Data Bases in the LEP Control System

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Introduction

This note examines the total data base requirements for the control, operation and maintenance of LEP. It extends the brief references to the subject made in LEP Controls Note No. 1 and in LEP Note No. 313 and suggests ways of satisfying the requirements.

The principles which have been followed in this note are that the data base should be distributed as far as possible, in such a way as to minimize the requirements for data communication between units, and that there should be only one single active copy of any data table in the system. Other copies will exist, for archival or reload purposes, but these must not be used by applications programs.

The simple control and data acquisition for the LEP components set the minimum requirements on a data base system, the operation of LEP as a machine imposes additional requirements and these, in turn, are increased when the provision of assistance in fault-finding and maintenance is taken into consideration.

Basic Control of LEP Equipments

The data module concept has been described elsewhere (Data Modules System Handbook, SPS/ACC/GJ/Comp. Note 79-34), and the application to LEP has been discussed in LEP Note 330. In this, it is proposed that the data module should be divided into two parts, the "equipment directory" which will be incorporated in the memory of the process computer controlling the equipment, and the "property module" which will be incorporated in the memory of a microprocessor in the equipment itself, or in the interface between the process computer and the equipment.
The equipment directory will be entered by a call to a data module with name, property, equipment number and possibly value or array. For that name, the directory will give the valid properties, the password requirements, the interface address of the property module, and any translation necessary to call the required property. This directory will contain semi-fixed data, which only needs to be changed if any changes are made to the equipment or to the property modules. The master copy of the data for each equipment directory will be kept in the library, and this master copy will be incorporated automatically into the equipment directory each time it is assembled. The exception to this could be some status indications for the equipments which would be read in from the property modules.

The property modules code should be in PROM with only the data table in RAM. This data table will have semi-fixed data, such as conversion factors, tolerances, maximum allowable values and interface addresses, and variable data, such as demanded values, status, measured values, etc. These distributed data tables form the operational data base for the control system; any program wishing to interact with the equipment or obtain information on its status, will use the property modules and their data tables. There will be no automatic update of a central equipment data base, as with some systems, although copies of the property module data tables will be taken and held in the library periodically. These copies will be solely for archives and for reloading into property modules if, for any reason, the working tables become corrupted.

**Operation of LEP**

The operation of LEP involves much more than the operation of the individual pieces of equipment. For a given operating condition, a large number of equipments must be set to certain values, and the ability to record and recall these standard settings must be provided. This will be done by programs creating and using files of standard settings kept in the library.

One of the major advantages of a computer control system is the ability to control derived or virtual parameters, such as \( Q \), beta, etc., rather than individual quadrupole currents. In setting up LEP it will be necessary to have files of a number of this type of parameters from which the settings of individual elements can be calculated, and with which the measured values can be compared. These files will form the central part of the distributed data base, and should be partitioned in such a way that a control program will only need to load a subset to provide the environment in which a certain series of actions can be performed.
Where modelling or simulation is involved, requiring greater computing power or capacity than can be provided by the console computers, the control program can send a request to a larger computer to obtain the appropriate file, perform the calculation and remit the results, either direct to the requestor or into a library file.

Another important aspect of operation is the reporting of errors and alarms. At the lowest level, all equipment or interface incorporating property modules should run periodic surveillance programs and report to their process computer any errors or malfunctions detected. The process computer should also run surveillance programs to interrogate the property modules, to check the operation of several equipments as a system, and to do some elimination of some alarms which are consequential on the malfunction of some other equipment. These surveillance programs will report the significant alarms to the alarm computer. Assuming the alarm computer operates in the same way as that for the SPS, it will need a special data base housing the messages to be displayed on the alarm screen on the receipt of a coded alarm signal.

An important aspect of control is the coordination of actions in different parts of LEP during ramping. For this the timing system will be used which will distribute clock pulses and event markers to all the equipment needing them. Each equipment, such as a power supply, involved in the ramping, will be loaded with a file of values. A local program will be instructed to set the power supply to the first value of the table on the occurrence of one of the event markers, and then to set to subsequent values, or some interpolation between the stored values, every n ticks of the timing clock. Thus the synchronization will not depend on any guaranteed response time of the computer system.

Maintenance of LEP

Once a fault has occurred, additional information is required to correct it. Firstly, the alarm message may not be specific enough to identify the actual part that is giving trouble, and so it will be necessary to have extensive test programs that can be run to give the necessary identification. After identification it is then necessary to answer the questions as to where exactly it is located, which group is responsible for it, who to call and where to find him, what is the spares situation and so on.
Since some of this type of information will have to be included in the Oracle LEP Data Base (LEP Note 374), for the installation of the equipment, etc., and duplication is to be avoided, it is proposed that all of this type of information, including maintenance "help" files, should be kept on this Oracle system. This means that access to the Oracle system must be provided from the LEP control network. The equipment directories in the various process computers should then have entries pointing to the appropriate Oracle files, and the request for information on a given equipment made at a control console should result in the automatic fetching and display of the Oracle information.

The interconnection of the various parts of the distributed data base is shown in the figure.
LEP CONTROL LIBRARY

VIRTUAL PARAMETERS
ENVIRONMENT

STANDARD SETTINGS

PROPERTY MODULE
DATA TABLES

EQUIPMENT
DIRECTORIES

HELP

LEP ORACLE DATA BASE

EQUIPMENT FILES
WHAT?
WHERE?
WHO RESPONSIBLE?
HOW TO CALL?
ETC

PROCESS COMPUTER
LEVEL

CONSOLE

ENVIRONMENT

ALARM
MESSAGES

RESTART

COMPILE OR ASSEMBLE

LEP DISTRIBUTED DATA BASE

PROPERTY MODULE

DATA TABLE

PROPERTY DIRECTORY

PROPERTIES
PROTECTION
INTERFACE ADDRESSES
HELP REFERENCES
ETC

DEMANDED VALUES
CALIBRATION FACTORS
LIMITS
STATUS
LOCAL I/O ADDRESSES
ETC.