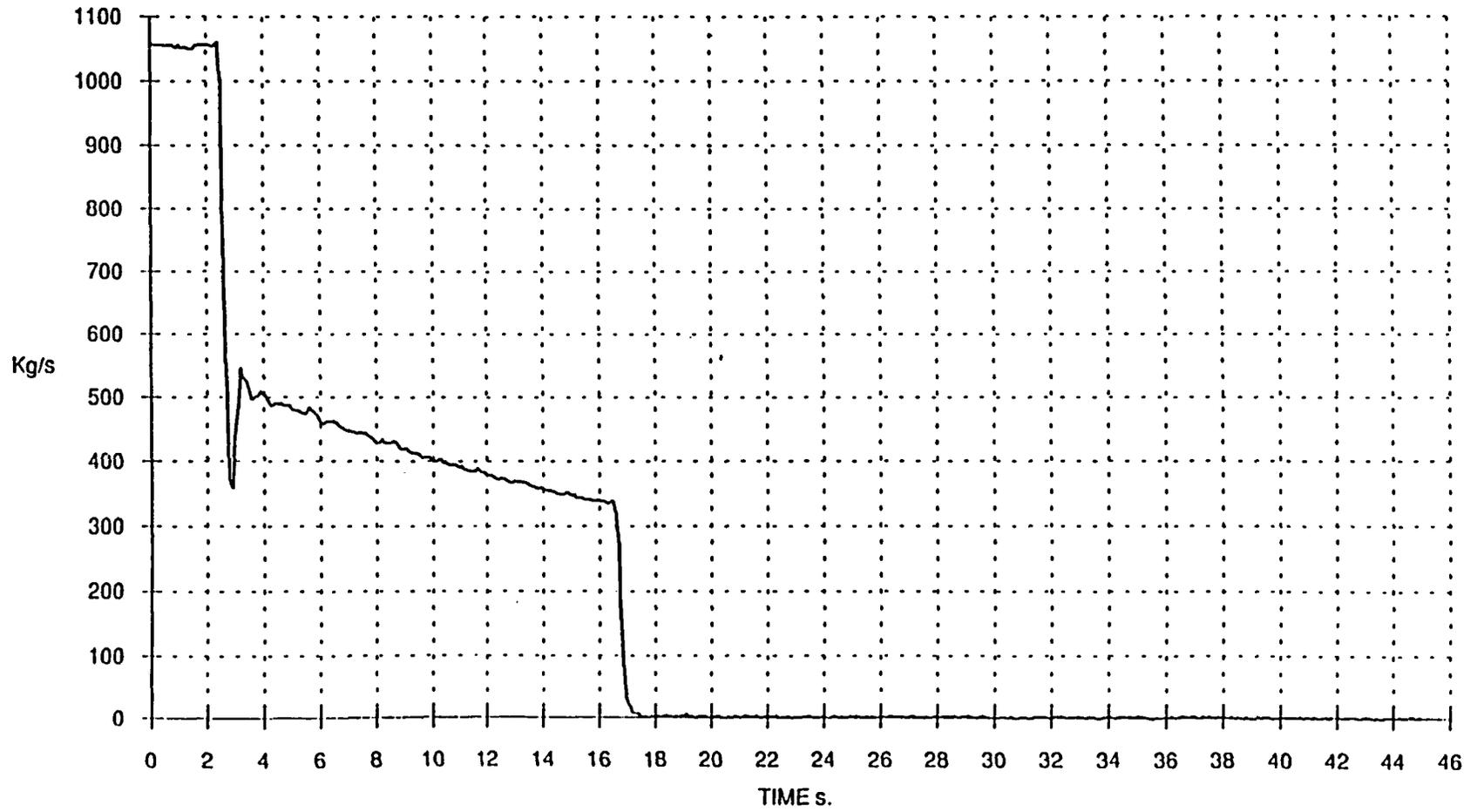


FIGURE 3.3

MEASURED STEAM FLOW



3-5

FIGURE 3.4

MEASURED WATER LEVEL

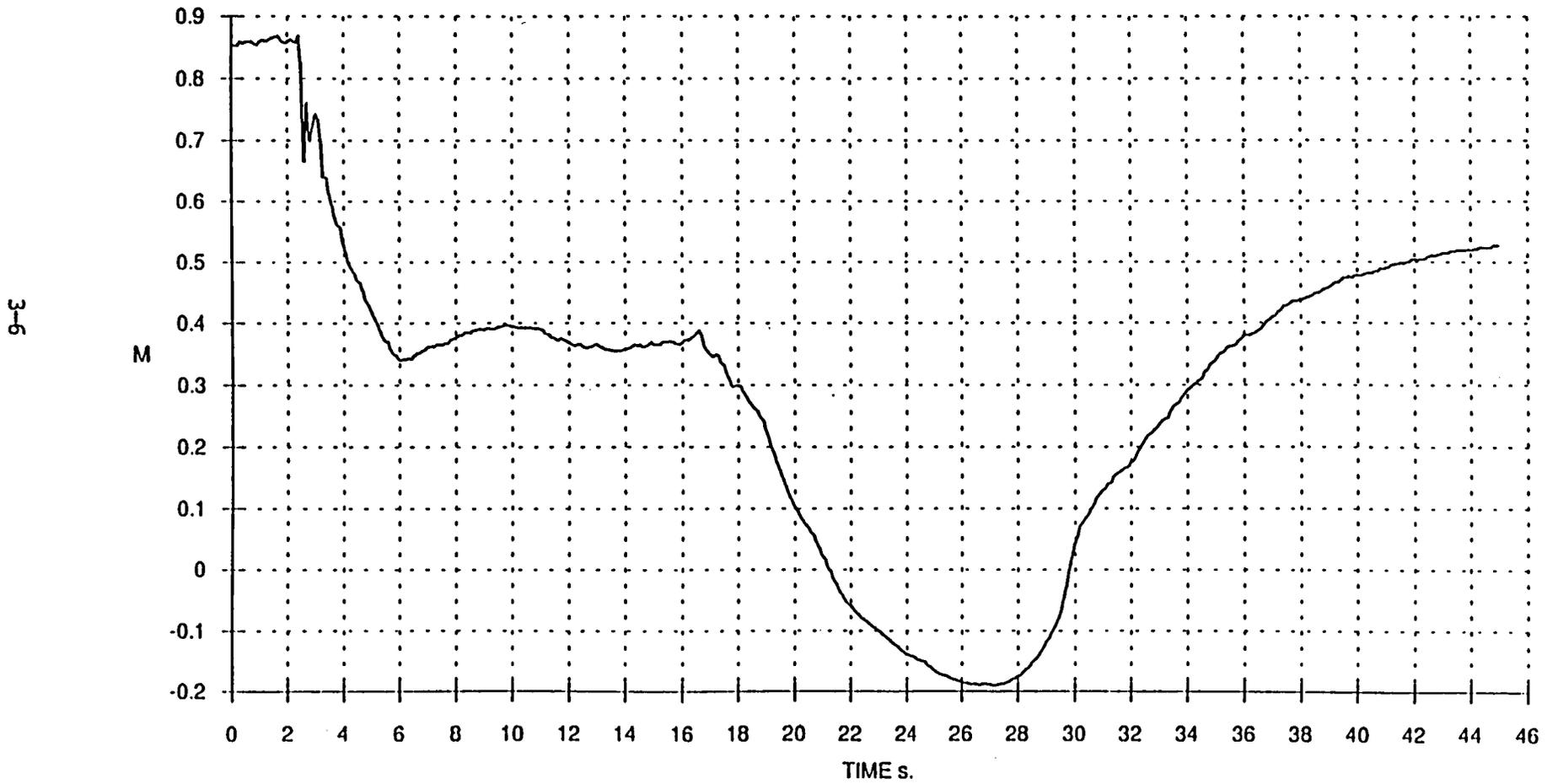


FIGURE 3.5

MEASURED WATER FLOW

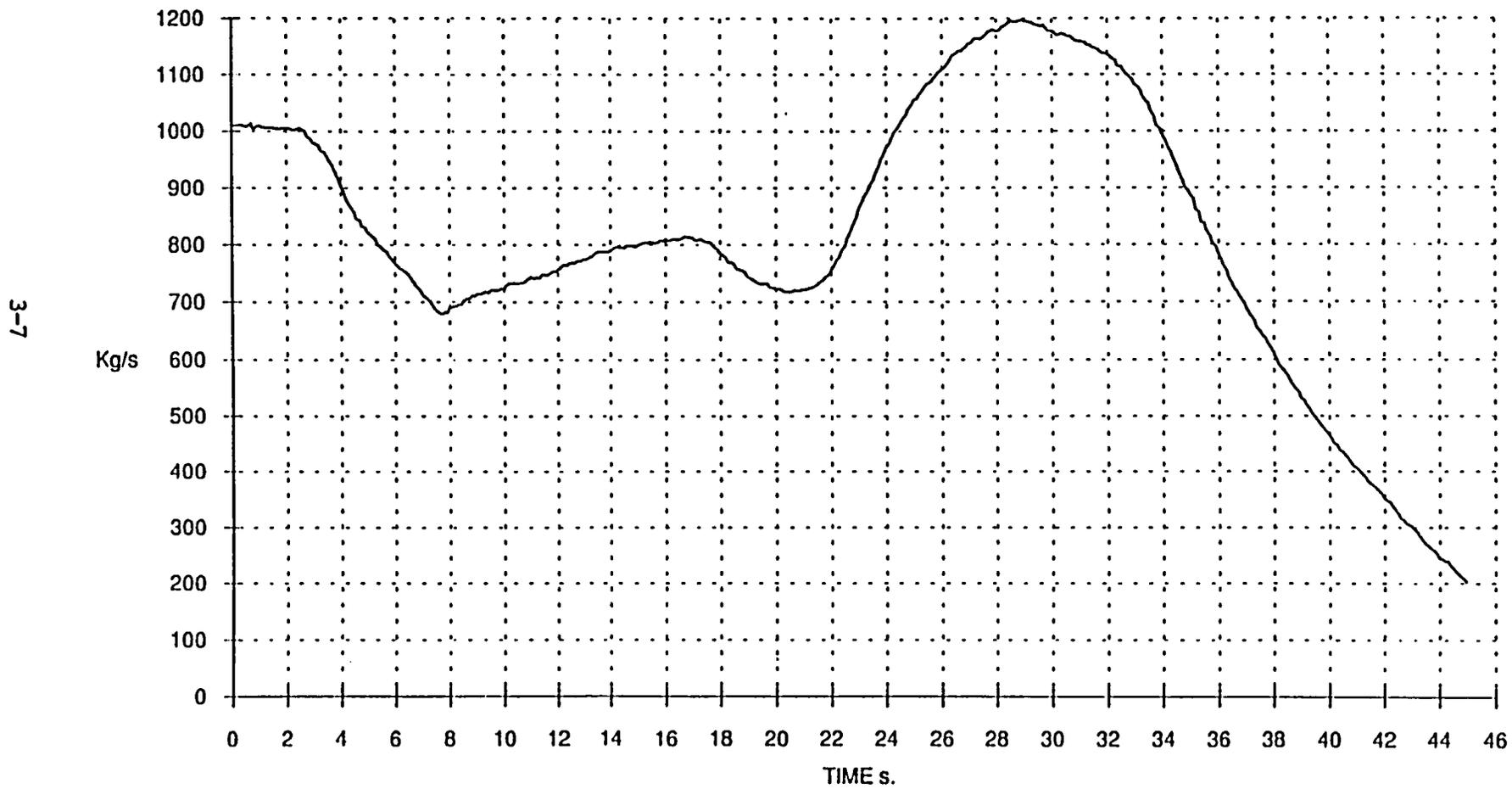


FIGURE 3.6

MEASURED CORE FLOW (1/2)

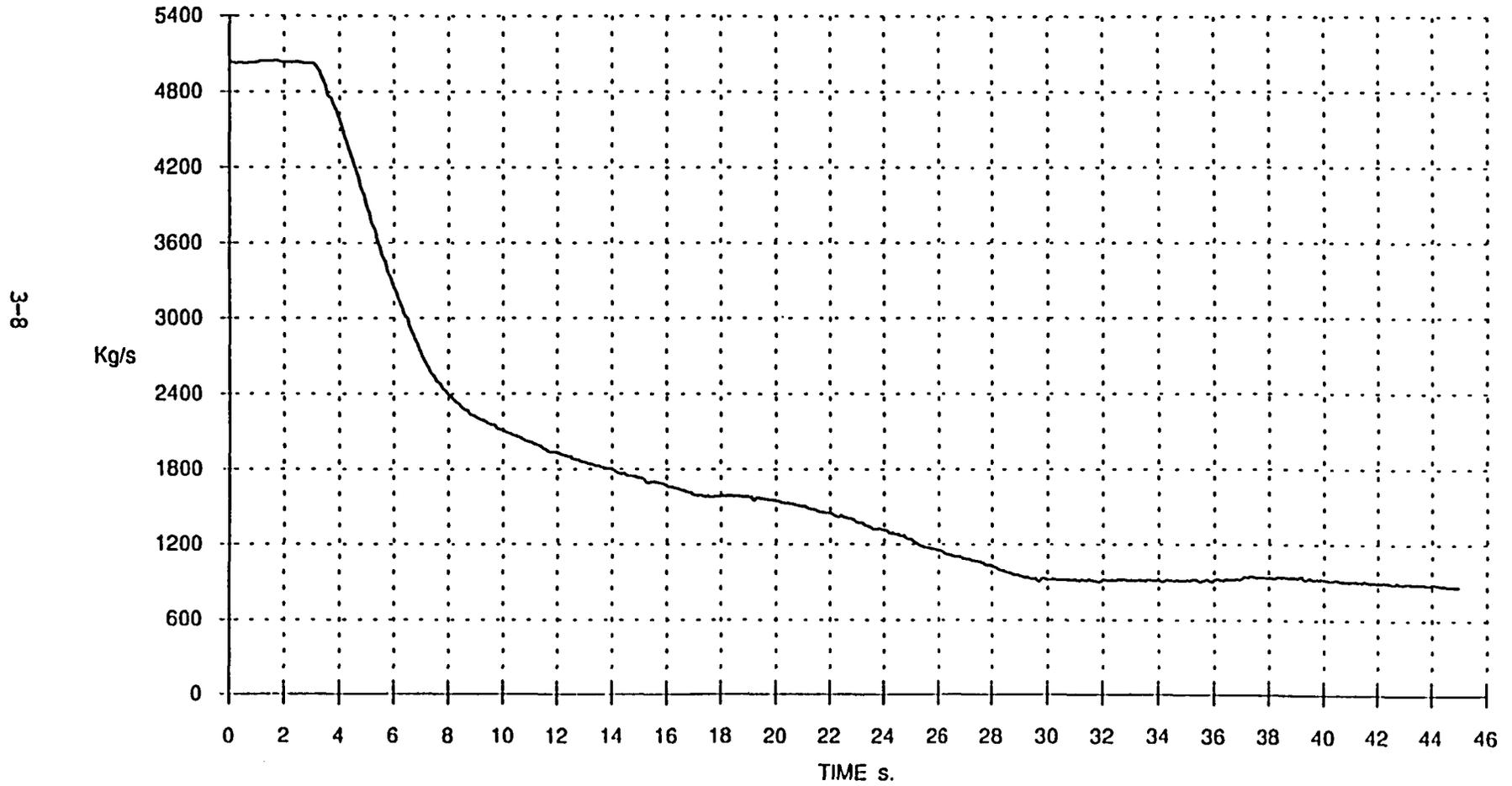


FIGURE 3.7

MEASURED RECIRCULATION FLOW (1 LOOP)

3-9

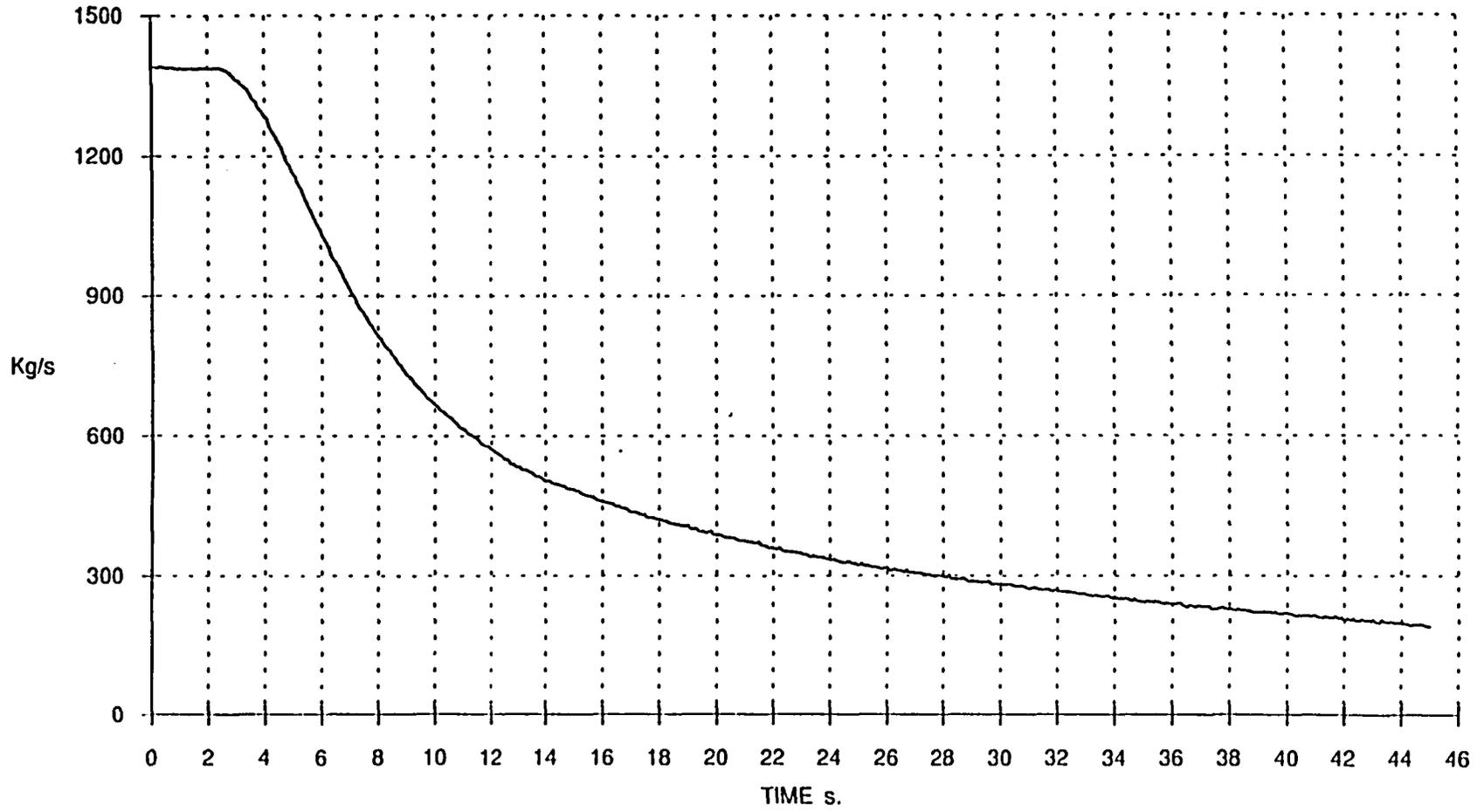


FIGURE 3.8

MEASURED RECIRCULATION PUMP SPEED

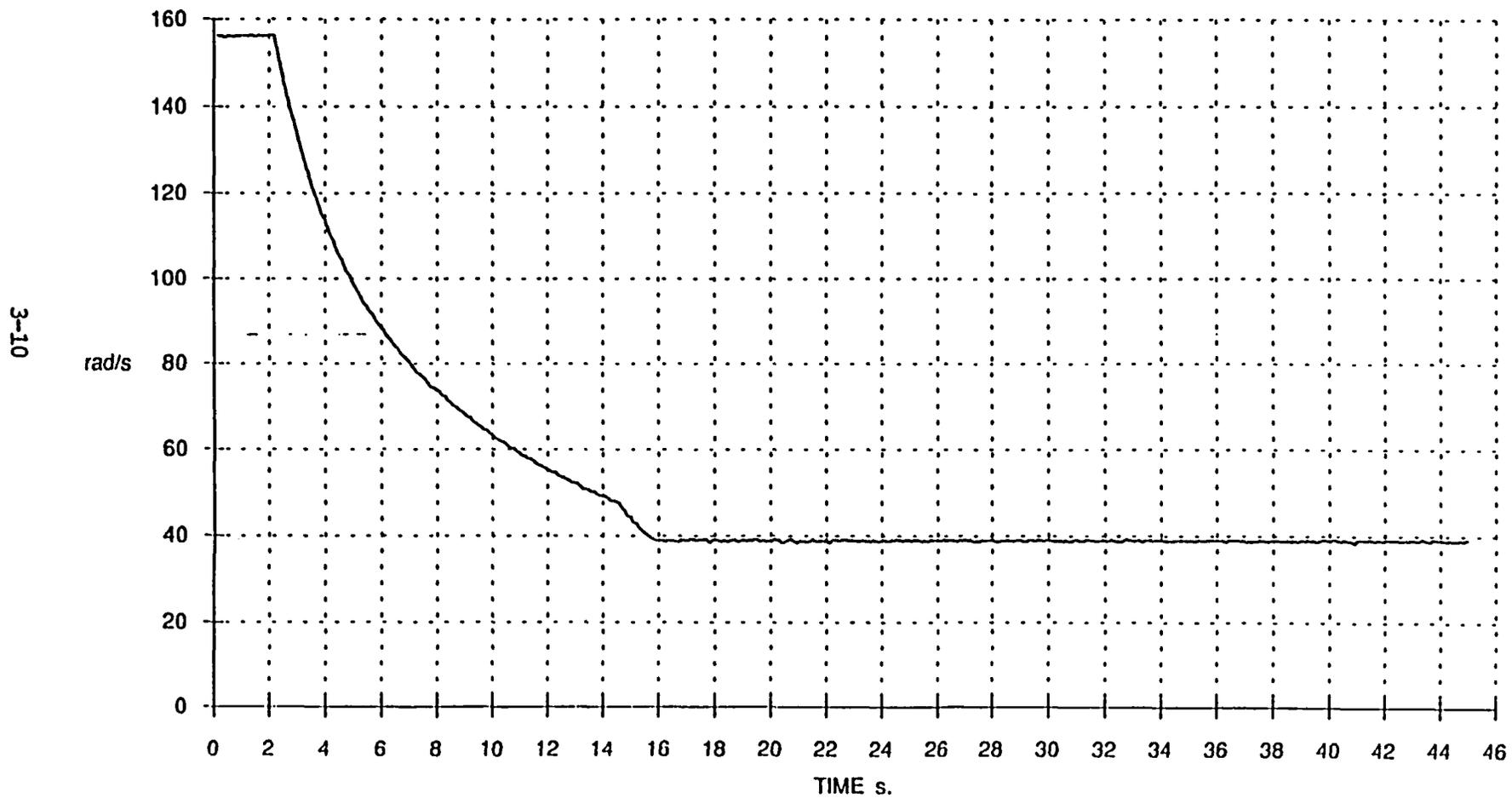


FIGURE 3.9

MEASURED BYPASS VALVE POSITION

3-11

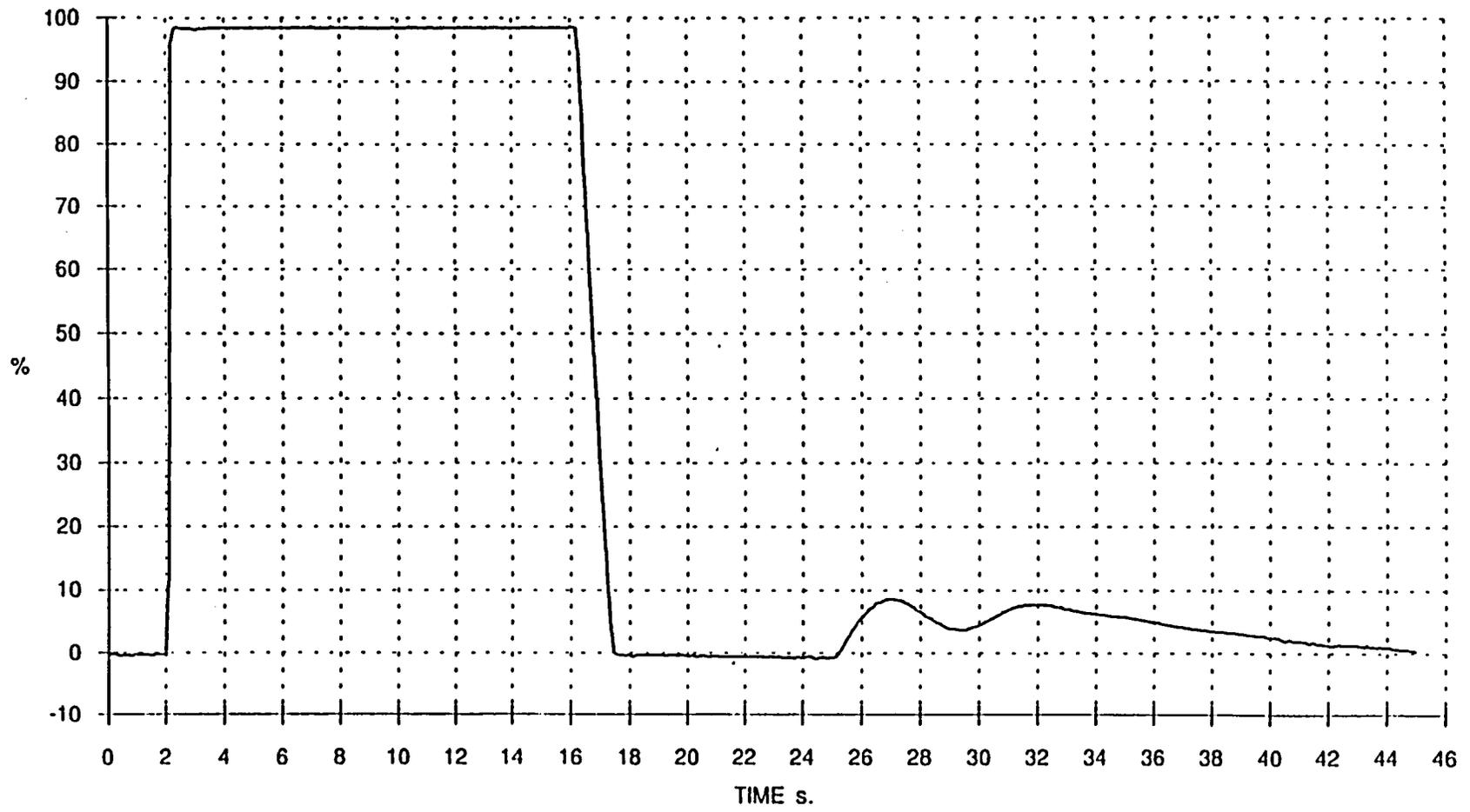


FIGURE 3.10

MEASURED RECIRCULATION FCV POSITION

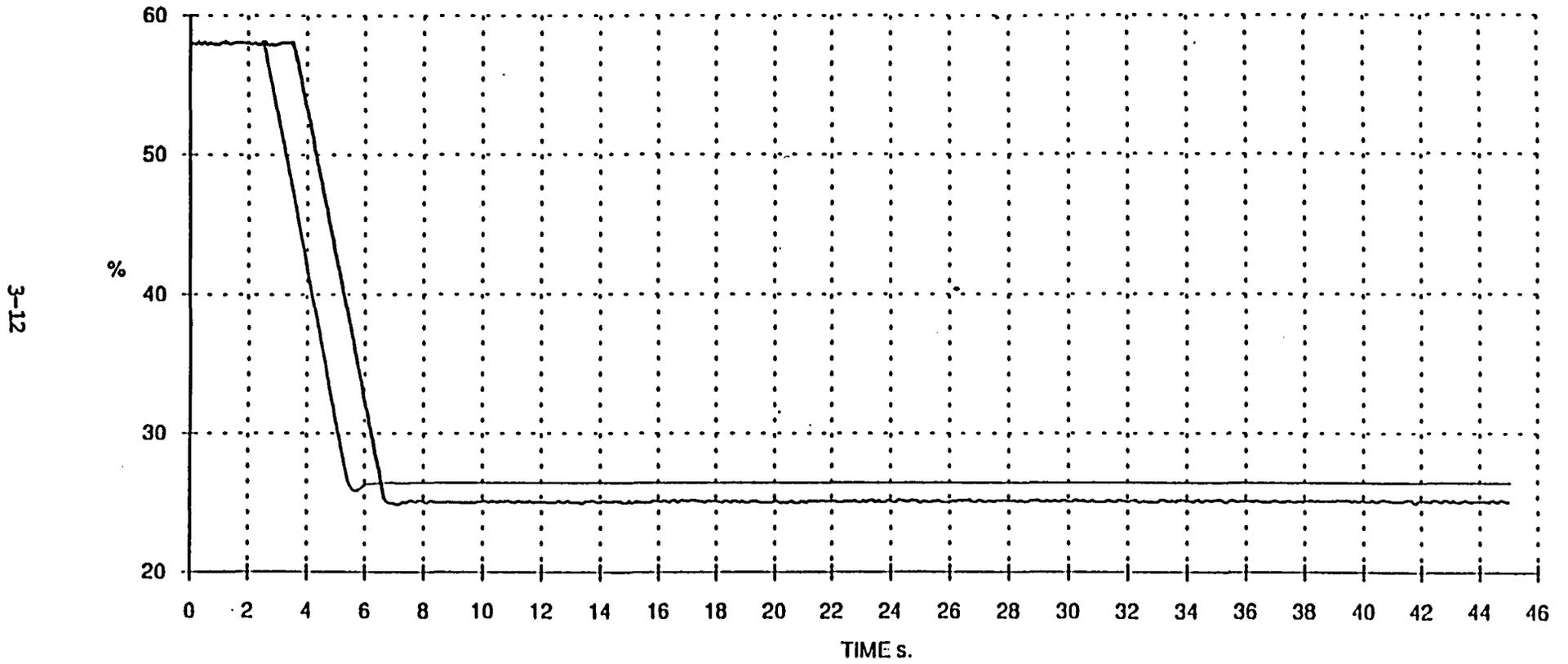


FIGURE 3.11

4.- MODEL DESCRIPTION.

Figure 4.1 shows the Cofrentes model which includes reactor vessel and core, recirculation loops, steam lines from vessel to turbine valves, and control systems. Input data were mainly obtained from a documented RETRAN model.

The main components of the model are discussed in the following sections.

4.1.- VESSEL.

Using the VESSEL component of TRAC-BF1, 4 rings and 8 axial levels were considered to model the reactor vessel. The three inner rings represent the volume inside the core shroud, with the core in levels 3 and 4, and the outer ring models the downcomer. As illustrated in Figure 4.1, levels 1 and 2 represent the core inlet plenum, with jet pumps discharge located in bottom of level 2 (ring 4); core exit plenum is represented by level 5 (rings 1,2,3).

For the type of transient being analyzed, it would be enough one single ring to model the core region, with one average bundle (CHAN component) to represent the fuel elements. However, three rings were considered to allow for future accident analysis (LOCA, ATWS), in which upper plenum 2D/3D effects, when spray is activated, are important to simulate the distribution of coolant over the fuel bundles.

The 624 fuel elements have been divided into three groups:

- high power
- average power
- low power (including peripheral elements)

connected to the lower and upper plenum in each core ring, as illustrated in Figure 4.2.

No metal structures were modeled as the time of interest in the transients to be analyzed is relatively small (150 sec. maximum), and temperature change in the vessel is not relevant

Separators and dryer are modelled in the axial level 6 using the perfect Separator option, after some failed attempts to use the mechanistic model; stand pipes are also included in this level.

Vessel connections to other components include feedwater inlet, modelled as a fill, governed by the level control system, discharging in the downcomer via a leak path (level 5, ring 4). Steam outlet is located in level 7, ring 4. Outlets to Recirculation loops from lower downcomer are located in level 2 (ring 4). Recirculation flow mixes in the jet pump (component external to vessel) with driven flow from downcomer level 4, to discharge into lower plenum.

Channel components representing fuel bundles are connected to lower and upper plena, with leakage flow discharging to the bypass flow region (levels 3-4, rings 1-2-3)

ECCS injections have been also modelled, using the leak path feature, although they are not used in the transient.

4.2.- RECIRCULATION SYSTEM.-

Both Recirculation loops have been modelled, each being divided into three components:

- PUMP 11-21, representing the suction pipe, from vessel downcomer, and centrifugal pump
- VALVE 12-22, representing the flow control valve and discharge pipe up to jet pump inlet
- JETP 15-25, modelling the 10 jet pumps connected to each loop.

Pump transfer to low speed has been modelled with control blocks and trips, that switch from normal to low speed motor pump torque curves based on pump speed response.

Flow control valve area is defined by the Recirculation control system.

Recirculation discharge piping consists of one main raiser that divides into ten branches to feed the corresponding jet pumps; these branches have been lumped into one single line, on the basis of maintaining steady state pressure drop.

The JETP component of TRAC-BF1 has been used to model the 10 jet pumps connected to each loop.

4.3.- MAIN STEAM LINES.-

One single equivalent line has been used to model the four parallel steam pipes, with 5 main components:

- TEE 80, models pipes from vessel exit to MSIVs, relief valves are connected to this component although not actuated during the transient
- VALVE 81, represents MSIVs and associated pipe
- TEE 82 represents pipes from MSIVs to turbine control/stop valves, and branching to bypass valves that discharge to main condenser.
- Turbine control and stop valves, modelled by VALVE 83, with position governed by pressure control system; they discharge to BREAK 92, which represents pressure boundary condition at turbine inlet.
- Bypass valves are modelled by VALVE 70 with boundary condition represented by BREAK 73

4.4.- FUEL ELEMENTS.-

The 624 fuel elements of the core have been divided into three groups (Figure 4.2), corresponding to the three inner rings of the vessel model:

80 central high power
436 central average power
108 peripheral low power

The CHAN component of TRAC-BF1 has been used to model the characteristics of the fuel bundles. 11 axial nodes have been selected, with active length between nodes 3 to 10, and one group to represent the 8x8 fuel rods

Leakage flow to the bypass region surrounding fuel channels has been considered by means of a leak path from the second axial node of the channels to vessel level 3.

4.5.- CORE POWER AND REACTIVITY FEEDBACK.-

Reactivity feedback has been modelled using the point kinetic option, with void and Doppler coefficients and scram curve obtained from perturbations on the 3D simulator (SIMULATE-2), performed around the steady state situation of the core

A common axial power distribution is defined for the three types of fuel channel/bundles modelled.

4.6.- CONTROL SYSTEMS AND TRIPS.-

The three control systems typical of boiling water reactors are included in the model, as well as trips associated to Reactor Protection System and other automatic actions.

4.6.1.- Pressure control system.-

This system governs turbine and bypass steam flow, as a function of pressure upstream turbine control valve.

Figure 4.3 illustrates the scheme of the model developed. Special attention was paid to the proper representation of turbine control valve characteristic, to reproduce actual behaviour in terms of steam flow versus position

Bypass system performance has been modelled including adjustment of flow to the condenser, via flow restrictor characteristics, and logic to simulate fast opening of the valves

4.6.2.- Feedwater control system.-

Based on a level error signal and mismatch between steam and feedwater flows, this system controls the amount of feedwater entering the vessel.

Downcomer water level, as computed by TRAC, is corrected based on dryer pressure drop, to obtain downcomer water level as measured in the plant. Sensors and controllers are modelled by available control blocks following the actual system design (Figure 4.4). A special logic was developed to reproduce coastdown of one pump and to obtain a smooth transition on total feedwater flow when the remaining available pump speeds-up in response to controller demand.

4.6.3.- Recirculation flow control system.-

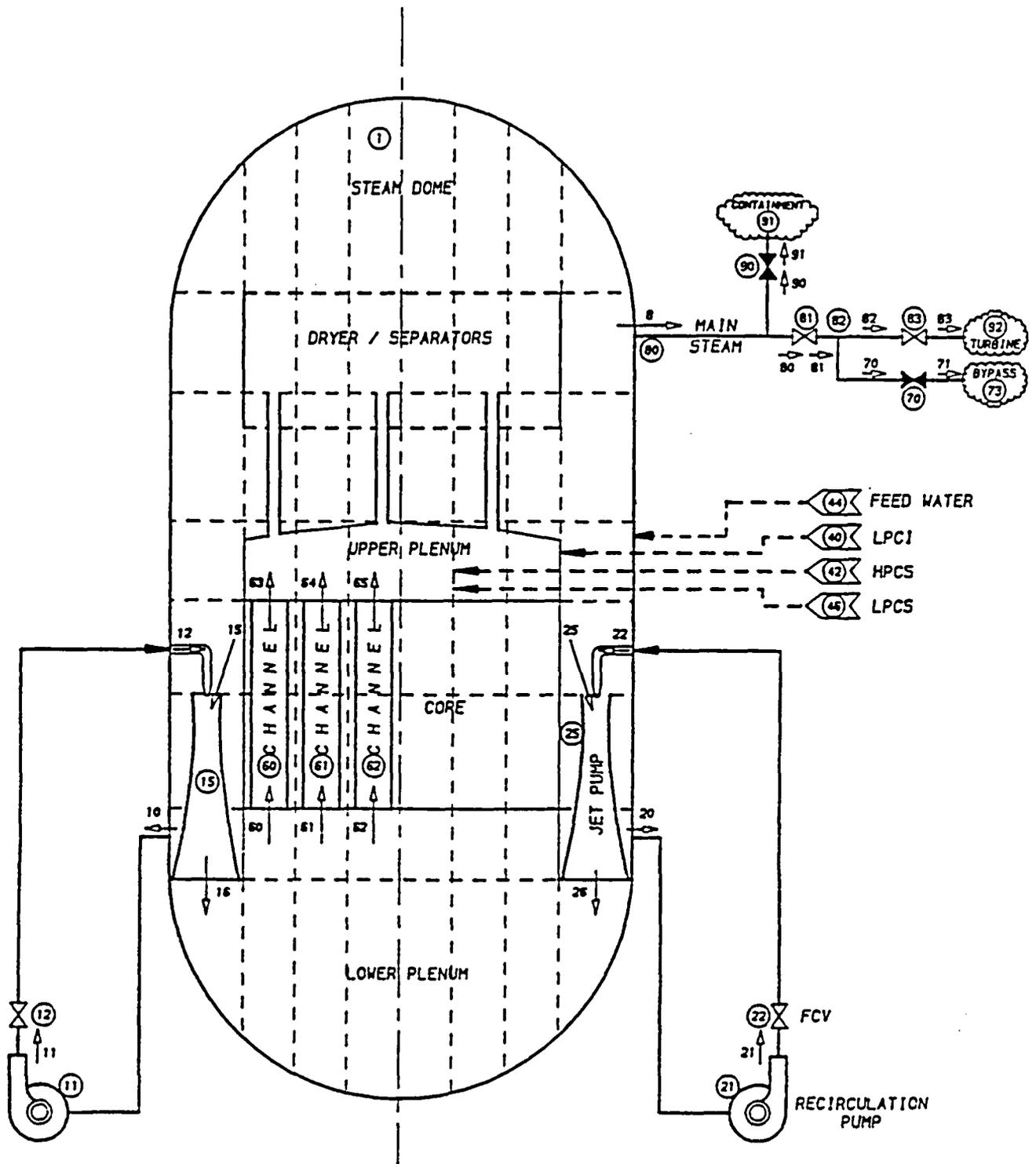
As the plant is operated in manual mode, only the portion of the system representing this function has been considered.

The output of the system determines Recirculation control valve position, which has been translated into valve area by a separate calculation, using a specific model of the valve to reproduce the Cv

versus position curve as given by the manufacturer.

One of the objectives of the test analyzed in this report was to verify the behaviour of the recirculation runback. A logic has been incorporated to the model that switches the manual valve position demand to a fixed position (26% open) corresponding to a core flow demand of 53.15% when low level alarm is detected, provided one feedwater pump is tripped (Figure 4.5).

FIGURE 4.1.- C.N. COFRENTES MODEL FOR TRAC-BF1



L-108

FIGURE 4.2.- CORE CHANNELS DISTRIBUTION

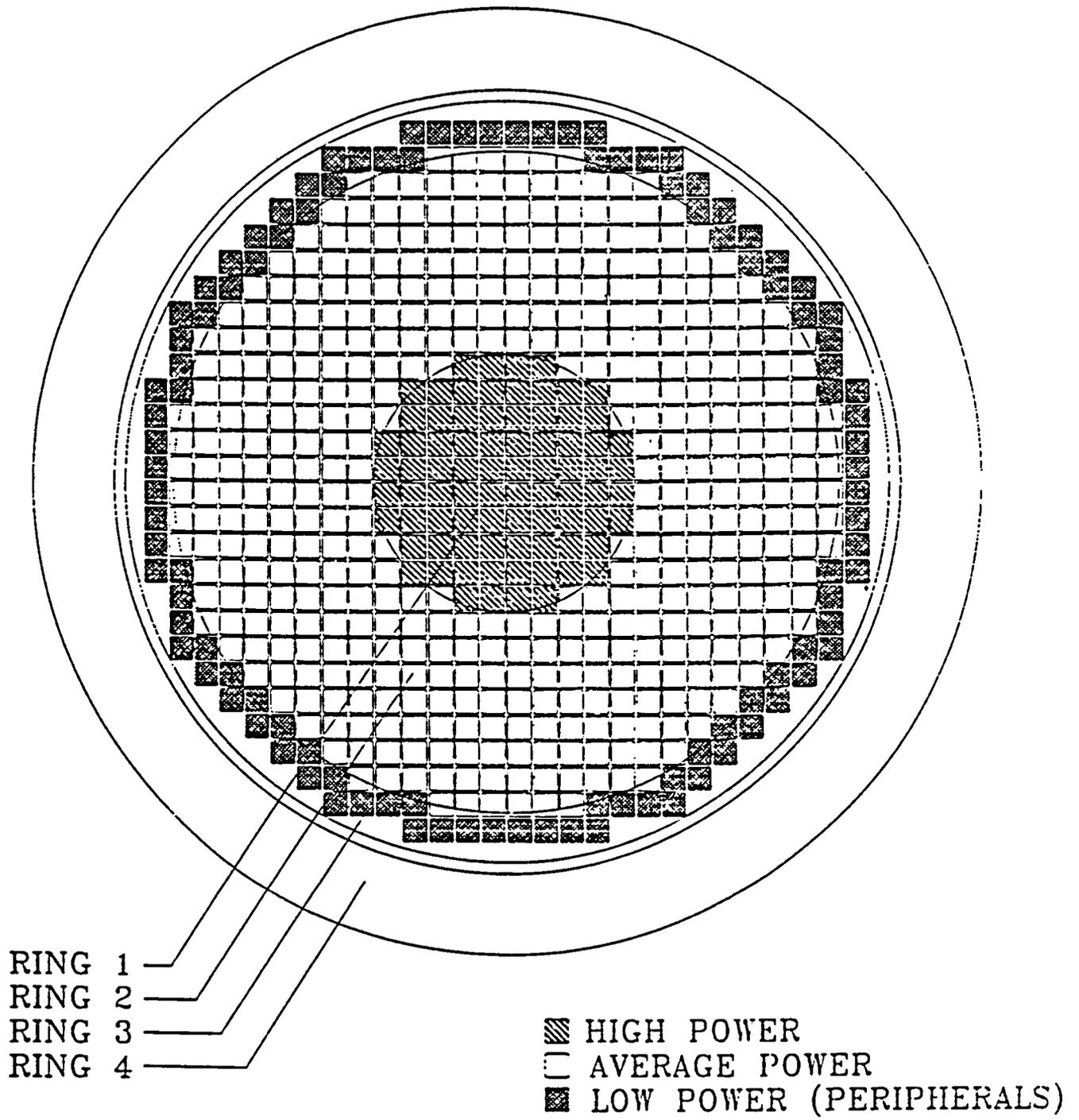


FIGURE 4.3. PRESSURE CONTROL SYSTEM

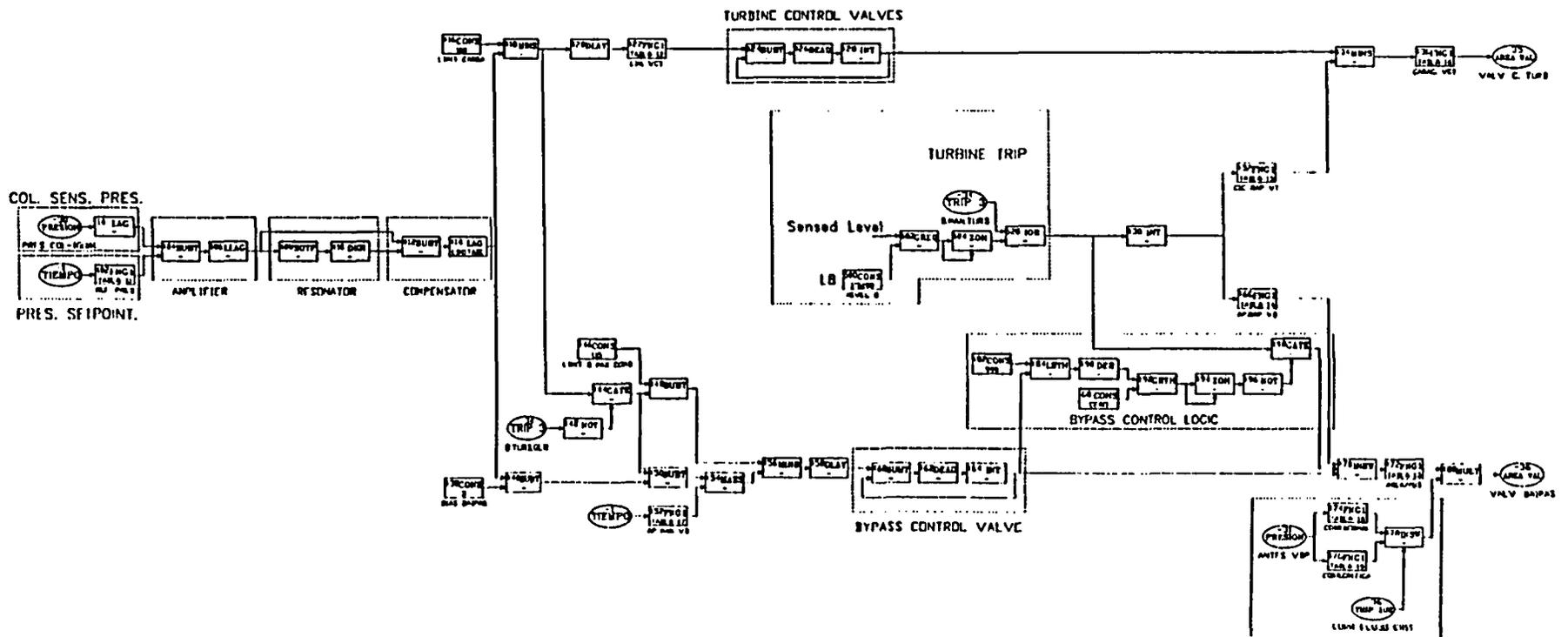


FIGURE 4.4. LEVEL/FW. CONTROL SYSTEM

4-10

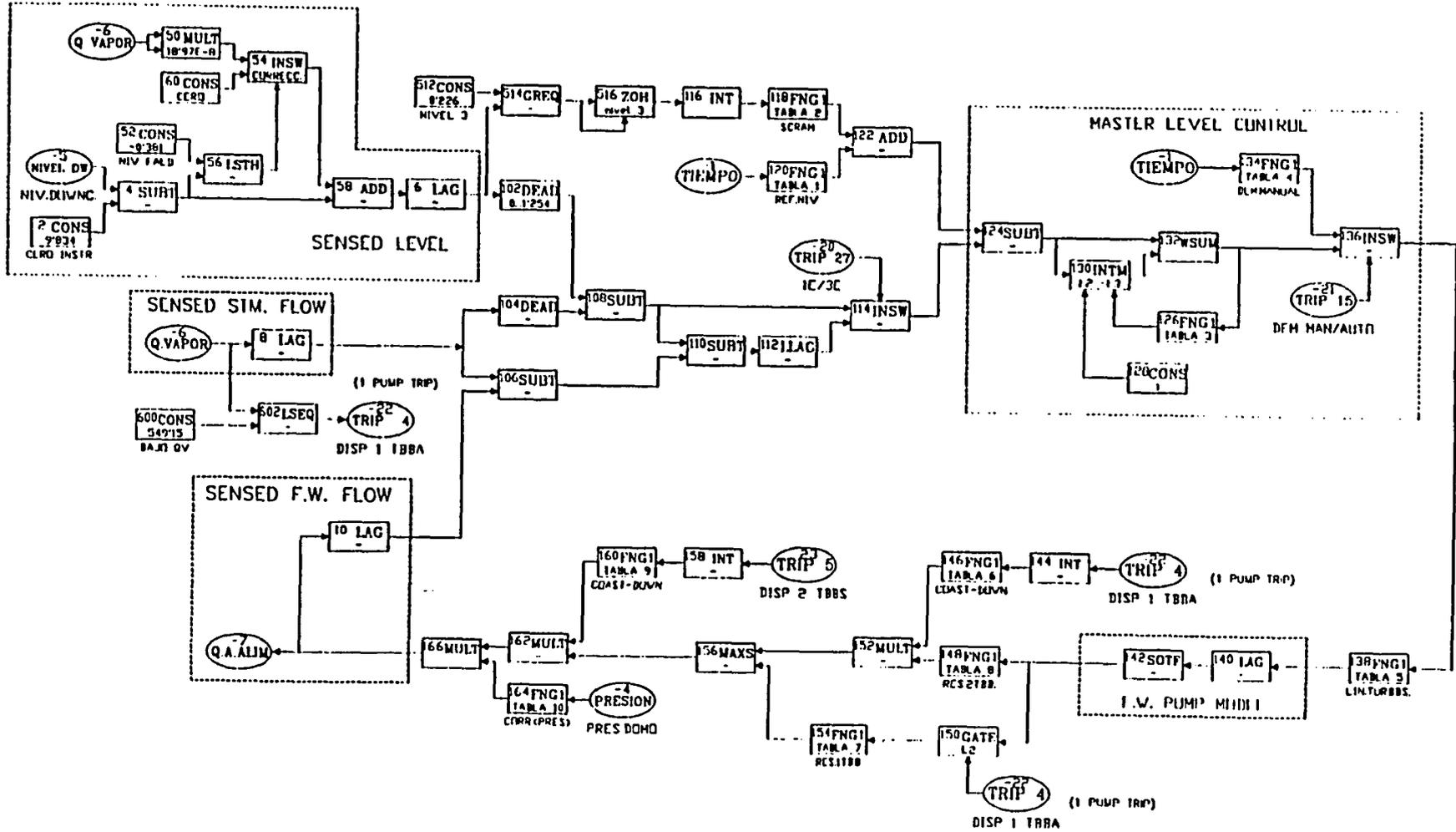
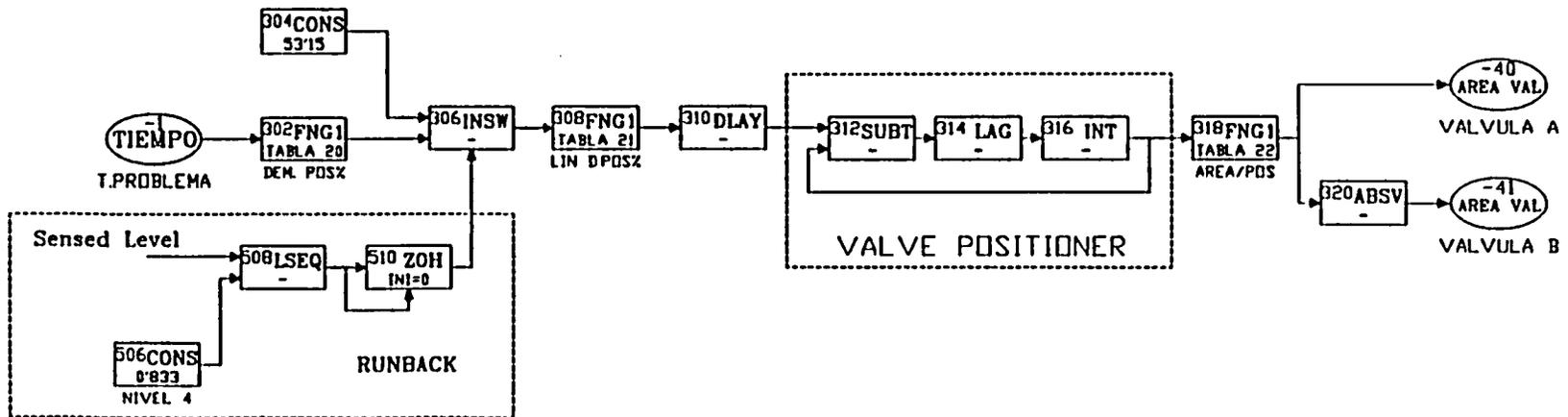


FIGURE 4.5. RECIRCULATION CONTROL SYSTEM



5.- STEADY STATE.-

A nominal steady state of the system (Table 5.1) was defined as a reference or base line condition

Flow split to the three modelled channels and bypass were calculated by a steady state analysis of the core with FIBWR code.

To adjust a steady state situation, with TRAC-BF1, for a model as that described for Cofrentes, is a hard task to perform if one has to deal with the whole system and too many variables and parameters to control. The approach followed was to adjust separately pieces or submodels with the proper boundary conditions, and assemble them one by one to build up the entire model.

Partial models were adjusted for channel, jet pumps, steam lines, recirculation loop, vessel and each of the control system

The final steady state reached is presented in Table 5.1 for the most significant variables, where comparison with target values is also included.

A null transient, from the steady-state reached, was run, with the reactivity feedback mechanism activated, to verify stability of steady state conditions.

Table 5.1.- Reference Steady State condition

Variable	Reference	TRAC
Core flow (Kg/s)	10646	10642
Recirculation flow, 1 loop (Kg/s)	1550	1550
Steam flow (Kg/s)	1569	1565
Feedwater flow (Kg/s)	1569	1565
Dome pressure (Pa)	7.17E6	7.17E6
Steam collector pressure (Pa)	6.765E6	6.764E6
Water level, from downc. bottom (m)	10.71	10.71
Core support plate pres. drop (Pa)	0.17E6	0.169E6
Core bypass flow (Kg/s)	1127.5	1129

6.- TRANSIENT RESULTS AND COMPARISON WITH PLANT MEASUREMENTS.-

The initial conditions prior to initiation of the transient, as measured in the plant on December the 18th, 1984, are presented in Table 6.1

From the reference steady state, the model was conducted to a new one corresponding to the above conditions, by adjusting the necessary control systems setpoints, and letting it run as a null transient to verify stability. Using the EXTRACT feature of TRAC, the model input file was updated to the test initial condition. Table 6.1 shows initial conditions of the model prior to initiation of the transient

Figures 6.1 to 6.12 show plots comparison of calculated and measured values for the most relevant variables; all plots include 2 secs. of steady state previous to the initiation of the transient.

The computed results presented were obtained after several adjustments based on the conclusions drawn from sensitivity studies described below.

The sequence and timing of relevant events is presented in Fig 6.2

In the first run of this transient there were two of the variables that didn't agree with measurements.

The evolution of pressure in reactor dome and steamlines was very close to measured values during 10 seconds after initiation of the transient (Figure 6.13) but, later on, the decrease rates were different (slower for calculations) and consequently some delay on bypass valves closure was obtained.

On the other hand, downcomer water level behaviour showed an increasing divergence from measurement, with no recovering after initial decrease, as shown in Figure 6.14.

Two sensitivity analysis were made to correct pressure response; first two calculations, with two different values for the fuel gap conductivity (Hgap), were performed, resulting in an advance of 1 sec. in the bypass valve closing time, for the low Hgap value, but in the first portion of the transient a greater divergence from measurements was obtained (Fig 6.15 a,b). The second sensitivity analysis to correct pressure response was based in the fact that this test was performed in the beginning of the initial core, and decay heat, after reactor scram, was low. Several runs were made with different values for the input variable DHMUL (multiplier for decay heat), getting the best adjustment for DHMUL=0.2 as shown in Figures 6.16 a,b.

To improve water level response, the distribution of liquid in the upper part of the vessel, for TRAC results, was investigated. It was detected some accumulation of liquid in the level 6, (rings 1,2,3), which represents the steam separator, as shown in Figure 6.18 where the void fraction in the four rings of level 6 is plotted. This plot indicates that liquid is retained inside the separator (rings 1, 2 and 3) instead of going to downcomer. To correct this situation, the volume fraction for rings 1,2 and 3 was changed, leading to a clear improvement in level response, as can be seen in Figure 6.19 where the results for one of the sensitivity cases (vol. fract. = 0.39) are shown and a better level behaviour is observed as compared with initial results in Fig 6.14.

Divergence from measured level, after 30 sec., is also due to the different timing calculated for the level setpoint modification, activated when low level (L3) is reached, compared in Fig 6.20; as a result of this anticipation, feedwater flow is reduced earlier than in the plant as shown in Fig 6.21. Some improvement in the level response, for the 0-18 sec. range, was obtained when decay heat was decreased and

time of steam discharge to the condenser was reduced to the actual measured value. Final adjustment of level response was made by tuning also the dryer loss coefficient and flow area fraction in the upper downcomer outside of the separator region.

The rest of the compared variables shows a good agreement with measured values

S

Table 6.1.- Steady State conditions at transient initiation

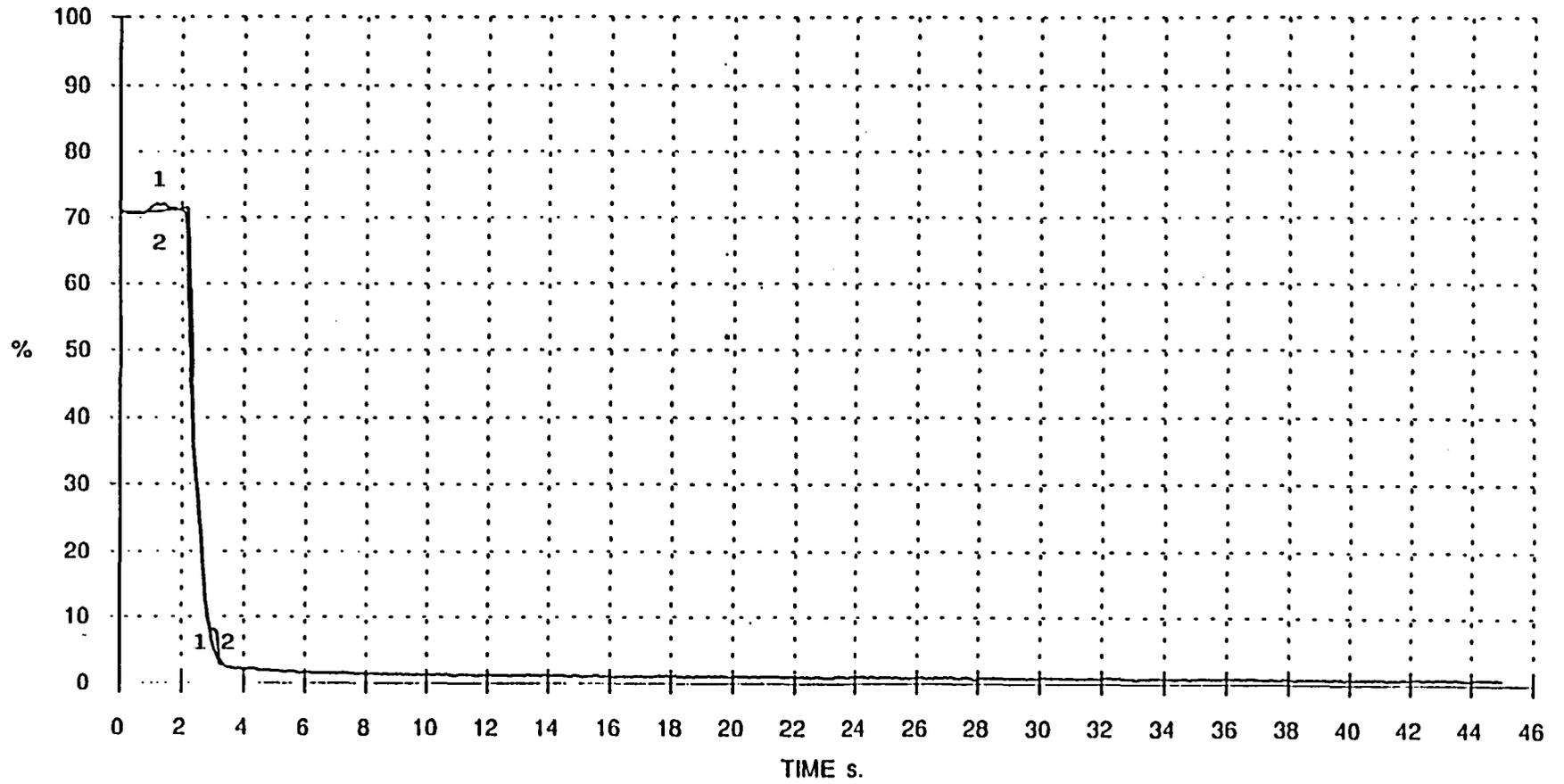
Variable	Plant	TRAC
Core power (Mwt)	2054.74	2055
Core flow (Kg/s)	1070.3	9912
Recirculation flow, 1 loop (Kg/s)	1377.4	1412
Steam flow (Kg/s)	1046	1040
Feedwater flow (Kg/s)	1046	1040
Dome pressure (Pa)	6.873E6	6.878E6
Water level (m) (ref. to 0 instr.)	0.88	0.877
Core support plate pres. drop (Pa)	0.109E6	0.1009E6

Table 6.2.- Sequence of events

TRAC	Plant	Event
0 - 2 s.	0 - 2 s.	steady state
2 s.	2 s.	turbine trip (stop valves closure)
2.06 s	2.06 s.	reactor trip
2.1 s.	2.1 s.	bypass valves open
2.14 s.	2.14 s.	recirculation pumps transfer to low speed
2.33 s.	2.59 s.	one FW pump trip (on low steam flow)
2.8 s.	3.12 s.	low level alarm (L4)
2.8 s.	3.12 s.	recirc. runback (L4+1FW pump tripped)
18.1 s.	17.05 s.	bypass valves close
17.8 s.	17.36 s.	recirc. pumps at low speed
19 s.	20.87 s.	low level signal (L3)
19 s.	20.87 s.	level setpoint modification

POWER (APRM)

9-9



<u>1</u> PLANT	<u>2</u> TRAC
----------------	---------------

FIGURE 6.1

6-7

DOME PRESSURE

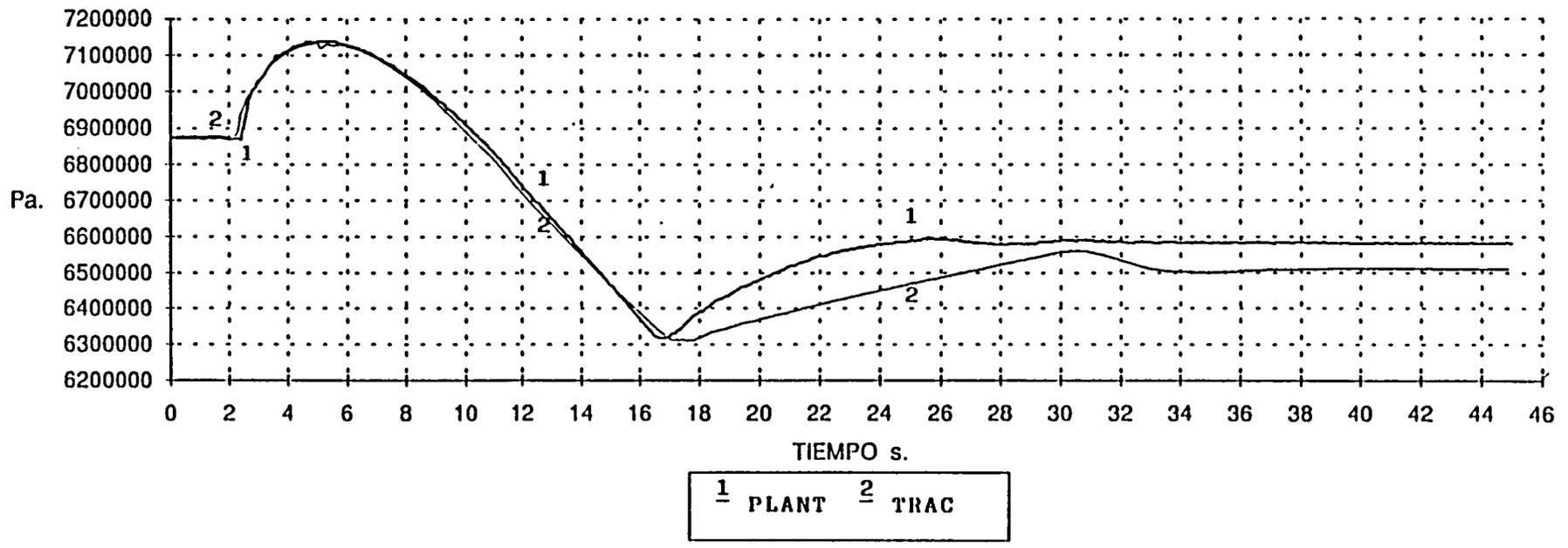


FIGURE 6.2

PRESSURE AT STEAM COLLECTOR

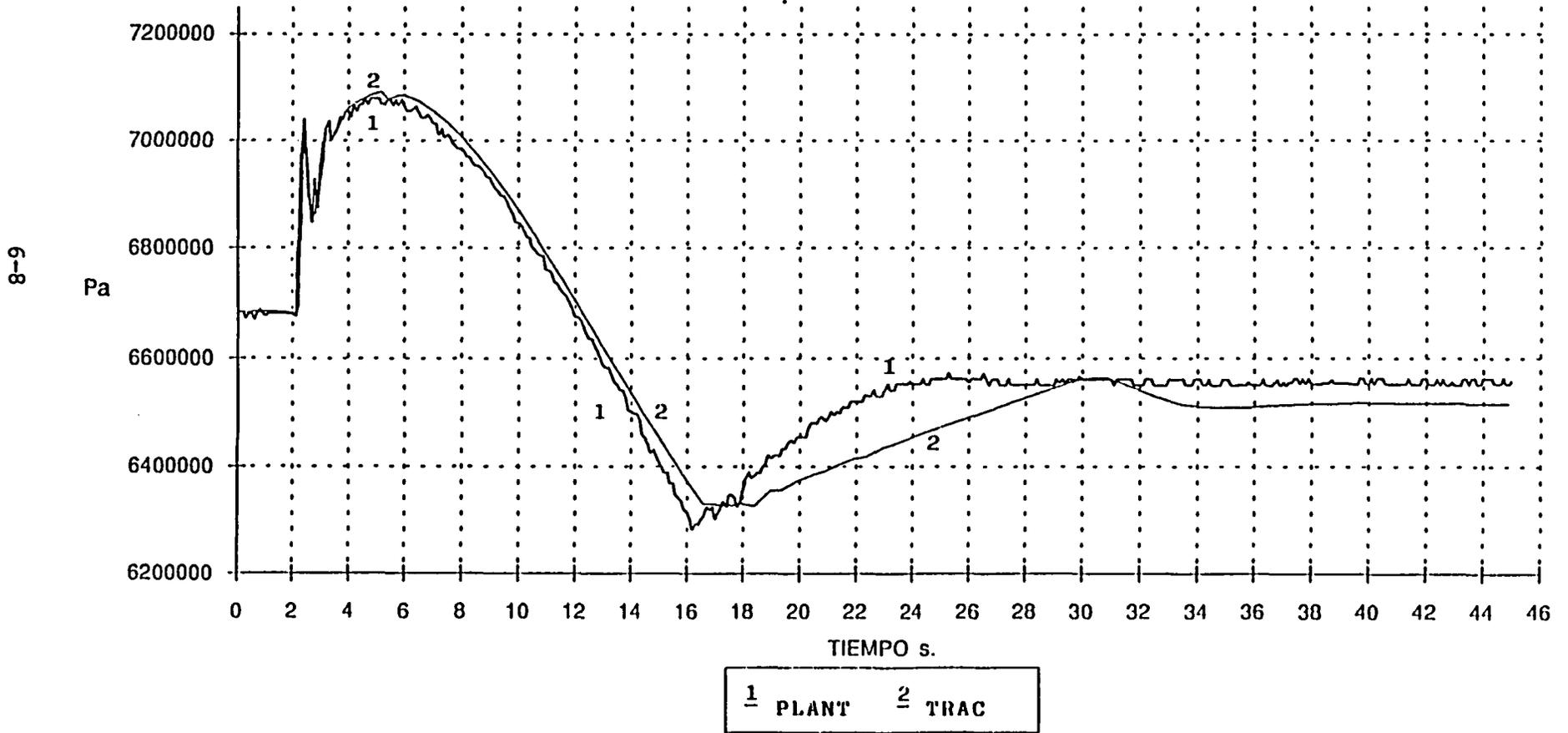


FIGURE 6.3

STEAM FLOW

6-9

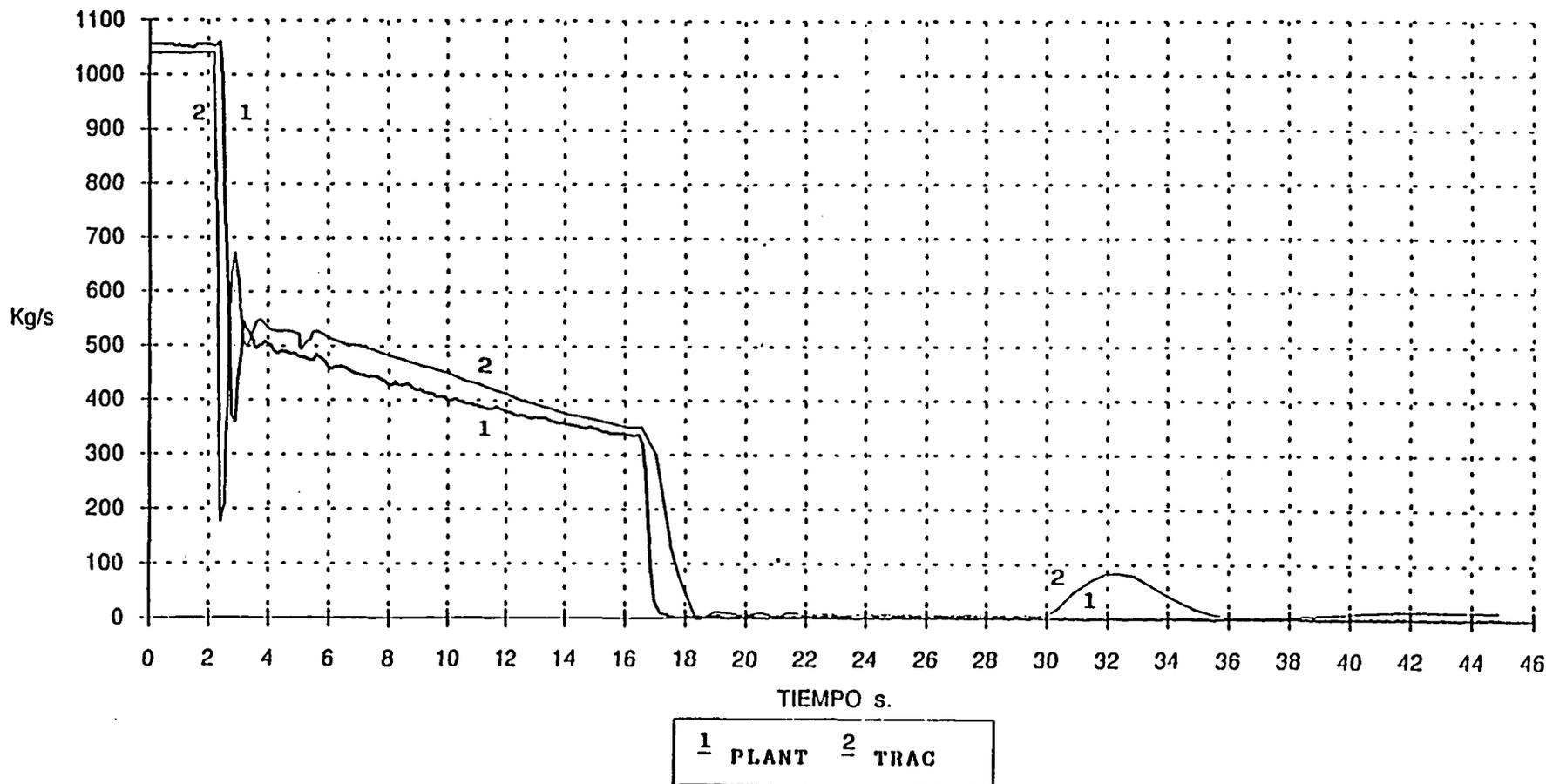


FIGURE 6.4

VESSEL SENSED LEVEL.

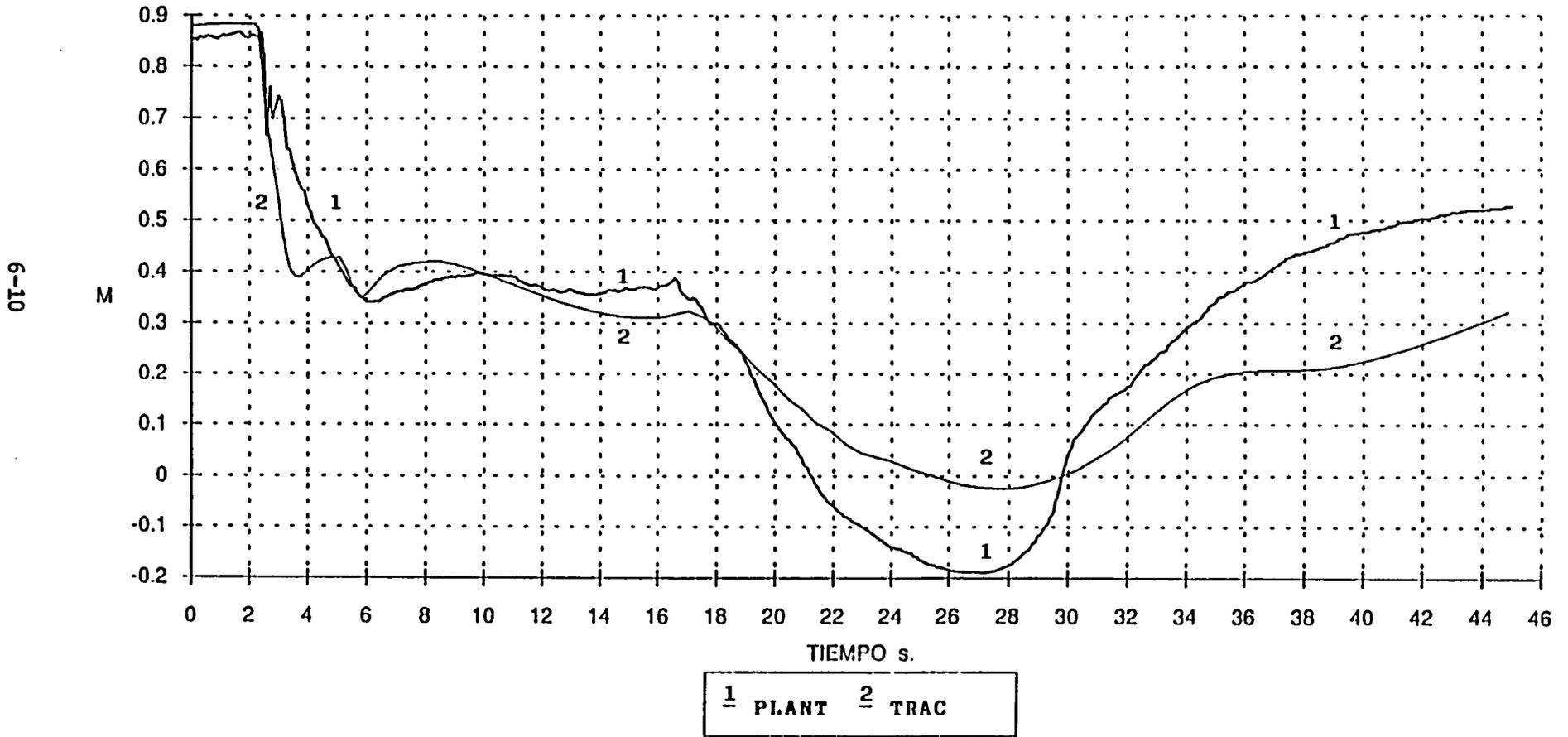


FIGURE 6.5

FEED WATER FLOW

6-11

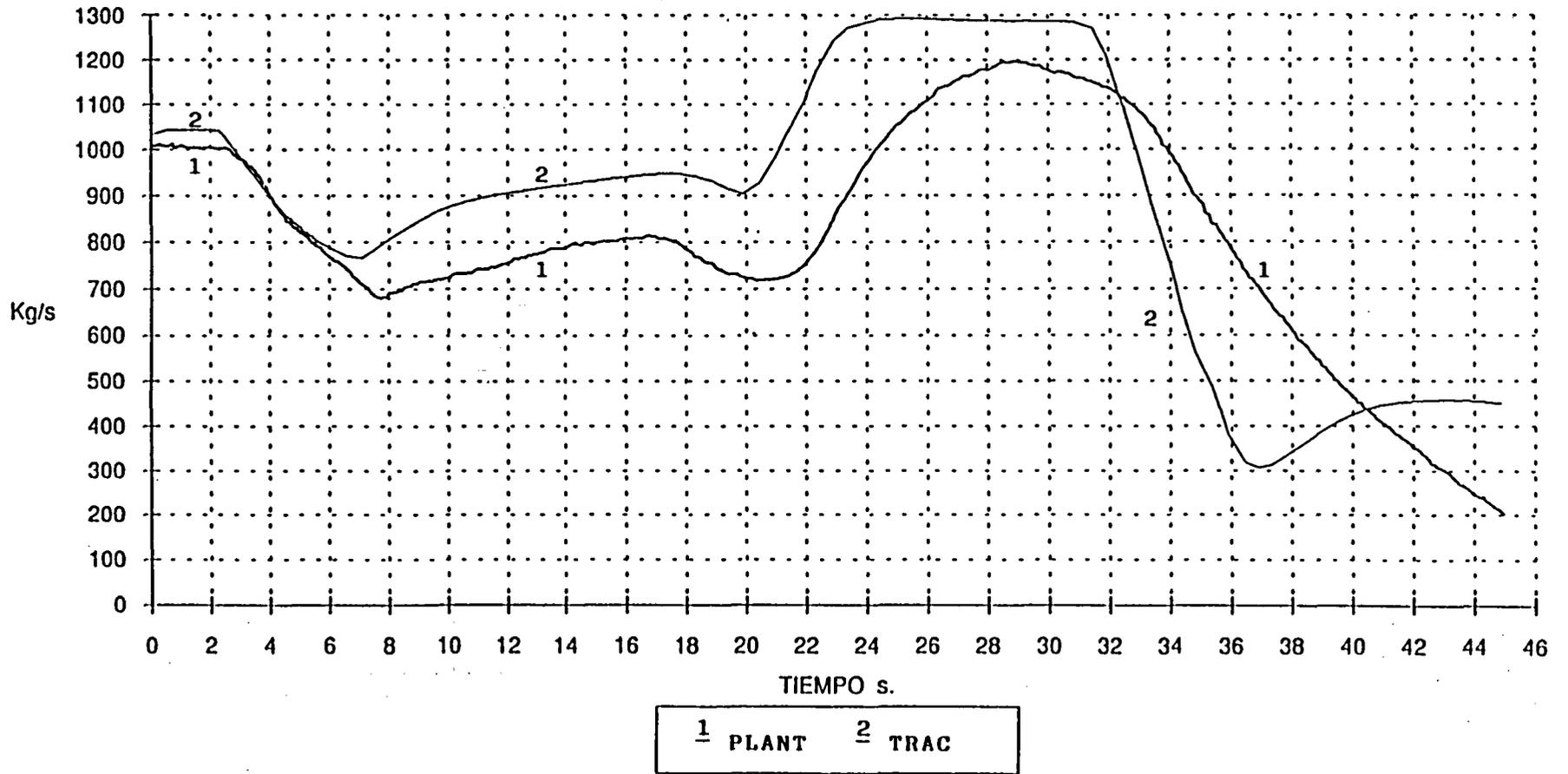


FIGURE 6.6

CORE FLOW/ (1/2)

6-12

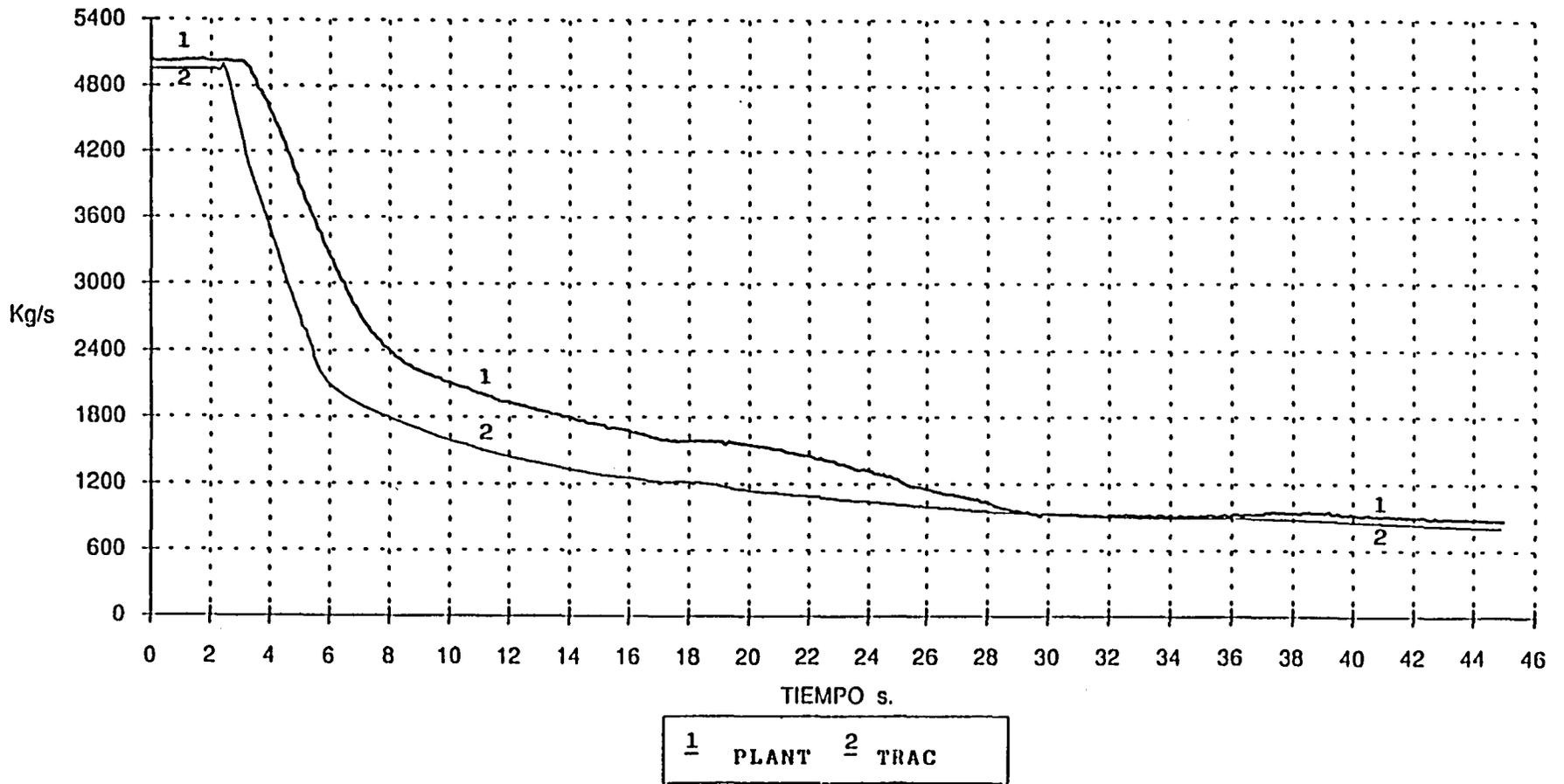


FIGURE 6.7

6-13

RECIRCULATION FLOW (1 LOOP)

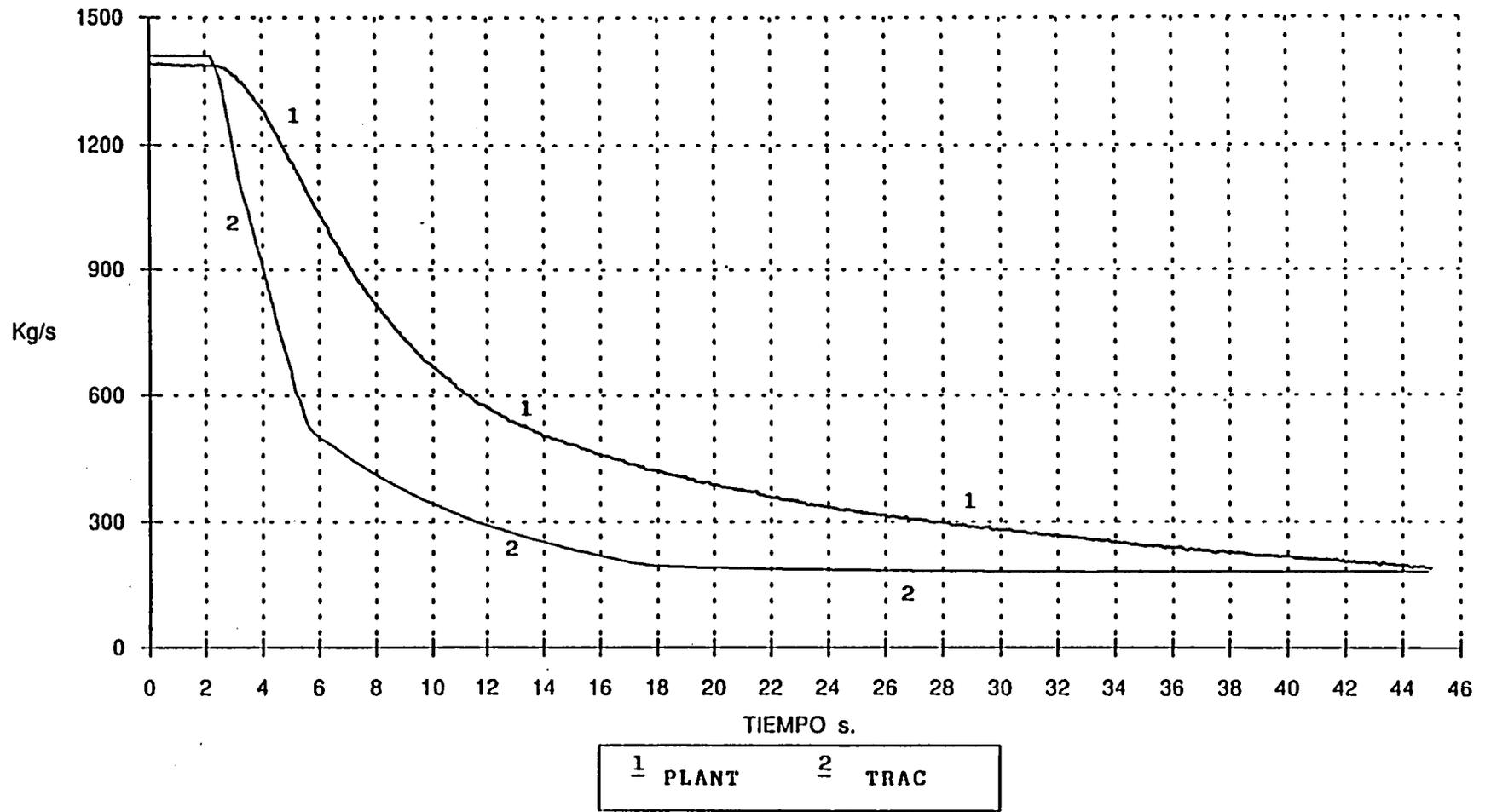


FIGURE 6.8

RECIRC. PUMP SPEED

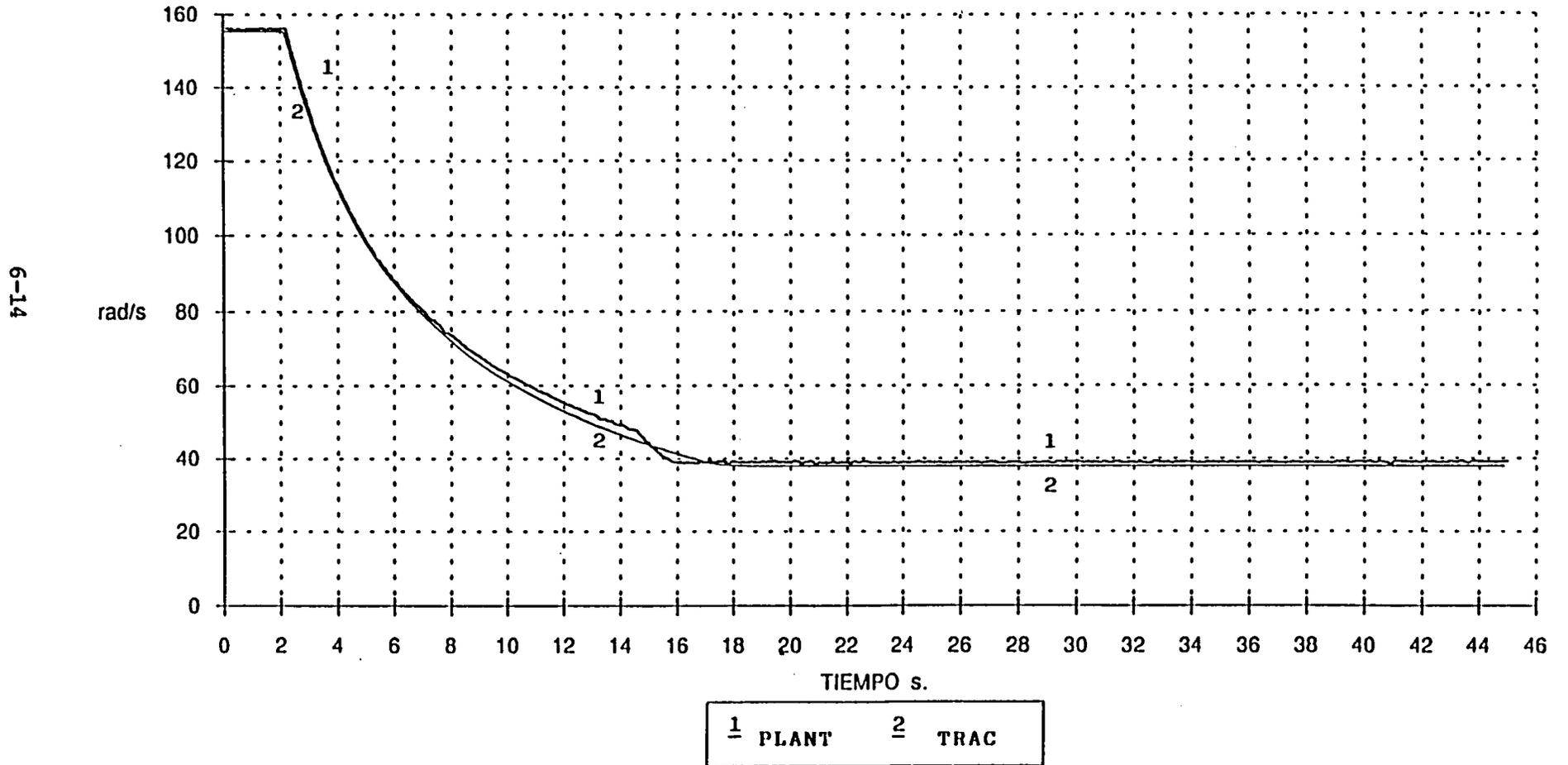
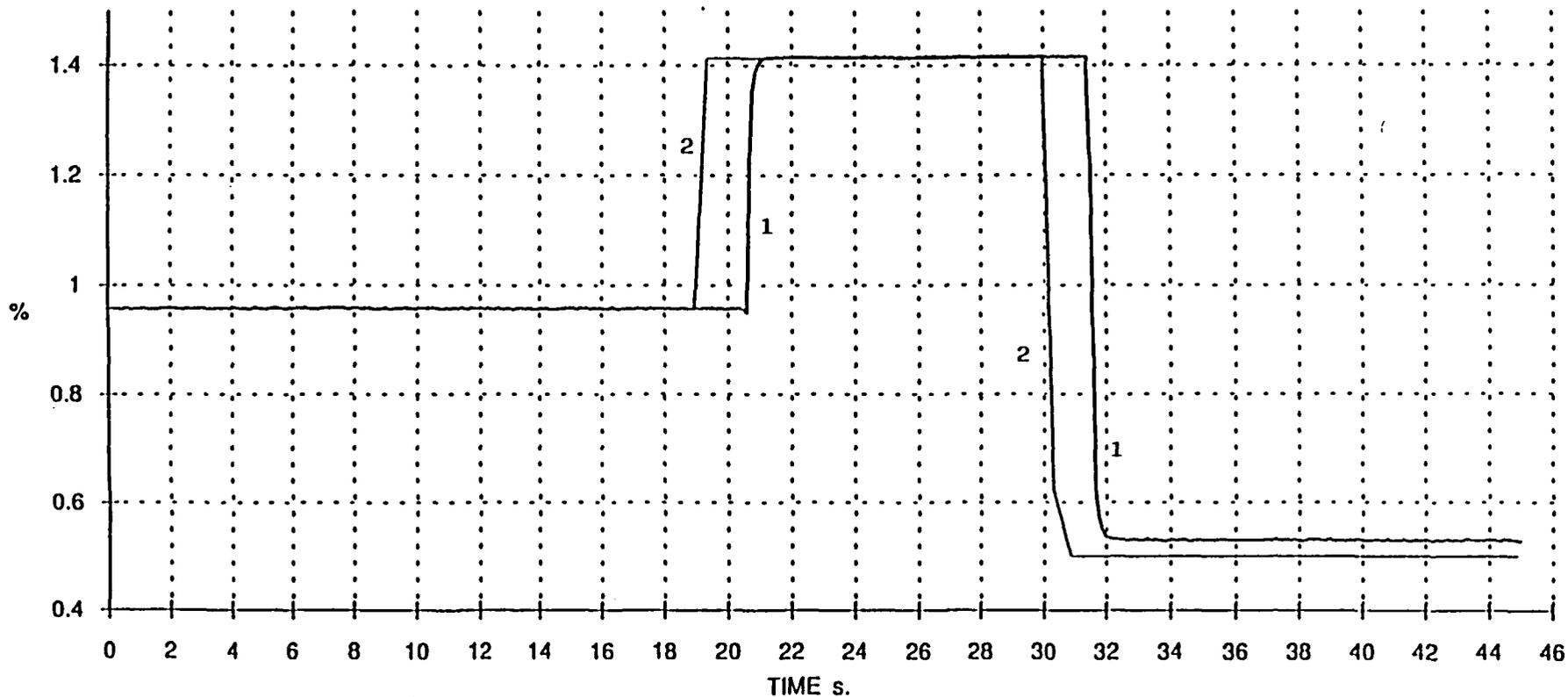


FIGURE 6.9

6-15

LEVEL SETPOINT



1 PLANT 2 TRAC

FIGURE 6.10

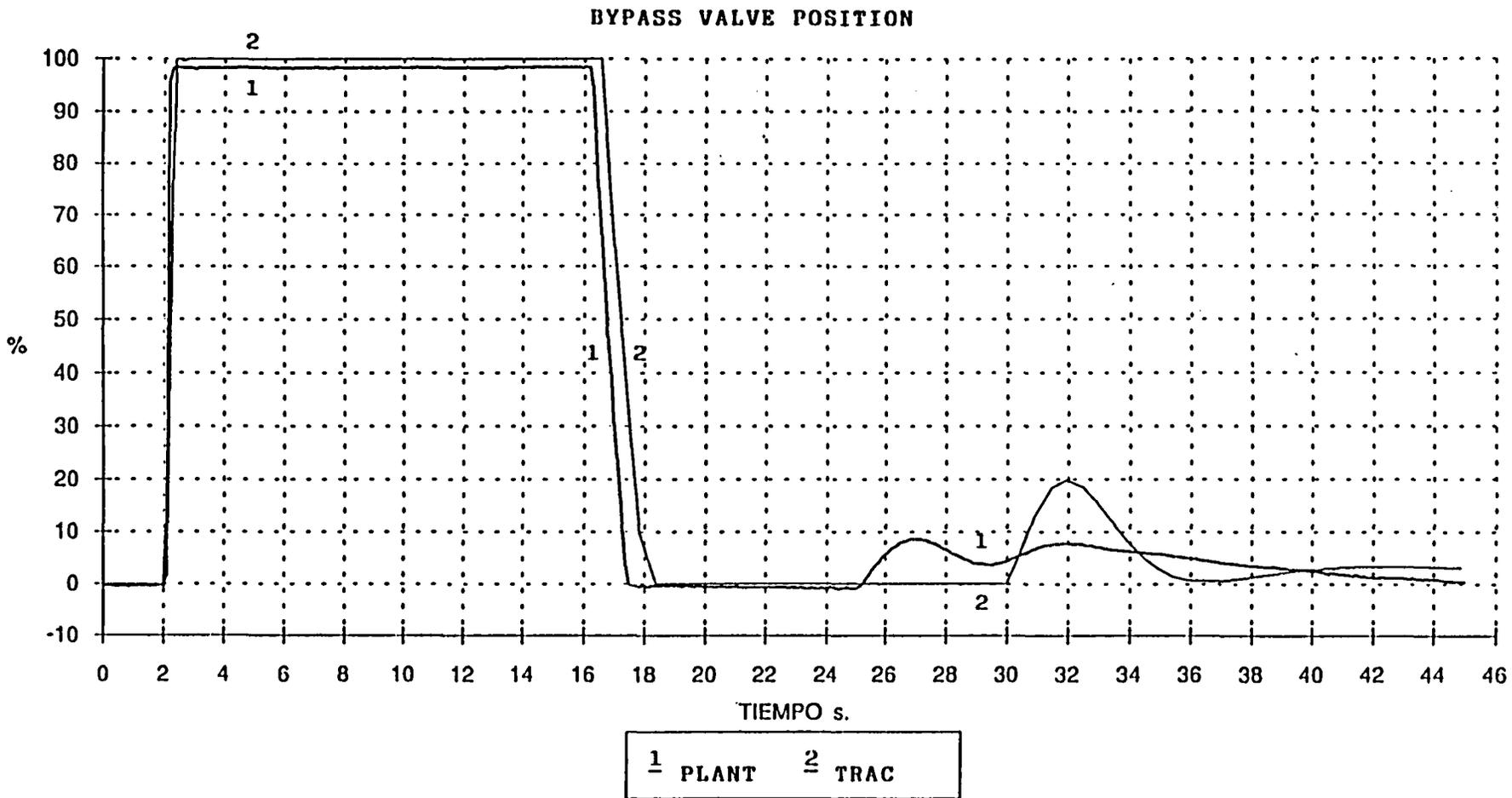


FIGURE 6.11

RECIRC FCV POSITION

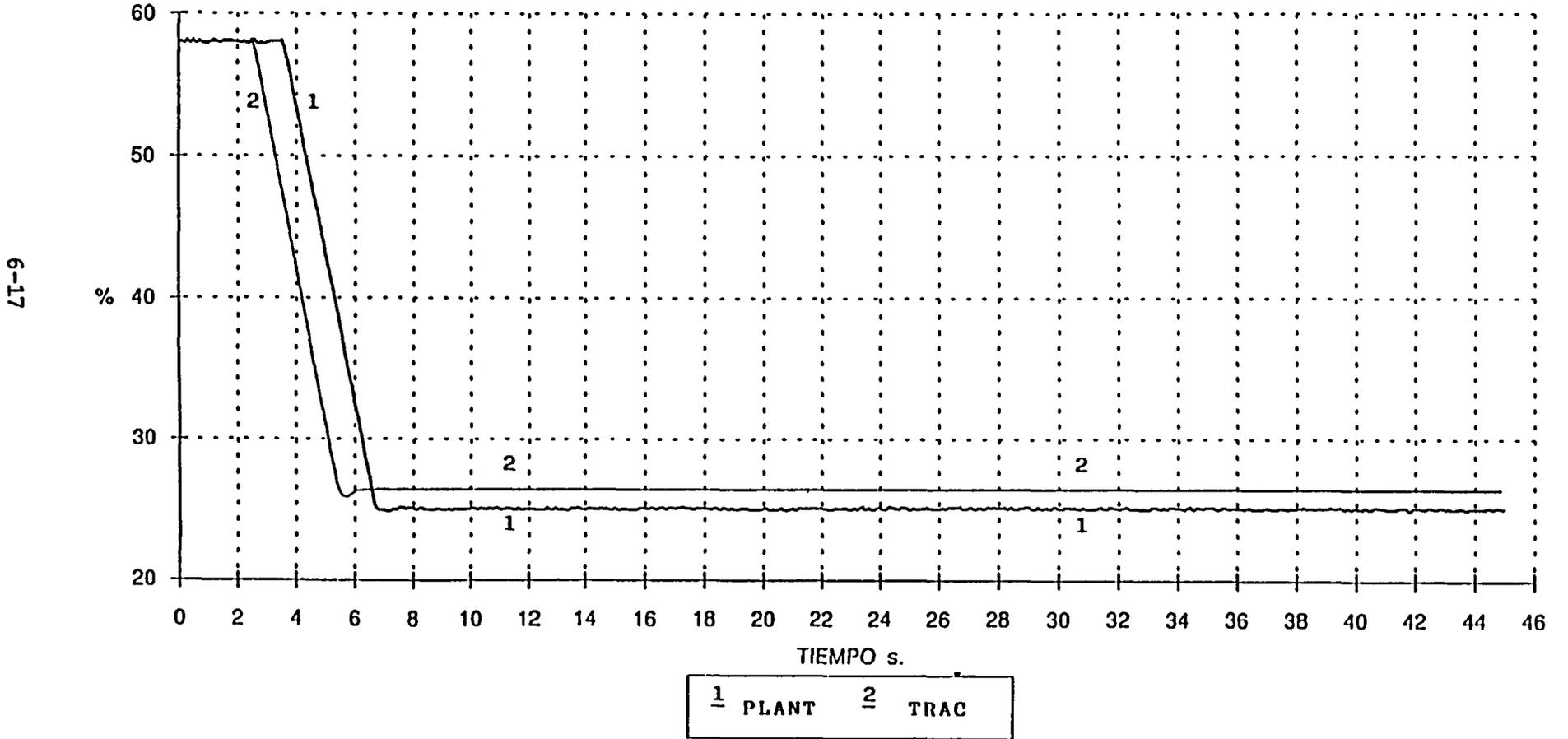


FIGURE 6.12

6-18

DOME PRESSURE

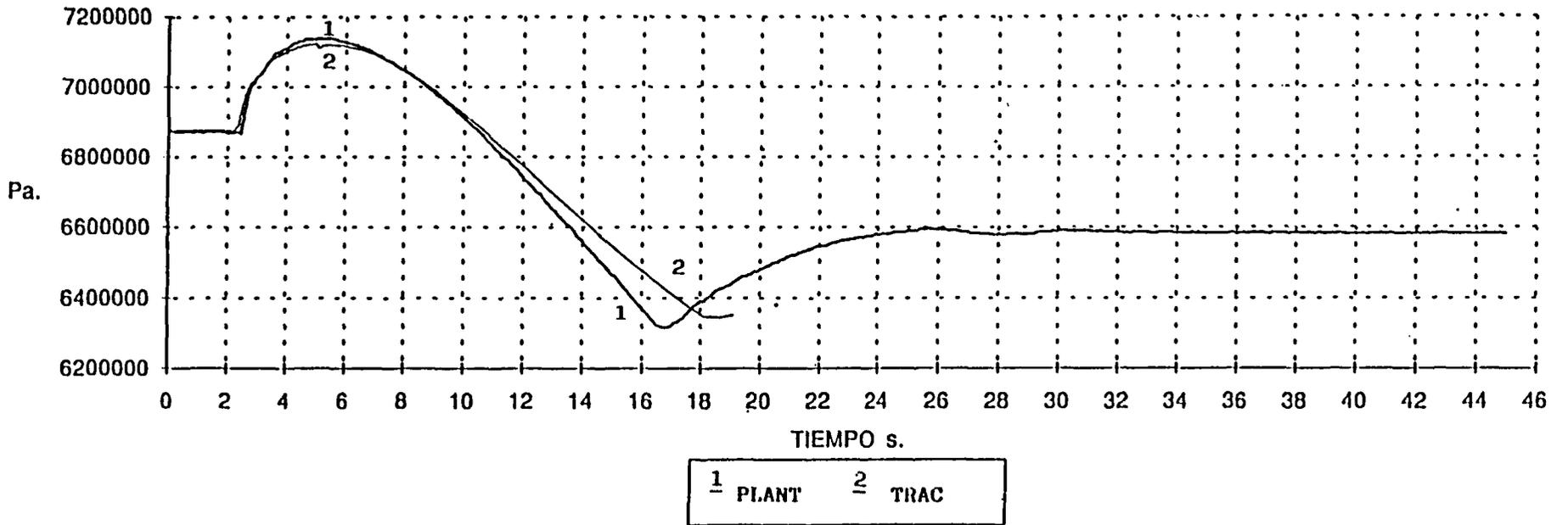


FIGURE 6.13

SENSED LEVEL

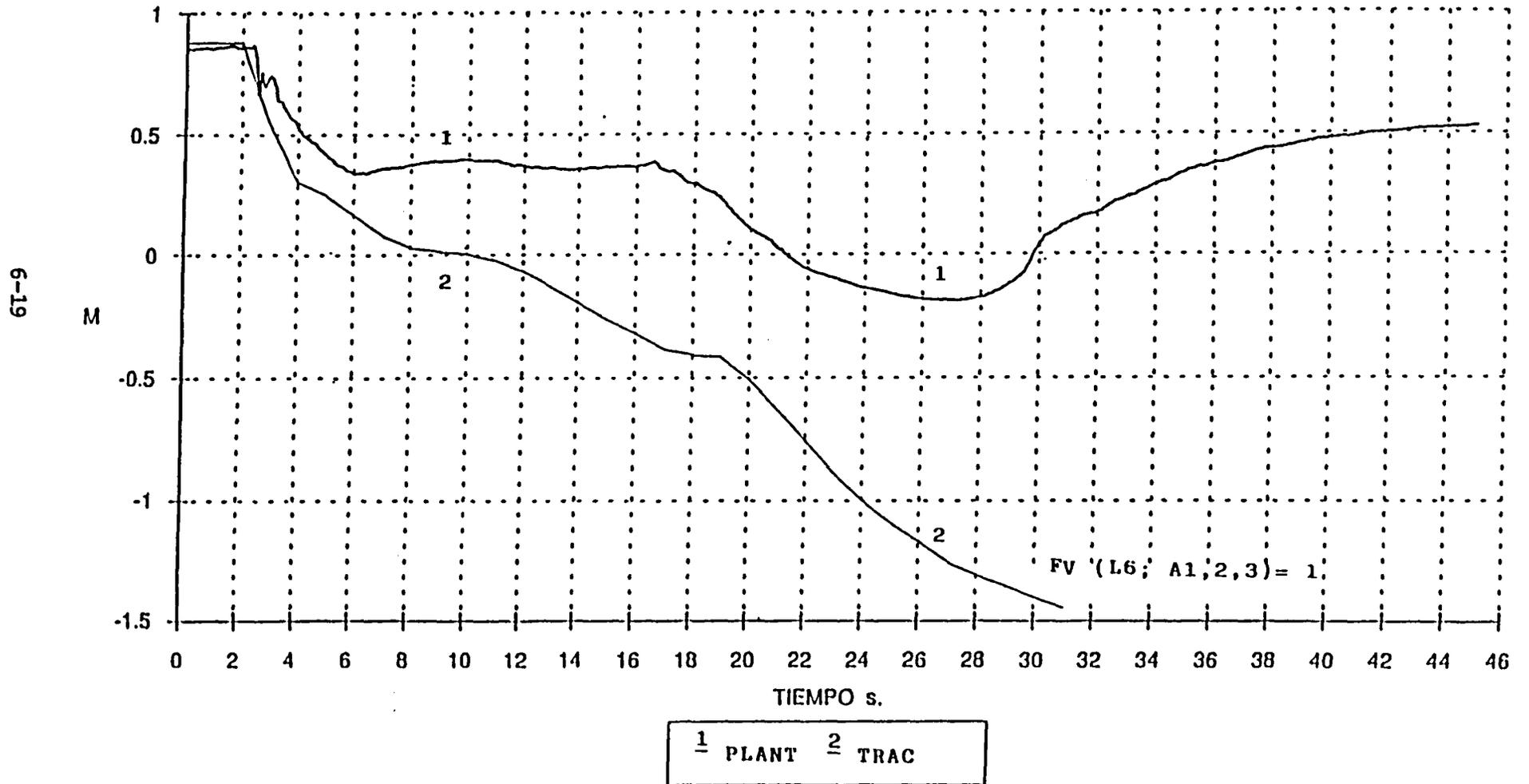
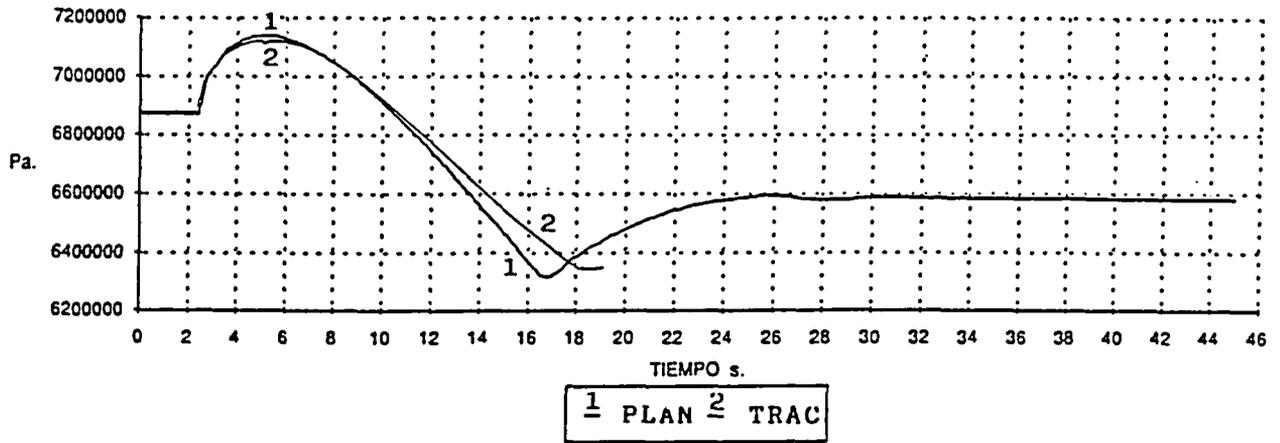


FIGURE 6.14

a) DOME PRESSURE (HGAP = 5600)



b) DOME PRESSURE (HGAP = 6600)

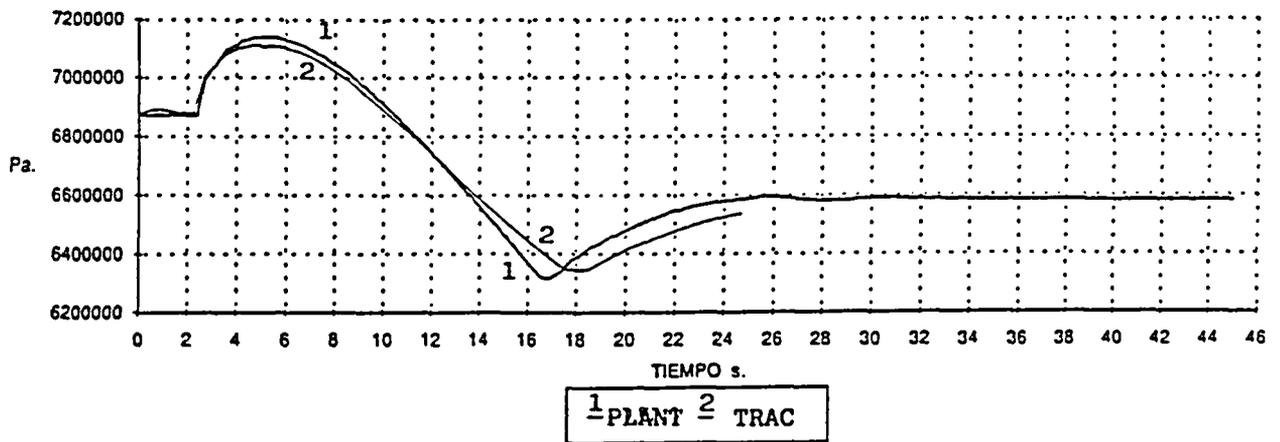
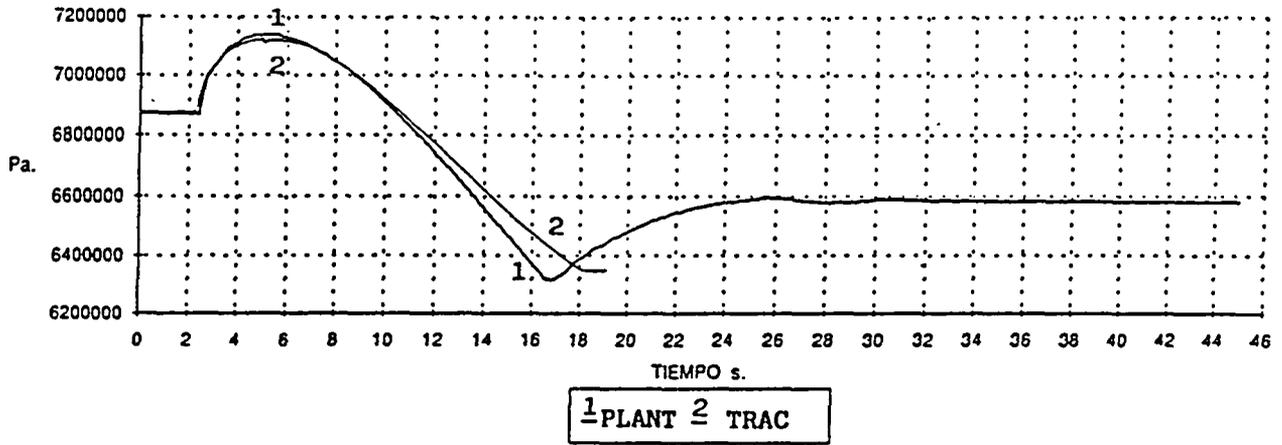


FIGURE 6.15

a) DOME PRESSURE (DHMUL = 1)



B) DOME PRESSURE (DHMUL = ..2)

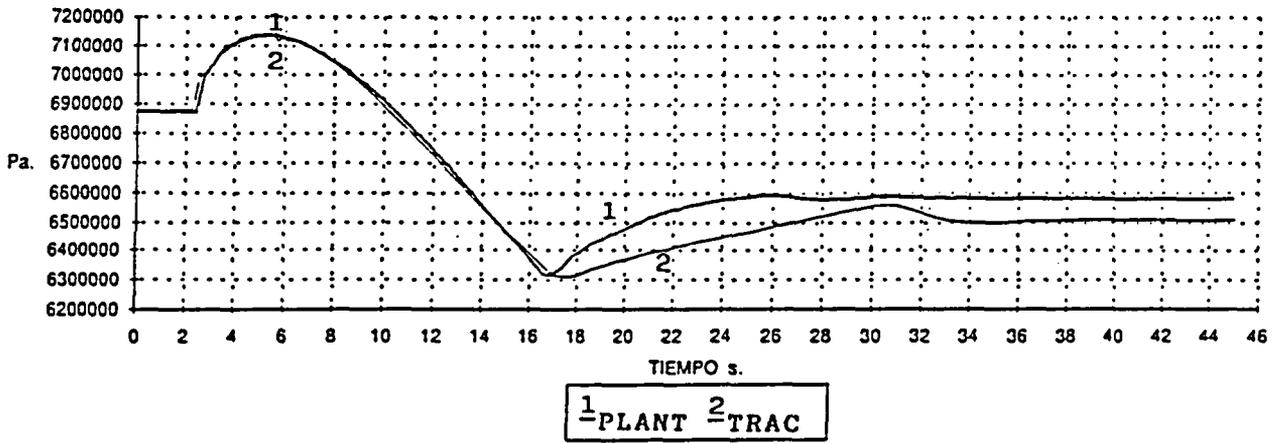


FIGURE 6.16

VESSEL LEVEL 6 VOID FRACTIONS

6-22

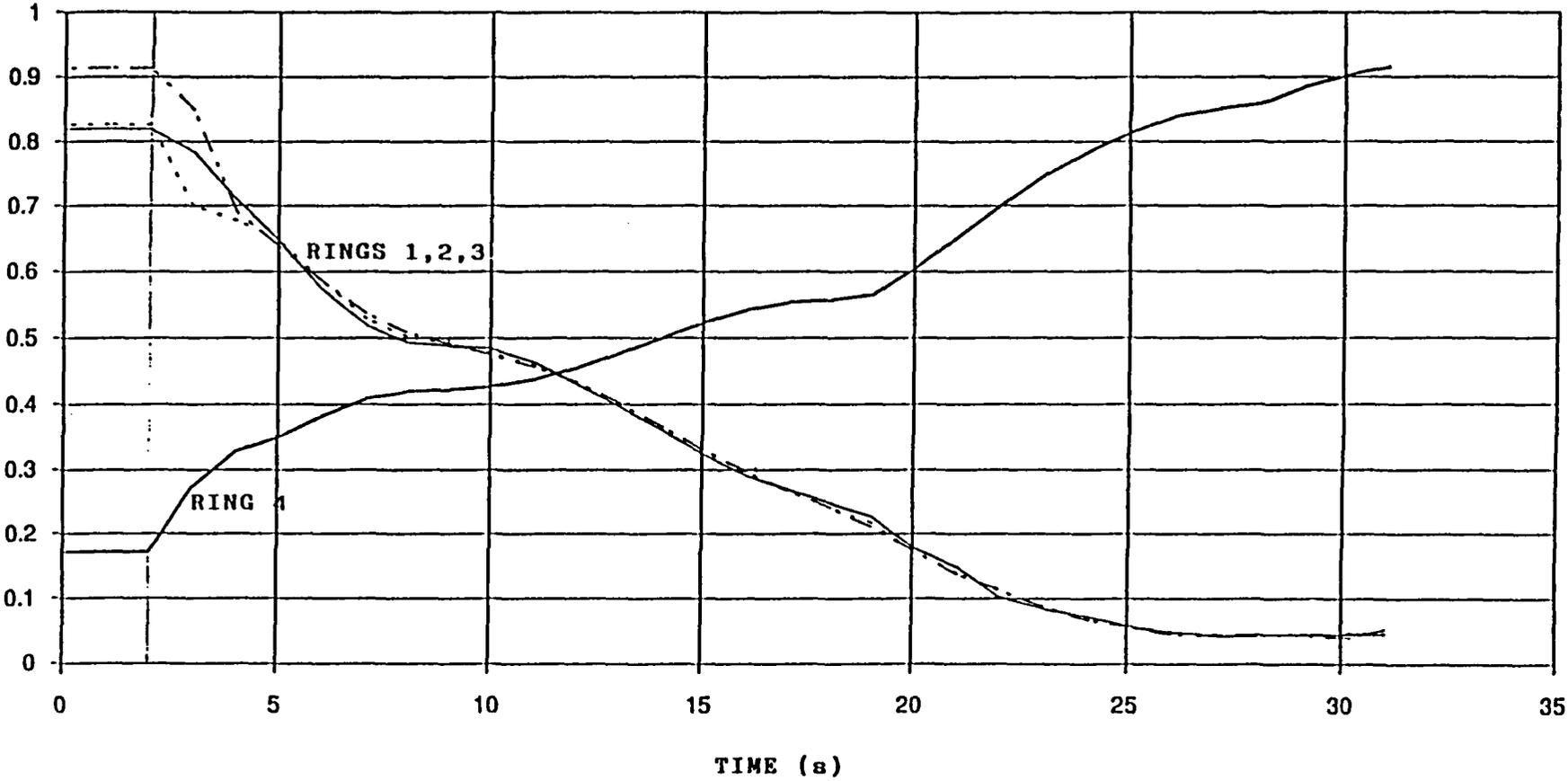


FIGURE 6.17

SENSEL LEVEL (SENSITIVITY TO VOL FRACT.)

6-23

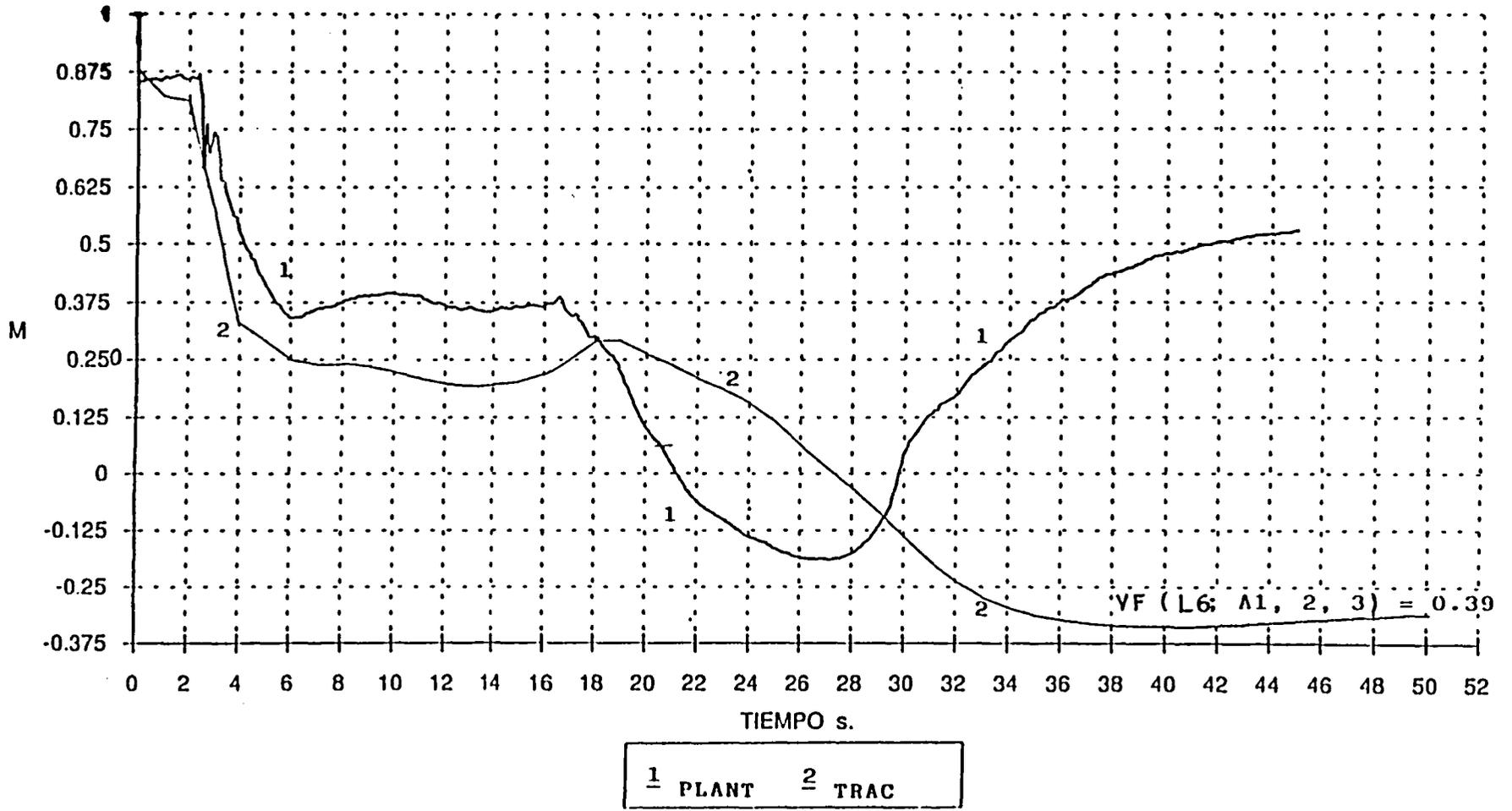


FIGURE 6.18

6-24

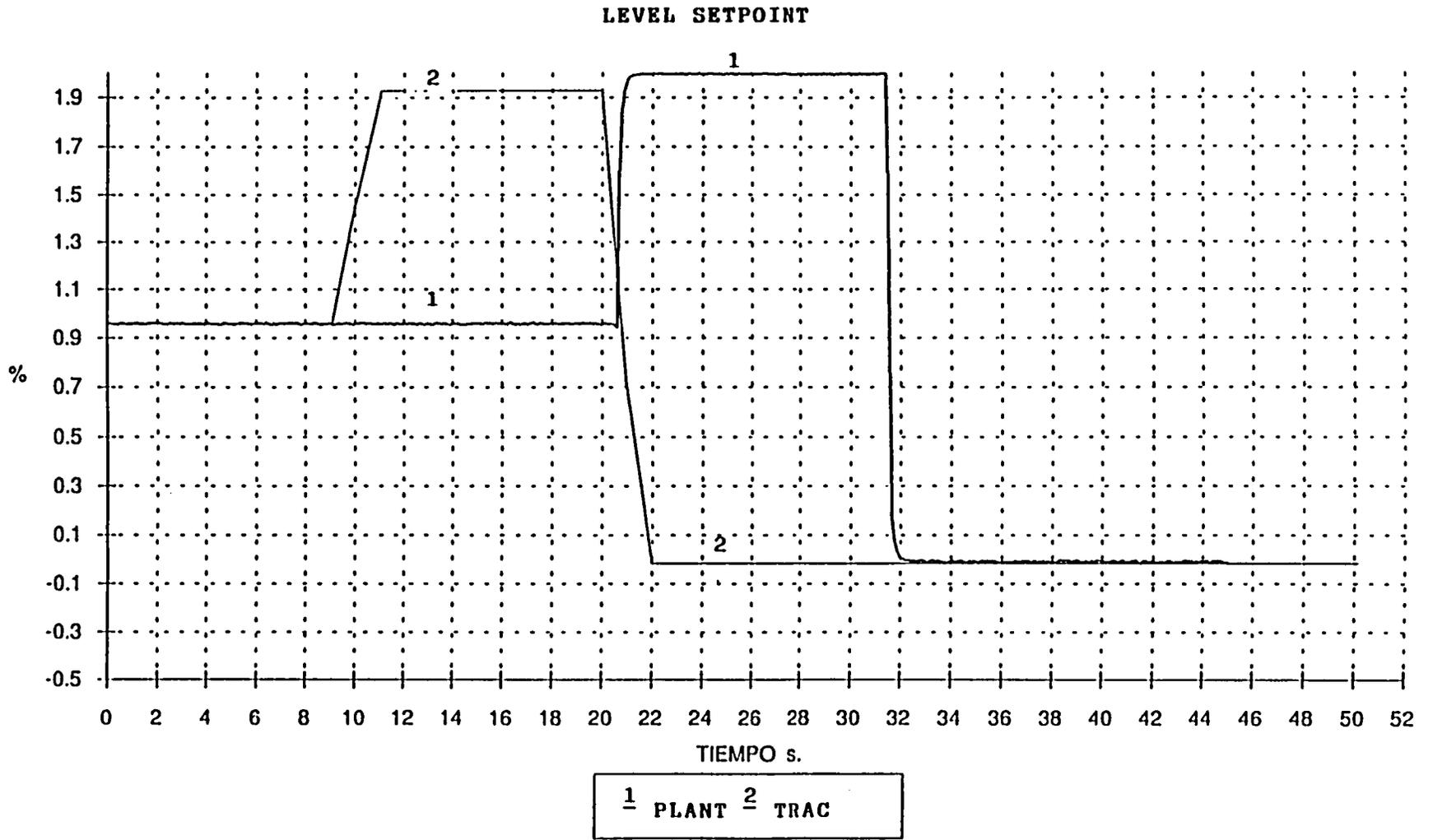


FIGURE 6.19

FEEEDWATER FLOW

6-25

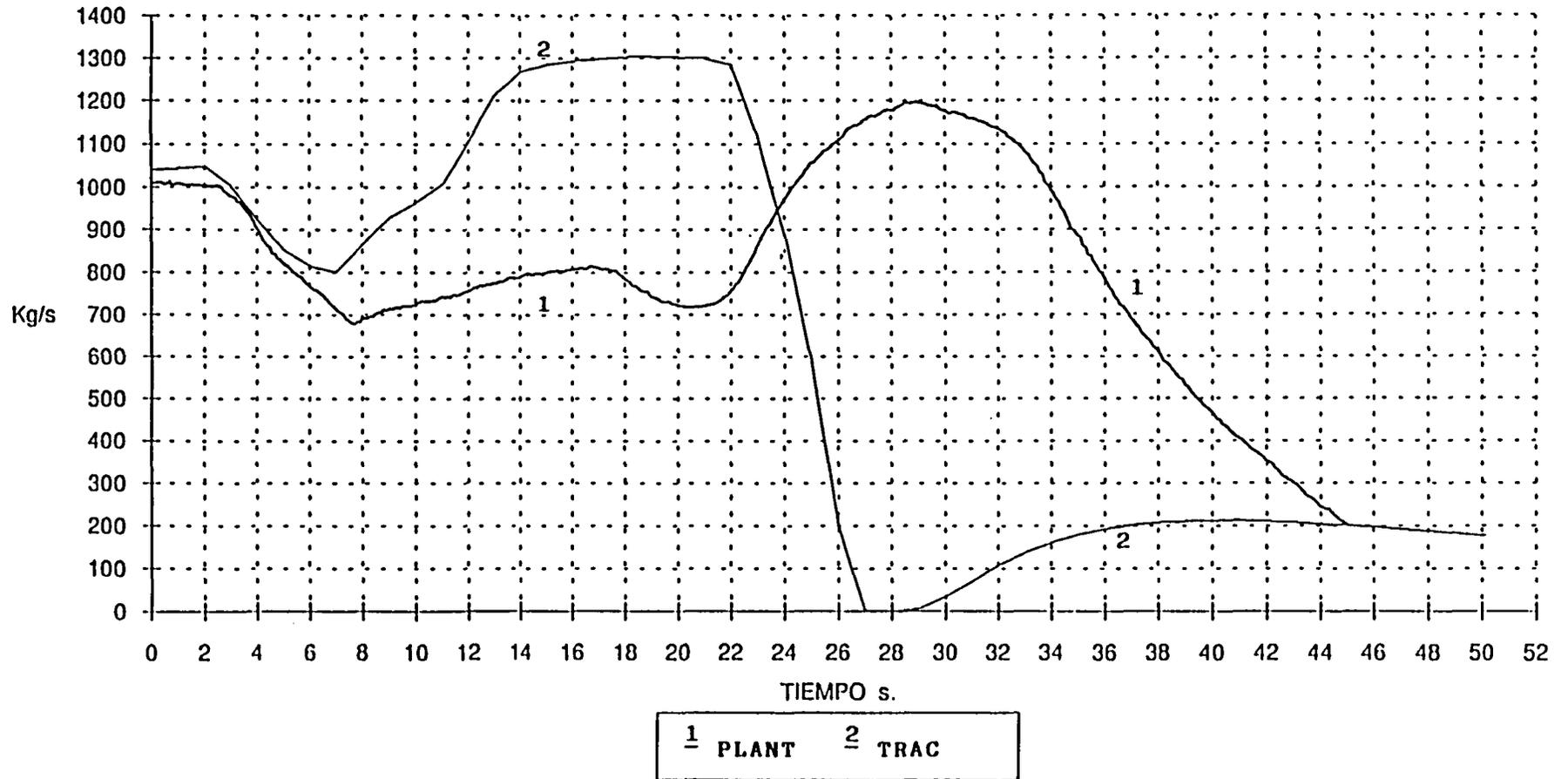


FIGURE 6.20

7.- RUN STATISTICS.-

All TRAC runs were made on a CONVEX-C120 vectorial computer owned by UITESA.

Figure 7.1 is a plot of the relation: "CPU time/transient time", as a function of transient time

Required calculation of "grind time" for this transient, with a total number of 128 cells, for the 23 components of the model, is as follows:

CPU (total execution time)	= 7240 s.
C (total number of volumes)	= 128
DT (total number of time steps)	= 147
RT (transient time)	= 45

$$(\text{CPU} \times 10^3) / (\text{C} \times \text{DT}) = 38.47$$

CPU TIME/ TRANSIENT TIME

7-2

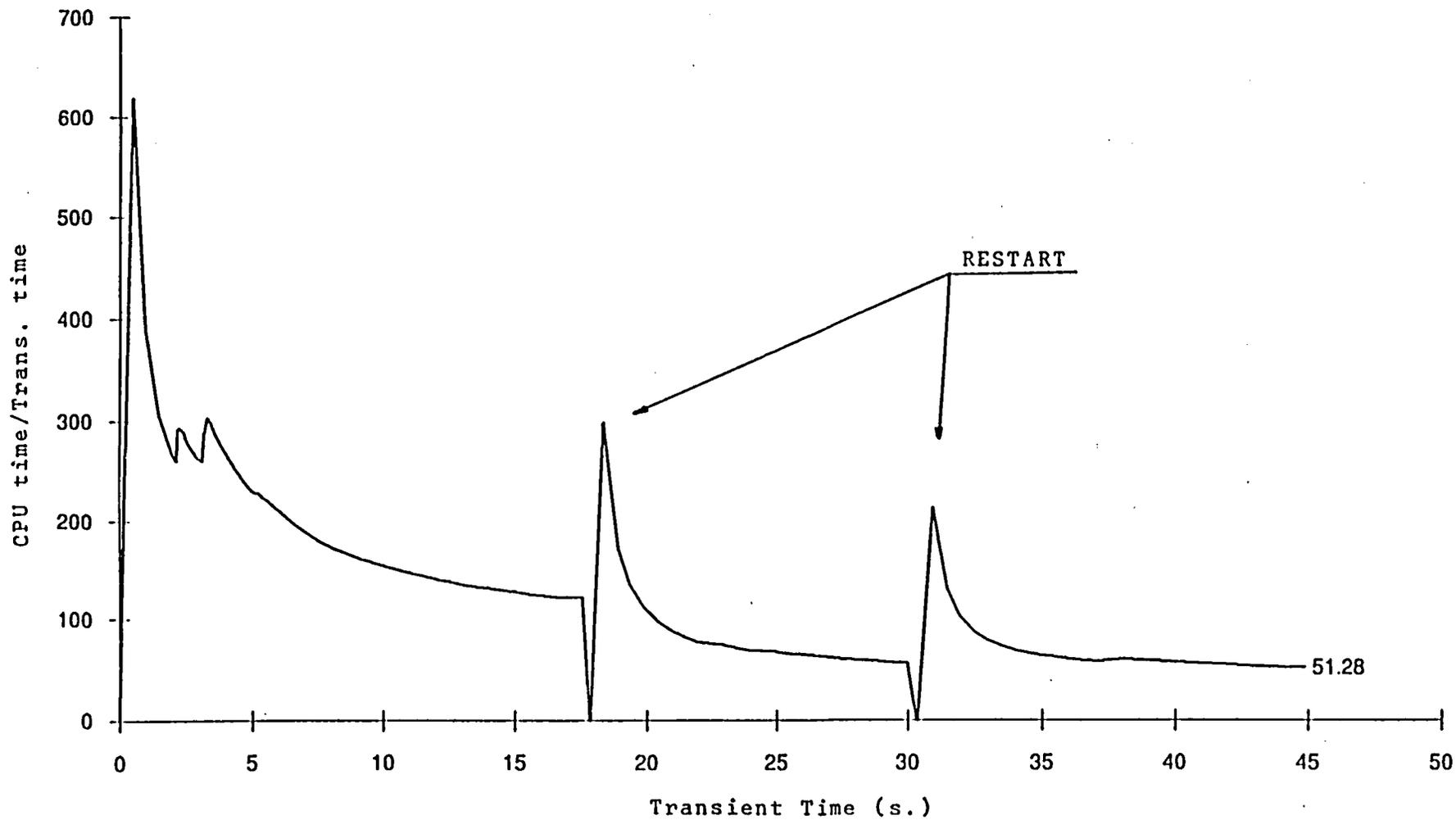


FIGURE 7.1

8.- CONCLUSIONS.

A model of C.N. Cofrentes for TRAC-BF1 has been developed and proved to be adequate for operational transient analysis.

The start-up test of "Turbine Trip" has been reproduced with this model and results have been compared with plant measured data.

A good agreement between calculated results and measured test data has been achieved.

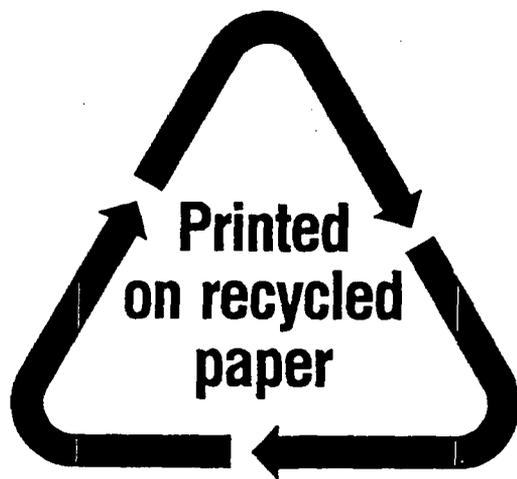
Control systems models closely simulates the response of plant controllers.

Sensed level simulation is a difficult task in presurization transients with drastic core flow reduction, due to the unknown transient distribution of the fluid into the complex flow paths in the separator region. Tuning of geometric vessel parameters for the region (level and rings) representing the separator/dryer leads to acceptable reproduction of sensed level.

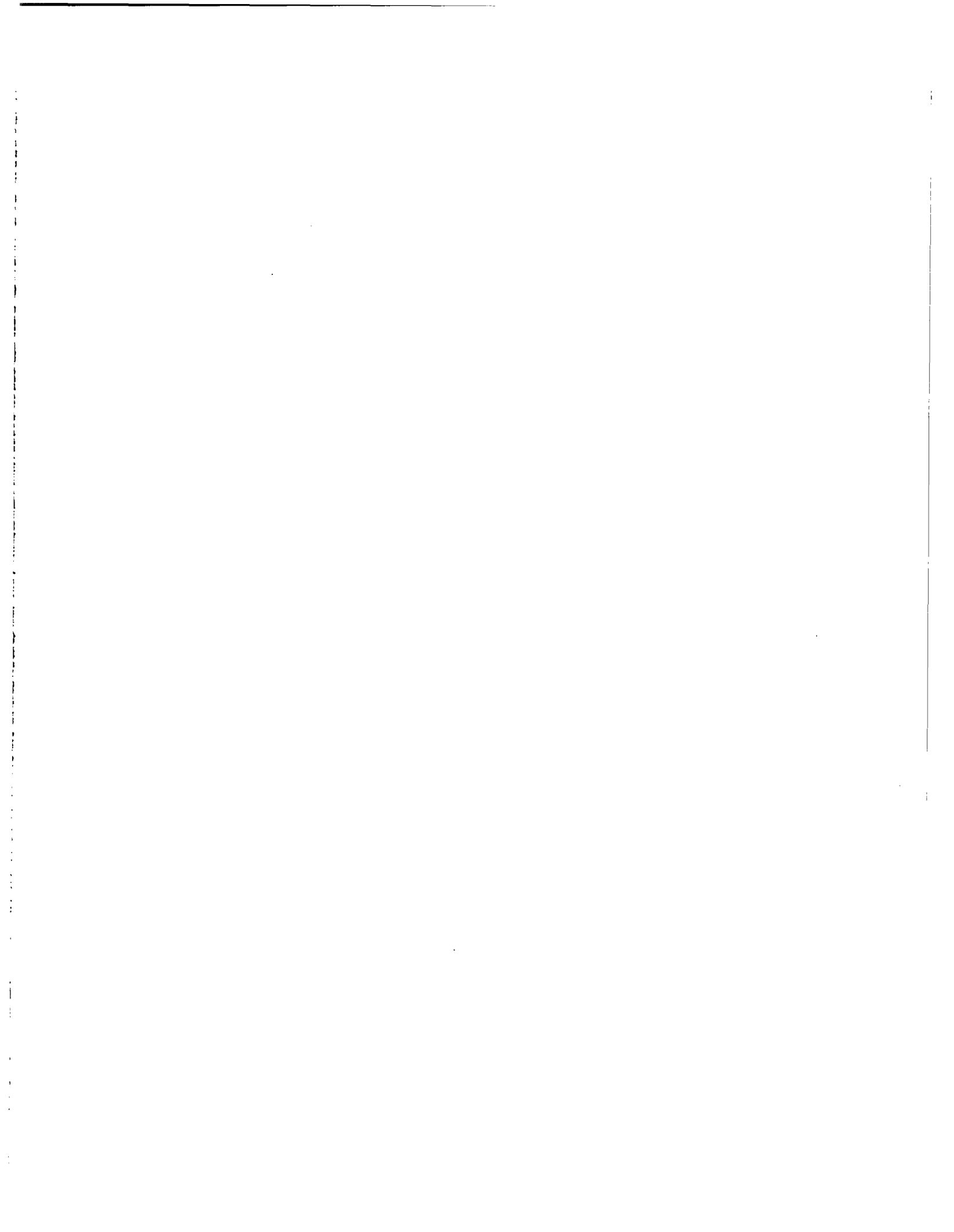
Separator and dryer have been modelled considering perfect separation as the mechanistic model included in TRAC-BF1 didn't work properly.

Recirculation and core flow are the variables which have the greatest differences between measurements and calculations. Improvement of recirculation loop model, and jet pump dynamic performance, are the areas identified for further work in this model.

NRC FORM 335 (2-89) NRCM 1-22, 3201, 3202	U.S. NUCLEAR REGULATORY COMMISSION BIBLIOGRAPHIC DATA SHEET <i>(See instructions on the reverse)</i>	1. REPORT NUMBER <i>(Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)</i> NUREG/IA-0120 EST-SIAN-22
2. TITLE AND SUBTITLE Assessment of the Turbine Trip Transient in Cofrentes NPP with TRAC-BF1	3. DATE REPORT PUBLISHED MONTH YEAR June 1993	4. FIN OR GRANT NUMBER L2245
5. AUTHOR(S) F. Castrillo/Hidroelectrica Espanola (H.E.) A. Gomez/Union Iberoamericana De Tecnologia (UITESA) I. Gallego/Union Iberoamericana De Tecnologia (UITESA)	6. TYPE OF REPORT Technical	7. PERIOD COVERED <i>(Inclusive Dates)</i>
8. PERFORMING ORGANIZATION - NAME AND ADDRESS <i>(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)</i> Unidad Electrica, S.A. c/Francisco Gervas, 3 28020-Madrid, Spain		
9. SPONSORING ORGANIZATION - NAME AND ADDRESS <i>(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)</i> Office of Nuclear Regulatory Research U.S. Nuclear Regulatory Commission Washington, DC 20555		
10. SUPPLEMENTARY NOTES		
11. ABSTRACT <i>(200 words or less)</i> This report presents the results of the assessment of TRAC-BF1 (G1-J1) code with the model of C. N. Cofrentes for simulation of the transient originated by the manual trip of the main turbine. C. N. Cofrentes is a General Electric designed BWR/6 plant, with a nominal core thermal power of 2894 Mwt, in commercial operation since 1985, owned and operated by Hidroelectrica Española, S. A. The plant incorporates all the characteristics of BWR/6 reactors, with two turbine driven FW pumps. As a result of this assessment a model of C. N. Cofrentes has been developed for TRAC-BF1 that fairly reproduces operational transient behavior of the plant. A special purpose code was generated to obtain reactivity coefficients, as required by TRAC-BF1, from the 3D simulator.		
12. KEY WORDS/DESCRIPTORS <i>(List words or phrases that will assist researchers in locating the report.)</i> ICAP Cofrentes TRAC Turbine Trip	13. AVAILABILITY STATEMENT Unlimited	14. SECURITY CLASSIFICATION <i>(This Page)</i> Unclassified
		<i>(This Report)</i> Unclassified
		15. NUMBER OF PAGES
		16. PRICE



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ASSESSMENT OF THE FORBIDING THE TRANSPORT AND CONFINEMENT OF HIGHLY ENRICHED
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