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Institut für Reaktorentwicklung

Models, Methods and Digital Computer Programs for Analyses in Reactor Dynamics with Emphasis on Fast Breeder Reactors and Compressible Single-Phase Coolants

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GESELLSCHAFT FÜR KERNFORSCHUNG M.B.H.

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Gesellschaft für Kernforschung m.b.H., Karlsruhe

Work performed within the association in the field of fast reactors between the European Atomic Energy Community and Gesellschaft für Kernforschung m.b.H., Karlsruhe.

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Preface

Obsoleteness is a common and often inherent feature found with digital computer codes. In spite of it a threefold purpose is seen in compiling a report such as this. One of its objectives is to serve as a manual for direct application of the codes described to the class of reactors and problems for which they were indended (see title). Secondly, a description of the model employed is to give sufficient information for potential applications and extensions to a range of cases wider than originally foreseen. Finally, some methods and techniques are presented which were developed during the course of this work and which are believed to have general significance in the field of reactor dynamics analysis.

The model and program described herein evolved from the FORE-code <u>/</u>1,2<u>7</u>. Therefore nearly all the model features of that code are incorporated as constituents of the basic model presented here. Abandoned parts are those which appeared either too restrictive (incompressible coolant) or overly simplifying (treatment of parallel channels). Many new features have been added; the most prominent ones concern the hydraulics model now able to cover any compressible single-phase coolant flowing through the reactor in two sections connected in series. Each of these sections itself may consist of an arbitrary number of different flow channels connected in parallel.

In this place the helpful assistance and advise is to be acknowledged of all those people who contributed to the completion of this work at various stages. The author is obliged especially to Ing. D. Janssen for valuable help with digital programming.

Karlsruhe, December 1968

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I. Introduction

Work reported here started as a part of the steam cooled fast breeder reactor project pursued by the GfK. Its early goal was to make available a tool for the analysis of the dynamic behavior of the type of reactors being considered at that time. Although a rather detailed analog model already existed $\sqrt{-3}$ 7 it was found necessary to complement it with a digital code. Arguments concerning the choice of computational means are as numerous as they are inconclusive. Extensive experience gained during this work from comparisons with analog calculations have led to the conclusion that neither system is pre-eminently suited for the whole range of problems posed in reactor dynamics. It appears that reactor stability and control as well as systems circuit analysis are mainly a domain of analog studies whereas reactor accident analysis and certain aspects of reactor stability are suitably studied by using digital techniques. Storage capacity and computing speed of second generation machinery (IBM 7074/7094) together with considerations of numerical stability restricts the study of dynamics models to roughly the same amount of detail as can be accommodated by models designed for large analog computers (76 integrators, 34 multipliers, 360 pots) where number of components is the only restriction. Only third generation digital computers (IBM 360) give a lead to digital methods with respect to handling complex nonlinear problems encountered in accident analysis. However, the ease of making adjustments to the model which is afforded by the analog computer cannot be matched on digital machines, a situation which has remained essentially unaffected by the advent of even the latest digital equipment.

The model which has been adopted here is characterized by the following prominent features:

a) The model covers only components of the reactor proper, such as: core, blankets, bypasses within the pressure vessel, orifices, plenum chambers, etc. An external reactivity disturbance as well as one out of a choice of three boundary conditions for the coolant at reactor entry and exit must be given as functions of time ("driving functions").⁺⁾

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⁺⁾ A digital model describing the dynamic behavior of all circuit components external to the reactor is being developed by the IRB (Institute for Reactor Components) at the GfK. Both programs are designed to be integrated into a single code giving a complete description of the entire reactor system.

- b) The reactor is assumed to remain intact at all times. The only changes in reactor geometry are those associated with certain feedback mechanisms. They are assumed to have negligible effects on the thermo-hydraulic characteristics of the reactor.
- c) Fuel elements are assumed to have the shape of solid cylinders (pins) surrounded by annular cladding and cooled uniformly over the perimeter. Fuel melting can be handled in good approximation. The coefficient of heat transfer through the fuel cladding-gap is assumed to be invariant. Coolant flow within the fictitious annular channel is assumed to be entirely in the turbulent regime. Any structural components inside the core and the blankets are accounted for by introducing equivalent structure along the flow channel.
- d) The hydraulic model permits rather accurate treatment of any single phase coolant (liquid or gaseous) for which the standard relations of state variables can be supplied. Pressure disturbances are assumed to propagate with infinite velocity throughout the coolant (extended version of the integral momentum model $_^{-4}_^{-1}$). A rather general formulation of the relation for the heat transfer between channel walls and coolant permits a wide range of applications. Coolant pressure drops in orifices and in the coolant channels are treated in the customary way and allow for integral treatment of turbulence promoters. An arbitrary number of different parallel flow channels individually orificed may be specified in both of the two main sections (radial blanket, core and axial blankets) which in turn are connected in series via an intermediary plenum chamber. Complete mixing and zero residence time are assumed for all of the three plenum chambers. Flow channels in the first section (radial blanket) may be treated as bypasses.
- e) A special feature of the model is its ability to handle transient problems where flow stagnation or reversal occurs.
- f) The time dependent behavior of the neutron density in the reactor core and blankets is described by the well known point reactor kinetics model. In order for this model to be consistent with the models for thermohydraulics and feedback it is consequent to assume time invariant functions for the spatial distribution of the thermal power density as well as for the reactivity importance throughout the reactor. The implications of these assumptions shall not be discussed in this report. Simplicity of this model was the guiding aspect in making this choice.

- g) A versatile and comprehensive feedback model is incorporated which accounts for the Doppler effect, for various causes of density changes due to thermal expansion of components and for changes in the overall core geometry due to thermal expansion of certain components.
- h) The reactor is assumed to be at an initial state of delayed criticality operating on a prescribed power level. The entire feedback of reactivity is thought to be balanced by external reactivity adjustments. (The relative value of this reactivity at different initial states can be used as a measure of the aperiodic stability of the reactor $\sqrt{5}$.) Furthermore, the thermohydraulic variables of the reactor also are assumed to be in a state of equilibrium at this power level. This equilibrium solution is obtained in a separate calculation but it is consistent with the set of equations describing the transient behavior.
- i) The transient solution is obtained by integration of the pertinent system of differential equations in discrete steps using explicit first order backward difference formuli. The size of these steps may be determined from considerations of numerical stability and accuracy internal to the program.

In addition to these main features and functions of the basic model there are some contingent areas which have been given special attention as they are of considerable importance for many problem cases of a general class. Three of these are listed below.

- j) The relations between state variables for superheated steam cannot be reduced to simple analytical formulations. Rather complex expressions on one hand and extensive tables on the other do not satisfy the need for compact and fast algorithms such as required by dynamics calculations in conjunction with multi-node models. Therefore, a set of polynomial expansions was generated by means of least squares fitting to the relations which are concerned and which were supplied accurately but inefficiently by other subprograms <u>/</u>6_7. Since excessive accuracy is not required here these expansions have proved to be of all important convenience and this technique is recommended for all coolants where simple relations for the state variables do not exist in the range of interest.
- k) Since many applications of this model relate to reactor accidents (excursions)-analyses a rather versatile model for SCRAM functions

(external reactivity vs. time, for emergency shut down) was worked out in several options to be described in this report.

- The computer program based on this model (subroutine REXION) is designed to be integrated with another program describing the dynamic behaviour of the system external to the reactor. However, there are instances where such a program does not exist and/or may not be required. Examples for such cases are:
 - stability and dynamics studies of the reactor alone
 - analyses of rapid excursions with little feedback from the reactor on the coolant circuit behavior.

To facilitate such studies the program is provided with a control section (main program REX) which admits applications independent of any other program. Of course, in such cases time dependent boundary conditions for the coolant at reactor inlet and outlet must be supplied as input information to the control section.

Subsequently the model will be described in greater detail. Then a concise description of the computer program will be given complete with instructions for input preparation and output listings. The pertinent system of equations is compounded in APPENDIX A. Further appendices are dedicated to the treatment of several special topics regarding models, methods and codes. An annotated sample problem is included for illustration in the last appendix.

II. Thermo-Hydraulic Model

II.1 General Lay-Out

The most general configurations that can be treated are sketched in Fig. 1. The coolant passes the reactor in two sections which are connected in series. These sections are separated by the intermediary plenum chamber and terminated by the entry and exit plenum chamber, respectively. The spatial arrangement of plenum chambers and flow sections is arbitrary and may be of a kind as shown in Fig. 1. With respect to the sketch on the left it must be remarked that the length of both flow sections is assumed to be equal. Order and nomenclature of these components are associated with the <u>initial</u> direction of coolant flow which is from the entry to the exit plenum chamber as depicted in Fig. 1.

The plenum chambers are characterized by complete and instant mixing of all entering coolant streams, zero residence time and zero pressure drop of the coolant.

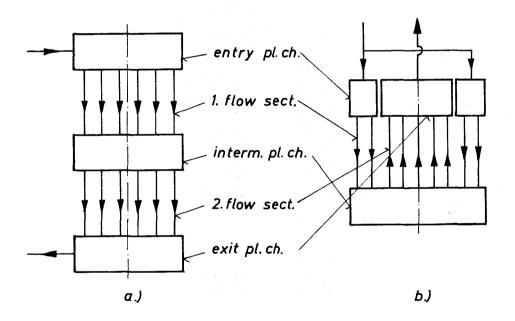


Fig. 1 Two Possible Configurations of Main Components

The first flow section is thought to represent the radial blanket. Its thermo-hydraulics are treated in a manner more crude than the one adopted for treating the second section. It does not contribute to the feedback of reactivity. It may be skipped entirely in the calculation. The coolant passes this first section through a number of parallel channels. Channels

with identical parameters are called a radial zone and are represented in the calculation by only one such channel. The number of radial zones is arbitrary +). Either one out of two different types of channels may be specified for any radial zone of the first section. The first type is to represent a typical radial breeder pin-channel-structure-combination consisting of a cylindrical pin with a uniform heat source, an equivalent annular flow channel which may be orificed at the entry, and an equivalent structural component (see Fig. 2). Neither axial subdivisions of the pinchannel-structure-unit nor annular subdivisions of the pin are provided since a rough model appears to be adequate in this place. The second type of channel is to represent a bypass and consists of two concentric tubes with coolant flowing in between. The inner tube may have an uniformly distributed heat source. Both tubes are assumed to be thermally insulated on their dry surfaces and may be orificed at the entrance. In particular, such a bypass may represent a single annular flow path outside the perimeter of the radial blanket.

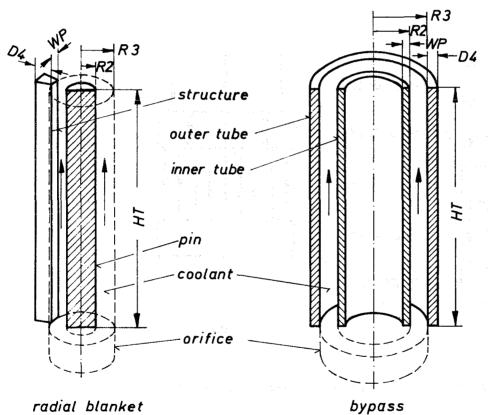


Fig. 2 Channel Types of First Section

⁺⁾Here, as well as in all subsequent instances arbitrary numbers of components and zones are restricted only by DIMENSIONS specified in the corresponding programs. In the present version these are chosen to accomodate most cases of practical interest and may be extended whenever necessary.

The second flow section is in many ways similar to the first one. It is to represent the core and the axial blankets of the reactor. Only one type of channel can be specified. Again, anyone such channel stands for a whole (radial-) zone of identical channels. The number of zones differing in geometry and/or thermo-hydraulic parameters is arbitrary. A channel consists of a cylindrical pin surrounded by an equivalent annular stream of coolant and an equivalent structural component. Flow may be orificed at the entrance. In axial direction (= direction of flow) the pin-channelstructure-unit is divided into the core section and one axial blanket section at both ends. Either one or both of these axial blanket sections may be omitted. The core section alone may be subdivided further into an arbitrary number of sections of equal height. In the core section the pin is composed of a cylindrical fuel body surrounded by annular cladding. For adequate description of the temperature distribution the fuel cylinder is subdivided by fictitious interfaces into an arbitrary number of concentric annuli of equal volume except for the outermost annulus and the center cylinder having half this volume.

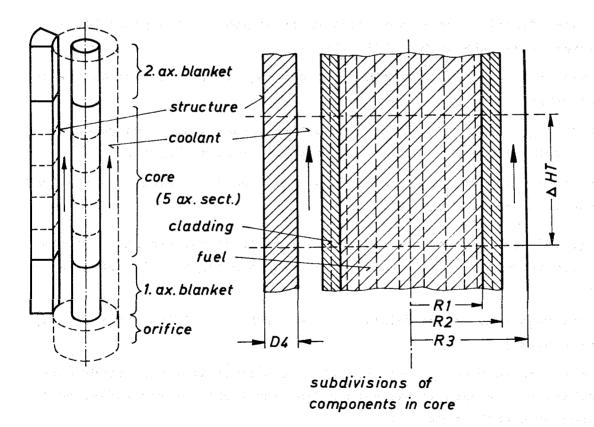


Fig. 3 Pin-Channel-Structure-Unit of the Second Section

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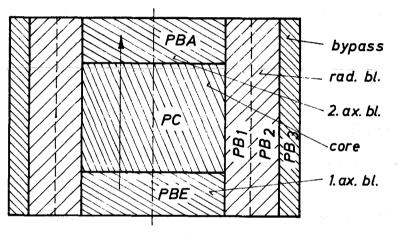
II.2 Heat Source Distribution

The reactor power determined by neutron kinetics in conjunction with external reactivity as well as feedback is released as thermal energy in various components of the reactor. The spatial distribution functions are assumed to be time invariant and are prescribed. Thus, a fixed fraction of the total power is released within the pins of each radial blanket zone and the walls of the inner tubes of each bypass zone. These fractions PB together with the dimensions of the components involved and in conjunction with the assumption of uniform heat source distribution determine the volumetric heat source strength required for the calculation of temperatures in the first flow section.

In the second flow section fixed fractions PBE and PBA of the total power are assumed to be released within the first and the second axial blanket, respectively. Distribution over radial zones and components of the axial blankets conform with those of the core. The remaining power (= total -(radial bl. zones + bypass zones) - l.ax. bl - 2.ax. bl) is distributed over the core in the following way (see also Fig. 4):

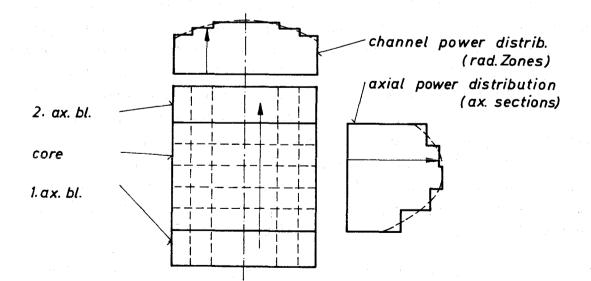
- a) The axial distribution is specified by fractions corresponding to individual axial subsections. Note that:
 - these fractions may be relative since normalization is carried out by the program;
 - these fractions are proportional to the average linear rod power of each subsection as these subdivisions are of equal height;
 - the same axial distribution applies to all parallel flow channels (rad. zones) in the second flow section.
- b) The radial distribution is specified by fractions corresponding to the relative thermal power of each channel representing a radial zone. Note that:
 - these fractions may be relative since normalization is carried out by the program;
 - these fractions are proportional to the volumetric radial power distribution (averaged within each radial zone) only if the radial core zones have equal geometry;
 - the radial distribution specified by these fractions applies to all axial core sections and to the axial blankets.

- c) The power distribution over the core components is specified by fractions giving the relative volumetric thermal power density in each component (fuel, clad, coolant, structure). Note that:
 - these fractions may be relative since normalization is carried out by the program;
 - uniform power distribution is assumed in each of the four components;
 - these fractions apply to all radial zones and axial sections of the core;
 - in both, the radial and the axial blanket all power is assumedly released in the pins only.

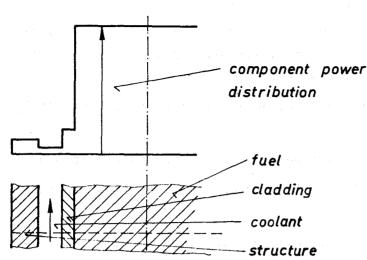


 $PC+PBE+PBA+\sum_{i}PB_{i}=1$

a) Power Distribution: Core-Blankets-Bypasses



b) Radial and Axial Power Distribution in Core (and Axial Blankets)



c) Power Distribution in Core-Components

Fig. 4 Power Distribution

II.3 Heat Flow and Temperatures

For the calculation of the temperatures in the fuel pin the customary assumptions of

- uniform heat release within the entire fuel pin volume of any axial section and
- no heat conduction in axial direction of the fuel pin

are made. The cylindrical fuel body is subdivided by fictitious interfaces such as described before. The temperature distribution in each axial section of any such annulus is represented by a single temperature and heat transfer as well as heat storage is computed in terms of this temperature ("nodal model", "lumped model"). Under steady state conditions this temperature is equal to the volume average temperature of the annular cell; for the central cylinder it is the central (maximum) temperature and for the outermost annulus it is the fuel surface temperature. If the thermal conductivity of the fuel is a function of temperature these statements are no longer accurate since the program evaluates the conductivity for each annulus at the temperature of the adjacent outer annulus.

In addition to the thermal conductivity the specific heat of the fuel also may be a prescribed function of the fuel temperature.

Fuel melting is treated in an approximate form: if the representative temperature of any fuel node reaches the melting point upon rising, it is

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kept constant until the net influx of heat into the volume equals the latent heat of fusion.

Recrystallization is treated in a similar manner upon a temperature drop through the temperature of recrystallization. Both, the temperature as well as the heat of fusion and recrystallization are taken to be equal. The program also admits the case that a part or all of the cells (nodes) in the fuel are molten at the initial equilibrium.

The nodal model which was selected here is one out of many possible choices. It is distinguished by yielding a correct steady state solution when the nodal temperatures are identified with the volumetric averages. This is significant especially with respect to calculating the reactivity feedback associated with the Doppler effect in the fuel. Regarding the transient solution one only can state that heat is conserved in the system of equations and that an increasing number of subdivisions will make the solution converge asymptotically to the correct solution. The results of a special study carried out for this purpose are described in APPENDIX B. and may serve as an aid in the selection of an adequate number of annular subdivisions for any particular case as a function of fuel parameters and accuracy requirements.

Heat transfer through the gap between fuel and cladding is assumed to be a function of the difference between the interface temperatures of fuel and clad only. The coefficient of heat transfer through the gap thus is a prescribed constant. More sophisticated models relating to this part may be introduced as they become available.

The annular cladding is treated as a thin slab and is subdivided by a fictitious interface into two annuli (slabs) of equal thickness. The nodal temperatures associated with these two annuli coincide with the temperatures at the inner and outer surface at steady state. In contrast to the fuel, the material parameters of the cladding are taken to be invariant. A heat source may be specified for the cladding and is assumed to be distributed evenly over the volume of each axial section.

In order to account for the effects brought about by the presence of structural components in core and blanket it is assumed that each channel also comprises a rectangular body of structural material extending over its full length (core + ax. blankets). This body is to be equivalent to the actual structure with respect to thermo-hydraulic characteristics. Three faces of the prismatic body are assumed to be thermally insulated, the remaining face is in contact with the stream of coolant and permits exchange of heat. Only in the core region heat sources may be specified for the structure, which then are distributed uniformly over the entire volume of an axial section (the axial distribution being the same as in fuel, cladding, and coolant). The nodal temperature representative for the actual temperature distribution of each axial section coincides with the volume average temperature at steady state conditions.

Heat transfer between the coolant and either the cladding or the equivalent structure is computed following a slightly generalized form of the Nusselt equation as proposed by Sutherland $\frac{7}{7}$. It is based on the assumption of a coolant wholly in the turbulent flow regime⁺⁾

$$N_{u}^{H} = CH \cdot Re^{AL1} \cdot Pr^{AL2} \cdot (\frac{T_{3} + 273.16}{T_{W} + 273.16})^{AL3}$$
 (1)

$$N_{u}^{*} = \frac{(H_{J} - AL_{J}) \cdot DH}{FLAM}$$
(2)
$$Re = \frac{N \cdot DH}{ETA}$$
(3)
$$Pr = \frac{CP_{J} \cdot ETA}{FLAM}$$
(4)

CH, AL1, AL2, AL3, AL4 ... prescribed parameters Solving equation (1) for the film coefficient H3 we get

$$H3 = AL4 + \frac{CH}{DH^{(1-AL1)}} \cdot (N)^{AL1} \cdot (\frac{FLAM^{(1-AL2)} \cdot CP3^{AL2}}{ETA^{(AL1-AL2)}})$$
$$\cdot (\frac{T3 + 273.16}{TW + 273.16})^{AL3}$$

(5)

The additional constant AL4 is introduced in equation (2) for convenience of specifying an invariant film coefficient $H_3 = AL4$ while at the same time setting AL1 = AL2 = AL3 = 0.

+) see APPENDIX A for nomenclature

All of the intensive parameters in equation (5) refer to the coolant with exception of the wall temperature TW. These parameters are evaluated at the midpoint of each axial section. The state variables of the coolant are taken to vary linearily over the length of each section. The occurrence of TW in equation (5) necessitates an iterative procedure for determination of TW at the initial equilibrium. This is described in APPENDIX D.

The energy balance of the coolant is computed in terms of its enthalpy. Contributions of kinetic and potential energy are neglected. The coolant pressure is obtained from hydraulics calculations described in the next chapter. These two state variables are sufficient for obtaining all of the remaining coolant properties required in equation (5) by way of state relationships(i.e. temperature, specific heat, specific volume, viscosity and thermal conductivity). For the energy balance in the transient case it is assumed that heat storage in the coolant of each axial section is associated with the value of the exit enthalpy. This particular choice of a nodal model is not quite as accurate as the one employing the enthalpy averaged along the channel length of each individual section. However, the error in the transient may be kept small by increasing the number of axial sections. On the other hand, this nodal representation is particularily suited for handling the case of flow reversal during a transient, which is a major objective of this work. For further details concerning the treatment of flow stagnation and reversal see APPENDIX E.

Much of what is said above also applies to the calculation of temperatures in the radial and axial blankets as well as in the bypass(es). However, there the calculation is simplified by prescribing invariants for all material properties as well as for the film coefficient of heat transfer to the coolant and by lumping the pin temperature distribution of each section into one node. In the case of the blanket pin the nodal temperature coincides with the maximum temperature on the center axis for steady state conditions, when the coefficient of heat transfer is specified so as to include also heat transfer through cladding gap and breeder pin, which are not accounted for separately ⁺⁾. For the nodes associated with equivalent structure and/or bypass walls the nodal temperatures agree with the

⁺⁾For the case indicated above the coefficient of heat transfer can be obtained from:

1./HFS = R1/R2.(R1/C4.CØ1)+1./HGP+(R2-R1/CØ2+R1/(R2.H23))

if the blanket pin is of a design similar to the fuel pin.

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volume averaged temperatures under the same conditions as before. It is recalled that the model does not provide axial subdivisions for any of the blankets and/or bypasses. Fig. 5 sketches the nodal representation of the reactor, on which the thermo-hydraulic model is based.

In solving the ordinary differential equations resulting for this nodal model (see APPENDIX A) a single explicit backward difference scheme is applied. It is known that in this case the step size for integration over time must comply with certain criteria in order to ensure numerical stability of this method. Since these criteria are prohibitively complex in the underlying case approximate criteria were developed, which yield conservative estimates of the maximum step size for stable integration of the thermo-hydraulic equations. Details on this subject are compiled in APPENDIX H.

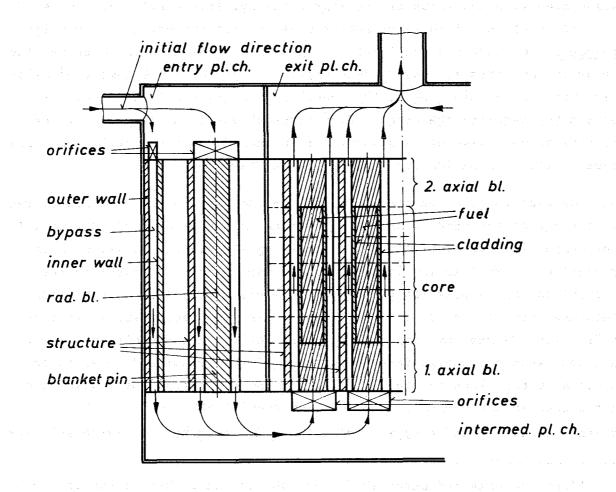


Fig. 5 Nodal Representation of the Reactor for Thermo-Hydraulic Model

II.4 Coolant Hydraulics

Three kinds of pressure losses are distinguished in each flow channel.

a) Pressure loss at the channel entrance:

$$\Delta p_{\rm E} = 1.5 \cdot \frac{N^2 \cdot V}{2 \cdot g \cdot 10^4} / [at_7]$$
(6)

It is assumed that no pressure recovery occurs at the channel exit. Note that this pressure loss will occur at the other end of the channel in case of flow reversal.

b) Pressure drop through orifice:

$$\Delta p_{\rm T} = FT \cdot \frac{N^2 \cdot V}{2 \cdot g \cdot 10^4} \qquad / at_7 \qquad (7)$$

The coefficient FT may be chosen different for each radial zone and is both purpose and means of controlling the distribution of coolant flow through the various flow paths in parallel.

c) Pressure loss due to friction along the wetted surface of the channels (cladding + equivalent structure) and to acceleration:

$$\Delta p_{R} = \frac{N^{2}}{g \cdot 10^{4}} \left[\frac{FR \cdot \Delta H}{2 \cdot DH} \cdot V + (VA - VE) \right] / at_{7} (8)$$

In the present model pressure loss associated with flow of coolant through the plenum chambers is neglected. The condition determining the distribution of coolant mass flow through parallel channels is that of equal pressure drop in all of these channels. For the initial steady state an iterative procedure is used to achieve this. In the transient calculation a scheme of delayed correction is applied to satisfy the criterion of equal pressure drops without need for iterations. APPENDIX C gives a rather detailed account of the pertinent procedures. APPENDIX E is referred to for more information about the calculation of pressure drops in the case of flow stagnation or reversal.

II.5 Coolant Boundary Conditions

There are three links by which this model representing the reactor is coupled to the remaining system. These are:

a) state of coolant at the entrance

b) " " " " exit

c) disturbances of external excess reactivity (control rods - control system)

Items a) and b) are not entirely independent of each other. In any case it appears practical to prescribe the enthalpy of the coolant as it enters the reactor. The exit enthalpy then is determined directly by the balance of energy. Regarding the hydraulic boundary conditions there is no such unique choice. Therefore, the model was made to accommodate three different choices:

- B.C.1 Prescribe: pressure at entry, as a function of time;
 - coolant mass flow rate through reactor, at initial steady state;
 - pressure at the exit relative to the initial value, as a function of time.
 - Obtain: pressure at the exit, at initial steady state; - coolant mass flow rate, as a function of time.

This particular set of boundary conditions is advantageous in connection with the integration of this model with a corresponding model for the external coolant circuit.

B.C.2 Prescribe: -pressure at exit, as a function of time; -coolant mass flow rate, as a function of time;

Obtain: -pressure at entry, as a function of time.

B.C.3 Prescribe: - pressure at entry, as a function of time; - coolant mass flow rate, as a function of time;

Obtain: - pressure at exit, as a function of time.

For B.C.2 an iterative procedure is required to find the initial steady state solution since in all cases the calculation starts at the entrance where coolant pressure is unknown in this particular instance. For the transient calculation of the same case a scheme of delayed correction is applied thus avoiding time consuming iterative procedures (see APPENDIX C).

III. Neutron Kinetics and Feedback Model

For the description of the transient reactor power the well known point reactor kinetics model is employed. Its solution requires integration of a coupled system of ordinary linear differential equations with time dependent coefficients. This integration is carried out using a semianalytic method taken over in main parts from the FORE-code / 1 7 and described in APPENDIX F. The basic scheme of integration outlined in the appendix is augmented by two other schemes. One of them is applied in the vicinity of prompt criticality since the basic scheme is singular at this point. The other scheme corresponds to the prompt jump approximation and is a more efficient scheme of integration which applies when the system is well below prompt critical. Decisions about selecting the proper scheme out of these three are based on the results of certain tests carried out at each step of the step by step-integration. Among other criteria the size of such a step is limited by the relative change of the reactor power during a step, for which upper and lower limit may be prescribed. The step size will be decreased or increased respectively until the actual value of the relative change falls within these limits. A correlation between both, accuracy and stability of this method of integration and this criterion for selection of step size could not be established in the framework of this effort. On the other hand, practical experience gained from its successful application as well as successful application of the same criterion in other methods of integration of point kinetics equations have given enough confidence to validate this approach.

The feedback model, too, draws main features from the FORE-code but it is implemented with a number of significant additions and modifications. In spite of the already great amount of details included in this feedback model it is felt that much more refinement might be required in certain cases. However, at this point such refinement must be left with further development efforts.

Presently, all feedback of reactivity accounted for is associated with temperature and/or density changes in the core only. The reactivity feedback from the Doppler effect is taken to be proportional to the weighted average over the fuel volume in the core of the natural logarithm of the fuel temperature in ^OK. Both, axial and radial weights may be specified. These weights may be relative as normal-

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ization is carried out in the program. The normalization is such that an isothermal temperature rise $\Delta T = T_1 - T_0$ throughout the fuel in the core will result in a Doppler reactivity change of $\Delta k_D = \text{RCD} \cdot \ln(T_1/T_0)$, where RCD is the Doppler constant specified in the input. The basic formula for calculating the Doppler feedback reactivity is

$$\Delta k_{\rm D} = RCD \frac{\int ARD \cdot AXD \cdot \ln((\overline{TF} + 273.16)/(\overline{TF}_{\rm o} + 273.16) \cdot dV_{\rm F}}{\int ARD \cdot AXD \cdot dV_{\rm F}}$$
(9)

 $\overline{TF} = \frac{1}{V_z} \cdot \int TF \, dV_z \dots \text{ fuel temperature averaged over the pin} \\ \text{volume } V_z \text{ of an axial section} \\ V_z = Rl^2 \cdot \Pi \cdot \Delta H$ (10)

The effects on reactivity of changes in the density of any core component are treated correspondingly as weighted averages over the component volume in the core of the respective temperatures multiplied by their linear thermal expansion coefficient. As in the case of the Doppler feedback, the weights are assumed to be separable into functions of the axial and radial coordinate (index) respectively (normalization not required). Thus, the product of feedback coefficient times expansion coefficient of each component is equal to the total feedback from this component if a uniform temperature change by 1 °C is imposed throughout the core. Here the basic formula is

$$k_{i} = -RC_{i} \frac{\int_{AR_{i}} AX_{i} \cdot T_{i} \cdot AE_{i} \cdot dV_{i}}{\int_{AR_{i}} AX_{i} \cdot dV_{i}}$$
(11)

where the index i refers to the three solid components: fuel (F), cladding (C), structure (M). For the coolant density changes can be computed directly as the specific volume V is available:

$$k_{s} = RCS \cdot \frac{\int ARS \cdot AXS \cdot (1/V) \cdot dV_{s}}{\int ARS \cdot AXS \cdot dV_{s}}$$
(12)

The effects of changes in the overall core geometry (height and radius) are also comprised in the feedback model. Increases in the core height are associated with thermal expansion of the fuel and radial increases with lateral expansion of the structural components of the core. Weighting functions have not been incorporated in this part of the model as yet. The pertinent formuli are:

$$k_{\rm H} = RCH \cdot \frac{\int AEF \cdot \overline{TF} \cdot dV_{\overline{F}}}{\int dV_{\overline{F}}}$$
(13)
$$k_{\rm R} = RCR \cdot \frac{\int AEM \cdot \overline{TM} \cdot dV'_{\rm M}}{\int dV'_{\rm M}}$$
(14)

$$V_{\rm M} = \Delta H \cdot AN$$
 (15)

With the general formulations used for the temperature and density feedbacks on reactivity (equation (11), (12)) it is possible to include mechanisms other than the change of smear density of a component caused by a change in its temperature. For instance, one may account for the effect of coolant displacement by cladding expansion and for effective density changes of all components caused by dimensional changes in the supporting core structure due to thermal expansion or contraction. In such cases, the reactivity coefficients (RC_i), the weights (AR_i, AX_i) and the expansion coefficients (AE_i) appearing in equations (11) and (12) must be determined by superposition of the various effects to be included. This is illustrated by a typical example presented in APPENDIX G.

IV. Program Description

IV.1 General Code Structure

Flexibility in operation and application of any complex program is furthered by employing modular programming techniques. This principle was followed here to a large extent. One of the most prominent exceptions is the feedback calculation, which is attached to the thermohydraulic calculations. The reason for this is a gain in computational speed and reduction in storage requirements since all contributions to the feedback originate from changes in thermo-hydraulic variables and may be computed efficiently along with these variables. Another exception is the calculation of the film coefficient of heat transfer to the coolant in the core. Here, too, the calculation is tied in strongly with thermo-hydraulics and an integrated treatment appears advantageous.

The programming language used in all parts is FORTRAN IV compatible with FORTRAN II if all READ and WRITE and COMMON statements are adjusted to comply with FORTRAN II rules. The program has been tested out successfully on the following computers: IBM 7074, 7094, 360/65. The version for IBM 7074 computers requires OVERLAY structure.

Fig. 6 lists all routines required by this program together with their major functional characteristics. Fig. 7 shows a logic flow diagram depicting the interconnections between these routines.

The main program REX is intended for independent application of the model, i.e. for cases where the boundary conditions of the coolant are known functions of time. Provisions are made for linking the present program with a compatible digital program describing the dynamics of the external circuit. In such a case the program may be used without the main program REX as a subroutine called by the name REXION (level 2 in Fig. 7). Guide lines and examples for such applications are given in APPENDIX J. Calls of this subroutine with different values for the last argument (IX) in the list causes execution of various operations such as: reading of input, calculation of initial steady state solution, execution of one step of the transient integration, output of variables. Some of the remaining arguments serve for input of coolant boundary conditions to the subroutine, others return information concerning: actual transient time after last step of integration, size of last step, power, energy and the compliment of coolant boundary conditions upon completion of the last step. Problem termination is also a

Name	Туре		Called Subprogram($_{S}$)
REX	MAIN	controlling program for indep. applications, input and evaluation of coolant boundary conditions, out- put frequency control	REXIØN, ZEIT
REXIØN	SUBROUTINE	controlling program, input of parameters for and execution of step size- and termination control	PREP, CØ1, CP1, PØWER, STS, TRS, STEPC, ØUTPUT
PREP	_ 11 _	input of parameters concerning geometry, thermo- hydr., feedback, iteration, output volume control, preparation of const. coefficients	
STS	_ 11 _	solution of initial steady state problem	TPEL, HDV, FLAML, ETAL, CØL
TRS		" " transient problem	TPE1, HDV, FLAM1, ETA1, CØ1, CP1
STEPC	_ 11 _	calculation of max. step size for stable integra- tion of thermo-hydr.	
ØUTPUT		output of thermo-hydraulic variables and feedback reactivities	
PØWER		input of point kinetics parameters, integration of point kinetics	RCBE
RCBE	FUNCTION	external (controlled) reactivity disturbance, input of pertinent parameters	
TPE1	SUBROUTINE	temperature and specific heat of coolant from enthalpy and pressure	
HDV	FUNCTION	specific volume of coolant from temperature and pressure	
FLAM1		thermal conductivity of coolant from temperature and pressure	
ETAl		dynamic viscosity of coolant from spec. vol. and temperature	
CØl	11	temp. dep. thermal conductivity of fuel, input of pert. parameters	
CP1	1ì	temp. dep. specific heat of fuel, input of per- tinent parameters	
ZEIT		computer clock	

Fig. 6 List and Major Functions of all Routines Comprised by the Complete Program

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-

function of this routine and is signalled to the calling program via the argument IX.

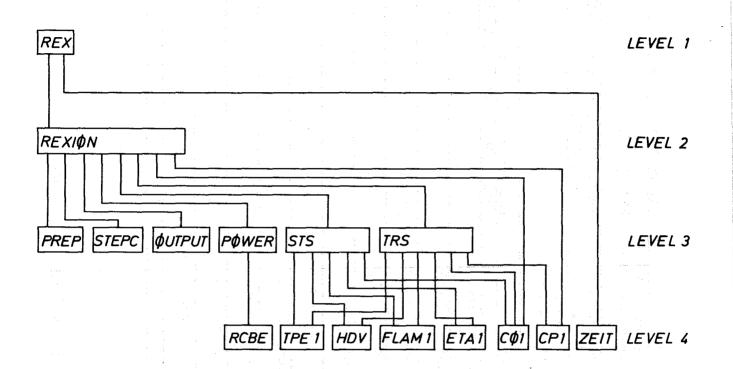


Fig. 7 Logic Flow Diagram

Instead of giving a detailed description or listing of all the routines involved it is considered to be both sufficient and helpful to include flow diagrams of these routines (APPENDIX I). The subprograms of level 4 should be considered non-standard since certain applications may demand individually supplied routines. Guide lines for the construction of such routines are given in the APPENDICES K, L, M, N together with descriptions of the particular versions of those routines which were developed in conjunction with studies for the steam cooled fast breeder project $\sqrt{-8}$. For the sake of completeness the input required by these specific program versions also is included in the subsequent input description.

IV.2 Input Description

Data input to the program is arranged in blocks. Each block is headed by a card carrying the block number IP (column 3) and a commentary (columns 4 - 75) which will be reproduced in the output. There are nine blocks of data as follows.

IP	Block Significance	Input for	 March 199
1	system data	REXION	aa n to tot dhahar
2	coolant enthalpy at entry	REX	
,3 _{6,0}	boundary condition parameter	H	Al and a second
. 4	pressure	tt. National and the	
5	initial coolant mass flow rate and pressure change	N States of the states of the	
6	coolant mass flow rate	n an	
7	initial reactor power	na <mark>fi</mark> losofia a tradición de la constante de la const	
8	output control- and clock termination parameter	си, с. с. с. с. с. 11	
9	end of job-card	tt The second se	1 K. Do

Data blocks 2, 4, 5, 6, 7 contain the information concerning all the external conditions (boundary conditions) required for independent application. The only other external condition needed is the external reactivity disturbance, which is specified as part of the system data in block IP = 1. Besides this block 1 contains all the characteristics of the reactor as well as control parameters concerning the computation, output volume, and termination. For convenience block 1 therefore is subdivided into subblocks, each of these headed by a card carrying the subblock number IPT (column 7) and a commentary (columns 8 - 79) which will be reproduced in the output. There are eight subblocks as follows:

1PT	Subblock - Significance in the second state of
l	geometry and thermo-hydraulic properties
2	temp. dep. fuel properties
3	point kinetics parameters and external reactivity
4	feedback parameters
5	iteration- and output volume control parameters
6	step- and termination-control parameters
7	(not used at present) and the second se
8	end of subblock-card

Any particular set of boundary conditions out of the choice of three is specified by the boundary condition parameter IBC (block 3) which may assume one of the values 1, 2, 3 accordingly. In either case the three subsequent blocks have to be used in the following way:

IBC =	l	2	3
block 4	entry pressure	exit pressure	entry pressure
block 5	initial mass flow rate, exit pressure change	omit	omit
block 6	omit	coolant mass flow rate	coolant mass flow rate

A job may consist of several transient problems to be solved successively. For the first problem of any job a full set of data for blocks 1-8 must be supplied in the order indicated by the block numbers. In any further problem only those blocks and/or subblocks need to re-occur in which new data are to replace old values. As an exception to this, the data block 8 must be the last block in the complete set of data for anyone problem. After the data set for the last problem in a job block 9 must appear. An example for block sequence pertaining to a feedback parameter study is given below (subblock numbers in parentheses).

1(1, 2, 3, 4, 5, 6, 7, 8,), 2, 3, 4, 6, 7, 8, 1(4, 8,), 8, 1(4, 8,), 8, 9

problem No. 1

problem No.2 problem No.3

Note, that in each case subblock 8 must appear last in block 1 and block 8 must appear last in each problem.

In an effort to make input as well as output consistent with respect to dimensional units all quantities are measured in terms of the following basic units:

mass:	kg	pressure:	at
length:	m	energy (therm.):	kcal
time:	sec	reactivity:	ø
temperature:	°C	power:	MW

Power could be measured in units of kcal/sec, however, this is not at all a customary unit for reactor power and MW are used for this variable instead. The same holds true for pressure which is measured in at (kp/cm^2) instead of kp/m^2 . It is possible to apply an entirely different set of basic units for input and output (as long as the set is selfconsistent) after adjusting four conversion factors which are required and defined in subroutine PREP (C1, C3, C4) and subroutine RCBE (C6). They have the following significance:

Cl = 238.89 (kcal/MWsec) C3 = $9.81 \cdot 10^4$ (kg m/kp sec²) · (kp/m² at) C4 = 1296 · C3 (kg m/kp h²) C6 = 9.81 (kg m/kp sec²)

Uniform formats are used for all input data:

integer	:	IP,	output	volume	control	parameters	. 13
		all	others		••••••	• • • • • • • • • • • • • •	, I7
real	:	• • • •					E 11.4

Restrictions listed in parentheses are imposed by DIMENSIONS specified in the program and may be altered if necessary. In the present version the following values are used:

NRBD = 4, NRD = 5, NXD = 10, NND = 10, NDD = 10, NYD = 50.

card	variable	format	units	significance	restrictions
Syst	em data (b	lock l)			
1	IP	I3	-	block identification, columns 4-75 free for commentary	= 1
Geom	etry and T	hermo-Hydra	ulics (subbl	lock 1)	
2	IPT	17	-	subblock identification, columns 8-79 free for commentary	= 1
3	NRB	17		number of radial zones (incl. bypass zones) in first flow section (= 0 no first section)	O€NRB€(NRBD)
	NBE	11	-	first axial blanket (entrance) (= 0 no first axial blanket)	0,1
	NBA	11	-	second axial blanket (exit) (= 0 no second axial blanket)	0,1
	NR	11	-	number of radial zones in second flow section (core+ax.bl.)	O <nr€(nrd)< td=""></nr€(nrd)<>
	NX	**	-	number of axial sections in core	O <nx₹(NXD)</nx
	NN	11	. _ .	number of annular zones in fuel pins	2 € NN€(NND)
4	НС	E 11.4	m	height of core	
	HBE	**	m	height of first axial blanket	
	PBE	11	%/100	fraction of total reactor power released in first ax. bl.	
	HBA	11	m	height of second axial blanket	
	PBA	11	%/100	fraction of total reactor power released in second ax. bl.	

5a	BP	**	-	indicator for channel type	= 0
	R2	11	m	breeder pin radius	
	R3	11	m	outer radius of equivalent annular flow channel	
	D4		m	thickness of equivalent structure component	
	WP	11	m	wetted perimeter of equivalent structure component	
	AN	11	-	total number of identical pins having these specifications	

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56	BP	E 11.4		indicator for channel type	= 1
	R2	11	m	inner radius of annular flow channel	
	R3	11	m	outer radius of a " to sail and " a sail and a sail a s	
	D4	11	m	thickness of outer wall	
	WP	11	m	" inner "	
	AN	11	-	number of identical channels having these specifications	
6	PB	the second s	%/100	fraction of total reactor power released in this radial zone	
	HA	11 · · ·	kcal/m ² sec ^O C	equivalent film coefficient of heat transfer to coolant	
	CV	ii l	kcal/m ³⁰ C	equivalent volumetric specific heat	
	FR	11	-	friction factor for channel walls	
	FT	TT	-	orificing factor	

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E

For a type 2-channel of the first flow section card 5 has an alternate meaning as follows

Cards 5 and 6 have to be repeated NRB times for each radial zone and/or bypass zone of the first flow section. If NRB = 0 cards 5 and 6 must be omitted.

7	Rl		an di m ajar	radius of fuel (inner radius of clad)	
	R2	n na star Na star Na star	m	radius of pin (outer radius of clad)	
	R3	11	ska teoria (minuto) National (minuto)	outer radius of equivalent annular flow channel	
	D4	11 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	n an an an an tha an	thickness of equivalent structural component	
	WP	11	m	wetted perimeter of equivalent structural component	
·	AN	11	-	number of identical channels having these specifications	
8	RØF	11	kg/m ³	density of fuel	
	RØC	11	kg/m ³	density of clad	
	RØM	TT .	kg/m ³	density of structure	
	AEF	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		linear coefficient of thermal expansion of fuel	
•	•		•		

	AEC	E 11.4	°c-1	linear coefficient of thermal expansion of clad	1 1
	AEM	17	°c-1	" " " " structure	
9	cøc	: 11	kcal/m sec ⁰ C	thermal conductivity of clad	
	СØМ	**		structure	
	CPC	TT.	kcal/kg °C	specific heat of clad	
а. — а. н.	CPM	ŤŤ ¹	i i i i i i i i i i i i i i i i i i i	" " structure	
. ,	СНС		-	coefficient for heat transfer relation: clad-coolant	
	CHM	11	-	" " " " : structure-coolant	
10	HGP	ŤŤ.	kcal/m ² sec ^o C	film coefficient for heat transfer through fuel-clad gap	
	ТМ	11	°c	melting point of fuel	
	WM	11	kcal/m ³	latent volumetric heat of fusion in fuel	
	FR	The second se	_	friction factor for channel walls	
	FT	11	l a companya da la co	orificing factor	
11	AQR	11		relative channel power for this radial zone	
	AQF	tT	-	relative volumetric power density in fuel	
	AQC	11	_	" " clad	
ľ	AQS	11	-	" " " coolant	
	AQM	11		" " " structure	
12	ARD	¥1		relative weight of this radial zone for Doppler reactivity effects	
	ARF	**	-	relative weight of this radial zone for reactivity effects from fuel density	
	ARC	11 		relative weight of this radial zone for reactivity effects from clad density	
	ARS	11		relative weight of this radial zone for reactivity effects from coolant density	
	ARM	tt		relative weight of this radial zone for reactivity effects from structure density	

13	HFS	11	1 · · · ·	first axial blanket, equivalent film coefficient of heat transfer pin-coolant
	CVF	11	kcal/m ³ °C	first axial blanket, equivalent volumetric specific heat of pin
	HMS	11	kcal/m ² sec ⁰ C	first axial blanket, equivalent film coefficient of heat transfer structure coolant
	СVМ	₩.1	kcal/m ³ °C	first axial blanket, equivalent volumetric specific heat of structure.
14	HFS	2 11	11	second axial blanket
	CVF	n H an an	11	n an
	HMS CVM	en H	H H	

Card 13 is omitted if NBE = 0., card 14 is omitted if NBA = 0. Cards 7-14 are repeated NR times for each radial zone of the second flow section (core).

15	AQX	E 11.4	-	relative power density of this axial section
	AXD	ана и Ц ана К	in a station and a	relative weight of this axial section for reactivity effects from Doppler effect in fuel
	AXF	11		relative weight of this axial section for reactivity effects from fuel density changes
	AXC	11	en La constanta de la constanta de Se	relative weight of this axial section for reactivity effects from clad density changes
	AXS	11		relative weight of this axial section for reactivity effects from coolant density changes
	АХМ	H		relative weight of this axial section for reactivity effects from structure density changes

Card 15 is repeated NX times for each axial section of the core.

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1

16	ALI	E 11.4	n an	ng n	wei
	AL2	ang N a ang Sagar	and a second s	exponents in heat transfer relation (see eq. (1))	
and the second second	AL3	a satt a g	-	n na sana ang ang ang ang ang ang ang ang ang	
	AL4	1 1	kcal/m ² sec ^o C	constant in heat transfer relation (see eq. (2))	

Parameters Pertaining to the Temperature Dependent Fuel Properties (subblock 2)

17	IPT	17		subblock identification, columns 8-79 free for commentary	= 2	
18	CK1 CK2 CK3	E 11.4 "	BTU/ft hr ^o F BTU/ft hr ^o F ² BTU/ft hr ^o F ³	coefficients for polynomial representation of thermal conductivity of fuel (APPENDIX K)		
19	CC1 CC2 CC3	H San Arana a An Ang Hora an Ang San Ang Hora an Ang Pag	kcal/kg ^O F kcal/kg ^O F ² kcal/kg ^O F ³	<pre>coefficients for polynomial representation of specific heat of fuel (see APPENDIX K)</pre>		- 30 -

Cards 18 and 19 refer to the specific form of subroutines COl and CPl described in APPENDIX K.

Parameters for Point Kinetics and External Reactivity Function (subblock 3)

20	IPT	17		subblock identification, columns 8-79 free for commentary				
21	ØM	E 11.4	sec ⁻¹	BM serge and the strugg path water p				
	ND	17	Contraction of the second sec second second sec	number of precursor groups	₹ (NDD)			
22	FY	E 11.4		β ₁ ∕β) the standard field of a state of the state of				
х Т	LA	11	sec ⁻¹	λ_1 relative fractional yield and decay constant for				
	FY	11		β_2/β precursor groups 1, 2, 3				
	LA	11 g	sec ⁻¹	λ_2 is the second se				
	FΥ	11	-	B ₃ /B ₁ b ₁ b ₂ b ₂ b ₃				
n de la composition Na composition de la composition	LA		sec	λ_3^{-1} and $\lambda_3^$				

Card 22 is to be repeated as necessary to accommodate all parameters for the ND precursor groups.

23 This card (plus eventual following car	
eters required as input to subprogram	RCBE defining the
external reactivity function. A set of	such cards required
for the particular version described i	
described in that place.	

Feedback Parameters (subblock 4)

24	IPT	17		subblock identification, columns 8-79 free for commentary = 4
25	RCD	E 11.4	ø	Doppler constant
	RCH	і ут	ø	reactivity coefficient related to changes in core height
	RCR	1.1 1.1	ø	" " " " " radius
and the second second	RCF	ndersen an inner an service en Service an strategie en service A	state in the state of the stat	" " It as a the set of the fuel, temp.
	RCC	1,1	ø	"" " " " clad "
	RCS	1000	ø·m ³ /kg	" " " " " coolant density
26	RCM	11	ø	" " structure temp.
	RC	11 III	-	coefficient for feedback reactivity (= 0. for elimination
				of feedback, = 1.0 for normal calc.)

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Parameters for Controlling Iteration in Finding Initial Steady State Solution and for Output Volume

Control (subblock 5)

27	IPT	I7		subblock identifications, columns 8-79 free for commentary	= 5
28	EST	E 11.4	engel (* 1977) file (* 1979) en	ratio of proposed step size to step size estimate for stable integration (APPENDIX H)	
	EV			fractional change in spec. vol. of coolant at which steady state iteration is terminated.	
	ETC	11		fractional change in clad temperature at which steady state iteration is terminated	
. *	ETM	11	- 	steady state iteration is terminated fractional change in structure temperature at which steady state iteration is terminated	
	EP	11		absolute change in pressure drop at which steady state iteration is terminated	

29	IRBN	I3		minimum	
	IRBX			maximum of loop parameter for output of thermo-hydr. maximum variables, concerning radial zones and/or	🗲 NRB
	IRBD	**	_	increment (bypasses of first flow section	
	IRN	11	-		
	IRX	tt.	– .	- ", concerning radial zones of second	🗧 NR
	IRD	. 11	-	flow section (core + ax.bl.)	
	IXN	11			
	IXX	tt		- ", concerning axial sections of core	€ NX
	IXD	11 11			
	IRIN	11	_	minimum of loop parameter for output of fuel temperatures	· · · · · · · · · · · · · · · · · · ·
	IR1X	Ŧt	-	maximum > concerning radial zones of second flow	₹ NR
	IRLD	**		increment section (core + ax.bl.)	
	IXIN	TT			
	IX1X	11			
	IX1D	11	-	concerning axial sections of core	₹ NX
	INN	11	-		
	INX	11	_	and the second	,
	IND	11		concerning annular subdivisions of fuel pellet	🗶 NN

Parameters for Step- and Termination Control (subblock 6)

30	IPT	17		subblock identification, columns 8-79 free for commentary	= 6
31	NTE	11	- -	number of steps after which approx. calculation of max. stable step size is repeated	
	NCX	11	-	number of steps to which integration is limited	
.	••••••••••••••••••••••••••••••••••••••		<u>,</u>		

- 32

32	ХМА	E 11.4	sec	(reactor-) time limit for integration (start at time $X = 0$.)
	XIN	11	sec	minimum step size admitted for integration.
	XIX	- 11	sec	maximum " " " "
	PIN	11		minimum relative change in power during step, propose doubling of step size if actual change is less.
	PIX	11	— ****	maximum relative change in power during step, halve step size if actual change is higher.

Parameter space available for purposes as yet undefined (subblock 7)

			and the second		1	1
33	1 PT	17	-	subblock identification, columns 8-79 free for commentary	= 7	1.
						i .

If no such parameters are needed card 33 may be omitted. If parameters are specified in accordance with

alterations	in	subroutine	REXION	they	have	to	be	given	on	cards	inserted	after	card	33
-------------	----	------------	--------	------	------	----	----	-------	----	-------	----------	-------	------	----

End Ca	rd for bl	ock 1 (sub	oblock 8)		
34	IPT	17	-	subblock identification, columns $8-79$ free for comments, this card indicates the end of the system data	= 8

Inlet Enthalpy (block 2)

35	IP	I3		block identification, columns 4-75 free for comments	= 2
36	NY	17	-	number of points given to define coolant inlet enthalpy (Y) as function of time (X)	🗧 (NYD)
37	X Y X Y X Y	E 11.4 "" " "	sec kcal/kg sec kcal/kg sec kcal/kg	<pre>} coordinates of first point " " second " " " third "</pre>	= 0.

Card 37 has to be repeated as to accommodate the coordinates of all NY points.

- 33 -

38	IP	13	an a 🗖 a chair A	block identification, columns 4-75 free for comments	= 3
39	IBC	17	ne over statene en en en er en er en er en er en er	indicator for choice of set of boundary conditions	= 1,2,3
Pres	sure (block	4)			
40	IP	I3		block identification, columns 4-75 free for comments	= 4
41	NY3	17		number of points given to define pressure (Y) as a function of time (X)	🗲 (NYD)
42	X Y X Y	E 11.4 "" "	sec at sec at	<pre>} coordinates of first point } " " second "</pre>	= 0.
	X	tt	sec	\} " " third "	

at

Card 42 has to be repeated as to accommodate the coordinates of all NY points.

Initial Coolant Mass Flow Rate and Deviation of Exit Pressure from Steady State Value as Function

of Time (block 5)

Y

Coolant Boundary Condition (block 3)

11

43	IP	I3		block identification, columns 4-75 free for comments	= 5
44	GO	E 11.4	kg/sec	coolant mass flow rate at initial steady state	> 0.
and an and a second s	NY ²	I7	and the second sec	number of points given to define exit pressure deviation (Y) as function of time (X)	
45	X	E 11.4	sec	<pre>coordinates of first point</pre>	= 0.
	Y	11	at		
	X	tt	sec	" " second "	
:	Y	11	at	Definition of the second se	
	x	11	sec	, , , , , , , , , , , , , , , , , , ,	;
	n a Yan waxaa ka	t terretaria de la constante de	at a subset at a subset of	a second	

34

Card 45 has to be repeated as to accommodate the coordinates of all NY points. The coordinate Y of the first point may be different from zero when step changes in the exit pressure are to be studied. Cards 43-45 are omitted if IBC \neq 1

Coolant	Mass	Flow	Rate	(block)	5)

46	IP	I3		block identification, columns 4-75 free for commentary	= 6
47	ΝY	17	1. <u>1</u>	number of points given to define coolant mass flow rate (Y) as function of time (X)	🗶 (NY
48	X Y X Y X Y	E 11.4 """""""""""""""""""""""""""""""""""	sec kg/sec sec kg/sec sec kg/sec	<pre>} coordinates of first point " " second " " " third "</pre>	= 0. > 0.

Card 48 has to be repeated as to accommodate the coordinates of all NY points.

Cards 46-48 are omitted if IBC = 1

Initial Reactor Power (block 7)

49	IP	I3	-	block identification, columns 4-75 free for comments	= 7
50	PO	E 11.4	MW	initial reactor power	
Outpu	it Frequenc	y Control	and Clock Ter	mination Control (block 8)	
51	IP	Ι3		block identification, columns 4+75 free for comments, indicates start of computation	= 8
52	NPR	17	-	number of steps between printed output	
	NCL	I7		" " " interrogation of computer clock	
	CLM	E 11.4	1 	maximum computer running time of this problem, in units of computer clock	201 1 2
End o	of Job Card	(block 9	<u>)</u>		
53	IP	13		block identification, columns 4-75 free for comments, indicates end of job	= 9

1 35 1

IV.3 Output Description

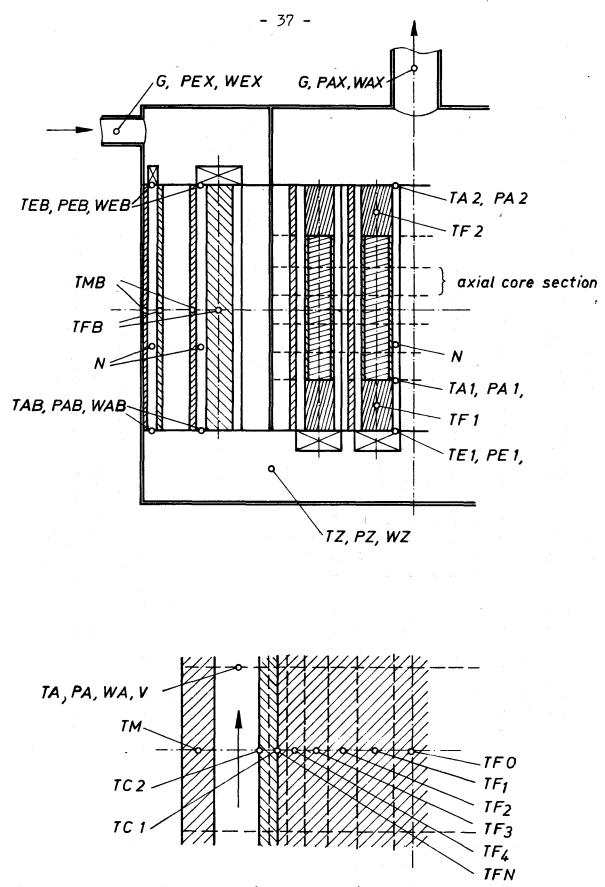
The first part of the output is a complete and annotated listing of all input data as well as all eventual comments given on block and subblock identification cards.

Next the steady state feedback is printed out (in \$ units) which needs to be balanced by external reactivity in order to make the reactor critical at its initial state. The absolute value of this number has no real significance but rather its value relative to values at states with other initial conditions.

The following part of the output gives the time dependent behavior of the most important system variable. A set of values of these variables is printed out every NPR (card 52) steps of the integration, the amount of variables in the output may be controlled by the parameters specified on card 29. Units of all variables in the output are consistent with the input and are the same as listed previously. The first set of values always refers to the initial steady state at time X=0.Only in this first set the absolute values of all contributions to the feedback reactivity are given. +) In all further steps the feedback contributions printed out are the deviations from the initial values printed out in the first set referring to time X = 0. Values of the state variables of the coolant at the reactor boundaries (entrance, exit) are printed both, in the first and in the last line of each set. Whenever these may be different, the values in the last line refer to time X given with this set whereas the corresponding value in the first line refers to the time at the beginning of this step. (Note, that X marks the time at the end of a completed step of integration.)

Notations used in this part of the output are listed in the subsequent table. It may be convenient to refer to Fig. 8 for locating most of these variables.

⁺⁾ These absolute values of the individual contributions may be used in the same sense as mentioned with the total steady state feedback for stability investigations.



axial core section

Fig. 8

Schematic Sketch of the Reactor and a Core Channel Section

Variable	Units	Other Notation	Significance
X	sec	t	time (transient calculation starts at time = 0.)
I	sec	Δt	time increment, as used for last step completed. Initially (t = 0.):I = increment computed and proposed for first step to be taken.
P	MW		total reactor power
E	MWsec	$=\int^{t} \mathbf{P} \cdot dt$	total energy released since beginning of transient
T	ø	ہ ∆k _m	external (controlled) excess reactivity
PEX	at		coolant pressure at reactor entrance (first plenum chamber)
PAX	at		""" exit (third "")
WEX	kcal/kg		" enthalpy " entrance (first " ")
WAX	kcal/kg		" " " exit (third ")
G	kg/sec		coolant mass flow rate
K	ø	Δk _K	total feedback reactivity
D	ø	Δk _D	feedback reactivity from Doppler effect
H	ø	Δk _H	" " change in core height
R	ø	∆k _R	n n n n n n n radius
F	ø	Δk _F	" " " " fuel temp. Steady state (X = 0.): ab-
С	ø	$\Delta \mathbf{k}_{\mathbf{C}}$	" " " clad temp. $transient (X \neq 0.)$: relative
S	ø	Δk_{S}	" " " coolant density values
М	ø	Δk _M	" " " structure temp.
IRB		-	index for radial zone and/or bypass in first flow section
IR	-		" " " in second flow section (core + ax.bl.)
IX	-	-	" " axial section of core
TEB	°c		coolant temp. at entry to radial zone and/or bypass, after orifice
TAB	°c		" " exit from " " "
		1	

1		
WEB	kcal/kg	coolant enthalpy at entry to radial zone and/or bypass
WAB	kcal/kg	" " exit from " " "
PEB	at	" pressure " entry to " " " ", after orifice
PAB	at	" " exit from " " "
TFB	°C	central temperature of pin in rad. zone or inner wall of bypass, resp.
TMB	°c	temperature of structure " " " outer " " "
N	kg/(sec m ²)	area flow rate of coolant " " " bypass
TZ	°c	temperature
PZ	at	pressure of coolant in intermediary (second) plenum chamber
WZ	kcal/kg	enthalpy
TEL	°c	coolant temp. at entry to first axial blanket, after orifice
TAl	°c	" " " section of core
TA2	°c	" " " exit from second axial blanket
PEL	at	" pressure at entry to first axial blanket, after orifice
PAl	at	" " " " section of core
PA2	at	" " " exit from second axial blanket
TFl	°c	central temperature of pin in first axial blanket
TF2	°C	" " second " "
N	$kg/(sec m^2)$	area flow rate of coolant in this radial zone of the core
TFO	°c	central fuel temperature
TFN	°c	fuel edge temperature
TCl	°c	clad temperature, inner edge
TC2		", outer ",
ТМ	°C	structure temperature
TA		coolant temperature
WA	kcal/kg	" enthalpy
PA	at	yressure by taken at exit of axial section IX
V	m ³ /kg	" spec. volume
1	1 1	

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	I	
NC	_	step counter
CL	-	computer time consumed since beginning of this problem

At the end of each problem the total number of steps and the (reactor-) time at the end of the transient are printed in the output.

Other messages:

A certain check on input data is carried out by way of the block- and subblock identification parameters IP and IPT, respectively. If the block (subblock) identification card required at the beginning of any block (subblock) is missing or if the parameter IP (IPT) is incorrect (out of permissible range) a message: INPUT ERROR is printed out together with the incorrect value of IP (IPT). After this the job is terminated.

If the step size required by the criteria for numerical stability and/or limited relative power changes is smaller than the specified lower limit XIN a message appears: STEP SIZE TOO SMALL, together with the last value of the time variable X. After this the job is terminated.

If the reading of a computer clock is made available through the function ZEIT (see APPENDIX N) a message appears (COMPUTING TIME CONSUMED) at the end of the output only if termination of the problem was caused by computation time exceeding the specified value CLM. After this computation continues with the next problem (if any).

If the specific version of function RCBE is used, which is described in APPENDIX L, a message will appear (SCRAM AT X = ...) whenever a scram situation is encountered; the current value of the time parameter is printed after the equal sign. A scram situation arises when at any step the actual reactor power exceeds for the first time the scram level PSC = PO \cdot SCR. The message is printed at this event and comes before any other eventual output with this step.

IV.4 Storage- and COMMON-Requirements, Computing Time

COMMON-storage is required by five of the subprograms on level 3. These are PREP; STS; TRS; STEPC; ØUTPUT. In the case of integrating the program as subroutine REXION with another program already having its own COMMON requirements it is suggested to use block-common-statements whenever FORTRAN IV is available. Otherwise collation of the COMMON-requirements of both program sections is necessary. Storage restrictions of the IBM 7074 require ØVERLAY structure of the program. The following structure is suggested (structure A):

RØUTSEGMENT:	REX, REXIØN, PØWER, RCBE, STEPC, ØUTPUT, ZEIT,
	TPEI, HDV, FLAMI, ETAI, CØI, CPI
ØRIGIN A :	PREP and the second
ØRIGIN A :	STS
ØRIGIN A :	${f TRS}^{(0)}$. The second

In case ØVERLAY procedures do not permit back-references to the next higher level, a different structure should be used (structure B):

	RØUTSEGMENT	:	REX,	REXIØN, PØWER, RCBE, STEPC, ØUTPUT, ZEIT,	
			CØl,	$\textbf{CP1} = \textbf{A}_{\text{res}} + \frac{1}{2} \left[\frac{1}{2$	
en (1914)	ØRIGIN A	:	PREP	an a shara a a shara a shara a shara a shara a shara a Tara a shara a s	
	ØRIGIN A	:	STS,	TPE1, HDV, FLAM1, ETA1, CØ1	
	ØRIGIN A	•	TRS,	TPE1, HDV, FLAMI, ETAI, CØ1, CP1	

The present version of the program has the following approximate total storage requirements:

10 K with ØVERLAY (structure B) 21 K without ØVERLAY

Computing times of individual problems depend on the number of nodes, output volume and frequency, complexity of subprograms on level 4, step size and range of integration. The following example (see also APPENDIX \emptyset) should give an indication of typical computing times.

Problem: see APPENDIX Ø (subprograms as in APPENDICES K, L, M) Number of nodes: NRB = 2, NR = 2, NBE = NBA = 1, NX = 5, NN = 4 Output frequency: NPR = 5, 10, 20 Stable step size: 0,5 - 5,0 milliseconds computation time per step (average): 0,9 sec IBM 7074 0,2 sec IBM 7094 0,07 sec IBM 360/65 (FØRTRAN

 $\emptyset PT = 1$)

V. Comments, Suggestions for Further Development

The models, methods and codes described in this report have proved to be useful and efficient tools for fast breeder analysis. Even though a relatively short time has elapsed since completion of the program a number of applications to accident analysis has provided significant results. Among these are:

- calculation of power reactivity coefficients for various reactor states of equilibrium;
- calculation of transient reactor behavior in blow down accidents (rupture of main steam pipes);
- parametric studies relating to scram characteristics, applied to blow down accidents.

Aside from these applications to specific systems many other studies can be envisaged including also investigations of a more general nature. The detailed and realistic features of the hydraulic model could - for example serve as the basis for studies concerning both, design and analysis of reactors.

This report shall be not complete without pointing out weaknesses and areas which will require further development in order to improve efficiency and applicability of this analytical tool. The remainder of this section is dedicated to a discussion of the more important ones of these items.

The Model

The main deficiency of the model is the fact that it does not cover the coolant circuit and other pertinent components external to the reactor. Although certain analyses can be carried out with such a restricted model (for example: rapid excursions extending over a few seconds only) most practical cases will require an integral treatment of the whole reactor system. Therefore, the development of a consistent dynamics model and code for the external circuit is an essential implementation needed and is an immediate goal for further efforts in this area.

Another shortcoming of the model is seen in the treatment of the feedback. The great variety encountered in reactor core designs entails an almost equal variety in feedback mechanisms and virtually precludes the establishing of a general feedback model covering all possible cases. Feedback mechanisms which cannot be accommodated by the ones already included in the present model will have to be added in individual cases, preferrably in the form of subprograms.

A third part of the model potentially requiring additional development is channel orificing. The orificing coefficients FT are determined by criteria related to channel temperature rise, channel power, channel pressure drops, e.t.c., all of these being characteristics of the static reactor design. Since most of the static design calculations do not yield directly the coefficients FT trial and error procedures have to be used with the present program which turns out to be quite time consuming. This could be avoided by developing a program consistent with the underlying model and code, which would calculate these coefficients on the basis of the pertinent criteria mentioned above.

Further areas for development of the model are identified with heat transfer through the fuel cladding-gap and with the plenum chambers. Provisions have already been made for a more sophisticated treatment of the gap coefficient as it might become available.

Methods

The approximate nature of the criteria determining the step size for integration may require special caution in certain cases such as

- during rapid changes in the coolant boundary conditions;
- reactor power near prompt criticality.

Similarily, the nodal representation of the fuel and the treatment of fuel melting need consideration when temperature dependence of thermal conductivity of the fuel and fuel melting are of importance. In all of these cases recourse may be taken to either one or both of the following means:

- increasing the number of nodes;
- limiting the step size to values considerably below the stability limit.

In either case the associated penalty in computation time has to be considered and may be severe. To overcome these problems different methods of treating fuel melting, thermo-hydraulics and point kinetics will have to be devised. Some available methods / 9, 10 / 7 which feature good numerical

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- fuel heat transfer;
- fuel melting;
- coolant thermo-hydraulics;
- integration of point kinetics;
- determination of max. step size for numerically stable
- integration.

At this point it cannot be clear to what extent any such innovation might be incorporated in the present program.

Program

Experience gained up to date has indicated that computation time will not be a limiting factor with normal cases. The calculation of a typical transient arising with a reactor accident as described in APPENDIX \emptyset requires about one minute computer time on an IBM 360/65 system to cover a range of interest of about 10 seconds of reactor time. Systems with a greater number of nodes will increase computation time accordingly as will be the case when using slower computers (IBM 7094: ca. 3 minutes; IBM 7074 ca. 12 minutes for the same problem). Computer storage practically does not impose limitations; COMMON and DIMENSION statements are formulated in such a way as to facilitate adjustments in special cases. VI. APPENDICES

APPENDIX A : Notation Equations

The following list of notations is complete only in conjunction with the lists for input and output given in sections IV.2 and IV. 3.

linear coefficient of thermal expansion AE; heat source density, coefficient for rad. zone-AR, component i distribution (= F, C, M)heat source density, coefficient for axial section-AX, distribution precursor concentrations (i = 1, 2, ... ND) C, Cl = 238,89 kcal/MWsecCØl thermal conductivity of fuel (function) CP specific heat (at constant pressure) CP1 specific heat of fuel (function) CP3 specific heat of coolant, average over axial section CPA , exit of axial section CPE , entry of axial section DH hydraulic diameter, wetted surface includes cladding + structure 11 DH2 , wetted surface of cladding only DH4 , wetted surface of structure only DP coolant pressure drop in axial section step size, time increment (\equiv I) DX ETA dynamic viscosity of coolant / kps/m²/ ETAl FC factor, indicator for flow direction FLAM thermal conductivity of coolant / kcal/m h $^{\circ}$ C 7 FLAM1 net area for coolant flow in a radial zone FQ 9.81 m/sec², acceleration of gravity g

GF	net flow rate per unit area of coolant in channel (\equiv N)
∆H	height of axial section
H3	film coefficient of heat transfer between coolant and channel walls
H23	II II II II II II II II Cladding
H34	II II II II II II II II Structure
HT	total core height
IR	index, for radial zones
IX	index, for axial sections
	argument, mode control of subroutine REXION
IV	argument, " " function RCBE
Δk	excess reactivity
Δk _T	", external, $(\geq T)$ as a property of the second
∆k _K	", feedback (total), $(\equiv K)$
$\Delta \mathbf{k}_{\mathrm{D}}$	" ", Doppler effect, $(\equiv D)$
$\Delta \mathbf{k}_{\mathrm{H}}$	", change in core height, (\equiv H)
∆k _R	", change in core radius, $(\equiv R)_{relation}$
Δk_{F}	" , change in fuel density, $(\equiv F)$
∆k _C	$" \qquad " \qquad " \qquad " \qquad " \qquad " \qquad claderer " \qquad , (\equiv C)$
Δ k S	" ", " " coolant ", $(\equiv S)$
∆k _M	", "structure density, $(\equiv M)$
ĸ	total steady state feedback (relative value, output)
Nu	generalized Nusselt's number in the second state of the second second second second second second second second
NRBD	dimension, maximum value for NRB
NRD	n n n n NR Barrade Brancarda de
NXD	n "prodytowa jenica (u NX-1) inger seeks die kande die beker in Ali
NND	n, and the second of the second of NN 1
NDD	n n n n n ND to de tradición de
NYD	и и и и NY substants de la de la service d
PC	fraction of total reactor power released in core
PE	coolant pressure at entry of axial section

```
ΡI
        = 3.14 15 927
\Pr
        Prandtl's number
PS.
        power level for reactor scram
P3
        coolant pressure
        coolant pressure loss due to entry
∆p<sub>F</sub>
            ...
                      11
                             11
                                  due to orifice
Δp<sub>m</sub>
            11
                      11
                             11
                                  due to friction
\Delta p_R
                      11
                             11
                                  due to acceleration
Δp<sub>Δ</sub>
        heat source density
q
        feedback coefficient, component i ( = F, C, S, M)
RC;
        Reynolds number
Re
Τ<sub>i</sub>
        temperature in component i (= F, C, M)
        coolant temperature, exit of axial section
\mathbf{T}\mathbf{A}
TE
           11
                       11
                              , entry of axial section
T3
           11
                       11
                               , average over axial section
\mathbf{TF}
        fuel temperature
TMl
        structure temperature in first axial blanket
             11
                           11
                                  n -
TM2
                                    second axial blanket
TSB
          temperature of structure in rad. bl.
                                                          first flow section
                =
                        11
                           outer wall in bypass
ΤW
        channel wall temperature
U
        variable, representing heat of fusion assoc. with a node
UH
        hypothetical change of enthalpy during a step of integration
        coolant velocity
v
VA
        specific volume of coolant, exit of axial section
             11
                      11
                           11
VE
                                  11
                                     , entry of axial section
V;
        volume of component i ( = F, C, M)
۷<sub>F</sub>
        total volume of fuel in core
٧<sub>s</sub>
        total volume of coolant in core
```

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WA	enthalpy of coolant, exit of axial section	
WE	" " , entry of axial section	
WI	" ", average over axial section	
WAL	enthalpy of coolant at channel exit	
Z	axial coordinate of core geometry	
α	reciprocal of generalized friction factor	
ß	total fraction of delayed neutrons	
η	dynamic viscosity of coolant <u>/kps/m²</u> 7	
λ	thermal conductivity of coolant <u>/</u> kcal/m h ^o C_7	
٨	prompt neutron generation time	
9	density of coolant (= $1./V$)	

Equations

Balance of total power: PC + PBE + PBA + PB = 1.0 PB = \sum_{IRB} (PB)

Heat source density in various components:

radial blanket: pin
bypass : inner wall
$$\begin{cases} R2 \\ 2.0 \cdot WP \end{cases}$$

 $q_{RB} = \frac{P \cdot C1 \cdot PB}{AN \cdot PI \cdot R2 \cdot R2M \cdot HT}$
radial blanket: structure
coolant $\begin{cases} no \text{ source} \end{cases}$
bypass: outer wall \end{cases}

axial blanket: pin

first blanket

$$q_{B1} = \frac{P \cdot C1 \cdot PBE}{PI \cdot HBE} \cdot \frac{AQR}{\sum (AQR \cdot AN)} \cdot \frac{1}{R2^2}$$

second blanket

$$q_{B2} = \frac{P \cdot C1 \cdot PBA}{PI \cdot HBA} \cdot \frac{AQR}{\frac{\Sigma}{IR}} \cdot \frac{1}{R2^2}$$

axial blanket: structure coolant

Core:

$$q_{E} = \frac{P \cdot C1 \cdot PC}{HC/NX} \cdot \frac{1}{SAQ \cdot \Sigma(AQX) \cdot \Sigma(AQR \cdot AN)}$$

$$SAQ = AQF + AQC + AQS + AQM$$

fuel:

$$q_F = q_E \frac{AQF \cdot AQX \cdot AQR}{Rl^2 \cdot PI}$$

clad:

$$q_{C} = q_{E} \frac{AQC \cdot AQX \cdot AQR}{(R2^{2} - R1^{2}) \cdot PI}$$

coolant:

$$q_{S} = q_{E} \cdot \frac{AQS \cdot AQX \cdot AQR}{(R3^{2} - R2^{2}) \cdot PI}$$

structure:

$$q_{M} = q_{E} \cdot \frac{AQM \cdot AQX \cdot AQR}{WP \cdot D4}$$

Steady State Temperatures

core:

coolant: WA = WE +
$$q_{B1} \cdot \frac{HBE \cdot R2^2}{(R3^2 - R2^2) \cdot GF}$$

WI = (WA + WE) $\cdot 0,5$
TA = $f_T(PA, WA)$
T3 = (TA + TE) $\cdot 0,5$

$$\frac{\text{radial blanket}}{\text{bypass}} R2M = \begin{cases} R2\\ 2 \cdot WP \end{cases}$$
pin:
inner wall:

$$TFB = T3 + q_{RB} \cdot \frac{R2M}{2 \cdot HA}$$
structure:
outer wall:

$$TSB = T3$$
outer wall:

$$WA = WE + q_{RB} \frac{HT \cdot R2 \cdot R2M}{(R3^2 - R2^2) \cdot GF}$$

$$WI = (WA + WE) \cdot 0.5$$

$$TA = f_T(PA, WA)$$

$$T3 = (TA + TE) \cdot 0.5$$

Transient Temperatures

Core:

$$\begin{aligned} \text{fuel:} & \text{TFO} = \text{TFO} + \frac{\text{DX}}{\text{R} \emptyset 1 \cdot \text{CPl}(\text{TFO})} \cdot \left\{ q_{\text{F}} + \frac{4 \cdot \text{NN}}{\text{Rl}^2} \cdot \left[\right. \\ & - (\text{TFO-TF}_1) \cdot \text{C} \emptyset 1 (\text{TF}_1) \right] \right\} \\ & \text{TF}_{\text{n}} = \text{TF}_{\text{n}} + \frac{\text{DX}}{\text{R} \emptyset 1 \cdot \text{CPl}(\text{TF}_{\text{n}})} \cdot \left\{ q_{\text{F}} + \frac{4 \cdot \text{NN}}{\text{Rl}^2} \cdot \left[(\text{n-0.5}) \cdot (\text{TF}_{\text{n-1}} - \text{TF}_{\text{n}}) \cdot \right. \\ & \cdot \text{C} \emptyset 1 (\text{TF}_{\text{n}}) - (\text{n+0.5}) (\text{TF}_{\text{n}} - \text{TF}_{\text{n+1}}) \cdot \text{C} \emptyset 1 (\text{TF}_{\text{n+1}}) \right] \right\} \\ & \text{n} = 1, \dots \text{N-1} \\ & \text{TFN} = \text{TFN} + \frac{\text{DX}}{\text{R} \emptyset 1 \cdot \text{CPl}(\text{TFN})} \cdot \left\{ q_{\text{F}} + \frac{4 \cdot \text{NN}}{\text{Rl}^2} \left[(2 \cdot \text{NN-1}) \cdot (\text{TF}_{\text{N-1}} - \text{TFN}) \cdot \text{C} \emptyset 1 (\text{TFN}) - (\text{TFN-TC1}) \cdot \text{R1} \cdot \text{HGP} \right] \right\} \\ & \text{cladding:} & \text{TC1} = \text{TC1} + \frac{\text{DX}}{\text{R} \emptyset 2 \cdot \text{CP2}} \cdot \left\{ q_{\text{C}} + \frac{4}{\text{R2}^2 - \text{R1}^2} \left[\text{R1} \cdot \text{HGP} \cdot (\text{TFN-TC1}) - (\text{TC1} - \text{TC2}) \cdot \frac{\text{R2} + \text{R1}}{2 \cdot (\text{R2} - \text{R1})} \cdot \text{C} \emptyset 2 \right] \right\} \\ & \text{TC2} = \text{TC2} + \frac{\text{DX}}{\text{R} \emptyset 2 \cdot \text{CP2}} \cdot \left\{ q_{\text{C}} + \frac{4}{\text{R2}^2 - \text{R1}^2} \cdot \left[\frac{\text{R2} + \text{R1}}{2 \cdot (\text{R2} - \text{R1})} \cdot (\text{M2} - \text{R1}) \cdot (\text{TC1} - \text{TC2}) \cdot \text{C} \emptyset 2 - \text{R1} \right] \end{aligned}$$

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,

*

structure:
$$TM = TM + \frac{DX}{R\emptyset 4 \cdot CP4} \cdot \left\{ q_M - \frac{H34'}{D4} (TM - T3) \right\}$$

coolant:
$$WA = WA + DX \cdot V \cdot \left\{ q_S + \frac{2 \cdot H23 \cdot R2}{R3^2 - R2^2} (TC2 - T3) + \frac{H34 \cdot WP}{PI \cdot (R3^2 - R2^2)} \cdot (TM - T3) + \frac{GF}{HC/NX} (WE - WA) \right\}$$

$$WI = (WA + WE) \cdot 0.5$$

$$TA = f_T(PA, WA)$$

$$T3 = (TA + TE) \cdot 0,5$$

first axial blanket (second ax.bl. accordingly):

 $T3 = (TA + TE) \cdot 0,5$

pin:	$TFI = TFI + \frac{DX}{CVF} \left\{ q_{B1} - \frac{2 \cdot HFS}{R2} \cdot (TFI - T3) \right\}$
structure:	$TMI = TMI + \frac{DX}{CVM} \left\{ - \frac{HMS}{D4} \cdot (TMI - T3) \right\}$
coolant:	$WA = WA + DX \cdot V \left\{ \frac{2 \cdot HFS \cdot R2}{R3^2 - R2^2} (TF1 - T3) + \frac{HMS \cdot WP}{PI \cdot (R3^2 - R2^2)} \right\}$
	• $(TM1-T3) + \frac{GF}{HBE} (WE-WA)$
	$WI = (WA + WE) \cdot 0,5$
	$TA = f_T(PA, WA)$

$$\frac{\text{radial blanket}}{\text{bypass}} \quad WPM = \begin{cases} WP \\ 2 \cdot R3 \cdot PI \end{cases}$$

$$\frac{\text{pin}}{\text{inner wall}} : \text{TFB} = \text{TFB} + \frac{DX}{CV} \quad \left\{ q_{RB} - \frac{2 \cdot HA}{R2} \text{ (TFB-T3)} \right\}$$

$$\frac{\text{structure}}{\text{outer wall}} : \text{TMB} = \text{TMB} + \frac{DX}{CV} \quad \left\{ -\frac{HA}{D4} \text{ (TMB-T3)} \right\}$$

$$\frac{\text{coolant:}}{\text{wA} = \text{wA} + DX} \cdot V \left\{ \frac{2 \cdot HA \cdot R2}{R3^2 - R2^2} \text{ (TFB-T3)} + \frac{HA \cdot WPM}{PF(R3^2 - R2^2)} \cdot (\text{TMB-T3)} + \frac{GF}{HT} \text{ (wE-wA)} \right\}$$

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$$WI = (WA + WE) \cdot 0,5$$

TA = $f_T(PA, WA)$
T3 = (TA+TE) \cdot 0,5

Orifices: conservation of enthalpy when passing orifice is assumed.

Plenum Chambers:

zero pressure loss of coolant zero residence time of coolant in chamber instantaneous mixing of all entering streams of coolant: $WI = \frac{\sum_{R} (FQ \cdot GF \cdot WA_{L})}{\sum_{R} (FQ \cdot GF)}$

where: $FQ = PI \cdot (R3^2 - R2^2) \cdot AN$

Fuel Melting

The basic model for treating fuel melting and recrystallization is the same as in $/ 1_7$. However, the computational technique differs and admits all possible cases (fuel partially or entirely molten at initial steady state, partial and/or total melting and/or recrystallization during transient). Melting point and recrystallization point are assumed to be identical (TM) as are the values of heat of fusion and heat of recrystallization (UM, $/ kcal/m^3 7$).

In the calculation a variable U is associated with each fuel node, which is a record of the latent heat of fusion of this node:

U = 0. solid U = UM molten 0 < U < UM partially molten

If in the steady state calculation the temperature of any fuel node TF is such that

TF > TM U = UMTF < TM U = O.

During the transient calculation fuel temperatures first are calculated according to the equations given before. Then a hypothetical enthalpy

$$UH = (TF - TM) \cdot RØl \cdot CPl (TM)$$

which may be \gtrless O depending on TF \gtrless TM. This enthalpy change if added to U yields a new quantity UN

UN = U + UH

which is subject to decisions on further procedures:

$$\begin{array}{l} \text{UN} < 0 \\ \left\{ \begin{array}{l} \text{U} = 0 \dots \text{ the node was solid and remained solid, set } \text{TF} = \text{TF} \\ \text{U} > 0 \dots \text{ the node just solidified entirely, } \text{TF} = \text{TF} + \text{U}/(\text{R} \emptyset 1 \cdot \text{CPl}(\text{TM})) \\ \text{U} = 0 \end{array} \right. \\ \text{UN} > 0 \\ \left\{ \begin{array}{l} \text{UN} < \text{UM} \dots \text{ fuel is partially molten, set } \text{TF} = \text{TM} \\ \text{U} = \text{UN} \end{array} \right. \\ \text{UN} > \text{UM} \dots \\ \left\{ \begin{array}{l} \text{U} = \text{UM} \end{array} \right. \text{ the node was molten, set } \text{TF} = \text{TF} \\ \text{U} < \text{UM} \end{array} \right. \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{UM} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \right. \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \text{U} = \text{UM} \end{array} \right. \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \right. \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \right. \end{array}$$
 } \\ \left. \begin{array}{l} \text{U} = \text{UM} \end{array} \right. \\ \left. \begin{array}{l} \text{U} = \text{UM}

Fig. Al should help to illustrate this scheme.

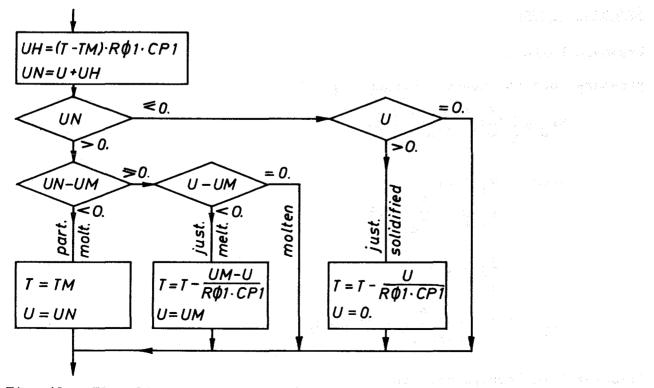


Fig. Al Flow Diagram for Calculations Regarding Fuel Melting

Film Coefficient of Heat Transfer to Coolant:

from cladding:

H23 = AL4 +
$$\frac{CH2}{DH2^{(1-AL1)}} \cdot (GF)^{AL1} \cdot (\frac{FLAM^{(1-AL2)} \cdot CP3^{AL2}}{ETA^{(AL1-AL2)}}) \cdot (\frac{T3+273.16}{TC2+273.16})^{AL3}$$

from structure:

$$H34 = AL4 + \frac{CH4}{DH4} \cdot (GF)^{AL1} \cdot (\frac{FLAM^{(1-AL2)} \cdot CP3^{AL2}}{ETA^{(AL1-AL2)}})$$

with DH2 = $\frac{2 \cdot (R3^2 - R2^2)}{R2}$ DH4 = $\frac{4 \cdot PI \cdot (R3^2 - R2^2)}{WP}$ FLAM = f_{λ} (PA,T3) ETA = f_{η} (V,T3) CPA = f_{cp} (PA,TA) CP3 = (CPA + CPE) $\cdot 0,5$

Hydraulic Model

Pressure Losses:

pressure loss at channel entrance (g = 1/V):

$$\Delta p_{E} = \left[\left(\frac{v_{1}}{\varphi}\right)^{2} - \left(v_{0}\right)^{2} \right] \frac{g}{2g}$$
with: $v_{0} = 0$.
 $v_{1} \cdot g = \frac{\dot{m}}{F_{q}} = GF$
 $\frac{1}{g^{2}} = 1.5$

$$\Delta p_{E} = 1.5 \cdot \frac{GF^{2}}{2 \cdot g \cdot 10^{4}} \cdot V / [at] 7$$

pressure loss through orifice:

$$\Delta p_{\rm T} = FT \cdot \frac{GF^2}{2g \cdot 10^4} \cdot V \quad /_at_7$$

pressure loss in channel due to friction and acceleration

channel length $\Delta H = \begin{cases} HT \dots radial blanket \\ HT \dots bypass \\ HBE \dots first axial blanket \\ HBA \dots second " " \\ HC/NX \dots axial section in core \end{cases}$

hydraulic diameter:

$$DH = \frac{4 \cdot PI \cdot (R3^2 - R2^2)}{WPM + 2 \cdot PI \cdot R2}$$

wetted perimeter:

WPM = $\begin{cases}
WP \dots radial blanket \\
2 \cdot R3 \cdot PI \dots bypass \\
WP \dots first, second ax.bl., core
\end{cases}$

$$\Delta p_{R} = \frac{GF^{2}}{g \cdot 10^{4}} \cdot \left[\frac{FR \cdot \Delta H}{2 \cdot DH} \cdot V + (VA - VE) \right] / at]$$

$$VA = f_V(PA,TA)$$
$$V = (VA+VE) \cdot 0.5$$

Feedback Equations

subscript x = $\begin{cases} 0 \dots \text{ steady state value} \\ T \dots \text{ transient value} \end{cases}$

Doppler feedback:

$$D_{\mathbf{x}} = \text{RCD} \cdot \frac{\sum_{\mathbf{x}} \cdot \sum_{\mathbf{R}} (\text{ADX} \cdot \text{ADR} \cdot \text{AN} \cdot \text{Rl}^2 \cdot \ln (\overline{\text{TF}}_{\mathbf{x}} + 273.16))}{\sum_{\mathbf{x}} \cdot (\text{ADX}) \cdot \sum_{\mathbf{R}} (\text{ADR} \cdot \text{AN} \cdot \text{Rl}^2)}$$

$$\overline{\mathrm{TF}}_{\mathbf{X}} = \frac{1}{\mathrm{NN}} \cdot \sum_{\mathbf{N}} (\mathrm{TF}_{\mathbf{X}})$$

core height feedback:

$$H_{x} = RCH \cdot \frac{\Sigma}{|X|} \cdot \frac{\Sigma}{|R|} (AN \cdot R1^{2} \cdot AEF \cdot \overline{TF}_{x})$$

$$NN \cdot \sum_{|R|} (AN \cdot R1^{2})$$

core radius feedback:

$$R_{x} = RCR \cdot \frac{\sum \cdot \sum_{ix} (AN \cdot AEM \cdot TM_{x})}{NN \cdot \sum_{ix} (AN)}$$

fuel density feedback:

$$F_{x} = -RCF \frac{\sum_{iR} \cdot \sum_{iR} (AXF \cdot ARF \cdot AN \cdot Rl^{2} \cdot AEF \cdot \overline{TF}_{x})}{\sum_{iR} \cdot (AXF) \cdot \sum_{iR} (ARF \cdot AN \cdot Rl^{2})}$$

cladding density feedback:

$$C_{x} = -RCC \frac{\sum_{ix} \cdot \sum_{ix} (AXC \cdot ARC \cdot AN \cdot (R2^{2} - R1^{2}) \cdot AEC \cdot \overline{TC}_{x})}{\sum_{ix} (AXC) \cdot \sum_{ix} (ARC \cdot AN \cdot (R2^{2} - R1^{2}))}$$

$$\overline{TC}_{x} = (TCl_{x} + TC2_{x}) \cdot 0,5$$

structure density feedback:

$$M_{x} = -RCM \frac{\sum_{ix} \cdot \sum_{ix} (AXM \cdot ARM \cdot AN \cdot WP \cdot D4 \cdot AEM \cdot TM_{x})}{\sum_{ix} (AXM) \cdot \sum_{ix} (ARM \cdot AN \cdot WP \cdot D4)}$$

coolant density feedback:

$$S_{x} = -RCS \frac{\sum_{ix} \cdot \sum_{ix} (AXS \cdot ARS \cdot AN \cdot (R3^{2} - R2^{2})/V_{x})}{\sum_{ix} (AXS) \cdot \sum_{ix} (ARS \cdot AN \cdot (R3^{2} - R2^{2}))}$$

Total steady state feedback:

$$K_{o} = (D_{o} + H_{o} + R_{o} + F_{o} + C_{o} + S_{o} + M_{o})$$

This total steady state feedback is assumed to be compensated by external reactivity.

Transient feedback

$$D = D_{x} - D_{o} \qquad F = F_{x} - F_{o} \qquad M = M_{x} - M_{o}$$

$$H = H_{x} - H_{o} \qquad C = C_{x} - C_{o}$$

$$R = R_{x} - R_{o} \qquad S = S_{x} - S_{o}$$

Total transient feedback

$K = (D + H + R + F + C + S + M) \cdot RC$

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<u>APPENDIX B</u> : Decay Time Constants for Nodal Temperatures in Cylindrical Fuel Pin

Taking fuel temperatures relative to the temperature TCl of the inner edge of the cladding we can write the system of equations for the nodal fuel temperatures as follows:

$$\begin{split} \mathbb{R} \not p_1 \cdot \mathbb{CP1} \cdot \frac{d \ \mathrm{TFO}}{dx} &= \ q_F \ + \ \frac{4 \cdot \mathcal{C} \not p_1 \cdot \mathrm{NN}}{\mathrm{Rl}^2} \left[\qquad \qquad - \ (\mathrm{TFO} - \mathrm{TF}_1) \right] \\ \mathbb{R} \not p_1 \cdot \mathbb{CP1} \cdot \ \frac{d \ \mathrm{TF}}{dx} n \ = \ q_F \ + \ \frac{4 \cdot \mathcal{C} \not p_1 \cdot \mathrm{NN}}{\mathrm{Rl}^2} \left[(n - 0 \cdot 5) \cdot (\mathrm{TF}_{n-1} - \mathrm{TF}_n) - (n + 0 \cdot 5) \cdot (\mathrm{TF}_n - \mathrm{TF}_{n+1}) \right] \\ n \ = \ 1, \ \dots, \ N-1 \\ \mathbb{R} \not p_1 \cdot \mathbb{CP1} \cdot \ \frac{d \ \mathrm{TFN}}{dx} \ = \ q_F \ + \ \frac{4 \cdot \mathcal{C} \not p_1 \cdot \mathrm{NN}}{\mathrm{Rl}^2} \left[(2 \cdot \mathrm{NN} - 1) \cdot (\mathrm{TF}_{\mathrm{N-1}} - \mathrm{TFN}) - \ \frac{\mathrm{R1} \cdot \mathrm{HGP}}{\mathbb{C} \not p_1} \cdot \mathrm{TFN} \right] \end{split}$$

All parameters except for volumetric heat source q_F are assumed to be invariants for this consideration. Fictitious subdivisions separate the cylindrical fuel pin into NN-1 concentric annuli of equal volume, as well as a central cylinder and an outer most annulus having only half of this volume. In the case of steady state the temperatures TF_1 , TF_2 , ... TF_{N-1} represent the volume average temperature of each annulus, respectively. TFO and TFN represent the temperature at the center axis and on the surface edge, respectively.

We assume that starting from a steady state equilibrium the heat source q_F vanishes at time x = 0. Consequently, all temperatures eventually will drop to the reference level (TFO = TF_n = TFN \Rightarrow 0.). The asymptotic solution of the temperature transients may be found by means of Laplace transformation as follows:

$$\frac{\mathrm{Rl}^{2}}{4 \cdot \mathrm{NN}} \cdot \frac{\mathrm{R} \emptyset 1 \cdot \mathrm{CP1}}{\mathrm{C} \emptyset 1} \cdot \mathrm{s} \cdot \widetilde{\mathrm{TFO}} = - (\widetilde{\mathrm{TFO}} - \widetilde{\mathrm{TF}}_{1})$$

$$\frac{\mathrm{Rl}^{2}}{4 \cdot \mathrm{NN}} \cdot \frac{\mathrm{R} \emptyset 1 \cdot \mathrm{CP1}}{\mathrm{C} \emptyset 1} \cdot \mathrm{s} \cdot \widetilde{\mathrm{TF}}_{n} = (\mathrm{n-0.5}) \cdot (\widetilde{\mathrm{TF}}_{\mathrm{n-1}} - \widetilde{\mathrm{TF}}_{\mathrm{n}}) - (\mathrm{n+0.5}) \cdot (\widetilde{\mathrm{TF}}_{\mathrm{n}} - \widetilde{\mathrm{TF}}_{\mathrm{n+1}})$$

$$n = 1, 2 \cdots \mathrm{N-1}$$

$$\frac{\mathrm{Rl}^{2}}{4 \cdot \mathrm{NN}} \cdot \frac{\mathrm{R} \emptyset 1 \cdot \mathrm{CP1}}{\mathrm{C} \emptyset 1} \cdot \mathrm{s} \cdot \widetilde{\mathrm{TFN}} = (2 \cdot \mathrm{NN-1}) \cdot (\widetilde{\mathrm{TF}}_{\mathrm{N-1}} - \widetilde{\mathrm{TFN}}) - \frac{\mathrm{R1} \cdot \mathrm{HGP}}{\mathrm{C} \emptyset 1} \cdot \widetilde{\mathrm{TFN}}$$

This is a linear and homogeneous system of equations for the temperatures TF_n with all negative Eigenvalues s. The asymptotic behavior is characterised

by the Eigenvalue s_N with the smallest magnitude. It is evident that this Eigenvalue as all others is a function only of three parameters:

$$s_{N} = s_{N}(NN, \frac{R1 \cdot HGP}{C\emptyset 1}, R1^{2} \cdot \frac{R\emptyset 1 \cdot CP1}{C\emptyset 1})$$

where the last parameter appears as a scaling factor only.

On the other hand the solution of this particular problem may be obtained analytically without discretization /[11]/?. The Eigenvalue with the smallest magnitude is given by:

$$s_{\infty} = \left(\frac{R1}{\alpha}\right)^2 \cdot \frac{R\emptyset_1 \cdot CP_1}{C\emptyset_1}$$

where α is the smallest value satisfying the transcendental equation

$$\alpha \cdot \frac{J_{1}(\alpha)}{J_{\alpha}(\alpha)} = \frac{R1 \cdot HGP}{C\emptyset 1}$$

In much the same way as above the Eigenvalue s_{∞} is a function of two parameters:

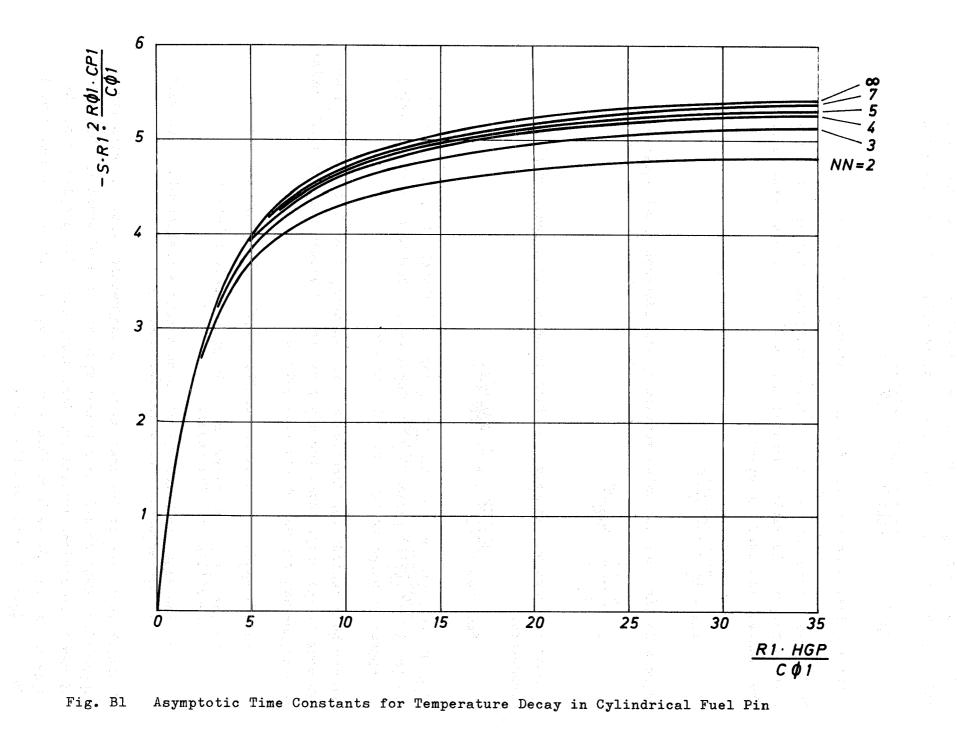
$$s_{\omega} = s_{\omega} \left(\frac{R1 \cdot HGP}{C\emptyset 1} , R1^2 \cdot \frac{R\emptyset 1 \cdot CP1}{C\emptyset 1} \right)$$

Fig. Bl is a plot of the function s_N and s (multiplied by the scaling factor $Rl^2 \cdot \frac{R \emptyset 1 \cdot CP1}{C \emptyset 1}$) versus $\frac{R1 \cdot HGP}{C \emptyset 1}$. These were obtained numerically using a separate program written for this purpose.

As may be expected, the function s is the asymptotic function to s_N , as NN goes to infinity. Thus, for any given set of values for the characteristic parameters one may obtain from this plot

- a) the asymptotic behavior of the correct solution,
- b) the asymptotic behavior of the approximate solution resulting for NN+1 nodes,
- c) the required number of nodes to obtain a predetermined accuracy in the asymptotic solution for this case

Although vanishing of the heat source in conjunction with the simplifying assumptions made constitute a rather specific case of transient behavior, it may be considered typical for fast transients. The simplicity of the diagram in Fig. Bl renders this a useful tool in selecting a proper mesh for a variety of pertinent problems.



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i

<u>APPENDIX C</u> : Predictor-Corrector-Schemes Applied in Solving the Hydraulics Problem.

The general expression for the pressure drop in a flow channel (index i) is

$$\Delta p_{i} = \Delta p_{Ei} + \Delta p_{Ti} + \Delta p_{Ri} + \Delta p_{Ai}$$
$$= \frac{1}{g} GF_{i}^{2} \cdot \left\{ \frac{1 \cdot 5 + FT_{i}}{2 \cdot 0} VE + \frac{FR_{i}}{2 \cdot DH_{i}} \Sigma \Delta H_{j} V_{ij} - (VA_{i} - VE_{i}) \right\}$$

The first term in parantheses represents entry and orifice losses, the second term frictional losses and the last term acceleration loss. If one assumes the specific volume to be constant throughout the channel and moreover to be the same in all (parallel) channels

$$V_E = V_{ij} = VA_i = \overline{V}$$

one may write the total pressure drop in a simpler form:

$$\Delta p_{i} = \frac{1}{g} GF_{i}^{2} \left\{ \frac{1 \cdot 5 + FT_{i}}{2 \cdot 0} + \frac{FR_{i} \cdot HT}{2 \cdot DH_{i}} \right\} \cdot \overline{V} = \frac{1}{g} GF_{i}^{2} \cdot \frac{1}{\alpha_{i}^{2}} \cdot \overline{V}$$

where

$$\frac{1}{\alpha_{i}^{2}} = \left\{ \frac{1.5 + FT_{i}}{2.0} + \frac{FR_{i} \cdot HT}{2.0} B_{i} \right\}$$

is a generalized coefficient of friction associated with each channel. The second relevant equation is obtained from the mass balance of the coolant:

$$\sum_{i} \left[(GF_{i}) \cdot (AN_{i} \cdot (R_{j}^{2} - R_{i}^{2}) \cdot PI) \right] = \sum_{i} \left[(GF_{i}) \cdot (FQ_{i}) \right] = G$$

where

$$FQ_{i} = AN_{i} \cdot (R3_{i}^{2} - R2_{i}^{2}) \cdot PI$$

a) Steady State Equilibrium

Calculation of flow distribution in parallel channels:

The condition that all Δp_i be equal in all parallel channels, together with the approximate expression for Δp_i and the mass balance yields the

predictor formula:

$$GF_{i} = G \cdot \frac{\alpha_{i}}{\sum_{i} (FQ_{i} \cdot \alpha_{i})}$$

With these estimates for the area net flow rates GF_i the associated pressure drops Δp_i may be calculated. A correction formula is obtained by assuming that the correct pressure drop $\Delta p^{\#}$ is related to the correct net flow rates $GF_i^{\#}$ by

$$\Delta p_{i}^{\mathbf{H}} = \Delta p_{i} \cdot \left(\frac{\mathrm{GF}_{i}^{\mathbf{H}}}{\mathrm{GF}_{i}}\right)^{2}$$

Combination of this relation with the mass balance yields the correction formula:

$$GF_{i}^{\mathbf{H}} = GF_{i} \frac{G/\sqrt{\Delta p_{i}}}{\sum_{i} (FQ_{i} \cdot GF_{i} / \sqrt{\Delta p_{i}})}$$

This correction is applied iteratively until the maximum difference between any two values Δp_i is less than a specified number DP. When this condition is satisfied one may compute a pressure drop $\overline{\Delta p}$ from the relation:

$$G = \sum_{i} (GF_{i} \cdot FQ_{i}) = \sum_{i} (GF_{i}^{*} \cdot FQ_{i}) = \sum_{i} (GF_{i} \cdot \sqrt{\frac{\Delta p}{\Delta p_{i}}} \cdot FQ_{i})$$

2

as

$$\overline{\Delta p} = \left[\frac{\sum_{i} (GF_{i} \cdot FQ_{i})}{\sum_{i} (GF_{i} \cdot FQ_{i} / \Delta p_{i})} \right]$$

This pressure drop $\overline{\Delta p}$ will be a good approximation of the actual pressure drop between the two plenum chambers.

Calculation of the entry pressure (B.C.2):

From the predictor formula and the approximation for the pressure drop Δp_i , both given previously in this appendix, we can derive:

$$\Delta p_{i} = \Delta p = \frac{1}{g} \cdot \left[\frac{G}{\sum_{i} (FQ_{i} \alpha_{i})} \right]^{2} \cdot \overline{V}$$

For the case of two flow sections connected in series (radial blanket, axial blankets + core) the corresponding formula is:

$$\Delta p = \frac{1}{g} \left[\frac{G}{\left(\sum_{i} (FQ_{i}\alpha_{i})\right)_{RB} + \left(\sum_{i} (FQ_{i}\alpha_{i})\right)_{AB+C}} \right]^{2} \cdot \overline{v}$$

A good estimate for \overline{V} is obtained by taking the average of VE and VA which in turn are determined by enthalpy and pressure at entrance and exit. Since the entrance pressure is not known an iterative procedure might be applied. This is not done here in the light of the fact that the expression for Δp is itself only an approximation. This pressure drop Δp and the given exit pressure $p_{out}^{\mathbf{X}}$ are combined to give the entry pressure p_{in} :

$$p_{in} = p_{out}^{\mathbf{x}} + \Delta p$$

Using this entry pressure we proceed to compute pressure drops as indicated. Finally, we obtain an exit pressure p_{out} , in general, will differ from the given value $p_{out}^{\#}$. The difference is used directly and iteratively for a correction of the entry pressure:

 $p_{in}^{\mathbf{H}} = p_{in} - (p_{out} - p_{out}^{\mathbf{H}})$

until the magnitude of the difference becomes less than a specified number DP.

b) Transient Calculations

The dominating requirement of short computing times together with the experience obtained from applications of this model to many practical cases have prompted the scheme of deferred correction as regarding the calculation of transient hydraulics. It implies that all necessary corrections are deferred to the consecutive step of the integration. The accuracy of this scheme shall not be discussed here but has been found satisfactory in all cases.

The correction is carried out in two consecutive parts. The first correction consists in a proportional change of all area net flow rates GF_i so as to affect the total flow rate of coolant G but not the relative distribution through parallel channels. This correction is applied in order to meet the boundary conditions across the reactor (prescribed pressure drop, or prescribed total coolant flow rate the correction obvious-

ly is:

$$GF_{i}^{\mathbf{H}} = GF_{i} \cdot \left(\frac{G}{\Sigma} \left(GF_{i} \cdot FQ_{i}\right)\right)$$

whereas in the case of prescribed pressure drop $\Delta p^{\mathbf{X}}$ the corresponding formula is:

$$GF_{i}^{\#} = GF_{i} \cdot \left(\bigvee_{\overline{\Delta p}}^{\underline{\#}} \right)$$

where

$$\overline{\Delta p} = \begin{bmatrix} \sum_{i} (GF_{i} \cdot FQ_{i}) \\ \vdots (GF_{i} \cdot FQ_{i} / \sqrt{\Delta p_{i}} \end{bmatrix}^{2}$$

in analogy to the corresponding equation derived for the steady state calculations. For the case of two flow sections in series the pressure drop $\overline{\Delta p}$ is computed for either section from this formula and added to give

$$\overline{\Delta p} = \overline{\Delta p}_1 + \overline{\Delta p}_2$$

The second correction is such that the channel net flow rates GF_i are altered while the total coolant flow rate G remains constant. This correction is applied in order to achieve equality of pressure drops in parallel flow paths. It is derived directly from the mass balance equation and the relation for the correct pressure drop Δp^* given earlier:

$$GF_{i}^{\mathbf{X}\mathbf{H}} = GF_{i}^{\mathbf{X}} \cdot \sqrt{\frac{\Delta p}{\Delta p_{i}}}$$

where

$$\overline{\Delta p} = \begin{bmatrix} \underline{\Sigma} & (GF_{i}^{\mathbf{X}} \cdot FQ_{i}) \\ \underline{\Sigma} & (GF_{i}^{\mathbf{X}} \cdot FQ_{i} / \sqrt{\Delta p_{i}} \end{bmatrix}^{2}$$

The logic flow diagrams presented in Fig. Cl and Fig. C2 illustrate the procedures described in this appendix.

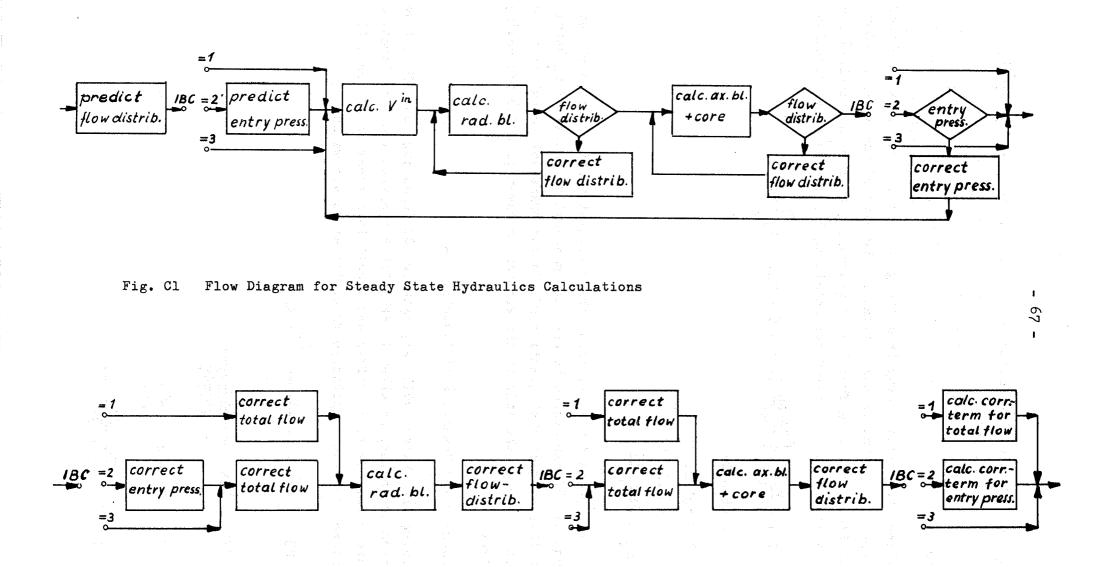


Fig. C2 Flow Diagram for Transient Hydraulics Calculations

<u>APPENDIX D</u> : Other Iterative Procedures Applied in Solving the Steady State Problem

a) Pressure Drop

Calculating the pressure drop from the given formuli requires knowledge of the specific volume of the coolant at the exit of the section under concern. Since this is a function of pressure (as well as enthalpy) the following iteration is devised for obtaining the steady state solution:

$$DP = \frac{(GF)^2}{2 \cdot g} \cdot \left\{ \frac{FR \cdot \Delta H}{2 \cdot DH} (1 + 0.5 \cdot \varepsilon_v) + \varepsilon_v \right\} VE$$

$$PA = PE - DP$$

$$TA = f_T(PA, WA)$$

$$VA = f_V(PA, TA)$$

$$\varepsilon_v = \frac{VA - VE}{VE}$$

The starting guess for ε_v is zero; the termination criterion is on the magnitude of the difference between two consecutive values of ε_v being smaller than a prescribed quantity EV. In the transient calculation the specific volume at the exit of the section is taken from the preceeding time step.

b) Heat Transfer and Channel Wall Temperatures

Determining the channel wall temperatures TC2 (cladding) and TM (structure) from the equations given in APPENDIX A requires another iterative procedure since the film coefficient itself is a function of the wall temperature. For the temperature TM of the structure we have:

$$H34 = H34 \cdot \left(\frac{1}{1 + \varepsilon_{T}}\right)^{AL3} + AL4$$

$$H34' = H34 \cdot \frac{1}{1 + \frac{D4 \cdot H34}{3 \cdot C\emptyset 4}}$$

$$TM = T3 + q_{M} \cdot \frac{D4}{H34'}$$

$$\varepsilon_{T} = \frac{TM - T3}{T3 + 273 \cdot 16}$$

Initialization and termination are done similarily as in case a) using the prescribed quantities ETC and ETM respectively for the wall temperature of cladding and structure. For the transient calculation the values of these two temperatures from the preceeding step are taken to calculate the film coefficients.

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 $\Delta = \sum_{i=1}^{n} (i - i) \sum_{i=1}^{n} (i - i)$

<u>APPENDIX E</u> : Stagnation and Reversal of Flow

Although there is only one minor modification required to adjust the model for accommodating flow reversal the numerical methods are affected extensively. The adjustment in the model concerns the shift in location of the entry pressure loss with flow reversal. This applies to both the radial blanket flow section as well as the core flow section. Thus, reversed flow experiences pressure losses from entry, friction and orificing, in this order.

Many of the numerical procedures used in similar context elsewhere are not suited for the treatment of flow reversal as they are numerically unstable at reversed flow direction. Also, it appears desirable to maintain the original sequence in which the calculation computes enthalpies and pressures, the sequence thus being independent of the direction of flow. This sequence was chosen to coincide with the initial direction of flow which was also used as a basis for the nomenclature and sequence of the various flow sections in series (entrance plenum chambers - rad. bl. - intermediary plenum chamber - first ax. bl. - core - second ax. bl. - exit plenum chamber). For both of these reasons - stability and simplicity - the method selected here is well suited.

a) Hydraulics

Aside from the adjustment for shift in location of entry losses there is no significant change required in the hydraulics-model and -calculation in the program. Reversed flow is indicated by a negative coolant flow rate. All other pressure losses (friction, acceleration) may be computed by the original formuli if the change in sign is accounted for by a factor FC = $\frac{1}{2}$ 1 as in the following example.

$$\Delta \mathbf{p}_{i} = \mathbf{p}_{i+1} - \mathbf{p}_{i} = FC \cdot \frac{(GF)^{2}}{2g} \cdot \left[\frac{FR \cdot \Delta H}{2 \cdot DH} \cdot \overline{V}_{i} + (V_{i+1} - V_{i}) \right]$$

where

$$FC = \left\{ \begin{array}{l} + 1 & \text{for normal flow} \\ - 1 & \text{for reversed flow} \end{array} \right.$$

and i,i+l refers to two consecutive axial nodes along the flow path the order of which does not change with change of flow direction. In case of stagnation of $flow(G = GF_i = 0)$ all pressure drops Δp_i would also vanish. Hence, a fictitious and very small flow rate must be maintained

 (10^{-8} kg/sec) in order to avoid deviding by zero in the correction formuli given in APPENDIX C.

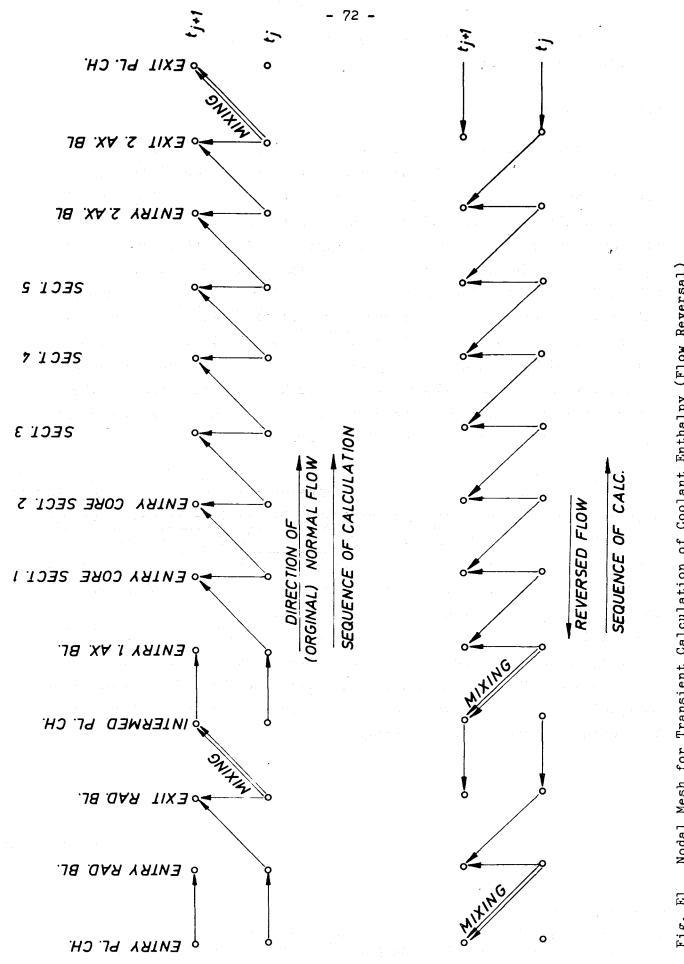
b) Thermodynamics

Flow reversal does not affect the equations for enthalpy balance in the coolant if WE and WA stands for the coolant enthalpy entering and leaving the node, respectively, and irrespective of flow direction. The schematic diagram in Fig. El shows how the nodal enthalpies are interrelated. A node entered by one arrow only indicates, that this enthalpy is transferred directly from one node to the other. If such a connection occurs between two nodes at different times (t_j and t_{j+1})this is equivalent to a transport delay of the length of the time increment I. It can be seen from this figure that there is in effect such a transport delay applied between all neighbouring nodes, including the nodes representing the plenum chambers⁺⁾. In as much as the step size of the integration approaches the transport time Δt_T this method will account for the actual transport effects (see APPENDIX H).

c) Boundary Conditions

When using program REX, flow reversal is achieved by appropriate choice of the boundary conditions. With B.C.l. flow reversal occurs when the specified exit pressure exceeds the entry pressure, which is also specified. In the case of B.C.2 and B.C.3 flow reversal occurs when the total coolant flow rate G becomes negative. The present version of the main program REX is such that for all three cases the enthalpy of the coolant entering the reactor under conditions of reversed flow is constant and equal to the value at this point (exit plenum chamber) just before flow reversal. Thus, the enthalpy values specified in data block 2 become irrelevant in case of flow reversal.

⁺⁾ To be quite exact at this point the prior assumption of zero residence time of the coolant in the plenum chambers must be corrected to state that a delay of a length I is included, which in general however will be small and may be neglected relative to actual residence times.



Nodal Mesh for Transient Calculation of Coolant Enthalpy (Flow Reversal) Fig. El <u>APPENDIX F</u> : Integration of the Point Kinetics Equations

Equations:

$$\frac{dP}{dt} = \frac{1}{\Lambda} \cdot \left[\beta \cdot \Delta k - \beta \right] \cdot P + \sum_{i} \lambda_{i} C_{i}$$

$$\frac{dC_{i}}{dt} = \frac{1}{\Lambda} \cdot \beta_{i} \cdot P - \lambda_{i} C_{i} \qquad i = 1, 2, \dots ND$$

$$\Delta k = \Delta k_{T} + \Delta k_{K} \qquad [\$ - units]$$
Substitutions:

$$Y_{i} = \frac{\Lambda \lambda_{i}}{\beta_{i}} \cdot C_{i}$$
$$f_{i} = \frac{\beta_{i}}{\beta}$$
$$\omega = \frac{\beta_{i}}{\lambda}$$

Yield:

$$\frac{dP}{dt} = \omega \cdot \left[(\Delta k - 1) \cdot P + \sum_{i} f_{i} \cdot Y_{i} \right]$$
$$\frac{dY_{i}}{dt} = \lambda_{i} \left[P - Y_{i} \right]$$

The basic assumption facilitating efficient integration by a semi-analytic method is that changes in the variables Y_i may be neglected relative to the change in P during a short time interval. Furthermore, the reactivity also is to remain constant during this interval. We introduce the following two quantities

$$\frac{1}{\tau_{\circ}} = \omega \cdot (\Delta k_{\circ} - 1)$$

$$S_{\circ} = \frac{1}{\Delta k_{\circ} - 1} \cdot \sum_{i} f_{i} Y_{i}$$

where the subscript O refers to (known) values at the beginning of an interval Δt over which we want to integrate. With this we now can write:

$$\frac{dP}{dt} = \frac{\Lambda}{\tau_{o}} \left[P + S_{o} \right]$$

which under the assumption made above can be integrated to give

$$P = (P_o + S_o) e^{\frac{At}{c_{\bullet}}} - S_o$$

Integrating again yields the energy release:

$$\Delta E = \int P dt = (P_{o} + S_{o}) \cdot \tau_{o} \cdot (e^{\frac{\Delta t}{\tau_{o}}} - 1) - S_{o} \cdot \Delta t$$

and

$E = E_{\circ} + \Delta E$

The variables Y_i corresponding to the concentration of the precursors are obtained from integration of the corresponding equations:

$$Y_i = Y_{i_0} + \lambda_i \left[\Delta E - Y_{i_0} \cdot \Delta t \right]$$

Assuming equilibrium at the power level P_o as the initial condition, the starting values of all variables have to be:

$$g_{\circ} = 0 \qquad \qquad S_{\circ} = -P_{\circ} \qquad \qquad \\ \frac{1}{\tau_{\circ}} = -\omega \qquad \qquad Y_{i_{\circ}} = P_{\circ} \qquad \qquad \\ E_{\circ} = 0 \qquad \qquad \qquad \\ E_{\circ} = 0 \qquad \qquad \qquad \\ \end{array}$$

Although the scheme is complete at this point two special cases shall be considered:

a) Prompt Criticality

Condition:

$$\left|\frac{\Delta t}{\tau_{\circ}}\right| \ll \mathcal{E}_{1} \ll$$

If this inequality is satisfied for an appropriate value of ε_1 , it is acceptable to approximate the exponential function by the first two terms of its Taylor expansion:

$$P = \left(P_{o} + S_{o}\right) \cdot \left(1 + \frac{\Delta t}{\tau_{o}}\right) - S_{o} = P_{o} \cdot \left(1 + \frac{\Delta t}{\tau_{o}}\right) + S_{o} \cdot \frac{\Delta t}{\tau_{o}}$$

For sufficiently small values of $\varepsilon_1 (= 10^{-6})$ we may simplify further and write:

 $P = P_{o} + S_{o} \frac{\Delta t}{\tau_{o}}$

For the energy increment ΔE we get in the same manner:

$$\Delta E = (P_{o} + S_{o}) \cdot \overline{c}_{o} \cdot \left(\frac{\Delta t}{\overline{c}_{o}} + \left(\frac{\Delta t}{\overline{c}_{o}}\right)^{2} \cdot \frac{1}{2}\right) - S_{o} \cdot \Delta t = (P_{o} + S_{o} \cdot \frac{1}{2} \cdot \frac{\Delta t}{\overline{c}_{o}}) \cdot \Delta t$$

The inequality above may be rewritten as:

$$\left| \Delta k_{o} - 1 \right| \ll \frac{10^{-6}}{\Delta t \cdot \omega}$$

which normally will be satisfied only when the excess reactivity $\Delta {\bf k}_{\rm A}$ is very nearly equal to unity (one dollar) (prompt criticality).

b) Prompt Jump Approximation

Condition:

$$\frac{\Delta t}{\tau_{v}} \leqslant \varepsilon_{2} < 0$$

If this condition is satis fied for sufficiently large values of ϵ_2 (e.g.-18.4) it is acceptable to neglect the experimental function relative to unity. Thus we get:

$$P = -S_{\circ}$$

$$\Delta E = -(P_{\circ} + S_{\circ}) \cdot \mathcal{T}_{\circ} - S_{\circ} \cdot \Delta t = P_{\circ} \cdot \mathcal{T}_{\circ} + S_{\circ} \cdot (\mathcal{T}_{\circ} - \Delta t)$$

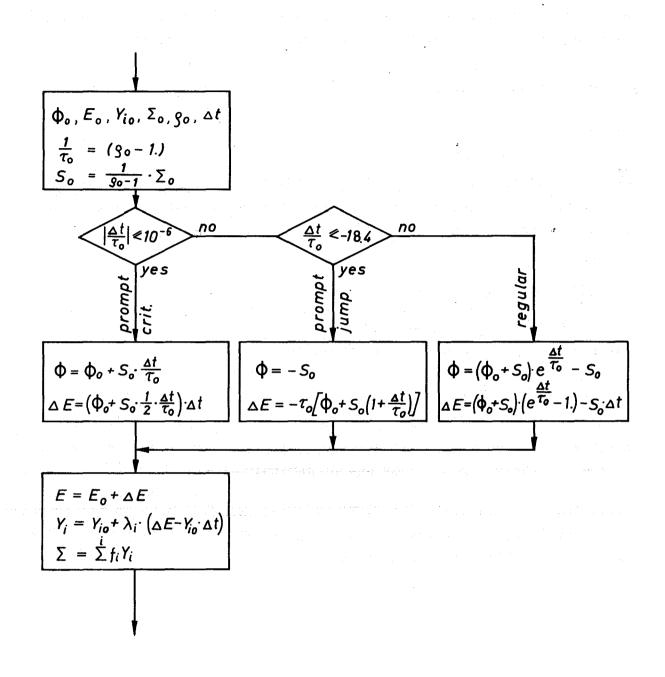
$$= \left[-P_{\circ} - S_{\circ} \cdot (1 + \frac{\Delta t}{\mathcal{T}_{\circ}}) \right] \cdot \mathcal{T}_{\circ}$$
incomplete may be rewritten as:

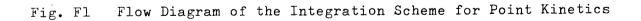
The inequality above may be rewritten as

 $\Delta k_{o} \leqslant 1 - \frac{18.4}{\omega \Delta t}$

which is satisfied whenever the reactor is sufficiently below prompt critical. The approximate solution obtained in this case is equivalent to the well-known prompt jump approximation.

Note, that both inequalities given under a) and b) depend on the step size At of the integration. The flow chart given in Fig. Fl illustrates the integration scheme described above.



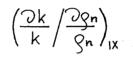


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<u>APPENDIX G</u> : Sample for Calculating Feedback Parameters from Results of Perturbation Calculations

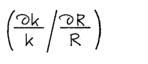
The example given below is based on feedback models employed by the FOREcode $/1_7$ and also by $/12_7$. These models are slightly modified and restricted to space dependence in axial direction only. Consequently, the radial distribution coefficients ARD, ARF, ARC, ARS, ARM are insignificant and may be assigned arbitrary values (\neq 0). Axial subdivisions are introduced at equal intervals along the vertical axis of the core.

A set of basic reactivity coefficients is assumed to be available, for instance, from one dimensional perturbation calculations for the particular case of interest:



rel. change in reactivity resulting from a relative change in density of material n (= F,C,S,M) in axial section IX,

 $\left(\frac{\Im k}{k} \middle/ \frac{\Im HC}{HC}\right) \qquad \text{relative change in reactivity resulting from a relative change in core height HC,}$



relative change in reactivity resulting from a relative change in core radius R,

(ok fotf)

ß

change in reactivity resulting from a change in fuel temperature TF by 1 $^{\circ}$ K in axial section IX due to the Doppler effect (Doppler coefficient)(fuel reference temperature 900 $^{\circ}$ K)

fraction of delayed neutrons

Additional parameters appearing in the following equations are

 α_{g}volume fraction of coolant per axial channel section

$$\frac{R3^2 - R2^2}{R3^2 + WP \cdot D4/PI}$$

 B_1volume fraction of spacers per axial channel section B_2 " " subassembly cans per axial channel section Before presenting the formuli special mention shall be made of some of the mechanisms and associated assumptions (indexing code refers to subsequent paragraphs):

- a 3), b 1), d 1) : the effective density of each of the components: fuel, clad and structure is not changed by the radial expansion of the respective component;
- d 2),d 3),d 4) : radial expansion of the core in any point is assumed to be a linear function of the local structural temperature alone.
- a) Fuel Temperature Effects
- a 1) Doppler effect:

$$AXD = (Ok/OTF)_{ix}$$
 axial distribution coefficients (unnormalized)

$$\mathsf{RCD} = \frac{900}{\beta} \sum_{ix} (\mathsf{AXD}) \qquad \dots \qquad \mathsf{Doppler constant}, \ \mathscr{B}\text{-units},$$

a 2) Change in core height due to axial expansion of fuel:

$$\mathsf{RCH} = \frac{1}{\beta} \left(\frac{\Im k}{k} / \frac{\Im Hc}{Hc} \right)$$

a 3) Change in effective fuel density due to axial expansion of fuel:

$$AXF = \left(\frac{\partial k}{k} / \frac{\partial \rho_F}{\beta_F}\right)_{12}$$
$$RCF = \frac{1}{\beta} \cdot \sum_{IX} (AXF)$$

b) Cladding Temperature Effects

b 1) Change in effective cladding density due to axial expansion of cladding:

$$AXC_{1} = \left(\frac{\partial k}{\kappa} / \frac{\partial g_{c}}{g_{c}}\right)_{1x}$$

b 2) Change in effective coolant density due to radial expansion of cladding:

$$AXC_{2} = \left(\frac{\partial k}{\kappa} / \frac{\partial \rho_{s}}{\beta_{s}}\right) \cdot \frac{\frac{d\rho_{s}}{\rho_{s}} / dTC}{\frac{d\rho_{c}}{\rho_{c}} / dTC} = \left(\frac{\partial k}{\kappa} / \frac{\partial \rho_{s}}{\beta_{s}}\right) \cdot \frac{-2 \cdot AEF \cdot \frac{1 - \omega_{s} - (B_{1} + B_{2})}{\omega_{s}}}{-AEC}$$

Total:

$$AXC = AXC_{4} + AXC_{2}$$
$$RCC = \frac{1}{15} \sum_{1x} (AXC)$$

c) Coolant Density Effect:

$$AXS = \left(\frac{\Im k}{\kappa} / \frac{\Im q_s}{\Im^s}\right) \frac{1}{\Im^s}$$

- $RCS = \frac{1}{3} \cdot \sum_{ix} (AXS)$ d) Structure Temperature Effects
- d 1) Change in effective structure density due to axial expansion of structure:

$$AXM_{4} = \left(\frac{\partial k}{\kappa} / \frac{\partial g_{H}}{g_{H}}\right)$$

d

d 2) Change in effective fuel density due to radial expansion of (supporting) structure

$$A \times M_{2} = \left(\frac{\partial k}{k} / \frac{\partial g_{F}}{S_{F}}\right) \cdot \frac{\frac{d g_{F}}{g_{F}} / dTM}{\frac{d g_{F}}{g_{M}} / dTM} = \left(\frac{\partial k}{k} / \frac{\partial g_{F}}{S_{F}}\right) \cdot \frac{-2 \cdot AEM}{-AEM} = \left(\frac{\partial k}{k} / \frac{\partial g_{F}}{S_{F}}\right) \cdot 2$$

d 3) Change in effective cladding density due to radial expansion of (supporting) structure

$$AXM_{3} = \left(\frac{\partial k}{k} / \frac{\partial q_{c}}{g_{c}}\right) \cdot \frac{\frac{d q_{c}}{g_{c}}}{\frac{\partial q_{m}}{g_{m}}} / dTM = \left(\frac{\partial k}{k} / \frac{\partial q_{c}}{g_{c}}\right) \cdot \frac{-2 \cdot AEM}{-AEM} = \left(\frac{\partial k}{k} / \frac{\partial q_{c}}{g_{c}}\right) \cdot 2$$

d 4) Change in effective coolant density due to radial expansion of (supporting) structure

$$AXM_{4} = \left(\frac{\partial k}{\kappa} / \frac{\partial q_{s}}{g_{s}}\right) \cdot \frac{\frac{d q_{s}}{g_{s}}}{\frac{d \rho_{m}}{g_{m}}} = \left(\frac{\partial k}{\kappa} / \frac{\partial q_{s}}{g_{s}}\right) \cdot \frac{2 \cdot AEM}{-AEM} = \left(\frac{\partial k}{\kappa} / \frac{\partial q_{s}}{g_{s}}\right) \cdot \left(-\frac{2 \cdot (1 - \alpha_{s})}{\alpha_{s}}\right)$$

d 5) Change in effective coolant density due to expansion of structure (spacers and subassembly cans)

$$AXM_{5} = \left(\frac{Ok}{k} / \frac{Os}{S^{5}}\right) \frac{\frac{dQ_{s}}{Q_{s}}}{\frac{dQ_{m}}{S^{m}}} = \left(\frac{Ok}{k} / \frac{Os}{S^{5}}\right) \frac{-AEM}{-AEM} \frac{\frac{3B_{4} + 2B_{2}}{\omega_{s}}}{-AEM} = \left(\frac{Ok}{k} / \frac{Os}{S^{5}}\right) \frac{\frac{3B_{1} + 2B_{2}}{\omega_{s}}}{-AEM}$$
Total: $AXM = \sum_{i=1}^{5} AXM_{i}$
 $RCM = \frac{A}{B} \sum_{i=1}^{5} \sum_{i=1}^{5} AXM$
d 6) Change in core radius due to radial expansion of structure
 $RCR = \frac{A}{B} \left(\frac{Ok}{k} / \frac{OR}{R}\right)$

- <u>APPENDIX H</u> : Determination of Integration Step Size, Numerical Stability of Integration of the Thermo-Hydraulic Equations
- a) Estimation of the Maximum Stable Step Size for Integration of the Thermo-Hydraulic Equations

Numerical instabilities occurring during integration by nodal approximation of problems of heat transfer and heat transport impose a dominating limitation on the step size of integration. With the nodes fixed at their spatial coordinates there is a maximum stable step size for the integration which depends on both the physical parameters involved as well as the particular method of discretization and mesh spacing. A classic approach to determine the maximum stable step size is the one of small perturbations which in general leads to an Eigenvalue problem. Computer storage requirements and considerations of computing speed preclude such an approach in most practical cases. To achieve the same purpose a much simpler technique is employed here which yields a conservative (too small) maximum step size granting numerical stability of the integration. A certain amount of flexibility is maintained by multiplying this step size estimate by a given constant coefficient EST before applying it to the integration. Furthermore, re-evaluation of the maximum stable step size may be restricted to every NTE'th step during the integration and keeping it unaltered for all the steps in between. This facilitates savings in computing time for step size determination in case of slowly varying transients. If the maximum stable step size (MSS) comes out to be smaller than the current step size, the latter will be halved until it in turn is smaller than MSS. If MSS is larger than twice the current step size the latter may be doubled for the following step of the integration if other tests are satisfied. These tests are listed under b) in this appendix.

The perturbation method consists of introducing small perturbances ε_i in all variables of the pertinent system of equations. These must not grow for any of the variables from any **•ne** step to the next in order for the system to be stable. Since we require the true solution to hold along with the perturbation solution we may subtract the(unpertubed) original system of equations from the perturbed one. In the case of a linear system - as we are dealing with - the remaining equations on the right hand side are linear and homogeneous in the perturbations ε_i which were introduced at the beginning of the step. The components of the left hand vector are the perturbations ε_i^* at the end of the step. Application of this scheme to the pertinent equations for transient temperatures in all components of one axial section (see APPENDIX A) we get the following system of equations:

$$\begin{aligned} \varepsilon_{1}^{*} &= \varepsilon_{1} \cdot (1 - \Delta t \cdot \alpha_{11}) + \varepsilon_{2} \cdot \Delta t \cdot \alpha_{12} \\ \varepsilon_{2}^{*} &= \varepsilon_{1} \cdot \Delta t \cdot \alpha_{21} + \varepsilon_{2} \cdot (1 - \Delta t \cdot \alpha_{22}) + \varepsilon_{3} \cdot \Delta t \cdot \alpha_{23} \\ \vdots \\ \varepsilon_{j}^{*} &= \varepsilon_{j-1} \cdot \Delta t \cdot \alpha_{j,j-1} + \varepsilon_{j} \cdot (1 - \Delta t \cdot \alpha_{jj}) + \varepsilon_{j+1} \cdot \Delta t \cdot \alpha_{j,j+1} \\ \vdots \\ \varepsilon_{3}^{*} &= \varepsilon_{3-1} \cdot \Delta t \cdot \alpha_{3-1,3} + \varepsilon_{3} \cdot (1 - \Delta t \cdot \alpha_{33}) \end{aligned}$$

where all of the coefficients $a_{i,j}$ are positive. Note, that some of these coefficients are functions of time as they contain temperature dependent fuel properties, coolant net flow rate and film coefficients.

Instead of solving the Eigenvalue-problem associated with the requirement of decreasing perturbations we apply a criterion of the form $/[13_7]$:

$$\sum_{j=4}^{3} |A_{ji}| \ll 1 \qquad j = 1, 2, ... J$$

where A_{ji} are the elements of the coefficient matrix in the system of equations above. Guarding against numerical instabilities of oscillatory nature this criterion yields a conservative estimate for the maximum stable step size in the following manner:

$$\begin{split} \sum_{i=4}^{J} |A_{ji}| &= \Delta t_{j} \alpha_{j,j-4} + (-1 + \Delta t_{j} \alpha_{jj}) + \Delta t_{j} \cdot \alpha_{j,j+1} = 1 \\ \Delta t_{j} &= \frac{2}{\alpha_{j,j-1} + \alpha_{j,j} + \alpha_{j,j+1}} \\ \Delta t_{max} &= MIN (\Delta t_{j}) \end{split}$$

In view of the last equation not all Δt_j need to be evaluated since certain ones always are larger than certain other ones by nature of the expressions from which they are computed. For instance, this is the case for the fuel nodes in any particular axial section, where only the surface node (TFN) needs to be considered here.

With regard to the equations for the coolant it is convenient to replace the enthalpy perturbations by temperature perturbations using the relations:

$$\varepsilon_{WA} = CPA \cdot \varepsilon_{TA}$$

 $\varepsilon_{T3} = 0.5 \cdot \varepsilon_{TA}$

The last equation follows from the assumption of a linear profile for the coolant temperature over anyone axial section.

Applying the equation for Δt_j to our particular system we get the following set of equations (core):

fuel edge:

$$\Delta t_{1} = \frac{R\emptyset 1 \cdot CP 1 \cdot R1^{2}}{4 \cdot NN \cdot \left[(2 \cdot NN - 1) \cdot C\emptyset 1 + R1 \cdot HGP \right]}$$

cladding, inner edge:

$$\Delta t_2 = \frac{R\emptyset 2 \cdot CP2 \cdot (R2^2 - R1^2)}{4 \cdot [R1 \cdot HGP + \frac{(R2 + R1)}{2 \cdot (R2 - R1)} \cdot C\emptyset 2]}$$

cladding, outer edge:

$$\Delta t_{3} = \frac{R\emptyset 2 \cdot CP2 \cdot (R2^{2} - R1^{2})}{4 \cdot \left[\frac{(R2 + R1)}{2 \cdot (R2 - R1)} \cdot C\emptyset 2 + R2 \cdot H23\right]}$$

coolant:

$$\Delta t_{4} = \frac{2}{\left[\frac{2 \cdot H23 \cdot R2}{CP3 \cdot (R3^{2} - R2^{2})} + \frac{H34' \cdot WP}{CP3 \cdot PI \cdot (R3^{2} - R2^{2})} + \frac{GF}{\Delta H}\right] \cdot V$$

structure:

$$\Delta t_5 = \frac{R\emptyset 4 \cdot CP 4 \cdot D4}{H34'}$$

Corresponding equations are obtained for blankets and bypasses. The proposed step size then is obtained from

$$\Delta t = EST \cdot MIN (\Delta t_j)$$

The last term in parentheses of the denominator in the expression for Δt_4 is the reciprocal of the transport time Δt_T of the coolant through the distance ΔH . In cases where this term dominates the maximum stable

$$\Delta t_{M} = 2 \cdot \Delta t_{T}$$

b) Step Size Limitations from Relative Changes of Total Power

Another criterion for the selection of the step size is applied in conjunction with the relative change in total power:

$$\Delta P = \frac{P_{n+1} - P_n}{P_n}$$

where the subscript refers to successive instances in time.

If $\Delta P > \Delta P_{Max}$ the step size is halved and integration of the point kinetics equations is repeated until $\Delta P < \Delta P_{Max}$.

If $\Delta P < \Delta P_{\rm Min}$ the step size may be doubled for the consecutive step.

The values for ΔP_{Max} and ΔP_{Min} are chosen from experience to be in the order of about 0.1 to 0.01.

c) Further Limitations

Finally, arbitrary limits may be set for the maximum and minimum value of the step size (XIX, XIN). If a step size smaller than XIN is required by either criterion given under a) and b) the computation is terminated. If a step size larger than XIX is permissible, the computation will continue using the most recent step size just below this upper limit. If, for the first step of integration, the stability criterion results in a step size larger than the upper limit XIX, then this value (XIX) will be taken as the size of the initial step of integration.

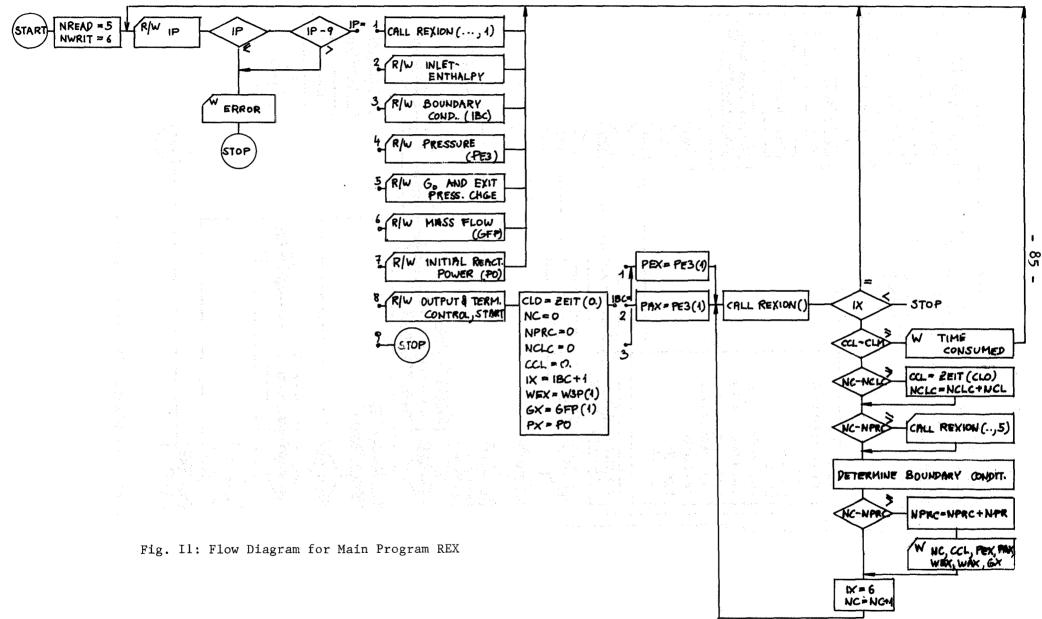
APPENDIX I: Flow Diagrams

The subsequent flow diagrams cover all routines on levels 1,2, and 3 as well as the reactivity function RCBE. Conventional symbols are employed to a large extent. Unconventional symbols are explained as follows:

R	REÁD ^{istatement}
W	WRITE statement
R/w	READ & WRITE statement
- X - A B	if: X 0 go to A IF statement X 0 go to B
$\frac{B}{B} = \frac{1}{2} \xrightarrow{A} A$ $\frac{2}{3} \xrightarrow{B} C$	<pre>if: IB=1 go to A computed GO TO statement IB=2 go to B IB=3 go to C</pre>
	DO statement; loop index goes from 1 to N. For simplicity, the loop index is omitted inside the loop. Examples: T(,,NN) corresponds to T(IX,IR,NN) WIØ(IX1,) corresponds to WIØ(IX1,IR) S corresponds to S(IX,IR)

Variable names in the flow diagrams are the same as in the actual routines and may differ from the names used elsewhere in this report.

Vertical dashed lines appearing in the flow diagram of subroutine STS signify iterative procedures as described in APPENDICES C and D.



i

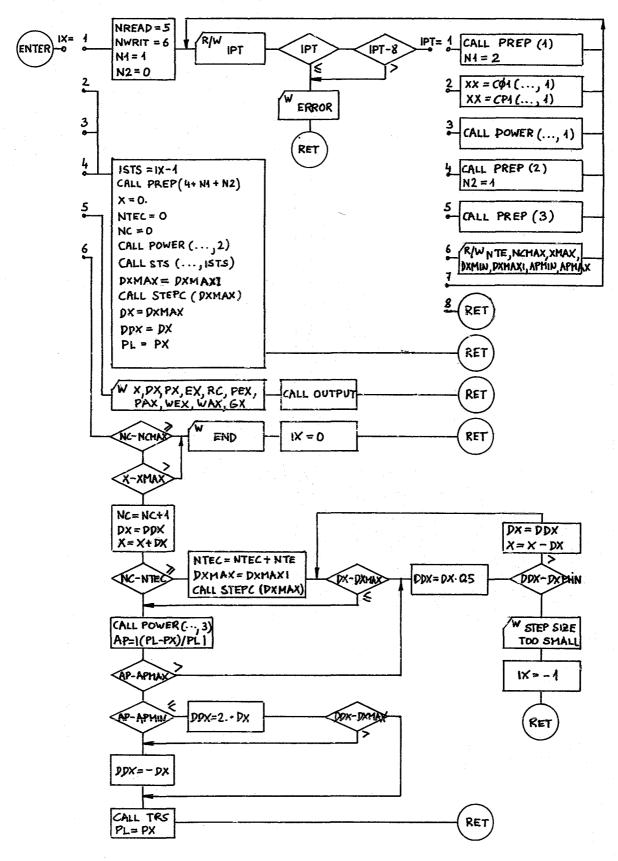


Fig. I2: Flow Diagram for Subroutine REXION

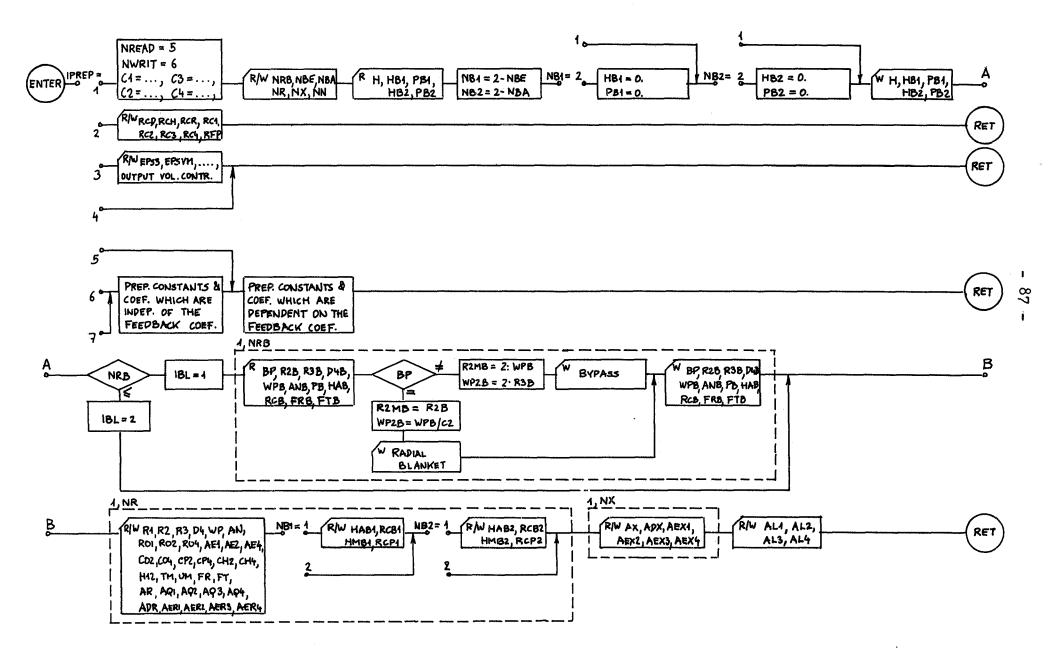


Fig. I3: Flow Diagram for Subroutine PREP

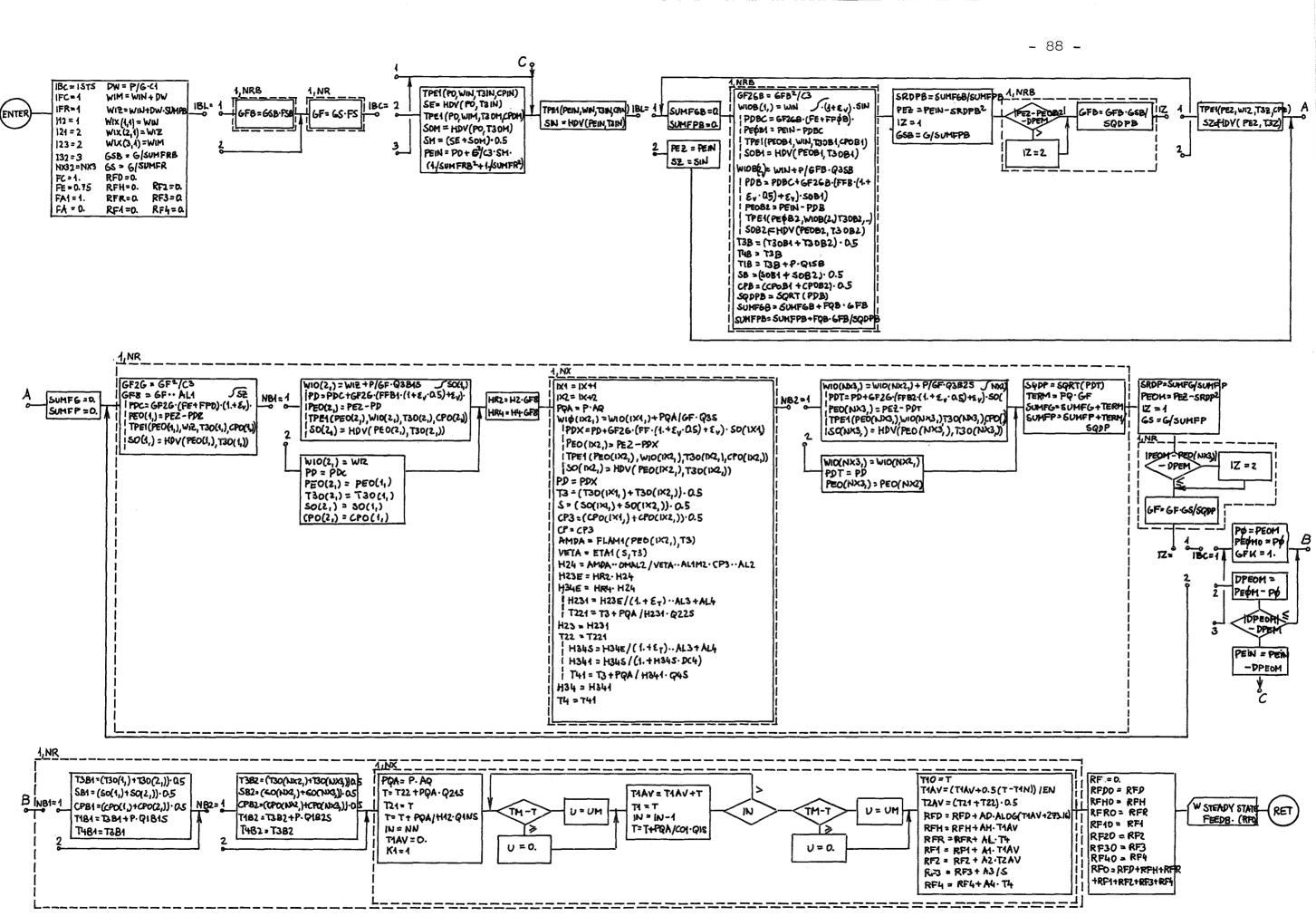
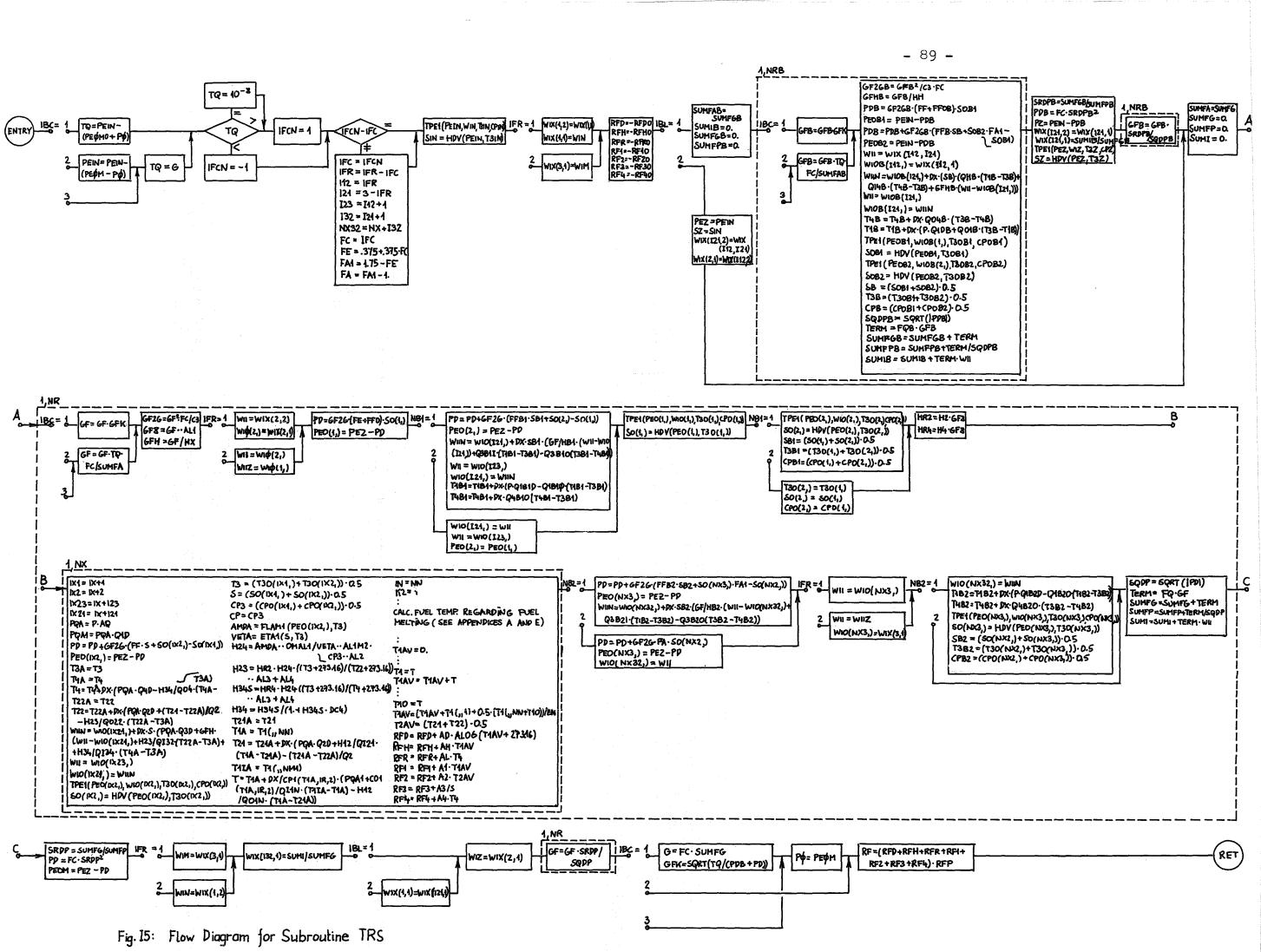


Fig. 14: Flow Diagram for Subroutine STS



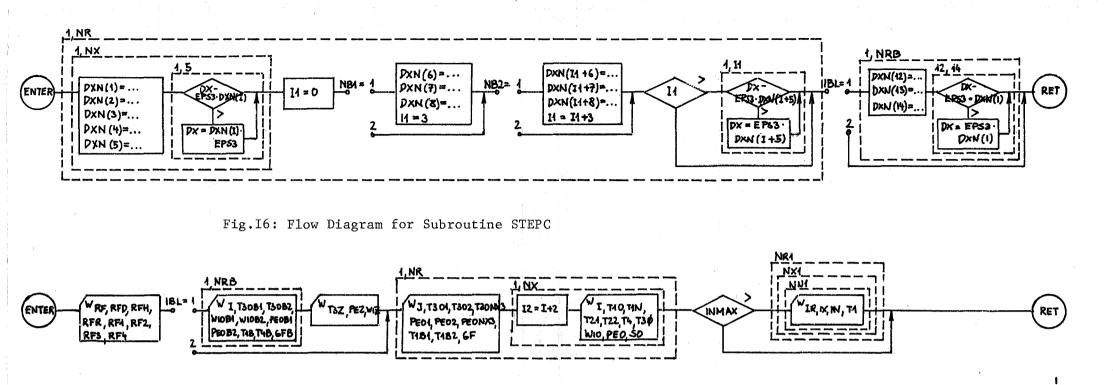


Fig.17: Flow Diagram for Subroutine OUTPUT

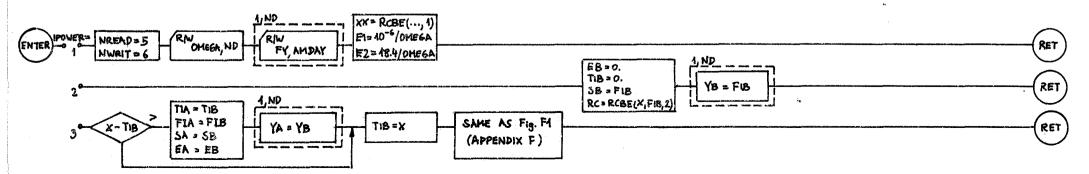
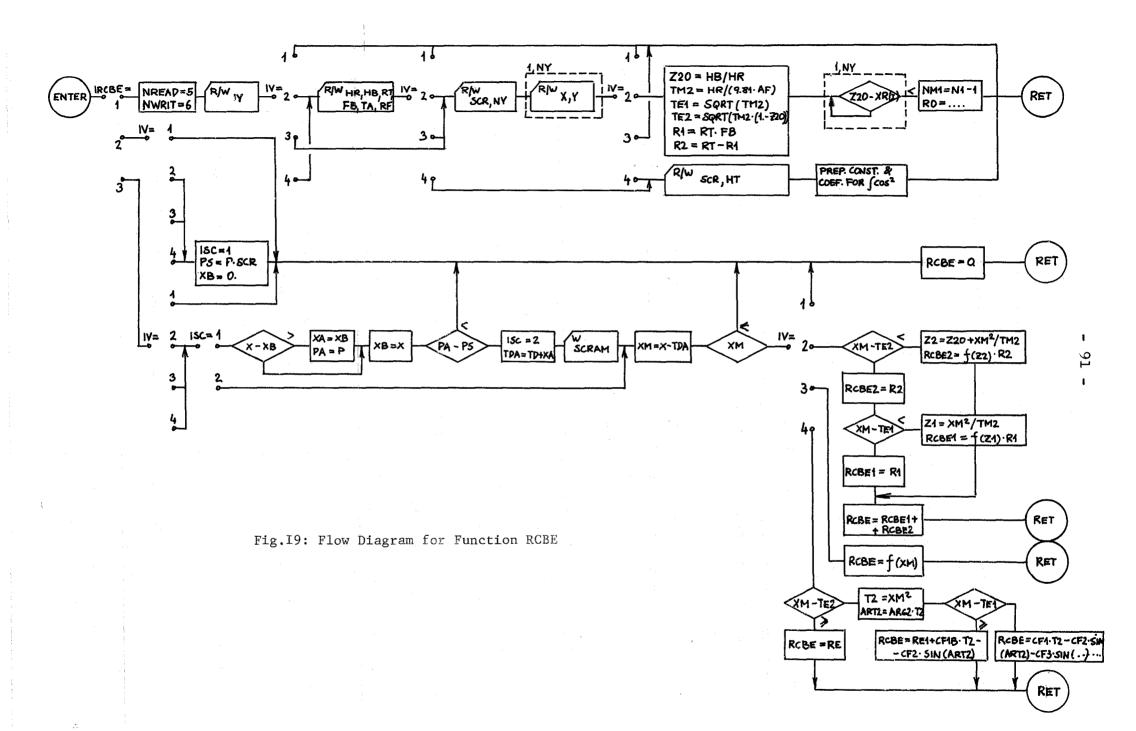


Fig.18: Flow Diagram for Subroutine POWER

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<u>APPENDIX J</u>: Subroutine REXION: Description and Instructions for Use The program described in this report can be used without the mainprogram REX by simply calling the subroutine REXION. The calling program must provide information specifying time dependent coolant boundary conditions et.c. The following rules should be observed:

The subroutine is called by:

CALL REXION (X, DX, P, E, G, PEX, PAX, WEX, WAX, IX)

The last argument in the list IX is used both as a parameter controlling the mode of operation of the subroutine as well as an error indicator. Calling the subroutine with different values for IX indicates the following operations:

- IX = 1 ... reading of all data required by the subroutine; these data are the ones designated SYSTEMS DATA constituting subblocks 1-8 as described in Chapter IV.2. A replica of this input is printed as first part of the output.

- IX = 5 ... output of all system variables, pertaining to time X, as described in Chapter IV.3
- IX = 6 ... integration of the transient problem over one step of length DX. The step length is determined internally from considerations presented in APPENDIX H.

After calling the subroutine with IX = 6, one out of three possible returns is made to the calling program:

IX = 6 ... (value unchanged) successful completion of the step of integration

IX = 0.... successful completion of the transient problem (internal termination criterion satisfied)

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IX = -1 integration not successful, step size required for stable
 and accurate integration is smaller than permitted minimum
 value XIN.

The remaining arguments in the list of the subroutine are explained in the input description, Chapter IV.2, and the list of notations, APPENDIX A. Which of these are input (I) and which are output (\emptyset) depends on the operational mode and is described in the following table:

IX	x	DX	P	E	G	PEX	PAX	WEX	WAX	Comment
2	ø ⁽¹⁾	ø ⁽³⁾	I	ø ⁽¹⁾	I · ·	I	ø	I	Ø	B.C.1
3	ø(1)	ø(3)	I	ø ⁽¹⁾	I	ø	I	I	ø	B.C.2 steady
4	ø ⁽¹⁾	ø(3)	I	ø(1)	I	I	Ø	I	ø	B.C.3
6(2)	ø ⁽²⁾	ø ⁽⁴⁾	ø	ø	ø	I	1/Ø ⁽⁵) [ø	B.C.1
(3)	ø(2)	ø ⁽⁴⁾		ø	I	ø		I	ø	B.C.2 transient
(4)	ø ⁽²⁾	ø ⁽⁴⁾	ø	ø	I	I	ø	I	ø	B.C.3

- (1) ... quantity is set equal to zero
- (2) ... time at the end of last step of integration
- (3) ... is set equal to the maximum step size for stable integration as calculated from initial steady state conditions or to the maximum permissible step size XIX which ever is smaller
- (4) ... step size used for the last step of integration
- (5) ... when calling the subroutine this argument has to be equal to the difference Δp of the current exit pressure and its initial value: $\Delta p = P_{ex} - P_{ex,0}$. Upon return this argument will be set equal to the acutal current exit pressure PAX.

None of the parameters listed with \emptyset in the last three lines (IX = 6) must be altered in the calling program during integration of anyone transient problem. Also, it should be noted that all arguments listed with I in the last three lines are evaluated at time X_{j-1} at the beginning of the step whereas the remaining arguments listed with \emptyset refer to the time $X_{j=X_{j-1}}$ +DX. The flow diagram in Fig. 31 gives an example for the integrated use of subroutine REXION. This flow diagram is essentially identical with the one of the main routine REX.

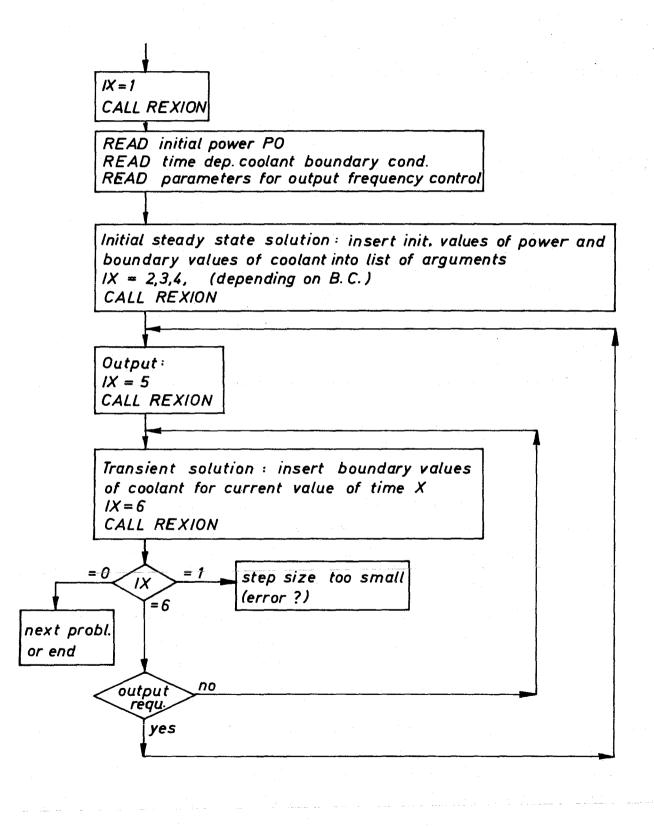


Fig. Jl Sample Flow Diagram for Application of Subroutine REXION

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APPENDIX K : Functions CØl and CPl

The functions $C\emptyset$ l and CPl are to compute the temperature dependent thermal conductivity and specific heat of the fuel. Both of these two functions have three arguments:

CØ1 (T, IR, IC) CP1 (T, IR, IC)

```
where T ... temperature of the fuel
IR .. index of the radial of the second flow section
IC .. parameter for mode control: \begin{cases} = 1 \dots \text{ input, preparation} \\ = 2 \dots \text{ calculation} \end{cases}
```

If input data are required for either of the two functions, they may be supplied in subblock 2 of the SYSTEM DATA. If data card 17 is inserted then each of the two functions is called just once, in the order CØl and CPl, with IC = 1. Thus, the required data cards must follow directly after card 17, such as card 18 and 19 shown in Chapter IV.2. For the routine calculation of the functional values the functions are called with IC = 2. If neither function CØl nor CPl require input the corresponding data cards 17, 18, 19 may be omitted and the parameter IC may be ignored.

The second argument IR may be significant in the case that fuel with different thermal properties in different radial core zones is specified.

Second order polynomials are used at present for both functions:

 $T^{\mathbf{X}} = \mathbf{a} \cdot \mathbf{T} - \mathbf{b}$ $C\emptyset \mathbf{l} = (CK\mathbf{l} + \mathbf{T}^{\mathbf{X}} \cdot (CK\mathbf{2} + \mathbf{T}^{\mathbf{X}} \cdot CK\mathbf{3})) \cdot CK\mathbf{0}$ $CP \mathbf{l} = (CC\mathbf{l} + \mathbf{T}^{\mathbf{X}} \cdot (CC\mathbf{2} + \mathbf{T}^{\mathbf{X}} \cdot CC\mathbf{3})) \cdot CC\mathbf{0}$

With a = 1.8 and b = 38.0 the transformation from T to T^{H} corresponds to a transformation from ^oC to ^oF with a reference temperature of 70 ^oF (≈ 21 ^oC). The coefficients CKO and CCO may be used for converting to different units (see / 1 7).

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APPENDIX L : Function RCBE

The function RCBE is to compute the external excess reactivity as a function of time and the total reactor power. The latter variable is included for providing the possibility of scram functions initiated by power level signals. If other system variables are to be used in controlling the reactor by external excess reactivity appropriate adjustments must be made in the present version of the program (CALL-statements).

The function is called by:

RCBE (X, P, IC)

where

Χ	time (sec)					
P	total reactor power (MW)					
IC	mode control parameter .					
			2	• • •	steady state	е
		=	3	• • •	transient	

If input data to this routine are required they may be supplied in subblock 3 of SYSTEM DATA (when the function RCBE is called once with IC = 1) directly after reading of the delayed neutron parameters. Thus, eventual data cards (cards numbered 23) must follow right after the last card numbered 22.

For calculating the steady state solution the function RCBE is called once with IC = 2 and with the second argument P equal to the initial power level PO. Preparatory calculations involving PO can be carried out during this step (e.g. setting of a scram level relative to the initial power). Upon returning the function should be set equal to zero, as the initial excess reactivity is equal to zero as required by the equilibrium condition.

Calls of RCBE with IC = 3 are the standard type in the transient case and are to give external excess reactivity as a function of the arguments: time (X) and power (P). It is essential for this mode of the routine that it may be called with decreasing values for X. This is the case when the step size has to be halved as a result of failing the test concerning maximum relative power change.

Description of the present version of RCBE

The present version of RCBE is intended specifically to supply excess reactivity as a function of time in case of a reactor scram. Three different

ways of specifying such functions are offered. One of them employs linear interpolation between points in the $\Delta k_{ext}/t$ -plane and thus it also is suited to represent quite general functions not necessarily relating to an emergency shut down.

a) Mode 1:

The external excess reactivity remains zero at all times

b) Mode 2:

The external excess reactivity as a function of rod position is described by straight lines interconnecting points in the $\Delta k_T/Z$ -plane. This function must be given in a normalized form $(\Delta k_T^{\mathbf{H}}/Z^{\mathbf{H}})$ where

$$\Delta k_{T}^{*} = \Delta k_{T}^{/RT}$$
$$Z^{*} = Z^{/HR}$$

Thus, the last point in the $\Delta k_{T}^{\#}/Z^{\#}$ -plane should be (1,1) which corresponds to the total external excess reactivity RT being inserted at the end position HR of the rods. The first point should have the coordinates (0,0) since zero excess reactivity is required for the initial equilibrium.

Scram action is triggered by the power reaching the excess level PS given by

$$PS = PO \cdot SCR$$

After this instant in time (XS) rod motion sets in with a time delay TD. Assuming constant acceleration by a multiple AF of the earths gravity g the rod position Z is obtained from:

$$Z = XM^2 \cdot (g \cdot AF)$$

where:

$$XM = X - (XS + TD).$$

Furthermore, it may be assumed that a fraction FB of all rods starts its motion from the edge of the reactor (Z = 0.) whereas the remaining rods (1.-FB) start at Z = HB (in particular: edge of core of axial blanket). The total reactivity is divided proportionately; the initial value of Δk_{ext} being zero the value at the final rod position becomes

$$\Delta k_{T}$$
, final = RT - RT · (1-FB) · Δk_{T} (Z = HB)

c) Mode 3

Scram triggering and rod delay are treated the same way as in mode 2. However, in this mode the external excess reactivity may be specified directly as a function of time after start of the rod motion:

$$\Delta k_{m} = \Delta k_{m}$$
 (XM)

d) Mode 4

Scram triggering as well as rod delay and rod motion are treated the same way as in mode 2. However, in this mode the spatial distribution of the external excess reactivity over the axial direction Z of the reactor (height HT) follows a \cos^2 -law. Note that the distance of total rod travel HR must be less than or equal to HT. Thus, the unnormalized function $\Delta k_{\rm T}$ is obtained by direct integration:

$$\Delta k_{\rm T} = \frac{1}{2} \left[\frac{2 \cdot Z}{\rm HT} - \frac{1}{\rm PI} \cdot \sin \left(\rm PI \frac{2 \cdot Z}{\rm HT} \right) \right]$$

If a fraction (1. - FB) of all rods starts from a point Z = HB the excess reactivity at the end position will no longer be RT but will be

$$\Delta k_{T,final} = RT-RT \cdot (1 \cdot O - FB) \cdot \Delta k_{T(Z = HB)}$$

Input description

card	name	format	units	comments	restrictions
23/1	IV	17	-	mode parameter	1, 2, 3, 4
No oth	er card	is requir	ed if IV =	1. If $IV = 2$ or $IV = 4$ the next card is $23/2$:	
23/2	HR	E 11.4	m	total distance of travel for rod fraction FB	
	HB	11	m	Z = HB is starting position for rod fraction (1.0-FB)	
	RT	tt	ø	total reactivity inserted when all rods at end position (only if $FB = 1.0$)	
	FB	11		fraction of rods starting from $Z = 0$. (remainder from $Z=HB$)	
	TD	11	sec	time delay between power level trip and start of rod motion.	
1	AF	- 11	-	AF•g is acceleration for rod motion	
23/3	SCR	E 11.4		PS = PO.SCR is power level at which scram is triggered	
	N	I7	-	number of points in $\begin{cases} \Delta k^{*}/Z^{*} - plane (IV = 2) \\ \Delta k / XM - plane (IV = 3) \end{cases}$	≪ (NYD)
23/4	x	Е 11.4	- sec	coordinates of first point this card is to be repeated	= 0.
	У	11	- \$	as required by parameter N	
	x	11	- sec	on card 23/3 (maximum	an africana An Angelan An Angelan
	У	11	- \$	number of cards is 17)	
	x	11	- sec	h l	an a
	Y Y	11	- \$	" " third "	
23/5	SCR	E 11.4		PS = PO.SCR is power level at which scram is triggered	
2010	HT	L 11.4	m	length of half wave for \cos^2 -distribution of reactivity over Z-coordinate (in particular: total reactor height)	

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mode IV =	1	2	3	4
	23/1	23/1	23/1	23/1
		23/2		23/2
		23/3	23/3	
	$\frac{\partial f_{\rm eff}}{\partial t} = \frac{\partial f_{\rm eff}}{\partial t} + \frac{\partial f_{\rm eff}}{\partial t} $	23/4	23/3 23/4	23/4

The input cards must be arranged according to the following table.

Calculations concerning heat transfer to the coolant as well as coolant pressure drop require certain variables, the functional relationships of which are derived from the equations of state of the coolant medium:

It is convenient to combine the computation of T and CP since

 $CP = \frac{\bigcirc WI}{\bigcirc T}$ P3=const

With this the following subprograms are introduced

SUBROUTINE TPEL (P3, WI, T, CP) FUNCTION HDV (P3, T) FUNCTION FLAML (P3, T) FUNCTION ETAL (V, T)

A particular set of these functions is described below which pertains to superheated steam. In other cases where the coolant may be approximated by an ideal gas the pertinent relations are quite simple:

$$T = a + b \cdot WI$$

$$CP = 1/b$$

$$V = c \cdot \frac{(T-273.16)}{P3}$$

In the case of an incompressible coolant (e.g. liqu. sodium) the last equation can be simplified to:

$$V = const.$$

If - as in the case of liquid sodium - the film coefficient of heat transfer to the coolant is approximately an invariant the values of λ and η are irrelevant and the corresponding functions may consist of simple statements such as

FLAM1 = 1.0 ETA1 = 1.0

Functions for Superheated Steam

The present analysis puts a premium on computational speed. In contrast to this the development of subprograms for state variables of superheated steam has been guided up to now by considerations of accuracy and range of applicability of a single expression. Using such conventional subprograms $\frac{76}{7}$ it turned out that about 75 % of the computer time needed for a typical transient problem was used by these subprograms alone. Consequently, a new set of subprograms was developed using simpler and faster methods yet having sufficient accuracy for transient problems in concern. The most severe restriction lies with the range of applicability. Using techniques indicated below one may choose position and size of this range with accuracy being a function primarily of the latter. In order to guarantee accuracies better than 1 - 3 % it is necessary to limit the range to pressures between 50 and 200 at.

The technique adopted for generating efficient representations of the functions f_T , f_V , f_λ was least squares fitting of polynomials of varying order in two variables. The functions of $\sqrt{6}$ were used as reference. In this manner the following expressions were used for the approximation of f_T :

$$T = a_{N} \cdot WI^{N} + a_{N+1} \cdot WI^{N+1} + \cdots = a_{N+M} \cdot WI^{N+M}$$
$$a_{N+1} = a_{N,K} \cdot P3^{K} + a_{N,K+1} \cdot P3^{K+1} + \cdots = a_{N,K+L} \cdot P3^{K+1}$$

where

i = 0, 1, 2, M N,K = -3, -2, +2, +3M,L = 0, 1, 5, 6 - 103 -

The choice of a suitable set of parameters N, M, K, L for the range and order of the polynomials was based on the magnitude of the residue as well as on the magnitude of M and L, i.e. if two approximations had residues of comparable magnitude the favored choice was the polynomial of lower order. The fitting procedure was carried out in two successive steps, first fitting the function at discrete values of one argument (e.g. pressure P3). The coefficients $a_{n(P3)}$ which are obtained from these fits are functions of the pressure P3 known only at a number of discrete points and may be fitted in turn by polynomials in this variable. The specific heat CP can be obtained analytically by differentiation of the polynomial with respect to enthalpy WI and taking the reciprocal.

Corresponding procedures were employed for fitting the other two functions ${\rm f}_V$ and ${\rm f}_\lambda$.

Extension of the range of applicability to higher enthalpies and temperatures (within the same range of pressure: 50 - 200 at) is possible by taking the following approach (ideal gas):

for WI > 900 kcal/kg use $T = T_{(WI=900)} + \frac{WI - 900}{CP_{(WI=900)}}$

The corresponding relations for specific volume and thermal conductivity are:

for T > 700
use V = V_(T=700)+
$$\frac{T-700}{P3}$$
 · 0.0051
and FLAM = FLAM_(T=700)+(T-700)·1.2·10⁻⁴

No least square fitting procedure was necessary with the function f_{η} since an analytic expression was already available <u>/</u>6_7 for approximation of this function in a range very nearly identical with the one required in this program.

APPENDIX N : Function ZEIT

With most computer facilities the user has access to the computer clock by way of a subprogram. If this is the case it may be used with the present program to monitor computation time as well as for problem termination. To this purpose the input parameter CLM specifies the maximum computation time allotted to a transient problem. The units of CLM must be the same as the ones used by the clock. In order to avoid excessive time consumption the frequency of clock interrogation may be restricted to every NCL'th step of the integration.

By definition the function ZEIT (CLO) must yield the computer clock reading CL minus the current value of the argument CLO

$$ZEIT = CL - CLO$$

If the computation time for any one transient problem in a job exceeds its allotted time CLM, this problem is terminated, a comment is printed out (CØMPUTING TIME CØNSUMED) and the next problem is started.

If no clock-subprogram is available a dummy function should be supplied, which returns a constant value to the calling program. In this case the parameter CLM is irrelevant.

The function ZEIT is called by the main program REX only and therefore it is not required if subroutine REXION alone is used. The sample problem presented in this appendix is taken from a study $/14_7$ of reactivity parameters in conjunction with a steam cooled fast breeder reactor $/8_7$.

The reactor system is represented by two flow sections. The first flow section consists of two (radial) zones, one of them representing an annular bypass around the perimeter of the core, the other representing the radial blanket. The second flow section represents the core with an axial blanket at each end. The core is subdivided into two radial zones and five axial sections. The first radial zone represents the average core channel whereas the second radial zone comprises a single channel only which is identified with the central channel of the core (nominal hot channel). Geometry and properties of this channel are the same as in the average channel, however, the power density is higher (310 vs. 266).

Power release is assumed to be distributed as follows: radial blanket 10 %, axial blankets 2,5 % each, core 85 %. Power is released in the fuel only (no heat sources in cladding, coolant, structure).

No orifices are assumed for the first flow section (FT = 0). Average channel and central channel of the second section (core) are orificed so as to achieve nearly equal exit temperatures for the coolant (i.e. 538.99 vs 548.32 at steady state).

Feedback coefficients and weighting factors were computed as indicated in APPENDIX G. External reactivity was calculated from mode IV = 4 of the function RCBE described in APPENDIX L (\cos^2 -distribution of reactivity weight, constant rod acceleration). Total reactivity insertion is \$\$-25.00, all rods start from the edge of the core and are accelerated by 2 g. Scram is initiated when power exceeds 25 % of the starting value (2320 MW, nominal reactor power) and rod motion follows after a 100 msec delay.

The reactor transient arises from a rupture of a steam pipe carrying superheated steam from the reactor. Mass flow and pressure transients for this accident were calculated with a different model representing the entire reactor circuit $/15_7$.

Output is printed every 100 steps and indicates the main features of the transient: Scram occurs at X = 0.050 sec, rod motion starts at X = 0.150 sec,

full insertion is completed at about 0.38 sec. Total excess reactivity $\Delta k = K + T$ reaches a maximum of about \emptyset 0.98, peak power is about $P_{Max} = 100\ 000\ MW$ at $X_{M} = 0.18$ sec, total energy release (up to X = 1.9sec) is about 10 500 MWsec.

Maximum fuel temperature rise (nominal hot channel) is about 2678 $^{\circ}$ C (just below melting point) at X = 0.293 sec. Maximum cladding temperature (nominal hot channel) is about 1317 $^{\circ}$ C at X = 1.15 sec.

الأحجي حديد محل محل معارية المعاد المعاد المعادي أنصاب المراجع المجل المراجع المحل المحاد المحلية المحلية المحل وقال المسلح حديد أصحاب المحلية أن المعاد المعاد المعادية المحلية المحلي المحلية المحلية المحلية المحلية المحلي المسلح المحلية المحلية المعادي المحلية المعادي المحلية المحلية المحلي المحلية المحلية المحلية المحلية المحلية ا معاد المحلومة المحلية ا معاد المحلية ا معاد المحلية الم معاد المحلية الم محلية المحلية ال المحلية الم

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RVDASS. IPB=1					
P2 0.10000F 01		R3 0.18600F 01	0+85000F-01	WP 0.30000F-01	AN 0.10000F 01
	HA 0.50000F 00	CV 0.77000F 03	FR 0.19830F-01	FT 0.0	
RAN.RI., TPP=2 RP 0.0	R2 0.62500F-02	R3 0.71650F-02	0-30000F-02	WP 0.36400F-02	AN 0.20280F 05
PB 0.1000F 00		CV 0.77000F 03	FR 0.19830F-01	FT 0.0	
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91 0.31000F-02	R2 0.35000F-02	R3 0.42850F-02	D4 0.30000F-02	WP 0.158005-02	AN 0.76446F 05
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CCC 0+45390F-02		CPC 0.97940F-01	CPM 0.97940F-01	CHC 0.24750E-01	CHM 0.24750E-01
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APP 0-266005 03 ARD 0-100005 01	AQE 0.10000E 01 ARE 0.10000E 01	AOC 0.0 ARC 0.10000E 01	AQS 0.0 ARS 0.10000E 01	AQM_ 0.0 ARM_ 0.10000E_01	
AX.BLENTRANCE		CVF 0.77000F 03	HMS 0.20000F 01	CVM 0.81780F 03	
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R1 0.31000F-02	P2 0.35000F-02	R3 0.42850F-02	P4 0.300005-02	WP 0.15800F-02	AN 0.10000E 01
RDF 0.94000F 04	PTC 0.83500F 04	ROM 0.835005 04	AFF 0.12000F-04	AFC 0.140005-04	AFM 0.14000F-04
COC 0.45390F-02	CDM 0.45390F-02	CPC 0.97940F-01	CPM 0.97940F-01	CHC 0.24750E-01	CHM 0.24750E-01
HGP 0.17917F 01	TH 0.27000E 04	W4 0.62824F 06	FR 0.19830F-01	FT 0.60000F 01	
AOP 0.31000F 03	AOF 0.10000F 01	AOC 0.0	AOS 0.0	AOM 0.0	
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AX.CORE ZONE IX=1	H-5 0.50000- 00	CVF 0.17000F 03	HMS 0.200000 01	CV# 0.81780# 05	
40X 0.94940E 00	AND 0.15790F 01	AXE 0.25600E 01	AXC 0.20670E 00	AXS 0.49400F 00	AXM 0.532605 00
AX.CORE ZONE IX=2					
AOX 0.15980F 01	AXD 0.43810F 01	AXE 0.60050F 01	AYC 0.749005 00	AXS 0.20000F 01	AXM 0.12438E 01
AX.CORE ZONE IX=3					
AOX 0.183835 01	AX9 0.56840F 01	AXE 0.80800F 01	AXC 0.10365F 01	AXS 0.32170F 01	AXM 0.16620F 01
AX.CORE ZOME IX=4					
AOX 0.15980F 01	AXD 0.43010F 01	AXE 0.67180E 01	AXC 0.78750E 00	AXS 0.28120F 01	AXM 0.13738E 01
AX.COPE ZONE IX=5	AND 0 144405 01	ANE 0 22200E 01	AKC 0 2/0105 00	AXS 0.101505 01	
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At 1 0.80000F 00	AL2 0.60000F 00	AL3 0.575005 00	A1 4 0.0		
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CK1 0.13882 01	CK2 0.0	CK3 0.0			
CC1 0.81940F-01	CC2 0.0	CC3 0.0			
3 POINT KINETICS AND CO	NTROLLED REACTIVITY				
OM 0.73150F 04	ND 6				
FY 0.24500F-01	LA 0.12700F-01	FY 0.22400F 00	LA 0.30100F-01	FY 0.18860F 00	LA 0.12400F 00
FY 0.35470F 00	LA 0.32500F 00	FY 0.14970F 00	TA 0.111205 01	FY 0.58500F-01	LA 0.26970F 01
CONTR.REACT.PPDG HR 0.13700F 01	HB 0.35000F 00	RT -0.250005 02	FB 0.0	TD 0.10000E 00	AF 0.2000F 01
SCP 0.12500F 01	HT 0.22300F 01	RT =0.25000± 02		10 0.10000F 00	A- 0.20000+ 01
4 EFFDBACK PARAMETERS	111				
PCD -0.33255F 01	PCH 0.20900F 02	P.P 0.0	PCF 0.82640E 02	RCC -0.94097F 02	RES -0.29632F 00
RCM 0.17040F 03	PC 0.10000F 01				
5 TTEPATTON AND DUTPUT					
EST 0.10000E-01	514 A 100005 A1				
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6 STEP AND TERMINATION NTE 10 XMA 0.189995 01 7 NOT USED	IR 1 2 1 CONTROL NCX 900	IX 1 5 1	IP1 0 0 0	IX1 0 0 0	TM 0 0 0
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6 STEP AND TERMINATION NTE 10 XMA 0.189995 01 7 NOT USED	IR 1 2 1 CONTROL NCX 900	IX 1 5 1	IP1 0 0 0	IX1 0 0 0	11 0 0 0
6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NET USED 8 END OF SYSTEM DATA INLET ENTHALPY	IR 1 2 1 CONTROL NCX 900	IX 1 5 1	IP1 0 0 0	IX1 0 0 0	TM 0 0 0
6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 BOUNDARY CONDITION	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05	IX 1 5 1 XIX 0.50000F ∩0	IP1 0 0 0	TX1 0 0 0	IM 0 0 0
6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHAI PY NY 2 X 0.0 PROUNDARY CONDITION IRC 2	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05	IX 1 5 1 XIX 0.50000F ∩0	IP1 0 0 0	TX1 0 0 0	IN 0 0 0
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6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHAI PY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PRESSURE NY 10- X 0.0	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.17000F 03	IX 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F-01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03	IX1 0 0 0 PIX 0.50000E-01 Y X 0.40000E-01	Y 0.16977F n3
6 STFP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NCT USED 8 END OF SYSTEM DATA INLET ENTHAIPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PDFSSURE NY 10 X 0.0 0.60000F-01	IR 1 2 1 CONTROL NEY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.17000F 03 Y 0.16944F 03	IX 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 0 X 0.20000F 0	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.34000F 00	Y 0.16977F ∩3 ¥ 0.16293F ∩3
6 STFP AND TERMINATION NTF 10 XMA 0.18999F 01 7 NGT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 SOUNDARY CONDITION IRC 2 PRESSURE NY 10. X 0.0 X 0.0000F-01 X 0.80000F 00	IQ 1 2 1 CONTROL NFY QOA YIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.15478F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03	IX1 0 0 0 PIX 0.50000E-01 Y X 0.40000E-01	Y 0.16977F n3
6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHAI PY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PRESSURE NY 10- X 0.0 X 0.6000F-01 X 0.19000F 01	IR 1 2 1 CONTROL NEY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.17000F 03 Y 0.16944F 03	IX 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 0 X 0.20000F 0	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.34000F 00	Y 0.16977F ∩3 ¥ 0.16293F ∩3
6 STFP AND TERMINATION NTF 10 XMA 0.18999F 01 7 NGT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 SOUNDARY CONDITION IRC 2 PRESSURE NY 10. X 0.0 X 0.0000F-01 X 0.80000F 00	IQ 1 2 1 CONTROL NFY QOA YIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.15478F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.34000F 00	Y 0.16977F ∩3 ¥ 0.16293F ∩3
6 STFP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NICT USED 8 END OF SYSTEM DATA INLET ENTHAIPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PDFSSURE NY 10- X 0.60000F-01 X 0.80000F 01 "ASS FLOW	IQ 1 2 1 CONTROL NFY QOA YIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.15478F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.34000F 00	Y 0.16977F ∩3 ¥ 0.16293F ∩3
6 STFP AND TERMINATION MTF 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 ROUNDARY CONDITION IRC 2 PPFSSURF NY 10. X 0.0 X 0.0000F-01 X 0.19000F 01 "ASS FLOW NY 10	IQ 1 2 1 CONTROL NFY QOO XIN 0.10000F-05 Y 0.65500F 03 Y 0.17000F 03 Y 0.16944F 03 Y 0.15478F 03 Y 0.14070F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03 Y 0.15032F 03	IX1 0 0 PIX 0.50000F-01 X 0.40000F-01 X 0.34000F-01 X 0.14000F-01	Y 0.16977F 03 Y 0.16293F 03 Y 0.14640F 03 Y 0.26200F 04 Y 0.45400F 03
6 STFP AND TERMINATION MTF 10 XMA 0.18999F 01 7 NOT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PRESURE NY 10. X 0.6000F-01 X 0.8000F 00 YASS FLOW NY 10 X 0.0 Y 0.3200F 00 X 0.86000F 00	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.10850F 04 Y 0.10850F 04 Y 0.10050F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.15638F 03 Y 0.15032F 03 Y 0.33600F 04	IX1 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.34000F 00 X 0.14000F 01 X 0.10000F 00	Y 0.16977F n3 Y 0.16293F n3 Y 0.14640F 03 Y 0.26200F 04
6 STFP AND TERMINATION NTF 10 XMA 0.18999F 01 7 NCT USED 8 END OF SYSTEM DATA INLET ENTHAIPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PDFSSURE NY 10 X 0.60000F-01 X 0.80000F 00 X 0.80000F 00 X 0.80000F 00 X 0.80000F 00 X 0.80000F 01	IR 1 2 1 CONTROL NEY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.17000F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16946F 03 Y 0.16950F 04	IX 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03 Y 0.15032F 03 Y 0.33600F 04 Y 0.59600F 04	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.4000F-01 X 0.4000F 00 X 0.10000F 00 X 0.45000F 00 X 0.45000F 00	Y 0.16977F 03 Y 0.16293F 03 Y 0.14640F 03 Y 0.26200F 04 Y 0.45400F 03
6 STFP AND TERMINATION NTF 10 XMA 0.18999F 01 7 NFT USED 8 END OF SYSTEM DATA INLET ENTHALPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PRESSURE NY 10 X 0.60000F-01 X 0.80000F 00 X 0.8000F 00 X 0.8	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.10850F 04 Y 0.10850F 04 Y 0.10050F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03 Y 0.15032F 03 Y 0.33600F 04 Y 0.59600F 04	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.4000F-01 X 0.4000F 00 X 0.10000F 00 X 0.45000F 00 X 0.45000F 00	Y 0.16977F 03 Y 0.16293F 03 Y 0.14640F 03 Y 0.26200F 04 Y 0.45400F 03
6 STEP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NET USED 8 END OF SYSTEM DATA INLET ENTHAIPY NY 2 X 0.0 POUNDARY CONDITION IRC 2 PRESSURE NY 10 X 0.0 Y 0.19000F 01 MASS FLOW NY 10 X 0.0 Y 0.3200F 00 X 0.19000F 01 INITIAL POWER PD 0.23200F 04	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.10850F 04 Y 0.10850F 04 Y 0.10050F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03 Y 0.15032F 03 Y 0.33600F 04 Y 0.59600F 04	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.4000F-01 X 0.4000F 00 X 0.10000F 00 X 0.45000F 00 X 0.45000F 00	Y 0.16977F 03 Y 0.16293F 03 Y 0.14640F 03 Y 0.26200F 04 Y 0.45400F 03
6 STFP AND TERMINATION NTE 10 XMA 0.18999F 01 7 NICT USED 8 END OF SYSTEM DATA INLET ENTHAIPY NY 2 X 0.0 BOUNDARY CONDITION IRC 2 PRESSURE NY 10 X 0.60000F-01 X 0.80000F 00 X 0.8000F 00 X 0.	IR 1 2 1 CONTROL NCY 900 XIN 0.10000F-05 Y 0.65500F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.16944F 03 Y 0.10850F 04 Y 0.10850F 04 Y 0.10050F 03	1X 1 5 1 XIX 0.50000F 00 X 0.60000F 02 X 0.20000F 01 X 0.20000F 01	IP1 0 0 0 PIN 0.10000F-01 Y 0.65500E 03 Y 0.17000F 03 Y 0.16588F 03 Y 0.15032F 03 Y 0.33600F 04 Y 0.59600F 04	IX1 0 0 0 PIX 0.50000F-01 Y X 0.40000F-01 X 0.4000F-01 X 0.4000F 00 X 0.10000F 00 X 0.45000F 00 X 0.45000F 00	Y 0.16977F 03 Y 0.16293F 03 Y 0.14640F 03 Y 0.26200F 04 Y 0.45400F 03

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STEADY STATE	FEEDRA	rK= \$ −∩.	4364	3280F 02													
* ^ ^	1.0	70715-02	B 0 3	23205 04	E 0.0		T 0.0		PFX	182.64	PAX	170.00	WEX	655.00	WAX	813.35	6 0.3500F 04
У 0.0 ЕЕЕЛВАСК -	K 0.		0-0.3	23685.02	H 0.2	2895 00			F-0.9	5445 00	C 0.6	8205 00	S-0.1	884E 02	M-0.1	081F 01	
TRR=1	TER	376.16	TAB	376.01	WFR		WAR	655.00	PEB	181.61	DVB	181.36	TFR		TMA	376.09	N C.36745 04
IPR=2	TFB	376.68	TAB	419.45	WEB	655.00	WAB	712.40	PFB	182.52	PAB	181.36	TFR	460.48	TMB	398.06	N 0.1235F 04
• •	Τ7	385.72		181.36	ΨZ	670.83				-							
10=1	TE1	382.96	TA1	385.25	TA2	538.99	PF1	176.63	PAL	175.91	PA2	170.00	TF.1	431.20	TF 2		N 0.2385E 04 V 0.1269E-01
[¥,= 1		990.19	TEN	507.43	TC 1	428.41	TC2	416.69	TM	392.09	TA	398.03	WA WA	693.22 724.25	PA		V 0.1459F-01
I X = 2		1259.24	TEN	614.98	TCI	481.98	TC2	462.25	TM	413.15	TA TA	427.37	W S	759.94	- PA		V 0.1669F-01
TX= 3		1430.81	Ţ⊑ Ŋ	689.67	TCI	536,66	TC2	513.97	TM	447.41	TA TA	507.77	W A	790.94	PA		V 0.18475-01
TX= 4		1348.15	TEN	703.90	TC1	570.89	TC 2	551.16 559.50	TM	487.61	TA TA	533.63	₩A	809.39	PA		V 0.1958F-01
IX= 5		1033.01	TEN	650.24	TC1 TA2	571.22	TC2 PF1	178.34	PAI	177.45	PA2	170.00	TEI	440.01	TF2		N 0.26621 04
TD=7	1-1		TA1	386.28 525.49	TCI	433.40	TC2	419.74	TM	393.41	TA	400.54	WA	694.21	PA		V 0.1264F-01
IX= 1 IX= 2			TEN	575.49	TCI	491.35	TE2	468.36	TM	415.48	TA	430.42	WA	726.59	PA		V 0.1463E-01
IX= 2		1397.18	TEN	728.25	TCI	549.94	TC2	523.49	TM	451.59	T۸	472.75	WA	763.84	PA	174.28	V 0.1681E-01
IX = 4		1491.44	TEN	740.61	TCI	585.61	TC2	562.62	TM	494.08	TA	515.40	W۸	796.23	ΡΔ	172.95	V 0.1868F-01
184 6		1122.51	TEN		TCI	584.44	TC2	570.78	TM	529.06	ΤA	542.73	WA	815.47	PΔ		V 0.1987E-01
1.4.5	, 1.5	1177.071			NC=	0	CL=	0.0	PFX	182.64	۶VC	170.00	WEX	655.00	WAX	813.35	G 0.3500E 04
SOCAM AT X-	0.50	159195-0	1														
X 0.13285 0	10 I 0.	44195-03	.o n.	3821F 05	F 0.8	935= 03	T 0.0		DEX	173.84		167.60		655.00			G 0.2394F 04
FEEDBACK	к о.	9416= 00	n-1,	12805 00	н о.1	0485-01	_R_0₊0			7915-01				089F 01	. M-0.4 TMB		N 0.2517E 04
100=1	1 C D			371.14	WER	655.00	WAB.	655.03	PFB	173.32	PAB	173.20	TFR	376.07	TMB		N 0.8411E 03
[99=2	T FR			422.44	WEB	655.00	WAR	720.02	PEB	173.78	PAB	173-20	1.0	40 7 1 7	1,40	390.02	W D.OTILE DD
	ŤΖ	382.26	۶d	173.20	WZ	672.87			PAT	170 51	DA2	147.61	TF1	435.60	TE2	598 05	N 0.1631F 04
[b =]	TET	380.84	TA 1	384.54	T A 2	550.80	PF1 JC2	170.88	TM	170.53	TA	401.60	 M A	699.80	PΛ		V 0.134801
Tx- 1		920.56	TEN	534 46	TC1	434.57 494.01	10.2	422.70	7.4	413.76	TA	435.24	W A	733.98	DA		V 0.1556E-01
1 X =		1310.36	TEN	660.96	TC1 TC1	551.68	TC2	529.76	TM	447.63	TA	480.21	WA	771.51	PΔ		V 0.1774F-01
[X= 2		1489.62	TEN	742.89	TC1	594.79	TC2	566.07	TM	487.89	TA	522.68	WΔ	802.53	PA	168.75	V 0.19505-01
IX = 4		1399,28			TCI	580.52	TC2	569.81	T ^M	520.98	TA	546.41	W۵	818.77	PA.	168.22	V 0.2045E-01
#P=2	5 - 1=0 7F1		TAL	385.29	TAZ	562.43	DET	171.72	P.8-7	171.28	D , 42	167.61	151	446.14	752	605-82	N 0-1816E-04
[X=]		1006.96	TEN	556.95	TCI	440.44	TC2	426.56	TM	393.41	T A	403.47	WA	701.47	P۸		V 0.1352F-01
IY= 2		1456.77	TEN	699.93	TCI	505.31	TC2	482.63	TH	415.67	ΤA	439.42	ĻΑ	737.48	P۸		V 0.1571F-01
TX= 7		1660.53	TEN	790.28	TC1	567.45	TC2	541.89	TM	451.86	T۸	487.52	W۸	776.91	PA		V 0.1799F-01
IX= 4		1551.03	TEN	794.81	TOT	601.87	TC2	580.06	тM	494.43	TA -	532.82	Ψ٨.	809.41	PA		V 0.1984F-01
IX= 5	TE0	1158.01	T⊑M	709.08	TC 1	595.41	TC2	582,97	T**	529.41	ΤA	557.82	¥.A	826.26	PA		V 0.2084E-01
																A 3 1 7 6	
					NC=	100	CL=	0.0	PEX	173.84	PAX	167.59	WEX	655.00	WAY		G 0.2391F 04
x n.1914F r	no r o.	8839F-03	₽ 0.	10705 06	F 0.5	445F 04	T-0.2	533F 00	PFX	173.84 170.64	ΡΑΧ	166.12	WFX	655.00	WAX	836.33	G 0.2391F 04 G 0.1989F 04
ECCORNCK	к О.	8839E-03 1222E 01	n-n.	93465 00	F 0.5	445F_04	T-0.2 R 0.0	533E 00	PFX 5-0.3	173.84 170.64 971= 00	PAX C 0.8	166.12 5095-01	WFX	655.00 3805 01	WAX	836-33 553F-02	G 0.1989F 04
TRB=1	К О. ТГВ	8839F-03 1222F 01 369+28	0-0.9 TAB	9346F 00 369.25	F 0.5 H 0.9 WEB	445F_04 103F-01 655+00	T-0.2 R 0.0 WAP	533F 00	PFX F-0.3 PER	173.84 170.64 971= 00 170.28	РАХ С 0.8 РАЧ	166.12 509=-01 170.19	WFX S 0.2 TFR	655.00 3805 01 376.04	WAX M-0.1 TMR	836.33 553F-02 376.05	G 0.1989F 04
ECCORNCK	к 0. Тгв Т ^р в	8839F-03 1222F 01 369+28 369+49	0-0.9 ΤΛΡ ΤΔΡ	93465 00 369.25 432.23	F 0.5 H 0.9 WEB WEB	445F 04 103F-01 655+00 655+00	T-0.2 R 0.0	533E 00	PFX 5-0.3	173.84 170.64 971= 00	PAX C 0.8	166.12 5095-01	WFX	655.00 3805 01	WAX	836.33 553F-02 376.05	G 0.1989F 04
TRB=1 IPR=2	к (). ТГВ ТЕВ ТZ	8839F-03 1222F 01 369.28 369.49 382.32	0-0.9 ΤΛΒ ΤΔΒ ΡΖ	93465 00 369.25 432.23 170.19	F 0.5 H 0.9 WEB WEB	445F 04 103F-01 655.00 655.00 675.65	T-0.2 R 0.0 WAR WAB	533F 00 655.05 730.99	PEX F-0.3 PER PER	173.84 170.64 971= 00 170.28 170.60	ΡΑΧ C 0.8 ΡΑΫ ΡΑΒ	166.12 509F-01 170.19 170.19	WFX S 0.2 TFR TFR	655.00 3805 01 376.04 488.29	WAX M-0.1 TMR TMR	836.33 553F-02 376.05 398.02	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03
TR B= 1 10 R= 2 10 F= 1	К О. ТГВ ТЕВ Т2 ТЕІ	8839E-03 1222E 01 369.28 369.49 382.32 381.33	0-0.9 ΤΛΡ ΤΔΡ Ρ7 ΤΑΙ	93465 00 369.25 432.23 170.19 387.90	F 0.5 H 0.9 WEB WEB WZ TA2	445F 04 103F-01 655.00 655.00 675.65 573.81	T-0.2 R 0.0 WAR WAB PF1	533F 00 655.05 730.99 168.54	PFX F-0.3 PER	173.84 170.64 971= 00 170.28 170.60 168.29	ΡΑΧ C 0.8 ΡΑΫ ΡΑΒ ΡΑ2	166.12 509F-01 170.19 170.19 166.15	WFX S 0.2 TFR	655.00 380F 01 376.04 488.29 468.47	WAX M-0.1 TMR	836.33 553F-02 376.05 398.02 621.39	G 0.1989F 04
TRB=1 10R=2 10r=1 [X= 1	K 0. TER TER TZ TZ TE1 TF0	8839E-03 1222E 01 369.28 369.49 382.32 381.33 1146.50	0-0.9 TAB TAB PZ TA1 TEN	93465 00 369.25 432.23 170.19 387.90 710.08	F 0.5 H 0.9 WEB WEB WZ TA2 TC1	445F 04 103F-01 655.00 655.00 675.65 573.81 467.78	T-0.2 R 0.0 WAP WAB PF1 TC2	533F 00 655.05 730.99 168.54 445.39	PER PER PER PER	173.84 170.64 971= 00 170.28 170.60 168.29 392.19	ΡΑΧ C 0.8 ΡΑΫ ΡΑΒ	166.12 509F-01 170.19 170.19	WFX S 0.2 TFR TFR TFR	655.00 3805 01 376.04 488.29 468.47 712.24	WAX M-0.1 TMR TMR TMP	836.33 553F-02 376.05 398.02 621.39 168.02	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1355F 04
TESPACK TRB=1 JPR=2 JP=1 IX= 1 JX= 2	K 0. TEB TEB TE1 TE1 TE0 TE0	8839E-03 1222E 01 369.28 369.49 382.32 381.33 1146.50 1690.66	TAP TAP TAP TAT TAI TEN TEN	9346F 00 369.25 432.23 170.19 387.90 710.08 957.42	F 0.5 H 0.9 WEB WEB WEB TA2 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21	T-0.2 R 0.0 WAR WAB PF1	533F 00 655.05 730.99 168.54 445.39 515.84	PER PER PER PAT	173.84 170.64 971= 00 170.28 170.60 168.29	ΡΑΧ C 0.8 ΡΑΫ ΡΑΒ ΡΑ2 ΤΑ	166.12 509F-01 170.19 170.19 166.15 411.81	WFX S 0.2 TFR TFR TFR TF1 WA	655.00 3805 01 376.04 488.29 468.47 712.24 753.23 794.83	₩ΑΧ M-0.1 TMR TMP TF2 PA PA PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1355F 04 V 0.1441F-01 V 0.1687F-01 V 0.1924F-01
FEEDPACK 18 B= 1 10 E= 2 10 = 1 1Y= 1 1Y= 2 Y= 3	K 0. TEB TEB TE1 TE1 TE0 TE0	8839E-03 1222E 01 369.28 369.49 382.32 381.33 1146.50 1690.66 1927.11	TAB TAB TAB TAB TAB TAB TAB TEN TEN	93465 00 369.25 432.23 170.19 387.90 710.08	F 0.5 H 0.9 WEB WEB WZ TA2 TC1	445F 04 103F-01 655.00 655.00 675.65 573.81 467.78	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2	533F 00 655.05 730.99 168.54 445.39	PEX F-0.3 PEB PEP PAT TM TM	173.84 170.64 971= 00 170.28 170.60 168.29 392.19 413.56	ΡΑΧ C 0.8 ΡΑΫ ΡΑΒ ΡΑΒ ΡΑ2 ΤΑ ΤΑ	166.12 509F-01 170.19 170.19 166.15 411.81 456.43 511.09	WFX S 0.22 TFR TFR TF1 WA WA WA	655.00 380F 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75	₩ΑΧ M-0.1 TMR TMR TF2 PΔ PΔ PΔ PΔ	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1355F 04 V 0.1441F-01 V 0.1887F-01 V 0.1827F-01 V 0.2099F-01
FEEDPACK IRB=1 IDE=7 IVE=7 IYE=7 IYE=7 IYE=4	K 0. TEB TEB TE1 TE1 TE0 TE0 TE0	8839E-03 1222E 01 369.28 369.49 382.32 391.33 1146.50 1690.66 1927.11 1779.58	TAB TAB TAB TAB TAB TAB TAB TEN TEN	93465 00 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99	F 0.5 H 0.9 WEB WEB WEB WEB TA2 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94	PEX PEB PEB PEP PAJ TM TM TM	173.84 170.64 971= 00 170.28 170.60 168.29 392.19 413.56 448.13	ΡΑΧ C 0.8 PA9 PA8 PA8 PA2 TA TA TA	166.12 509F-01 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59	WFX S 0:2 TFR TFR TF1 WA WA WA	655.00 3805 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86	₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1455F 04 V 0.1441F-01 V 0.1837F-01 V 0.1924F-01 V 0.2099F-01 V 0.2166F-01
FEEDPACK 18 B= 1 10 E= 2 10 = 1 1Y= 1 1Y= 2 Y= 3	K 0. TEB TEB TE1 TE1 TE0 TE0 TE0	8839E-03 1222E 01 369.28 369.49 382.32 381.33 1146.50 1690.66 1927.11	TAB TAB TAB TAB TAB TAB TAB TEN TEN TEN TEN	93465 00 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99	E 0.5 H 0.9 WEB WEB WZ TA2 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65 646.31	T-0.2 R 0.0 WAP WAB PF1 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15	DEX R=0.3 PER PCP PAT TM TM TM TM TM TM PA1	173.84 170.64 971= 00 170.28 170.60 168.29 392.19 413.56 448.13 488.51 521.57 168.83	PAX C 0.8 DA9 PA8 PA8 PA7 TA	166.12 509F-01 170.19 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14	WFX S 0:2 TFR TFR TFR WA WA WA TF1	655.00 380F 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44	₩AX M-0.1 TMR TMR TF2 PA PA PA PA TF2	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1455F 04 V 0.1641F-01 V 0.1687F-01 V 0.1687F-01 V 0.2099E-01 V 0.2166F-01 N 0.1550E 04
FEEDPACK IR B= 1 ID E= 2 IV = 1 IY = 2 IY = 3 IY = 3 IY = 4 IY = 4 IY = 5	K 0. TFB TER TZ TF1 TF0 TF0 TF0 TF0 TF0 TF1 TF1	8839F-03 1222F 01 369.28 369.49 382.32 3P1.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28	TAB TAB TAB TAB TAB TAB TEN TEN TEN TEN TAL TEN	9346 00 369,25 432,23 170,19 387,90 710,08 957,42 1084,63 1047,99 855,60 388,88 761,54	F 0.5 H 0.9 WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65 646.31 618.98 590.36 478.89	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15 452.66	DEX C-0.3 PER DER DAJ TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.60 168.79 392.19 413.56 448.13 488.51 521.57 168.83 393.52	PAX C 0.8 PAR PAR PAR PAR PAR TA TA TA TA TA TA TA TA TA TA TA	166.12 509F-01 170.19 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14 415.25	WFX S 0.22 TFR TFR WA WA WA TF1 WA	655.00 380F 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44 715.47	₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA TF2 PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70 168.50	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1355F 04 V 0.1441F-01 V 0.1887F-01 V 0.1887F-01 V 0.2166F-01 V 0.2166F-01 V 0.1500E 04 V 0.1457F-01
FEEDPACK IRB=1 IDE=2 IDE=1 IYE=2 IYE=2 IYE=3 IYE=4 IYE=5 IDE=2	K 0. TFR TER TER TFC TFC TFC TFC TFC TFC TFC	8839F-03 1222F 01 369.28 369.29 382.32 381.33 1146.50 1690.66 1927.11 1270.58 1289.31 381.71 1270.28 1890.97	TAP TAP TAP TAI TEN TEN TEN TEN TEN TAI TEN TEN	9346 0.25 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37	F 0.5 H 0.9 WEB WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65 646.31 618.98 590.36 478.89 572.94	T-0.2 R 0.0 WAP WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 452.66 530.46	DEX E-0.3 PER DER TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.60 168.20 392.19 413.56 448.13 488.51 521.57 168.83 393.52 415.98	PAX C 0.8 DAR DAR DAR TA TA TA	166.12 509F-01 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14 415.25 464.26	WFX 5 0.2 TFR TFR WA WA WA TF1 WA WA	655.00 380F 01 376.04 488.29 468.47 712.24 4753.23 794.83 825.75 836.86 483.44 715.47 759.43	WAX M-0.1 TMR TMR TF2 PA PA PA PA TF2 PA PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70 168.50 168.50 168.10	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1457F 04 V 0.1441F-01 V 0.1687F-01 V 0.1924F-01 V 0.2099E-01 V 0.2166F-01 N 0.1500E 04 V 0.1457F-01 V 0.1457F-01
FEEDPACK IR R= 1 ID = 2 ID = 1 IX = 1 IX = 2 IY = 4 IX = 5 ID = 2 IX = 5 IX = 1 IX = 1 IX = 5 IX = 1 IX = 2 IX	K 0. TER TER TER TEN TEN TEN TEN TEN TEN TEN TEN	8839F-03 1222F 01 369.28 369.28 382.32 391.33 1146.50 1690.66 1927.11 1779.58 1270.28 381.71 1270.28 1899.97 2170.39	TAB TAB DZ TAI TEN TEN TEN TEN TEN TEN TEN TEN TEN TEN	9346 000 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54	F 0.5 H 0.9 WEB WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 572.21 620.65 646.31 618.98 590.36 478.89 572.94 647.71	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 452.66 530.46 600.20	DEX P-0.3 PER PCP TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.60 168.70 392.19 413.56 448.13 488.51 521.57 168.83 393.52 415.98 452.47	PAX C 0.8 DAR DAR DAR DAR TA TA	166.12 509F-01 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14 415.25 464.26 524.09	WFX S 0+2 TFR TFR WA WA WA WA WA WA WA	655.00 380F 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44 715.47 759.43 803.81	WAX M-0.1 TMR TMR TF2 PA PA PA TF2 PA PA PA PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70 168.50 168.10 167.65	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1451F-01 V 0.1687F-01 V 0.1024F-01 V 0.2099E-01 V 0.2166F-01 N 0.1500E 04 V 0.1457F-01 V 0.1477F-01 V 0.1718F-01
FEEOPACK IR R= 1 ID = 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 5 IY = 2 IY = 2 IY = 2 IY = 2 IY = 2 IY = 2 IY = 1 IY = 1 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 369.28 382.32 371.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1899.97 2170.28 1899.97 2194.23	TAB TAB DZ TAI TEN TEN TEN TEN TEN TEN TEN TEN TEN TEN	93465 000 369,25 432,23 170,19 387,90 710,08 957,42 1084,63 1047,99 855,60 388,88 761,54 1045,37 1188,54 1045,37	F 0.5 H 0.9 WEB WEB WZ TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65 646.31 618.99 590.36 478.89 572.94 647.71 673.56	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15 452.66 530.46 630.20 633.33	DEX PER PER PER PER TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.60 168.29 392.19 413.56 448.13 488.51 521.57 168.83 393.52 415.98 452.47 495.20	PAX C 0.8 PAP PAB PA2 TA	166.12 509F-01 170.19 170.19 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14 415.25 464.26 524.09 573.20	WFX S 0.2 TFR TFR WA WA WA WA WA WA WA WA WA	655.00 380F 01. 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44 715.47 759.43 803.81 836.48	₩АХ M-0+1 ТМВ ТМР ТF2 РА РА РА РА РА РА РА РА РА	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70 168.50 168.10 167.65 167.17	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1355F 04 V 0.1441F-01 V 0.1687F-01 V 0.2099E-01 V 0.226F-01 V 0.2166F-01 N 0.150F 04 V 0.1457F-01 V 0.1718F-01 V 0.2156F-01 V 0.2156F-01
FEEDPACK IR B= 1 ID = 2 ID = 1 IX = 1 IX = 2 IX = 4 IX = 5 IX = 1 IX = 2 IX = 1 IX = 2 IX = 1 IX = 2 IX = 1 IX = 2 IX = 1 IX = 2 IX	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 369.28 382.32 391.33 1146.50 1690.66 1927.11 1779.58 1270.28 381.71 1270.28 1899.97 2170.39	TAB TAB DZ TAI TEN TEN TEN TEN TEN TEN TEN TEN TEN TEN	9346 000 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54	F 0.5 H 0.9 WEB WEB WE TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 552.21 620.65 646.31 618.98 590.36 478.89 572.94 647.71 647.71 640.42	T-0.2 R 0.0 WAR WAR WAR WAR WAR WAR TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15 452.66 530.46 600.20 633.33 617.87	DEX PER PER DER TM TM TM TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971=00 170.28 170.60 168.20 392.19 413.56 448.13 488.51 521.57 168.83 393.52 415.98 452.47 495.20 530.16	PAX C 0.8 DA9 DA9 DA9 TA TA TA TA TA TA TA TA TA TA	166.12 509F-01 170.19 166.15 411.81 456.43 511.09 556.55 573.59 166.14 415.25 464.26 524.09 573.20 590.52	WFX S 0:2 TFR TFR WA WA WA WA WA WA	655.00 380F 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44 715.47 759.43 803.81 836.48 847.59	₩АХ M-0+1 ТМВ ТМВ ТF2 РА РА РА РА РА РА РА РА РА РА	836.33 553F-02 376.02 398.02 621.39 168.02 167.70 167.74 166.96 166.58 644.70 168.50 168.10 167.65 167.17 166.69	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1455F 04 V 0.1441F-01 V 0.1687F-01 V 0.2099E-01 V 0.2165F-01 N 0.1550E 04 V 0.2156F-01 V 0.2156F-01 V 0.2225F-01
FCEOPACK IR R= 1 ID = 2 ID = 1 IX = 1 IX = 1 IX = 2 IX	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 389.32 382.32 382.32 382.32 1146.50 1690.66 1927.11 1779.58 1890.67 1779.58 1870.78 1870.78 1870.79 1994.23 1421.32		93465 0.0 369.25 432.23 170.19 387.90 710.08 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54 1141.66 915.97	F 0.5 H 0.9 WEB WEB TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103F-01 655.00 675.65 573.81 467.78 572.21 620.65 646.31 618.98 590.36 478.89 572.94 647.71 673.56 640.42 200	T-0.2 R 0.0 WAR WAR WAR DF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 452.66 530.46 633.33 617.87 0.0	РЕХ 3 РЕВ РЕР ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ	173.84 170.64 971= 00 170.28 170.60 168.79 392.19 413.56 448.13 488.51 521.57 168.83 393.52 415.98 452.47 455.26 530.16	РАХ С 0.8 РАР РАВ РА2 ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	166.12 509-01 170.19 170.19 170.19 170.19 170.19 166.15 411.81 456.43 511.09 555.55 573.59 166.14 415.25 464.26 524.09 573.20 590.52 166.10	WFX S 0:2 TFR TFR WA WA WA WA WA WA WA WA WA WA	655.00 3807 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 836.86 483.44 715.47 759.43 803.81 836.48 847.59 655.00	₩AX ₩-0.1 TMR TMP TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 398.02 621.39 168.02 167.70 167.34 166.96 166.58 644.70 168.50 168.10 167.65 167.17 166.69 836.33	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1451F-01 V 0.1687F-01 V 0.1687F-01 V 0.2099F-01 V 0.2166F-01 N 0.1500E 04 V 0.1457F-01 V 0.1457F-01 V 0.1457F-01 V 0.2156F-01 V 0.225F-01 G 0.1983E 04
FEEDPACK IR R= 1 ID = 2 ID = 1 IY = 1 IY = 2 IY = 3 IY = 4 IY = 7 IY = 7 IY = 1 IY = 7 IY = 2 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 382.32 382.32 1146.56 1927.11 1779.58 1289.31 381.71 1270.28 1899.97 2170.28 1899.97 2170.28 1894.23 1421.32	О-О. ТАВ ТАВ Р ТАВ ТАВ ТАВ ТАВ ТАВ ТЕП	93465 000 369,25 432,23 170,19 387,90 1084,63 1047,99 855,60 388,88 761,54 1045,37 1188,54 915,97 10985 05	F 0.5 H 0.9 WEB WEB TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445 F 04 103 F 07 655.00 675.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 590.36 478.89 577.94 647.71 673.56 640.42 200 1948 F 04	T-0.2 R 0.0 WAP WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 530.46 603.33 617.87 7.90 719E 01	РЕХ 3 РЕВ РЕВ РЕР ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ	173.84 170.64 971= 00 170.28 170.28 170.60 168.79 392.19 413.56 448.13 448.51 521.57 166.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51	PAX C 0.8 PAR PAR PAR TA	166.12 509-01 170.19 166.15 411.81 456.43 511.09 554.55 573.59 166.45 511.09 554.00 573.20 590.52 164.10 164.61	WFX S 0.2 TFR TFR TF1 WA WA WA WA WA WA WA WA WA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 825.75 836.86 483.447 715.43 803.81 833.48 833.48 847.59 655.00 655.00	₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA PA PA PA PA PA	836.33 5535-02 376.05 398.02 621.39 167.02 167.70 167.34 166.96 166.58 644.70 168.50 168.10 167.65 167.17 166.69 836.33 878.11	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1455F 04 V 0.1441F-01 V 0.1687F-01 V 0.2099E-01 V 0.2165F-01 N 0.1550E 04 V 0.2156F-01 V 0.2156F-01 V 0.2225F-01
FEEDPACK IR B= 1 ID E= 2 ID E= 7 IV = 1 IV = 7 IV = 1 IV = 7 IV = 7 I	K 0. TFR TFR TFR TFR TFR TFI TFO TFO TFO TFO TFO TFO TFO TFO	8839F-03 1222F 01 369.28 369.28 369.29 382.32 391.33 1146.50 1690.66 1927.11 1779.81 381.71 1270.28 1800.97 2170.39 1994.23 1421.32 4419F-03 3218F 01	О-О ТАВ Дая Р ТАІ ТЕМ ТЕМ <td>93466 000 369.253 432.23 170.10 987.90 710.08 957.42 1084.63 1047.90 855.60 388.88 761.54 1045.37 1188.54 1141.66 15.97 1098E 05</td> <td>F 0.5 H 0.9 WEB WEB TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1</td> <td>445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 570.36 485.90 647.71 673.56 646.31 618.98 572.94 647.71 673.56 646.91 647.61 675.65 572.94 647.71 673.65 646.91 647.65 646.91 647.65 646.91 647.71 673.65 648.99 647.71 673.65 646.91 647.75 648.99 647.75 647</td> <td>T-0.2 R 0.0 WAP WAP WAP WAP WAP WAP WAP TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2</td> <td>533F 00 655.05 730.99 168.54 445.39 515.84 515.84 515.84 515.84 599.53 169.15 169.15 530.46 600.20 633.33 617.87 0.0</td> <td>Р Е Х Р Е Я Р Е Я Р Е Я Р Е Я Р А Ј Т М Т М Т М Т М Т М Т М Т М Т М</td> <td>173.84 170.64 971= 00 170.28 170.28 170.40 168.29 392.19 413.56 448.13 478.51 521.57 168.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51 1656 00</td> <td>PAX C 0.8 PAR PAR PAR TA TA</td> <td>166.12 509-01 170.19 170.19 166.15 411.81 456.43 511.09 553.59 166.14 415.25 464.26 573.59 166.14 415.25 464.26 594.09 573.59 166.10 164.63 594.63 594.63</td> <td>WFX S 0.2 TFR TFR TFR WA WA WA WA WA WA WA WA WA WA</td> <td>655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 875.75 835.86 483.44 715.47 759.43 803.81 843.54 847.59 655.00 655.00 655.00</td> <td>₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA PA PA PA PA PA</td> <td>836.33 553F-02 376.05 378.02 621.39 167.70 167.70 167.70 167.70 164.58 166.58 644.70 168.10 167.65 167.17 166.69 878.11 304F-07</td> <td>G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1451F-01 V 0.1687F-01 V 0.1687F-01 V 0.2099F-01 V 0.2166F-01 N 0.1500E 04 V 0.1457F-01 V 0.1457F-01 V 0.1457F-01 V 0.2156F-01 V 0.225F-01 G 0.1983E 04</td>	93466 000 369.253 432.23 170.10 987.90 710.08 957.42 1084.63 1047.90 855.60 388.88 761.54 1045.37 1188.54 1141.66 15.97 1098E 05	F 0.5 H 0.9 WEB WEB TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 570.36 485.90 647.71 673.56 646.31 618.98 572.94 647.71 673.56 646.91 647.61 675.65 572.94 647.71 673.65 646.91 647.65 646.91 647.65 646.91 647.71 673.65 648.99 647.71 673.65 646.91 647.75 648.99 647.75 647	T-0.2 R 0.0 WAP WAP WAP WAP WAP WAP WAP TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 515.84 515.84 515.84 599.53 169.15 169.15 530.46 600.20 633.33 617.87 0.0	Р Е Х Р Е Я Р Е Я Р Е Я Р Е Я Р А Ј Т М Т М Т М Т М Т М Т М Т М Т М	173.84 170.64 971= 00 170.28 170.28 170.40 168.29 392.19 413.56 448.13 478.51 521.57 168.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51 1656 00	PAX C 0.8 PAR PAR PAR TA	166.12 509-01 170.19 170.19 166.15 411.81 456.43 511.09 553.59 166.14 415.25 464.26 573.59 166.14 415.25 464.26 594.09 573.59 166.10 164.63 594.63 594.63	WFX S 0.2 TFR TFR TFR WA WA WA WA WA WA WA WA WA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 875.75 835.86 483.44 715.47 759.43 803.81 843.54 847.59 655.00 655.00 655.00	₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 378.02 621.39 167.70 167.70 167.70 167.70 164.58 166.58 644.70 168.10 167.65 167.17 166.69 878.11 304F-07	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1451F-01 V 0.1687F-01 V 0.1687F-01 V 0.2099F-01 V 0.2166F-01 N 0.1500E 04 V 0.1457F-01 V 0.1457F-01 V 0.1457F-01 V 0.2156F-01 V 0.225F-01 G 0.1983E 04
FEEDPACK IR B= 1 ID E= 2 ID E= 1 IX = 1 IY = 2 IY = 4 IY = 5 IY = 2 IY = 4 IX = 5 IY = 2 IX = 1 IX = 7 IY = 4 IX = 1 IX = 1 IY = 2 IY = 4 IX = 1 IX = 1 IY = 2 IY = 4 IX = 1 IX = 1 IY = 2 IY = 4 IY = 4 I	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 391.33 1146.50 1690.66 1927.11 1779.58 1899.31 371.71 270.28 1899.423 1421.32 4419F-03 3218F 01 367.34	О-О ТАВ ТАВ Ф7 ТА1 ТЕМ	93466 000 369,255 432,23 170.19 387.49 710.08 957.42 1047.99 855.60 388.88 761.54 1045.37 1188.54 1141.66 915.97 10985 05 15305 01 367.36	F 0.5 H 0.9 WEB WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 103E-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 572.94 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 647.75 200 1948F 04 640F 00 655.00	T-0.2 R 0.0 WAP WAP PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15 452.66 630.20 633.33 617.87 0.0 779E 01 655.09	РЕХ РЕВ РЕР РАТ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ЕСХ РСО.7 РЕВ	173.84 170.64 971= 00 170.28 170.28 170.60 168.79 392.19 413.56 448.11 521.57 169.83 393.52 415.98 452.47 530.16 170.64 167.51 156F 00	PAX C 0.8 PAB PAB PA2 TA	166.12 509-01 170.19 166.15 411.81 456.43 511.09 554.55 573.59 166.45 511.09 554.00 573.20 590.52 164.10 164.61	WFX S 0.2 TFR TFR TF1 WA WA WA WA WA WA WA WA WA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 825.75 836.86 483.447 715.43 803.81 833.48 833.48 847.59 655.00 655.00	₩AX M-0.1 TMR TMR TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 376.05 398.02 621.39 167.34 166.96 186.58 644.70 168.50 168.10 167.65 167.17 166.69 836.33 878.11 304F-02 376.03	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ N & 0.1500F & 04 \\ V & 0.2156F-01 \\ V & 0.1457F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ \end{array} $
FEEDPACK IR B= 1 ID E= 2 ID E= 7 IV = 1 IV = 7 IV = 1 IV = 7 IV = 7 I	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 369.28 382.32 382.32 382.32 382.32 146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1899.97 2170.28 1899.97 2170.38 1421.32 4419F-03 3218F 01 367.34	О-0 ТАВ ДАВ Р7 ТАП ТЕМ ТАВ	93466 000 369,255 432,233 170,199 387,90 1084,63 1047,99 855,60 388,88 761,84 1045,37 1188,54 1045,37 1188,54 1045,37 1188,54 1045,37 1188,54 1141,66 915,97 1098E 05 1530E 01 3658,22	F 0.5 H 0.9 WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445 F 04 1035-01 655.00 655.00 657.01 467.78 577.21 670.65 646.31 618.98 579.94 646.47.71 673.56 647.71 673.56 647.71 047.71 048 F 04 647.01 048 F 04 647.01 655.00	T-0.2 R 0.0 WAP WAP WAP WAP WAP WAP WAP TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 515.84 515.84 515.84 599.53 169.15 169.15 530.46 600.20 633.33 617.87 0.0	Р Е Х Р Е Я Р Е Я Р Е Я Р Е Я Р А Ј Т М Т М Т М Т М Т М Т М Т М Т М	173.84 170.64 971= 00 170.28 170.28 170.40 168.29 392.19 413.56 448.13 478.51 521.57 168.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51 1656 00	PAX C 0.8 DAQ PAB PAB PA2 TA TA C 0.02	166.12 509=01 170.19 166.15 411.81 456.43 551.09 553.59 166.14 415.25 464.26 574.09 573.20 574.09 573.20 166.15 166.4 10 166.55 166.16 166.15 166.15 166.15 166.15 10 166.15 10 10 10 10 10 10 10 10 10 10	WFX S 0.2 TFR TFR TFI WA WA WA WA WA WEX S 0.5 TFP	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 825.75 836.86 483.44 715.47 759.43 803.81 833.48 847.59 655.00 655.00 655.01 376.057 01 376.02 377.02 3	₩AX ₩-0.1 TMR TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 376.05 398.02 621.39 167.70 167.70 167.70 167.70 166.58 165.58 644.70 168.10 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13	G 0.1989F 04 N 0.2099F 04 N 0.6918F 03 N 0.1457F 04 V 0.1457F-01 V 0.1924F-01 V 0.2099E-01 V 0.2156F-01 N 0.1577F-01 V 0.1457F-01 V 0.1457F-01 V 0.1457F-01 V 0.1457F-01 V 0.2156F-01 V 0.225F-01 G 0.1983F 04 G 0.1508F 04 N 0.5136F 03
FEEDPACK IR B= 1 ID E= 2 ID E= 1 IX = 1 IX = 2 IY = 4 IX = 5 IX = 1 IX = 7 IX = 2 IX = 1 IX = 2 IX = 2 IX = 1 IX = 2 IX = 2 I	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 369.28 369.29 382.32 381.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1405-03 1421.32 4419F-03 3218F 01 367.34 367.47 384.88	О-0 ТАВ Ф7 ТАІ ТЕМ	93466 000 369,253 432,23 170,19 387,90 710,08 957,42 1084,63 1047,99 855,60 388,88 761,56 1045,37 1188,54 1144,56 9185,05 11985,05 115305,01 367,36 458,22 167,24	F 0.5 H 0.9 WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 1103-01 655.00 655.00 675.65 573.81 467.78 573.21 670.65 646.31 618.98 647.71 673.56 447.89 572.94 647.71 673.56 647.71 673.56 647.70 675.00 648.64 640.00 655.00 655.00 681.64 681.64	T-0.2 R 0.0 WAP WAP PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 169.15 452.66 630.20 633.33 617.87 0.0 779E 01 655.09	РЕХ РЕВ РЕР РАТ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ЕСХ РСО.7 РЕВ	173.84 170.64 971= 00 170.28 170.28 170.60 168.79 392.19 413.56 448.11 521.57 169.83 393.52 415.98 452.47 530.16 170.64 167.51 156F 00	PAX C 0.8 PAB PAB PA2 TA	166.12 509=01 170.19 166.15 411.81 456.43 551.09 553.59 166.14 415.25 464.26 574.09 573.20 574.09 573.20 166.15 166.4 10 166.55 166.16 166.15 166.15 166.15 166.15 10 166.15 10 10 10 10 10 10 10 10 10 10	WFX S 0.2 TFR TFR TFI WA WA WA WA WA WEX S 0.5 TFP	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 825.75 836.86 483.44 715.47 759.43 803.81 833.48 847.59 655.00 655.00 655.01 376.057 01 376.02 377.02 3	₩AX M -0.1 TMP TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 376.05 398.02 621.39 167.07 167.70 167.64 166.96 186.58 644.70 168.50 168.10 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.6918F & 03 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ N & 0.1697F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1256F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.5136F & 03 \\ N & 0.1027F & 04 \\ \end{array} $
FEEDPACK IR B= 1 ID B= 2 ID E] IX = 1 IY = 2 IY = 4 IY = 5 IY = 7 IY = 4 IX = 5 IY = 7 IX = 1 IX = 7 IY = 4 IX = 7 IX = 1 IX = 7 IY = 4 IX = 7 IX	K 0. TFR TER TZ TEI TFO TEO TEO TEO TEO TEO TEO TEO TEO TEO TE	8839F-03 1222F 01 369.28 369.28 382.32 382.32 381.46.66 1927.11 1779.68 1289.31 1779.68 1289.31 1779.68 1270.28 1870.31 1270.28 184.21 367.34 367.47 384.88 384.28	О-0 ТАВ Р7 ТАІ ТЕМ	93466 0,00 369,253 432,23 170.19 387.90 710.08 957.42 1047.99 855.60 388.88 761.54 1045.37 1188.54 1141.66 915.97 10985 05 15305 01 367.36 458.22 167.24 397.41	F 0.5 H 0.9 WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445 F 04 1035-01 655.00 655.00 657.01 467.78 577.21 670.65 646.31 618.98 579.94 646.47.71 673.56 647.71 673.56 647.71 047.71 048 F 04 647.01 048 F 04 647.01 655.00	T-0.2 R 0.0 WAR WAR TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 515.84 515.84 599.53 599.53 599.53 530.46 600.20 633.33 617.87 .00 779F 01 655.09 754.89	DEX PER PER PA1 TM TM TM TM TM F PC PER DE DE DE	173.84 170.64 971= 00 170.28 170.28 170.40 168.29 392.19 413.56 448.13 478.61 521.57 168.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51 155F 00 167.29 167.48	PAX C 0.8 PAB PAB PAD TA TA TA	166.12 5095-01 170.19 170.19 166.15 411.81 456.43 5511.09 5573.59 575.59 575.59	WFX2 S OF TFR TFR WA WA WA WA WA WA WA WA WA WEX S OF TFR TFR TFI WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 734.83 835.86 483.44 715.47 759.43 833.81 835.86 483.44 847.59 655.00 655.00 655.00 655.00 555.01 376.02 511.88 499.56	₩AX ₩ -0.1 TMR TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 378.02 621.39 167.70 167.70 167.34 166.58 644.70 168.50 167.17 168.50 167.17 166.69 836.33 878.11 804F-02 376.03 398.13 654.22 165.90	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1637F-01 \\ V & 0.1924F-01 \\ V & 0.2099E-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1718F-01 \\ V & 0.156F-01 \\ V & 0.225F-01 \\ G & 0.193E & 04 \\ G & 0.1508F & 04 \\ S & 0.1603F & 04 \\ N & 0.6163F & 04 \\ N & 0.5136F & 03 \\ N & 0.1027F & 04 \\ V & 0.1663F-01 \\ \end{array} $
FEEDPACK IR B= 1 ID E= 2 ID E= 1 IX = 1 IX = 2 IY = 4 IX = 5 IX = 1 IX = 7 IX = 2 IX = 1 IX = 2 IX = 2 IX = 1 IX = 2 IX = 2 I	K 0. TFR TFR TFR TF1 TF0 TF0 TF0 TF0 TF0 TF0 TF0 TF0	8839F-03 1222F 01 369.28 369.28 369.29 382.32 381.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1405-03 1421.32 4419F-03 3218F 01 367.34 367.47 384.88		93466 0.00 369,253 432,273 170.19 387.09 387.49 1047.99 855.60 388.88 761.54 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 1098F 05 367.36 458.22 167.24 397.41 815.30 1137.22	F 0.5 H 0.9 WEB WEB WZ TA2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 577.21 670.65 646.31 618.98 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 640.00 655.00 655.00 681.64 640.23 538.57 679.06	T-0.2 R 0.0 WAR WAR PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 599.53 530.46 600.20 633.33 617.87 0.0 779F 01 655.09 754.89 166.25 509.43 633.00	РЕХ РЕР РЕР РАТ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ Т	173.84 170.64 971= 00 170.28 170.28 170.40 168.29 392.19 413.56 448.13 478.51 521.57 168.83 393.52 415.98 452.47 495.20 530.16 170.64 167.51 1655 00 167.29 167.48 166.09 392.72 414.77	PAX C 0.8 PA8 PA8 PA2 TA TA TA TA TA TA TA TA TA PAX C 0.2 C 0.8 PA8 PA2 TA PA2 TA TA	166.12 5095-01 170.19 170.19 166.15 411.81 456.43 511.09 557.59 573.59 573.59 573.59 573.59 573.52 166.14 415.25 464.26 524.09 573.59 530.67 164.64 167.24 164.64 446.85	WFX S 0.2 TFR TF1 WA WA WA WA WA WA WEX S 0.5 TFR TFR TFR TFR WA WA	655.00 '3800 01 376.04 488.29 468.47 712.24 753.23 875.83 836.86 483.44 715.47 759.43 803.81 847.59 655.00 655.00 655.00 1376.02 511.88 499.56 808.85	WAX M - 0.1 TMP TF2 PA PA PA PA PA PA PA PA PA PA	836.33 553F-02 376.05 376.05 398.02 621.39 167.70 167.70 167.70 167.70 166.96 166.58 644.70 168.10 167.65 167.17 166.69 836.33 878.11 904F-02 376.03 398.13 654.22 165.69	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1024F-01 \\ V & 0.1024F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1970F-01 \\ V & 0.256F-01 \\ V & 0.256F-01 \\ V & 0.256F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.5136F & 03 \\ N & 0.1027F & 04 \\ V & 0.2021F-01 \\ V & 0.2021F-01 \\ \end{array} $
FEEDPACK IR R= 1 ID R= 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 369.29 382.32 381.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1421.32 4419F-03 3218F 01 367.34 367.47 384.88 384.28 1366.90 2061.64		93466 0.0 369,25 432,23 170,19 387,90 10,08 957,42 10,47,99 855,60 388,88 761,84 1047,99 855,87 1188,54 1045,37 1188,54 1098E 05 1530F 03 458,22 167,24 397,41 815,30	F 0.5 H 0.9 WEB WZ TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445 = 04 103 = 01 655 = 00 655 = 00 655 = 00 657 = 01 467 = 78 577 = 11 678 = 670 = 66 478 = 89 572 = 94 647 = 71 673 = 56 647 = 71 673 = 56 647 = 71 673 = 56 647 = 71 673 = 56 647 = 71 655 = 00 655 = 00 655 = 00 655 = 00 655 = 00 772 = 37 772 = 77 772 = 77 77 77 77 77 77 77 77 77 77	T-0.2 R 0.0 WAR WAR PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 f11.78 599.53 169.15 452.66 630.20 633.33 617.87 7.79E 01 655.09 754.89 166.25 509.43 633.00 721.88	DFX C-0.3 PFR DCP DCP TM TM TM TM TM TM TM TM DFX FC0.7 PFB DFR PA1 TM TM DFX FC0.7 PFB DFR PA1 TM TM <	173.84 170.64 971E 000 170.28 170.28 170.40 168.29 392.19 413.56 448.13 448.51 521.57 168.83 393.52 415.98 452.47 530.16 157.69 167.29 167.28 166.99 392.72 414.77 455.07	PAX C 0.8 PA3 PA8 PA2 TA TA TA TA TA TA TA TA TA PAX C 0.2 PAR PAR PAX C 0.2 PAR TA TA TA	166.12 5095-01 170.19 166.15 411.81 456.43 511.09 554.55 573.59 166.14 415.25 464.26 574.09 573.20 573.20 166.24 166.10 164.43 5225 00 167.24 167.24 164.64 444.85 530.67 619.16	WFX.2 S OFR TFR WA WA WA WA WA WA WEX.5 TFR TFR TFR TFR WA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 825.75 836.86 4483.44 715.47 759.43 803.81 836.48 847.59 655.00 655.00 655.00 655.00 2511.88 499.56 745.98 808.85 805.64	WAX M-O0-1 TMP TMP TF2 PA	836.33 553F-02 376.05 376.05 378.02 621.39 167.34 166.96 186.96 186.96 186.96 186.96 167.65 167.17 186.69 836.33 878.11 804F-02 376.03 398.13 654.27 165.68 165.68	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.6918F & 03 \\ N & 0.6918F & 03 \\ V & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1024F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.5136F & 03 \\ N & 0.1603F & 04 \\ V & 0.2167F-01 \\ V & 0.2246F-01 \\ V & 0.246F-01 $
FEEDPACK IR B= 1 ID = 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY = 1 IY = 7 IY = 7 IY = 1 IY = 7 IY	K 0. TFR TER TFR TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1	8839F-03 1222F 01 369.28 369.28 369.29 382.32 381.33 1146.50 1690.66 1927.11 1779.58 1289.31 381.71 1270.28 1421.32 4419F-03 3218F 01 367.34 367.47 384.88 384.28 1366.90 2061.64	О-0. ТАВ Р ТАВ Р ТЕРМ ТЕРМ <	93466 0.00 369,253 432,273 170.19 387.09 387.49 1047.99 855.60 388.88 761.54 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 1098F 05 367.36 458.22 167.24 397.41 815.30 1137.22	F 0.5 H 0.9 WEB WEB TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	1445F 04 1103F-01 655.00 655.00 657.65 573.81 467.78 557.21 670.65 646.31 618.98 570.94 647.71 673.52 200 640.65 640.65 640.65 640.65 640.65 640.65 640.65 640.65 655.00 655.00 655.00 655.00 655.00 772.37 773.22 773.22	T-0.2 R 0.0 WAR WAB PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 457.66 530.46 600.20 633.33 617.87 0.0 754.89 166.25 509.43 633.00 721.88 633.00 741.69	0FX FC-0-3 0FR 0FR 0FR 0FR 0FR 0FR 0FR 0FR	173.84 170.64 971= 00 170.28 170.28 170.40 168.79 392.19 413.56 448.51 521.57 166.83 393.52 415.98 452.47 445.00 530.16 170.64 167.51 1565 00 167.29 167.48 166.09 392.72 414.77 450.07 490.90	PAX C 0.8 PA2 TA TA TA TA TA TA TA TA TA TA C 0.8 C DA2 TA TA TA TA TA TA TA TA TA TA	166.12 509-01 170.19 170.19 166.15 411.81 456.43 5511.09 553.59 166.14 415.25 464.26 554.09 573.59 166.16 464.26 559.59 164.63 5225 00 167.24 167.24 164.64 446.85 533.67 619.16	WFX2 SOFTFR TFR WA WA WA WA WA WA WA WA WA WA WA WA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 836.86 483.44 715.47 759.43 803.81 847.59 655.00 655.00 655.00 511.88 409.56 745.98 805.64 897.97	$\label{eq:hardensity} \begin{array}{l} WAX \\ WAC0.5 \\ TMP \\ TMP \\ PA \\ $	836.33 553F-02 376.05 378.02 621.39 167.70 167.34 166.58 644.70 167.65 167.17 166.58 167.17 166.59 878.11 804F-02 376.03 398.13 654.27 165.68 165.43 165.43 165.43	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1431F-01 \\ V & 0.1637F-01 \\ V & 0.1924F-01 \\ V & 0.2099E-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.2225F-01 \\ V & 0.2225F-01 \\ G & 0.1935F & 04 \\ G & 0.1508F & 04 \\ G & 0.1508F & 04 \\ N & 0.5136F & 03 \\ N & 0.1603F & 04 \\ N & 0.5136F & 01 \\ V & 0.2021F-01 \\ V & 0.2021F-01 \\ V & 0.268F-01 \\ V & 0.2538F-01 \\ V & 0.2538F-01 \\ \end{array} $
FECOPACK IR B= 1 ID = 2 ID = 1 IY = 2 IY = 4 IY = 4 IY = 5 IY = 2 IY = 4 IY = 7 IY = 4 IY = 6 FEFORACK IRR=1 IP = 2 IY = 1 IY = 2 IY = 4 IY = 2 IY = 4 IY = 2 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 3P1.33 1146.66 1927.11 1779.58 189.31 371.71 1270.28 189.31 371.71 1270.28 189.31 371.71 1094.23 149F-03 3218F 01 367.34 367.44 367.44 367.44 364.98 1366.97 150.55 1509.71	О-0. ТАВЯ Ф7 ТАВЯ Ф7 ТАВЯ ТАВЯ <td>93466 000 369,253 432,23 170.19 387.90 710.08 957.49 1047.99 855.60 388.88 761.56 1045.37 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 10985 01 367.36 458.22 1637.24 397.41 815.30 1137.22 1293.66 1231.48 966.86</td> <td>F 0.5 H 0.9 WE8 WZ2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1</td> <td>445E 04 103E-01 655.00 655.00 675.65 573.81 467.78 572.21 670.65 646.31 618.98 572.94 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.57 647.71 673.57 647.71 673.57 647.71 673.57 647.71 677.57 777.27 777.29 707.01</td> <td>T-0.2 R 0.0 WAR WAR PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2</td> <td>533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 599.53 530.46 530.46 530.46 530.46 530.70 779E 01 655.09 754.89 166.25 509.43 633.00 721.88 741.69 685.34</td> <td>DFX FR PFR PFR PFR PFR PFR TM TM TM TM TM TM TM TM TM TM PFX PFS PFR PA1 TM TM TM TM TM TM TM TM</td> <td>173.84 170.64 971= 00 170.28 170.28 170.60 168.79 392.19 413.56 448.11 521.87 169.83 393.52 415.98 445.47 495.20 530.16 170.64 167.51 1567.09 167.48 166.09 392.72 415.74 167.48 166.09 392.72 414.77 450.07 450.97 523.79</td> <td>P AX C 0.8 D A4 P A8 P A8 TA TA</td> <td>$\begin{array}{c} 166.12\\ 5095-01\\ 170.19\\ 170.19\\ 170.19\\ 170.19\\ 166.15\\ 411.81\\ 456.43\\ 5573.59\\ 573.59\\ 573.59\\ 573.59\\ 166.10\\ 164.44\\ 445.25\\ 454.26\\ 594.59\\ 573.59\\ 166.10\\ 164.48\\ 552.5\\ 00\\ 167.24\\ 147.24\\ 164.64\\ 446.85\\ 553.67\\ 619.16\\ 664.28\\ \end{array}$</td> <td>WFX2 S OF TFR TFR WAA WAA WAA WEX S OF FR TFR TFR TFR TFR TFR WAA WAA WAA WAA WAA WAA WAA WAA WAA</td> <td>655.00 '380C 01 376.04 488.29 468.47 712.24 753.23 825.75 836.84 4715.47 759.43 803.81 847.59 655.00 655.00 1376.02 511.88 499.56 745.98 808.64 807.57 803.24 807.97 803.24 803.25 803.85 803.25 803.85 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.85 803.25 80</td> <td>$\begin{array}{l} WAX\\ WAO \in L\\ TMR\\ TMR\\ TMR\\ TF7\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ TMR\\ TF7\\ OA\\ PA\\$</td> <td>836.33 553F-02 376.05 376.05 378.02 621.39 167.70 167.70 166.96 166.96 166.96 166.96 166.96 167.65 167.17 166.69 836.33 878.11 904F-02 376.03 398.13 654.22 165.69 165.64 165.43 165.61</td> <td>$\begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1451F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.1457F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ V & 0.2221F-01 \\ V & 0.2221F-01 \\ V & 0.2231F-01 \\ V & 0.2346F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ \end{array}$</td>	93466 000 369,253 432,23 170.19 387.90 710.08 957.49 1047.99 855.60 388.88 761.56 1045.37 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 10985 01 367.36 458.22 1637.24 397.41 815.30 1137.22 1293.66 1231.48 966.86	F 0.5 H 0.9 WE8 WZ2 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445E 04 103E-01 655.00 655.00 675.65 573.81 467.78 572.21 670.65 646.31 618.98 572.94 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.56 647.71 673.57 647.71 673.57 647.71 673.57 647.71 673.57 647.71 677.57 777.27 777.29 707.01	T-0.2 R 0.0 WAR WAR PF1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 599.53 530.46 530.46 530.46 530.46 530.70 779E 01 655.09 754.89 166.25 509.43 633.00 721.88 741.69 685.34	DFX FR PFR PFR PFR PFR PFR TM TM TM TM TM TM TM TM TM TM PFX PFS PFR PA1 TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.28 170.60 168.79 392.19 413.56 448.11 521.87 169.83 393.52 415.98 445.47 495.20 530.16 170.64 167.51 1567.09 167.48 166.09 392.72 415.74 167.48 166.09 392.72 414.77 450.07 450.97 523.79	P AX C 0.8 D A4 P A8 P A8 TA	$\begin{array}{c} 166.12\\ 5095-01\\ 170.19\\ 170.19\\ 170.19\\ 170.19\\ 166.15\\ 411.81\\ 456.43\\ 5573.59\\ 573.59\\ 573.59\\ 573.59\\ 166.10\\ 164.44\\ 445.25\\ 454.26\\ 594.59\\ 573.59\\ 166.10\\ 164.48\\ 552.5\\ 00\\ 167.24\\ 147.24\\ 164.64\\ 446.85\\ 553.67\\ 619.16\\ 664.28\\ \end{array}$	WFX2 S OF TFR TFR WAA WAA WAA WEX S OF FR TFR TFR TFR TFR TFR WAA WAA WAA WAA WAA WAA WAA WAA WAA	655.00 '380C 01 376.04 488.29 468.47 712.24 753.23 825.75 836.84 4715.47 759.43 803.81 847.59 655.00 655.00 1376.02 511.88 499.56 745.98 808.64 807.57 803.24 807.97 803.24 803.25 803.85 803.25 803.85 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.25 803.85 803.25 80	$\begin{array}{l} WAX\\ WAO \in L\\ TMR\\ TMR\\ TMR\\ TF7\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ TMR\\ TF7\\ OA\\ PA\\ $	836.33 553F-02 376.05 376.05 378.02 621.39 167.70 167.70 166.96 166.96 166.96 166.96 166.96 167.65 167.17 166.69 836.33 878.11 904F-02 376.03 398.13 654.22 165.69 165.64 165.43 165.61	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1451F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.1457F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ V & 0.2221F-01 \\ V & 0.2221F-01 \\ V & 0.2231F-01 \\ V & 0.2346F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ \end{array} $
FEEDPACK IR R= 1 ID R= 2 ID = 1 IX= 1 IY= 2 IY= 4 IY= 4 IY= 2 IY= 4 IY= 2 IY= 3 IY= 4 IY= 2 IY= 3 IY= 4 IY= 2 IY= 1 IY= 1 IY= 2 IY= 1 IY= 2 IY= 1 IY= 2 IY= 1 IY= 2 IY= 2 I	K 0. TFR TER TER TFI TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1 TF1	8839F-03 1222F 01 369.28 349.49 382.32 3P1.33 1146.50 1927.11 1779.58 1289.31 371.71 1270.28 1899.97 1270.28 1899.97 1924.23 1421.32 4419F-03 32187.34 367.47 384.88 384.88 1366.90 2061.64 2353.88 2150.55 150.57 1384.57	0 - 0, TAP TAP $0 > 7$ TAP $0 > 7$ TAP $0 > 7$ TAP $0 > 7$ TEN TEN TEN TEN TEN TEN TEN TEN TEN TAP TAP TAP	93466 000 369,255 432,23 170.19 387.49 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 10985 05 15305 05 167.24 458.22 167.24 167.24 397.41 815.30 1137.29 1293.66 1231.48 966.86 399.20	F 0.5 H 0.9 WEB WZ TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	1445E 04 1103E-01 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 577.94 647.71 673.56 640.42 200 640.42 200 655.00 655.00 655.00 655.00 655.00 655.00 655.00 655.00 655.00 671.13 538.57 7783.29 707.01 671.01	$\begin{array}{c} T-0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ WAR \\ F \\ 1 \\ TC2 \\ TC2$	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 452.66 600.20 633.33 617.87 0.0 779E 01 655.09 754.89 166.25 509.43 633.00 721.88 741.69 685.34 166.65	DFX C-0.3 PFR PFR PFR DCP TM TM TM PC2 F PC8 DC8 PA1 TM TM TM PA1 TM PA1 TM	173.84 170.64 971= 00 170.28 170.28 170.40 168.79 392.19 413.56 448.13 448.11 521.57 168.83 393.52 415.98 452.47 449.10 530.16 170.64 170.64 167.29 167.48 166.09 392.72 414.77 450.07 450.07 450.379 166.44	PAX C 0.8 PA3 PA8 PA2 TA TA TA TA TA TA TA TA TA TA TA TA TA	166.12 5095-01 170.19 166.15 411.81 456.43 551.09 553.59 166.14 415.25 464.26 573.20 573.20 574.09 573.20 574.09 573.20 166.14 415.25 464.26 574.09 573.20 166.16 166.16 415.25 464.26 574.09 573.20 166.16 166.25 166.16 674.26 166.25 167.24 167.24 164.64 444.85 530.67 619.16 164.28 164.2	WFX2 SOFR TFR TFR WA WA WA WA WA WA WA WA WA TFR TFR TFR TFR TFR TFR TFI WA WA WA TFI	655.00 3807 01 376.04 488.29 468.47 712.24 753.23 794.83 835.86 483.44 715.43 833.81 833.81 835.86 487.59 655.00 655.00 655.00 655.00 655.00 1376.02 511.88 499.56 745.98 808.85 845.94 21.85 845.97 803.24 519.65 519.66 519.65 519.55 519.65 519.65 519.65 519.65 519.65 519.55 519.65 519.5	$ \begin{array}{l} \mbox{WAX} & \mbox{WAX} & \mbox{WAX} & \mbox{TMR} \\ \mbox{TMR} & \mbox{TMR} \\ \mbox{PA} & \mbox{PA} \\ \mbox{TMR} & \mbox{TMR} \\ \mbox{TF2} & \mbox{PA} \\ \mbox{PA} & \$	836.33 555F-02 376.05 378.02 621.39 167.70 167.34 166.96 168.10 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13 654.22 165.68 165.43 165.43 165.43 165.43	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1431F-01 \\ V & 0.1637F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1478F-01 \\ V & 0.1506F-01 \\ V & 0.225F-01 \\ G & 0.1506F-01 \\ V & 0.225F-01 \\ G & 0.1508F & 04 \\ N & 0.5136F & 03 \\ N & 0.5136F & 03 \\ N & 0.5136F-01 \\ V & 0.2021F-01 \\ V & 0.2021F-01 \\ V & 0.2036F-01 \\ V & 0.2536F-01 \\ V & 0.2536F-01 \\ V & 0.2536F-01 \\ V & 0.214F-01 \\ N & 0.1120F & 04 \\ \end{array} $
FEEDPACK IR R= 1 ID = 2 ID = 7 ID = 7 IV = 1 IV = 7 IV	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 3791.33 1146.0166 1927.11 1779.68 1890.47 1289.31 371.71 1270.28 1800.97 2170.28 1421.32 4419F-03 3218r 01 367.34 367.47 384.88 384.88 384.28 1366.055 1509.71 352.157.13	0-0. - TAR TAR PZ TAI TFN TFN TFN TAI TFN TAI TFN TAI TFN TAI TFN TAI TFN TAI TFN TAN TFN TFN	93466 000 369,253 432,23 170.10 987.90 710.08 1084.63 1047.90 388.88 764.53 1047.90 388.88 764.54 1188.54 1141.66 15305 01 367.36 458,22 167.24 397.41 815.30 1137.22 1293.66 1231.48 966.80 399.20	F 0.5 H 0.9 WEB WEB TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	1445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 579.36 478.89 577.94 647.71 673.56 640.47 857.00 640.47 200 655.00 655.00 655.00 655.00 655.00 772.37 773.29 777.01 671.13 560.88	$\begin{array}{c} T-0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ PF \\ 1 \\ TC2 \\ TC$	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.53 169.15 452.66 530.46 600.20 633.33 617.87 0.07 754.89 166.25 509.43 633.00 721.88 741.69 685.34 166.63 526.59	0FX C-0.3 PFR PFR PFR PFR PFR TM TM TM TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.28 170.40 168.79 392.19 392.19 413.56 448.51 521.57 166.83 393.52 415.98 452.47 445.00 530.16 170.64 167.51 1565 00 167.48 166.09 392.72 414.77 450.07 450.07 453.79 166.44 394.15	PAX PAX PAX PAX PAR PA2 TA TA TA TA TA TA TA TA TA PAX PAX CDAR PAR PAR TA TA TA TA TA TA TA TA TA TA TA TA	$\begin{array}{c} 166.12\\ 5.09-01\\ 170.19\\ 170.19\\ 170.19\\ 170.19\\ 166.15\\ 411.81\\ 456.43\\ 573.59\\ 166.16\\ 457.45\\ 573.59\\ 166.16\\ 415.25\\ 464.26\\ 594.09\\ 573.20\\ 590.52\\ 166.10\\ 164.64\\ 456.45\\ 530.67\\ 619.16\\ 644.28\\ 164.64\\ 455.45\end{array}$	WFX2 SOFTFR TFR WA WA WA WA WA WA WA WA WA SOFFR TFR TFR TFR TFR TFA WA WA WA TFA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 836.86 483.44 715.47 759.43 803.81 847.59 655.00 655.00 655.00 1376.02 511.88 499.56 745.98 805.64 893.24 519.66 773.04	$\begin{array}{l} WAX\\ WAO0\mathbf{b}\mathbf{c}\\ TMP\\ TMP\\ TMP\\ TFP\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ M-Os5\\ TMP\\ TFP\\ TMP\\ TFP\\ PA\\ PA$	836.33 553F-02 376.05 378.02 621.39 167.70 167.34 166.70 167.34 166.58 644.70 167.65 167.17 168.50 167.65 167.67 376.03 398.13 654.27 165.09 165.68 165.43 165.4	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1924F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.1457F-01 \\ V & 0.1477F-01 \\ V & 0.225F-01 \\ G & 0.193F & 04 \\ G & 0.193F & 04 \\ G & 0.193F & 04 \\ N & 0.1603F & 04 \\ N & 0.2221F-01 \\ V & 0.246E-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ N & 0.2514F-01 \\ N & 0.120E & 04 \\ V & 0.1701F-01 \end{array} $
FREEPACK IR B= 1 IP B= 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 5 IY = 2 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 7 IY = 1 IY = 1 IY = 1 IY = 2 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 391.33 1146.50 1697.61 1779.68 1270.18 1270.28 189.31 371.71 1270.28 189.31 371.71 1270.28 1421.32 4419F-03 3218F 01 367.34 367.44 364.98 156.55 1509.71 384.52 1527.13 2332.31	$\begin{array}{c} 0 - 0 \cdot \cdot \\ TAP \\ TAP \\ P \\ 7 \\ TAP \\ TAP \\ TAP \\ TFN \\ TFN$	93466 000 369,255 432,273 170.19 387.90 710.08 957.49 1047.99 855.60 1047.99 855.60 1047.99 855.60 1047.99 855.60 1047.99 855.60 1048.54 1045.37 1088.54 1141.66 915.97 1098.01 367.36 458.22 167.24 397.41 815.30 1137.22 1293.66 1231.48 966.86 399.20 1254.72	F 0.5 H 0.9 WF8 WZ TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	1445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 670.65 646.31 670.65 646.31 670.65 647.71 677.94 647.74 647.75 647.74 647.75 647.74 677.77 773.56 640c n0 655.00 655.00 655.00 681.64 640.23 538.57 640.23 538.57 777.37 773.20 707.01 671.13 560.88 720.23	$\begin{array}{c} T=0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ PF1 \\ TC2 \\$	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 611.78 599.53 599.53 530.46 530.46 530.46 530.46 530.77 779E 01 655.09 754.89 166.25 509.43 633.00 721.88 741.69 685.34 166.63 526.59	DFX C-0,3 PFR PFR DFR DFA TM TM TM TM TM TM TM TM TM TM TM TM TM	$\begin{array}{c} 173.84\\ 170.64\\ 971 = 00\\ 170.28\\ 170.28\\ 170.40\\ 168.79\\ 392.19\\ 413.56\\ 448.13\\ 448.41\\ 521.57\\ 169.83\\ 393.52\\ 415.98\\ 452.47\\ 159.83\\ 393.52\\ 415.98\\ 452.47\\ 167.58\\ 167.59\\ 167.48\\ 166.09\\ 392.72\\ 414.77\\ 450.07\\ 490.90\\ 523.79\\ 166.44\\ 394.15\\ 417.45\\ 417.45\\ \end{array}$	P AX C 0.8 D AR P AB P AB P AB TA	166.12 5095-01 170.19 170.19 166.15 411.81 456.43 573.59 166.14 415.25 464.26 573.20 573.20 573.20 573.20 166.10 166.42 166.16 166.16 166.16 573.20 573.20 166.10 166.16 573.20 573.20 166.10 166.16 573.20 573.20 166.10 166.16 573.20 573.20 166.16 167.24 166.46 166.45 166.4	WFX2 SOFR TFR TFR WAA WAA WAA WAA WAA WAA WEXS TFR TFI WAA WAA WAA TFI WAA WAA WAA WAA WAA WAA WAA WAA WAA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 825.75 836.84 4715.47 759.43 803.81 833.81 837.95 805.00 655.00 376.02 511.88 499.56 745.98 808.64 807.97 803.24 519.66 753.04 822.31	$ \begin{array}{l} WAX\\ WAO = \mathbf{L}\\ TMR\\ TMR\\ TMR\\ TF7\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ VAY\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ WAY\\ TMR\\ TF7\\ OA\\ PA\\ $	836.33 553F-02 376.05 376.05 378.02 621.39 167.70 167.70 167.70 164.96 644.70 168.50 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13 654.22 165.90 165.68 165.43 165.43 165.43 164.11 643.03 164.21 165.90	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1451F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1970F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.1603F & 04 \\ N & 0.163F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ N & 0.1214F-01 \\ N & 0.1214F-01 \\ N & 0.2514F-01 \\ N & 0.2514F-01 \\ N & 0.2514F-01 \\ N & 0.2193F-01 \\ N & 0.2093F-01 \\ \end{array} $
FCCOPACK IR R=1 IP R= 2 IP = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 1 IY = 1 IY = 1 IY = 1 IY = 1 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR TFR TFR TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 382.32 387.32 1146.50 1997.51 1270.28 1899.61 1270.28 1899.97 1270.28 1899.97 1994.23 1421.32 4419F-03 367.34 367.34 367.34 2150.55 1509.71 384.88 2150.55 1509.71 384.75 2332.31 267.75	0 - 0. TAP TAP 0 7 TAP 0 7 TAP TAP $0 7 TAPTENTENTENTENTENTENTENTEN$	93466 000 369,255 432,23 170.19 387.49 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 1098E 05 1530E 05 1530E 05 167.24 815.30 1137.22 167.24 815.30 1137.25 1293.66 1231.48 399.20 883.91 1254.72 1432.00	F 0.5 H 0.9 WER WER TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	1445F 04 1103F-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 618.98 579.36 478.89 577.94 647.71 673.56 640.422 200 948F 04 640.55.00 655.00 655.00 655.00 655.00 655.00 772.37 777.3.29 707.01 671.13 560.88 720.23 824.10	$ \begin{array}{c} T-0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ WAR \\ PF1 \\ TC2 $	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 452.66 600.20 633.33 617.87 0.0 774.89 166.25 509.43 633.00 754.89 166.25 509.43 635.34 166.65 525.34 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.54 166.65 526.55 526.54 526.54 526.55 526.54 526.55 526.54 526.55 526.54 526.55 527.54 527.55	0FX C-0.3 PFR PFR DFP DA1 TM TM TM TM TM TM TM TM PA1 TM TM F-0.7 PFB PFR PFR PFR PFR TM TM TM TM TM TM TM TM TM TM	$\begin{array}{c} 173.84\\ 170.64\\ 971E 00\\ 170.28\\ 170.28\\ 170.40\\ 168.79\\ 392.19\\ 413.56\\ 448.51\\ 521.57\\ 1521.57\\ 169.83\\ 393.52\\ 415.98\\ 452.47\\ 448.51\\ 521.57\\ 169.83\\ 393.52\\ 415.98\\ 452.47\\ 448.51\\ 155E 00\\ 167.48\\ 167.51\\ 156E 00\\ 167.28\\ 165.44\\ 394.5\\ 450.37\\ 9166.44\\ 394.15\\ 447.45\\ 454.88\\ 454.88\\ 454.88\\ 455$	$\begin{array}{c} PAX\\ PAX\\ PAX\\ PAX\\ PAR\\ PA2\\ TA\\ CDAR\\ PAX\\ CDAR\\ PAX\\ CDAR\\ PAX\\ TA\\ \mathsf$	$\begin{array}{c} 166.12\\ 509-01\\ 170.19\\ 170.19\\ 170.19\\ 170.19\\ 170.19\\ 166.15\\ 411.81\\ 456.43\\ 573.59\\ 166.14\\ 415.25\\ 464.26\\ 554.09\\ 573.59\\ 166.14\\ 455.45\\ 590.52\\ 166.10\\ 167.24\\ 164.64\\ 455.45\\ 530.67\\ 664.28\\ 164.64\\ 455.45\\ 550.94\\ 655.99\\ 455.95\\ 165.94\\ 655.99\\ 455.95\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 165.94\\ 105.95\\$	w $r x = 2$ S OFRR T F F 1 WAA WAA WAA WAA WAA WAA WAA WA	655.00 3807 01 376.04 488.29 468.47 712.24 753.23 794.83 825.75 833.86 483.44 715.47 759.43 833.81 843.44 759.43 833.81 843.44 759.43 833.81 847.59 655.00 753.24 511.88 849.56 745.98 803.24 519.66 753.04 807.97 803.24 519.60 753.04 807.97 803.24 819.00 753.04 822.31 855.00 675.00 753.04 875.00 755.0	$\begin{array}{l} WAX\\ WAO0\mathbf{b}\mathbf{c}\\ TMP\\ TMP\\ TMP\\ TFP\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ PA\\ M-Os5\\ TMP\\ TFP\\ TMP\\ TFP\\ PA\\ PA$	836.33 555F-02 376.05 378.02 621.39 167.70 167.70 167.34 166.58 644.70 168.50 168.10 167.45 167.17 166.68 878.11 804F-02 376.03 378.13 654.22 165.68 165.43 165.43 165.43 165.45 165.94 165.94	$ \begin{array}{c} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1431F-01 \\ V & 0.1637F-01 \\ V & 0.1924F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1477F-01 \\ V & 0.1477F-01 \\ V & 0.1477F-01 \\ V & 0.163F-01 \\ V & 0.225F-01 \\ G & 0.193E-04 \\ G & 0.1508F-04 \\ N & 0.5136F-03 \\ N & 0.5136F-03 \\ N & 0.5136F-01 \\ V & 0.2021F-01 \\ V & 0.2246F-01 \\ V & 0.2538F-01 \\ V & 0.214F-01 \\ V & 0.214F-01 \\ V & 0.214F-01 \\ V & 0.1701F-01 \\ V & 0.203F-01 \\ V & 0.203F$
FEEDPACK IR B= 1 ID = 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 7 IY = 7 IY = 1 IY = 7 IY	K 0. TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 3791.33 1146.50 1690.66 1927.11 1779.68 1890.97 1289.31 371.71 1270.28 1890.97 1421.32 4419F-03 32187.01 367.34 367.47 384.88 384.28 384.28 1366.55 1509.71 384.57 1527.13 2332.31 2667.75 2426.58	$\begin{array}{c} n-0, \cdot, \\ TAB q\\ PZ TAB q\\ PZ TAB q\\ TAB q\\ TAB q\\ TAB q\\ TEN q\\ TAB q\\ TEN q$	93466 000 369,253 432,23 170.19 387.90 710.68 1047.90 388.88 764.53 1047.90 388.68 764.54 1045.37 1188.54 1141.66 9088 05 1637.24 367.36 458.22 1637.24 367.36 458.22 1637.24 367.36 458.22 163.23 163.25 1231.48 966.86 399.20 1254.72 1255.51	$ \begin{array}{c} F & 0.5 \\ F & 0.9 \\ WEB \\ WEB \\ WZ \\ TC1 \\ TC1$	445F 04 1103=-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 678.64 679.36 647.71 673.65 646.31 678.64 647.71 673.74 674.64 647.71 673.65 646.05 00 655.00 655.00 655.00 655.00 655.00 655.00 655.00 677.237 7783.29 707.01 671.13 560.88 720.23 824.10 833.224 1032 103 10 10 10 10 10 10 10 10 10 10	T-0.2 R 0.0 WAR WAR DF 1 TC2 TC2 TC2 TC2 TC2 TC2 TC2 TC2	533F 00 655.05 730.99 168.54 445.39 515.84 452.66 530.46 600.20 633.33 617.87 0.07 779F 01 655.09 754.89 166.25 509.46 633.30 721.88 741.69 685.34 166.63 526.59 666.42 765.06 784.74	0FX C-0.3 PFR PFR PFR PFR PFR PA1 TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.28 170.40 168.79 392.19 413.56 448.13 448.51 521.57 166.83 393.52 415.98 452.47 455.47 455.47 455.07 455.07 455.07 450.07 450.07 453.79 166.44 394.15 417.45 454.88 454.81	$\begin{array}{c} PAX\\ PAX\\ PAX\\ PAX\\ PAR\\ PAR\\ PA2\\ TA\\ PAX\\ C O.2\\ DAR\\ PAR\\ PAR\\ TA\\ TA\\$	166.12 5095-01 170.19 170.19 166.15 411.81 456.43 511.09 553.59 166.14 415.25 464.26 524.09 573.59 530.52 166.10 164.43 5225 00 164.43 5225 00 164.43 5225 00 164.64 446.45 550.67 619.16 644.28 104.64 455.45 550.94 650.99 770.05	WFX.2 S TER TFR WAA WAA WAA WEX S TER TFI WAA WAA WEX S TER TFI WAA WAA TFI WAA WAA WAA WAA WAA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 875.75 835.86 835.86 835.86 849.59 655.00 655.00 655.00 655.00 655.00 655.00 511.88 499.56 745.98 803.81 376.02 511.88 803.81 875.64 893.24 519.66 773.04 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 825.64 822.31 825.64 825.64 822.31 825.64 825.64 825.65 835.64 835.64 835.65 835.6	$\label{eq:hardenergy} \begin{array}{l} WAX \\ WAO0 \in \mathbf{I} \\ WAO\mathbf{V} \\ TMP \\ TMP \\ TF7 \\ PA \\ PA$	836.33 553F-02 376.05 378.02 621.39 167.70 167.34 166.58 166.58 167.17 168.10 167.65 167.17 166.69 836.33 878.11 804F-07 376.03 398.13 165.68 165.43 165.	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1451F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.2099F-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.1457F-01 \\ V & 0.1457F-01 \\ V & 0.1970F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.1603F & 04 \\ N & 0.163F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ V & 0.2514F-01 \\ N & 0.1214F-01 \\ N & 0.1214F-01 \\ N & 0.2514F-01 \\ N & 0.2514F-01 \\ N & 0.2514F-01 \\ N & 0.2193F-01 \\ N & 0.2093F-01 \\ \end{array} $
FCCOPACK IR R=1 IP R= 2 IP = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 7 IY = 4 IY = 1 IY = 1 IY = 1 IY = 1 IY = 1 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY = 1 IY = 2 IY	K 0. TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 382.32 382.32 382.32 382.32 381.46 1946.50 1946.50 1947.11 1779.58 1899.31 381.71 1270.28 1899.97 1944.23 1421.32 4419F-03 367.34 367.34 367.34 2353.88 2150.55 1509.71 384.82 1564.57 1592.11 3232.31 267.75	$\begin{array}{c} n-0, \cdot, \\ \tau A p \\ \tau A p$	93466 000 369,255 432,23 170.19 387.49 957.42 1084.63 1047.99 855.60 388.88 761.54 1045.37 1188.54 1045.37 1188.54 1141.66 915.97 1098E 05 1530E 05 1530E 05 167.24 815.30 1137.22 167.24 815.30 1137.25 1293.66 1231.48 399.20 883.91 1254.72 1432.00	F 0.5 H 0.9 WF8 WZ TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1 TC1	445F 04 1103E-01 655.00 655.00 675.65 573.81 467.78 577.21 670.65 646.31 618.98 577.94 647.78 577.94 647.74 670.65 646.31 670.65 646.31 670.65 647.71 677.74 200 655.00 655.00 655.00 681.64 640.23 538.57 670.00 777.37 773.37 773.32 824.10 833.22 743.76 743.26 743.76 743.76 743.76 743.27 743.26 743.76 743.76 743.76 743.27 743.27 743.27 743.27 743.27 743.27 743.22 743.76 743.76 743.27 743.27 743.27 743.27 743.27 743.27 743.27 743.27 743.27 743.27 743.22 743.76 745.76	$ \begin{array}{c} T-0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ WAR \\ PF1 \\ TC2 $	533F 00 655.05 730.99 168.54 445.39 515.84 579.94 411.78 599.51 579.94 411.78 599.51 630.20 633.00 779E 01 655.09 754.89 166.25 509.43 633.00 721.88 741.69 685.34 166.63 526.59 666.42 755.06 784.74 718.81	0 F X F C - 0, - 3 P F R P F R P F R P F R P F R T M T M T M T M T M T M T M T M	$\begin{array}{c} 173.84\\ 170.64\\ 971 = 00\\ 170.28\\ 170.28\\ 170.40\\ 168.29\\ 392.19\\ 413.56\\ 448.51\\ 521.57\\ 169.85\\ 2415.98\\ 452.47\\ 455.47\\ 169.85\\ 2415.98\\ 452.47\\ 455.07\\ 497.29\\ 167.48\\ 166.99\\ 392.72\\ 414.77\\ 450.07\\ 450.07\\ 450.07\\ 453.99\\ 166.44\\ 394.15\\ 532.99\\ 166.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 165.48\\ 498.21\\ 552.99\\ 100\\ 100\\ 100\\ 100\\ 100\\ 100\\ 100\\ 1$	$\begin{array}{c} PAX\\ PAX\\ PAX\\ PAX\\ PAR\\ PA2\\ TA\\ CDAR\\ PAX\\ CDAR\\ PAX\\ CDAR\\ PAX\\ TA\\ \mathsf$	166.12 5095-01 170.19 166.15 411.81 456.43 511.09 553.57 166.14 415.25 464.26 573.20 573.20 573.20 573.20 166.10 166.42 166.16 166.16 166.16 573.20 573.20 166.10 166.16 573.20 573.22 166.10 166.16 573.20 573.20 573.20 166.10 166.16 573.20 573.20 573.20 573.20 573.20 573.20 573.20 166.16 166.16 573.20 573.20 573.20 573.20 573.20 573.20 573.20 166.16 166.16 573.20 573.20 166.16 166.16 573.20 573.20 573.20 573.20 573.20 573.20 573.20 573.20 573.20 573.20 573.20 166.16 166.16 166.16 166.16 166.16 166.16 166.16 573.20 573.20 573.20 573.20 573.20 166.10 166.16 166.10 166.16 167.24 167.24 166.64 455.45 550.94 657.99 70.16 664.28 166.26 664.28 166.26 664.28 166.26 664.28 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 664.28 167.29 166.26 167.29 166.26 167.29 166.26 167.29 166.26 166.26 167.29 166.26 167.26 167.26 166.26	w $r x = 2$ S OFRR T F F 1 WAA WAA WAA WAA WAA WAA WAA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 724.83 825.75 836.86 448.44 715.47 759.43 803.81 837.94 847.59 803.81 847.59 847.59 805.60 1376.02 511.88 499.56 745.98 807.97 803.24 519.66 733.04 822.31 885.06 920.31 885.06 921.31 863.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 843.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 845.06 921.31 921.85 921.95 921.85 921.	WAX WAX WAX WAY	836.33 553F-02 376.05 376.05 378.02 621.39 167.70 167.70 167.70 167.70 164.96 644.70 168.50 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13 654.22 165.90 165.68 165.43 165.43 165.43 165.43 165.43 165.43 165.90 165.62 165.62 165.62 165.62 165.62	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.2099F & 04 \\ N & 0.6918F & 03 \\ N & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.2099E-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.2225F-01 \\ G & 0.1983F & 04 \\ G & 0.1508F & 04 \\ N & 0.5136F & 03 \\ N & 0.1603F & 04 \\ N & 0.5136F & 03 \\ N & 0.1027F & 04 \\ V & 0.2165F-01 \\ V & 0.223F-01 \\ V & 0.223F-01 \\ V & 0.238F-01 \\ V & 0.253F-01 \\ V & 0.2662F-01 \\ V & 0.2662F-01 \\ V & 0.2662F-01 \\ V & 0.2662F-01 \\ \end{array} $
FEEDPACK IR B= 1 ID = 2 ID = 1 IY = 1 IY = 2 IY = 4 IY = 4 IY = 7 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 7 IY = 1 IY = 7 IY = 1 IY = 7 IY = 7 IY = 7 IY = 1 IY = 7 IY	K 0. TFR TFR TFR	8839F-03 1222F 01 369.28 369.28 3791.33 1146.50 1690.66 1927.11 1779.68 1890.97 1289.31 371.71 1270.28 1890.97 1421.32 4419F-03 32187.01 367.34 367.47 384.88 384.28 384.28 1366.55 1509.71 384.57 1527.13 2332.31 2667.75 2426.58	$\begin{array}{c} n-0, \cdot, \\ \tau A p \\ \tau A p$	93466 000 369,253 432,23 170.19 387.90 710.68 1047.90 388.88 764.53 1047.90 388.68 764.54 1045.37 1188.54 1141.66 9088 05 1637.24 367.36 458.22 1637.24 367.36 458.22 1637.24 367.36 458.22 163.23 163.25 1231.48 966.86 399.20 1254.72 1255.51	$ \begin{array}{c} F & 0.5 \\ F & 0.9 \\ WEB \\ WEB \\ WZ \\ TC1 \\ TC1$	445F 04 1103=-01 655.00 655.00 675.65 573.81 467.78 557.21 670.65 646.31 670.65 646.31 618.98 570.94 647.71 673.62 647.71 673.62 647.71 673.62 6405.00 655.00 655.00 655.00 655.00 655.00 681.64 640.23 538.57 773.29 707.01 671.13 560.88 720.23 824.10 833.22	$\begin{array}{c} T-0.2 \\ R \\ 0.0 \\ WAR \\ WAR \\ PF1 \\ TC2 \\$	533F 00 655.05 730.99 168.54 445.39 515.84 452.66 530.46 600.20 633.33 617.87 0.07 779F 01 655.09 754.89 166.25 509.46 633.30 721.88 741.69 685.34 166.63 526.59 666.42 765.06 784.74	0FX C-0.3 PFR PFR PFR PFR PFR PA1 TM TM TM TM TM TM TM TM TM TM	173.84 170.64 971= 00 170.28 170.28 170.40 168.79 392.19 413.56 448.13 448.51 521.57 166.83 393.52 415.98 445.47 445.47 445.47 167.50 167.29 167.48 166.99 392.72 414.77 450.07 450.07 453.79 166.44 394.15 417.45 454.88 449.21	$\begin{array}{c} PAX\\ PAX\\ PAX\\ PAX\\ PAX\\ PAX\\ PAX\\ TA\\ PAX\\ PAX\\ PAX\\ C \\ DAP\\ PAR\\ DA2\\ TA\\ T$	166.12 5095-01 170.19 170.19 166.15 411.81 456.43 511.09 553.59 166.14 415.25 464.26 524.09 573.59 530.52 166.10 164.43 5225 00 164.43 5225 00 164.43 5225 00 164.64 446.45 550.67 619.16 644.28 104.64 455.45 550.94 650.99 770.05	WFORR STFFR TFFR WAA WAA WFFA STFFR TFI WAA WAA WFT STFR TFI WAA WAA WAA WAA WAA WAA WAA WAA WAA WA	655.00 3800 01 376.04 488.29 468.47 712.24 753.23 875.75 835.86 835.86 835.86 849.59 655.00 655.00 655.00 655.00 655.00 655.00 511.88 499.56 745.98 803.81 376.02 511.88 803.81 875.64 893.24 519.66 773.04 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 822.31 825.64 825.64 822.31 825.64 825.64 822.31 825.64 825.64 825.65 835.64 835.64 835.65 835.6	$\begin{array}{l} WAX \\ WAO & L \\ TMR \\ TMR \\ TMR \\ TF7 \\ PA \\ VAY \\ WAY \\ WAY \\ WAY \\ WAY \\ WAY \\ WAY \\ TMP \\ TF7 \\ PA \\ \mathsf$	836.33 553F-02 376.05 376.05 378.02 621.39 167.70 167.70 167.70 167.70 164.96 644.70 168.50 167.65 167.17 166.69 836.33 878.11 804F-02 376.03 398.13 654.22 165.90 165.68 165.43 165.43 165.43 165.43 165.43 165.43 165.90 165.62 165.62 165.62 165.62 165.62	$ \begin{array}{l} G & 0.1989F & 04 \\ N & 0.6918F & 03 \\ N & 0.6918F & 03 \\ V & 0.1441F-01 \\ V & 0.1687F-01 \\ V & 0.1687F-01 \\ V & 0.2099E-01 \\ V & 0.2166F-01 \\ V & 0.2166F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.2156F-01 \\ V & 0.225F-01 \\ G & 0.1983E & 04 \\ G & 0.1508F & 04 \\ N & 0.1603F & 04 \\ N & 0.1603F & 04 \\ N & 0.163F-01 \\ V & 0.254F-01 \\ V & 0.2254F-01 \\ V & 0.263F-01 \\ V & 0.253F-01 \\ N & 0.1216F-01 \\ V & 0.2514F-01 \\ N & 0.1216F-01 \\ V & 0.2514F-01 \\ N & 0.1216F-01 \\ V & 0.2514F-01 \\ N & 0.1216F-01 \\ V & 0.263F-01 \\ \end{array} $

STEADY STATE FEEDBACK= \$ -0.43643280F 02

X 0.30405 00 1 0.44195-03 P 0	1485F 04	F 0.1014E 0	5 T-0.	7713E 01	PFY	165.63	PAX	163.70	WEX	655.00	WAX	901.45	G 0.1199F 04
FEEDBACK K 0.4602F 01 0-0	1513F 01	H 0.1618F 0	0 R 0.(כ	F-0./	059E 00	-C 0.5	37P 00	2 11.0	0002F. UI	- U • 1	0126-01	
TFB 366.15 TA	3 366.19	WEB 655.0	O WAB	655.12	PEB	165.49		165.46	TFB	375.99	TMB		N 0.1281E 04
TRB=2 TER 366+23 TA		WEB 655.0		770.87	PEB	165.62	PAR	165.46	TFR	512.05	TMB	398.30	N 0.4033E 03
TZ 386.75 P		WZ 685.5					PA2	163.71	TF1	499.21	TF2	466 00	N 0.8172F 03
1P=1 TF1 386.37 TA		TA2 678.1		164.82	PA1 TM	164.71 393.31	TA	470.24	WA	765.53	PA		V 0.1790E-01
TY= 1 TFO 1371.21 TF		TC1 567+8		543.30	14	416.12	TA	582.52	WA	843.00	PA	164.42	V 0.2230F-01
IX= 2 TEO 2068.90 TF		TC1 734.6		696.89 800.66	ŤM	410.12	TA	693.43	WA	911.00	PA	164.74	V 0.2629E-01
IX= 3 TFO 2362.24 TF		TC1 841.3 TC1 848.5		816.14	TM	493.71	ΤĂ	749.67	WA	945.07	₽A		V 0.2809E-01
	V 1191.37 V 946.08	TC1 752.9		737.77	TM	526.38	ŤĂ	725-35	WA	930.37	PA	163.89	V 0.2737F-01
IX= 5 TFN 1514.03 TF 1P=2 TF1 386.53 TA		TA2 716.5		165.07	PAI	164.94	PAZ	163.71	TFI	519.23	TF2		N 0.8856F 03
IX= 1 TEO 1532.16 TE		TC1 594.5		565.69	TM	394.84	TA	482.05	WA	774.50	PA	164.79	V 0.1839E-01
	1202.65	TC1 784.6		740.36	TM	419.10	TA	610.73	WA	860.59	P-A	164.59	V 0.2329F-01
	1374.96	TC1 903.9		856.27	TM	457.70	TA	735.70	HA	936.57	PA		V 0.2761F-01
	1308.75	TC1 909.0		871.23	TM	501.76	TΑ	798.58	W۸	974.68	P۸		V 0.2960E-01
	1021.98	TC1 797.9		780.53	TM	536.28	TA	769.11	WA	956.85	PΔ		V 0.2872E-01
		NC= 40		0.0	PFX	165.63	PAX	163.69	MEX	655.00	WAX		G 0.1196F 04
X 0.3615F 00 J 0.8839F-03 P 0	3823E 03	F 0.1018E 0	5 T-0.	1998E 02	PEX	163.57	PAX	167.56	WEX.	655-00	WAX		G 0.8368E 03
FEEDRACK K 0.5771F 01 0-0		H 0.1568# #						197F 00		372F 01	TMB	375 00	N 0.8987F 03
IRB=1 TFB 364.80 TA		WFB 655.0		655.18	PFB	163.50	PAB	163.48	TEB	375.97	TMB	208 45	N 0.2773E 03
189=2 TER 364.85 TA		WEB 655.0		790.16	b E b	163.56	PAB	163.48	TER	511.28	, i me	370+03	N V.21 V. V.J
TZ 389.15 P		WZ 690.0			PAI	163.10	PAZ	162.58	TF1	497.37	TE2	657.72	N 0.5702F 03
TR=1 TF1 389.00 TA		TA2 699.9		163.16	PA1 74	394.17	TA	495.76	· WA	785.20	PA		V 0.1920E-01
IX≠ 1 T=0 1366.51 T=		TC1 595.6		575.89	TM	418.15	ТА	637.22	WA	877.12	PΔ		V 0.7449F-01
	1072.43	Tr1 788.1		757.98 876.57	TM	418.17	TA	767.15	WA	955.80	PA		V 0.2886F-01
	1225.20	TC1 908.4		876.57	ти:	455.19	TA	825.86	WA.	991.33	PA		V 0.3072E-01
	1178.15	TC1 913.5 TC1 801.0		790.73	TM	530.35	TA	783.19	WΔ	965.53	PA		V 0.2940E-01
TX= 5 TEN 1509-33 TE		TC1 801.0 TA2 742.9		163.29	PA1	163.22	PAZ	162.58	TEI	517.05	TF2		N 0.6148F 03
IP-2 TE1 389.08 TA IX= 1 TE0 1526.69 TE		TC1 626.6		603.37	TY	395.86	TA	511.38	WA	796.27	PA	163.14	V 0.1982E-01
IX= 2 TFO 2331.59 TF	1178.66	TC1 846.2		810.86	TM	421.58	TA	673.58	W۸	899.15	PA	163.04	V 0.2578F-01
	1351.64	TC1 981.4		943.90	T M	462.01	T۵	820.42	WA	988.02	. PA		V 0.3052F-01
	1 1293.19	TC1 984.4		955.54	ŢЧ	507.25	TA	886.19	W۸	1027.83	P٨		V 0.3260E-01
	1019.46	TC1 854.5		842.75	ΤM	541.32	TA	836.09	WA	997.53	P۵		V 0.3105F-01
		NC= 50	o CL=	0.0	PFX	163.57	PAX	162.55	WFX	655.00	WAX		G 0.8314F 03
X 0.94225 00 I 0.70715-02 9 0	24145 03	F 0.1034F 0	5 T-0.	2416= 02	PEX	153.83	PAX	152.77	WEX	655.00	WAX		G 0.7854F 03
FEEDBACK K 0.9022E 01 0-0	1264F 01	H 0.1303E 0						3455 00		011F 02		259E 00	
IRB=1 TFB 357.90 TA		WEB 655.0		655.72	PFB	153.76	PAB	153.74	TFR	375.78	TMB		N 0.8530E 03
IRR=2 TER 357.95 TA	3 569.31	₩FB 655.0	O WAB	836.91	PER	153.82	PAB	153.74	1-B	506.55	тмв	406.17	N 0.2518F 03
TZ 392.62 P		. WZ 701.1	9									(05 F)	
1P=1 TF1 392.37 TA	420.47	WZ 701.1 TA2 838.5	9 4 ¤⊏1	153.42	PAI	153.37	PA2	152.76	TFI	481.68	TF2		N 0.5351F 03
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TF	420.47	WZ 701.1 TA2 838.5 TC1 688.4	9 4 PF1 3 TC2	673.86	TM	405.13	TA	567.56	V:A	835.91	PA	153,29	N 0.5351F 03 V 0.2351F-01
19=1 TF1 392.37 TA IX=1 TF0 1295.42 TF TX= 2 TF0 1942.08 TF	420.47 780.65 1115.94	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8	9 4 PF1 3 TC2 8 TC2	673.86 958.10	TM TM	405.13 445.82	TA TA	567.56	WA WA	835.91 978.83	PA PA	153.29 153.19	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01
IP=1 TF1 392.37 TA IX= 1 TF0 1295.42 TF IX= 2 TF0 1942.08 TF IX= 3 TF0 2716.97 TF	420.47 780.65 1115.94 1304.95	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6	9 4 PF1 3 TC2 8 TC2 6 TC2	673.86 958.10 1144.29	ТМ ТМ ТМ	405.13 445.82 505.47	ΤΑ ΤΑ ΤΑ	567.56 803.46 1015.23	WA WA	835.91 978.83 1106.34	PA	153,29 153,19 153,08	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01
10-1 TF1 392.37 TA IX= 1 TF0 1295.42 TF IX= 2 TF0 1942.08 TF IX= 3 TF0 2716.07 TF IX= 3 TF0 2716.07 TF	420.47 780.65 1115.94 1304.95 1289.21	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8	9 4 PF1 3 TC2 8 TC2 6 TC2 1 TC2	673.86 958.10 1144.29 1179.23	ТМ ТМ ТМ ТМ	405.13 445.82 505.47 560.82	ΤΑ ΤΑ ΤΑ ΤΑ	567.56 803.46 1015.23 1112.07	WA WA WA	835.91 978.83 1106.34 1164.66	РА РА РА	153.29 153.19 153.08 152.96	M 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01
IN-1 TF1 392.37 TA IX=1 TF0 1295.42 TF IX=2 TF0 1942.08 TF IX=3 TF0 2216.97 TF IX=4 TF0 2032.18 TF IX=5 TF0 1440.23 TF	420.47 780.65 1115.94 1304.95 1289.21 1068.06	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1045.1	9 4 PF1 3 TC2 8 TC2 6 TC2 1 TC2 3 TC2	673.86 958.10 1144.29 1179.73 1045.08	ТМ ТМ ТМ ТМ ТМ	405.13 445.82 505.47 560.82 587.35	ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ	567.56 803.46 1015.23 1112.07 1044.68	V:A WA WA WA	835.91 978.83 1106.34 1164.66 1124.09	РА РА РА РА	153,29 153,19 153,08 152,96 152,85	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01 V 0.4009E-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1242.08 TE IX=3 TF0 2216.07 IF IX=4 TF0 202.18 TE IX=5 TF0 1440.23 TE IX=2 TF1 392.46 TA	420.47 780.65 1115.94 1304.95 1289.21 1068.06 424.53	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1164.6 TC1 1191.8 TC1 1045.1 TA2 909.0	9 4 PF1 3 TC2 8 TC2 6 TC2 1 TC2 3 TC2 9 PF1	673.86 958.10 1144.29 1179.23 1045.08 153.56	ΤΜ ΤΜ ΤΜ ΤΜ ΤΜ ΡΔ1	405.13 445.82 505.47 560.82 587.35 153.49	ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΡΑ2	567.56 803.46 1015.23 1112.07 1044.68 152.76	VA WA WA WA TF1	835.91 978.83 1106.34 1164.66 1124.09 498.24	ΡΑ ΡΔ ΡΑ ΡΑ	153,29 153,19 153,08 152,96 152,85 732,48	M 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01 V 0.4209E-01 N 0.5677F 03
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE TX=2 TF0 1942.08 TE IX=3 TF0 2216.07 TE IX=4 TF0 2032.18 TE TX=5 TF0 1440.23 TE IQ=2 TF1 392.46 TA IX=1 TF0 1443.79 TE	420.47 780.65 N 1115.94 N 1304.95 H 1289.21 N 1068.06 L 424.53 N 841.27	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1045.1 TA2 909.0 TC1 732.7	9 4 PE1 3 TC2 8 TC2 6 TC2 1 TC2 3 TC2 9 PE1 4 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57	ТМ ТМ ТМ ТМ ТМ	405.13 445.82 505.47 560.82 587.35 153.49 408.84	ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64	WA WA WA WA TF1 WA	835.91 978.83 1106.34 1164.66 1124.09	ΡΑ ΡΑ ΡΑ ΡΑ ΡΑ	153-29 153-19 153-08 152-96 152-85 732-48 153-41 153-29	N 0.5351F 03 V 0.2351F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4209E-01 N 0.5677F 03 V 0.2445F-01 V 0.3379E-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1242.08 TE IX=3 TF0 2216.97 IF IX=4 TF0 2032.18 TE IX=5 TF0 1440.23 TE IV=2 TF1 392.46 TA IX=5 TF0 1440.23 TE IV=1 TF0 1443.79 TE IX=1 TF0 1432.79 TE IX=2 TF0 2192.93 TE	420.47 780.65 N 1115.94 N 1304.95 H 1289.21 N 1068.06 L 424.53 N 841.27 H 1225.39	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1063.3	9 4 PE1 3 TC2 8 TC2 6 TC2 1 TC2 3 TC2 9 PE1 4 TC2 8 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70	ТМ ТМ ТМ ТМ ТМ РА1 ТМ	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22	ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΡΑ2 ΤΑ ΤΑ	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83	WA WA WA TF1 WA	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53	ΡΑ ΡΔ ΡΑ ΡΑ ΡΑ ΤF2 ΡΑ	153-29 153-19 153-08 152-96 152-85 732-48 153-41 153-29	N 0.5351F 03 V 0.2351F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4009E-01 N 0.5677F 03 V 0.2445F-01 V 0.3379E-01
In=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1295.42 TE IX=3 TF0 2216.97 TF IX=3 TF0 2216.97 TF IX=3 TF0 2216.97 TF IX=5 TF0 1440.23 TF IV=2 TF1 392.46 TA IV=1 TF0 1443.79 TF IX=2 TF0 1443.79 TF IX=2 TF0 2508.14 TF	420.47 780.65 N 1115.94 N 1304.95 H 1289.21 N 1068.06 L 424.53 N 841.27 H 1225.39 N 1439.20	WZ 701.1 TA2 838.5 TC1 668.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5	9 4 PE1 3 TC2 8 TC2 8 TC2 1 TC2 3 TC2 9 PE1 4 TC2 8 TC2 7 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15	TM TM TM TM TM PA1 TM TM	405.13 445.82 505.47 560.82 587.35 153.49 408.84	ТА ТА ТА ТА ТА РА2 ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64	WA WA WA TF1 WA WA	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16	РА РА РА РА РА ТЕ2 РА РА	153-29 153-19 153-08 152-96 152-85 732-48 153-41 153-29 153-14 153-00	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01 V 0.4009E-01 N 0.6677E 03 V 0.2445F-01 V 0.4186F-01 V 0.465E-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 TF0 2716.07 TF IX=4 TF0 2032.18 TE IX=5 TF0 1440.23 TE IX=1 TF0 1440.79 TE IX=1 TF0 1443.79 TE IX=2 TF0 212.03 TE IX=3 TF0 2508.14 TE IX=3 TF0 2508.14 TE IX=4 TF0 2288.61 TE	420.47 780.65 1115.94 1304.95 1289.21 1068.06 424.53 841.27 1225.39 1425.39 1429.20 1419.96	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1045.1 TC1 1045.2 TC1 1043.3 TC1 1043.3 TC1 1043.4 TC1 122.7 TC1 1243.4 TC1 1243.4	9 4 PE1 3 TC2 8 TC2 8 TC2 1 TC2 3 TC2 9 PE1 4 TC2 8 TC2 7 TC2 0 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48	TM TM TM TM TM PA1 TB TM TM	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46	ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32	WA WA WA TF1 WA WA WA	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32	РА РА РА РА РА ТF2 РА РА РА	153.29 153.19 153.08 152.96 152.85 732.48 153.41 153.29 153.14 153.00 152.87	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.421F-01 V 0.421F-01 V 0.421F-01 V 0.4409E-01 N 0.6677E 03 V 0.2445F-01 V 0.4186F-01 V 0.4565F-01 V 0.4565F-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 TF0 2716.07 TF IX=4 TF0 2032.18 TE IX=5 TF0 1440.23 TE IX=1 TF0 1440.79 TE IX=1 TF0 1443.79 TE IX=2 TF0 212.03 TE IX=3 TF0 2508.14 TE IX=3 TF0 2508.14 TE IX=4 TF0 2288.61 TE	420.47 780.65 N 1115.94 N 1304.95 H 1289.21 N 1068.06 L 424.53 N 841.27 H 1225.39 N 1439.20	WZ 701.1 TA2 838.5 TC1 668.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5	9 4 PE1 3 TC2 8 TC2 8 TC2 1 TC2 3 TC2 9 PF1 4 TC2 9 PF1 4 TC2 8 TC2 7 TC2 7 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15	TM TM TM TM TM PA1 TM TM TM	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46 585.40	ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53	44 44 44 45 45 45 45 45 45 45 45 45 45 4	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00	РА РА РА РА РА ТF2 РА РА РА РА	153,29 153,19 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,00 152,87 997,60	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4209F-01 V 0.2445F-01 V 0.4186F-01 V 0.4186F-01 V 0.4565F-01 V 0.4320F-01 G 0.7897F 03
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 IF0.2716.97 JF IX=4 TF0.2716.97 JF IX=5 TF0.1440.23 TE IX=5 TF0.1440.23 TE IX=1 TF0.1440.23 TE IX=2 TF1.392.46 TA IX=1 TF0.1443.79 TE IX=2 TF0.2508.14 TE IX=3 TF0.2508.14 TE IX=4 TF0.2508.14 TE IX=4 TF0.2508.14 TE IX=5 TF0.1597.28 TE IX=5 TF0.1597.28 TE X 0.1649F 0.1 0.7071F-02 0	L 420.47 4 780.65 1304.95 4 1289.21 1068.06 1 424.53 9 841.27 4 1225.39 1439.20 1439.20 1419.96 1166.11 .1774F 03	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 1139.8 NC= 6 0.049F 0	9 4 9 4 9 1 1 1 1 1 1 1 1 1 1 1 1 1	673.86 958.10 1144.29 1179.73 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02	TM TM TM TM TM TM TM TM TM TM TM	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46 585.40 612.76 153.83 145.96	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.64	₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α ₩Α	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00	РА РА РА РА РА ТF2 РА РА РА РА ЧАХ Х	153,29 153,19 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,00 152,87 997,60 1065,22	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.421F-01 V 0.421F-01 V 0.421F-01 V 0.4409E-01 N 0.6677E 03 V 0.2445F-01 V 0.4186F-01 V 0.4565F-01 V 0.4565F-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 TF0 2716.07 TF IX=4 TF0 2032.18 TE IX=5 TF0 1440.23 TE IX=1 TF0 1440.79 TE IX=1 TF0 1443.79 TE IX=2 TF0 212.03 TE IX=3 TF0 2508.14 TE IX=3 TF0 2508.14 TE IX=4 TF0 2288.61 TE	L 420.47 4 780.65 1304.95 4 1289.21 1068.06 1 424.53 9 841.27 4 1225.39 1439.20 1439.20 1419.96 1166.11 .1774F 03	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1144.6 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 1139.8 NC= 60	9 4 5 5 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0	TM TM TM TM TM TM TM TM TM TM TM TM TM T	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46 585.40 612.76 153.83 145.96 641F 00	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА С 0.6	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 158.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00	WA WA WA WA WA WA WA WA WA WA WA WA WA W	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 655.00 950F 01	РА РА РА РА РА ТF2 РА РА РА РА ЧАХ МАХ М-0-2	153.29 153.19 153.08 152.96 152.85 732.48 153.41 153.29 153.14 153.00 152.87 997.60 1065.22 1810F 00	N 0.6351F 03 V 0.2351F-01 V 0.3905F-01 V 0.421F-01 V 0.421F-01 V 0.4231F-01 V 0.4405F-01 V 0.4245F-01 V 0.4186F-01 V 0.4186F-01 V 0.4551F-01 G 0.7897F 03 G 0.1136F 04
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1295.42 TE IX=3 TF0 2216.07 TF IX=3 TF0 2216.07 TF IX=5 TF0 1440.23 TF IX=5 TF0 1440.23 TF IX=2 TF0 1440.23 TF IX=2 TF0 1440.23 TF IX=2 TF0 1492.93 TF IX=2 TF0 1492.93 TF IX=3 TF0 2288.61 TF IX=4 TF0 2288.61 TF IX=5 TF0 1597.28 TF X 0.1649F 01 0.7071F-02 0 FFF0ARCK K 0.8905F 10 -0 IP=1 TFR 351.86 TA TF	L 420.47 4 780.65 N 1115.94 1 1289.21 1 1068.06 4 424.53 8 841.27 1 1225.39 N 1419.96 N 1419.96 N 1419.96 N 1166.11 .1774F 03 .1062F 01	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 1139.8 NC= 6 0.049F 0	9 4 5 5 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0	TM TM TM TM TM TM TM TM TM TM TM TM TM T	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46 585.40 612.76 153.83 145.96 641F.00 145.82	ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ ΤΑ	567.56 803.46 1015.23 1112.07 1044.68 152.64 858.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00 145.78	WA WA WA WA WA WA WA WA WA WA WA WA WA W	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 655.00 6950F 01 375.45	РА РА РА РА РА РА РА РА РА ЧАХ МАХ М-0-2 ТМВ	153,29 153,19 153,08 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,00 152,87 997,60 1065,22 810F,00 375,78	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4035F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4245F-01 V 0.2445F-01 V 0.4365F-01 V 0.4565E-01 V 0.4565E-01 V 0.4565E-01 O 0.7897F 03 G 0.1136F 04 N 0.1228F 04
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1295.42 TE IX=3 TF0 2216.07 TF IX=3 TF0 2216.07 TF IX=5 TF0 1440.23 TF IX=5 TF0 1440.23 TF IX=2 TF0 1440.23 TF IX=2 TF0 1440.23 TF IX=2 TF0 1492.93 TF IX=2 TF0 1492.93 TF IX=3 TF0 2288.61 TF IX=4 TF0 2288.61 TF IX=5 TF0 1597.28 TF X 0.1649F 01 0.7071F-02 0 FFF0ARCK K 0.8905F 10 -0 IP=1 TFR 351.86 TA TF	L 420.47 4 780.65 1304.95 4 1289.21 1068.06 1 424.53 9 841.27 1 1225.39 1 1439.20 9 1419.96 1 1419.96 1 166.11 1062F 01 3 352.26	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.8 TC1 1104.8 TC1 104.8 TC1 104.8 TC1 104.8 TC1 104.8 TC1 127.5 TC1 1304.6 TC1 139.8 NC= 60 WF8 655.0 WF8 655.0	9 4 5 5 6 5 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0	TM TM TM TM TM TM TM TM TM TM TM TM TM T	405.13 445.82 505.47 560.82 587.35 153.49 408.84 455.22 523.46 585.40 612.76 153.83 145.96 641F 00	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА С 0.6	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 158.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00	WA WA WA WA WA WA WA WA WA WA WA WA WA W	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 655.00 950F 01	РА РА РА РА РА ТF2 РА РА РА РА ЧАХ МАХ М-0-2	153,29 153,19 153,08 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,00 152,87 997,60 1065,22 810F,00 375,78	N 0.6351F 03 V 0.2351F-01 V 0.3905F-01 V 0.421F-01 V 0.421F-01 V 0.4231F-01 V 0.4405F-01 V 0.4245F-01 V 0.4186F-01 V 0.4186F-01 V 0.4551F-01 G 0.7897F 03 G 0.1136F 04
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IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 IF0.2716.97 IF IX=4 TF0.2716.97 IF IX=5 TF0.1440.23 TE IX=2 TF1.392.46 TA IX=1 TF0.1440.23 TE IX=2 TF1.392.46 TA IX=3 TF0.2808.14 TE IX=4 TF0.2808.14 TE IX=3 TF0.2808.14 TE IX=4 TF0.2808.14 TE IX=3 TF0.2808.14 TE IX=4 TF0.2808.14 TE IX=5 TF0.1597.28 TE IX=4 TF0.2808.14 TA IP=1 TFR.351.86 TA IP=2 TFR.351.86 TA IP=1 TFR.351.86 TA IP=1 TF1.383.25 TA IX=1 TF0.119.42 TE	420.47 4780.65 1115.94 N 1105.94 N 1304.95 424.53 N 1225.39 N 1439.20 N 1439.20 N 166.11 .1774F 03 .1062F 01 3 552.26 2 145.78 4 40.71 7 70.6.84	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.8 TC1 1104.8 TC1 1045.1 TA2 9090 TC1 732.7 TC1 1043.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 WF8 655.0 WF8 655.0 WZ 697.3 TA2 946.4 TC1 612.8	9 4 5 5 6 1 7 6 1 7 2 6 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 1 7 2 2 3 7 7 2 2 7 7 7 7 7 7 7 7 7 7 7 7 7	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 655.72 819.64 145.09 597.29	TM TM TM TM TM TM TM TM TM TM TM TF S S S S S S S S S S S S S S S S S S	405.13 445.82 505.47 560.82 587.35 173.49 408.84 455.22 523.46 523.46 523.46 612.76 173.83 145.96 641F 00 145.85 144.97 144.97	ΤΑ	567.56 873.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00 145.78 143.64 145.78 143.63 143.64	WA WA WA TF1 WA WA WA WA WA WA TFB TFB TFB TFB	835,91 978,83 1106,34 1106,34 1164,66 1124,09 498,24 851,53 1012,16 1157,57 1225,14 1180,32 655,00 655,00 655,00 655,00 1376,45 5500,12	РА РА РА РА РА РА РА РА РА РА ВА ЧАХ М-0-2 ТМВ ТМВ ТМВ ТМВ	153,29 153,19 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,00 105,22 810F 00 375,78 412,96 765,22 144,83	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4251F-01 V 0.4186F-01 V 0.4255F-01 V 0.4265F-01 V 0.4320F-01 G 0.1136F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740F 03 V 0.2257F-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1295.42 TE IX=3 TF0 216.07 TF IX=3 TF0 2032.18 TE IX=5 TF0 1440.23 TE IX=1 TF0 1443.79 TE IX=2 TF1 392.46 TA IX=3 TF0 2032.18 TE IX=2 TF0 1440.23 TE IX=1 TF0 1443.79 TE IX=3 TF0 2084.61 TE IX=3 TF0 2508.14 TE IX=5 TF0 1597.28 TF IX=4 TF0 2159.28 TE X 0.1649F 01 10.7071F-02 0 FFF=016 TFR 351.86 TA IP=1 TFR 351.86 TA IP=2 TFR 351.70 TA IP=1 TF1 383.76 P IX=1 <t< td=""><td>4 420.47 4 780.65 5 1115.94 1304.95 1289.21 4 1304.95 4 1304.95 4 1289.21 4 1225.39 1439.20 1439.20 1419.96 1166.11 .1774F 03 .1062F 13 .263 539.26 .2145.78 401.71 4 706.84 4 704.265</td><td>WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1045.1 TA2 909.0 TC1 1141.8 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1043.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 TC1 1139.8 NC= 60.1049F 0 WF8 655.0 WF8 655.0 WF8 655.0 TA2 946.4 TC1 612.8 RC1 818.5</td><td>$\begin{array}{cccccccccccccccccccccccccccccccccccc$</td><td>673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 1289.48 1139.81 0.0 2416F 02 0 655.72 819.64 145.09 9597.29 858.05</td><td>ТМ ТТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ</td><td>405.13 445.82 505.47 505.47 505.47 587.35 173.49 408.84 455.22 523.46 515.40 612.76 612.76 612.76 612.76 612.78 145.92 145.92 145.95 145.95 145.95</td><td>TA TA TA TA TA TA TA TA TA TA PAX C 0.6 PAB PAX PAX TA</td><td>567.56 803.46 1015.23 1112.07 1044.68 152.76 4592.64 4592.64 4592.64 1100.32 1212.53 1138.09 152.67 143.63 165.78 143.63 508.48 143.63 508.48 100.72</td><td>WA WA WA TFI WA WA WA WA WFX S S S S S TFB TFB TFB TFB TFA WA</td><td>835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1157.57 1225.14 1157.57 500.12 655.00 9550F 01 37*.45 500.12 463.46 799.69</td><td>РА РА РА РА РА РА РА РА РА РА ЧАХ ЧАС 2 ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ</td><td>153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,21 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,19 15</td><td>N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3907F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4245F-01 V 0.4186F-01 V 0.4186F-01 V 0.4186F-01 V 0.4565E-01 V 0.4320F-01 G 0.71897F 03 G 0.1136F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 V 0.2257F-01 V 0.3066E-01</td></t<>	4 420.47 4 780.65 5 1115.94 1304.95 1289.21 4 1304.95 4 1304.95 4 1289.21 4 1225.39 1439.20 1439.20 1419.96 1166.11 .1774F 03 .1062F 13 .263 539.26 .2145.78 401.71 4 706.84 4 704.265	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1045.1 TA2 909.0 TC1 1141.8 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1043.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 TC1 1139.8 NC= 60.1049F 0 WF8 655.0 WF8 655.0 WF8 655.0 TA2 946.4 TC1 612.8 RC1 818.5	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 1289.48 1139.81 0.0 2416F 02 0 655.72 819.64 145.09 9597.29 858.05	ТМ ТТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТМ	405.13 445.82 505.47 505.47 505.47 587.35 173.49 408.84 455.22 523.46 515.40 612.76 612.76 612.76 612.76 612.78 145.92 145.92 145.95 145.95 145.95	TA TA TA TA TA TA TA TA TA TA PAX C 0.6 PAB PAX PAX TA	567.56 803.46 1015.23 1112.07 1044.68 152.76 4592.64 4592.64 4592.64 1100.32 1212.53 1138.09 152.67 143.63 165.78 143.63 508.48 143.63 508.48 100.72	WA WA WA TFI WA WA WA WA WFX S S S S S TFB TFB TFB TFB TFA WA	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1157.57 1225.14 1157.57 500.12 655.00 9550F 01 37*.45 500.12 463.46 799.69	РА РА РА РА РА РА РА РА РА РА ЧАХ ЧАС 2 ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ	153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,21 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,19 15	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3907F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4245F-01 V 0.4186F-01 V 0.4186F-01 V 0.4186F-01 V 0.4565E-01 V 0.4320F-01 G 0.71897F 03 G 0.1136F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 V 0.2257F-01 V 0.3066E-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TF IX=2 TF0 1942.08 TF IX=3 IF0.2716.97 FF IX=4 IF0.2716.97 FF IX=5 TF0.1440.23 TF IX=5 TF0.1440.23 TF IX=2 TF0.1440.23 TF IX=2 TF0.1440.79 TF IX=2 TF0.2508.14 TF IX=4 TF0.2508.14 TF IX=3 TF0.2508.14 TF IX=4 TF0.2508.14 TF IX=3 TF0.2508.14 TF IX=4 TF0.2508.14 TF IX=5 TF0.1597.28 TF IX=5 TF0.1597.28 TF IP=1 TFR 351.80 TA IP=2 TFR 351.80 TA IP=1 TF1.383.25 TA IX=1 TF0.191.42 TF IX=1 TF0.191.42 TF IX=2 TF0.1172.44 TF IX=3 TF0.2026.87 <	420.47 4780.65 4780.65 1115.94 1304.95 1289.21 1068.06 424.53 841.27 11225.39 11225.39 11225.39 1166.11 .1062F01 .1062F01 .1062F01 .1166.11 .11774F03 .128.73	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1191.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 F 0.1049F 0 H 0.1071F 0 WF8 655.0 WF8 655.0 WF8 655.0 WF8 655.1 C1 612.8 TC1 612.8 TC1 612.8 TC1 1083.9	9 4 5 5 5 5 5 5 5 5 5 5 5 5 5	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 655.72 819.64 145.09 597.29 858.05 1059.75	ТМ ТТМ ТА1 ТМ ТМ ТМ ТМ ТМ ТМ ТМ ТР РЕВ РЕВ РА1 ТМ ТМ ТМ	405.13 445.82 505.47 550.47 550.82 587.35 113.49 408.84 455.22 523.46 523.46 523.46 523.46 523.46 513.83 145.96 641F 00 145.82 145.95 144.97 416.90 480.62 572.65	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 157.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.63 508.48 710.72 919.60	WA WA WA WA WA WA WA WA VA VA WA WA	835,91 978,83 1106,34 1106,34 1104,66 1124,09 498,24 851,53 1012,16 1157,57 1225,14 1180,32 655,00 655,07 0505 01 375,45 500,12 463,46 799,66 9924,19 1049,46	РА РА РА РА РА РА РА РА РА МАХ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТА РА	153,29 153,19 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,29 153,14 153,00 1065,22 1810F 00 375,78 412,96 765,22 144,83 144,38	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4035F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4245F-01 V 0.2445F-01 V 0.4456F-01 V 0.4565E-01 V 0.4565E-01 V 0.4565E-01 V 0.4520F-01 G 0.7187F 03 G 0.1136F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3066E-01 V 0.3060E-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TE IX=2 TF0 1942.08 TE IX=3 IF0.2716.97 IF IX=4 IF0.2032.18 TE IX=5 TF0.1440.23 TE IX=2 TF1.392.46 TA IX=1 IF0.1440.23 TE IX=2 TF1.392.46 TA IX=3 IF0.2508.14 TE IX=4 IF0.2508.14 TE IX=3 IF0.2508.14 TE IX=4 IF0.2508.14 TE IX=3 IF0.2508.14 TE IX=3 IF0.2508.14 TE IX=4 TF0.2508.14 TE IX=4 TF0.2508.14 TE IX=5 TF0.1507.28 TE IX=4 TF0.2508.14 TE IX=4 TF0.2508.14 TE IX=4 TF0.2508.16 TE IX=4 TF0.2508.16 TE IX=4 TF0.2508.16 TE IP=1 TFR 351.86	420.47 4780.65 115.94 1304.95 1289.21 1062.06 424.53 1125.39 1125.39 11419.96 141.27 13352.26 1662F 1352.26 141.9.96 13352.26 144.119.96 141.27 13352.26 145.78 140.11 1022.65 1228.78 1228.71 1228.73	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.8 TC1 1104.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1043.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 WFB 655.0 WFB 655.0 WZ 697.3 TA2 946.4 TC1 881.5 TC1 1083.9 TC1 1166.3	9 4 5 5 5 9 9 9 1 1 1 1 1 1 1 1 1 1 1 1 1	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 655.72 819.64 145.09 597.29 858.05 1059.75	ТМ ТТМ ТТМ ТА1 ТТМ ТТМ ТТМ ТТМ ТТМ С-0.4 9FB 9FB 0A1 ТТМ ТТМ ТТМ	405.13 445.82 505.47 505.47 505.47 587.35 87.35 87.35 408.84 445.22 523.46 585.40 612.76 145.82 145.92 145.95 144.97 416.90 480.62 572.65 654.30	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 597.64 858.83 1100.32 1212.53 1138.09 152.67 133.64 1551F 00 145.78 143.64 555F.00 145.78 143.64 556.87 10.72 919.60 1060.93	WA WA WA WA WA WA WA WA WA WA WA WA WA	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 9505 01 376.45 500.12 463.46 799.66 924.19 1049.46 1134.19	РА РА РА РА РА РА РА РА РА РА ЧАХ ЧАС РА ТМА ТБА РА РА РА РА РА РА РА РА РА РА РА РА РА	153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,41 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 152,87 997,60 375,78 412,96 745,22 144,63 144,63 144,63	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.395F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.425F-01 V 0.4186F-01 V 0.4186F-01 V 0.4565E-01 V 0.4565E-01 V 0.4565E-01 V 0.4565E-01 V 0.4565E-01 N 0.1228F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 V 0.2257F-01 V 0.3066E-01 V 0.3810F-01 V 0.3810F-01 V 0.417F-01
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	L 420.47 4 780.65 1304.95 4 1289.21 4 1289.21 4 224.53 8 441.27 1225.39 1439.20 1432.78 1439.20 1432.78 1439.20 1432.78 1432.26 1422.57 1228.73 1228.73 1228.73 1228.25 1228.25 1228	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 114.6 TC1 114.6 TC1 114.7 TC1 114.7 TC1 104.5 TC1 114.7 TC1 104.7 TC1 104.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.0 TA2 946.4 TC1 612.8 TC1 1168.9 TC1 1166.1	9 4 $TC2$ 8 $TC2$ 8 $TC2$ 8 $TC2$ 9 $PE12$ 9 $PE1$	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.48 1139.48 1655.72 819.64 145.09 597.29 858.05 1059.75 1149.22	ТМ ТТМ ТА1 ТА1 ТТМ ТТМ ТТМ ТТМ ОСЕВ ОСЕВ ОСЕВ ОСЕВ ОСЕВ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТ	405.13 445.82 505.47 505.47 505.47 53.46 587.35 1153.49 408.84 455.22 523.46 523.46 515.40 612.76 612.76 641F 00 145.82 145.95 144.97 416.90 480.62 572.65 654.30 686.97	ΤΑ ΤΑ <td>567.56 873.46 1015.23 1112.07 1044.68 152.76 8152.76 8152.76 8152.76 1100.32 1212.53 1100.32 122.53 1100.32 122.53 1138.69 152.67 143.63 508.48 710.72 919.60 1078.58</td> <td>WA WA WA WA WA WA WA WA WA WA WA WA WA W</td> <td>835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1157.57 1225.14 1157.57 507.12 463.46 799.66 924.19 1049.46 1134.19</td> <td>РА РА РА РА РА РА РА РА РА РА ЧАХ РА ТМЯ ТГРА РА РА РА РА РА РА РА РА РА РА РА РА Р</td> <td>153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,87 997,60 1055,22 997,60 1055,22 997,67 8412,96 765,22 144,83 144,83 144,38</td> <td>N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.397F-01 V 0.4035F-01 V 0.4035F-01 V 0.4037F-01 V 0.2445F-01 V 0.2445F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 N 0.1228F 04 N 0.1228F 04 N 0.2257F-01 V 0.3810F-01 V 0.3810F-01 V 0.4387F-01 V 0.4387F-01</td>	567.56 873.46 1015.23 1112.07 1044.68 152.76 8152.76 8152.76 8152.76 1100.32 1212.53 1100.32 122.53 1100.32 122.53 1138.69 152.67 143.63 508.48 710.72 919.60 1078.58	WA WA WA WA WA WA WA WA WA WA WA WA WA W	835.91 978.83 1106.34 1164.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1157.57 1225.14 1157.57 507.12 463.46 799.66 924.19 1049.46 1134.19	РА РА РА РА РА РА РА РА РА РА ЧАХ РА ТМЯ ТГРА РА РА РА РА РА РА РА РА РА РА РА РА Р	153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,87 997,60 1055,22 997,60 1055,22 997,67 8412,96 765,22 144,83 144,83 144,38	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.397F-01 V 0.4035F-01 V 0.4035F-01 V 0.4037F-01 V 0.2445F-01 V 0.2445F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 N 0.1228F 04 N 0.1228F 04 N 0.2257F-01 V 0.3810F-01 V 0.3810F-01 V 0.4387F-01 V 0.4387F-01
IP=1 TF1 392.37 TA IX=1 TF0 1295.42 TF IX=2 TF0 1942.08 TF IX=3 IF0.2716.97 IF IX=4 TF0.2716.97 IF IX=5 TF0.1440.23 TF IX=5 TF0.1440.23 TF IX=2 TF1.392.46 TA IX=1 TF0.1440.79 TF IX=2 TF0.2508.14 TF IX=3 TF0.2508.14 TF IX=4 TF0.2508.14 TF IX=5 TF0.1597.28 TF IX=5 TF0.1597.28 TF IX=5 TF0.1597.28 TF IP=1 TFR 351.67 TA IP=2 TF1.383.76 P IP=1 TF1.383.25 TA IX=1 TF0.1191.42 TF IX=1 TF0.1191.42 TF IX=2 TF0.1372.44 TF IX=4 TF0.1374.45 TF IX=2 TF0.1384.45 TF IX=2 TF0.1384.45 <	420.47 4780.65 115.94 1304.95 1289.21 108.06 424.53 841.25 1225.39 11225.39 1225.39 14125.39 14125.39 14166.11 .1062F01 352.26 1415.78 352.26 145.78 401.71 4706.84 1222.65 1228.73 128.131 403.85	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1164.6 TC1 1164.7 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 WF8 655.0 WF8 655.0 WF8 655.0 WF8 655.0 TA2 946.4 TC1 612.8 TC1 881.5 TC1 183.9 TC1 1166.3 TC1 1166.3	9 4 PE1 3 TC2 8 TC2 8 TC2 8 TC2 9 PE1 9 TC2 9 PE1 4 TC2 8 TC2 9 PE1 4 TC2 8 TC2 7 TC2 8 TC2 7 TC2 8 TC2 7 TC2 8 TC2 7 TC2 8 TC2 7 TC2 8 TC2 8 TC2 7 TC2 8 TC2 1 TC2 1 TC2 8 TC2 1 TC2	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0 655.72 819.64 145.09 597.29 858.05 1059.75 1149.22 1102.45 145.38	ТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ	405.13 445.82 505.47 550.47 550.82 587.35 113.49 408.84 455.22 523.46 523.46 585.40 612.76 113.83 145.96 641F 00 145.82 145.95 144.97 416.90 480.62 572.65 654.30 686.30 145.25	TA TA TA TA TA TA TA TA TA TA TA TA TA T	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.64 5551F 00 145.78 145.78 143.63 508.48 710.72 919.60 106.93 1078.58 143.63 143.63 143.63 1078.58 143.63 1078.58 143.63 1078.58 143.63 143.63 1078.58 143.63 1078.58 143.63 1078.58 143.63 1078.58 143.63 1078.58 143.64 143.64 143.64 145.78 145.7	WA WA WA WA WA WA WA WA WA S TFR TFR WA WA WA TFR TFR TFR TFR TFR TFR TFR TFR TFR TFR	835.91 978.83 1106.34 1105.34 1105.34 1104.66 1124.09 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 655.00 655.00 655.01 376.45 500.12 463.46 799.66 994.19 144.78 476.70	РА РА РА РА РА РА РА РА РА РА ЧАХ ЧАС РА ТМА ТБА РА РА РА РА РА РА РА РА РА РА РА РА РА	153,29 153,08 152,08 152,08 152,85 732,48 153,41 153,29 153,14 153,14 153,24 153,14 153,29 153,14 153,00 1065,22 1810F 00 376,78 412,96 765,22 144,83 144,63 144,38 144,12 143,87 R13,89	N 0.6351F 03 V 0.2351F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.445F-01 V 0.445F-01 V 0.4456F-01 V 0.4565E-01 V 0.420F-01 G 0.7807F 03 G 0.1136F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3066E-01 V 0.3680F-01 V 0.4387F-01 V 0.4387F-01 N 0.8227F 03
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	420.47 4780.65 115.94 1304.95 1289.21 1062.06 424.53 1125.39 1125.39 11439.20 1439.20 1439.20 1439.20 1439.20 1166.11 .1774F 352.26 145.78 401.71 706.84 1022.65 1228.73 1228.73 1228.73 1228.13 128.13 403.85	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1104.7 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1043.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 WF8 655.0 WZ 697.3 TA2 946.4 TC1 1063.3 TC1 106.3 TC1 106.3 TC1 106.4 TC1 106.4	9 9 4 3 1 1 1 1 1 1 1 1 1 1 1 1 1	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 655.72 819.64 145.09 597.29 858.05 1059.75 1149.22 1102.45 145.38 625.90	ТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ	405.13 445.82 505.47 505.47 505.47 587.35 23.49 408.84 455.22 523.46 523.46 523.46 512.76 145.82 145.95 145	ΤΑ	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00 145.78 145.78 145.78 145.78 145.78 145.78 145.78 145.78 508.48 710.72 919.60 1078.58 143.43 524.07	WA WA WA WA WA WA WA WA WA WA WA WA WA W	835.91 978.83 1106.34 498.24 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 376.45 500.12 463.46 799.66 924.19 1049.46 1134.19 1144.78 474.70	РА РА РА РА РА РА РА РА РА РА РА ЧАХХ ТМВ ТМВ ТМВ ТК2 РА РА РА РА РА РА РА РА РА РА РА РА РА	153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,29 153,14 153,29 153,14 153,29 765,22 1810F (00 375,78 412,96 765,22 144,83 144,63 144,63 144,63 144,87 R13,89 145,07	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.3965F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.425F-01 V 0.4456F-01 V 0.4456F-01 V 0.4456F-01 V 0.4565E-01 V 0.4565E-01 G 0.7897F 03 G 0.1136F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 V 0.2257F-01 V 0.3810F-01 V 0.4387F-01 N 0.8227F 03 V 0.2219F-01
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	420.47 4780.65 4780.65 1304.95 41289.21 424.53 841.27 1225.39 1439.20 1439.20 1439.20 1439.20 1439.20 1439.20 1439.20 11625.39 11625.11 10625.11 12352.26 352.26 352.26 353.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 352.26 147.71 470.88 401.71 401.71 403.85 403.85 403.85 403.85 403.85 403.85	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.6 TC1 1191.8 TC1 1191.8 TC1 1045.1 TA2 909.0 TC1 732.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 1139.8 NC= 60 F 0.1049F 0 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.5 TC1 612.8 TC1 1083.9 TC1 1166.3 TC1 106.1 TA2 1027.2 TC1 644.1 TC1 947.2	9 4 PE12 3 TC2 8 TC2 8 TC2 8 TC2 9 PE12 9 PE12	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0 655.72 819.64 145.09 597.29 858.05 1059.75 1149.22 1102.45 145.38 625.90 919.52	ТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ	405.13 445.82 505.47 505.47 505.47 515.47 408.84 455.22 523.46 523.46 523.46 515.40 612.76 612.76 612.76 612.76 612.76 612.76 641F 00 145.82 145.92 144.97 416.90 480.62 572.65 654.30 686.97 145.25 422.40	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 8152.76 8592.64 859.26 1138.09 122.53 1138.09 152.67 143.64 551F 00 145.78 143.63 5054.87 143.63 5054.87 1078.58 143.63 502.47 1078.58 1075.58 1075.5	WAA WAA WAA WAA WAA WAA WAA S TFF T WAA WAA X S TF T WAA WAA X S TF T WAAA WAA X S TF T WAAA WAA X S TF T WAAA WAAA WAAA WAAA WAAA WAAA WAAA	835,91 978,83 1106,34 1106,34 1104,66 1122,04 498,24 498,24 498,24 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 15	РА РА РА РА РА РА РА РА РА РА РА ТРА ТМВ Т ТРА Т РА РА РА РА РА РА РА РА РА РА РА РА РА	153,29 153,08 153,08 152,96 152,85 732,48 153,41 153,29 153,14 153,00 1055,22 997,60 1055,22 997,60 1055,22 144,83 142,96 765,22 144,83 144,38 144,38 144,12 143,87 R13,89 145,07 144,84	N 0.6351F 03 V 0.2351F-01 V 0.3905F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.445F-01 V 0.445F-01 V 0.4456F-01 V 0.4565E-01 V 0.420F-01 G 0.7807F 03 G 0.1136F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3066E-01 V 0.3680F-01 V 0.4387F-01 V 0.4387F-01 N 0.8227F 03
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1 420.47 4 780.65 4 780.65 4 780.65 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1225.39 8 841.25 9 1439.20 1 1265.39 1 1265.39 1 1419.96 4 1166.11 .1062F 11 3 537.26 2 145.78 4 401.71 4 706.84 4 1022.65 1 403.85 4 754.31 4 1343.75	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.8 TC1 1164.8 TC1 1164.8 TC1 1164.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 655.0 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.0 WFB 655.0 TC1 612.8 TC1 881.5 TC1 1166.3 TC1 1166.3 TC1 1166.7 TC1 127.2 TC1 644.1 TC2 947.2 TC1 644.1 TC1 947.2 TC1 147.5 TC1 147.5	9 4 PE1 4 PE1 4 PE1 4 PE1 4 PE1 4 PE1 4 PE1 4 PE1 6 PE1	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0 655.72 819.64 145.09 597.29 858.05 1059.75 1149.22 102.45 145.38 625.90 91.52 1142.77	ТМ ТТМ ТА ТА ТТМ ТА ТТМ ТА ТТМ ТА ТТМ ТА ТС ТС ТС ТС ТС ТС ТС ТС ТС ТС ТС ТС ТС	$\begin{array}{c} 405.13\\ 445.82\\ 515.47\\ 550.47\\ 550.47\\ 550.47\\ 550.47\\ 550.48\\ 515.22\\ 523.46\\ 523.46\\ 585.40\\ 612.76\\ 113.83\\ 145.96\\ 641F\\ 00\\ 145.82\\ 145.95\\ 145.95\\ 145.95\\ 654.30\\ 686.97\\ 145.25\\ 422.40\\ 495.96\\ 603.06\\ 603.06\\ 603.06\\ \end{array}$	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 592.64 858.83 1100.32 1212.53 1138.09 152.67 143.64 551F 00 145.78 145.78 145.78 145.78 145.78 145.78 145.78 145.78 508.48 710.72 919.60 1078.58 143.43 524.07	WAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	835,91 978,83 1106,34 1164,66 1124,09 498,24 851,53 1012,16 1157,57 1225,14 1180,32 655,00 655,00 655,07 12 463,46 799,66 990,65 9144,19 1144,78 476,70 80,95 90,95 91,088,27	РА РА РА РА РА РА РА РА РА РА РА ТРА ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ ТМВ	153,29 153,08 152,08 152,08 152,08 152,08 153,08 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,14 153,00 1065,22 161,00 1065,22 164,83 164,38 144,12 143,87 R13,89 145,07 144,84 144,55	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4245F-01 V 0.2445F-01 V 0.4466F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.430F-01 G 0.7140F 03 V 0.2257F-01 V 0.3810F-01 V 0.3810F-01 V 0.4317F-01 N 0.4327F-01 N 0.4317F-01 N 0.43
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	420.47 4780.65 11280.21 1304.95 1289.21 1062.06 1225.39 1125.39 1125.39 1125.39 1125.39 1125.39 1125.39 11439.20 11419.96 1166.11 .1062F 13352.26 143.352.26 144.774F 13352.26 145.78 144.10.71 1022.65 1228.73 1228.73 1228.73 1228.73 128.13 403.85 1128.13 413.45.75 1343.75 1343.30	WZ 701.1 TA2 838.5 TC1 668.4 TC1 978.8 TC1 1045.1 TA2 909.0 TC1 1141.8 TC1 1145.1 TA2 909.0 TC1 732.7 TC1 1043.5 TC1 1304.6 TC1 11304.6 TC1 11304.6 TC1 11304.6 TC1 612.8 TC1 612.8 TC1 642.1 TC1 106.1 TA2 1027.2 TC1 1171.5 TC1	9 4 $P=12$ 3 $TC2$ 8 $TC2$ 8 $TC2$ 9 $P=12$ 9 $TC2$ 9 $P=12$ 9 $P=1$	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.61 2416F 02 0 655.72 819.64 145.09 9597.29 858.05 1059.75 1149.22 1102.45 145.38 145.39 1059.75 1149.22 1142.37 1245.62	ТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ ТТМ	405.13 445.82 505.47 505.47 505.47 515.47 408.84 455.22 523.46 523.46 523.46 515.40 612.76 612.76 612.76 612.76 612.76 612.76 641F 00 145.82 145.92 144.97 416.90 480.62 572.65 654.30 686.97 145.25 422.40	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 4592.64 858.83 1100.32 1212.53 1138.09 152.67 143.63 551F 00 145.78 145.78 145.78 145.63 1078.58 145.43 508.48 710.72 919.60 1078.58 145.43 524.07 757.43 984.37 1145.44	WAA WAA WAA WAA WAA WAA WAA WAA WAA WAA	835,91 978,83 1106,34 1106,34 1104,66 1122,04 498,24 498,24 498,24 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1225,14 1157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 1255,10 157,57 15	РА РА РА РА РА РА РА РА РА ЧАХ РА ТМЯ ТЕ2 РА РА РА РА	153,29 153,08 152,96 152,85 732,48 153,41 153,24 153,41 153,24 153,41 153,24 153,41 153,24 153,41 153,24 154,25 154,25 144,33 144,43 144,38 144,43 144,44 143,87 144,45 144,44 144,24 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,44 144,45 14	N 0.6351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4095F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.445F-01 V 0.445F-01 V 0.4456F-01 V 0.4565E-01 V 0.420F-01 G 0.7897F 03 G 0.1136F 04 N 0.1228F 04 N 0.3297F-01 V 0.3066E-01 V 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3066E-01 V 0.3207F-01 V 0.3207F-01 V 0.3207F-01 V 0.3207F-01 V 0.434F-01 V 0.434E-01
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$	L 420.47 4 780.65 4 780.65 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 1289.21 4 128.73 4 1419.96 4 1419.96 4 1419.96 4 1419.96 4 1419.96 4 145.78 1 401.71 4 706.84 4 1022.65 8 1228.73 1 403.85 4 754.31 4 113.52 4 1388.30 1 231.35 1 231.35 1 231.35 1 121.35 1	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.8 TC1 1164.8 TC1 1164.8 TC1 1164.9 TC1 132.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 H 0.1071E 0 WFB 655.0 WZ 697.3 TA2 946.4 TC1 612.8 TC1 881.5 TC1 1166.3 TC1 1166.3 TC1 1166.7 TC1 127.2 TC1 644.1 TC1 947.2 TC1 1264.2 TC1 1265.2 TC1 1265	9 4 PE12 4 PE12 4 PE12 4 PE12 6 TC2 7	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.61 2416F 02 0 655.72 819.64 145.09 9597.29 858.05 1059.75 1149.22 1102.45 145.38 145.39 1059.75 1149.22 1142.37 1245.62	TM TM TM TM TM DA1 TM TM PA1 TM PF8 DF8 DF1 TM TM TM TM TM DF2 DF8 DF4 TM TM TM	$\begin{array}{r} 405.13\\ 445.82\\ 505.47\\ 505.47\\ 505.47\\ 505.47\\ 153.49\\ 408.84\\ 455.22\\ 523.46\\ 558.40\\ 612.76\\ 612.76\\ 612.76\\ 612.76\\ 6145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 572.65\\ 654.30\\ 686.97\\ 145.25\\ 422.40\\ 4495.96\\ 633.06\\ 696.95\\ 733.14\\ \end{array}$	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 859.264 858.83 1100.32 1212.53 1138.097 152.67 143.64 145.78 143.63 505.48 145.78 143.63 505.48 143.63 505.48 1078.58 1078.58 143.63 524.07 755.43 984.37 1145.44 1170.04	ИА WA WA WA WA WA WA WA WA WA WA	835.91 978.83 1106.34 1106.34 1106.36 1122.04 498.24 498.24 498.24 1157.57 1225.14 1157.57 1225.14 1157.57 1225.14 1157.57 1225.14 1157.57 500.12 465.00 950F 01 950F 01 950F 01 9375.45 500.12 463.46 799.66 924.19 1049.46 1134.19 1144.78 476.70 809.95 947.98 476.70 807.95 947.98 1088.27 1184.85	РА РА РА РА РА РА РА РА РА РА РА РА РА Р	153,29 153,08 153,08 152,96 152,85 732,48 153,14 153,29 153,14 153,14 153,00 152,87 997,60 1065,22 810F (00 810F (00 810))))))))))))))))))))))))))))))))))	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4035F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4265F-01 V 0.2445F-01 V 0.4456F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4520F-01 G 0.7187F 03 G 0.1136F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3810F-01 V 0.3810F-01 V 0.4317F-01 N 0.8227F 03 V 0.2319F-01 V 0.3202F-01 V 0.4034E-01 V 0.4612F-07 V 0.410E-01
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	420.47 4780.65 11280.21 1304.95 1289.21 1062.06 1225.39 1125.39 1125.39 1125.39 1125.39 1125.39 1125.39 11439.20 11439.20 11419.96 11662F 13352.26 1435.78 1445.78 147.74F 13352.26 1435.78 14228.73 1228.73 1228.73 1228.73 1228.13 140.228.73 128.13 403.85 1128.13 4134.75 1343.75	WZ 701.1 TA2 838.5 TC1 688.4 TC1 978.8 TC1 1164.8 TC1 1164.8 TC1 1164.8 TC1 1164.9 TC1 132.7 TC1 1063.3 TC1 1272.5 TC1 1304.6 TC1 139.8 NC= 60 H 0.1071E 0 WFB 655.0 WZ 697.3 TA2 946.4 TC1 612.8 TC1 881.5 TC1 1166.3 TC1 1166.3 TC1 1166.7 TC1 127.2 TC1 644.1 TC1 947.2 TC1 1264.2 TC1 1265.2 TC1 1265	9 4 $P=1$ 4 $P=1$ 5 $TC2$ 6 $TC2$ 7 $TC2$	673.86 958.10 1144.29 1179.23 1045.08 153.56 715.57 1038.70 1248.15 1289.48 1139.81 0.0 2416F 02 0 555.72 819.64 145.09 557.29 858.05 1059.75 1149.22 1102.45 145.38 625.90 919.52 1142.77 1245.62	TM TM TM TM TM DA1 TM TM PA1 TM PF8 DF8 DF1 TM TM TM TM TM DF2 DF8 DF4 TM TM TM	$\begin{array}{r} 405.13\\ 445.82\\ 505.47\\ 505.47\\ 505.47\\ 505.47\\ 153.49\\ 408.84\\ 455.22\\ 523.46\\ 558.40\\ 612.76\\ 612.76\\ 612.76\\ 612.76\\ 6145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 145.92\\ 572.65\\ 654.30\\ 686.97\\ 145.25\\ 422.40\\ 4495.96\\ 633.06\\ 696.95\\ 733.14\\ \end{array}$	ТА ТА ТА ТА ТА ТА ТА ТА ТА ТА	567.56 803.46 1015.23 1112.07 1044.68 152.76 859.264 858.83 1100.32 1212.53 1138.097 152.67 143.64 145.78 143.63 505.48 145.78 143.63 505.48 143.63 505.48 1078.58 1078.58 143.63 524.07 755.43 984.37 1145.44 1170.04	ИА WA WA WA WA WA WA WA WA WA WA	835.91 978.83 1106.34 498.24 498.24 851.53 1012.16 1157.57 1225.14 1180.32 655.00 376.45 500.12 463.46 799.66 924.19 1049.46 1134.19 1144.78 473.68 924.19 1144.78 474.79 803.95 947.98 1088.27 1188.85 1199.58 655.00	РА РА РА РА РА РА РА РА РА РА РА РА РА Р	153,29 153,08 153,08 152,96 152,85 732,48 153,14 153,29 153,14 153,14 153,00 152,87 997,60 1065,22 810F (00 810F (00 810))))))))))))))))))))))))))))))))))	N 0.5351F 03 V 0.2351F-01 V 0.3197F-01 V 0.4035F-01 V 0.4231F-01 V 0.4231F-01 V 0.4231F-01 V 0.4265F-01 V 0.2445F-01 V 0.4456F-01 V 0.4565F-01 V 0.4565F-01 V 0.4565F-01 V 0.4520F-01 G 0.7187F 03 G 0.1136F 04 N 0.1228F 04 N 0.1228F 04 N 0.3690F 03 N 0.7740E 03 V 0.2257F-01 V 0.3810F-01 V 0.3810F-01 V 0.4317F-01 N 0.8227F 03 V 0.2319F-01 V 0.3202F-01 V 0.4034E-01 V 0.4612F-07 V 0.410E-01

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