Power System Dynamic

MODES Network Simulator

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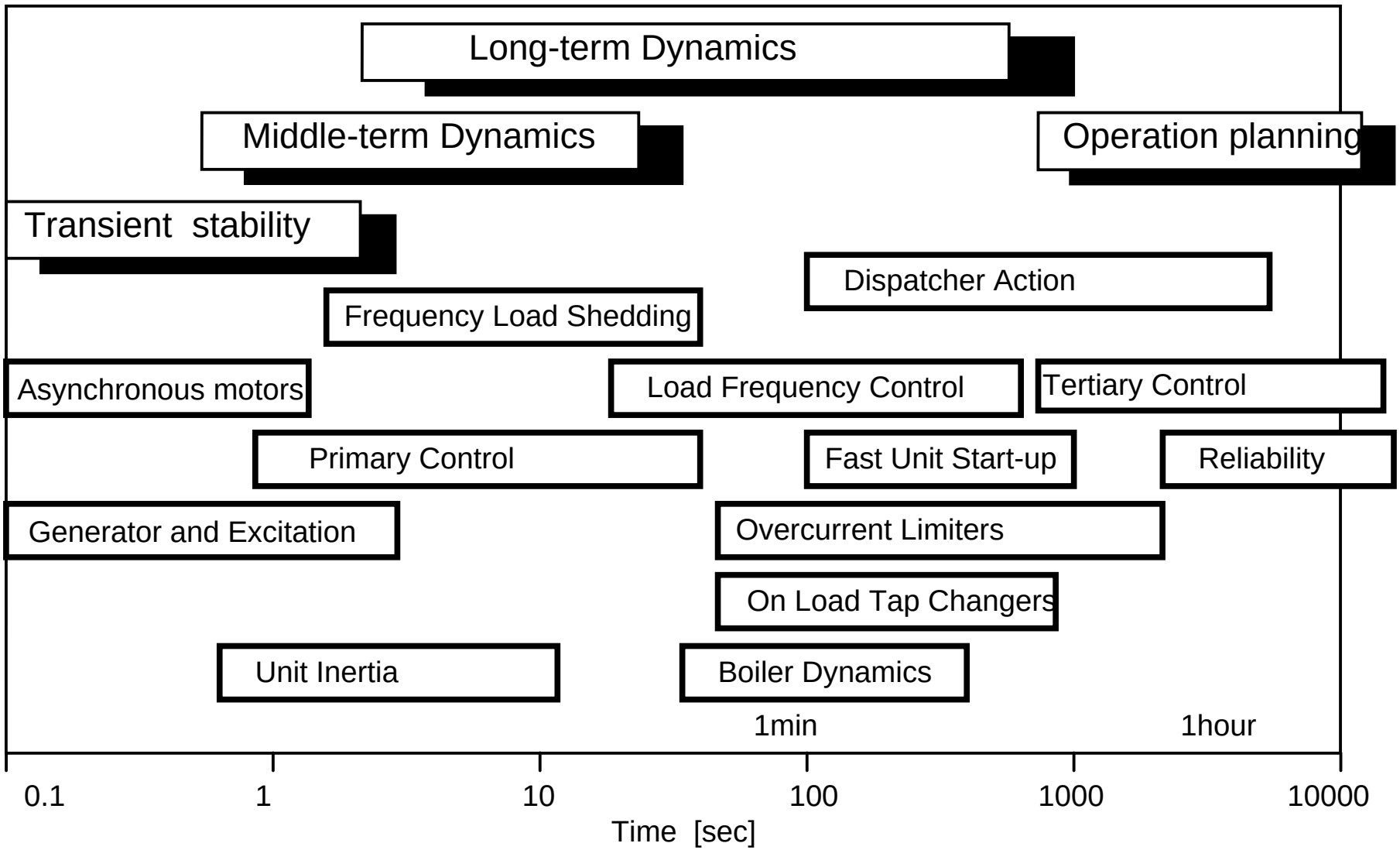
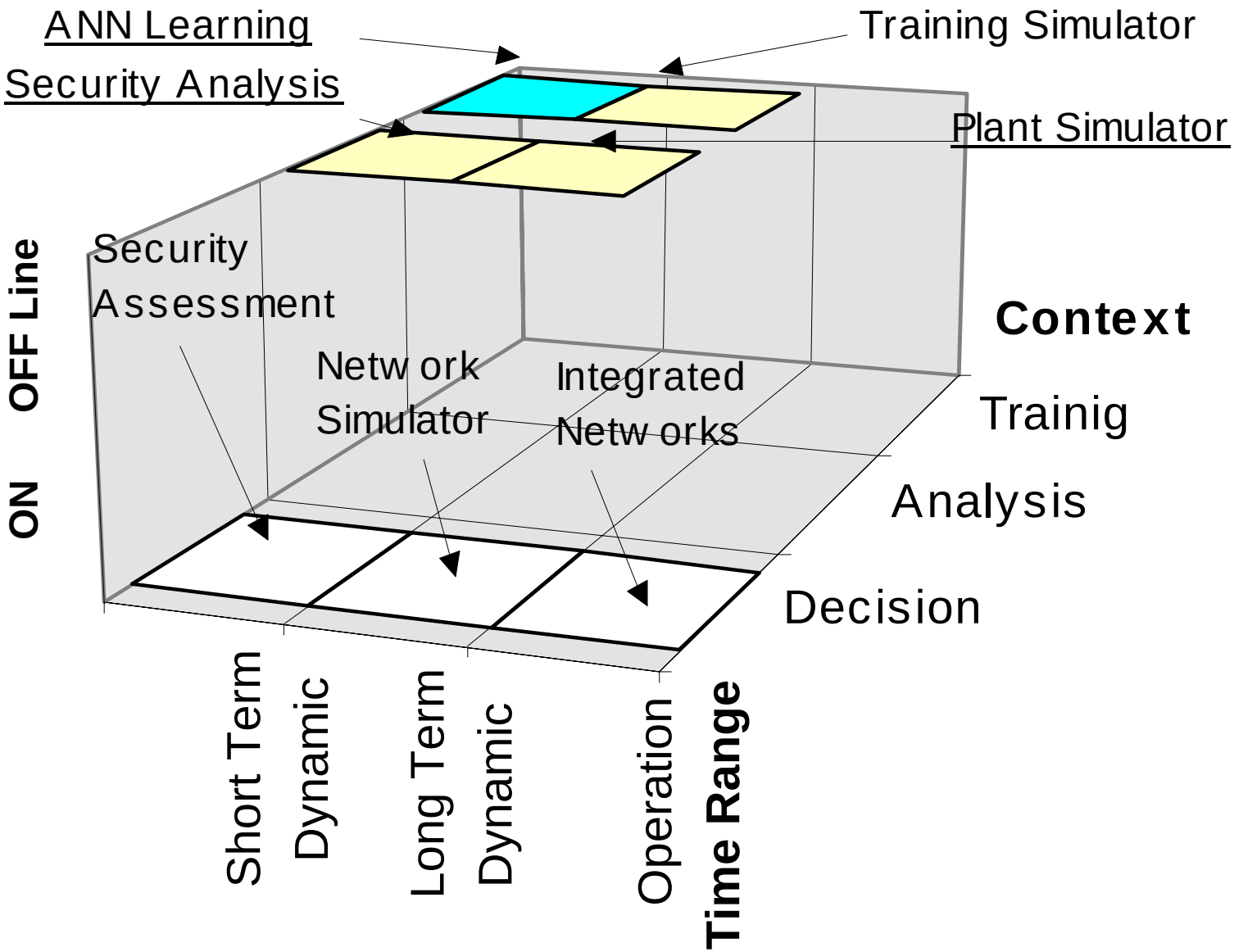
The network simulator MODES is:

- intended for investigation of electromechanical transients in large power system
- exploiting by Transmission System Operators and by several project and research institutions in the Czech and Slovak Republic
- a proof tool for projection work and stability studies (design of auxiliaries back-up power supply and safety reports for nuclear power stations)
- testing by comparing with another tools (including EMTP) and Control equipment data (Automatics and logics, LFC, external stabilisers and regulators)
- as simple as possible fro dynamic model creation
- flexible tool (EXE for DOS and WINDOWS, with possibilty to call users DLLL with defined models of excitation and prime mover systems)
- variable, it exists like a DLL with interfaces functions as well

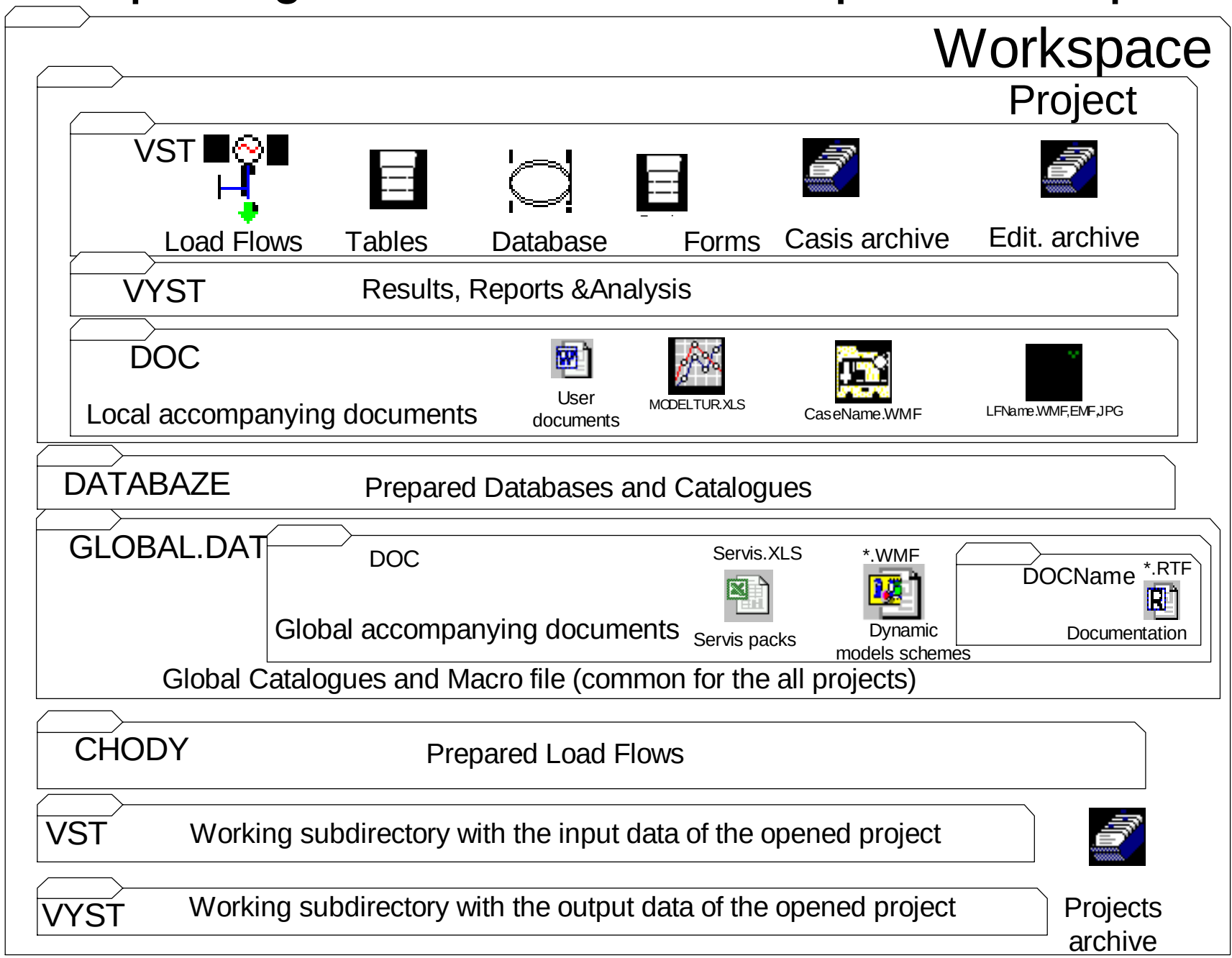
MODES operating range

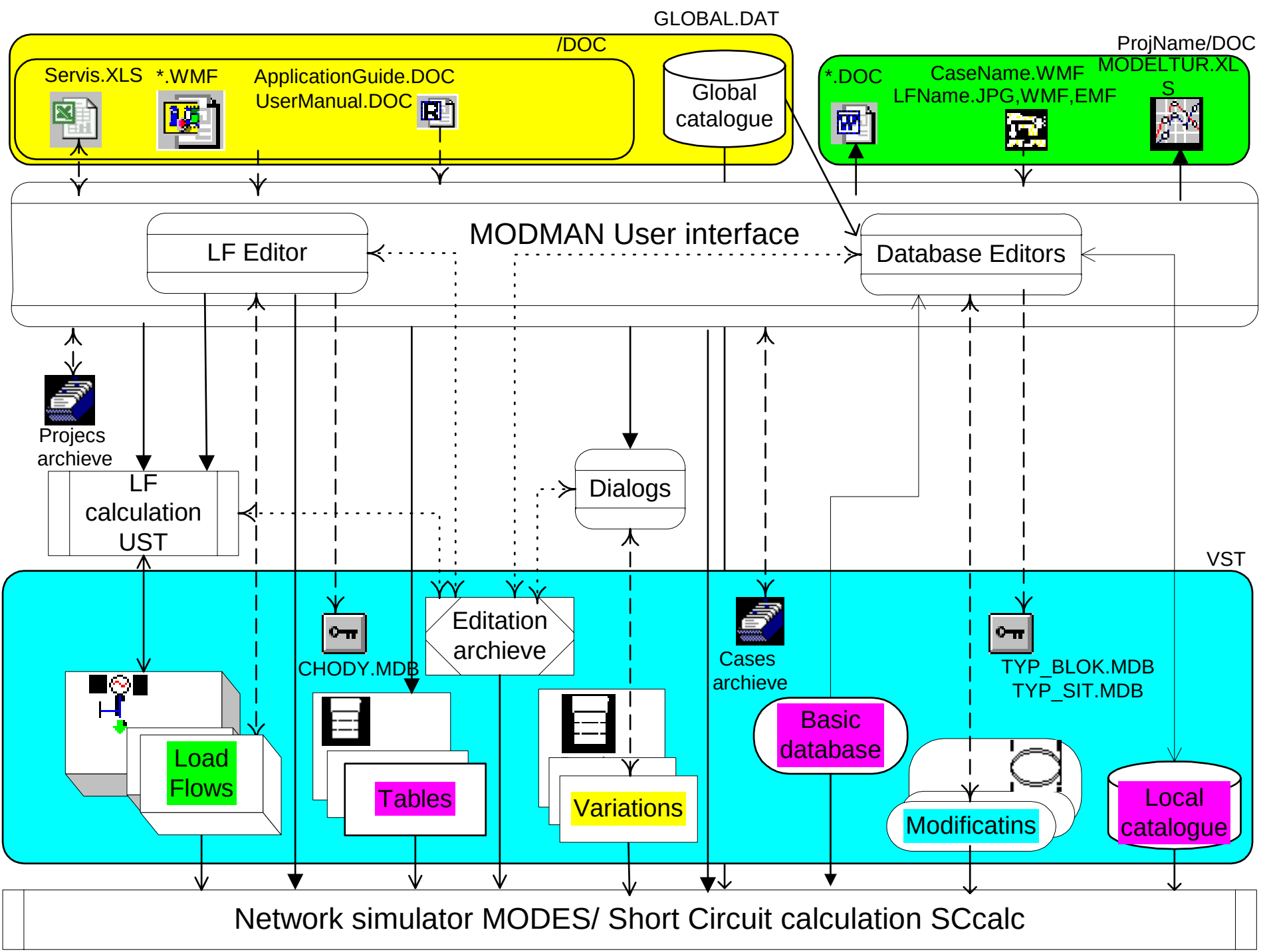


MODES applications overview



MODES package architecture – workspace concept




GLOBAL.DAT
/DOC
Servis.XLS
*.WMF
ApplicationGuide.DOC
UserManual.DOC
Global catalogue
ProjName/DOC
*.DOC
CaseName.WMF
LFName.JPG,WMF,EMF
MODELTUR.XLS
MODMAN User interface
LF Editor
Database Editors
Projecs archieve
LF calculation UST
Dialogs
VST
CHODY.MDB
Editation archieve
Cases archieve
TYP_BLOK.MDB
TYP_SIT.MDB
Load Flows
Tables
Variations
Basic database
Modificatins
Local catalogue
Network simulator MODES/ Short Circuit calculation SCcalc

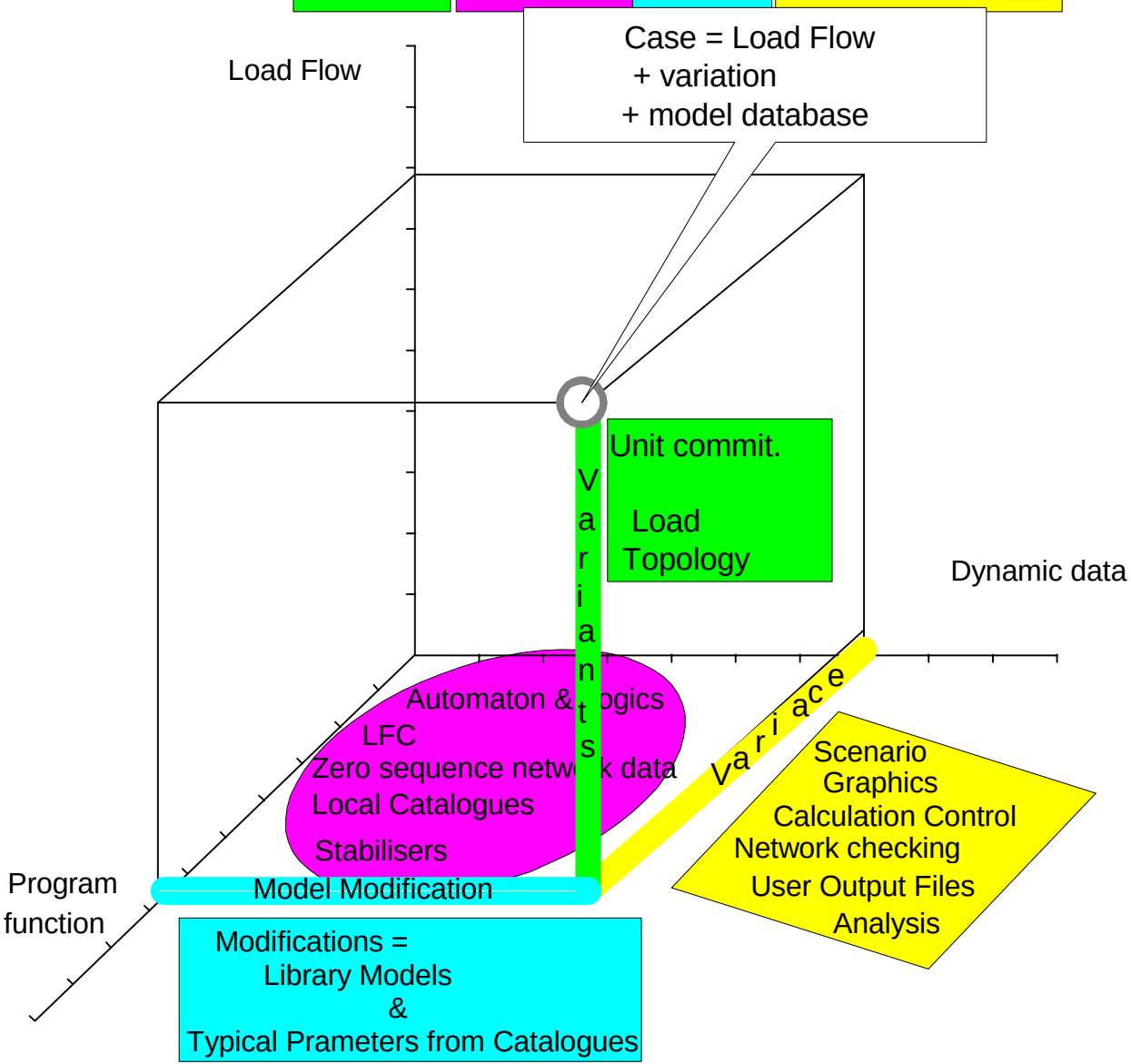
Input data

- The input data are separated into:
- Load flow data - necessary for load flow calculation and extended to generator/motor data
- Control equipment data (Automatics and logics, LFC, external stabilisers and regulators)
- Unit dynamic models data (model type from library + typical parameters from catalogues)
- Load models (including four stage LFS)
- Network equipment model (OLTC)
- Calculation parameters (analysis, checking, graphic, output files and scenario)
- Macro data (using for scenario, automatics and logics)

“Three” dimensional input data philosophy

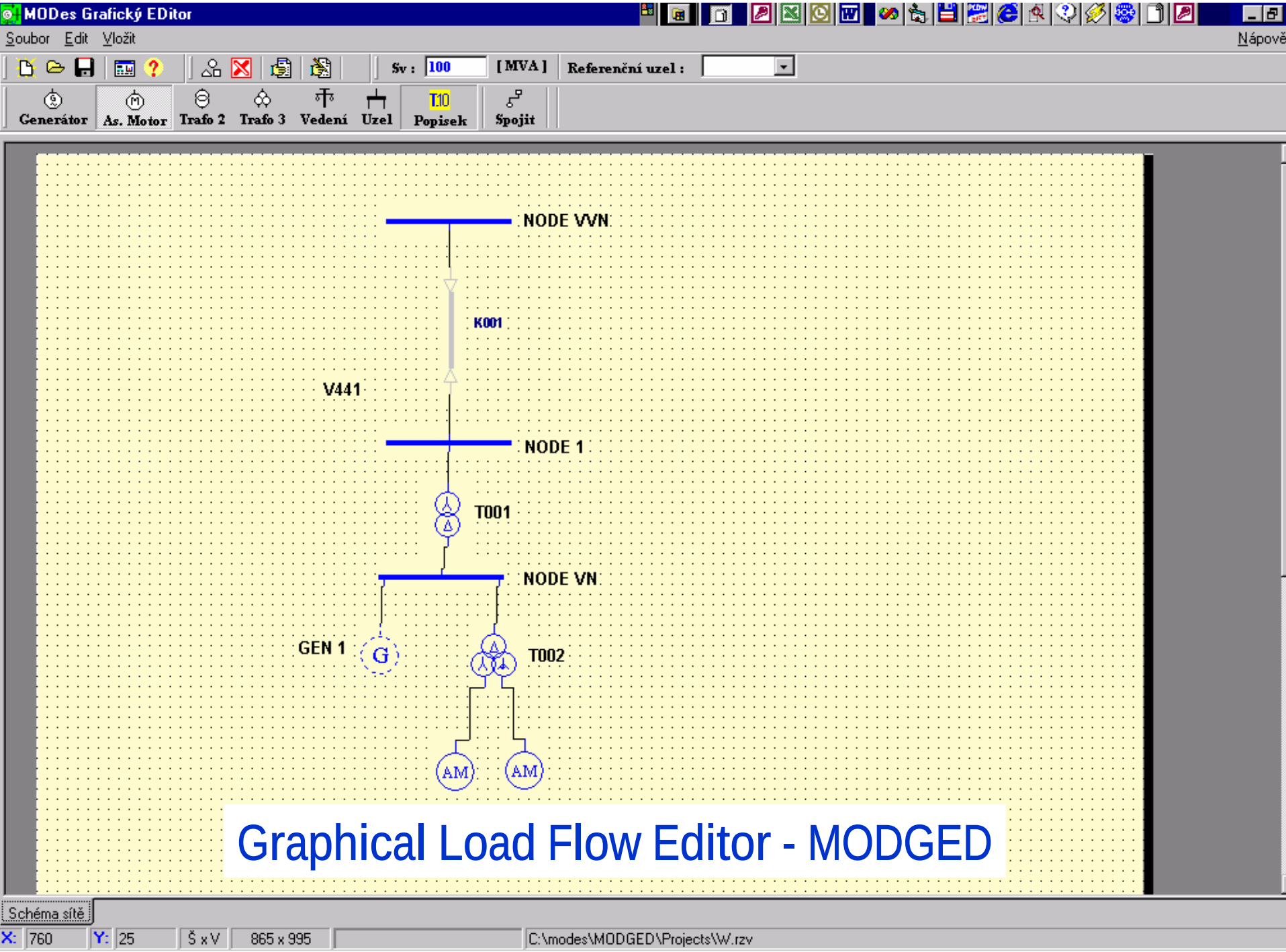
Casses archieve

hlavicka	Load flo N Z T	Aut Sta LFC Log	Blo Uzl Sit	Con Ana Che Sce Gra UF	Coment
ROZBEHAS;Author;Dates;	CHODB;2;2;3;	000;000;000;000;	000;000;000;	000;000;000;000;001;000;	Rozbìh
USTSTAV ;Author;Dates;	CHODB;2;2;0;	000;000;000;000;	000;000;000;	001;000;000;001;002;000;	Ustálený



Load flow data

- Transformation from another data format (e.g. PSSE) by auxiliary programs
- Directly provided from another application (GLF)
- Using of the **Load flow editor** - creation new models, tuning of load flow and initialisations of dynamic models in one environment
- Exchange of load flow data through unified interface (for on line application where the MODES is a server)
- Using of the MODGED (graphical one-line scheme) – under preparation


MODes Grafický EDitor
Soubor Edit Vložit
Nápově
Sv : 100 [MVA] Referenční uzel :
Generátor
As. Motor
Trafo 2
Trafo 3
Vedení
Uzel
Popisek
Spojit
NODE VVN
K001
V441
NODE 1
T001
NODE VN
GEN 1
G
T002
AM
AM
Graphical Load Flow Editor - MODGED
Schéma sítě
X: 760
Y: 25
Š x V
865 x 995
C:\modes\MODGED\Projects\W.rzv

Control equipment data

- Text (ASCII files) in predefined format
- edited by predefined text editor

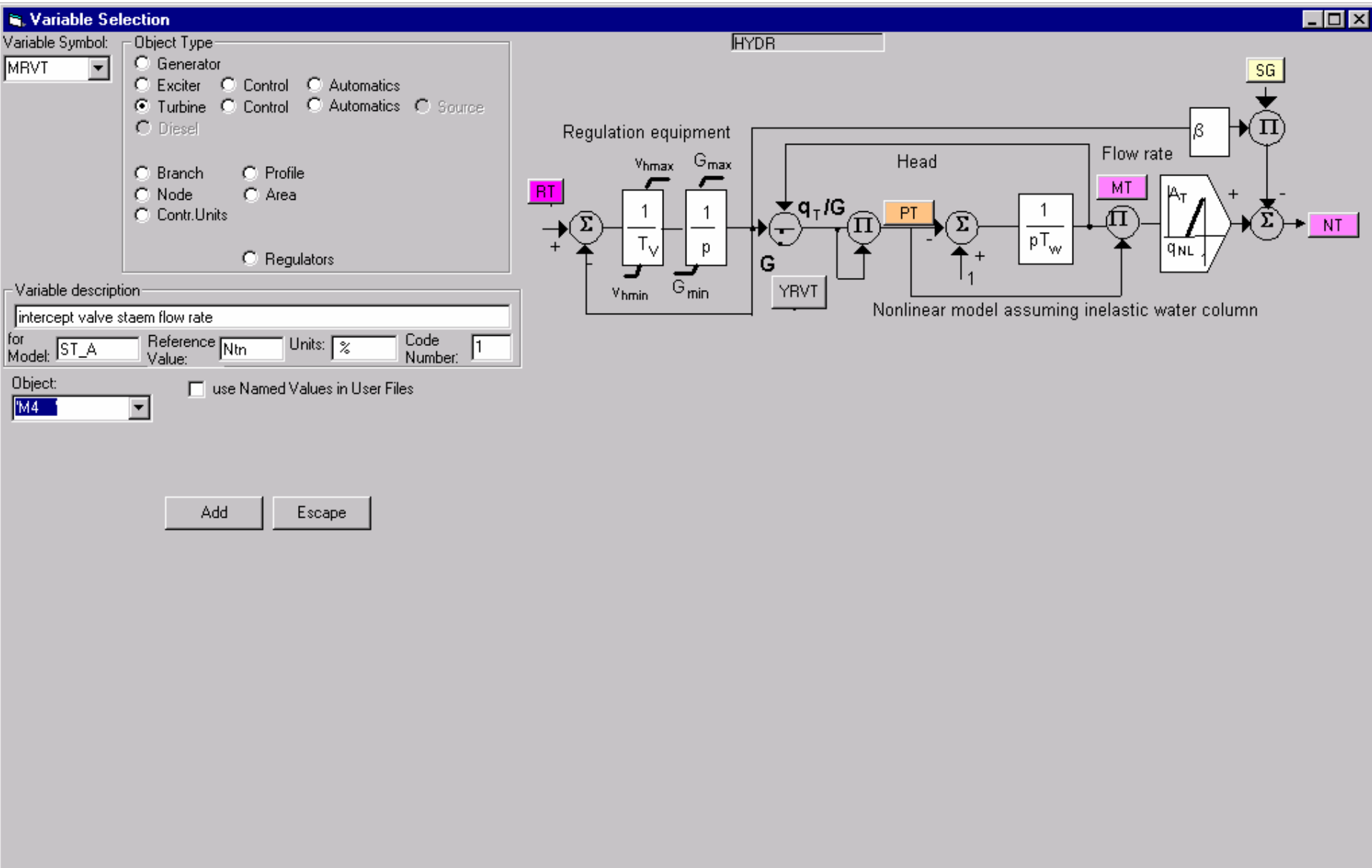
Dynamic models data

- model type from library + typical parameters from catalogues
- If no model is defined the MODES uses a standard one
- If no parameters are defined the MODES uses default ones
- It is not necessary to define dynamic models for the all objects
- edited by **models editors** or predefined text editor

Calculation parameters

- Text (ASCII files) in predefined format
- edited in **dialogue** or text regime

Dialogue for selection variables for graphics



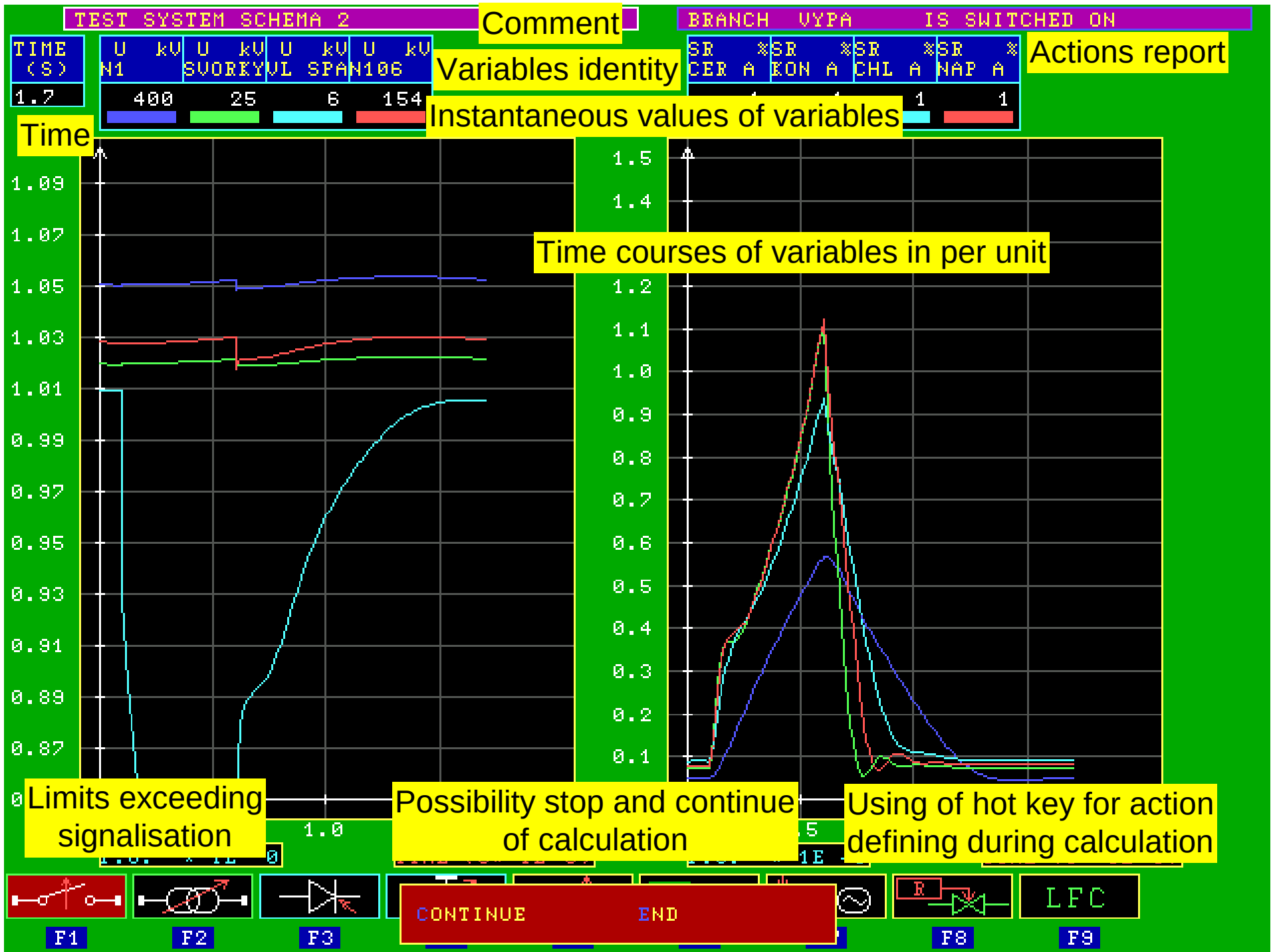
Output data

- The MODES provides the following possibilities:
- showing information on display during calculation (so called graphic)
- saving the simulated variables time courses into output files (so called user output files)
- displaying of time courses after calculation
- checking of values of predefined network variables (so called network checking)
- reporting the calculation into output files (reports)
- providing analysis of network state, primary and secondary control (so called analysis)
- short circuit currents reporting.

The Graphic

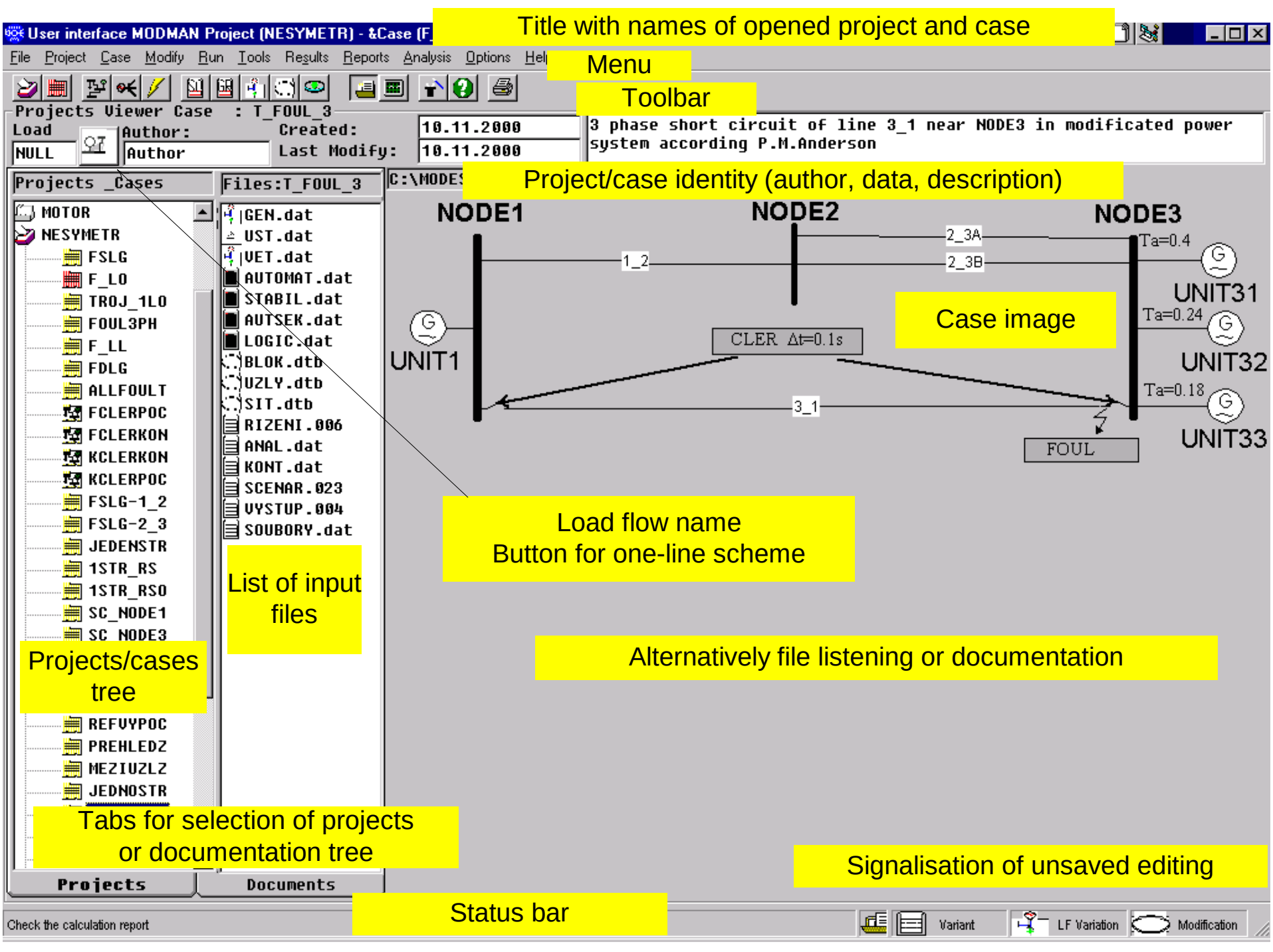
The graphic mediates interaction between user and program during simulation.

- Case and projects name information
- Events messages
- Instantaneous values of variables from charts
- Up to four charts with up to seven time courses of selected variables
- Hotkeys F1-F8
- Escape key for stop calculation Limits signalling for „on line“ checking


TEST SYSTEM SCHEMA 2
Comment
BRANCH VYPA IS SWITCHED ON
Actions report
TIME (S)
U kV N1
U kV SVORKY
U kV VL SPA
U kV N106
SR % CER A
SR % KON A
SR % CHL A
SR % NAP A
Variables identity
1.7
400
25
6
154
1
1
Instantaneous values of variables
Time
Time courses of variables in per unit
1.09
1.07
1.05
1.03
1.01
0.99
0.97
0.95
0.93
0.91
0.89
0.87
1.0
1.5
1.4
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Limits exceeding signalisation
Possibility stop and continue of calculation
Using of hot key for action defining during calculation
LFC
CONTINUE
END
F1
F2
F3
F8
F9

User interface – MODMAN provides:

- navigation in workspace by the Projects Viewer
- navigation in documentation by the Documentation Viewer
- projects and cases management (open, save, save as, delete)
- new projects/ cases creation by the Project/ Cases editors
- starting the package applications by menu or toolbar
- context and What this help, ToolTips and the status bar
- access to input files by menu in text or dialogue regime
- load flow data editing by the Load Flow Editor
- dynamic data editing by the Unit and Load Model Editors
- access to the user output files in text or graphic regime
- access to the documents (user's or program's)
- handling of service packages


User interface MODMAN Project (NESYMETR) - &Case (F
Title with names of opened project and case
File Project Case Modify Run Tools Results Reports Analysis Options Hel
Menu
Toolbar
Projects Viewer Case : T_FOUL_3
Load
NULL
Author:
Author
Created:
10.11.2000
Last Modify:
10.11.2000
3 phase short circuit of line 3_1 near NODE3 in modificated power system according P.M.Anderson
Project/case identity (author, data, description)
Projects _Cases
MOTOR
NESYMETR
FSLG
F_LO
TROJ_1LO
FOUL3PH
F_LL
FDLG
ALLFOULT
FCLERPOC
FCLERKON
KCLERKON
KCLERPOC
FSLG-1_2
FSLG-2_3
JEDENSTR
1STR_RS
1STR_RSO
SC_NODE1
SC_NODE3
REFVYPOC
PREHLEDZ
MEZIUZLZ
JEDNOSTR
Projects/cases tree
Files:T_FOUL_3
GEN.dat
UST.dat
VET.dat
AUTOMAT.dat
STABIL.dat
AUTSEK.dat
LOGIC.dat
BLOK.dtb
UZLY.dtb
SIT.dtb
RIZENI.006
ANAL.dat
KONT.dat
SCENAR.023
VYSTUP.004
SOUBORY.dat
List of input files
Tabs for selection of projects or documentation tree
Projects
Documents
NODE1
NODE2
NODE3
1_2
2_3A
2_3B
3_1
Ta=0.4
Ta=0.24
Ta=0.18
UNIT1
UNIT31
UNIT32
UNIT33
CLER Δt=0.1s
FOUL
Case image
Load flow name
Button for one-line scheme
Alternatively file listening or documentation
Signalisation of unsaved editing
Status bar
Check the calculation report
Variant
LF Variation
Modification

Load flow editor – nodes, branches and objects tables

LF editor : NAPRA330 - Edit the Load Flow ... Initialisation

File Show Edit Load Flow Dynamic Initialisation

Menu

Title with LF name

'Triuzlovy model prevzaty P.M.Anderson Foulted Power System

'Pridan odber do NODE_2 a dodavka do NODE_3

Comments with LF description

Reference Power [MVA]: 100

Reference Nodes: 1

Text boxes with reference power and slack buses

Save

Exit

Button for LF data saving into MODES input files

A330.ust

	IdentN	NodeName	aldNumber	Uv(kV)	absU(kV)				Pgen(MW)	Qgen(MVAr)	Qcomp(MVAr)	Qmin(MVAr)	Qmax(MVAr)
▶	1	NODE_1	2	100	100	0	0	0	30	11.5	0	-9999	9999
	2	NODE_2	2	100	99.11	-1.2133	80	40	0	0	0	0	0
	3	NODE_3	2	100	100	-0.2807	0	0	50	30.4	0	-9999	9999
✳													

Table for editing of nodes data

Table of Branches: NAPRA__0.vet

	BranchName	FromNode	ToNode	R(Ohm)	X(Ohm)	B(mikroS)	abs{Up(-)/Uk(-)}(-)	State(0/1)	Gi(mikroS)	Bi(mikroS)	Gj(mikroS)	Bj(mikroS)	Imax/Smax(A/MVA)	Pi(MW)	Qi(MVAr)	Ii(A)	Pj(MW)	Qj(MV
	1_2	1	2	0	8	0	1	1	0	0	0	0	15183	26.23	11.46	165	-26.23	-10
	2_3A	2	3	0	6	0	1	1	0	0	0	0	15183	-26.88	-14.6	178	26.88	15
	2_3B	2	3	0	6	0	1	1	0	0	0	0	15183	-26.88	-14.6	178	26.88	15
▶	3_1	3	1	0	13	0	1	1	0	0	0	0	520	-3.77	0.02	22	3.77	-0
✳																		

Table for editing of branches data

Button for LF calculation launching

Text boxes with allowed power unbalance and number of iteration

	StateG	UnitName	NodeName	Number(-)	Sn(MVA)	Ntmax(MW)	Ntmin(MW)	Xd(-)
▶	1	UNIT_1	NODE_1		127	0	108	0.2
	1	UNIT_3	NODE_3		158.75	0	135	0.16
✳								

Table for editing of areas, profiles, OLTC, three winding transformers, generators and motors data

Recalculate LF

Load Flow Calculation:

Allowed Power Unbalance [MVA]: .02

Allowed Number of Iteration: 30

| Program UST 2.2/7 |
| Released: 20.7.2002 |
|(c) Karel Maslo PhD 1994-2002 |
| Serie:6_2002 |
t calculation of the Jacobian in the each iteration
Triuzlovy model prevzaty P.M.Anderson Foulted Power System
Pridan odber do
Nodes number,

Report about LF calculation details

Load flow editor – after dynamic initialization

LF editor : ust - Edit the Load Flow or Run the Initialisation

File Show Edit Load Flow Dynamic Initialisation

'CIGRE SC39 TEST SCHEME '

'WITH SELFCONSUMPTION Calculated 7:38:23 13. 9.2002'

Reference Power [MVA]: 1000 Reference Nodes: 15

Save Exit

Command for dynamic models intialisation

Table of Nodes: ust.dat

	IdentN	NodeName	ald			deg)	Pload(MW)	Qload(MVAr)	Pgen(MW)	Qgen(MVAr)	Qcomp(MVAr)	Qmin(MVAr)	Qmax(MVAr)
	1	N1				2952	0	0	0	0	0	0	0
	2	N2	1	380	419.07	-1.4931	0	0	0	0	0	0	0
	3	N3	1	380	403.54	-2.3206	0	0	0	0	0	0	0
	4	N4	1	380	412.23	-1.8925	0	0	0	0	0	0	0
	5	N5	1	380	409.6	-2.3048	0	0	0	0	0		
▶	6	N6	1	380	403.68	-2.152	0	0	0	0	0		
	7	N7	1	380	395.96	-2.653	0	0	0	0	0		
	8	N8	1	380	404.79	-1.1422	237	78	0	0	0		
	9	N9	1	380	404.88	-1.1062	223	73	0	0	0	0	0

Button for showing of branch table

Show Branches

Generating nodes with exceeding of dynamic models limits

Unit	Node	Limit exceeding
BLOK2	SVORKY	Ubmin>UB>Ubmax 4.674 > 4.5
BLOK2	SVORKY	Ntmin>NZ>Ntmax 0.418 < 0.47
M4	N103	Uzmin>UZAD>Uzmax 0.895 < 0.9

Motoric nodes with power unbalance

Node	Pgen	Pmot	Qgen	Qmot
VL_SPA	-12.6	-12.6	-9.0	-7.2

Dynamic allocation reports

```
Aloc: TypGen      0   12
Aloc: TypExc      0   11
Aloc: TypRegExc     0    7
Aloc: TypAutExc     0    4
Aloc: TypTur      0   12
Aloc: TypRegTur     0   13
Aloc: TypAutTur     0    9
Aloc: TypSource     0   10
```

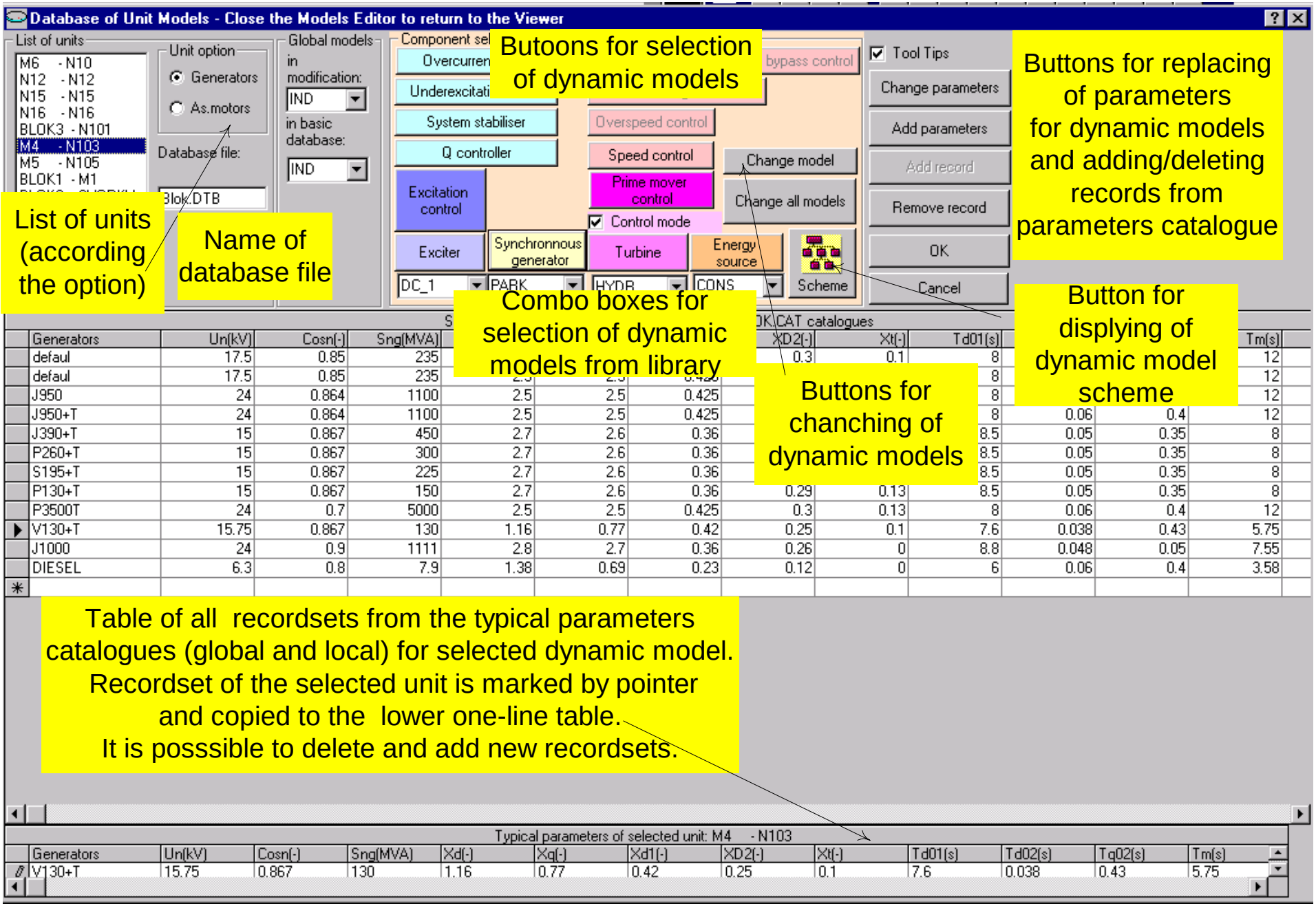
List of units with exceeding of excitation and prime mover models limits. When you click on the unit/node name the pointers in the units/nodes tables move to the selected unit/node record.

List of motoric nodes with power unbalance (difference between negative generated power defined in nodes table and actual power absorbed by motors)

Report of dynamic allocation of dynamic models parameters and network objects (nodes, branches, areas, profiles, OLTC, three winding transformers, generators and motors)

	1	M4	N103		300	140		
	1	M5	N105		450	170	390	0.9091	0.13
	1	BLOK1	M1		1100	500	950	1	0
	1	BLOK2	SVORKY		1100	450	950	1	0

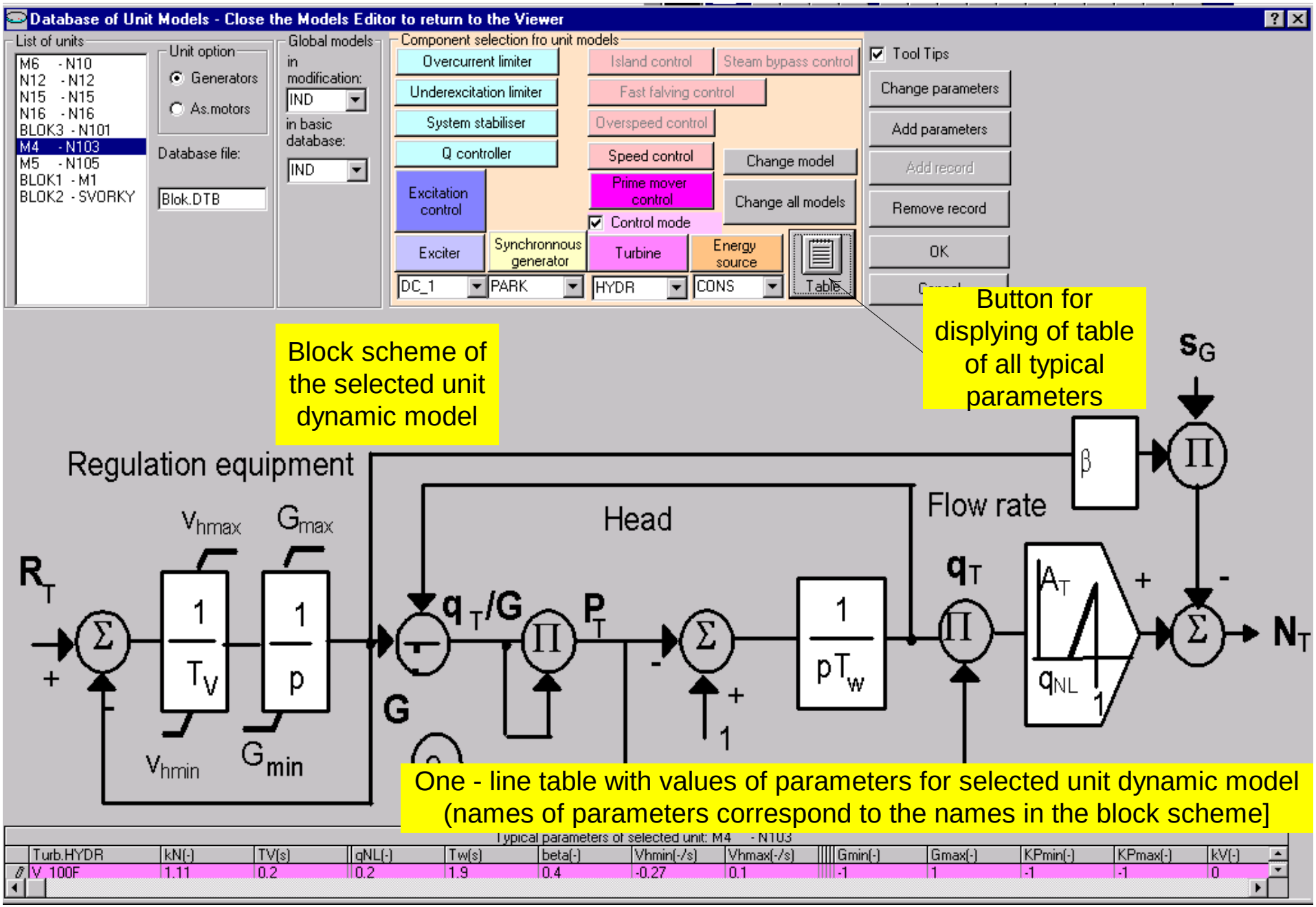
Unit models editor – table of typical parameters from catalogue



Generators	Un(kV)	Cosn(-)	Sng(MVA)				XD2(-)	Xt(-)	Td01(s)			Tm(s)
defaul	17.5	0.85	235				0.3	0.1	8			12
defaul	17.5	0.85	235						8			12
J950	24	0.864	1100	2.5	2.5	0.425			8			12
J950+T	24	0.864	1100	2.5	2.5	0.425			8	0.06	0.4	12
J390+T	15	0.867	450	2.7	2.6	0.36			8.5	0.05	0.35	8
P260+T	15	0.867	300	2.7	2.6	0.36			8.5	0.05	0.35	8
S195+T	15	0.867	225	2.7	2.6	0.36			8.5	0.05	0.35	8
P130+T	15	0.867	150	2.7	2.6	0.36	0.29	0.13	8.5	0.05	0.35	8
P3500T	24	0.7	5000	2.5	2.5	0.425	0.3	0.13	8	0.06	0.4	12
V130+T	15.75	0.867	130	1.16	0.77	0.42	0.25	0.1	7.6	0.038	0.43	5.75
J1000	24	0.9	1111	2.8	2.7	0.36	0.26	0	8.8	0.048	0.05	7.55
DIESEL	6.3	0.8	7.9	1.38	0.69	0.23	0.12	0	6	0.06	0.4	3.58

Generators	Un(kV)	Cosn(-)	Sng(MVA)	Xd(-)	Xq(-)	Xd1(-)	XD2(-)	Xt(-)	Td01(s)	Td02(s)	Tq02(s)	Tm(s)
V130+T	15.75	0.867	130	1.16	0.77	0.42	0.25	0.1	7.6	0.038	0.43	5.75

Unit models editor – block scheme of selected dynamic model



Database of Nodes Models; EDU_BEZP; 4a_ZV433

List of Nodes:

BTIHAN
BTIHAN
D2ETZ
D2GR__
D2GROH
D2IN__2
D2IS__1
D2IS__1
D7KKE_

Active Database File:

noRecord

Name of database file

List of nodes

Akctive Models:

Number of Active Records in Modification:

0

Number of Active Records in Basic Database:

0

Model Selection

Termostatic load

Static load

Dynamic load

shedding

Butoons for selection of dynamic models

Participation on the Load Model

Termostatic load

0 0% 100

Dynamic load

0 0% 100

Constant active curre

0 0% 100

Constant reactive current

0 0% 100

0 0% 100

Sliders for defining of participation of the each load model on the total load

Change Participation

Taable of typical parameters for: Termostatic load

	Dyn_chai	AlfaS(-)	AlfaT(-)	Tp(s)	BetaS(-)	BetaT(-)	Tq(s)	Koment(te	Katal(text	Dupl(bool)	umber(Int)
▶	defaul	0.04	0.06	0.3	0.4	0.7	0.5	!	Global	0	6
*											

Table of all recordsets from the typical parameters catalogues (global and local) for selected load model.
Recordset of the selected node load model is marked by pointer and copied to the lower one-line table.
It is posssible to delete and add new recordsets.

▶	defaul	0.04	0.06	0.3	0.4	0.7	0.5	!	Global	0

Frequency Load Shedding Volumes

the first stage

0 100%

0%

the second stage

0%

the fourth stage

Sliders for defining of volumes for four stage load frequncy shedding

Tool Tips

Change parameters

Add parameters

Add record

Remove record

Buttons for replacing of parameters for dynamic models and adding/deleting records from parameters catalogue

Conclusions

- The MODES is suitable for education and study of power system transients
- It contains library of dynamic models and set of typical parameters collected in catalogues
- It contains a number of solved projects for testing and education (lecture notes is under preparation)

Conclusions

- The MODES is suitable as an engineering package for power system analysis, planning and design.
- It contains tools for load flow, transients and short circuit calculation.
- It can be used as stand alone application with the MODMAN user interface.
- It can be used as dynamic linking library in frame of a user application (for on line operation as well).