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公開資料

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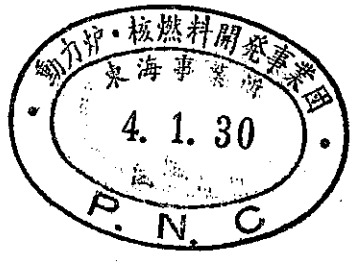


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TOKAI WORKS

Power Reactor and Nuclear Fuel Development Corporation

# A REAL-TIME ACCOUNTANCY AND CONTROL SYSTEM AT PLUTONIUM FUEL FACILITY OF PNC

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## Abstract

It must be provided for the mass criticality control to keep accurate material accountancy and control in facility where significant amounts of fissile materials are processed. The computerized accountancy and control system was applied into the plutonium facility of PNC and has been improved according to the accumulation of fabrication experience. This system is being operated on real-time basis and also is very useful for the safeguards requirements. The source data for MUF analysis activities are obtained by processing the PIT data. The requirements, structures and operational method of this system will be described in this paper.

## 1. INTRODUCTION

The Plutonium Fuel Development Facility (PFDF), the initial plutonium facility of PNC, was put in operation in early 1966. The PFDF is a facility for conducting physical properties measurements and fabrication technology development of mixed oxide fuels. In 1971, the Plutonium Fuel Fabrication Facility (PFFF), the new facility, was constructed in order to meet the plutonium fuel fabrication requirements from the PNC's FBR and ATR projects. The production capacities of PFFF are 15 and 50 kilograms of mixed oxide per day for FBR and ATR fabrication lines, respectively.

In the PFDF, the fabrication experience for more than 1,000 kilograms of mixed oxide has been accumulated since it was put in operation. On the other hand, in the PFFF, 119 subassemblies for the experimental fast reactor "JOYO" have been fabricated and about 1.5 tons of mixed oxide have been processed during fabrication at the FBR line. The fuel for the prototype advanced thermal reactor "FUGEN" is being fabricated at the ATR line.

It is necessary for mass criticality control to keep accurate accountancy and control in the facility. Therefore, the computerized system for accountancy and control was introduced for the plutonium operation since its early stage. This system has been improved according to the accumulation of fabrication experience. The present version has successfully been operated on real-time basis and also effectively utilized to safeguards procedure.


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## 2. OBJECTIVES AND/OR REQUIREMENTS OF COMPUTERIZED SYSTEM

The main purpose of the computerized system is to maintain an acculate accounting of amount and location of nuclear materials. In the PFDF and PFFF, various types and large amounts of the materials always exist in all fabrication processes. They move through a complicated path in the process at random. Considering these situation, it is practically difficult by usual accountancy method to classify without fail individual material during dynamic operation for fabrication.

Therefore, the computerized system was designed to meet the following requirements:

(1) To check against mass criticality limit at a time when the material transfer occurs

(2) To maintain the running inventory of all materials in each handling area

(3) The material transfer is always confirmed doubly by the personnel of accountancy and control group

(4) To give a unique identification code to the material and handling area for standardization of material transfer

(5) To produce routine reports for management of the facility operation and nuclear materials

(6) All available data should be stored and output for the process and quality control.

## 3. COMPUTER HARDWARE SYSTEM

In order to accommodate the above mentioned requirements, a computer hardware configuration is arranged as shown in Figure 1. The central unit is a FACOM230-45S digital computer with 320 kilobytes of core memory. In addition, there are the other units of peripheral input/output device connected to the central unit. The four remote terminal typewriters and one characteristic display unit are used for communication between the computer system and some staff or group concerned with a job such as process, quality and accountancy control. Each input/output device is operated in on-line basis monitoring system called "OS-II".

## 4. STRUCTURES OF THE SYSTEM AND DATA

In order to satisfy the requirements mentioned above, the data file should be brief as far as possible and used as a general purpose file. Therefore, the concept of data base was applied and a series of file-oriented programs were developed. Complying with the purpose such as daily material transfer control, physical inventory data processing and so on, following three subsystems were developed:

(1) Nuclear material transfer procedure

(2) Physical inventory data processing

(3) Data retrieval, back-up and filesaving.

Figure 2 shows the general structure of this system. All computer programs of these subsystem are written in PL/1.

The computer programs are always run with some data files under the data base concept. The files are constructed by random access mode and placed on disc-pack memory. The main data files are as follow:

(1) Material file

This file is of the material batch identified to the system. The identification code consists of two letters and three digits; for example: PU001, EU014, NU502, DU601. The two letters show the element of material and three digits are assigned by mean of material property such as origin nation, fissile content and the project. These characters are assigned when the material is received from other facility which is outside material balance area (MBA). And then, in addition to this file, the origin, isotopic ratio, content, the project code, received date and so on are recorded.

(2) Inventory file

All processes in the facility are divided to about 500 sub-MBA (accountancy unit where material balance is taken only for the criticality control) such as glove-box, fuel pin fabrication process and storage of source material, scrap and product. This file is having the running inventory in each sub-MBA. The record of this file contains following information:

A. Sub-MBA code consisting of one letter and three digits; for example: A001, D017, G015

B. Fabrication process code of sub-MBA

C. Mass criticality limit

D. Nuclear and fissile material weight

E. Each origin material weight

F. Existing material identification code and the weight

G. Last transfer number for sub-MBA

H. A number of fuel pin or subassembly in sub-MBA of fuel pin assembling process.

(3) Current transfer file

This file is set up by the transfer request sheets. The key-code of the request sheet, date, sheet number, sub-MBA code of shipping and receiving, material identification code, actual or estimated weight, content, composition, transfer

object, etc. are recorded in this file. Some data in this file are used to update the inventory of sub-MBA.

(4) Completed transfer file

This file is the log of the completed transfer. In addition to the items of current transfer file, the serial transfer number, the transfered net and fissile material weight, and the transfered time are recorded in this file. These records are kept on disc-pack memory for three months and subsequently will be saved onto magnetic tape memory.

## 5. BASIC OPERATION

The each file is protected by the unique "pass-word" in order to prevent file failure due to the system operation mistake, and is closely checked by the computer operator everyday. This computerized system for the accountancy and control is being operated having priority over other system. The subsystem described below are operated according to demand.

(1) Nuclear material transfer procedure

This subsystem consists of inquiry program which is operated by the remote terminal typewriter placed at fabrication process, and several foreground and background programs which are operated by the central computer unit. The general flow of this subsystem is shown in Figure 3.

Prior to the material transfer, the transfer request sheets (optical mark reader sheet; OMR sheet) in which sub-MBA code of shipping and receiving, material identification code and other items concerned with the transfer are marked, are submitted from fabrication process section to accountancy and control group. These sheets are read by the optical mark reader without punching, and verified whether valid or not. When error is found, the sheet is rejected. The current transfer file are set up from corrective sheets and then the transfer plan sheets on which are listed the same items as this file, are printed out. The foreground programs are used to treat these procedure.

Whenever the material are transfered, the inquiry program accepts the key-code of the plan sheet and net weight to be transfered via a remote typewriter. Then, the computer accesses the file, checks the input data, calculates the transfered amounts and the sum of amounts in receiving sub-MBA, and compares the summed amounts with the mass criticality limit. The answer of "YES" or "NO" for the transfer operation is printed out on the transfer confirmation sheet as shown in Figure 4 via the remote typewriter. In a case of "YES", the computer further asks the personnel of accountancy and control group in order to verify the transfer. After the verification, the inventory and the current transfer file are updated.

At the end of each day, the background programs are operated. Then they produce some reports for accountancy and control, add the actual transfer records to the completed transfer file, and delete all records of the current transfer

file for the request sheet of next day.

(2) Physical inventory data processing

Though the numerical processing for the daily material transfer procedure is performed by using the computer, the material weight in the inventory file (the book inventory) contains some errors due to weighing, analysis, recording mistake and operation loss. Therefore, these errors which cause the difference between the book and the physical inventory increase day by day. In order to correct this difference, the periodical physical inventory taking (PIT) is carried out at the end of every three months.

A lot of data are picked up at the PIT, so that OMR sheets are used for these data which are recorded in each sub-MBA field. After the processing for the OMR sheets, the inventory file is corrected to the physical inventory, and the difference (material unaccounted for; MUF) of each sub-MBA are analyzed and classified to some factors such as weighing error, analysis error and operation loss.

(3) Data retrieval, back-up and filesaving

The files are being operated by random access basis, so that the required information, such as the output data for verification at safeguards inspection and the total inventory in the PFDF and the PFFF, can be retrieved on demand at any time. It is quickly obtained by the remote characteristic display unit which is operated on conversational mode, and placed in accountancy and control group office. One example, inventory of material identification in a sub-MBA, is shown in Figure 5.

There are some utility programs which back up and save up all files. These programs are written in order to generate the back-up files, and to reconstruct the files in a case of file failure due to computer operation mistake. The inventory file which is one of most important file is saved to magnetic tape memory at the end of each day.

By using this computerized system, the processing of all data for the accountancy and control become more speedy, and the mass criticality control can be performed to keep more safety. This system is very useful for safeguards procedure, because the amounts, location and whole available data concerned with the nuclear material are always kept accurate on-time. If the accountancy and control was carried out without computer application, it seems that this task could be overburden on PNC plutonium operation.

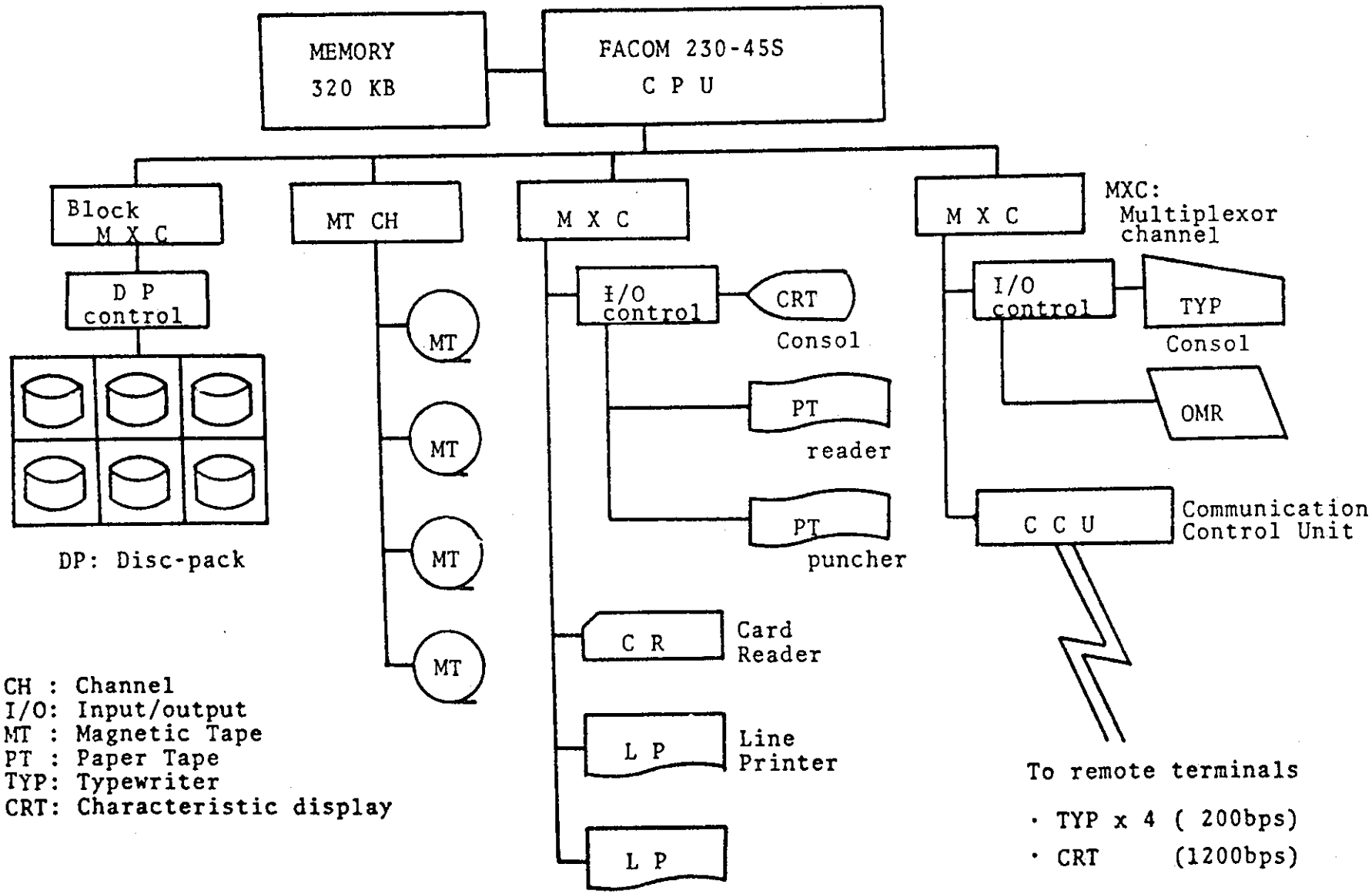


**Figure 1 Computer Hardware Configuration**

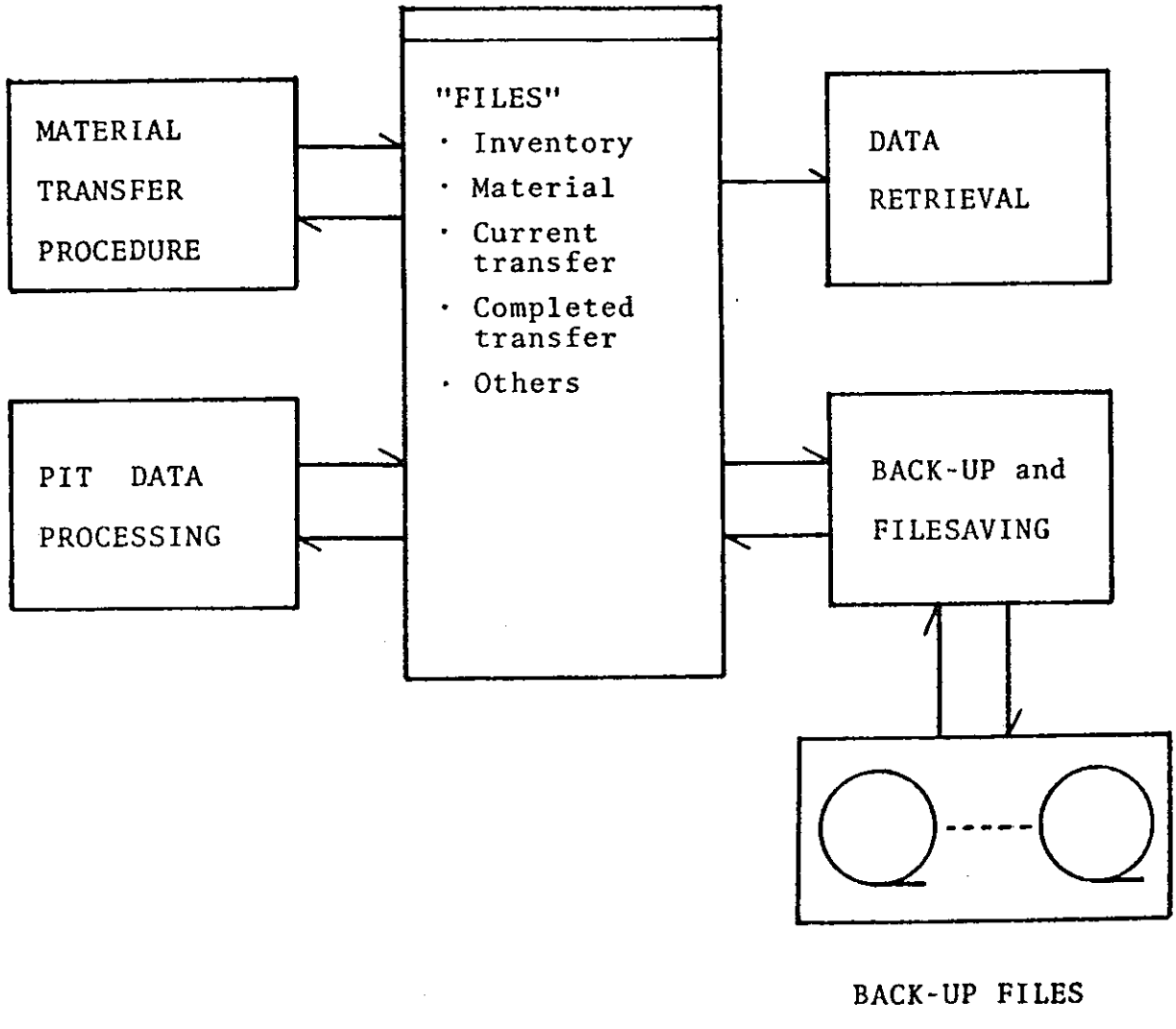


Figure 2 General Structure of Computerized System

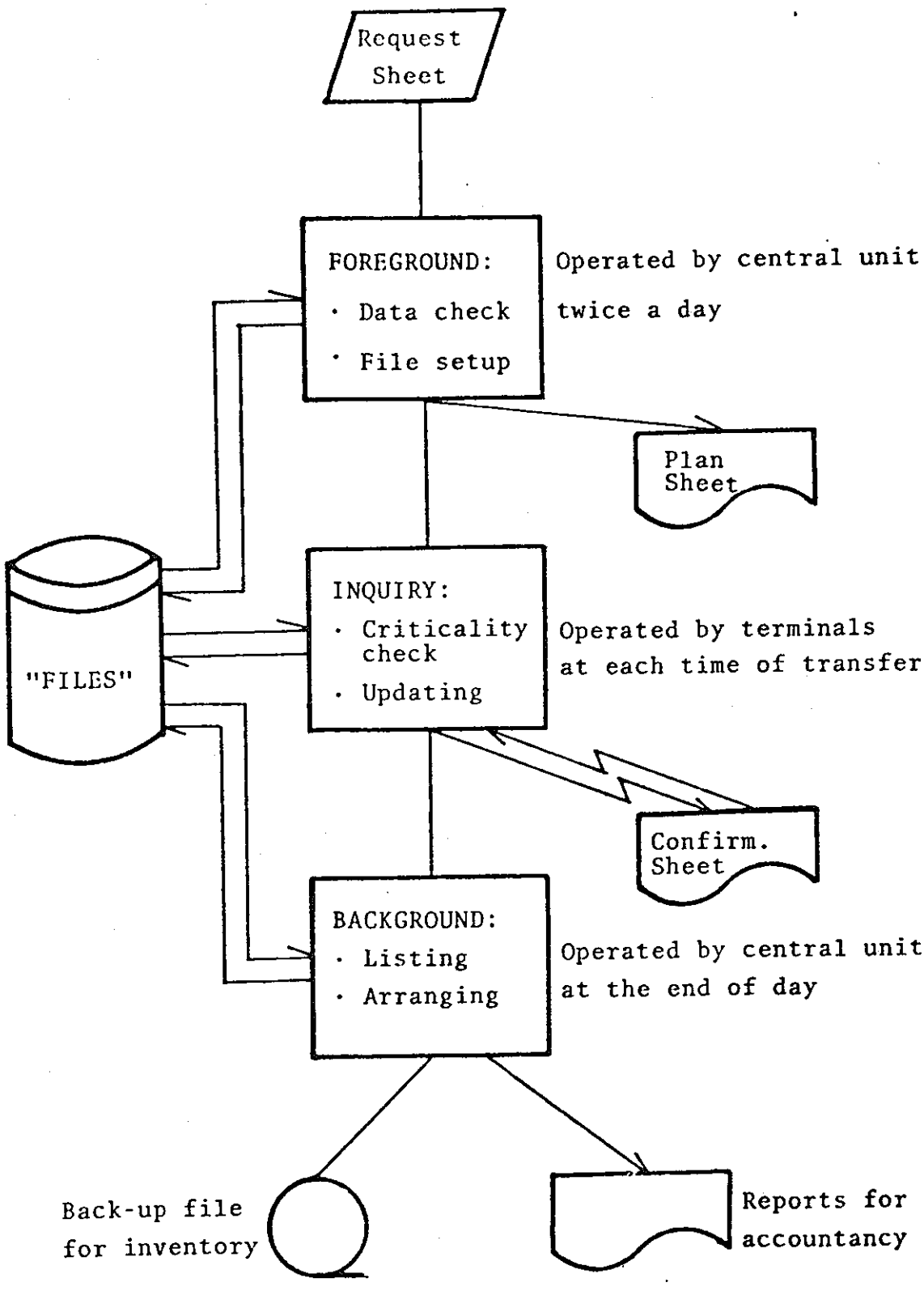


Figure 3 General Flow of Material Transfer Procedure

( Transfer Confirmation Sheet )

# 核物質移動確認票(1)

(受入先保管)

86613 | 02760550 |

プルトニウム燃料部管理課

(KEY-code) (Input weight, F8.2)

| 移動は… | 移動方法 | 名称 | 日付 | 移動時間 | SQ.NO. | 運搬番号 | 個数・本数 |
|---|---|---|---|---|---|---|---|
| "YES" | CART | PU02-U02 | 75-05-01 | 10-31 | 12643 | 5101-0 | |

| 重量区分 | 物質区分(1) | 物質区分(2) | 確定重量(グロスg)又は容積(l又はml) | 形状 | 目的 | 製造ロット |
|---|---|---|---|---|---|---|
| | PU-601 | NU-508 | 27605.50 | POWDER | PRESS | 0012-0 |

| Pu混合率 | Eu,Nu/Du混合率 | Pu核分裂性重量(グロスg又はml) | Eu,Nu,Pu核分裂性重量(グロスg又はml) | Pu-fissle率 | Eu濃縮率 | 補正係数 |
|---|---|---|---|---|---|---|
| 0.02152 | 0.97848 | 0.87280 | 0.87651 | 0.7998 | | |

(Inventory in shipping sub-MBA after updated)

| 払出グループ | Pu | Eu | Nu | Du | FIS | |
|---|---|---|---|---|---|---|
| D-010 | 31.74 | 0.00 | 146.14 | 0.00 | 26.42 | 払出 |
| (Transfer weight) | 518.50 | 0.00 | 23675.79 | 0.00 | 585.17 | 計量値 |
| 受入グループ | Pu | Eu | Nu | Du | FIS | |
| D-014 | 638.04 | 0.00 | 29734.33 | 0.00 | 724.46 | 受入 |

(Inventory in receiving sub-MBA after updated)

(備考)
*** 10643 *** (serial transfer number)

Figure 4 Output of the transfer confirmation sheet

***** GROUP INVENTORY (LOT) *****  DATE & TIME : 75.05.07 : 16.18.57.500

GROUP NUMBER = F001  NUMBER OF LOT : 15

| | | | | | |
|---|---|---|---|---|---|
| PU001 | 174.15 | PU004 | 189.00 | PU102 | 4.54 |
| PU501 | 85.41 | EU001 | 9.50 | EU002 | 4.86 |
| EU003 | 259.87 | EU004 | 24.41 | EU008 | 2.64 |
| EU009 | 168.54 | EU521 | 1.25 | NU001 | 1,394.91 |
| NU002 | 565.81 | NU003 | 6.40 | DU001 | 20.70 |

Figure 5 Inventory of material identification in a sub-MBA