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INTEGRATED QUALITY STATUS AND INVENTORY TRACKING SYSTEM FOR FAST FLUX TEST FACILITY DRIVER FUEL PINS

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Integrated Quality Status and Inventory Tracking System for FFTF Driver Fuel Pins

by

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ABSTRACT

An integrated system for quality status and inventory tracking of Fast Flux Test Facility (FFTF) driver fuel pins has been developed. Automated fuel pin identification systems, a distributed computer network, and a data base are used to implement the tracking system.

KEYWORDS: Fuel pins, quality status tracking system, inventory tracking system, fuel pin identification system, manufacturing information system

INTRODUCTION

Rigid manufacturing, quality assurance, and safeguards requirements mandate the need for an integrated system for management of breeder reactor fuel pin and assembly manufacturing data. Reliability must be maximized by compiling all required data in one central store and by minimizing manual data entry.

This paper describes a system at the Hanford Engineering Development Laboratory (HEDL) for demonstration in the FFTF driver fuel assembly manufacturing process. The system design and concepts provide a basis for use in other processes as well as the one described herein.

PRINCIPLE OF OPERATION

The system concept is based upon the elimination of manual record systems at individual process and inspection stations and establishing one central, on-line set of process, inspection, and inventory data. This concept allows real-time maintenance of all data enabling background status checks to prevent further processing of defective or held materials.

Automated data acquisition techniques are employed to minimize the need for operator entry of data. A distributed microcomputer system is integrated with the existing process equipment to allow acquisition of the process data from the various fuel pin and assembly stations. A combination of hardware and software is used to implement the on-line system and maintain the quality status and inventory data. The hardware and software meets the design goals to provide:

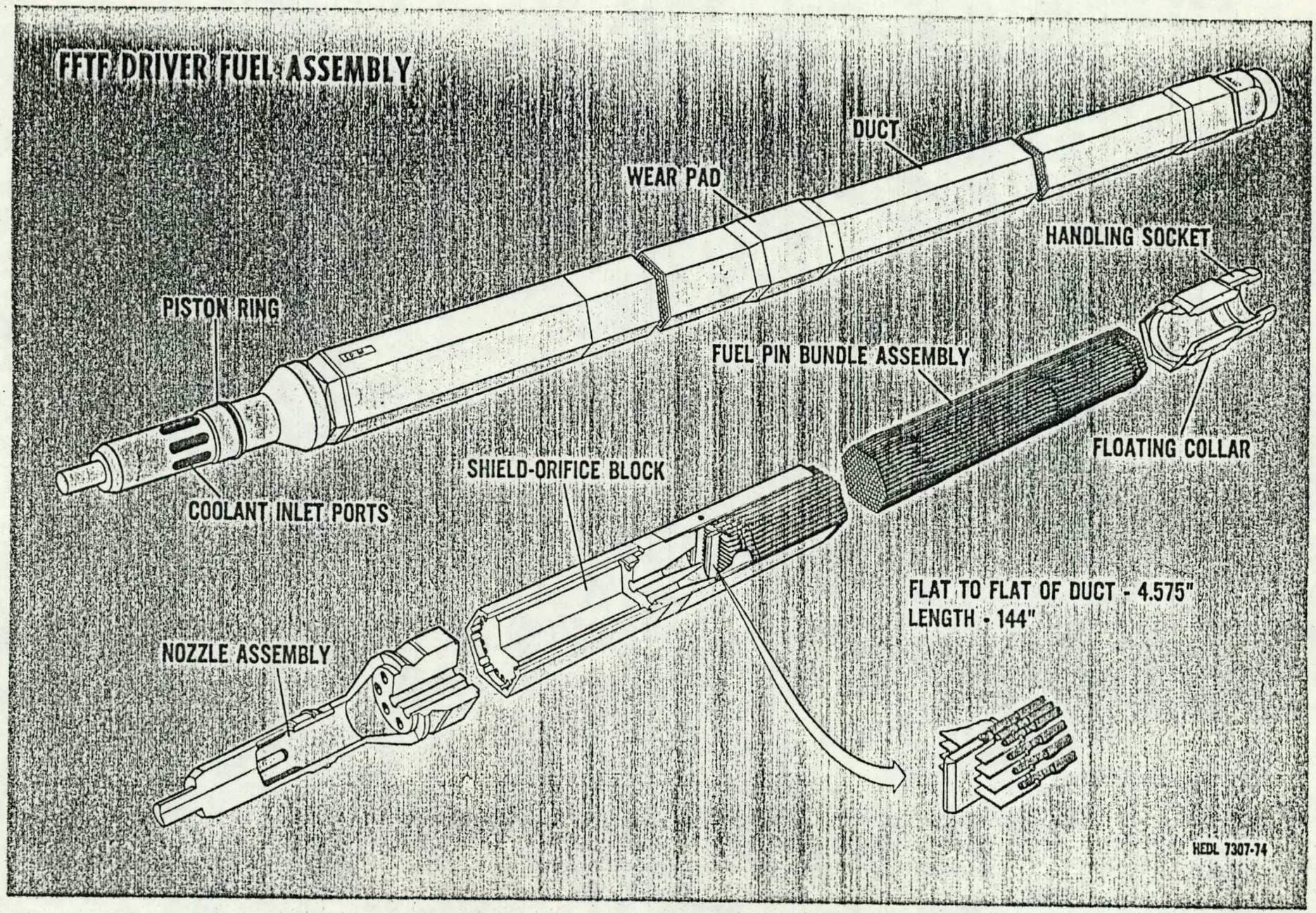
- Data protection and data access controls
- Real-time response to process and inspection data
- User oriented work station operation

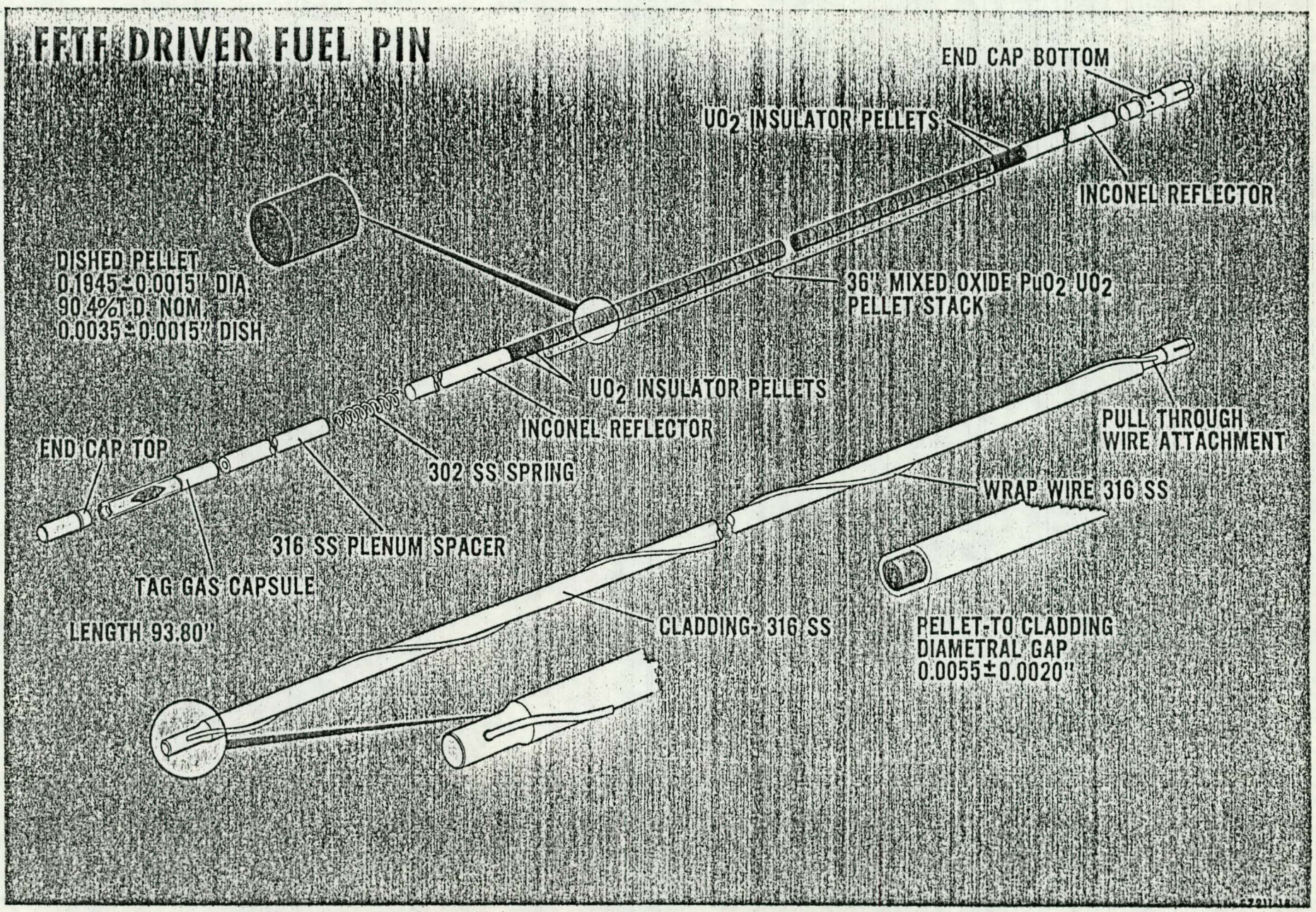
PROCESS DESCRIPTION

Commercially manufactured fuel pins are received, inspected, and processed into 217-pin bundles. Addition of a duct over the bundle completes the assembly process. The assembly is then inspected and characterized prior to certification for use in the FFTF reactor. The FFTF fuel pin and assembly designs are shown in Figures 1 and 2.

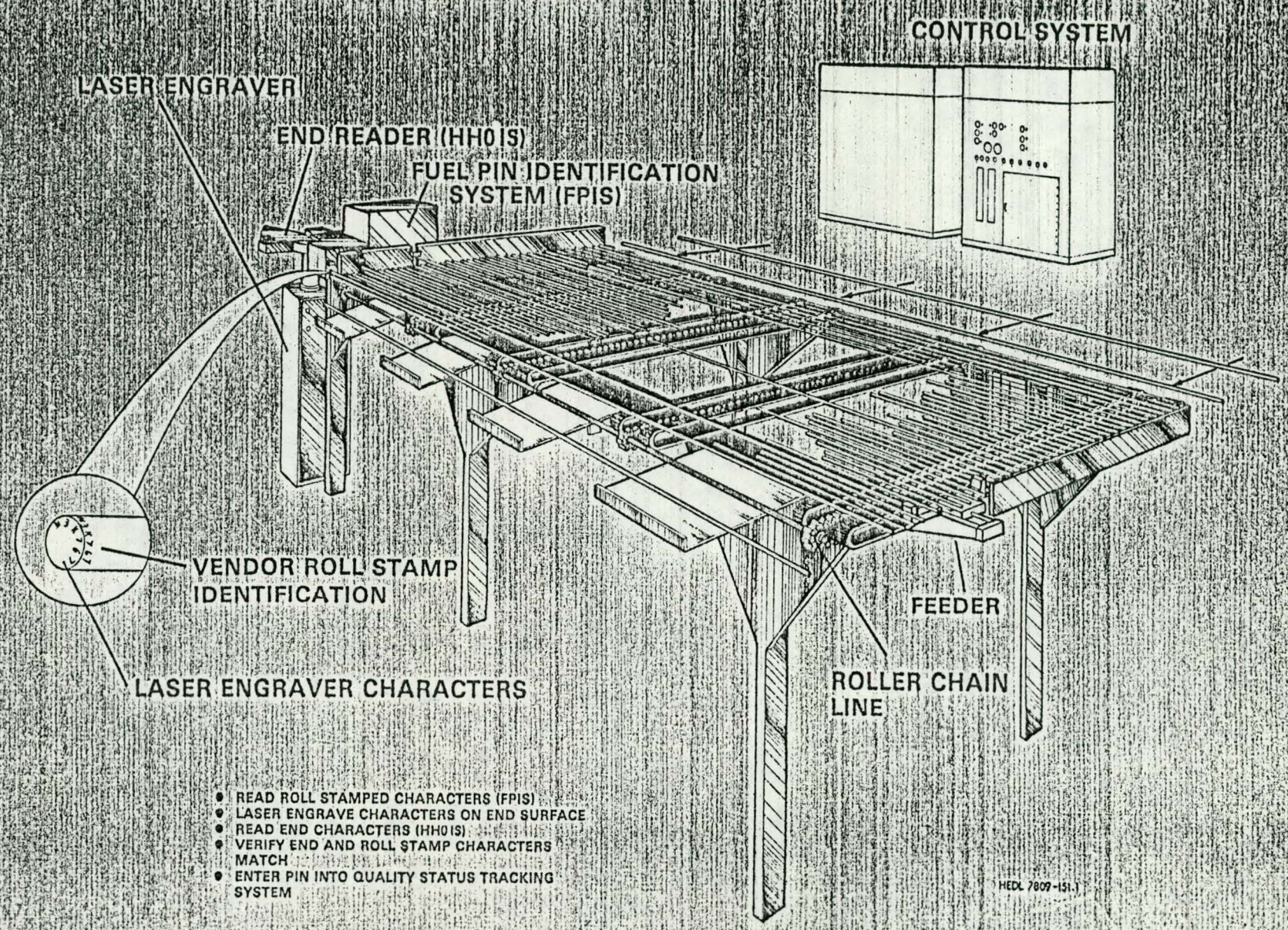
Each individual fuel pin is uniquely identified by a six-digit code indicating the manufacturer, fuel enrichment, and sequence number. As received, the identification is roll-stamped around the circumference of the top end cap. The first process operation is to laser-engrave this identification on the end surface of the top end cap. In addition to being more amenible to machine reading, the laser-engraved characters provide a means of identifying fuel pins once they are fixed into the 217-pin bundle. The identification systems and work station used for laser engraving the end characters are shown in Figure 3.

The fuel pin receiving inspection and fuel assembly manufacturing processes are well established and have been operating routinely for approximatley six years. The process and the integration with the quality status and inventory tracking system are outlined in Figure 4.


FFTF DRIVER FUEL ASSEMBLY
DUCT
WEAR PAD
HANDLING SOCKET
PISTON RING
FUEL PIN BUNDLE ASSEMBLY
FLOATING COLLAR
SHIELD-ORIFICE BLOCK
COOLANT INLET PORTS
FLAT TO FLAT OF DUCT - 4.575"
LENGTH - 144"
NOZZLE ASSEMBLY
HEDL 7307-74


FFTF DRIVER FUEL PIN
END CAP BOTTOM
UO_2 INSULATOR PELLETS
INCONEL REFLECTOR
DISHED PELLET
0.1845±0.0015" DIA.
90.4%T.D. NOM.
0.0035±0.0015" DISH
36" MIXED OXIDE PuO_2 UO_2
PELLET STACK
UO_2 INSULATOR PELLETS
INCONEL REFLECTOR
PULL THROUGH
WIRE ATTACHMENT
END CAP TOP
302 SS SPRING
WRAP WIRE 316 SS
316 SS PLENUM SPACER
TAG GAS CAPSULE
LENGTH 93.80"
CLADDING- 316 SS
PELLET-TO CLADDING
DIAMETRAL GAP
0.0055±0.0020"

FUEL PIN RECEIVING STATION



- READ ROLL STAMPED CHARACTERS (FPIS)
- LASER ENGRAVE CHARACTERS ON END SURFACE
- READ END CHARACTERS (HH01S)
- VERIFY END AND ROLL STAMP CHARACTERS MATCH
- ENTER PIN INTO QUALITY STATUS TRACKING SYSTEM

HEDL 7809-151.1

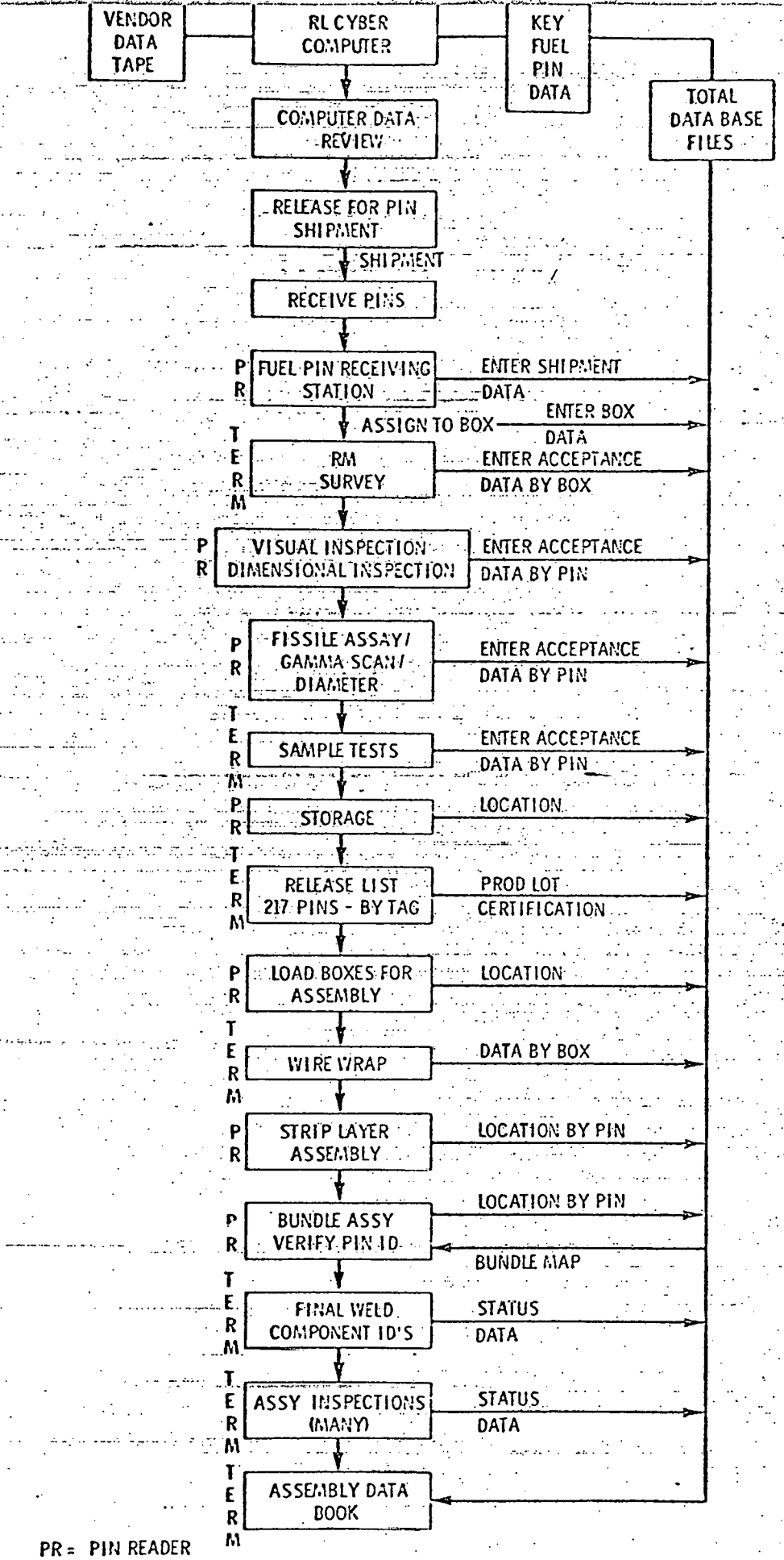


Figure 13. Flow Chart of Data Acquisition Implementation

The first step in the process involves adding a pre-shipment data set to the on-line data base. This information, furnished by the fuel pin manufacturer, consists of fuel pin manufacturing and component lot data. Each fuel pin is checked against this data base to assure the pin was accepted and certified by the reader as part of the receiving operation. A series of 100-percent and sampling inspections are performed prior to releasing the fuel pins for assembly operations.

Processing at each station is preceded by a background check to assure that no hazardous conditions are created by further processing the fuel pin. For the bundle assembly operation, the quality status of the pins is also checked to assure that only accepted pins are included in the finished assembly.

Following final assembly inspecitons all data are again reviewed as part of the assembly certification process.

SYSTEM DESCRIPTION

The system described herein is implemented as a collection of individual subsystems, carefully integrated to form the system required to maintain continuously current information.

The major components described in the following sections include:

- Information Management Center (IMC)
- Remote Process Stations

At the end of the section, a specific application is described:

- Fuel Pin Fissile Assay--an example remote station

Each individual component contributes to the performance of the system and is described with reference to its relationship in the system.

Information Management Center

The primary function of the Information Management Center (IMC) is to provide a central store for all process, inspection, and inventory data. Additionally, the IMC acts as the communications and access control manager for the integrated system. Combining these features with the real-time data handling capabilities, the system allows constant monitoring of fuel pin and assembly status as well as current inventory and item location data. These features are provided by the use of a PDP-11 minicomputer

operating under the RSX-11M operating system. The TOTAL data base system is combined with application specific software to manage the quality status and inventory data.

During on-line operations, data are pre-processed by the remote process stations and submitted as transactions to the IMC. Following additional validity checks by the IMC, the transactions are processed and the transaction status returned to the remote station.

A central access control file is maintained by the IMC. Access to each mode of operation is allowed only if associated access flags are set for both the requesting operator and the requesting station. The remote station submits a logon transaction to the IMC and the IMC returns a transaction to the remote station indiciating the allowed operating modes for display and menu selection at the remote station.

The following are allowed operating modes:

Logon-Menu	- As described above
Move	- Update fuel pin locations
Process	- Add process/inspection data to the data base
Certify	- Complete fuel/assembly certification reviews
Trans	- Privileged access to host

Each mode involves a cooperative effort between the IMC and remote station. By allowing only pre-tested programs for normal operation, the system reliability is greatly improved. The trans mode allows privileged users direct access to specific tasks residing in the host. Such tasks include BASIC, QUERY, and REPORT-WRITER. Normal users are allowed access only to the functions required by their particular job description.

Remote Process Station

The remote station concept evolved from the need for local automated data acquisition at selected work stations, to provide stand-alone systems for easy interface to the existing process equipment, and to allow for expansion to meet future unforeseen requirements.

The primary function of the remote station is to act as a pre-processor for the IMC. In operation, the remote stations acquire all real-time process data and perform the time consuming validation and verification checks in all transactions for the IMC. One of the major advantages of

the remote station concept is in providing an additional access control level between the user and the host. Each remote station is configured to run only carefully tested and tried programs. This concept, in conjunction with the central host control of access rights, makes inadvertant or intentional tampering with the data base exceedingly difficult.

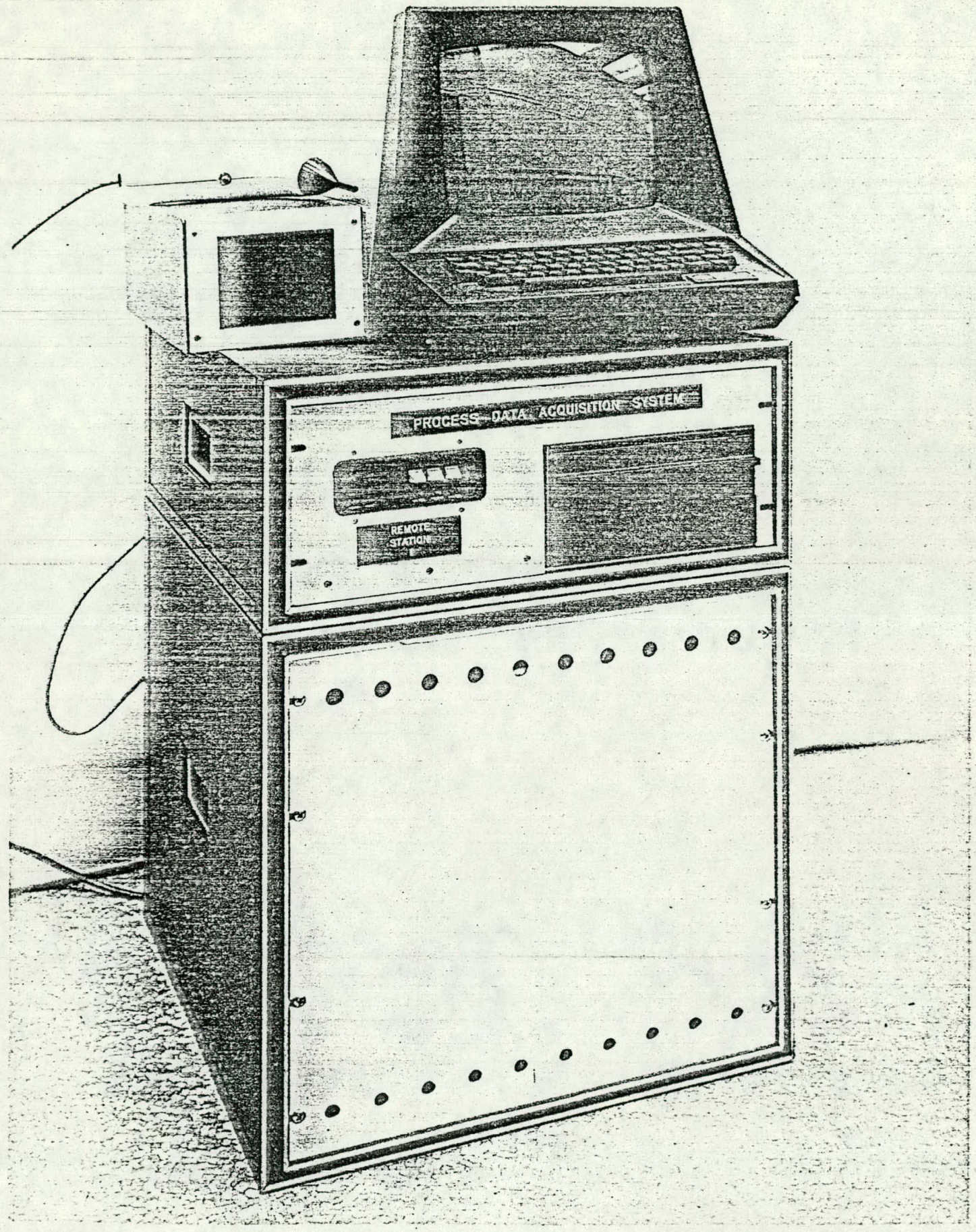
The remote stations, by performing many of the tedious and resource consuming check functions, free up valuable resources on the host while giving the user nearly instantaneous response at his operator terminal. Figure 5 shows a typical remote station consisting of the fuel pin reader system, dedicated operator CRT, and microprocessor controller. The pin reader consists of the large electronics cabinet, the actual camera, and a small CRT for display of the raw video data and processed pin identification characters. The microprocessor provides for control of the pin reader, communication with the operator and the IMC, and for the acquisition of process data as required for each station.

In operation, the pin identification is read by the automated reader system and verified from the operator keyboard. Key process data and the pin identification are screened and transmitted to the IMC for processing.

Additional verification is performed by the IMC prior to updating the data base. The IMC always returns a transaction status to the remote station providing feedback on the success of the transaction.

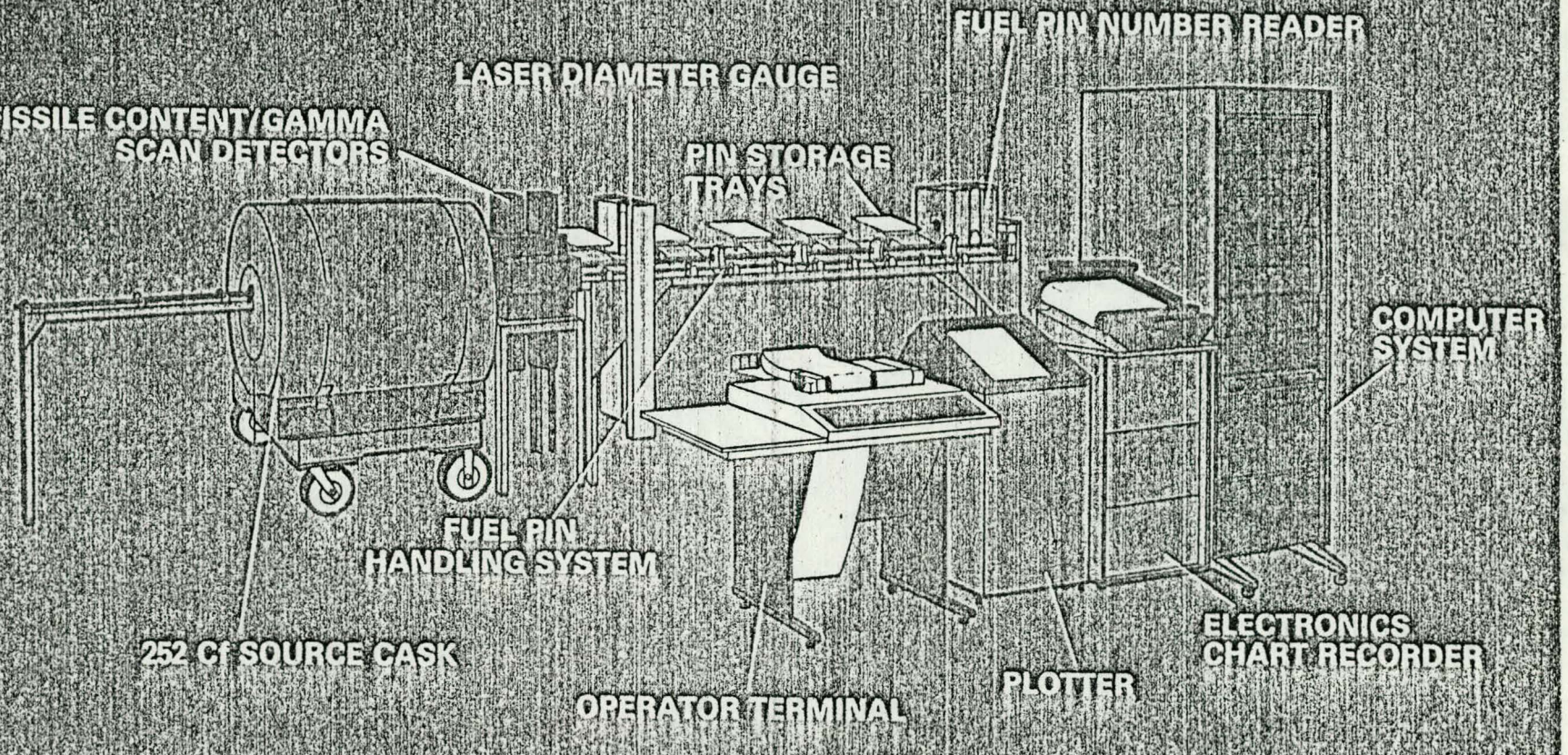
Fuel Pin Fissile Assay--An Example Remote Station

One of the most important process operations in the receiving inspection process is the fuel pin fissile assay system. The ^{252}Cf fuel pin assay system developed by the Los Alamos Scientific Laboratory (Reference 1) has been upgraded (Reference 2) and integrated into the quality status system. This equipment is used to inspect the commercially produced FFTF driver fuel pins. Total fissile content, fuel column fissile uniformity and fuel pin diameter are measured, and pin identification is automatically determined at the assay station (Figure 6). In operation, the fissile assay, gamma scan, and pin diameter data are accumulated. Calibration data obtained at four-hour intervals provide the basis to calculate actual pin mass, pellet deviations, and pin diameter from the raw data acquired during the assay cycle. The raw data, pin identification, and calculated acceptance information are logged to magnetic media for permanent storage. Key process information is transmitted to the IMC to update the quality status and location records. Once this information and the other process status data are stored in the central data base, it is available for further calculation, various process reports, and for generating the final inspection records package for each fuel pin.


PROCESS DATA ACQUISITION SYSTEM
REMOTE STATION

FUEL PIN FISSILE ASSAY WITH FPIS

- MEASURE TOTAL FISSILE CONTENT (^{239}Pu + ^{241}Ru)
- EXAMINE FOR HIGH/LOW ENRICHED PELLETS
- MEASURE FUEL PIN DIAMETER
- RECORD PIN SERIAL NUMBER



SUMMARY

The implementation of the system described is progressing at a rapid pace. Currently, the software for communications, remote logon, and move have been developed. In addition, a demonstration data base containing data for 8,000 fuel pins has been loaded with the vendors' pre-shipment data set. The target goal for complete implementation of the components described in this paper is mid-1980.

REFERENCES

1. H. G. Menlove, et al, ^{252}Cf Assay System for FBR Fuel Pins: Description and Operating Procedures Manual, LA-5071-M.

2. G. P. Gottschalk, Real Time Analysis of FFTF Fuel Pin Inspection Data at the ^{252}CF Assay Station, HEDL-TME-79-1.