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**ASBLT—A SYSTEM OF DATATRAN
MODULES WHICH PROCESS CORE
FUEL LOADING FOR USE IN
AS-BUILT CALCULATIONS
(LWBR Development Program)**

MASTER

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**BETTIS ATOMIC POWER LABORATORY
WEST MIFFLIN, PENNSYLVANIA**

Operated for the U. S. Department of Energy by
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(LWBR Development Program)

B. R. Beaudoin
W. J. Beggs
C. R. Case
R. Wilczynski

February 1979

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FOREWORD

The Shippingport Atomic Power Station located in Shippingport, Pennsylvania was the first large-scale, central-station nuclear power plant in the United States and the first plant of such size in the world operated solely to produce electric power. This program was started in 1953 to confirm the practical application of nuclear power for large-scale electric power generation. It has provided much of the technology being used for design and operation of the commercial, central-station nuclear power plants now in use.

Subsequent to development and successful operation of the Pressurized Water Reactor in the DOE-owned reactor plant at the Shippingport Atomic Power Station, the Atomic Energy Commission in 1965 undertook a research and development program to design and build a Light Water Breeder Reactor core for operation in the Shippingport Station.

The objective of the Light Water Breeder Reactor (LWBR) program has been to develop a technology that would significantly improve the utilization of the nation's nuclear fuel resources employing the well-established water reactor technology. To achieve this objective, work has been directed toward analysis, design, component tests, and fabrication of a water-cooled, thorium oxide fuel cycle breeder reactor for installation and operation at the Shippingport Station. The LWBR core started operation in the Shippingport Station in the Fall of 1977 and is expected to be operated for about 3 to 4 years. At the end of this period, the core will be removed and the spent fuel shipped to the Naval Reactors Expended Core Facility for a detailed examination to verify core performance including an evaluation of breeding characteristics.

In 1976, with fabrication of the Shippingport LWBR core nearing completion, the Energy Research and Development Administration established the Advanced Water Breeder Applications (AWBA) program to develop and disseminate technical information which would assist U. S. industry in evaluating the LWBR concept for commercial-scale applications. The program will explore some of the problems that would be faced by industry in adapting technology confirmed in the LWBR program. Information to be developed includes concepts for commercial-scale prebreeder cores which would produce uranium-233 for light water breeder cores while producing electric power, improvements for breeder cores based on the technology developed to fabricate and operate the Shippingport LWBR core, and other information and technology to aid in evaluating commercial-scale application of the LWBR concept.

FOREWORD (Cont)

All three development programs (Pressurized Water Reactor, Light Water Breeder Reactor, and Advanced Water Breeder Applications) have been administered by the Division of Naval Reactors with the goal of developing practical improvements in the utilization of nuclear fuel resources for generation of electrical energy using water-cooled nuclear reactors.

Technical information developed under the Shippingport, LWBR, and AWBA programs has been and will continue to be published in technical memoranda, one of which is this present report.

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ASBLT is a computer program consisting of DATATRAN MODULES which was used during the manufacturing phase of LWBR to collect and evaluate as-built data. The program was part of the LWBR fuel rod inspection process and produced sections of module assembly certification reports. ASBLT used fuel pellet, fuel rod and module assembly data to compute core inventories and to supply input to nuclear design programs for as-built core calculations.

ASBLT - A SYSTEM OF DATATRAN MODULES WHICH PROCESS CORE MANUFACTURING
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I. INTRODUCTION

The Light Water Breeder Reactor (LWBR) Program is developing the technology to breed fissile material in a light water thermal reactor to make more efficient use of nuclear fuel in such reactors. This technology is being developed through the design and fabrication of a breeder reactor core that is now in operation in the existing Department of Energy (DOE) owned pressurized water reactor plant at Shippingport, Pennsylvania. The design and fabrication of the LWBR core were accomplished by the Bettis Atomic Power Laboratory under the technical direction of the Division of Naval Reactors, DOE. The operation of the LWBR core in the Shippingport Atomic Power Station is expected to confirm that breeding of fissile material can be achieved in a pressurized light water reactor using a thorium (ThO_2) and a urania/thorium or binary ($\text{UO}_2\text{-ThO}_2$) fuel system. The LWBR core is the first large scale fabrication of a thorium base binary fuel of high density and the first fabrication of uranium-233 into ceramic fuel for use in a power reactor.

The design of the LWBR core (Reference 1) operating in the Shippingport Plant simulates a large LWBR core environment in the core's interior and permits net breeding in the entire core. The core is a seed-blanket configuration consisting of an inner region containing 12 movable seed assemblies each surrounded by a blanket assembly. The inner region is surrounded by an outer reflector region containing 15 reflector modules. The LWBR core contains no control rods and maintains criticality by varying the axial positions of the movable fuel assemblies.

Inspection procedures were developed and implemented during LWBR fabrication to control the finished product and to provide as-manufactured core data necessary for as-built performance evaluation. To assist in collecting and evaluating the as-built data obtained during fabrication for use in performance calculations, a computerized system called ASBLT was developed. ASBLT is a system of DATATRAN subprograms, called MODULES, which collects, saves, evaluates, and tabulates specific LWBR fabrication data. DATATRAN, described in Reference 2, is a data base management language for a modular computer program network developed jointly by the Knolls Atomic Power Laboratory and the Bettis Atomic Power Laboratory. ASBLT was developed as a computer system to collect certain fuel pellet, fuel rod and module assembly inspection data and to convert the as-built data into input required by the nuclear design computer programs used to evaluate core performance. During LWBR fabrication, the data processed by ASBLT were used directly in the inspection process and ASBLT was expanded to perform data checks which would normally have been done manually. ASBLT was one of the inspection tools for fuel rods in that fuel rod data collected at several fabrication points were evaluated by ASBLT for completeness, consistency and conformance to design specifications. The final version of the ASBLT system contains MODULES which collected, evaluated and checked as-built data and were an important part of LWBR fuel loading assurance during fabrication. Other MODULES generated the input required for as-built performance calculations. The data base maintained by ASBLT will be retained for use during the proof-of-breeding phase of LWBR when fuel rods will be assayed to demonstrate that LWBR did indeed breed fissile material.

To provide a better understanding of the nature of the data processed by ASBLT, a brief description of the LWBR manufacturing process is provided in Section II. Section III provides a summary description of the MODULES which comprise ASBLT. Appendix A presents a detailed description of the ASBLT MODULES, the input they require, the functions they perform and the results which they produce as either hard copy output or computer data files. Section IV provides a summary of the information presented in this report and conclusions relating to its general use.

II. DESCRIPTION OF LWBR MANUFACTURING PROCESS

Thoria fuel was made by compacting thoria powder into pellets, heating the pressed pellets in a sintering furnace to achieve the desired density and grinding the sintered pellets to achieve the desired diameter. A known amount of thoria powder produced a thoria pellet blend with its own unique designation or

blend identity for inspection and inventory purposes. Binary pellets were produced by mixing specified amounts of urania powder and thoria powder to achieve a required composition or weight percent UO_2 in $\text{UO}_2\text{-ThO}_2$, pressing the $\text{UO}_2\text{-ThO}_2$ powder into pellets, sintering the pellets and grinding the pellets. Depending on the pellet type, chamfers and/or tapers were applied to produce the pellet cross section depicted in Figure 1. Each binary pellet blend received a unique blend identity. For both thoria and binary pellet blends the blend identities were of the form III-J-KK. In the case of binary blends, whose inspected properties were saved in computer files maintained by ASBLT, the digit J in the blend identity signified the type or zone of binary fuel as listed in Table 1. Fuel zoning and fuel rod types are described in Reference 1.

TABLE 1. BINARY FUEL

<u>J</u>	<u>Type of Fuel</u>
1	Low zone seed
2	High zone seed
3	Low zone standard blanket
4	Medium zone standard blanket
5	High zone standard blanket
6	Low zone power flattening blanket
7	Medium zone power flattening blanket
8	High zone power flattening blanket

Random pellet samples were taken from both thoria and binary pellet blends. The samples were measured, weighed, and volume corrected for the dished and chamfered/tapered ends, and their densities computed. All of the binary pellet samples were nondestructively analyzed for total uranium content, using a delayed neutron pellet assay gage described in Reference 3, and a portion of the samples were destructively analyzed for total uranium content and for uranium isotopic content. The mean data for each binary blend were stored in computer files for use by ASBLT.

Finished fuel pellets were loaded into Zircaloy tubing which was sealed by end plugs welded at each end to form fuel rods. The fuel stack of a typical LWBR seed or blanket fuel rod consisted of a zone of binary fuel with zones of thoria fuel above and below. Reflector rods contained only thoria pellets. The length of the binary zone varied depending on rod type as did the composition of

NOTE: NOT TO SCALE

Figure 1. Cross Sections of Typical LWBR Fuel Pellets

the binary fuel in the binary zone. Each fuel rod was assigned a unique 7-digit serial number which was permanently engraved on the rod. The first two digits of the serial number identified the type of rod. A stacking data sheet was completed for each fuel rod on which were recorded the important characteristics of the rod as determined at the time of loading. The following stacking data were entered into the computer for processing by ASBLT (see Figure 2):

1. Rod serial number
2. Lengths of fuel zones and fission gas plenum (A, D, P, and S from Figure 2)
3. Binary blend identities, pellet quantities and weights by blend
4. Total weight of thorium pellets
5. Date and time of stacking
6. Identification of balance used to weigh binary fuel
7. Identification of furnace runs to remove moisture and other possible contaminants.

Length D for binary fuel rods, shown in Figure 2, was used to control the position of the top of the binary stack in seed rods and the bottom of the binary stack in blanket rods. Therefore, length D was the length of the binary zone plus the bottom thorium zone in seed rods and the length of the bottom thorium zone in blanket rods. The length D control was applied during pellet stacking of the bottom thorium zone and will be referred to later in this report as the bottom thorium control length.

Each rod was x-rayed, using the in-motion x-ray process described in Reference 4, after end closure welding (in-process radiography) and upon completion of manufacturing processes (final radiography). The following dimensions of binary rods were measured from the radiographs and entered into a computer file for use by ASBLT (see Figure 2):

1. Lengths of fuel zones (A, D and P)
2. Lengths of first and last two pellets in binary rods (W, X, Y and Z)
3. Stem length (H)
4. Identity hole location (I).

ASBLT compared the data from the x-rays to both specifications and to values recorded for the pellet stack before loading into the fuel rod. Discrepancies were identified by the program and corrected manually as required.

Figure 2. Schematics of LWBR Fuel Rods Showing Axial Dimensions Used in ASBLT

Every fuel rod was scanned ultrasonically to obtain a trace of clad wall thickness, using the ultrasonic inspection process described in Reference 5, and the mean wall thickness was filed by ASBLT. The outer diameter of each finished fuel rod was measured at four axial elevations on the rod and two orientations (at right angles to each other) at each elevation. The mean of the eight diameter values was also filed by ASBLT.

Finished fuel rods, as they were released for use in the core, were assigned to specific modules. The list of assigned fuel rods for a module was punched onto computer cards and retained as the master rod list for the module. As rods were installed in each module, a computerized verification procedure (in addition to manual administrative procedures) confirmed the correct installation of fuel rods. Computer files were maintained which contained permanent records of the rods installed in modules. These files were later checked against the module master lists, by ASBLT, as part of the module certification process.

The as-built data processed by ASBLT during LWBR core fabrication were used to help confirm that pellet blends, fuel rods and modules were fabricated according to design requirements. Data for the rods used in the core were processed by ASBLT into computer input for the as-built nuclear analysis calculations.

III. DESCRIPTION OF THE ASBLT COMPUTER SYSTEM

The ASBLT system was designed to maintain computer files of as-built fuel pellet, fuel rod and module fabrication data; to check the data against specification requirements; to perform statistical evaluations on the data; and to transform the data into input for the nuclear design programs used to evaluate core performance. ASBLT consists of 15 DATATRAN MODULES or subprograms which perform the required tasks. This section describes the ASBLT system, through brief descriptions of the ASBLT MODULES, and shows how ASBLT was used during LWBR manufacturing to assist in the inspection process and to evaluate as-manufactured properties. Appendix A describes each MODULE in detail and serves as the input manual for the ASBLT system.

A. START - The MODULE Used to Initiate the ASBLT System

Each ASBLT job executed on the computer is initiated by the MODULE START which writes key DATATRAN lists describing the core design. These lists define the core fuel regions (seed, standard blanket, power flattening blanket and reflector), the rod types in each region, the fuel zones in each region, the compositions to be used in the analysis programs, the nominal values and tolerances

for fuel rod parameters maintained in the ASBLT files, the module identifications and the orientations of the modules in the core. ASBLT will not function without these lists. The START MODULE, which is described in detail in Section A.I.a of Appendix A, initiates the ASBLT system specifically for the LWBR core design. Other similar core designs comprised of fuel elements contained in module assemblies can be accommodated by ASBLT by simply redefining the DATATRAN lists written by START; that is, by tailoring a START MODULE to each particular core design. Thus, ASBLT is not strictly limited in application to LWBR.

B. PUTAFM and GETAFM - MODULES Used to Save and Retrieve Files of Fuel Rod Data

Fuel rod data such as fuel zone lengths, binary blend identities, binary pellet quantities, binary and thorium stack weights, clad dimensions and rod locations in modules are held in DATATRAN lists by ASBLT for use by MODULES which perform data checks, statistical evaluations and other computations. The DATATRAN lists are written onto disk or tape using the MODULE PUTAFM and retrieved from disk or tape using the MODULE GETAFM. A typical ASBLT job related to fuel rod data executes START to initiate the job, executes GETAFM to retrieve fuel rod data and reconstruct the DATATRAN fuel rod data lists which existed upon termination of the most recent file update, executes one or more of the other ASBLT MODULES (described in the following sections) to either add new data or perform computations with existing data and executes PUTAFM to file revised DATATRAN lists for future use. PUTAFM and GETAFM, which are described in detail in Sections A.I.b and A.I.c of Appendix A, are not used to save and retrieve the card image files of fuel rod inspection data (intermediate files) or the files of blend data discussed in the following sections. These files are maintained by the MODULES NEWROD, ASBLT and GATHER.

C. NEWROD - The MODULE Used to Add New Data to the ASBLT Fuel Rod DATATRAN Lists

During LWBR manufacturing, fuel pellets, fuel rods, and module assemblies were at varying stages of fabrication on any given day. Inspection data became available for use in ASBLT in somewhat random fashion in terms of type of data relative to component identity. The NEWROD MODULE, which is described in detail in Section A.I.d of Appendix A, was developed to accept data from several sources and to direct the data to the appropriate locations in the DATATRAN fuel rod lists. NEWROD contains options to maintain the following four categories of data files:

1. Binary fuel rod data
2. Thorium fuel rod data

3. Fuel pellet impurity data
4. Composite binary blend data (defined later).

All of the above are files consisting of DATATRAN lists.

The first file type maintained by NEWROD contains as-built data for binary fuel rods (seed, standard blanket and power flattening blanket rods). Three binary fuel rod files were used during LWBR manufacturing, one for each of the three binary regions, so that all seed rods were grouped into the first file, all standard blanket rods into the second and all power flattening blanket rods into the third. The following data were saved in the DATATRAN lists for the binary fuel rod files:

1. Data recorded during pellet stacking and loading (binary pellet quantities, binary blend identities, binary and thoria stack weights, zone lengths, date and time of loading)
2. Clad thickness and outer diameter
3. Fissile and fertile loading data computed by the GATHER MODULE (Section III.F)
4. Fuel rod disposition (e.g., normal, reject, unloaded)
5. Data recorded during module assembly (module serial number, cell location).

The above data were recorded during inspections and later entered into the computer.

The second file type maintained by NEWROD contains data for reflector fuel rods. The following data were saved for reflector rods:

1. Data recorded during pellet stacking and loading (thoria stack length and weight, date and time of loading)
2. Clad thickness and outer diameter
3. Fertile loading
4. Fuel rod disposition
5. Data recorded during module assembly.

NEWROD uses GETAFM and PUTAFM for file retrieval and storage, respectively, of both fuel rod file types.

The third file type maintained by NEWROD contains fuel pellet impurity data. Sample pellets taken from binary and thoria pellet blends were analyzed, using mass spectroscopy, to determine the concentrations of elements in the pellets.

The concentrations, in parts per million, were written into DATATRAN lists by NEWROD. NEWROD uses the DATATRAN SAVE and RECALL statements to store and retrieve the blend impurity data.

The fourth file type maintained by NEWROD contains the descriptions of composite binary blends. Composite binary blends were fuel pellet blends produced by mixing pellets from two or more parent blends. For example, fuel rods which were rejected for reasons other than fuel properties were unloaded and their binary pellets were re-inspected for possible reuse. Recycled pellets from different blends were sometimes mixed together to form composite blends. The information which defined the makeup of composite binary blends was written into DATATRAN lists by NEWROD and saved and retrieved using SAVE and RECALL.

As discussed above, maintenance of computer files containing fuel rod data, fuel pellet impurity data and composite blend data in DATATRAN lists was done by the NEWROD MODULE during LWBR fabrication. Other files required by the ASBLT system but not used as DATATRAN lists, such as intermediate data files and binary blend data files, were maintained by other MODULES described in later sections of this report.

D. ASBLT - The MODULE Used to Maintain Intermediate Data Files and to Perform Computer Checks on Rod Data

The previous section described the use of NEWROD to maintain computer files containing fuel rod inspection data held in DATATRAN lists. Each execution of NEWROD related to fuel rod data operates on one category of data. The categories used during LWBR manufacturing reflected the inspections from which the fuel rod data originated as listed below:

1. Reflector rod loading inspection (stacking of fuel pellets into tubing)
2. Seed rod loading inspection
3. Blanket rod loading inspection
4. Final rod outer diameter inspection
5. Final clad thickness inspection
6. Module assembly inspection.

The ASBLT MODULE, which is described in detail in Section A.I.e of Appendix A, serves two functions. First, it operates as a preprocessor of rod inspection data for NEWROD; second, it checks the data against specification requirements and against data obtained from fuel rod x-rays.

As data sheets for the six inspection points listed above became available, data required by the ASBLT system were either keypunched onto computer cards or entered into the DEC-10 computer*, which stored card image files, from the inspection forms. The ASBLT MODULE was used to maintain files of data on cards (intermediate rod data files) for the six data categories, to sort the card images by fuel rod serial number and to transmit new or revised data to NEWROD. NEWROD, in turn, directed the data to the fuel rod DATATRAM lists. The combination of the MODULES ASBLT and NEWROD, functioning as the link between inspection forms and the ASBLT system's fuel rod data lists, operated smoothly and efficiently throughout LWBR manufacturing to build data banks of necessary inspection data in timely fashion.

The second function performed by the ASBLT MODULE is checking fuel rod inspection data against requirements. As discussed in Section III.A, nominal values and tolerances for various fuel rod parameters are entered into the ASBLT system, by the START MODULE, in the form of DATATRAM lists. These lists provide the requirements against which the ASBLT MODULE checks the actual inspection values for each fuel rod. The checking option of ASBLT, which is discussed in detail in Section A.I.e.3 of Appendix A, compares fuel rod data obtained during the stacking operation (ASBLT DATATRAM files) to similar data obtained from in-motion radiographs (two sets, in process and final, stored in separate files maintained by ASBLT) and compares all three sets of data to the fuel rod requirements. The fuel zone lengths from the three inspections must agree with each other within a specified value and all recorded lengths and the fissile loading must meet the requirements for ASBLT to flag a rod's data as acceptable. Discrepant data flagged by ASBLT during manufacturing were manually evaluated and corrected, as appropriate, before releasing the affected rods for use in the core. This extensive checking of fuel rod inspection data, by computer using ASBLT, complemented other manual inspections and ensured that every rod used in the LWBR core was fabricated according to specifications.

E. EDIT1 and EDIT2 - MODULES Used to Edit ASBLT Fuel Rod and Binary Blend Files

EDIT1 sorts the DATATRAM lists of fuel rod data by rod serial number and prints summary edits. EDIT2 produces detailed edits of binary blend data and

*The DEC-10 computer is part of a time-sharing system with remote terminals and is connected to the Control Data Corporation (CDC) computer (CDC-6600) on which the ASBLT system is executed.

fuel rod data. EDIT1, which is described in detail in Section A.I.f of Appendix A, was used during LWBR manufacturing, after each execution of NEWROD which added new inspection data to the fuel rod files, to sort the files by rod serial number. Sorting the files simplified the task of locating specific rods in the output edits. The summary edits produced by EDIT1 include listings, by fuel zone, of all serial numbers in the system and a total rod count by rod type. EDIT2, which is described in detail in Section A.I.g of Appendix A, produces edits of the fuel rod data contained in both the card image files (intermediate files) and the DATATRAN lists. EDIT2 will also produce listings of data by binary blend identity; that is, all rods containing the same blend are listed together, either by serial number or by loading date and time. The fuel rod edits produced by EDIT1 and EDIT2 were useful during fuel rod fabrication and saved many hours of effort in locating needed information concerning fuel rods.

The ASBLT system uses files of binary blend data for computing fuel rod fissile loading and fissile loading uncertainty. The computations are performed on each rod using binary stack weights and blend identities, which are part of the fuel rod data, and using the uranium weight percent, uranium isotopic fractions and inspection statistics, which are part of the binary blend data. The EDIT2 MODULE can be used to print the contents of the binary blend files, which are described in Section A.I.g.1 of Appendix A. During LWBR binary pellet fabrication, pellet samples were taken from each binary blend and the samples were inspected for dimensions, density, total uranium content and uranium isotopic content. DEC-10 computer programs were used to process the inspection results, perform calculations and maintain files of binary blend data. These files were transmitted to the CDC-6600 computer, sorted by the GATHER MODULE discussed in Section III.F, returned to the DEC-10 and filed on the CDC-6600 for use in the loading computations. Processing binary blend data by computer eliminated the need to hand transcribe large amounts of data and provided assurance that the blend data base contained no errors.

F. GATHER - The MODULE Used to Sort the Binary Blend Files, Compute Fuel Rod Loadings and Generate Input for Nuclear Design Programs

The binary blend files discussed in Section III.E can be read by the GATHER MODULE, sorted by blend identity and rewritten. The GATHER MODULE is described in detail in Section A.I.h of Appendix A. The sorting facilitates searching for specific blends in the blend output edits produced by the EDIT2 MODULE. Using the DATATRAN lists which contain fuel rod data (Section III.C) and the files

which contain binary blend data, GATHER computes fuel rod loadings (U^{total} , U^{fissile} and thorium) and the fissile loading uncertainty (commonly referred to as the loading precision). Having performed the loading calculations, GATHER places the computed results in the appropriate locations in the DATATRAN lists and sets indicators for each rod identifying whether the loading and precision requirements were satisfied. Computerizing the tedious rod loading and loading uncertainty computations produced accurate results within hours of completion of blend data generation. Verification calculations, performed using hand calculators, proved the worth of automating the loading calculations. The calculations required from a few minutes per rod for rods containing one parent binary blend to many minutes per rod for rods containing combinations of parent blends and composite blends.

In addition to sorting the binary blend files and performing loading computations, GATHER computes input parameters for the nuclear design programs used to assess nuclear performance. These programs require dimensions and inventories which GATHER supplies by composition (fuel zone). By searching the DATATRAN lists for all rods in core modules, GATHER produces a set of input values, describing the as-built core, for use in performance evaluations. This capability saved a significant amount of time in the performance of LWBR as-built calculations while providing an accurate description of the fabricated core.

G. RODTST, STATS and SPREAD - MODULES Used to Perform Statistical Evaluations on Data

The MODULES STATS and SPREAD function together to perform statistical evaluations (determination of mean, variance, standard deviation, range, coefficient of skewness) on a set of data residing in DATATRAN lists. These MODULES will operate on any set of data, not only data maintained by the ASBLT system. RODTST uses STATS and SPREAD to evaluate data contained in the ASBLT fuel rod DATATRAN files. The MODULES RODTST, STATS and SPREAD are described in detail in Sections A.I.i, A.I.j and A.I.k, respectively, of Appendix A. During LWBR fabrication, RODTST performed periodic fuel rod evaluations. RODTST was used to identify questionable rod data (outliers) for further examination and to temporarily discard such data so that reasonable mean values and variances of fuel rod parameters could be used in intermediate core performance predictions. Sensitivities of LWBR core behavior (lifetime and breeding capability) to deviations in pellet and rod properties were built into RODTST. RODTST used the sensitivities, nominal properties and as-built properties to periodically estimate core behavior based

on the status of manufacturing at the time of the evaluations. This feature of the ASBLT system gave rapid feedback on the influence of the manufacturing process on predicted LWBR core performance.

H. CRTVER - The MODULE Used to Perform Final Loading Ensurance Checks for Module Certification

Upon completion of fabrication of a module assembly and as part of the module certification process, the CRTVER MODULE, which is described in detail in Section A.I.l of Appendix A, was used to perform consistency checks on certain computer files which contained information about the module. These files included all of the ASBLT files, files generated during verification of correct rod installation while rods were being installed in the module and files generated outside of the ASBLT system containing rod release and special requirements information. All of these files listed the module identifications and cell locations of rods installed in modules. CRTVER was used to verify that all of these files were consistent, for the module being certified, with a master list of rod serial numbers and cell locations which had been prepared prior to rod installation and which defined the rods chosen for the module. Having verified that the computer files were consistent, CRTVER generated the listing of rod serial numbers and pertinent rod information for the module's certification report. This proved to be a fast and reliable way to generate the section of each certification report which contained the list of fuel rods in the module.

I. ORIENT and SYMTRY - MODULES Used to Record a Rod's Orientation in the Core and to Evaluate Core Symmetry

The ORIENT MODULE, which is described in detail in Section A.I.m of Appendix A, is used to add indicators to the fuel rod DATATRAN lists for identifying the location of each fuel rod relative to core sectors. Figure 3 in Appendix A shows the configuration of the LWBR core with its six symmetric sectors. ORIENT is executed for one module at a time to identify the one or two core sectors which contain the module. This input allows ORIENT to add the core location indicator to the rod data list. The indicators assigned to each fuel rod by ORIENT are used by SYMTRY to produce edits over core sectors. SYMTRY, which is described in detail in Section A.I.n of Appendix A, executes the GATHER MODULE to obtain fuel rod data from the DATATRAN lists then organizes the data by core sector. Summary edits are printed by sector and can be used to evaluate core symmetry.

J. COMPLP - The MODULE Used to Compute Composition Fissile Loading Precision

Since operation of the LWBR core is intended to demonstrate breeding of fissile fuel in a light water moderated system, the initial fissile loading must be known very accurately. During LWBR manufacturing, requirements were assigned to fuel rod fissile loading precision and to composition (fuel zone) fissile loading precision. Rod fissile loading precisions were computed by GATHER (Section III.F) and composition loading precisions were computed by COMPLP, described in detail in Section A.I.o of Appendix A. The COMPLP MODULE reads the DATATRAN lists containing fuel rod data and the binary blend files, locates all rods of a specified composition used in the core and computes the fissile loading and the loading precision for that composition. The results of COMPLP runs were used, upon completion of LWBR fabrication, to demonstrate that the fissile loading precision of the eight binary compositions satisfied the composition fissile loading precision requirement.

K. Overview

The previous sections described the ASBLT computer system, which was developed to maintain and evaluate LWBR fabrication data (as-built data), and presented brief descriptions of the DATATRAN MODULES which comprise ASBLT. While developed specifically for LWBR, many aspects of the system can be tailored to other similar core designs through alterations of the lists prepared by START (Section III.A). During LWBR manufacturing, ASBLT performed numerous data checks and evaluations which complemented manual inspections to provide adequate assurance that all fuel rods and module assemblies were fabricated according to design requirements. ASBLT's calculations of fuel rod loadings and loading uncertainties were of immense value because of the large amount of data involved, the complexity of the computations and the stringent manufacturing schedule. During module certifications, a few minutes of computer time confirmed the accuracy of all related data files and produced printed listings of the fuel rods used in the modules as permanent records. In preparing input for nuclear design programs, to be used in as-built core calculations, ASBLT again rapidly and reliably digested large amounts of data to produce summary descriptions of the core. It is judged that many of these operations performed by ASBLT for LWBR are adaptable to other core designs.

IV. SUMMARY AND CONCLUSIONS

The ASBLT computer program was used during LWBR fabrication to collect, check and evaluate as-built data for fuel pellet blends, fuel rods and module

assemblies. The data were used (a) to assist in confirming that blends, rods and modules were fabricated according to specifications (b) to periodically estimate the effect of as-manufactured components on breeding predictions, and (c) to provide as-manufactured properties for use in as-built performance calculations upon completion of the core. The ASBLT data base has been permanently filed on magnetic tape for use in the proof-of-breeding phase of LWBR. The ASBLT system described in this report was programmed using DATATRAN and demonstrates the usefulness and flexibility of a modular data base programming language like DATATRAN.

During the fabrication of binary pellet blends and fuel rods, inspection data were recorded and stored in the computer using ASBLT. ASBLT used the pellet and rod data to compute the thorium contents of reflector rods and the thorium and uranium contents and the fissile loading precision of binary rods. ASBLT eliminated thousands of man-hours of tedious, time-consuming and error-prone hand computations required to determine the fuel loadings and fissile loading precision of each rod fabricated. ASBLT automatically confirmed that rods satisfied some of the more important design specifications, especially those related to loading assurance. The system detected numerous errors in recorded inspection data, focused attention on such errors and ensured that all errors were evaluated and resolved before the affected rods were released for use in modules. Upon completion of individual module assemblies, ASBLT computed the module fuel loadings and prepared module loading summaries and sections of the module certification reports. The ASBLT data base provides a traceable path of fuel identities and inventories from blends up through rods, modules and core compositions.

On a periodic basis (generally monthly) throughout LWBR manufacturing, the ASBLT data base was used to update the estimated core reactivity, lifetime and breeding. ASBLT again saved numerous man-hours of effort each month by computing means and variances of as-built pellet and rod data. Given sensitivities of reactivity and breeding to core properties, ASBLT computed changes in reactivity and breeding based on current as-built data relative to nominal or design values.

Upon completion of the LWBR core, when the ASBLT data base contained the module identities and cell locations of every fuel rod used in the core along with all the required data for those rods, ASBLT was used to produce input for the nuclear design programs. The input provided by ASBLT included pellet, rod and cell dimensions and fuel properties. These inputs were used by the nuclear design programs to obtain material inventories which exactly matched those computed by ASBLT for the fabricated core. Given the as-built properties from

ASBLT, core performance calculations were performed, prior to initial operation, which were representative of the as-manufactured core. ASBLT provided assurance that an accurate description of the LWBR core was used in these important performance calculations.

The ASBLT system, in addition to being an important tool in the inspection and evaluation of the LWBR core, provides a computerized framework which could be adapted to the fabrication of other cores. Two of the MODULES in ASBLT - STATS and SPREAD - are general in nature. They will execute with any population of data. DATATRAN proved to be a convenient and reliable language for the maintenance and evaluation of the large LWBR as-built data base. It should be noted that the structure of the ASBLT fuel rod files resulted from timing studies performed prior to coding any of ASBLT. The goal was to use the random access capability of DATATRAN while maintaining reasonable computer run times. The timing studies showed that attempting to file some 30,000 fuel rods in individual DATATRAN lists would cost hours in run time, whereas blocking data in blocks of 100 rods would result in jobs which run in minutes and still provide for a sufficient degree of random access. The special uses of the ASBLT data base described in Appendix A demonstrate the flexibility of a modular programming language like DATATRAN. ASBLT itself demonstrates the benefits of using the computer in a manufacturing process.

V. REFERENCES

1. D. R. Connors, et al, "Design of the Shippingport Light Water Breeder Reactor," WAPD-TM-1208, January 1979.
2. H. J. Kopp, Editor, "DATATRAN User's Guide," KAPL-M-7372, October 1974.
3. S. Milani and C. J. Emert, "The Delayed Neutron Gage," WAPD-TM-1088, November 1974.
4. A. J. Caffarel, "The Inspection of Assembled LWBR Fuel Rods for Internal Dimensions and Pellet Integrity Utilizing In-Motion Radiography," WAPD-TM-1239, February 1979.
5. P. Dickerson, "The Ultrasonic Examination of LWBR Fuel Rods for Cladding Thickness Measurements and End Closure Weld Integrity," WAPD-TM-1228, February 1979.
6. W. R. Cadwell, Editor, "Reference Manual - Bettis Programming Environment," WAPD-TM-1181, September 1974.
7. J. Kotula, "LWBR Pellet Length Gage," WAPD-TM-1226, February 1979.

8. L. B. Freeman, Editor, "The Computational Model Used in the Analysis of Nuclear Performance of the Light Water Breeder Reactor (LWBR)," WAPD-TM-1314, August 1978.

APPENDIX A - THE ASBLT MODULES AND EXAMPLES OF THEIR USE

Appendix A describes the DATATRAN MODULES which comprise the ASBLT system, the computer files maintained by ASBLT and the input required by the MODULES to perform key tasks related to LWBR.

A.I. Detailed Description of the DATATRAN MODULES in ASBLT

The ASBLT system consists of 15 DATATRAN MODULES or subprograms which perform specific computer tasks related to LWBR as-built data. The tasks performed by the MODULES include initializing the system, storing and retrieving fuel rod data files, maintaining fuel rod data, checking and editing rod data, calculating rod fissile loading and precision, maintaining and editing fuel blend and module data, and preparing module loading sheets and portions of the module certification reports. Some of the MODULES must be executed in each ASBLT job, other MODULES are executed only to perform specific ASBLT tasks and two of the MODULES are general in nature and not tied specifically to ASBLT. Each will be described in detail.

A.I.a. START - A MODULE Which Initializes the ASBLT System

The START MODULE initializes certain DATATRAN lists (Reference 2 describes DATATRAN lists) which are needed by other MODULES in ASBLT. These lists, in general, describe the LWBR core. Performing the initializations in a separate MODULE eliminates the need to include them in each MODULE and also provides a central location for key LWBR information. These are desirable features when adding, deleting, changing or searching for such information. The DATATRAN lists initialized by the START MODULE and their descriptions follow.

1. N.CLASSES

N.CLASSES = 4

The ASBLT system is structured to maintain fuel rod data files for the four fuel regions of the LWBR core; i.e., seed, standard blanket, power flattening blanket and reflector blanket. This list specifies that ASBLT recognizes four classes (regions) of rod data files.

2. N.FILESIN

N.FILESIN = SEEDIN,BLKTIN,PFBKIN,REFLIN

This list defines the synonyms used by the Advanced File Manager (AFM), which is described in Reference 6, while retrieving the ASBLT fuel rod data files from either magnetic tape or disk.

3. N.FILESOUT

N.FILESOUT = SEEDOUT,BLKTOUT,PFBKOUT,REFL. OUT

This list defines the synonyms used by AFM while storing the fuel rod data files.

4. N.RODTYPES

N.RODTYPES = 8,6,7,2

This list specifies the number of unique fuel rod types in each of the four classes or regions. Fuel rods in the LWBR core are designated by seven-digit serial numbers where the first two digits identify the type. The types for the four regions are:

- a. Seed; 01, 02, 03, 04, 05, 06, 07 and 08
- b. Standard blanket; 11, 12, 13, 14, 15 and 16
- c. Power flattening blanket; 21, 22, 23, 24, 25, 26 and 27
- d. Reflector blanket; 31 and 32.

5. N.SUBS(1)

N.SUBS(1) = 4,12,9,32

This list defines the highest subscripts ASBLT allows for the following list names: REGION (4), COMP (12), ZONE (9) and TYPE (32).

6. N.REGION(i); i = 1, 2, 3, 4

N.REGION(1) = SEED 3 COMPS 1,2,3
N.REGION(2) = BLKT 4 COMPS 4,5,6,7
N.REGION(3) = PFBK 4 COMPS 8,9,10,11
N.REGION(4) = REFL 1 COMP 12

These lists define each of the four fuel regions by specifying a four-character region name, the number of fuel compositions in the region (compositions are required by the programs used to evaluate core performance) and integer designations of the compositions. For example, N.REGION(1) defines region 1 to be "SEED" having 3 compositions numbered 1, 2, and 3.

7. N.COMP(i); i = 1, 2, 3, ..., 12

```
N.COMP(1) = BINARY 1 ZONE 2
N.COMP(2) = BINARY 1 ZONE 1
N.COMP(3) = THORIA 2 ZONES 1,2
N.COMP(4) = THORIA 3 ZONES 3,4,5
N.COMP(5) = BINARY 1 ZONE 3
N.COMP(6) = BINARY 1 ZONE 4
N.COMP(7) = BINARY 1 ZONE 5
N.COMP(8) = THORIA 3 ZONES 6,7,8
N.COMP(9) = BINARY 1 ZONE 6
N.COMP(10) = BINARY 1 ZONE 7
N.COMP(11) = BINARY 1 ZONE 8
N.COMP(12) = THORIA 1 ZONE 9
```

These lists define each of the compositions in the ASBLT system by specifying the type of composition; i.e., binary (uranium oxide-thorium oxide) or thoria (thorium oxide), the number of fuel zones in the composition and the integer designations of the zones. Binary compositions must consist of only one zone; thoria compositions may consist of several zones. For example, composition 1, which is part of the seed region, consists of the binary portion of fuel zone 2. Composition 3, which is also part of the seed region, consists of the thoria portions of fuel zones 1 and 2.

8. N.ZONE(i); i = 1, 2, 3, ..., 9

```
N.ZONE(1) = LOW 6 RODTYPES 01,02,03,04,07,08
N.ZONE(2) = HIGH 2 RODTYPES 05,06
N.ZONE(3) = LOW 2 RODTYPES 11,12
N.ZONE(4) = MED 2 RODTYPES 14,15
N.ZONE(5) = HIGH 2 RODTYPES 13,16
N.ZONE(6) = LOW 2 RODTYPES 21,22
N.ZONE(7) = MED 2 RODTYPES 24,27
N.ZONE(8) = HIGH 3 RODTYPES 23,25,26
N.ZONE(9) = NA 2 RODTYPES 31,32
```

These lists define each of the fuel zones in the ASBLT system by specifying the type of the binary portion, the number of rod types in the zone and the two-digit rod type identifiers (first two digit of rod serial number). For example, zone 1 is low zone seed consisting of six rod types - 01, 02, 03, 04, 07 and 08.

The lists described thus far define the building blocks of the ASBLT system in terms of fuel rod types, fuel zones, fuel compositions and fuel regions. These lists permit ASBLT to assign the as-built data for each rod found in the ASBLT fuel rod data files to the correct portion of the core. The remaining lists initialized by START are the following.

9. N.DATAWRDS

N.DATAWRDS = 34,34,34,16

This list defines the number of data words required to fully describe the fuel rods in each of the four core fuel regions. The data words are defined in the description of the NEWROD MODULE (Section A.I.d).

10. N.DATAGP(i); i = 1, 2, 3, 4

```
N.DATAGP(1) = 74285,20,74297,1,74290,1,00001,2
N.DATAGP(2) = 74286,20,74297,1,74290,1,00001,2
N.DATAGP(3) = 74286,20,74297,1,74290,1,00001,2
N.DATAGP(4) = 74288, 2,74297,1,74290,1,00001,2
```

These lists define the groups of as-built data which ASBLT maintains for the fuel rods within each of the core regions. For example, the list N.DATAGP(1) specifies that 20 items of as-built data are obtained from inspection form 74285 (seed stacking data sheet), 1 item is obtained from inspection form 74297 (final dimensional inspection), 1 item is obtained from inspection form 74290 (clad ultrasonic inspection) and 2 items are obtained from form 00001 (a dummy form number for the module assembly inspection data sheets). Precisely which data items are obtained from the inspection sheets will be identified in Section A.I.d describing NEWROD.

11. N.BALANCES

```
N.BALANCES = 11192,11190,12941,13399,50083,50084,50099
```

This list identifies the serial numbers of the balances used to weigh the pellet stacks loaded into the binary fuel rods. This information is required in the event that bias adjustments must be made to recorded stack weights.

12. N.NOMINAL

```
N.NOMINAL=
X 42.000,51.720,103.740,328.012,7.8098,495.883,8.0318,14.1918,.337
X9,0.0,0.3060,0.02200,1.100,2.400
/ 42.000,50.920,103.740,328.012,7.8098,495.883,8.0318,14.1918,.337
X9,0.0,0.3060,0.02200,0.200,2.400
/ 56.000,65.780,103.740,437.012,7.8098,383.438,8.0318,18.9244,.337
X9,0.0,0.3060,0.02200,1.200,2.525
/ 70.000,73.920,103.740,546.686,7.8098,270.993,8.0318,23.6530,.337
X9,0.0,0.3060,0.02200,0.300,2.525
/ 84.000,92.780,103.740,659.425,7.8503,158.548,8.0318,34.2552,.407
X8,0.0,0.3060,0.02200,1.300,2.650
/ 84.000,92.920,103.740,659.425,7.8503,158.548,8.0318,34.2552,.407
X8,0.0,0.3060,0.02200,0.400,2.650
/ 42.000,51.780,103.740,328.012,7.8098,495.883,8.0318,14.1918,.337
X9,0.0,0.3060,0.02200,1.100,1.750
/ 42.000,50.920,103.740,328.012,7.8098,495.883,8.0318,14.1918,.337
X9,0.0,0.3060,0.02200,0.200,1.750
/ 42.000,53.500,103.690,1332.56,31.7270,1972.91,31.9810,16.1406,.3
X843,0.0,0.5715,0.02775,1.400,4.225
/ 42.000,51.500,104.740,1332.56,31.7278,2006.49,31.9810,16.1406,.3
X843,0.0,0.5715,0.02775,0.500,4.225
/ 70.000,25.500,103.690,2248.36,32.1195,1077.44,31.9810,44.9750,.6
X825,0.0,0.5715,0.02775,1.500,4.350
/ 56.000,37.500,104.740,1793.97,32.0352,1558.76,31.9810,29.8200,.5
X825,0.0,0.5715,0.02775,0.600,4.350
/ 84.000,11.500,103.690,2690.96,32.0352,629.708,31.9810,44.7300,.5
X825,0.0,0.5715,0.02775,1.600,4.475
/ 84.000, 9.500,104.740,2698.04,32.1195,663.288,31.9810,53.9700,.6
X423,0.0,0.5715,0.02775,0.700,4.475
```

```

/ 42.000,53.500,103.690,1136.38,27.0565,1660.81,26.9219,18.7446,.4
X460,0.0,0.5275,0.02625,1.780,4.225
/ 42.000,51.500,104.740,1136.38,27.0565,1689.08,26.9219,18.7446,.4
X463,0.0,0.5275,0.02625,0.800,4.225
/ 70.000,23.500,103.690,1901.01,27.1574,906.999,26.9219,51.9610,.7
X423,0.0,0.5275,0.02625,1.800,4.350
/ 56.000,37.500,104.740,1512.69,27.0125,1312.17,26.9219,30.3408,.5
X418,0.0,0.5275,0.02625,0.900,4.350
/ 84.000,11.500,103.690,2281.21,27.1574,530.092,26.9219,62.3532,.7
X423,0.0,0.5275,0.02625,1.900,4.475
/ 34.000, 9.500,104.740,2231.21,27.1574,558.360,26.9219,62.3532,.7
X423,0.0,0.5275,0.02625,1.000,4.475
/ 84.000,11.500,103.690,2269.04,27.0125,530.092,26.9219,45.5112,.5
X418,0.0,0.5275,0.02625,2.000,4.600
/ 100.94,6826.92,67.6335,0.832,0.942,0.0,0.0,0.0,0.0,0.0
/ 102.94,6962.19,67.6335,0.832,0.042,0.0,0.0,0.0,0.0,0.0

```

This multi-record list (Reference 2 describes such lists whereby slashes separate the records) defines the nominal or design values for important LWBR fuel rod parameters. Each record in the list contains values for a single rod type such that records 1 through 8 are for seed rod types 01 through 08, records 9 through 14 are for standard blanket rod types 11 through 16, records 15 through 21 are for power flattening blanket rod types 21 through 27 and records 22 and 23 are for reflector rod types 31 and 32. The values contained in records 1 through 21 apply to the binary rods and are defined as follows:

Word	Description
1	Nominal length in inches of the binary fuel pellet stack (A in Figure 2 in Section II of this report)
2	Nominal length in inches for controlling the position of the binary-thoria interface (D in Figure 2)
3	Minimum acceptable overall fuel pellet stack length in inches (P in Figure 2)
4	Expected binary stack weight in grams
5	Expected binary linear density (weight divided by length) in grams per inch
6	Expected thoria stack weight in grams
7	Expected thoria stack linear density in grams per inch
8	Expected fissile weight in grams
9	Nominal fissile linear density in grams per inch
10	Null value; not used
11	Null value; not used
12	Nominal fuel rod clad outer diameter in inches
13	Nominal fuel rod clad thickness in inches
14	Nominal identity hole location (an identity hole is drilled in each rod's bottom end cap) in inches (I in Figure 2)

Word	Description
15	Nominal stem length in inches (the end of the rod which is held by the baseplate has an end cap with a stem which fits into the baseplate; the stem length and identity hole location are unique for each rod type) (H in Figure 2)

The values contained in records 22 and 23 apply to reflector rods and are defined as follows:

Word	Description
1	Minimum overall stack length in inches (P in Figure 2)
2	Expected thoria stack weight in grams
3	Expected thoria stack linear density in grams per inch
4	Nominal fuel rod clad outer diameter in inches
5	Nominal fuel rod clad thickness in inches
6-15	Null values; not used

13. N.TOLERANC

```

N.TOLERANC=
X 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.368,0.060,0.0,0.0,0.0,0.0,0.0098,0.0,0.0015,0.00125,0.030,0.040
/ 0.368,0.060,0.0,0.0,0.0,0.0,0.0098,0.0,0.0015,0.00125,0.030,0.040
/ 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.282,0.060,0.0,0.0,0.0,0.0,0.0081,0.0,0.0015,0.00125,0.030,0.040
/ 0.325,0.060,0.0,0.0,0.0,0.0,0.0115,0.0,0.0020,0.00150,0.030,0.040
/ 0.325,0.060,0.0,0.0,0.0,0.0,0.0115,0.0,0.0020,0.00150,0.030,0.040
/ 0.452,0.060,0.0,0.0,0.0,0.0,0.0193,0.0,0.0020,0.00150,0.030,0.040
/ 0.495,0.060,0.0,0.0,0.0,0.0,0.0160,0.0,0.0020,0.00150,0.030,0.040
/ 0.495,0.060,0.0,0.0,0.0,0.0,0.0160,0.0,0.0020,0.00150,0.030,0.040
/ 0.452,0.060,0.0,0.0,0.0,0.0,0.0193,0.0,0.0020,0.00150,0.030,0.040
/ 0.495,0.060,0.0,0.0,0.0,0.0,0.0134,0.0,0.0020,0.00150,0.030,0.040
/ 0.495,0.060,0.0,0.0,0.0,0.0,0.0134,0.0,0.0020,0.00150,0.030,0.040
/ 0.410,0.060,0.0,0.0,0.0,0.0,0.0223,0.0,0.0020,0.00150,0.030,0.040
/ 0.452,0.060,0.0,0.0,0.0,0.0,0.0163,0.0,0.0020,0.00150,0.030,0.040
/ 0.410,0.060,0.0,0.0,0.0,0.0,0.0223,0.0,0.0020,0.00150,0.030,0.040
/ 0.410,0.060,0.0,0.0,0.0,0.0,0.0223,0.0,0.0020,0.00150,0.030,0.040
/ 0.452,0.060,0.0,0.0,0.0,0.0,0.0163,0.0,0.0020,0.00150,0.030,0.040
/ 0.0,0.0,0.003,0.002,0.0,0.0,0.0,0.0,0.0,0.0
/ 0.0,0.0,0.003,0.002,0.0,0.0,0.0,0.0,0.0,0.0

```

This list defines the tolerances on the parameters described in the N.NOMINAL list. A zero value indicates that a tolerance value does not apply for the parameter to which zero tolerance is assigned.

14. N.BINARYLD

```

N.BINARYLD=
X LOW SEED 7.785, 7.954
/ HIGH SEED 7.825, 7.995
/ LOW BLKT 31.729, 32.479
/ MED BLKT 32.037, 32.794
/ HIGH BLKT 31.996, 32.752
/ LOW PFBK 27.042, 27.681
/ MED PFBK 27.099, 27.739
/ HIGH PFBK 27.115, 27.756

```

This list defines the lower and upper limits on binary stack linear density in grams per inch (stack weight divided by stack length) used with the binary fuel pellet stacking and weighing operations during rod fabrication. These limits were used to check the recorded binary stack weights during rod loading.

15. N.THORIALD

```

N.THORIALD=
X SEED 7.989, 8.197
/ BLKT 31.813, 32.640
/ PFBK 26.686, 27.475

```

This list is similar to N.BINARYLD and applies to the thoria portion of each binary rod.

16. N.ZONES

This list contains 32 words where the j^{th} word is the zone number for rod type j as defined by the N.ZONE(i) lists described previously; that is

```

N.ZONES = 1, 1, 1, 1, 2, 2, 1, 1, 0, 0, 3, 3, 5, 4, 4, 5, 0, 0,
          0, 0, 6, 6, 8, 7, 8, 8, 7, 0, 0, 0, 9, 9

```

17. N.XXXSN: XXXX = SEED, BLKT, REFL

```

N.SEEDSN=F.SEED1,F.SEED2,F.SEED3,F.SEED4
N.BLKTSN=F.BLKT1,F.BLKT2,F.BLKT3,F.BLKT4
N.REFLSN=F.REFL4,F.REFL5

```

These three lists contain the serial numbers of the 13 seed modules (12 in core, 1 spare), the 13 blanket modules (12 in core, 1 spare) and the 15 reflector modules as defined by the following FORTRAN DATA statements:

```

DATA SEED1/30HL-BB01-04 L-BB01-05 L-BB01-06 /
DATA SEED2/30HL-BB01-09 L-BB01-10 L-BB01-13 /
DATA SEED3/60HL-BB01-07 L-BB01-08 L-BB01-12 L-BB01-11 L-BB01-14 L-
XBB01-16 /
DATA SEED4/10HL-BB01-15 /
DATA BLKT1/30HL-CU52-01 L-CU52-02 L-CU51-01 /
DATA BLKT2/30HL-GV51-01 L-GS22-01 L-GV52-01 /
DATA BLKT3/60HL-GW51-01 L-GW52-01 L-GW53-01 L-GT22-01 L-GT22-02 L-
XGT22-03 /
DATA BLKT4/10HL-GT32-01 /
DATA REFL4/90HL-RA01-06 L-RA01-02 L-RA01-10 L-RA01-09 L-RA01-07 L-
XRA01-04 L-RA01-05 L-RA01-08 L-RA01-03 /
DATA REFL5/60HL-RB01-07 L-RB01-04 L-RB01-06 L-RB01-08 L-RB01-03 L-
XRB01-05 /

```

18. N.XXXXTYP; XXXX = SEED, BLKT, REFL

N.SEEDTYP=I-1, I-2, I-3, II-1, II-2, II-3, III-1, III-2, III-3, III-4, III-5
X, III-6, SPR-1
N.BLKTTYP=N.SEEDTYP
N.REFLTYP=IV-1, IV-2, IV-3, IV-4, IV-5, IV-6, IV-7, IV-8, IV-9, V-1, V-2, V-3
X, V-4, V-5, V-6

These three lists define the module types for the previously defined module serial numbers. For example, blanket module L-GS22-01 is type II-2.

19. N.XXXXPVN; XXXX = SEED, BLKT, REFL

N.SEEDPN=71,72,73,75,76,78,74,77,80,79,81,83,82
N.BLKTPN=86,85,93,90,95,94,87,92,91,84,89,88,96
N.REFLPN=69,65,63,67,68,61,64,66,62,51,54,55,52,56,53

These three lists contain the manufacturing process numbers assigned to the modules as they were being assembled. For example, blanket module L-GS22-01 was process number 95.

20. N.XXXXNR; XXXX = SEED, BLKT, REFL

N.SEEDNR=619,619,619,619,619,619,619,619,619,619,619,619,619
N.BLKTNR=443,443,443,563,564,563,632,632,633,633,633,633,0
N.REFLNR=228,228,228,228,228,228,227,228,228,166,166,166,166,166,1
X66

These three lists define the number of fuel rods required in each module. For example, blanket module L-GS22-01 required 56⁴ fuel rods.

21. N.XXXXØRN; XXXX = SEED, BLKT

N.SEEDORN = 1,6,3 / 1,2,5 / 1,4,1 / 2,5,4 / 2,1,3 / 2,3,2 / 3,6 /
X3,2 / 3,4 / 3,1 / 3,3 / 3,5
N.BLKTORN = 6 / 2 / 4 / 5 / 1 / 3 / 6 / 2 / 4 / 1 / 3 / 5

These two lists define the orientations of modules in the core for use in performing core symmetry calculations. These lists are used by MODULE ORIENT described in Section A.I.m.

22. N.EXCLUDE

N.EXCLUDE=PREPRO

This list instructs ASBLT to disregard preproduction rods (third serial number digit is 7) in certain calculations and edits. Preproduction rods can be included in a job by supplying the DATATRN statement

KALL START
N.EXCLUDE =

at the start of the job.

23. N.THORIUM

N.THORIUM=0.878809

This list instructs ASBLT to use a factor of 0.878809 for converting mass of thorium oxide to mass of thorium. The value is based on the atomic weight of thorium divided by the atomic weight of thorium oxide; that is,

$$\frac{232.038}{232.038 + 2 \times 15.9994} = 0.878809$$

24. N.START

N.START=1

This list tells ASBLT that START has been executed and need not be executed again in the job. Each remaining module in ASBLT is programmed to execute START before proceeding unless N.START has been initialized as above.

The lists described above, with the possible exception of N.EXCLUDE, must not be redefined in a job since the results may be unpredictable. The uses for these lists will become evident as the other MODULES in ASBLT are described. One other function performed by START deals with the binary blend file needed by the GATHER MODULE described in Section A.I.h. Quite simply, if START detects that the blend data were retrieved from AFM in two sections (system file TAPE21 for seed blend data and system file TAPE22 for blanket blend data), the MODULE rewrites all of the blend data into a single system file named TAPE11 as required by GATHER. START, in addition to providing a convenient central location for the ASBLT system framework for LWBR, provides a pattern which can be modified to suit other similar core designs.

A.I.b. PUTAFM - A MODULE Which Stores the ASBLT Fuel Rod Data Files

PUTAFM performs the task of saving the DATATRAN lists containing as-built fuel rod data by executing the DATATRAN SAVE command. Files saved by PUTAFM are copied to tape or disk by the Advanced File Manager (AFM) during AFM wrap-up. The files can then be recalled in a subsequent ASBLT job by the GETAFM MODULE described in Section A.I.c. The following input lists are used by PUTAFM:

1. N.STORE = $I_2, I_2, I_3, \dots$ (required)

I_j = a region number whose rod data are to be stored; $1 \leq I_j \leq 4$.

As discussed in Section A.I.a, regions 1, 2, 3 and 4 are seed, standard blanket, power flattening blanket and reflector blanket, respectively.

2. N.LOCKOUT = $A_1, A_2, A_3, \dots$ (optional)

A_j = a MODULE name .

If PUTAFM is one of the MODULE names in the list, PUTAFM will not execute. Since several of the other MODULES in ASBLT automatically KALL PUTAFM upon completion, this bypass control is useful in debug jobs and may be useful in some production jobs.

PUTAFM will save all DATATRAN lists of the form D.CLASS(i).a.b.c..., where a, b, c, etc. represent list names under D.CLASS(i), for each value of i ($1 \leq i \leq 4$) found in the input list N.STORE. For example, the DATATRAN statement

```
N.STORE = 2
KALL PUTAFM
```

would result in the storing of standard blanket fuel rod data contained in DATATRAN lists of the following form:

D.CLASS(2).TYPE(j).BLOCK(k); ($11 \leq j \leq 16$), $k = 1, 2, 3, \dots$

along with any other D.CLASS(2) lists in existence at the time of the KALL. These list structures will be defined in more detail in later sections. PUTAFM prints a summary of the D.CLASS(i) lists which were saved or an error message if no data were found under D.CLASS(i). File update summaries are exported to the DEC-10 computer for bookkeeping purposes. To perform this task, PUTAFM uses system files named TAPE75 and TAPE76.

A.I.c. GETAFM - A MODULE Which Retrieves the ASBLT Fuel Rod Data Files

GETAFM performs the reverse of PUTAFM described in Section A.I.b and requires the following input list:

N.FETCH = $I_1, I_2, I_3, \dots$ (required)

I_j = a region number whose rod data are to be retrieved; $1 \leq I_j \leq 4$.

GETAFM uses the DATATRAN RECALL command to retrieve from tape or disk the D.CLASS(i) lists for each region specified in the N.FETCH list. For example, the DATATRAN statements

```
N.FETCH = 1, 3
KALL GETAFM
```

would cause GETAFM to retrieve all stored fuel rod data for seed and power flattening blanket rods and to reconstruct all D.CLASS(1) AND D.CLASS(3) lists. File reference summaries are exported to the DEC-10 computer for bookkeeping purposes using a system file named TAPE76.

A.I.d. NEWROD - A MODULE Which Adds Data to the ASBLT DATATRAN Lists

NEWROD is a multipurpose MODULE which is used to add fuel rod as-built data to existing ASBLT DATATRAN lists retrieved by GETAFM. The updated lists are then saved using PUTAFM. In addition to maintaining fuel rod data, NEWROD maintains fuel pellet impurity data and composite binary blend data.

A.I.d.1. Fuel Rod Data File Formats

Before describing the file maintenance functions performed by NEWROD and the required input, the formats of the fuel rod data files and of the DATATRAN lists contained in the files will be described. The ASBLT system utilizes four file classes (1, 2, 3 and 4) which contain data for seed, standard blanket, power flattening blanket and reflector blanket fuel rods, respectively. Within each class (i) the DATATRAN lists containing as-built fuel rod data have the following name structure:

D.CLASS(i).TYPE(j).BLOCK(k)

where j identifies the rod types within the class, as described in Section A.I.a, and k identifies a block of up to 100 rods within the type. The first record in each such list contains the serial numbers (in display code) of the 100 rods whose data are contained in records 2 through 101 of the list. The first rod in record 1 has its data in record 2; the second rod in record 1 has its data in record 3; up through the 100th rod in record 1 which has its data in record 101. The last block for a rod type may be incomplete; for example, if the data file contained 1239 type 11 rods, blocks 1 through 12 would contain 100 rods each and block 13 would contain 39. Record 1 of block 13 would still contain 100 words (39 actual serial numbers and 61 blank words) but block 13 would contain only 40 records.

The data records (records 2 and on) each contain 34 words for seed, standard blanket and power flattening blanket rods (binary rods) and 16 words for reflector rods. The 34 words of data for binary rods are the following:

<u>Word(s)</u>	<u>Parameter</u>
1	7-digit rod serial number in display code

Word(s)Parameter

2	10-character disposition code where character 1 = disposition N for normal D if rod failed one of the 13 ASBLT checks (Section A.I.e) but was accepted for selective use in the core M if rod can be used in core symmetry locations G if rod is reserved for end-of-life delayed neutron gage calibration T if rod is a test rod Y if rod is in reject hold (good) category Z if rod is in reject hold (bad) category R if rod is to be unloaded S if rod has been unloaded Characters 2 and 3 = year rod was loaded (73, 74, 75, ...) Characters 4 and 5 = month rod was loaded (01, 02, ...) Characters 6 and 7 = day rod was loaded (01, 02, ...) Character 8 = hour rod was loaded in octal Character 9 = minute rod was loaded in octal Character 10 = index of balance used to weigh fuel (see N.BALANCES in Section A.I.a)
3	The digits 2074285 for seed or 2074286 for blanket, indicating that 20 items of data (words 5 through 24) are filed from inspection form 74285 or 74286 (Stacking Data Sheets) or related data.
4	A string of characters identifying the Product Inspection Records' (PIR) data file which supplied the form 74285 or form 74286 data.
5	Length of binary fuel stack (inches).
6	Length of binary plus bottom thorium fuel stacks for seed rods; length of bottom thorium fuel stack for blanket rods (inches).
7	Length of overall fuel stack (inches).
8-11	10-character identities (iii-j-kkXX) for the 1, 2, 3 or 4 binary blends in the rod.
12-15	Compressed (SQOZed - Reference 6) words containing the recorded binary stack weight in the left half of the word (W_C) and the binary stack weight bias in the right half of the word (W_R) for the 1, 2, 3 or 4 binary blends in the rod. The bias adjusted stack weight must be obtained by UNSQOZing (Reference 6) each word and computing $W_e - W_r$ (grams).
16-19	Number of pellets used from the 1, 2, 3 or 4 binary blends in the rod.
20	Recorded weight and bias of thorium pellets in the rod, compressed as for binary (grams).

Word(s)	Parameter
21	Weight of fissile uranium ($U^{233} + U^{235}$) in the rod, compressed as for binary (grams).
22	Fissile loading precision (relative percent); computed by GATHER (Section A.I.h).
23	Weight of ThO_2 in the binary stack (grams); computed by GATHER (Section A.I.h).
24	10-character loading code constructed as follows: Character 1 = status of fissile loading calculation I - loading and precision not computed W - passed fissile loading requirement, passed precision requirement X - passed fissile loading requirement, failed precision requirement Y - failed fissile loading requirement, passed precision requirement Z - failed fissile loading requirement, failed precision requirement Character 2 = status of inspection data O - original data E - stack lengths and/or thoria weight adjusted after engineering review B - binary stack weights adjusted after engineering review Characters 3-6 = blank - no adjustment in binary blend 1, 2, 3 or 4 weight; * - adjustment was made in binary blend 1, 2, 3 or 4 weight (character 3 corresponds to blend 1, 4 to blend 2, 5 to blend 3 and 6 to blend 4) Character 7 = module type (1, 2 or 3) into which rod was installed or blank if not installed Character 8 = core sector (1 through 6) into which rod was installed or blank Character 9 = other core sector if rod is on a sector boundary Character 10 = X if rod must not be used for end-of-life assay, blank otherwise
25	The digits 174297 indicating that 1 item of data (word 27) is filed from inspection form 74297.
26	A string of characters identifying the PIR file which supplied the form 74297 data.
27	Mean rod outer diameter (inches).
28	The digits 174290 indicating that 1 item of data (word 30) is filed from inspection form 74290.

Word(s)	Parameter
29	A string of characters identifying the PIR file which supplied the form 74290 data.
30	Mean clad wall thickness (inches).
31	The digits 200001 indicating that 2 items of data (words 33 and 34) are filed from dummy form 00001 - the Seed Assembly Inspection Data Sheets (SAIDS) or the Blanket Assembly Inspection Data Sheets (BAIDS).
32	A string of characters identifying the computer file which supplied the assembly data.
33	Module serial number (L-XXii-jj) into which the rod is installed or blank.
34	Cell location (Xii) into which the rod is installed or blank.

The 16 words of data for reflector rods are the following:

Word(s)	Parameter
1	7-digit rod serial number in display code.
2	10-character disposition and loading code where Character 1 = N for normal; S for scrapped Characters 2-7 are blank Character 8 = O or E; same as binary rod loading code Characters 9 and 10 are blank
3	The digits 274288 indicating that 2 items of data (words 5 and 6) are filed from inspection form 74288.
4	A string of characters identifying the PIR data file which supplied the form 74288 data.
5	Fuel stack length (inches).
6	Fuel stack weight (grams).
7-16	Same as words 25-34 for binary rods.

Other lists under D.CLASS(i) include D.CLASS(i).SIGWE used by the GATHER MODULE (Section A.I.h) and D.CLASS(i).DSR used by the ASBLT MODULE (Section A.I.e). These lists will be described in later sections since they are not maintained or used by NEWROD.

A.I.d.2. Updating Fuel Rod Data

NEWROD is used either to add new fuel rod data to the DATATRAN lists described in Section A.I.d.1 or to modify existing fuel rod data. To perform these functions NEWROD utilizes DATATRAN lists for communication with other MODULES within the

ASBLT system. The following lists, which are identified here only as a precaution against inadvertently disabling the ASBLT system, are used by NEWROD for input from and output to other MODULES:

N.STORE(i)
N.REPLACE
N.LASTB
N.SUBS(i)
N.RODTYPES
N.HEADER(i)
N.DATAGP(i)
N.NEWRODS(i)
N.RODDATA(i,j)
D.CLASS(i).TYPE(j).BLOCK(k)

The list N.REPLACE=YES instructs NEWROD to replace existing data in the fuel rod files; any attempt to modify data without specifically instructing NEWROD to do so via the N.REPLACE list results in an error message and no change in filed data. The lists N.NEWROD(i), where i indicates rod type, must contain the serial numbers of rods whose data are to be processed by NEWROD. The incoming data must reside in the lists N.RODDATA(i,j) where i and j point to the data for the jth type i rod being processed. Each N.RODDATA(i,j) list must contain data for one fuel rod as follows:

word 1 - rod serial number
word 2 - inspection form number
words 3 and on - data values from the inspection form.

The inspection form numbers recognized by NEWROD are:

74285, 74286 and 74284 - rod assembly data
74297 - final rod outer diameter
74290 - final rod clad thickness
00001 - dummy form number for module assembly data sheets.

NEWROD reads each N.RODDATA(i,j) list, checks the validity of the rod serial number, and updates the rod data file by either adding a new record to the file if the rod is not present or by modifying the rod's data record if it is in the file. The data records are formatted as described in Section A.I.d.1.

A.I.d.3. Modifying Fuel Rod Disposition Codes

Fuel rod disposition codes, described in Section A.I.d.1, are modified by supplying the following lists to NEWROD:

- a. $N.CODES = A_1, A_2, A_3, \dots$ identifies the single-letter disposition codes (A_i) permitted in the job.
- b. $N.A_i(j) = RODS, B_1, B_2, B_3, \dots$ instructs NEWROD to change the disposition codes of all type j rods containing the binary blends identified by the B_k to letter code A_i .

For example, a NEWROD run with the following input lists

```
N.CODES=M,S,R
N.M(06)=RODS,1062,1558,16132
N.S(15)=ALL
N.S(16)=RODS,73,102,1063,10148
N.R(21)=BLENDS,121-6-14
```

would instruct NEWROD to give rods 0601062, 0601558 and 0616132 disposition code M; to give all type 15 rods and rods 1600073, 1600102, 1601063 and 1610148 disposition code S; and to give all type 21 rods containing binary blend 121-6-14 disposition code R.

Rods may be deleted from the ASBLT files by supplying NEWROD with the following lists:

```
N.CODES=DELETE
N.DELETE(j)=RODS, I1, I2, I3 ...
```

in which case the I_k would identify the type j rods to be deleted. An edit of all rods with disposition codes other than N can be obtained by supplying the single list

```
N.CODES=EDIT
```

A.1.d.4. Updating the Fuel Impurities (NPE) File

A measure of the effect of fuel impurities on core performance is provided by the total Neutron Poison Equivalence (NPE) which is computed from the concentrations, in parts per million (ppm), and the neutron poison equivalence of each element. Impurity concentrations from mass spectroscopic analyses on sample fuel pellets are stored in the blend NPE file and used to compute the total NPE of fuel pellet blends. NEWROD is used to maintain the NPE file.

The following input lists are used by NEWROD for updating and listing the NPE file:

- a. N.OPTION=EDIT to print the impurity data by blend and to compute the total NPE.
- b. N.OPTION=MODIFY to add or modify impurity data.
- c. N.LETTER="string" where "string" identifies the document which transmitted the impurity data.
- d. N.BLENDS= $B_1, B_2, B_3, \dots$ where the B_i are blend identities.
- e. N.RCS= $R_1, R_2, R_3, \dots$ where R_i is the route card which requested the analysis for the i^{th} blend in the N.BLENDS list.
- f. N.TYP= $T_1, T_2, T_3, \dots$ where T_i is the fuel type ($\text{UO}_2\text{-ThO}_2$ or ThO_2) for the i^{th} blend in the N.BLENDS list.
- g. N.E_j= $C_1, C_2, C_3, \dots$ where E_j is an element abbreviation; for example, H for hydrogen, HE for helium, LI for lithium. C_i is the concentration in ppm of the element in the i^{th} blend in the N.BLENDS list.

Given the above lists, NEWROD will read the existing impurity file, reconstruct the DATATran lists (of the form D.PPML.) contained in the file, add new data to the D.PPML lists, print the lists and write a new file. The MODULE computes worst case and best estimate total NPE values for each blend and the averages over all blends in the file from built-in sets of NPE factors by element.

A.I.d.5. Updating the Composite Binary Blend File

Composite binary blends were fuel pellet blends produced by mixing pellets from two or more parent blends. For example, rods which were rejected for reasons other than fuel properties were unloaded and their binary fuel pellets were reinspected for possible reuse. Blend identities and pellet counts were carefully maintained as each rod was unloaded and as pellets from several rods (and possibly several parent blends) were combined into a single composite blend for use in fabricating new rods. The makeup of each composite blend, in terms of pellet quantities and parent blend identities, was needed in order to compute the fuel rod fissile loadings and loading precision of rods containing composite binary blends. One of the functions of NEWROD is that of maintaining the composite binary blend data file.

The DATATran lists required by NEWROD for maintaining the composite blend file are of two forms, the first of which is

$$\text{N.CB}(i)=A_i, C, I_i, B_i, P_1, N_1, P_2, N_2, \dots$$

where

- a. i identifies the i^{th} composite blend.
- b. A_i is the composite blend identity input; for example, as *501112RS* for blend 501-1-12RS.
- c. C identifies a normal composite blend (no special taper properties) for the precision calculation of GATHER (Section A.I.h).
- d. I_i is 1 if the pellets from the different parent blends were randomized (perfectly mixed), 2 if the blend is biased (no pellet mixing).
- e. B_i is an additional bias term to be added to the precision calculated in GATHER.
- f. P_j is the identity of the j^{th} parent blend.
- g. N_j is the quantity of pellets from the j^{th} parent blend.

The second form of the composite blend input list is as follows:

$$N.CB(i)=A_i, C_i, I_i, B_i, N_k, N_r, P_1, N_1, R_1, P_2, N_2, R_2, \dots$$

where i , A_i , I_i and B_i are as defined above and

- a. C_i identifies a special composite blend (special taper properties) for the precision calculation of GATHER.
- b. N_k = number of high quality pellets; that is, pellets with special taper properties.
- c. N_r = number of regular pellets.
- d. P_j identifies the j^{th} parent blend.
- e. N_j is the number of pellets from the j^{th} parent blend which were originally of high quality (special taper properties).
- f. R_j is the number of pellets from the j^{th} blend which were regular pellets.

Given the above input lists NEWROD reads the existing composite blend file, reconstructs its DATATRAN lists (of the form D.COMPOSIT.), adds the new data and writes a new file. The list $N.CB(1)=\text{EDIT}$ is used to request a listing of the composite blend file.

A.I.e. ASBLT - A MODULE Which Processes Fuel Rod Data for NEWROD and Performs Computer Checks on the Data

As discussed in Section A.I.d, NEWROD requires input lists of as-built fuel rod data organized by fuel rod type and by data category (inspection form number) in order to store the data in the fuel rod files. During the course of manufacturing, rods of all types were at different stages of processing; therefore, inspection data became available in somewhat random fashion relative to rod type

and data category. The ASBLT MODULE was designed to accept inspection data for a category punched on computer cards or contained in computer card image files, to sort the data by rod serial number and to generate the input lists for NEWROD. After NEWROD had filed the data and after rod loadings had been computed by GATHER, ASBLT was used to perform detailed consistency checks on the data prior to release of rods for use in module assemblies.

A.I.e.1. Collecting and Sorting Fuel Rod Inspection Data

The fuel rod data processed by the ASBLT MODULE for use in updating the fuel rod files, described in Section A.I.d.1, were obtained from the following inspection forms:

- a. 74288 - Reflector rod stacking data
- b. 74285 - Seed rod stacking data
- c. 74286 - Blanket rod stacking data
- d. 74297 - Final outer diameter
- e. 74290 - Final clad wall thickness
- f. Dummy form 00001 - module assembly data.

The ASBLT MODULE requires that the data be punched on computer cards, or contained in card image computer files, according to the following formats:

a. Form 74288 (1 card per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Rod serial number	1-7	A7
Engineering change code	9	1X, A1
Total fuel stack length	10-16	F7.3
Total fuel stack weight	17-25	F9.1

b. Forms 74285 and 74286 (2, 3, or 4 cards per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Rod serial number	1-7	A7
Engineering change code	9	1X, A1
Length A (binary)	10-16	F7.3
Length D (control)	17-23	F7.3
Length P (overall)	24-31	F8.3
Length S (plenum)	32-38	F7.3
Thoria weight	39-45	F7.1
Number of binary blends	46-47	I2

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Binary ID #1	49-58	1X, A10
Binary quantity #1	59-62	I4
Binary Weight #1	63-69	F7.1
Binary change code #1	70	A1
Rod serial number	1-7	A7
Binary ID #2	11-20	3X, A10
Binary quantity #2	21-24	I4
Binary weight #2	25-31	F7.1
Binary change code #2	32	A1
Binary ID #3	34-43	1X, A10
Binary quantity #3	44-47	I4
Binary weight #3	48-54	F7.1
Binary change code #3	55	A1
Rod serial number	1-7	A7
Binary ID #4	11-20	3X, A10
Binary quantity #4	21-24	I4
Binary weight #4	25-31	F7.1
Binary change code #4	32	A1
Rod serial number	1-7	A7
Month loaded	11 12	3X, A2
Day loaded	14-15	1X, A2
Year loaded	17-18	1X, A2
Hour loaded	21-22	2X, I2
Minute loaded	23-24	I2
Balance ID	25-32	I8

c. Form 74297 (1 card per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Rod serial number	1-7	A7
Rod outer diameter	8-11	I4
Form serial number	12-16	A5

d. Form 74297 alternate form (1 card per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Rod serial number	1-7	A7
Rod outer diameter	27-30	19X, I4
Form serial number	47-51	16X, A5

e. Form 74290 (1 card per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Rod serial number	1-7	A7
Clad wall thickness	9-16	1X, F8.4
Form serial number	21-30	4X, A10

f. Form 00001 (1 card per rod)

<u>Data</u>	<u>Columns</u>	<u>Format</u>
Module serial number	2-10	1X, A9
Cell identity	28-30	17X, A3
Rod serial number	34-40	3X, A7

To update the fuel rod files each ASBLT job must contain input cards for one of the above categories in a system file named TAPE11. The following DATATRAN input lists control the execution of the module:

N.OPTION = ASBLT

N.ASBLT = A_1 , A_2 , I_1

where

A_1 = SORT if input cards in TAPE11 are to be sorted by rod serial number.
= NOSORT if sort is not required.

A_2 = Six-character label to be added to each card in columns 71-76. For example, if the 39th set of binary fuel rod data are being processed, one might assign the label BIN039. A sequence number is placed by ASBLT in columns 77-80. For example, the 158th rod in deck 39 would be labeled BIN0390158. This numbering system aids in locating the source of raw data.

I_1 = Five-digit form number; one of the following - 74288, 74285, 74286, 74297, 74298 (alternate to 74297), 74290 or 00001.

ASBLT can be used to maintain history files of card data and to convert card data into input for NEWROD. To maintain history files of card data along with the ASBLT fuel rod files described in Section A.I.d.1, the following steps are required:

- a. Copy the history file to TAPE11
- b. Copy the new card data to TAPE11
- c. Execute ASBLT - ASBLT will sort TAPE11, write a new history file into TAPE13, place the new data (sorted) into TAPE12 and automatically update the ASBLT fuel rod files from TAPE12
- d. Copy TAPE13 (new history file) to disk or tape.

To use ASBLT to update the ASBLT fuel rod files without saving the card data, the following steps are required:

- a. Copy the new card data to TAPE11
- b. Execute ASBLT; ASBLT will sort TAPE11, write the new data (sorted) into TAPE12 and automatically update the ASBLT fuel rod files.

The ASBLT module can also be used to maintain any card image data base where card columns 1 through 7 contain key data for sorting, columns 8 through 70 contain data and columns 71 through 80 are used by ASBLT for identifiers and sequencing within identifiers. By setting $I_1 = 0$ in the N.ASBLT list, the user instructs ASBLT to terminate after sorting a card file (from TAPE11 into TAPE13) without attempting to update the ASBLT fuel rod files. This feature has been used to maintain a data base of fuel rod in-motion radiography data for use by ASBLT in performing the consistency checks discussed in Section A.I.e.3.

A.I.e.2. Correcting and Deleting Card Data

Incorrect data contained in a card file and in the ASBLT fuel rod files can be replaced by using the following procedure:

- a. Copy the existing card file to TAPE11
- b. Copy the corrected data cards to TAPE11
- c. Execute ASBLT with the additional list N.REPLACE=YES making certain that the label A_2 in the list N.ASBLT= A_1 , A_2 , I_1 was never used before.

Whenever ASBLT encounters duplicate rod serial numbers, it will retain only those cards whose label in columns 71 through 76 matches A_2 . TAPE13 will contain the corrected card data and the ASBLT fuel rod files will be automatically corrected if I_1 is one of the expected inspection form numbers.

Data can be deleted from a card file by including the following input lists in the ASBLT job:

N.OPTION = DELETE

N.DELETE = TYPE, I_1 , I_2 , I_3 , ... to delete all cards for each rod type I_j .

N.DELETE = SET, A_1 , A_2 , A_3 , ... to delete all cards with identifiers A_j in columns 71 through 76.

N.DELETE = SN, A_1 , A_2 , A_3 , ... to delete those cards with serial numbers A_j in columns 1 through 7.

To perform the DELETE option, the existing cards must be copied into TAPE11. The remaining cards, after deletion, will be in the file TAPE12.

Sections A.I.e.1 and A.I.e.2 have described the use of the ASBLT MODULE to maintain card files of inspection data (data keypunched directly from inspection forms) and the use of ASBLT to update the DATATRAN fuel rod files described in Section A.I.d.1. The card files are general in nature - the only requirements being the use of key data (like rod serial number) in columns 1 through 7 and identifier sequences in columns 71 through 80. The DATATRAN files require data from specific inspection forms in order to perform specific as-built data analyses. The next section will describe the so-called 16 ASBLT computer checks of fuel rod fabrication data.

A.I.e.3. ASBLT Fuel Rod Data Checks

One of the steps in the fuel rod inspection process was the use of the ASBLT MODULE to perform computer checks on key fuel rod data to verify that each rod met those specifications which distinguish the various fuel rod types. The checks were important for loading assurance; that is, assurance that each rod used in the LWBR core contained the correct fissile loading for its type. In performing the checks, ASBLT used the fuel rod data files described in Section A.I.d.1 and a system file containing fuel rod in-motion radiography data. Each fuel rod was x-rayed twice during fabrication - once shortly after the rod was loaded (in-process radiography) and again near the end of the manufacturing process (final radiography). As discussed in Reference 4, final radiography was done at 3 to 9 orientations, depending on rod type. One orientation was selected for use

in the ASBLT program. The following data were obtained from measurements of the radiographs, keypunched and stored in a card image file maintained by the ASBLT MODULE:

<u>Column(s)</u>	<u>Data</u>
1-7	Fuel rod serial number
11-16	Total fuel stack length from in-process radiograph
17-21	Binary stack length from in-process radiograph
22-26	Bottom thoria control stack length from in-process radiograph
27-30	Identity hole location from in-process radiograph
31-34	Stem length from in-process radiograph
35-37	Length of first pellet from in-process radiograph
38-40	Length of second pellet from in-process radiograph
41-43	Length of next-to-last pellet from in-process radiograph
44-46	Length of last pellet from in-process radiograph
47	A letter code indicating that the end connectors were checked
48	The digit 1 indicating that the data up to this point on the card are in-process data
49-54	Total fuel stack length from final radiograph
55-59	Binary stack length from final radiograph
60-64	Bottom thoria control stack length from final radiograph
65	The digit 2 indicating final data
71-76	Date data were input (year/month/day)

Given the radiograph data and the rod stacking data saved in the ASBLT fuel rod DATATRAN lists, ASBLT performs the following checks on the data:

- a. Validity of rod serial number; serial numbers are constructed using an algorithm whereby the seventh digit depends on the first six. ASBLT confirms that each serial number conforms to that algorithm.
- b. Overall fuel stack length (P in Figure 2) from in-motion radiography is checked against specifications.
- c. Binary stack length (A in Figure 2) from in-motion radiography is checked against specifications.
- d. Bottom thoria control length (D in Figure 2; binary plus bottom thoria for seed rods, bottom thoria for blanket rods) from in-motion radiography is checked against specification.

- e. Location of identity hole in bottom end cap from in-motion radiography is checked against specification. The hole location provides visual confirmation of the rod type.
- f. Stem length from in-motion radiography is checked against specifications. The stem length provides visual confirmation of the rod type.
- g. Lengths of first two pellets from in-motion radiography are checked against specifications.
- h. Lengths of last two pellets from in-motion radiography are checked against specifications. The lengths of the first two pellets and the last two pellets in the fuel rods were checked by ASBLT because of the inability of the Pellet Length Gage, described in Reference 7, to reliably measure and check the length of the first pellet in a stack and the length of the last pellet in a stack. The use of ASBLT to check the first two pellets and the last two pellets, using lengths measured from the radiographs, served as an overcheck of the Pellet Length Gage inspection.
- i. Confirmation that the end connector check was recorded.
- j. Overall stack length from both radiographs and from the stacking data sheet must be within a specified value of each other.
- k. Binary stack length from both radiographs and from the stacking data sheet must be within a specified value of each other.
- l. Bottom thorium control length from both radiographs and from the stacking data sheet must be within a specified value of each other.
- m. Binary stack weight per unit length (linear density) must meet specified limits.
- n. Thorium stack linear density must meet specified limits.
- o. Fissile loading in weight per unit length must meet specified limits.
- p. Rod fissile loading precision value must be no higher than a specified value. The precision value was computed to be two times the standard deviation of the fissile loading uncertainty in relative percent.

Rods which met all 16 of the above checks were flagged as "ACCEPT." Rods which failed one or more of the checks were flagged as "REJECT" and corrective action was taken before the rods were used in the LWBR core.

The following lists control the running of ASBLT for the loading assurance option:

- a. N.OPTION = ASSURE

- b. N.TYPES = I_1 , I_2 (optional) to edit only rod types I_1 through I_2
- c. N.MODULE = A_1 (optional)
 if A_1 = INCLUDE, all rods (including those already in modules) will be edited; if A_1 = ALL, only rods in modules will be edited; if A_1 = a module serial number, only rods in that module will be edited.
- d. N.DATE = I_1 , I_2 (optional) to edit rods loaded between two dates identified by I_1 and I_2 ; for example, I_1 = 730501 and I_2 = 741231 will produce an edit for rods loaded between May 1, 1973 and December 31, 1974. If I_2 is missing, rods loaded after date I_1 will be edited.
- e. N.EDITREJ = YES (optional) to write a summary file of rejected rods in TAPE12.
- f. N.CONDITN = A_1 (optional)
 if A_1 = A only accepted rods will be edited; if A_1 = R only rejected rods will be edited; if A_1 = 1 only rods with incomplete data will be edited.
- g. N.PIR = YES (optional) may be used without N.EDITREJ to write a summary file of all accepted rods in TAPE12.

Rods which were rejected by ASBLT were sometimes identified for use in selected locations in the core or modules. Such rods were given a special identification in the DATATRAN files by altering the disposition code (Section A.I.d.3). For example, if rod 0617333 failed ASBLT checks 10, 11 and 12, it would be labeled "DSR ACCEPT" by running a DATATRAN job with the following input statements:

- a. N.FETCH=1
- b. KALL GETAFM
- c. D.CLASS(1).DSR.R0617333=10,11,12
- d. N.CODES = D
- e. N.D(6) = 17333
- f. KALL NEWROD

Statements a and b retrieve the seed file. List c identifies rod 0617333, which is in class 1, as having special requirements for ASBLT checks 10, 11 and 12. Statements d, e, and f give rod 0617333 (type 6) disposition code D (Section A.I.d.1) and automatically save the new seed file.

The ASBLT loading assurance option performs other data checks including the following:

- a. Comparison of binary stack weights from the stacking data sheets to weights computed from the mean pellet weights inferred from the blend data and the quantities of pellets in rods
- b. The filed rod diameter is checked against the specification limits
- c. The filed clad thickness is checked against the specification limits.

These additional checks, while not required for rod release, are performed to provide additional confidence in the filed data. To perform check a above, ASBLT requires the binary blend file described in Section A.I.g.1.

A.I.f. EDIT1 - A MODULE Which Sorts the ASBLT Fuel Rod Files and Produces Summary Edits

The EDIT1 MODULE reads the ASBLT fuel rod data files containing the DATATRAN lists, described in Section A.I.d.1, and performs the following functions:

1. Sorts and prints the files by rod serial number and, at user request, rewrites the DATATRAN lists so that the sorted files can be stored
2. Summarizes the quantities of rods in the files by region and type
3. Prints the serial number of each rod in the files as the rods appear in the files.

The sort option is requested by supplying the following list:

$$N.EDIT = SORT, I_1, I_2, I_3, \dots$$

where I_j is a region number (1 for seed, 2 for standard blanket, 3 for power flattening blanket and 4 for reflector). This option simply lists the filed rods in ascending order of serial number without modifying the DATATRAN lists. The EDIT1 rod sort option was generally performed each time new rod data were added to the ASBLT files so that rods would be listed in ascending order in the ASBLT system data displays. If the list

$$N.EDIT = SORTSTOR, I_1, I_2, I_3, \dots$$

is used, EDIT1 will rewrite the DATATRAN lists after sorting.

To obtain a one-page summary of the quantities of rods in the ASBLT files, the following list must be supplied:

$$N.EDIT1 = SUMMARY, , I_1, I_2, I_3, \dots$$

where I_j is described above. The control list

$$N.EDIT = RODS, I_1, I_2, I_3, \dots$$

will cause EDIT1 to print the serial numbers of all fuel rods filed under the specified region number, I_j .

A.I.g. EDIT2 - A MODULE Which Produces Detailed Edits of Binary Blend Data and Fuel Rod Data

The EDIT2 MODULE reads the binary blend data file described in Section A.I.g.1, the card image files of rod inspection data described in Section A.I.e.1 and the DATATRAN fuel rod files described in Section A.I.d.1 and produces detailed edits of the data in those files. Several options are available for displaying blend and rod data to assist in evaluating as-built data and the characteristics of blends and rods.

A.I.g.1. Print Binary Blend Data

As binary pellets were manufactured, a random sample of twenty pellets was taken from each blend and used to determine the characteristics of the blend. To ensure that random samples were taken, each blend was assigned a computer-prepared form which specified the number of samples to be taken from each batch in the blend. The form also identified the randomized numbering (1 to 20) of the samples. The pellet samples were weighed, measured, nondestructively analyzed for uranium content and, on a less frequent basis, destructively analyzed for uranium composition. Five of the twenty pellets were analyzed for uranium content using wet chemistry. From one to three pellets (in addition to the twenty) were used to determine the uranium isotopic content for the blend. Data needed to compute fuel rod loadings and loading precision (see GATHER, Section A.I.h) and other data required for evaluating binary blends were stored in a computer file for use by ASBLT using the file format described below.

The first record of the blend file can contain up to 105 characters of general information and is not used by the ASBLT system. The second record must contain header information formatted as follows:

<u>Column(s)</u>	<u>Data</u>
2-9	Date of last update (MO-DA-YR)
11-20	Time of last update (XX XX XX.X; Hr, Min, Sec)
26-30	Number of blends in file (N_b)
85-90	Number of records containing blend identities (N_r)
101-105	Checksum digits for checking the data record.

The next N_r records must contain 10-character blend identities, ten per line (10A10 format) in columns 1 through 100 and the checksum digits in columns 101 through 105. The next $2 \times N_b$ records must consist of record pairs containing data for each blend filed. The first record of the pair is formatted as follows:

Item	Column(s)	Data
-	1-10	Blend identity (iii-j-kkxx where j is from 1 to 8 and identifies the fuel type).
1	11	Signoff code; 0 for incomplete data 1 if all inspections are complete S if this is a sub-divided blend (portion of a blend) U if blend had been completed but is in the process of being reevaluated X if blend cannot be signed off as complete because of questionable data.
2	12-14	UO ₂ powder lot number
3	15-17	Second UO ₂ powder lot, if applicable
4	18-20	U ²³² concentration in ppm of U ^T (F3.1)
5	21-26	U ²³³ concentration in weight percent of U ^T (F6.3)
6	27-31	U ²³⁴ concentration in weight percent of U ^T (F5.3)
7	32-35	U ²³⁵ concentration in weight percent of U ^T (F4.3)
8	36-39	U ²³⁶ concentration in weight percent of U ^T (F4.3)
9	40-43	U ²³⁸ concentration in weight percent of U ^T (F4.3)
10	44-48	Mean diameter of sampled pellets in inches (F5.4)
11	49-53	Standard deviation on diameter (F5.4)
12	54-59	Mean length of sampled pellets in inches (F6.4)
13	60-64	Standard deviation on length (F5.4)
14	65-71	Mean weight of sampled pellets in grams (F7.4)
15	72-76	Standard deviation on weight (F5.4)
16	77-82	Mean density of sampled pellets in gms/cc (F6.4)
17	83-87	Standard deviation on density (F5.4)
18	88-94	Mean linear density of sampled pellets in gms/in. (F7.4)
19	95-99	Standard deviation on linear density (F5.4)
--	101-105	Checksum digits

Items 2 through 9 above were obtained from the mass spectrometric analyses for uranium isotopic content and manually entered into the DEC-10 computer. The weights, lengths and diameters of the sampled pellets were manually entered into

the DEC-10 computer and a program computed items 10 through 19 and automatically filed these results in the blend file. The second record of the pair of blend data is formatted as follows:

Item	Column(s)	Data
20	1-5	σ_p , delayed neutron gage (Reference 3) estimate of pellet-to-pellet standard deviation of fissile uranium content in percent (F5.4).
21	6-11	σ_c , standard deviation of the uncertainty in the delayed neutron gage calibration curve in percent (F6.5).
22	12-17	σ_o , gage observation standard deviation in percent (F6.5).
23	18-23	Gage w/o U^T for the chemistry pellets (F6.4).
24	24-29	Uncorrected gage w/o U^T for all pellets sampled (F6.4).
25	30-34	Standard deviation on uncorrected gage w/o U^T (F5.4).
26	35-41	Multiplicative correction on gage w/o U^T (F7.5).
27	42-47	Additive correction on gage w/o U^T (F6.4).
28	48-52	$\hat{\mu}$, best estimate w/o U^T (F5.3).
29	53-57	$\sigma_{\hat{\mu}}$, standard deviation of $\hat{\mu}$ (F5.4).
30	58-63	V_c , variance term where V_c^2 is the difference between the variance for chemistry and the covariance of the gage and chemistry (F6.5).
31	64-69	V_x , variance term where V_x^2 is the difference between the variance of the gage and the covariance of the gage and chemistry (F6.5).
32	70-75	$A = V_c / (V_c + V_x)$ (F6.5).
33	76-81	Estimate of w/o U^T from chemistry analyses (F6.4).
34	82-87	Fissile linear density (gms fissile/in.) (F6.4).
35	88-93	Gage normalization error (F6.5).
36	94-99	σ_D , standard deviation which is used to determine significance of the difference between gage w/o U^T and chemistry w/o U^T (F6.5).
--	101-105	Checksum digits.

Items 20 through 36 were computed by the delayed neutron gage analysis codes on the DEC-10 computer and automatically stored in the blend file. The blend file was transmitted to the CDC-6600 computer and used by the ASBLT system.

Detailed edits of the contents of the binary blend file and summaries by fuel type are obtained by executing the EDIT2 MODULE with the following control list:

N.EDIT = BLENDS

The binary blend file must be copied to system file TAPE11 prior to executing EDIT2. The detailed edit by blend is written by EDIT2 into system file TAPE12 and the summary by fuel type is written into system file TAPE13. If the list

N.EDIT = LDGFAC

is supplied, EDIT2 will read the binary blend file and compute and print as-built fuel loading factors instead of editing the contents of the blend file. The binary blend file is used by the GATHER MODULE when computing fuel rod loadings and by the loading assurance option of the ASBLT MODULE.

A.I.g.2. Print the Card Image Files of Fuel Rod Stacking Data

Section A.I.e.1 described the card image files of fuel rod stacking data maintained by the ASBLT MODULE. Various cross-reference lists of the data in the card image files can be obtained using the EDIT2 MODULE. The stacking data files must be copied to system file TAPE11 prior to executing EDIT2. The following table summarizes the edit options available in EDIT2 along with the required control lists.

Type of Edit	Control Lists
(a) Stacking data listed by rod serial number printed if A_1 or A_2 = OUTPUT and written into system file TAPE12 if A_1 or A_2 = TAPE12 for rod types I_1 through I_2 .	N.OPTION = LIST, RODS, A_1 , A_2 N.LIST = I_1 , I_2
(b) Same as (a) except that only rods with two or more binary blends will be listed.	N.OPTION = LIST, MULTI, A_1 , A_2 N.LIST = I_1 , I_2
(c) Stacking data listed by blend identity for type I_1 fuel. Data is listed by rod serial number within a blend unless A_1 = YES in which case data is listed by loading date within a blend.	N.OPTION = LIST, BLENDS N.LIST = I_1 N.LOADSEQ = A_1

The above edit options are useful for characterizing rod and blend data, for identifying the binary blends used in rods and for identifying the rods loaded with specific binary blends.

A.I.g.3. Print Fuel Rod Data Contained in the DATATRAN Fuel Rod Files

Section A.I.d.1 described the DATATRAN lists which contain fuel rod inspection data. The EDIT2 MODULE can be used to produce detailed edits of the contents of these lists as summarized in the following table.

Type of Edit	Control Lists
(a) List the data for all type I_j rods as specified in N.EDIT.	N.EDIT = $I_1, I_2, I_3, \dots$
(b) Same as (a) except that only the rods in module A_1 are listed.	N.EDIT = $I_1, I_2, I_3, \dots$ N.MODULE = A_1
(c) List the locations (cell and module) of the type I_j rods used in the core.	N.EDIT = I_1, I_2, I_3 N.OPTION = CORERODS
(d) Prepare a summary loading sheet for reflector module A_1 listing the serial number, cell location, and thorium loading of each rod in the module and the total thorium loading for the module.	N.OPTION = ACCOUNT N.MODULE = A_1 N.EDIT = 31, 32

Options (b) and (c) above can be performed on all module types (seed, blanket, reflector). Option (d) can only be performed for reflector modules. Summary loading sheets for seed and blanket modules require special calculations for binary rods and are generated only in the GATHER MODULE.

A.1.h. GATHER - A MODULE Which Sorts the Binary Blend File and Computes Uranium and Thorium Loadings

GATHER is a multipurpose MODULE which sorts the binary blend file, processes the binary blend and fuel rod data files, and computes the uranium and thorium loadings of rods, modules and compositions (core zones). The MODULE also computes fissile loading precision. The Fuel Rod Data file read by GATHER is described in Section A.1.d.1 and the binary blend data file is described in Section A.1.g.1. The following input lists are used by GATHER:

1. N.OPTION = A_1, A_2, I_1, A_3 (required)
 - a. N.OPTION = SORT, BLENDS

This list instructs GATHER to sort the binary blend file.

- b. N.OPTION = LOADING, ALL

This list instructs GATHER to calculate the rod total uranium, fissile uranium and thorium loadings, and the fissile loading precision for all rods in the ASBLT files. The equations used to calculate rod loading precision are presented in Appendix B.

- c. N.OPTION = LOADING, NEW

This list instructs GATHER to perform the loading calculations for any new rods added to the as-built files since the last computation.

- d. N.OPTION = LOADING, POB

This list instructs GATHER to calculate and print data pertinent to proof-of-breeding, such as the uranium isotopics, thorium and fissionable content and core location.

- e. N.OPTION = LOADING, ACCOUNT, I_1 , A_3

This list instructs GATHER to calculate thorium U^{233} , and total uranium loadings for a module and to write the loadings of each rod and the total loadings for the module into a system file. The system file can then be directed to any printing device.

I_1 = the number of lines to be printed per page.

A_3 = blank, if this is a preliminary report; CERT, if this is the final report.

2. N.GATHER = I_1 , I_2 , I_3 , ... (required)

I_j = a region number whose rod data are to be processed; $1 \leq I_j \leq 4$.

As discussed in Section A.I.a, regions 1, 2, 3 and 4 are seed, standard blanket, power flattening blanket and reflector blanket, respectively.

3. N.BYZONE = 1 (optional)

I = a fuel zone number whose rod data are to be processed; the calculations are performed for only those rods in the specified zone.

$1 \leq I \leq 8$. See Section A.I.a, list 8.

4. N.BYTYPE = I (optional)

I = a composition whose rod data are to be processed; $1 \leq I \leq 12$. See Section A.I.a, list 7.

5. N.ROWS = A_1 , A_2 , A_3 , ... (optional)

A_j = the letter of a row whose rod data are to be processed; $A \leq A_j \leq Q$, $A_j \neq I$, $A_j \neq O$. In the LWBR modules, the seed region contains rows A through Q, the standard blanket contains rows A through F, the power flattening blanket contains rows A through K, the reflector blanket contains rows A through Q and rows I and O do not exist in any region.

6. N.MODULE = A (optional)

A = ALL, instructs GATHER to perform calculations for all rods in modules, including the spare modules.

A = CORE, instructs GATHER to perform calculations for all rods in modules that are in the core.

A = RODS, instructs GATHER to perform calculations for all rods with disposition N, D, or M. See Section A.I.d.1.

A = L-XXXX-XX, instructs GATHER to perform calculations for all rods in module L-XXXX-XX. See Section A.I.a, list 17.

7. N.DISP = A (optional)

A = a letter designating which disposition code is to be processed. See Section A.I.d.1.

8. N.PRINT = NO (optional)

This list instructs GATHER to write results into system file TAPE12 rather than system file OUTPUT, which is automatically directed to a printer.

9. N.NORMWPC = NO (optional)

The standard procedure in GATHER is to normalize the uranium isotopic weight percents to 100 percent for each binary blend. This list instructs GATHER to use the unnormalized uranium isotopic weight percents.

10. N.THORIUM = F_{th} , fractional weight of thorium in thorium-oxide. See Section A.I.a, list 23.

11. N.PREP1 = I_1, X_1, X_2, X_3 (optional)

This list instructs GATHER to calculate data to be used as input to the PREP1 program which prepares input for the LWDR calculational model (Reference 8). There are either two or four values in the list.

a. N.PREP1 = I_1, X_1, X_2, X_3 (for thoria compositions)

I_1 = a composition whose data are to be processed $1 \leq I \leq 12$. See Section A.I.a, list 7.

X_1 = the mean pellet outer diameter for composition I_1 .

X_2 = the fraction of theoretical density for composition I_1 .

X_3 = the total length of the fuel stacks in the composition (summed over all rods in the composition). If X_3 is greater than zero, GATHER uses X_3 in the computations. If X_3 equals zero, GATHER uses the nominal value in the computations. If X_3 is less than zero, GATHER uses the value it computes from the as-built rods in the computations. The actual amount of fuel in the composition will be homogenized over the stack length, as selected above, for use in performance calculations.

b. $N.PREPl = I_1, X_3$ (for binary compositions).

I_1 and X_3 as defined above.

A.I.i. RODTST - A MODULE Which Performs Statistical Evaluations on Fuel Rod As-Built Data

RODTST reads the ASBLT DATATran fuel rod files described in Section A.I.d.1 and performs statistical evaluations on the as-built fuel rod data. RODTST can be executed repeatedly within a job, in which case questionable data are flagged and deleted from the population (not from the files) and the statistics are recomputed. The questionable data can be examined and reinput if in error. For each rod type requested in the job RODTST collects data by category and computes the range, mean, variance, standard deviation and coefficient of skewness of each category or fuel rod parameter. The following fuel rod parameters are examined by RODTST for seed and blanket rods:

1. Binary stack length
2. Thoria control length
3. Total fuel stack length
4. Binary stack weight
5. Binary stack linear density (weight/length)
6. Thoria stack weight
7. Thoria stack linear density
8. Fissile weight
9. Fissile linear density
10. Weight of thoria in binary
11. Linear density of thoria in binary
12. Rod outer diameter
13. Clad thickness.

The following parameters are examined for reflector rods:

1. Total fuel stack length
2. Total fuel stack weight
3. Total fuel stack linear density
4. Rod outer diameter
5. Clad thickness.

In addition to computing the statistics of the populations of data for the above parameters, RODTST prepares histograms of the results in tabular and graphical form, generates summary tables of the as-built data and estimates

the effects of the as-built data on Fissile Inventory Ratio (FIR - measure of breeding in LWBR) relative to the nominal values for the fuel rod parameters.

The following control lists are used by RODTST:

1. N.EDIT = $I_1, I_2, I_3, \dots$ (required)

I_j = a rod type number

2. N.CØRE = YES (optional)

Instructs RODTST to access only the rods used in the core.

3. N.PRINT = I_1 (optional)

$I_1 = 1$ to suppress all output except the listing of rods with questionable data.

$I_1 = 2$ to print above plus fissile loading and precision histograms.

$I_1 = 3$ to print above plus summary lines for all other parameters plus edit of FIR effects.

$I_1 = 4$ to print above plus detailed histograms.

4. N.DEVIATE = F (optional)

F = number of standard deviations to use while checking for questionable data (outliers). Any value outside $\bar{X} \pm Fs$ ($\bar{X}$ = computed mean, s = computed standard deviation) will be flagged.

RODTST uses the MODULE STATS (Section A.I.j) to compute the statistics of each population and to generate output histograms and the MODULE SPREAD (Section A.I.k) to locate outliers in the data.

A.I.j. STATS - A MODULE Which Computes the Statistics of a Population and Displays the Population

The STATS MODULE computes the statistics (range, mean, variance, standard deviation and coefficient of skewness) of a set of numbers and displays the population as a histogram in tabular and graphical form. The graph produced by STATS will show a superimposed normal distribution having the population mean and standard deviation. The MODULE operates on any population and is not restricted to the ASBLT system; however, the control lists and the data list (population) must be in DATATRAN. The RODTST MODULE, described in Section A.I.i, generates the lists required by STATS using as-built fuel rod data and calls STATS into execution.

The following DATATRAN lists must be input to STATS:

1. N.DISPLA = N, NAME, I, J, S, V, F, CHECK

N = number of values in the population.

NAME = name of the DATATRAN list which contains the data.

I = subscript for the list which contains the data.

J = number of classes for the output histogram if S=0.

S = step size for the output histogram if J=0.

V = nominal value of the parameter being displayed.

F = number of standard deviations at which to terminate the normal distribution on the plotted histogram.

CHECK = YES instructs STATS to read the first N values in the list identified by NAME. Otherwise, the list identified by NAME must contain exactly N values.

2. N.((NAME))(I)

NAME = name of the DATATRAN list which contains the data as defined in N.DISPLA.

I = subscript of the N.((NAME)) list for example; if NAME = CLADT and I = 8 in the N.DISPLA list, STATS will expect to find the data in the list N.CLADT(8). The data within the list must be blocked into records of no more than 1000 values and the list can have no more than 100 records; thus, 100,000 values can be processed by STATS.

3. N.OTTITLE

Up to 60 characters for output heading.

4. N.UNITS

Up to 10 characters for identifying the units of the population being processed.

5. N.PTITLE

Up to 30 characters for the plot title.

6. N.XLABEL

Up to 30 characters for the X-axis of the plot.

7. N.YLABEL

Up to 30 characters for the Y-axis of the plot.

8. N.PRINT = I_1

$I_1 = 1$ to obtain printed output.

$I_1 = 0$ to suppress printing.

After computing the statistics of the input population, STATS generates an output list (in DATATRAN) which can be used by any MODULE (for example, RODTST) which calls STATS. The output list is formatted as follows:

N.STAT = N, $X_{\min}$, $X_{\max}$, $\bar{X}$, v, s, c

N = population size

$X_{\min}$ = minimum value in the population.

$X_{\max}$ = maximum value in the population.

$\bar{X}$ = mean value of the population.

v = variance of the population.

s = standard deviation ($\sqrt{v}$) of the population.

c = coefficient of skewness of the population.

A.I.k. SPREAD - A MODULE Which Scans a List of Data and Prints Values Which Fall Outside a Specified Range

The SPREAD MODULE scans a set of data and prints those values which fall outside the range $\bar{X} \pm Ys$. The MODULE operates on any population and is not restricted to the ASBLT system; however, the control lists and the data list (population) must be in DATATRAN. The RODTST MODULE described in Section A.I.i generates the lists required by SPREAD, using as-built fuel rod data, and calls SPREAD into execution.

The following DATATRAN lists must be input to SPREAD:

1. N.DATAID.(I)/ = a list of not more than 1000 identifiers per record I for the values in the N.DATA list.
2. N.DATAIX.(I)/ = a list of not more than 1000 indices per record I for the values in the N.DATA list.
3. N.DATA.(I)/ = a list of not more than 1000 values of the population per record I.
4. N.OTITLE

Up to 60 characters for output heading.

5. N.DEVIATE = Y

Y = the number of standard deviations to use in defining the acceptable range.

6. $N.STAT = X_{\min}, X_{\max}, \bar{X}, v, s, c$

$X_{\min}$ = minimum value in the population.

$X_{\max}$ = maximum value in the population.

$\bar{X}$ = mean value of the population.

v = variance of the population.

s = standard deviation ($\sqrt{v}$) of the population.

c = coefficient of skewness of the population.

The values which fall outside the range are put into the following output lists:

$N.BADATA(J) = K, ID$

where

K = index of the j^{th} out-of-range data point.

ID = identifier of the j^{th} data point.

When all out-of-range data points are identified the following list is written:

$N.BAD = N$

where

N = number of out-of-range data points.

A.I.2. CRTVER - A MODULE Which Performs Final Loading Assurance Checks for Module Certification

The DATATRAN MODULE CRTVER was designed to perform the following functions related to the certification of core modules:

1. Confirmed that all pertinent computer files were consistent and in agreement with a master list of rods assigned to each module prior to module assembly. The following computer files were checked by CRTVER:
 - a. ASBLT files described in Section A.I.d.1.
 - b. Rod release file containing the serial number of the rod release form for each rod released for use in the core.
 - c. DSR file containing the serial numbers of forms which identified special evaluations performed on some fuel rods. Each rod which received special evaluations was assigned a DSR number (special evaluation form number) for each such evaluation. Rods which required special handling such as being restricted to selected core locations or selected modules, as a result of the special evaluations,

were conditionally released and were assigned conditional DSR numbers. The DSR file identified each fabricated fuel rod and any associated DSR numbers and conditional DSR numbers.

- d. Module assembly file containing a list of module cell locations and the serial number of the rod installed in each location for the module being checked.
2. Prepared a list of rod serial numbers, module cell locations, rod release numbers, conditional DSR numbers, and binary blend identities for use in the Module Certification Reports.

The list of rods prepared by CRTVER for a module was used to manually check the validity of all rod releases and to check that all conditional DSR's had been satisfied. These checks were performed by examining all documents related to the rods listed by CRTVER for the particular module. Since the rod list prepared by CRTVER was crucial to module certification, the majority of the work done by CRTVER involved checking computer files for consistency.

CRTVER is executed by specifying option names in the N.OPTION list. The allowed option names are:

- FORMA - check master list using format a, Section A.I.2.1.
- FORMB - check master list using format b, Section A.I.2.2.
- LDVER - check LDVER module assembly file, Section A.I.2.3.
- ASBLT - check ASBLT files, Section A.I.2.4.
- MODDSR - check seed and blanket rod release and DSR file, Section A.I.2.5.
- REPORT - prepare certification listing for seed or blanket module, Section A.I.2.6.
- REFREL - check reflector rod release and DSR file and prepare certification listing for reflector module.

A.I.2.1. The FORMA Option

The FORMA option of CRTVER reads the master list of rod installation sequence, module cell identity and fuel rod serial number for a module and performs consistency checks on the list. The master list is a deck of cards, one card per installation sequence, which was generated automatically by a rod

selection program at the time rods were selected and assigned to a particular module. In other words, the master deck or list reflects the fuel rods and their intended locations in the module. The format of the FORMA file is as follows:

Card 1

- a. Date of rod assignment in columns 1-9 (DA-MON-YR)
- b. Time of rod assignment in columns 11-20 (HR, MI, SECS)

Card 2

- a. Module serial number in columns 1-9
- b. Subset code (A, B, C, ...) in column 15. Subset codes identify portions of a module whose rods were assigned as a group.

Card 3

- a. First installation sequence (N_1) in columns 1-3
- b. Last installation sequence (N_2) in columns 4-6

Cards 4 through ($N_2 - N_1 + 4$)

- a. Installation sequence in columns 1-3
- b. Cell identification in columns 4-8
- c. Rod serial number in columns 9-15

Within the master deck, the above pattern is repeated until all installation sequences (module cell locations) have been defined. CRTVER checks the master deck to confirm that

- a. The installation sequences run from 1 through the number of cells in the module,
- b. The first two digits of the cell identity, which define the rod type required in that cell, match the first two digits of the rod serial number.

A.I.2.2. The FORMB Option

The FORMB option is similar to the FORMA option except that the format of the master deck is as follows:

All cards 1 through number of cells in module

- a. Module serial number of columns 2-10
- b. Installation sequence in columns 11-20

- c. Cell identity in columns 26-30
- d. Rod serial number in columns 34-40

Both the FORMA option and the FORMB option produce the internal master list for the current CRTVER job. All other files are compared to this master list.

A.I.2.3. The LDVER Option

During fuel rod installation (the manufacturing step where fuel rods were installed in the grid cells of a particular module) a computer program on the DEC-10 computer, LDVER, was used to confirm that each rod was installed in the correct grid cell. A record was kept of each installation sequence number, the grid cell identity and the serial number of the rod actually installed. These data were entered into the DEC-10 computer via LDVER and a file was maintained containing the LDVER transactions. This file, in addition to being checked by LDVER shortly after each rod was installed, is checked by CRTVER as part of the module certification process. The LDVER file must agree with the master file from the FORMA or FORMB options and the LDVER file must indicate that all rods listed were actually installed in the module. The LDVER file is formatted as follows:

Record 1

- a. Module serial number in columns 2-10

Records 2 and on

- a. Installation sequence in columns 1-3
- b. Cell identity in columns 4-8
- c. Rod serial number in columns 9-15
- d. Disposition code in columns 16-19
- e. Error flag in column 20

The disposition code is placed in the file by LDVER. The code 1hh (h denotes a blank) indicates no rod installed, bAh indicates correct rod installed and bbR indicates wrong rod installed. The character * is inserted in column 20 by LDVER if an error occurred during installation and this * is never removed. CRTVER prints the * lines for information.

A.I.2.4. The ASBLT Option

The ASBLT option of CRTVER reads the fuel rod DATATRAN files described in Section A.I.d.1, locates all fuel rods in the files which reference the module being certified and flags any discrepancies between the DATATRAN files and the

master list. The ASBLT option will also flag any rods in the reference module which contain a loading code of reject (failed fissile loading or precision). Rods which exceed specification limits on diameter and clad thickness are listed for information, since they required special handling.

A.I.2.5. The MODDSR Option

MODDSR is a DEC-10 program which accesses a computer data base, scans the data base for references to a specified seed or blanket module and writes a file containing rod release numbers and conditional DSR numbers for the rods in the specified module. Release numbers and conditional DSR numbers were described at the beginning of Section A.I.2. The MODDSR output file, which is used as the input file for the MODDSR option of CRTVER, is formatted as follows:

All Records

- a. Rod serial number in columns 1-7 (several records may exist for a given rod)
- b. Rod release number in columns 9-15
- c. Pellet blend identity in columns 17-30
- d. DSR number in columns 32-36
- e. DSR type (nature of special evaluation) in columns 38-41
- f. DSR disposition code (whether or not special handling was required) in column 43
- g. Grid cell identity in columns 46-49

The MODDSR option of CRTVER reads the file generated by MODDSR for the specified seed or blanket module and compares it to the master list. This option is not executed for reflector modules. If any discrepancies exist, they are identified. For reflector modules, a reflector rod release file is accessed as described in the next section.

A.I.2.6. The REPORT Option

The REPORT option of CRTVER generates the list of rod serial numbers, rod release numbers, module cell identities, conditional DSR numbers and binary blend identities for a module certification report. The REPORT option can only be executed if the FORMA or FORMB, LDVER, ASBLT, and MODDSR options were executed without any errors being detected. Having successfully run the prior options, CRTVER can execute the REPORT option and produce a certification listing with the

ensurance that all related data files are consistent. All entries on the certification listings were manually checked by examinations of the referenced product inspection documents before the listings were used in the certification reports.

As mentioned above, the MODDSR option is not executed for reflector modules. The REPORT option is programmed to automatically execute the REFRPT routine whenever a certification listing is requested for a reflector module. In this case a file of reflector rod release numbers and DSR numbers is accessed. The reflector file must have the following format:

All records

- a. Rod serial number in columns 1-7
- b. Rod release number in columns 9-13
- c. Rod release type (unconditional or conditional) in columns 15-16
- d. DSR number in columns 18-25
- e. Module cell location in columns 58-61

To produce a reflector rod listing for a certification report, the FORMA or FORMB, LDVER and ASBLT options must run successfully and the reflector rod release file must be consistent with the master list produced by FORMA or FORMB.

Execution of the CRTVER MODULE requires the following input:

N.OPTION = A₁, A₂, ... (list of options)
KALL CRTVER

The option list

N.OPTION = FORMA, REPORT

causes CRTVER to automatically execute the required options (LDVER, ASBLT, MODDSR) prior to generating the certification listing.

A.I.m. ORIENT - A MODULE Which is Used to Record a Rod's Location in the Core Relative to Core Sectors

All of the rods in each 1/6 sector of the core must be identified to calculate beginning-of-life symmetry data and to perform end-of-life reprocessing calculations. ORIENT is a MODULE which adds an indicator to the ASBLT files, for each rod installed in a module, identifying the core sector in which the rod is located. The indicator is described in Section A.I.d.1 (see ASBLT file word 24, characters 7 through 9) and the core sectors are defined in Figure 3. If a seed module lies in two sectors (e.g., II-2), an orientation identifier

Figure 3. Orientation of MODULES in the LWBR Core

must be supplied to determine which rods lie on the sector boundary. The orientation identifier is determined by the position of the serial number side of a seed module relative to the core sectors. The serial number side of a seed module is the side on which is engraved the module's serial number. The serial number sides of the seed modules, as installed in the LWBR core, are shown as

the dark lined sides of the modules in Figure 3. The correspondence between the positions of the serial number sides and the orientation identifier is given in the following table:

<u>Serial Number Side Faces Core Sector</u>	<u>Orientation Indicator</u>
1	4
2	5
3	6
4	1
5	2
6	3

The orientation identifiers for seed modules I-1, I-2, I-3, II-1, II-2 and II-3 (circled numbers in Figure 3) are 3, 5, 1, 4, 3 and 2, respectively. The blanket modules do not require an orientation identifier. ORIENT uses the following input list:

N.ORIENT = *L-XXNN-NN*, I₁, I₂, I₃

where

L-XXNN-NN = the module serial number (must be enclosed in asterisks).

I₁ = the module type (see Section A.I.a, list 18).

I₂ = the core sector which contains half or all of the module (e.g., II-2 lies in sectors 1 and 2: I₂ = 1; I-2 lies in sectors 2 and 3: I₂ = 2; I-1 lies in sectors 6 and 1: I₂ = 6).

I₃ = the orientation identifier for the seed module (if applicable).

The statement KALL ORIENT executes the ORIENT MODULE.

A.I.n. SYMTRY - A MODULE Which Computes Important Parameters by Core Sector to Evaluate Beginning-of-Life Symmetry

SYMTRY is a MODULE which uses the GATHER MODULE to compute important parameters by core sector to evaluate beginning-of-life core symmetry. GATHER calculates and stores results in a DATATRAN list used by SYMTRY; SYMTRY organizes the results and generates printed output. Core sectors are defined in Section A.I.m. The parameters which are computed by core sector are the binary and thoria stack length, weight, and density, the isotopic weights, the mean rod outer diameter, and the mean wall thickness. Portions of sectors can also be evaluated rather

than entire sectors by using the input lists N.GATHER, N.BYZONE, N.BYTYPE, N.ROWS, and N.MODULE as described in Section A.I.h. The following input lists are used by SYMTRY:

1. N.OPTION=LOADING,ALL (required)

This list instructs SYMTRY to use the total rod population for the data base.

2. D.SECTOR(K).MODTYP(J).ZONE(I).ROW(K9)

$1 \leq K \leq 6, 1 \leq J \leq 3, 1 \leq I \leq 9, A \leq K9 \leq Q, K9 \neq I, K9 \neq 0.$

This is the data list generated by GATHER.

The statement KALL SYMTRY executes the SYMTRY MODULE.

A.I.o. COMPLP - A MODULE Which Computes Composition Fissile Loadings and Loading Precision

COMPLP is a MODULE which is used to calculate the fissile loading and precision for each of the eight compositions (i.e., high zone seed, low zone seed, etc.) in the LWBR core. The calculations involve the use of binary blend properties (i.e., fissile weight percent, fissile weight percent uncertainty, calibration uncertainty, pellet-to-pellet loading uncertainty, etc.) and rod properties (i.e., the number of pellets from each binary and/or composite blend in a given rod, stack weight, stack weight uncertainty, etc.). This information is available in or derivable from the ASBLT data files described in Section A.I.d.1.

There are three different types of binary blends (parent, composite, and special composite) and four types of rods (pure, multiblend, composite blend, and special composite blend). Parent blends are those originally fabricated as unique blends whereas composite blends are those which resulted from combining pellets from one or more parent blends recycled from unloaded fuel rods. COMPLP divides a special composite blend, one with special taper* properties, into two normal composite blends by applying a correction factor to the number of pellets from each binary blend which make up the special composite blend. COMPLP, therefore, effectively reduces the number of blend types from three to two and consequently reduces the number of rod types from four to three. That is, a

*Tapered pellets are depicted in Figure 1 in Section II of this report.

special composite blend rod becomes a normal composite blend rod with its pellets coming from either of the two composite blends created from the one special composite blend.

The logic programmed into the COMPLP MODULE is as follows:

1. Determine which binary blends, parent and/or composite, are used in a given composition. This is accomplished by searching the rod files for the rods in the requested composition and retrieving a list of all blends used in those rods and at the same time retrieving the number of pellets per blend, the weight of the pellets and the weighing uncertainty.
2. Determine from the composite blend file (Section A.I.d.5) the identity of each binary blend in the composite blends and the initial number of pellets from each binary blend in the composite blends.
3. Search through the binary blend file (Section A.I.g.1) to obtain blend fissile weight percents, blend fissile weight uncertainties, calibration uncertainties, and pellet-to-pellet variabilities. From this data, composite blend fissile weight and composite blend pellet-to-pellet variabilities are calculated.
4. Calculate the composition loading and loading precision where the loading precision is defined as twice the square root of the loading variance plus the bias due to rods manufactured from biased composite blends (Section A.I.d.5).

The equations used to compute composition loading precision are presented in Appendix C.

COMPLP requires the following input lists:

1. N.BYZONE = I

I is the zone number for which the loading is being requested (Section A.I.2, list 7).

2. N.OPTION = I

I = 1 to generate a temporary file of rods in modules for the requested fuel zone and exit without performing computations.

I = 2 to generate the temporary file then compute loading precision.

I = 3 to compute loading precision (assumes temporary file already exists).

3. N.PRINT = I_1 , I_2 , I_3 (edit control)

I_1 = 0 to print data for every 50th rod

I_1 = 1 to print data for every rod

I_2 = 0 no debug edit.

I_2 = 1 debug edit of section of computations

I_3 = 0 no debug edit

I_3 = 1 debug edit of a second section of computations.

The N.PRINT list is normally omitted so that the final results are printed. The statement KALL COMPLP executes the COMPLP MODULE.

A.II. Examples of ASBLT Input Decks for Key Tasks

The previous section of Appendix A presented descriptions of the DATATRAN MODULES in the ASBLT system with minimal attention to examples. This section presents typical examples of the use of ASBLT to perform key tasks related to LWBR as-built data. The examples are presented in the order in which tasks were performed during LWBR manufacturing. Computer printed output is included for some of the examples. The input deck for a DATATRAN job in the ASBLT system consists of a record of control cards (beginning with a jobcard) followed by one or more records of input. The input deck records are separated by an end-of-record card represented in the examples by "EOR." The input deck must terminate with an end-of-file card ("EOF"). The control cards listed in the examples are those used at the Bettis Atomic Power Laboratory. The record of DATATRAN input must be organized as follows:

JOB ASBLT

CALL DTTOC (5HASBLT)

(Note: This card makes all
MODULES of the ASBLT system
available to the job.)

[DATATRAN and FORTRAN
statements for execut-
ing the MODULES]

STOP

END

END JOB

A.II.a. Example 1 - Binary Blend File Edit (Including Portions of Output)

The first example, listed at the end of this section, uses the EDIT2 MODULE to generate a detailed edit (in system file TAPE12) and a summary edit (in system

file TAPE13) of the binary blend file (fetched into system file TAPE11). The first record of input is the control card record which performs the following functions:

- Card 1 - identifies user, sets time limit, central memory (CM) and extended core (ECS)
- Card 2 - retrieves all DATATRAM system files
- Card 3 - retrieves all ASBLT system files (MODULES)
- Card 4 - retrieves the binary blend file into a file named TAPE11
- Card 5 - executes the standard DATATRAM control cards
- Card 6 - copies TAPE12 generated by EDIT2 to OUTPUT for printing
- Card 7 - copies TAPE13 generated by EDIT2 to OUTPUT for printing.

The second record of input contains statements recognized by DATATRAM and is used by the DATATRAM scanner. The N.EDIT list requests the blend edit option and KALL EDIT2 executes the EDIT2 MODULE.

In the example, the files TAPE12 and TAPE13 are copied to the file named OUTPUT resulting in printed output from the line printer. The files could have been transmitted to the DEC-10 computer for printing on another device. The output from example 1 is organized into three sections (A, B and C pages). The page numbered A1 (only one page from the A section is shown) displays items 1 through 19 in the binary blend file (Section A.I.g.1 defines these items). The page numbered B1 (only one page from the B section is shown) displays items 20 through 36 in the binary blend file. Pages C1 and C2 contain summaries by binary fuel zone. Pages A1, B1, C1 and C2 are presented after the input listing for example 1. The remaining pages from the A and B output sections are not included since they are identical in form to pages A1 and B1. Items 4 through 36 listed for a blend (output pages A1 and B1) are based on inspection results obtained using the pellets sampled from the blend.

INPUT FOR EXAMPLE 1

```
YHBB001,3,004,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=BLEND$.BIN,T=33,V=1,F=S,S=TAPE11)
GOREAD(DTCC,PART=OFF)
COPY(TAPE12,OUTPUT)
COPY(TAPE13,OUTPUT)
EOR
      JOB ASBLT
      CALL DTT0C(5HASBLT)
      N.EDIT=BLEND$
      KALL EDIT2
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 1

78/02/27 (16- 7-76 9:47:14.9 891 BLENDS,

LAST SCNOFF: 16-JUL-76 09:22 14.8)

PAGE A 1

FIL	BLEND	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SEQ	IDENTITY	S	UO2	LOT	PPM	W/O	W/O	W/O	W/O	W/O	DIAMETER.	DIAMETER.	LENGTH.	LENGTH.	WEIGHT.	WEIGHT.	DENSITY.	DENSITY.	LINEAR	DENS.
		0	1	2	232	233	234	235	236	238	MEAN	SIGMA	MEAN	SIGMA	MEAN	SIGMA	MEAN	SIGMA	MEAN	SIGMA
1	105-1-02	1	109	110	7.0	98.350	1.270	.067	.013	.310	.2518	.0002	.4462	.0013	3.5009	.0107	9.7697	.0258	7.8459	.0184
2	105-1-03	1	110	000	7.7	98.420	1.200	.024	.001	.357	.2520	.0001	.4455	.0018	3.5106	.0156	9.8031	.0257	7.8798	.0184
3	105-1-04	1	110	000	7.7	98.420	1.200	.024	.001	.358	.2519	.0001	.4460	.0015	3.5073	.0116	9.7885	.0239	7.8649	.0159
4	105-1-06	1	110	000	7.7	98.430	1.200	.023	.001	.354	.2519	.0001	.4460	.0019	3.5073	.0128	9.7866	.0301	7.8635	.0236
5	106-1-01	1	110	000	7.7	98.420	1.200	.023	.001	.362	.2517	.0001	.4465	.0013	3.5067	.0100	9.7886	.0173	7.8544	.0144
6	106-1-02RS	1	110	000	7.7	98.420	1.200	.024	.001	.356	.2519	.0001	.4453	.0026	3.5093	.0158	9.8087	.0396	7.8806	.0310
7	106-1-03	1	110	000	7.7	98.430	1.190	.022	.001	.358	.2519	.0001	.4454	.0015	3.5095	.0119	9.8078	.0139	7.8786	.0127
8	106-1-04	1	110	000	7.7	98.420	1.190	.024	.001	.357	.2520	.0001	.4450	.0017	3.5050	.0185	9.7965	.0273	7.8760	.0222
9	106-1-06	1	110	000	7.7	98.420	1.200	.024	.001	.357	.2519	.0001	.4459	.0014	3.5094	.0137	9.7916	.0212	7.8698	.0140
10	108-1-01	1	110	000	7.7	98.420	1.190	.026	.001	.356	.2518	.0001	.4460	.0013	3.5213	.0112	9.8328	.0184	7.8951	.0143
11	108-1-02RS	1	110	000	7.7	98.420	1.200	.023	.001	.358	.2519	.0001	.4450	.0017	3.5138	.0174	9.8235	.0243	7.8955	.0178
12	108-1-03	1	110	000	7.7	98.420	1.200	.023	.001	.357	.2519	.0001	.4449	.0015	3.5150	.0125	9.8369	.0186	7.9008	.0150
13	108-1-06RS	1	111	000	8.0	98.420	1.200	.023	.001	.356	.2519	.0001	.4475	.0013	3.5288	.0085	9.8153	.0188	7.8857	.0158
14	108-1-07RS	1	111	000	8.0	98.420	1.200	.023	.001	.359	.2518	.0002	.4450	.0014	3.5120	.0113	9.8291	.0235	7.8923	.0197
15	108-1-08RS	1	111	112	7.4	98.380	1.220	.040	.005	.351	.2519	.0002	.4448	.0016	3.5124	.0104	9.8248	.0174	7.8957	.0154
16	108-1-09	1	112	000	6.9	98.210	1.330	.121	.027	.308	.2519	.0001	.4442	.0021	3.4999	.0133	9.8051	.0370	7.8794	.0317
17	108-1-10	1	112	000	6.9	98.210	1.330	.120	.027	.309	.2519	.0001	.4465	.0037	3.5142	.0283	9.7974	.0340	7.8711	.0271
18	108-1-11RS	1	112	000	6.9	98.200	1.340	.121	.027	.310	.2519	.0001	.4452	.0014	3.5126	.0142	9.8226	.0231	7.8901	.0187
19	108-1-12RS	1	112	000	6.9	98.210	1.330	.123	.027	.308	.2519	.0001	.4443	.0019	3.5053	.0174	9.8171	.0214	7.8899	.0208
20	108-1-13RS	1	112	000	6.9	98.200	1.340	.122	.028	.310	.2521	.0001	.4458	.0017	3.4997	.0152	9.7590	.0227	7.8508	.0165
21	108-1-14	1	112	000	6.9	98.200	1.340	.122	.027	.308	.2519	.0001	.4450	.0016	3.4984	.0129	9.7876	.0143	7.8620	.0141
22	108-1-15	1	112	000	6.9	98.200	1.340	.122	.027	.310	.2519	.0001	.4445	.0013	3.4868	.0151	9.7629	.0320	7.8435	.0245
23	108-1-16RS	1	112	000	6.9	98.210	1.330	.122	.027	.309	.2519	.0002	.4460	.0010	3.5018	.0103	9.7708	.0273	7.8519	.0195
24	108-1-17	1	113	000	7.5	98.210	1.340	.124	.028	.304	.2520	.0001	.4454	.0015	3.5085	.0138	9.7986	.0160	7.8766	.0138
25	109-1-01RS	1	112	000	6.9	98.200	1.340	.122	.027	.309	.2518	.0001	.4442	.0015	3.4984	.0159	9.8150	.0285	7.8759	.0240
26	109-1-02RS	1	112	000	6.9	98.200	1.340	.122	.027	.310	.2519	.0001	.4465	.0026	3.5070	.0222	9.7786	.0228	7.8544	.0162
27	109-1-04RS	1	113	000	7.5	98.200	1.340	.123	.028	.304	.2519	.0001	.4452	.0015	3.5111	.0129	9.8148	.0178	7.8865	.0124
28	109-1-05RS	1	113	000	7.5	98.200	1.340	.124	.027	.306	.2519	.0001	.4448	.0013	3.5003	.0133	9.7960	.0263	7.8690	.0233
29	109-1-06	1	113	000	7.5	98.210	1.340	.123	.028	.302	.2519	.0001	.4458	.0019	3.4993	.0130	9.7696	.0264	7.8501	.0242
30	109-1-07	1	113	000	7.5	98.200	1.340	.125	.028	.305	.2519	.0001	.4445	.0012	3.4974	.0136	9.7932	.0214	7.8675	.0184
31	109-1-08A	1	113	000	7.5	98.200	1.340	.124	.027	.304	.2518	.0001	.4459	.0014	3.4942	.0109	9.7627	.0159	7.8360	.0117
32	109-1-08B	1	113	000	7.5	98.200	1.340	.124	.028	.306	.2519	.0002	.4468	.0019	3.4955	.0102	9.7361	.0381	7.8231	.0261
33	109-1-09	1	113	114	7.2	98.190	1.350	.127	.029	.307	.2519	.0001	.4452	.0014	3.4924	.0116	9.7675	.0171	7.8449	.0132
34	109-1-10	1	114	000	7.0	98.200	1.340	.127	.029	.305	.2519	.0002	.4428	.0024	3.4818	.0150	9.7852	.0459	7.8625	.0370
35	109-1-11	1	114	000	7.0	98.190	1.350	.127	.029	.307	.2520	.0002	.4445	.0013	3.4954	.0111	9.7837	.0164	7.8637	.0173
36	109-1-12RS	1	114	000	7.0	98.200	1.340	.128	.029	.305	.2519	.0001	.4454	.0017	3.5025	.0132	9.7834	.0240	7.8630	.0206
37	109-1-13RS	1	114	000	7.0	98.200	1.340	.127	.029	.305	.2519	.0001	.4447	.0011	3.5054	.0091	9.8095	.0149	7.8820	.0134
38	109-1-14RS	1	114	000	7.0	98.200	1.340	.129	.028	.304	.2519	.0002	.4447	.0020	3.4967	.0149	9.7897	.0248	7.8635	.0250
39	109-1-15RS	1	114	000	7.0	98.200	1.340	.127	.028	.305	.2518	.0001	.4449	.0012	3.4973	.0094	9.7894	.0216	7.8610	.0164
40	109-1-16RS	1	114	000	7.0	98.190	1.340	.127	.027	.307	.2520	.0001	.4457	.0008	3.5138	.0102	9.8078	.0172	7.8836	.0158
41	109-1-17RS	1	114	000	7.0	98.200	1.340	.128	.030	.302	.2519	.0002	.4451	.0019	3.5062	.0177	9.8039	.0174	7.8779	.0145
42	109-1-18RS	1	115	000	5.8	97.940	1.550	.210	.073	.235	.2519	.0001	.4457	.0012	3.5035	.0085	9.7856	.0178	7.8612	.0149
43	109-1-19RS	1	115	000	5.8	97.930	1.550	.214	.074	.232	.2520	.0001	.4463	.0016	3.5031	.0085	9.7592	.0292	7.8491	.0222
44	111-1-85	1	110	000	7.7	98.420	1.200	.023	.001	.353	.2519	.0001	.4448	.0017	3.5103	.0117	9.8216	.0236	7.8912	.0181
45	112-1-85	1	111	000	8.0	98.420	1.200	.021	.001	.356	.2520	.0001	.4439	.0012	3.5078	.0126	9.8288	.0140	7.9015	.0139
46	115-1-85	1	111	000	8.0	98.420	1.200	.024	.001	.359	.2518	.0001	.4456	.0010	3.5070	.0103	9.8016	.0207	7.8705	.0174
47	130-1-01RS	1	145	000	6.8	98.310	1.300	.081	.019	.289	.2520	.0002	.4420	.0006	3.4972	.0057	9.8395	.0138	7.9122	.0150
48	131-1-01RS	1	145	000	6.8	98.300	1.300	.082	.019	.294	.2519	.0002	.4431	.0009	3.5005	.0057	9.8305	.0219	7.9002	.0194
49	132-1-85	1	111	000	8.0	98.420	1.200	.023	.001	.355	.2519	.0001	.4434	.0014	3.5021	.0093	9.8350	.0226	7.9087	.0182
50	133-1-85	1	111	000	8.0	98.420	1.200	.023	.001	.357	.2519	.0001	.4452	.0019	3.5008	.0161	9.7832	.0220	7.8626	.0171
51	134-1-85	1	111	000	8.0	98.420	1.200	.023	.001	.357	.2520	.0001	.4449	.0024	3.5185	.0201	9.8335	.0196	7.9075	.0161
52	135-1-85RS	1	111	000	8.0	98.420	1.200	.024	.001	.358	.2520	.0001	.4456	.0017	3.5239	.0158	9.8357	.0347	7.9082	.0262
53	136-1-85	1	111	000	8.0	98.420	1.190	.023	.001	.356	.2520	.0001	.4469	.0021	3.5109	.0273	9.7703	.0597	7.8570	.0477
54	137-1-85	1	112	000	6.9	98.210	1.330	.118	.026	.310	.2519	.0002	.4458	.0022	3.5111	.0172	9.7989	.0177	7.8751	.0197
55	138-1-85RS	1	112	000	6.9	98.200	1.340	.122	.028	.309	.2519	.0001	.4435	.0020	3.5029	.0167	9.8337	.0338	7.8977	.0270
56	139-1-85	1	112	000	6.9	98.200	1.340	.122	.027	.310	.2519	.0001	.4454	.0015	3.4720	.0141	9.7035	.0510	7.7957	.0433
57	140-1-85	1	112	113	7.2	98.210	1.340	.122	.027	.308	.2519	.0001	.4441	.0020	3.5080	.0180	9.8325	.0255	7.8990	.0205

PARTIAL OUTPUT FROM EXAMPLE 1 (CONTINUED)

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(16- 7-76 9:47:14.9 891 BLENDS,

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PAGE B 1

FIL	BLEND	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
SEQ	IDENTITY	SIGMA	SIGMA	SIG 0	CORRECTED-CAGE--W/O	ALL	S 0/0	..CORRECTIONS.	W/O U-TOTAL	MULTIPL	ADDITV	MUHAT	S 0/0	VC	VX	A	CHEM	FISSIL
		P 0/0	C 0/0	0/0	CHEMIS											W/O	LN DN	SIC N S DBAR
1	105-1-02	.1324	.05089	.40698	4.4054	4.4110	.1413	1.00000	.0000	4.400	.0967	.01513	.01923	.44041	4.3918	.3393	.00000	.00000
2	105-1-03	.0000	.05164	.47930	4.3912	4.3966	.1743	1.00000	.0000	4.389	.0941	.01250	.03037	.29155	4.3854	.3404	.00000	.00000
3	105-1-04	.1055	.05168	.47196	4.3964	4.3959	.1316	1.00000	.0000	4.391	.0908	.01417	.01677	.45797	4.3870	.3400	.00000	.00000
4	105-1-06	.0000	.05192	.50905	4.3886	4.3912	.1508	1.00000	.0000	4.382	.0898	.01250	.02275	.35463	4.3772	.3393	.00000	.00000
5	106-1-01	.0000	.05226	.44209	4.3861	4.3846	.1538	1.00000	.0000	4.386	.0964	.01250	.02365	.34583	4.3866	.3391	.00000	.00000
6	106-1-02RS	.0711	.05244	.32144	4.3868	4.3813	.1574	1.00000	.0000	4.382	.0941	.01326	.02453	.35083	4.3820	.0000	.00000	.00000
7	106-1-03	.1119	.05210	.34766	4.3792	4.3879	.1425	1.00000	.0000	4.384	.0945	.01438	.01969	.42207	4.3804	.3401	.00000	.00000
8	106-1-04	.0000	.05276	.44738	4.3643	4.3752	.1410	1.00000	.0000	4.372	.0376	.01250	.01988	.38599	4.3696	.3390	.00000	.00000
9	106-1-06	.0000	.05264	.42340	4.3789	4.3775	.1451	1.00000	.0000	4.379	.0886	.01250	.02107	.37237	4.3798	.3393	.00000	.00000
10	108-1-01	.1193	.05167	.43925	4.4011	4.3961	.1464	1.00000	.0000	4.390	.0964	.01464	.02072	.41393	4.3364	.0000	.00000	.00000
11	108-1-02RS	.1330	.05208	.34028	4.3927	4.3935	.1677	1.00000	.0000	4.393	.1031	.01515	.02723	.35753	4.3928	.0000	.00000	.00000
12	108-1-03	.0000	.05161	.44410	4.3996	4.3971	.1194	1.00000	.0000	4.389	.0816	.01250	.01426	.46720	4.3824	.3414	.00000	.00000
13	108-1-06RS	.0000	.05134	.48726	4.3892	4.3904	.1480	1.00000	.0000	4.392	.0892	.01250	.02191	.36331	4.3928	.3409	.00000	.00000
14	108-1-07RS	.0000	.05122	.55339	4.3938	4.3966	.1015	1.00000	.0000	4.396	.0752	.01250	.01031	.54804	4.3948	.3415	.00000	.00000
15	108-1-08RS	.1293	.05095	.40204	4.4085	4.4019	.1099	1.00000	.0000	4.399	.0852	.01501	.01124	.57172	4.3954	.3419	.00000	.00000
16	108-1-09	.1183	.05069	.43017	4.4101	4.4070	.1739	1.00000	.0000	4.403	.1023	.01460	.02935	.33072	4.4008	.3411	.00000	.00000
17	108-1-10	.1871	.05135	.43441	4.3986	4.3941	.1381	1.00000	.0000	4.396	.1026	.01775	.01732	.50615	4.3984	.3403	.00000	.00000
18	108-1-11RS	.0000	.05039	.46527	4.4041	4.4128	.1855	1.00000	.0000	4.408	.0958	.01250	.03442	.26642	4.4062	.3420	.00000	.00000
19	108-1-12RS	.1845	.05119	.50367	4.4065	4.3972	.1162	1.00000	.0000	4.397	.0936	.01760	.01181	.59852	4.3978	.3412	.00000	.00000
20	108-1-13RS	.0000	.05112	.41366	4.3993	4.3985	.1133	1.00000	.0000	4.400	.0796	.01250	.01283	.49349	4.4012	.3396	.00000	.00000
21	108-1-14	.0605	.05079	.42914	4.4015	4.4050	.1322	1.00000	.0000	4.405	.0873	.01305	.01730	.42992	4.4050	.3405	.00000	.00000
22	108-1-15	.0000	.05077	.47260	4.4055	4.4053	.1535	1.00000	.0000	4.410	.0904	.01250	.02357	.34659	4.4120	.3401	.00000	.00000
23	108-1-16RS	.0000	.05069	.48707	4.4042	4.4069	.1577	1.00000	.0000	4.403	.0912	.01250	.02406	.33462	4.4012	.3400	.00000	.00000
24	108-1-17	.0851	.05023	.42487	4.4099	4.4159	.1441	1.00000	.0000	4.408	.0923	.01359	.02041	.39957	4.4022	.3414	.00000	.00000
25	109-1-01RS	.1860	.05013	.40390	4.4181	4.4178	.1613	1.00000	.0000	4.419	.1094	.01769	.02428	.42146	4.4196	.3422	.00000	.00000
26	109-1-02RS	.0000	.05117	.42086	4.3977	4.3976	.1411	1.00000	.0000	4.392	.0876	.01250	.01991	.38567	4.3884	.3392	.00000	.00000
27	109-1-04RS	.0000	.05012	.48080	4.4218	4.4180	.1583	1.00000	.0000	4.418	.0913	.01250	.02507	.33274	4.4174	.3426	.00000	.00000
28	109-1-05RS	.1601	.05027	.46489	4.4228	4.4150	.1202	1.00000	.0000	4.412	.0926	.01635	.01317	.55385	4.4072	.3413	.00000	.00000
29	109-1-06	.0000	.05072	.42659	4.4077	4.4064	.1389	1.00000	.0000	4.399	.0871	.01250	.01930	.39304	4.3940	.3396	.00000	.00000
30	109-1-07	.0000	.05023	.43647	4.4151	4.4159	.1335	1.00000	.0000	4.407	.0857	.01250	.01782	.41229	4.4008	.3409	.00000	.00000
31	109-1-08A	.0000	.05094	.48753	4.4107	4.4021	.1351	1.00000	.0000	4.402	.0861	.01250	.01825	.40652	4.4026	.3392	.00000	.00000
32	109-1-08B	.0000	.05084	.47720	4.4020	4.4040	.1467	1.00000	.0000	4.409	.0889	.01250	.02153	.36731	4.4114	.3391	.00000	.00000
33	109-1-09	.0000	.04939	.48170	4.4363	4.4324	.1444	1.00000	.0000	4.427	.0884	.01250	.02084	.37495	4.4244	.3415	.00000	.00000
34	109-1-10	.0000	.04981	.47772	4.4319	4.4242	.1659	1.00000	.0000	4.422	.0927	.01250	.02751	.31239	4.4214	.3419	.00000	.00000
35	109-1-11	.1955	.04899	.35350	4.4388	4.4404	.1397	1.00000	.0000	4.436	.1043	.01823	.01760	.50879	4.4316	.3430	.00000	.00000
36	109-1-12RS	.0000	.05042	.48774	4.4217	4.4121	.1379	1.00000	.0000	4.412	.0868	.01250	.01902	.39662	4.4126	.3411	.00000	.00000
37	109-1-13RS	.2322	.04945	.40138	4.4428	4.4312	.1327	1.00000	.0000	4.425	.1065	.02059	.01491	.58000	4.4172	.3430	.00000	.00000
38	109-1-14RS	.0000	.04971	.46846	4.4259	4.4261	.1067	1.00000	.0000	4.414	.0495	.00312	.01138	.21537	4.4109	.3413	.00000	.00000
39	109-1-15RS	.0000	.05026	.55614	4.4094	4.4154	.1608	1.00000	.0000	4.413	.0918	.01250	.02586	.32589	4.4122	.3411	.00000	.00000
40	109-1-16RS	.1127	.05078	.43203	4.4127	4.4052	.1608	1.00000	.0000	4.410	.0990	.01441	.02522	.36352	4.4126	.3418	.00000	.00000
41	109-1-17RS	.0000	.05108	.50994	4.4022	4.3993	.1553	1.00000	.0000	4.401	.0907	.01250	.02413	.34123	4.4024	.3409	.00000	.00000
42	109-1-18RS	.0000	.04913	.53287	4.4329	4.4376	.1650	1.00000	.0000	4.432	.0926	.01250	.02723	.31466	4.4290	.3419	.00000	.00000
43	109-1-19RS	.0000	.04895	.46632	4.4451	4.4411	.1658	1.00000	.0000	4.440	.0927	.01250	.02748	.31264	4.4398	.3420	.00000	.00000
44	111-1-85	.1321	.05217	.36798	4.3858	4.3865	.1487	1.00000	.0000	4.382	.0985	.01512	.02123	.41592	4.3796	.3404	.00000	.00000
45	112-1-85	.0000	.05100	.44107	4.4131	4.4088	.1311	1.00000	.0000	4.404	.0851	.01250	.01718	.42117	4.4012	.3426	.00000	.00000
46	115-1-85	.0000	.05158	.47110	4.4001	4.3977	.1490	1.00000	.0000	4.395	.0894	.01250	.02220	.36018	4.3942	.3406	.00000	.00000
47	130-1-01RS	.0000	.03891	.39598	4.4083	4.4065	.1351	1.00000	.0166	4.409	.0861	.01250	.01825	.40648	4.4100	.3432	.09291	.16372
48	131-1-01RS	.0000	.03874	.37731	4.4106	4.4108	.1151	1.00000	.0166	4.412	.0802	.01250	.01325	.48547	4.4140	.3430	.06928	.15369
49	132-1-85	.1572	.05188	.31646	4.3889	4.3910	.1401	1.00000	.0000	4.390	.0994	.01614	.01833	.46825	4.3888	.3414	.00000	.00000
50	133-1-85	.1386	.05135	.36394	4.3974	4.3942	.1329	1.00000	.0000	4.396	.0947	.01538	.01671	.47929	4.3982	.3403	.00000	.00000
51	134-1-85	.1646	.05172	.43389	4.3871	4.3871	.1461	1.00000	.0000	4.388	.1020	.01656	.02000	.45295	4.3886	.3416	.00000	.00000
52	135-1-85RS	.0000	.05180	.44143	4.3817	4.3856	.1427	1.00000	.0000	4.387	.0880	.01250	.02036	.38044	4.3876	.3415	.00000	.00000
53	136-1-85	.0000	.05101	.48231	4.3996	4.4006	.1358	1.00000	.0000	4.403	.0863	.01250	.01843	.40414	4.4040	.3405	.00000	.00000
54	137-1-85	.0000	.05196	.44268	4.3784	4.3824	.1376	1.00000	.0000	4.385	.0868	.01250	.01894	.39759	4.3860	.3395	.00000	.00000
55	138-1-85RS	.1583	.05041	.48392	4.4180	4.4124	.1730	1.00000	.0000	4.404	.1078	.01626	.02869	.36171	4.3998	.3420	.00000	.00000
56	139-1-85	.0000	.05095	.46719	4.3958	4.4019	.1467	1.00000	.0000	4.399	.0889	.01250	.02152	.36748	4.3972	.3372	.00000	.00000
57	140-1-85	.1230	.05097	.42808	4.4005	4.4016	.1457	1.00000	.0000	4.399	.0966	.01477	.02048	.41900	4.3980	.3417	.00000	.00000

PARTIAL OUTPUT FROM EXAMPLE 1 (CONTINUED)

78/02/27 (16- 7-76 9:47:14.9 891 BLENDS) BLEND STATISTICS BY PELLET TYPE (EXCLUDING SCRAPPED BLENDS) PAGE C 1

PELLET TYPE	1	2	3	4	5	6	7	8
	LOW SEED	HIGH SEED	LOW BLKT	MED BLKT	HIGH BLKT	LOW PFBK	MED PFBK	HIGH PFBK
PPM U-232.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	7.45473	6.93185	8.37179	7.70246	8.14795	8.18000	7.90000	7.03684
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.52662	.53057	.44186	.76950	.28680	.17947	.22005	.28293
W/O U-233.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	98.30100	98.35784	98.30349	98.31880	98.25351	98.31035	98.20950	98.04041
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.08850	.09508	.10622	.14513	.09375	.04322	.05925	.08735
W/O U-234.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	1.29301	1.27893	1.32897	1.30646	1.35389	1.31850	1.37235	1.24289
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.05551	.04180	.06018	.08758	.05287	.02254	.03265	.13840
W/O U-235.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	.08247	.07149	.08808	.08070	.10670	.08610	.11870	.09667
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.03652	.03430	.03532	.04921	.03150	.01292	.01892	.04584
W/O U-236.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	.01840	.01487	.02423	.02009	.03111	.02230	.03495	.02630
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.01101	.00811	.01384	.01974	.01258	.00453	.00754	.01834
W/O U-238.....								
BLENDS IN MEAN	148	270	39	203	73	20	20	114
MEAN	.30465	.27627	.25354	.27342	.25382	.26285	.26535	.59279
BLENDS IN STD. DEV.	148	270	39	203	73	20	20	114
STANDARD DEVIATION	.03164	.02090	.00839	.02515	.00659	.00543	.00300	.22055
PELLET DIAMETER.....								
BLENDS IN MEAN	148	267	39	198	73	21	20	114
MEAN	.25196	.25198	.51046	.51048	.51048	.46949	.46953	.46961
BLENDS IN STD. DEV.	148	255	39	183	69	21	20	114
STANDARD DEVIATION	.00013	.00012	.00014	.00014	.00014	.00013	.00014	.00012
PELLET LENGTH.....								
BLENDS IN MEAN	148	267	39	198	73	21	20	114
MEAN	.44434	.61487	.53066	.86805	.78543	.86964	.78580	.70120
BLENDS IN STD. DEV.	148	256	39	198	73	21	20	114
STANDARD DEVIATION	.00137	.00165	.00093	.00232	.00131	.00166	.00147	.00138

PARTIAL OUTPUT FROM EXAMPLE 1 (CONTINUED)

7B/02/27 (16- 7-76 9:47:14.9 891 BLENDS)								
BLEND STATISTICS BY PELLET TYPE (EXCLUDING SCRAPPED BLENDS) PAGE C 2								
PELLET TYPE	1	2	3	4	5	6	7	8
	LOW SEED	HIGH SEED	LOW BLKT	MED BLKT	HIGH BLKT	LOW PFBK	MED PFBK	HIGH PFBK
PELLET WEIGHT.....								
BLENDS IN MEAN	148	267	39	198	73	21	20	114
MEAN	3.50183	4.86363	17.16101	28.14732	25.48192	23.88335	21.55810	19.19102
BLENDS IN STD. DEV.	148	256	39	198	73	21	20	114
STANDARD DEVIATION	.01164	.01533	.03497	.08048	.05177	.05162	.04726	.04280
PELLET DENSITY.....								
BLENDS IN MEAN	148	266	39	198	73	21	20	114
MEAN	9.80425	9.79529	9.87193	9.80685	9.82698	9.81727	9.81966	9.81186
BLENDS IN STD. DEV.	148	199	39	198	73	21	20	114
STANDARD DEVIATION	.02184	.02016	.01513	.02174	.01287	.01209	.01510	.01735
PELLET LINEAR DENSITY....								
BLENDS IN MEAN	148	261	39	198	73	21	20	114
MEAN	7.88095	7.91019	32.33922	32.42592	32.44341	27.46378	27.43423	27.36925
BLENDS IN STD. DEV.	148	260	39	198	73	21	20	114
STANDARD DEVIATION	.01846	.01725	.05212	.07321	.04528	.03458	.04243	.04955
GAGE W/O (CHEM. PELLETS)								
BLENDS IN MEAN	148	199	39	191	73	20	20	114
MEAN	4.40873	5.28672	1.23354	1.69584	2.03873	1.68068	2.04363	2.79045
BLENDS IN STD. DEV.	0	0	0	0	0	0	0	0
0/0 STANDARD DEVIATION	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
GAGE W/O (ALL PELLETS)...								
BLENDS IN MEAN	148	256	39	191	73	20	20	114
MEAN	4.40819	5.28977	1.23377	1.69586	2.03859	1.68043	2.04332	2.79088
BLENDS IN STD. DEV.	148	199	39	191	73	20	20	114
0/0 STANDARD DEVIATION	.14494	.12605	.12453	.10238	.10445	.10317	.11133	.12376
W/O U-TOTAL (MU-HAT).....								
BLENDS IN MEAN	148	266	39	185	73	20	20	114
MEAN	4.40809	5.28485	1.23379	1.69546	2.03825	1.68070	2.04415	2.79077
BLENDS IN STD. DEV.	148	266	39	185	73	20	20	114
0/0 STANDARD DEVIATION	.09221	.08730	.08737	.07685	.07771	.07660	.08286	.08672
FISSILE LINEAR DENSITY...								
BLENDS IN MEAN	140	226	39	185	73	19	19	114
MEAN	.34177	.41183	.39259	.54116	.65045	.45425	.55153	.74959
BLENDS IN STD. DEV.	140	226	39	185	73	19	19	114
STANDARD DEVIATION	.00128	.00153	.00094	.00270	.00156	.00095	.00144	.00156
NUMBER OF BLENDS SIGNED OFF	148	266	38	156	73	20	20	114

A.II.b.. Example 2 - Composite Binary Blend File Modification (No Output Included)

Example 2 uses NEWROD to add three composite binary blends to the composite blend file. As discussed in Section A.I.d.5, the composite blend file consists of DATATRAN lists and as such is an interface format file (Reference 6), as opposed to a system file. The existing composite blend file is fetched and given the synonym COMPIN as required by NEWROD. The N.CB lists describe three composite blends having identities 900-4-22, 900-4-33 and 900-4-34. In identifying blends, the dashes are omitted and the remaining digits and letters are enclosed in asterisks. This instructs DATATRAN to use the entries as display code (alphanumeric) variables rather than numeric variables. The new file is written by NEWROD and given the synonym COMPOUT. This file is then stored on disk and the old file is deleted.

INPUT FOR EXAMPLE 2

```

YHBB002,6,001,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(I=COMPOSITE.BLENDS,T=446,S=COMPIN,D=4)
STORE(I=COMPOSITE.BLENDS,T=446,S=COMPOUT,D=1N)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTOC(5HASBLT)
C
      N.CB(1)=*900422 *,C ,1, .000
      X*514420 *,      194
      X*510420RS*,     158
      X*514411 *,      36
      X*509401 *,      97
      N.CB(2)=*900433 *,C ,1, .000
      X*509409 *,      81
      X*509403 *,      16
      X*509406B *,     108
      X*509412RS*,     32
      X*509401 *,      58
      X*509402 *,       8
      X*509413CR*,     31
      X*509405 *,      51
      N.CB(3)=*900434 *,C ,1, .000
      X*514402 *,     128
      X*514416 *,     166
      X*514415RS*,     32
      X*511409 *,      34
      X*511420 *,      47
      X*510416RS*,     16
      X*514409 *,      81
      X*514408 *,      16
      X*509406A *,     58
      X*128401 *,      35
C
      KALL NEWROD
      STOP
      END
      END JOB
EOF

```

A.II.c. Example 3 - Composite Binary Blend File Edit (Including Portions of Output)

The third example uses NEWROD to edit the composite binary blend file. The list N.CB(1)=EDIT requests the edit. The list N.U=YES requests that the uranium content (w/o) be computed for each composite blend. To perform this calculation, NEWROD needs the binary blend file which must be copied into system file TAPE11. The partial output from example 3 (first page and last page) follows the input listing. The first line on page 1 lists the number of composite binary blends for each fuel zone; e.g., zone 1 (low zone seed) has 12 composite binary blends. The remainder of the output consists of the identity and makeup of each composite binary blend in the composite blend file.

INPUT FOR EXAMPLE 3

```
YHBB003,6,001,140,0001:ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(I=COMPOSITE.BLENDS,T=446,S=COMP IN)
FETCH(I=BLENDS.BIN,T=33,F=S,S=TAPE11)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTOC(5HASBLT)
C
C-----EDIT COMPOSITE BLENDS FILE
      N.CB(1)=EDIT
      N.U=YES
      KALL NEWROD
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 3

YHBB003 78/02/27 DT2SYS BEAUD PC 1

COMPOSITE BLENDS NUMBER BY ZONE --

12 16 0 33 49 0 0 4

ZONE 1

1	900-1-02	C 2 6.000	* BIASED *	6 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 16 WORDS *
	PARENTS/NUMBER	149-1-85 190 509-1-07	475 509-1-08 190 109-1-19RS 504 109-1-11	157
	PARENTS/NUMBER	508-1-39 95		
	U-TOT, U-233, U-FISS FRACTIONS --	.0443525 .0435413 .0435963		
2	900-1-03	C 2 9.000	* BIASED *	9 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 22 WORDS *
	PARENTS/NUMBER	108-1-09 687 508-1-44 95 508-1-03 376 508-1-06 662 509-1-13 504		
	PARENTS/NUMBER	138-1-85RS 221 108-1-14 157 109-1-08A 157 508-1-07 158		
	U-TOT, U-233, U-FISS FRACTIONS --	.0440164 .0432566 .0432977		
3	900-1-04	C 2 9.000	* BIASED *	9 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 22 WORDS *
	PARENTS/NUMBER	109-1-13RS 282 148-1-85 180 509-1-05 380 540-1-87 453 508-1-40 126		
	PARENTS/NUMBER	509-1-12 504 509-1-04 158 508-1-24 158 109-1-09 439		
	U-TOT, U-233, U-FISS FRACTIONS --	.0442384 .0434769 .0435160		
4	900-1-05	C 2 7.000	* BIASED *	7 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 18 WORDS *
	PARENTS/NUMBER	108-1-06RS 188 508-1-08 380 139-1-85 657 140-1-85 252 544-1-85 126		
	PARENTS/NUMBER	108-1-12RS 282 509-1-06 95		
	U-TOT, U-233, U-FISS FRACTIONS --	.0439641 .0432018 .0432448		
5	900-1-06	C 2 9.000	* BIASED *	9 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 22 WORDS *
	PARENTS/NUMBER	508-1-26 190 141-1-85 282 508-1-34 282 508-1-05 126 508-1-01 378		
	PARENTS/NUMBER	131-1-01RS 126 508-1-15 474 540-1-85 157 509-1-03A 95		
	U-TOT, U-233, U-FISS FRACTIONS --	.0441173 .0433750 .0434116		
6	900-1-07	C 2 3.000	* BIASED *	3 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 10 WORDS *
	PARENTS/NUMBER	137-1-85 564 508-1-09 378 508-1-11 756		
	U-TOT, U-233, U-FISS FRACTIONS --	.0438433 .0430920 .0431325		
7	900-1-08	C 2 8.000	* BIASED *	8 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 20 WORDS *
	PARENTS/NUMBER	508-1-02 188 143-1-85 187 509-1-11 473 509-1-09 126 508-1-10B 314		
	PARENTS/NUMBER	108-1-15 94 508-1-20 190 109-1-07 94		
	U-TOT, U-233, U-FISS FRACTIONS --	.0440536 .0433030 .0433389		
8	900-1-09	C 2 10.000	* BIASED *	10 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 24 WORDS *
	PARENTS/NUMBER	508-1-54RS 94 146-1-85 252 109-1-15RS 252 508-1-17 126 144-1-85 157		
	PARENTS/NUMBER	109-1-12RS 157 508-1-19 158 508-1-49 316 508-1-52 158 508-1-51 475		
	U-TOT, U-233, U-FISS FRACTIONS --	.0440969 .0433388 .0433809		
9	900-1-10	C 2 8.000	* BIASED *	8 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 20 WORDS *
	PARENTS/NUMBER	147-1-85 470 509-1-03 380 509-1-10 126 508-1-35 126 508-1-45 126		
	PARENTS/NUMBER	508-1-50 252 109-1-01RS 158 508-1-42 95		
	U-TOT, U-233, U-FISS FRACTIONS --	.0441841 .0434216 .0434622		
10	900-1-11	C 2 5.000	* BIASED *	5 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 14 WORDS *
	PARENTS/NUMBER	109-1-04RS 94 508-1-41 282 509-1-14 252 508-1-33 121 508-1-04 157		
	U-TOT, U-233, U-FISS FRACTIONS --	.0441499 .0434052 .0434407		
11	900-1-12	C 2 4.000	* BIASED *	4 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 12 WORDS *
	PARENTS/NUMBER	508-1-22 190 508-1-28 190 508-1-46 316 508-1-23 157		
	U-TOT, U-233, U-FISS FRACTIONS --	.0442681 .0435066 .0435468		

PARTIAL OUTPUT FROM EXAMPLE 3 (CONTINUED)

YHEB003 78/02/27 DT2SYS BEAUD PG 10

U-TOT, U-233, U-FISS FRACTIONS -- .0203655 .0200054 .0200286

48 900-5-13 C 1 7.000 * RANDOMIZED * 7 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 18 WORDS *
 PARENTS/NUMBER 144-5-01RS 65 539-5-05RS 22 540-5-01RS 15 540-5-03 9 540-5-06 85
 PARENTS/NUMBER 540-5-12 22 540-5-15 85
 U-TOT, U-233, U-FISS FRACTIONS -- .0203987 .0200233 .0200515

49 900-5-14 C 1 6.000 * RANDOMIZED * 6 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 16 WORDS *
 PARENTS/NUMBER 357-5-01 77 540-5-01RS 15 540-5-07 74 540-5-14RS 85 540-5-17RS 22
 PARENTS/NUMBER 541-5-09 19
 U-TOT, U-233, U-FISS FRACTIONS -- .0203930 .0200303 .0200542

ZONE 6

ZONE 7

ZONE 8

1 900-8-01 C 2 13.000 * BIASED * 13 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 30 WORDS *
 PARENTS/NUMBER 141-8-63 599 145-8-04 1255 152-8-12 240 389-8-80 275 392-8-75 239
 PARENTS/NUMBER 546-8-20 100 546-8-22 239 546-8-26 220 546-8-27 61 550-8-65 120
 PARENTS/NUMBER 551-8-03 824 551-8-08 583 551-8-11 120
 U-TOT, U-233, U-FISS FRACTIONS -- .0279510 .0273838 .0274046

2 900-8-02 C 2 13.000 * BIASED * 13 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 30 WORDS *
 PARENTS/NUMBER 141-8-56 120 393-8-39 108 497-8-60 596 545-3-14 120 546-8-14 240
 PARENTS/NUMBER 547-8-33 108 550-8-57 120 550-8-58RS 357 550-3-72 599 551-8-06 585
 PARENTS/NUMBER 551-8-73 354 551-8-76 225 551-8-79 96
 U-TOT, U-233, U-FISS FRACTIONS -- .0278951 .0273451 .0273654

3 900-8-03 C 2 4.000 * BIASED * 4 PARENT BLENDS * 0.000 ADDITIONAL BIAS * 12 WORDS *
 PARENTS/NUMBER 549-8-31 345 550-8-53 219 551-8-05 119 551-8-07 453
 U-TOT, U-233, U-FISS FRACTIONS -- .0279981 .0274459 .0274726

4 900-8-04 C 1 10.000 * RANDOMIZED * 10 PARENT BLENDS * 6.000 ADDITIONAL BIAS * 24 WORDS *
 PARENTS/NUMBER 121-8-15 44 145-8-04 85 152-8-12 110 389-8-80 41 549-8-01 76
 PARENTS/NUMBER 551-8-05 145 551-8-09 80 551-8-10 79 551-8-11 48 551-8-77 9
 U-TOT, U-233, U-FISS FRACTIONS -- .0279697 .0274020 .0274272

A.II.d. Example 4 - Add New Stacking Data to Fuel Rod Data File (No Output Included)

The fourth example uses ASBLT to add new stacking data to the fuel rod files. The first input record consists of control cards, the second record consists of DATATRAN statements for the DATATRAN scanner and the third record consists of the fuel rod input data, formatted as described in Section A.I.e.1. The control cards perform the following functions:

- Cards 1, 2, 3 - same as prior examples;
- Card 4 - identifies the existing card image file of fuel rod stacking data to be read from disk and copied to the system file named ALL
- Card 5 - identifies the updated card image file to be stored on disk from system file TAPE13 at job termination
- Card 6 - identifies the existing DATATRAN interface file containing fuel rod data
- Card 7 - identifies the new DATATRAN interface file containing fuel rod data
- Card 8 - rewinds the system files SCNIN, TAPE11 and ALL
- Card 9 - copies input record 2 into SCNIN
- Card 10 - copies input record 3 (new data) into TAPE11
- Card 11 - copies file ALL into TAPE11 so that TAPE11 now contains the card images for the new data followed by the existing data retrieved from disk at card 4
- Card 12 - rewinds SCNIN which contains input for the DATATRAN scanner
- Card 13 - executes the standard DATATRAN control cards
- Card 14 - instructs the system to store TAPE13 which at this point contains the old card image data and the new card data sorted by rod serial number.

The third card in input record 2 is the control list for the ASBLT MODULE. This list instructs ASBLT to sort TAPE11, to identify the new cards with characters BIN126 and to process the new input, supplied in the third input record, according to the programmed format for inspection sheet 74286. The DATATRAN file containing standard blanket fuel rod data will be automatically stored upon completion of the job.

INPUT FOR EXAMPLE 4

```

YHBB004,2,008,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(I=BINARY.ROD.LOAD.BLKT,T=33,F=S,S=ALL,D=4)
STORE(I=BINARY.ROD.LOAD.BLKT,T=33,F=S,S=TAPE13,D=1N)
FETCH(I=BLKT.RODS.2,T=446,S=BLKTIN,D=4)
STORE(I=BLKT.RODS.2,T=446,S=BLKTOUT,D=1N)
REWIND(SCNIN,TAPE11,ALL)
COPYBR(INPUT,SCNIN)
COPYBR(INPUT,TAPE11)
COPYEOI(ALL,TAPE11)
REWIND(SCNIN)
CCREAD(DTCC,INPUT=SCNIN,SCNOUT=OUTPUT,PART=OFF)
FN(STORE,TAPE13)
EOR
    JOB ASBLT
    CALL DTTOC(5HASBLT)
    N.ASBLT=SORT,BIN126,74286
    KALL.ASBLT
    STOP
    END
    END JOB
EOR
1103057 O 41.983 53.518 103.815 9.871 1995.3 2 520-3-17 70 1200.6
1103057 533-3-03RS 9 154.8
1103057 12-10-75 1030 50099 20682065
1107677 O 41.988 53.530 103.796 9.883 1993.9 2 520-3-17 70 1200.3
1107677 533-3-03RS 9 154.2
1107677 12-10-75 0910 50099 20682065
1104819 O 41.901 53.506 103.789 9.886 1999.7 2 549-3-85 70 1198.0
1104819 533-3-03RS 9 154.2
1104819 12-10-75 1925 50083 20702068
1107035 O 41.910 53.501 103.790 9.882 1995.7 2 549-3-85 70 1198.3
1107035 533-3-03RS 9 154.4
1107035 12-10-75 1905 50099 20702068
1205523 O 41.958 51.523 104.870 9.867 2034.6 2 549-3-85 67 1147.9
1205523 533-3-03RS 12 206.3
1205523 12-10-75 1810 12941 20702068
1105854 O 41.962 53.522 103.805 9.878 1993.5 2 549-3-85 70 1201.4
1105854 520-3-12 9 154.0
1105854 12-10-75 1745 50099 20702065
1100006 O 41.923 53.527 103.815 9.866 1993.5 2 549-3-85 70 1197.9
1100006 533-3-03RS 9 154.5
1100006 12-10-75 1725 50099 20702065
1104424 O 41.943 53.509 103.811 9.875 1994.0 2 549-3-85 70 1198.9
1104424 533-3-03RS 9 155.0
1104424 12-10-75 1505 50099 20702065
1102307 O 41.927 53.513 103.795 9.879 1996.0 2 549-3-85 70 1199.6
1102307 533-3-03RS 9 153.8
1102307 12-10-75 2100 50099 207020682071
1105809 O 41.889 53.512 103.795 9.880 1999.6 2 549-3-85 70 1197.5
1105809 533-3-03RS 9 154.9
1105809 12-10-75 1740 50099 20702068
1206530 O 41.909 51.516 104.849 9.870 2038.8 2 549-3-85 67 1146.0
1206530 533-3-03RS 12 206.4
1206530 12-11-75 1031 12941 20712068
1200014 O 41.918 51.510 104.841 9.873 2039.2 2 549-3-85 67 1145.6
1200014 533-3-03RS 12 205.9
1200014 12-11-75 1125 12941 20712068
1208336 O 41.913 51.505 104.847 9.877 2038.8 2 549-3-85 67 1147.1
1208336 533-3-03RS 12 206.3
1208336 12-11-75 0915 12941 20712068
1104525 O 41.967 53.496 103.783 9.883 2003.2 2 550-3-85 70 1199.3
1104525 131-3-01 9 154.0
1104525 12-13-75 1710 50099 20832086
EOF

```

A.II.e. Example 5 - Add New Wall Thickness Data to Fuel Rod Files (No Output Included)

Example 5 uses ASBLT to process wall thickness data and demonstrates a second way of using the ASBLT MODULE. Input record 1 contains control cards, input record 2 contains wall thickness data cards and input record 3 contains DATATRAN input. The control cards perform the following functions:

Card 1 - as in prior examples

Card 2 - requests a reel of tape (FILE1 is reel 12916)

Card 3 & 4 - as in prior examples

Card 5 - identifies the file for the new data (system file NEW) to be copied to tape (R=1 for FILE1) at job termination

Cards 6-13 - identify the DATATRAN input and output files for seed, standard blanket, power flattening blanket and reflector blanket fuel rod data, respectively

Card 14 - copies the wall thickness cards from input record 2 into the system file NEW

Card 15 - rewinds NEW and TAPE11

Card 16 - copies NEW into TAPE11

Card 17 - instructs the system to store the current contents of system file NEW (will be placed on tape because of card 5)

Card 18 - executes the standard DATATRAN control cards.

The three control lists for ASBLT in record 3 (N.ASBLT, N.THK073 and N.REPLACE) instruct ASBLT to sort the new data by rod serial number, to label the new data THK073, to process the new data using the format for inspection form 74290 and to use the new data if any rod in the input already contains a wall thickness value in the DATATRAN files.

INPUT FOR EXAMPLE 5

```

YHBB005,2,008,140,0001,ASBLT,BEAUD,U,P.
REQUEST(FILE1)R12916.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
STORE(I=WALL,THK.74290,T=33,V=073,F=S,S=NEW,R=1)
FETCH(I=SEED,RODS.1,T=446,S=SEEDIN,D=4)
STORE(I=SEED,RODS.1,T=446,S=SEEDOUT,D=1N)
FETCH(I=BLKT,RODS.2,T=446,S=BLKTIN,D=4)
STORE(I=BLKT,RODS.2,T=446,S=BLKTOUT,D=1N)
FETCH(I=PFBK,RODS.3,T=446,S=PFBKIN,D=4)
STORE(I=PFBK,RODS.3,T=446,S=PFBKOUT,D=1N)
FETCH(I=REFL,RODS.4,T=446,S=REFLIN,D=4)
STORE(I=REFL,RODS.4,T=446,S=REFLOUT,D=1N)
COPYCR(INPUT,NEW)
REWIND(NEW,TAPE11)
COPYEOI(NEW,TAPE11)
FM(STORE,NEW)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
0107667      .0219      1528015805
0107723      .0218      1528015805
0107658      .0218      1528015805
0107759      .0221      1528015805
0106513      .0225      1528015805
0102460      .0218      1528015805
0107520      .0226      1528015805
0107630      .0220      1528015805
0102553      .0219      1528015805
0107557      .0215      1528015805
0107705      .0225      1528015805
0107649      .0224      1528015805
0107605      .0222      1528015805
0107714      .0225      1528015805
0107768      .0225      1528015805
2608883      .0263      1528015986
2700037      .0262      1528015803
2701045      .0267      1528015803
EOR
      JOB ASBLT
      CALL DTTC(5HASBLT)
      N.ASBLT=80RT,THK070,74290
      N.THK073=ALL
      N.REPLACE=YES
      KALL ASBLT
      STOP
      END
      END JOB
EOF

```

A.II.f. Example 6 - Add New Diameter Data to Fuel Rod Files (No Output Included)

Example 6 demonstrates the use of ASBLT to process fuel rod diameter data.
This example is similar to examples 4 and 5.

INPUT FOR EXAMPLE 6

```
YHBB006,3,004,140,1546.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(I=SEED.RODS.1,T=446,S=SEEDIN,D=4)
STORE(I=SEED.RODS.1,T=446,S=SEEDOUT,D=1N)
FETCH(I=BLKT.RODS.2,T=446,S=BLKTIN,D=4)
STORE(I=BLKT.RODS.2,T=446,S=BLKTOUT,D=1N)
FETCH(I=PFBK.RODS.3,T=446,S=PFBKIN,D=4)
STORE(I=PFBK.RODS.3,T=446,S=PFBKOUT,D=1N)
FETCH(I=REFL.RODS.4,T=446,S=REFLIN,D=4)
STORE(I=REFL.RODS.4,T=446,S=REFLOUT,D=1N)
REWIND(SCNIN,TAPE12)
COPYBR(INPUT,SCNIN)
COPYBR(INPUT,TAPE12)
REWIND(SCNIN)
CCREAD(DTCC,INPUT=SCNIN,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTTC(5HASBLT)
      N.ASBLT=NOSORT,REPLACE,74297
      KALL ASBLT
      STOP
      END
      END JOB
EOR
2300711527416815
2300775527616814
2300849527916815
2301177528016815
2305155527116815
2305247528216814
2305430528616815
2305568528016815
2305752528016815
2305808527216014
2305835527016814
2306071527916815
2306356527216815
2306420528216814
2306457528616815
2306466528416814
2501029527616808
2501139527116810
2501258527816810
2502037527616808
2502880527316808
2503577527816810
2503624527516808
EOF
```

A.II.g. Example 7 - Sort the ASBLT DATATRAN Fuel Rod File (Including Portions of Output)

Example 7 demonstrates the use of the EDIT1 MODULE to sort the DATATRAN lists by fuel rod serial number. EDIT1 prints the rod serial numbers after completing the sort as shown in the partial output from example 7. In the example, PUTAFM is used to save the sorted DATATRAN lists.

INPUT FOR EXAMPLE 7

```
YHRR007,2,008,140,0001.ASBLT,DEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=SEED.RODS.1,T=446,V=1,S=SEEDIN,D=4)
STORE(I=SEED.RODS.1,T=446,V=1,S=SEEDOUT,D=1N)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTOC(5HASBLT)
      N.EDIT=SORISTOR 1
      KALL EDIT1
      N.STORE= 1
      KALL PUTAFM
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 7

YHBB007 78/02/27 DT2SYS BEAUD PC 1

CLASS	1, FILE WITH SYNONYM	SEEDIN	RECALLED						
YHBB007	YHBB01D	DT2SYS	BEAUD	77/08/31	10.04.23	1.000000	1.000000	34.000000	
CLASS 1, TYPE 5, BLOCK 1									
0500000	0500019	0500028	0500037	0500046	0500055	0500064	0500073	0500082	0500102
0500110	0500129	0500138	0500147	0500156	0500165	0500174	0500183	0500203	0500212
0500220	0500239	0500248	0500257	0500266	0500275	0500284	0500304	0500313	0500322
0500330	0500349	0500358	0500367	0500376	0500385	0500405	0500414	0500423	0500432
0500440	0500459	0500468	0500477	0500486	0500506	0500515	0500524	0500533	0500542
0500550	0500569	0500578	0500607	0500616	0500625	0500634	0500643	0500652	0500660
0500679	0500688	0500708	0500717	0500726	0500735	0500744	0500753	0500762	0500770
0500789	0500809	0500818	0500827	0500836	0500845	0500854	0500863	0500872	0501009
0501018	0501027	0501036	0501045	0501054	0501063	0501072	0501081	0501100	0501119
0501128	0501137	0501146	0501155	0501164	0501173	0501202	0501210	0501229	0501238
CLASS 1, TYPE 5, BLOCK 2									
0501247	0501256	0501265	0501274	0501283	0501303	0501312	0501320	0501339	0501348
0501357	0501366	0501375	0501384	0501404	0501413	0501422	0501430	0501449	0501458
0501467	0501476	0501505	0501514	0501523	0501532	0501540	0501559	0501568	0501577
0501586	0501606	0501615	0501624	0501633	0501642	0501650	0501669	0501678	0501687
0501707	0501716	0501725	0501734	0501743	0501752	0501760	0501779	0501788	0501808
0501817	0501826	0501835	0501844	0501853	0501862	0501870	0501889	0502008	0502017
0502026	0502035	0502044	0502053	0502062	0502071	0502089	0502109	0502118	0502127
0502136	0502145	0502163	0502172	0502181	0502200	0502219	0502228	0502237	0502246
0502255	0502264	0502273	0502282	0502302	0502310	0502329	0502338	0502347	0502356
0502365	0502374	0502383	0502403	0502412	0502420	0502439	0502448	0502457	0502466
CLASS 1, TYPE 5, BLOCK 3									
0502475	0502484	0502504	0502513	0502522	0502530	0502549	0502558	0502567	0502576
0502585	0502605	0502614	0502623	0502632	0502640	0502668	0502677	0502686	0502706
0502715	0502724	0502742	0502750	0502769	0502778	0502807	0502816	0502825	0502834
0502843	0502852	0502860	0502879	0502888	0503007	0503016	0503025	0503034	0503043
0503052	0503061	0503079	0503088	0503108	0503117	0503126	0503135	0503144	0503153
0503162	0503171	0503189	0503209	0503218	0503227	0503236	0503245	0503254	0503263
0503272	0503281	0503300	0503319	0503328	0503346	0503355	0503364	0503373	0503382
0503402	0503410	0503429	0503438	0503447	0503456	0503465	0503474	0503483	0503503
0503512	0503520	0503539	0503548	0503557	0503566	0503575	0503584	0503604	0503613
0503622	0503649	0503658	0503667	0503676	0503685	0503705	0503714	0503723	0503732
CLASS 1, TYPE 5, BLOCK 4									
0503740	0503759	0503768	0503777	0503786	0503806	0503815	0503824	0503833	0503842
0503850	0503869	0503878	0504006	0504015	0504024	0504033	0504042	0504051	0504069
0504078	0504087	0504107	0504116	0504125	0504134	0504143	0504152	0504161	0504179
0504188	0504208	0504217	0504226	0504244	0504253	0504262	0504271	0504289	0504309
0504318	0504327	0504336	0504345	0504354	0504363	0504372	0504381	0504400	0504419
0504428	0504437	0504446	0504455	0504464	0504482	0504502	0504510	0504529	0504538
0504547	0504556	0504565	0504574	0504583	0504603	0504612	0504620	0504639	0504648
0504657	0504666	0504675	0504684	0504704	0504713	0504722	0504730	0504749	0504758
0504767	0504776	0504785	0504805	0504814	0504823	0504832	0504840	0504859	0504868
0504877	0504886	0505005	0505014	0505023	0505032	0505041	0505059	0505068	0505077
CLASS 1, TYPE 5, BLOCK 5									
0505086	0505106	0505115	0505124	0505133	0505142	0505151	0505169	0505178	0505187
0505207	0505216	0505225	0505234	0505243	0505252	0505261	0505279	0505288	0505308
0505317	0505326	0505335	0505344	0505353	0505362	0505371	0505389	0505409	0505418
0505427	0505436	0505445	0505454	0505463	0505472	0505481	0505500	0505519	0505528
0505537	0505546	0505555	0505564	0505573	0505582	0505602	0505610	0505629	0505638

 PARTIAL OUTPUT FROM EXAMPLE 7 (CONTINUED)

						YHB3007	78/02/27	DT2SYS	BEAUD	PG	22
0703638	0703647	0703656	0703665	0703674	0703683	0703703	0703712	0703720	0703739		
0703748	0703757	0703766	0703775	0703784	0703804	0703813	0703822	0703830	0703849		
0703858	0703867	0703876	0703885	0704004	0704013	0704022	0704031	0704049	0704058		
0704067	0704076	0704085	0704105	0704114	0704123	0704132	0704141	0704159	0704168		
CLASS 1, TYPE 7, BLOCK 4											
0704177	0704186	0704206	0704215	0704224	0704233	0704242	0704251	0704269	0704278		
0704287	0704307	0704316	0704325	0704334	0704343	0704352	0704361	0704379	0704388		
0704408	0704417	0704426	0704435	0704444	0704453	0704462	0704471	0704489	0704509		
0704518	0704527	0704536	0704545	0704554	0704563	0704572	0704581	0704600	0704619		
0704628	0704637	0704646	0704655	0704664	0704673	0704682	0704702	0704710	0704729		
0704738	0704747	0704756	0704765	0704774	0704783	0704803	0704812	0704820	0704839		
0704848	0704857	0704866	0704875	0704884	0705003	0705012	0705021	0705039	0705048		
0705057	0705066	0705075	0705084	0705104	0705113	0705122	0705131	0705149	0705158		
0705167	0705176	0705185	0705205	0705214	0705223	0705232	0705241	0705259	0705268		
0705277	0705286	0705306	0705315	0705324	0705333	0705342	0705351	0705369	0705378		
CLASS 1, TYPE 7, BLOCK 5											
0705387	0705407	0705416	0705425	0705434	0705443	0705452	0705461	0705479	0705488		
0705508	0705517	0705526	0705535	0705544	0705553	0705562	0705571	0705589	0705609		
0705618	0705627	0705636	0705645	0705654	0705663	0705672	0705681	0705700	0705719		
0705728	0705737	0705746	0705755	0705764	0705773	0705782	0705802	0705810	0705829		
0705838	0705847	0705856	0705865	0705874	0705883	0706002	0706011	0706029	0706038		
0706047	0706056	0706065	0706074	0706083	0706103	0706112	0706121	0706139	0706148		
0706157	0706166	0706175	0706184	0706204	0706213	0706222	0706231	0706249	0706258		
0706267	0706276	0706285	0706305	0706314	0706323	0706332	0706341	0706359	0706368		
0706377	0706386	0706406	0706415	0706424	0706433	0706442	0706451	0706469	0706478		
0706487	0706507	0706516	0706525	0706534	0706543	0706552	0706561	0706579	0706588		
CLASS 1, TYPE 7, BLOCK 6											
0706608	0706617	0706626	0706635	0706644	0706653	0706662	0706671	0706689	0706709		
0706718	0706727	0706736	0706745	0706754	0706763	0706772	0706781	0706800	0706819		
0706828	0706837	0706846	0706855	0706864	0706873						
CLASS 1, TYPE 8, BLOCK 1											
0800007	0800025	0800034	0800043	0800052	0800079	0800108	0800117	0800126	0800135		
0800144	0800153	0800162	0800171	0800209	0800218	0800227	0800236	0800245	0800254		
0800263	0800382	0800402	0800410	0800429	0800438	0800447	0800456	0800474	0800512		
0800539	0800548	0800557	0800575	0800584	0800604	0800613	0800622	0800630	0800649		
0800658	0800667	0800676	0800685	0800705	0800714	0800723	0800732	0800740	0800759		
0800768	0800777	0800786	0800806	0800815	0800824	0800833	0800842	0800850	0800869		
0800878	0800887	0801006	0801015	0801024	0801033	0801042	0801051	0801069	0801078		
0801087	0801107	0801125	0801134	0801143	0801152	0801161	0801179	0801188	0801208		
0801217	0801226	0801235	0801244	0801253	0801262	0801271	0801289	0801309	0801318		
0801327	0801336	0801345	0801354	0801363	0801372	0801381	0801400	0801419	0801428		
CLASS 1, TYPE 8, BLOCK 2											
0801437	0801446	0801455	0801464	0801473	0801482	0801502	0801510	0801529	0801538		
0801547	0801556	0801565	0801574	0801583	0801603	0801612	0801620	0801639	0801648		
0801657	0801666	0801675	0801684	0801704	0801713	0801722	0801730				

A.II.h. Example 8 - Compute Fuel Rod Loading and Loading Precision (Including Portion of Output)

Example 8 demonstrates the use of the GATHER and the PUTAFM MODULES to perform the following functions:

1. Access the DATATRAN files for power flattening blanket rods
2. Access the binary blend files
3. Compute loadings and precision for medium zone power flattening blanket rods
4. Place the loadings and precision values into the DATATRAN lists
5. Save the new lists.

The controlling lists for the GATHER MODULE (N.GATHER, N.BYZONE and N.OPTION) instruct GATHER to operate on region 3 (power flattening blanket), zone 7 (medium P.F.B.) and to compute loadings for all rods. The computed fissile loading and precision for each rod are checked against the requirements and the appropriate accept/reject code is placed in the loading code. A portion of the output from example 8 is included after the input listing. Page 1 contains a summary of the uranium weight fractions for the medium zone power flattening blanket blends. Pages 2 and 14 are typical of the fuel rod loading information which can be displayed using ASBLT.

INPUT FOR EXAMPLE 8

```
YHBB008,2,008,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=PFBK.RODS.3,T=446,V=1,S=PFBKIN,D=4)
STORE(I=PFBK.RODS.3,T=446,V=1,S=PFBKOUT,D=1N)
FETCH(P=YHBB,I=BLEND.BIN,T=33,V=1,F=S,S=TAPE11)
FETCH(P=YHBB,I=COMPOSITE.BLENDS,T=446,V=1,S=COMPIN)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTTC(5HASBLT)
      N.GATHER= 3
      N.BYZONE=7
      N.OPTION=LOADING,ALL
      KALL GATHER
      N.STORE= 3
      KALL PUTAFM
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 8

YHBB008 78/02/27 DT2SYS BEAUD PG 1

BINARY BLEND FILE ACCESSED

4-JAN-78 16:55 06.2 869 LAST SCNOFF: 16-JUL-76 09:22 14.8
URANIUM WT FRACTION DATA FOR SIGNED OFF BLENDS

ALL 87[3110,316] 704

BLEND ID	AVG. WT. FRAC. U	AVG. WT. FRAC. U233	AVG. WT. FRAC. FIS
112-7-01	2.044000	2.007789	2.010037
115-7-11	2.047000	2.010957	2.013208
544-7-01	2.042000	2.005945	2.008171
544-7-02	2.045000	2.008892	2.011141
544-7-03	2.042000	2.005945	2.008191
544-7-04	2.036000	2.000007	2.002247
545-7-01	2.044000	2.007910	2.010137
545-7-02	2.041000	2.005062	2.007287
545-7-03	2.043000	2.007087	2.009314
545-7-04	2.038000	2.001955	2.004196
545-7-05	2.038000	2.002155	2.004397
545-7-06	2.043000	2.007027	2.009274
545-7-07	2.046000	2.009770	2.012000
545-7-08	2.048000	2.011774	2.014007
545-7-09	2.045000	2.008851	2.011080
545-7-10	2.043000	2.007067	2.009314
545-7-12	2.049000	2.010564	2.013555
545-7-13	2.053000	2.013773	2.017037
545-7-14	2.051000	2.011827	2.015068
545-7-15	2.045000	2.005946	2.009177

URANIUM ISOTOPIC WEIGHT PERCENTS WERE NORMALIZED TO 100 PERCENT FOR EACH BINARY BLEND.

THE FOLLOWING DEFINES ANY MARKS FOUND TO THE LEFT OF A ROD SERIAL NUMBER

- + THE BLENDS IN THIS ROD HAVE BEEN RECENTLY SIGNED OFF AND THE LOADING HAS BEEN CALCULATED.
- THE BLENDS IN THIS ROD HAVE BEEN RECENTLY UNSIGNED OFF AND THE LOADING CANNOT BE CALCULATED.
- M THE BLENDS IN THIS ROD HAVE BEEN REEVALUATED AND A NEW LOADING HAS BEEN CALCULATED.

CLASS	3, FILE WITH SYNONYM	PFBKIN	RECALLED					
YHBBCTS	YHBB07Z	DT2SYS	BEAUD	77/09/07	15.07.02	3.000000	1.000000	34.000000

PARTIAL OUTPUT FROM EXAMPLE 8 (CONTINUED)

(CORRECTED FOR WEIGHING BIAS.)										YHBB008	78/02/27	DT2SYS	BEAUD	PC	2	
ROD S/N	LTH A	LTH D	LTH P	WT THORIA	BLEND ID	QY	WT BINARY	TOTAL U GRAMS	U-233 GRAMS	FISS U GRAMS	FISSILE LOADING....			THORIUM KCS		
											GRAMS	GMS/IN	0/0PRCSN			
2400013	55.790	37.502	104.854	1336.5	545-7-01	71	1529.6	31.265	30.713	30.747	30.747	.55112	A	.198	A 2.4875	WO
2400022	55.793	37.503	104.869	1338.2	544-7-04	71	1530.0	31.151	30.600	30.634	30.634	.54907	A	.194	A 2.4895	WO
2400030	55.832	37.518	104.857	1340.8	545-7-08	71	1532.0	31.375	30.820	30.855	30.855	.55263	A	.188	A 2.4933	WO
2400049	55.840	37.508	104.864	1335.0	544-7-04	71	1530.3	31.157	30.606	30.640	30.640	.54872	A	.194	A 2.4869	WO
2400058	55.777	37.510	104.857	1341.9	545-7-06	71	1529.2	31.242	30.691	30.726	30.726	.55087	A	.193	A 2.4919	WO
2400067	55.866	37.503	104.857	1340.5	544-7-02	71	1531.5	31.319	30.766	30.801	30.801	.55133	A	.207	A 2.4926	WO
2400076	55.783	37.499	104.845	1341.4	544-7-02	71	1531.1	31.311	30.758	30.793	30.793	.55201	A	.207	A 2.4931	WO
2400085	55.882	37.503	104.854	1337.7	112-7-01	71	1527.6	31.224	30.671	30.705	30.705	.54947	A	.182	A 2.4868	WO
2400105	55.831	37.504	104.867	1340.9	544-7-02	71	1532.6	31.342	30.788	30.823	30.823	.55207	A	.207	A 2.4939	WO
2400114	55.777	37.496	104.840	1341.2	544-7-02	71	1530.7	31.303	30.750	30.785	30.785	.55192	A	.207	A 2.4926	WO
2400123	55.826	37.494	104.855	1341.4	545-7-05	71	1533.2	31.247	30.697	30.731	30.731	.55049	A	.215	A 2.4950	WO
2400132	55.800	37.509	104.843	1329.0	544-7-02	71	1531.2	31.313	30.760	30.795	30.795	.55187	A	.207	A 2.4823	WO
2400140	55.783	37.501	104.858	1342.0	545-7-07	71	1530.0	31.304	30.749	30.784	30.784	.55185	A	.208	A 2.4927	WO
2400159	55.778	37.494	104.841	1340.7	545-7-07	71	1531.3	31.330	30.776	30.810	30.810	.55236	A	.208	A 2.4926	WO
2400168	55.781	37.504	104.846	1342.1	545-7-07	71	1530.0	31.304	30.749	30.784	30.784	.55187	A	.208	A 2.4927	WO
2400177	55.875	37.502	104.860	1342.7	544-7-02	71	1533.9	31.368	30.814	30.849	30.849	.55211	A	.207	A 2.4966	WO
2400186	55.810	37.511	104.847	1341.0	545-7-08	71	1532.0	31.375	30.820	30.855	30.855	.55285	A	.188	A 2.4935	WO
2400206	55.820	37.490	104.860	1334.4	544-7-03	71	1531.3	31.269	30.717	30.751	30.751	.55090	A	.214	A 2.4871	WO
2400215	55.759	37.505	104.846	1340.5	545-7-07	71	1531.5	31.334	30.780	30.814	30.814	.55262	A	.208	A 2.4926	WO
2400224	55.794	37.500	104.866	1321.5	544-7-04	71	1529.0	31.130	30.580	30.614	30.614	.54870	A	.194	A 2.4739	WO
2400233	55.855	37.513	104.853	1340.4	544-7-02	71	1532.7	31.344	30.790	30.825	30.825	.55187	A	.207	A 2.4936	WO
2400242	55.897	37.501	104.847	1338.2	544-7-02	71	1533.3	31.356	30.802	30.837	30.837	.55167	A	.207	A 2.4922	WO
2400250	55.806	37.513	104.856	1342.7	544-7-02	71	1530.9	31.307	30.754	30.789	30.789	.55171	A	.207	A 2.4941	WO
2400269	55.831	37.517	104.857	1341.2	545-7-08	71	1532.1	31.377	30.822	30.857	30.857	.55268	A	.188	A 2.4937	WO
2400278	55.763	37.499	104.851	1342.3	545-7-07	71	1531.4	31.332	30.778	30.812	30.812	.55255	A	.208	A 2.4941	WO
2400287	55.800	37.490	104.860	1341.0	545-7-06	71	1530.7	31.272	30.722	30.756	30.756	.55118	A	.193	A 2.4924	WO
2400307	55.821	37.506	104.876	1314.0	544-7-04	71	1530.0	31.151	30.600	30.634	30.634	.54880	A	.194	A 2.4682	WO
2400316	55.841	37.520	104.873	1341.2	544-7-01	71	1533.0	31.304	30.751	30.785	30.785	.55130	A	.174	A 2.4946	WO
2400325	55.904	37.494	104.856	1336.9	544-7-02	71	1533.8	31.366	30.812	30.847	30.847	.55178	A	.207	A 2.4914	WO
2400334	55.833	37.496	104.858	1333.5	544-7-03	71	1531.8	31.279	30.727	30.761	30.761	.55095	A	.214	A 2.4868	WO
2400343	55.814	37.501	104.854	1341.6	544-7-02	71	1532.0	31.329	30.776	30.811	30.811	.55202	A	.207	A 2.4940	WO
2400352	55.780	37.505	104.859	1339.2	545-7-07	71	1530.0	31.304	30.749	30.784	30.784	.55188	A	.208	A 2.4902	WO
2400360	55.857	37.510	104.846	1340.4	544-7-04	71	1531.0	31.171	30.620	30.654	30.654	.54880	A	.194	A 2.4923	WO
2400379	55.777	37.507	104.854	1340.7	545-7-07	71	1529.6	31.296	30.741	30.776	30.776	.55176	A	.208	A 2.4912	WO
2400408	55.773	37.509	104.857	1338.4	545-7-07	71	1529.3	31.300	30.745	30.780	30.780	.55187	A	.208	A 2.4893	WO
2400417	55.844	37.493	104.852	1334.8	544-7-03	71	1531.0	31.263	30.711	30.745	30.745	.55056	A	.214	A 2.4872	WO
2400426	55.869	37.507	104.850	1337.4	544-7-02	71	1534.4	31.378	30.824	30.859	30.859	.55234	A	.207	A 2.4924	WO
2400435	55.761	37.495	104.841	1342.6	545-7-07	71	1530.6	31.316	30.762	30.796	30.796	.55228	A	.208	A 2.4937	WO
2400444	55.801	37.499	104.857	1342.7	544-7-03	71	1530.5	31.253	30.701	30.735	30.735	.55080	A	.214	A 2.4938	WO
2400453	55.857	37.504	104.867	1341.5	544-7-04	71	1531.2	31.175	30.624	30.658	30.658	.54887	A	.194	A 2.4934	WO
2400462	55.813	37.486	104.853	1342.5	545-7-05	71	1530.9	31.200	30.651	30.685	30.685	.54979	A	.215	A 2.4940	WO
2400470	55.862	37.511	104.844	1333.8	545-7-01	71	1530.7	31.287	30.735	30.769	30.769	.55081	A	.198	A 2.4861	WO
2400518	55.844	37.510	104.855	1335.5	544-7-04	71	1530.8	31.167	30.616	30.650	30.650	.54886	A	.194	A 2.4878	WO
2400527	55.802	37.495	104.855	1341.7	544-7-04	71	1529.1	31.132	30.582	30.616	30.616	.54866	A	.194	A 2.4918	WO
2400536	55.900	37.505	104.858	1340.3	544-7-02	71	1532.8	31.346	30.792	30.827	30.827	.55146	A	.207	A 2.4936	WO
2400545	55.819	37.504	104.864	1334.9	544-7-03	71	1531.3	31.269	30.717	30.751	30.751	.55091	A	.214	A 2.4876	WO
2400554	55.857	37.506	104.852	1334.2	544-7-03	71	1532.3	31.290	30.737	30.772	30.772	.55090	A	.214	A 2.4878	WO
2400563	55.792	37.511	104.843	1340.8	545-7-05	71	1532.7	31.236	30.687	30.721	30.721	.55064	A	.215	A 2.4940	WO
2400572	55.797	37.495	104.842	1332.6	545-7-01	44	948.6	19.389	19.047	19.068	30.721	.55059	A	.146	A 2.4850	WO
					544-7-04	27	582.0	11.850	11.640	11.653						
2400580	55.813	37.503	104.860	1342.3	544-7-03	71	1530.8	31.259	30.707	30.741	30.741	.55079	A	.214	A 2.4937	WO
2400619	55.825	37.509	104.861	1341.2	544-7-02	71	1532.2	31.333	30.780	30.815	30.815	.55199	A	.207	A 2.4939	WO
2400628	55.781	37.513	104.856	1341.3	544-7-02	71	1531.0	31.309	30.756	30.791	30.791	.55199	A	.207	A 2.4929	WO
2400637	55.765	37.515	104.867	1332.4	544-7-04	71	1528.5	31.120	30.570	30.604	30.604	.54881	A	.194	A 2.4831	WO
2400646	55.741	37.509	104.876	1341.2	545-7-06	71	1530.0	31.258	30.708	30.742	30.742	.55151	A	.193	A 2.4920	WO
2400655	55.817	37.500	104.866	1336.0	544-7-04	71	1528.1	31.112	30.562	30.596	30.596	.54815	A	.194	A 2.4859	WO

PARTIAL OUTPUT FROM EXAMPLE 8 (CONTINUED)

(CORRECTED FOR WEIGHING BIAS.)										YHBB008	78/02/27	DT2SYS	BEAUD	PG	14	
2701303	84.261	11.493	103.821	536.4	112-7-01	107	2303.4	47.081	46.247	46.299	46.299	.54947	A	.182	A 2.4486	WO
2701312	84.103	11.498	103.807	539.5	545-7-08	107	2306.6	47.239	46.404	46.455	46.455	.55236	A	.188	A 2.4540	WO
2701320	84.086	11.495	103.806	537.2	545-7-08	107	2306.5	47.237	46.402	46.453	46.453	.55245	A	.188	A 2.4519	WO
2701339	84.188	11.495	103.824	537.5	545-7-08	39	841.4	17.232	16.927	16.946	46.373	.55082	A	.137	A 2.4512	WO
					112-7-01	68	1464.0	29.924	29.394	29.427						
2701348	84.229	11.493	103.813	534.8	112-7-01	107	2302.0	47.053	46.219	46.271	46.271	.54935	A	.182	A 2.4460	WO
2701357	84.053	11.508	103.799	540.0	115-7-11	107	2310.0	47.286	46.453	46.505	46.505	.55328	A	.208	A 2.4573	WO
2701366	83.940	11.506	103.810	544.5	545-7-09	107	2297.0	46.974	46.143	46.195	46.195	.55033	A	.210	A 2.4502	WO
2701375	84.006	11.507	103.827	542.9	115-7-11	107	2309.1	47.267	46.435	46.487	46.487	.55338	A	.208	A 2.4591	WE
2701384	84.057	11.502	103.804	540.8	115-7-11	107	2309.3	47.271	46.439	46.491	46.491	.55309	A	.208	A 2.4574	WO
2701404	84.051	11.498	103.802	539.5	115-7-11	107	2309.9	47.284	46.451	46.503	46.503	.55327	A	.208	A 2.4568	WO
2701413	83.932	11.506	103.803	544.2	545-7-09	107	2298.5	47.004	46.173	46.225	46.225	.55074	A	.210	A 2.4512	WO
2701422	84.020	11.496	103.810	535.8	545-7-09	28	600.9	12.288	12.071	12.085	46.521	.55368	A	.165	A 2.4549	WE
					115-7-11	79	1710.5	35.014	34.397	34.436						
2701430	84.016	11.511	103.817	542.0	545-7-09	107	2297.0	46.974	46.143	46.195	46.195	.54983	A	.210	A 2.4480	WO
2701449	84.057	11.494	103.811	540.4	115-7-11	107	2309.3	47.271	46.439	46.491	46.491	.55309	A	.208	A 2.4571	WO
2701458	84.104	11.495	103.804	538.9	115-7-11	107	2311.0	47.306	46.473	46.525	46.525	.55319	A	.208	A 2.4572	WO
2701467	84.082	11.502	103.807	539.7	115-7-11	107	2310.4	47.294	46.461	46.513	46.513	.55319	A	.208	A 2.4574	WO
2701476	83.941	11.502	103.810	544.6	545-7-09	107	2297.9	46.992	46.161	46.213	46.213	.55054	A	.210	A 2.4510	WO
2701485	84.078	11.499	103.817	541.2	545-7-14	107	2307.0	47.317	46.413	46.488	46.488	.55291	A	.209	A 2.4557	WO
2701505	84.088	11.506	103.805	539.4	545-7-14	107	2309.7	47.372	46.467	46.542	46.542	.55349	A	.209	A 2.4565	WO
2701514	84.103	11.515	103.797	537.5	545-7-14	107	2309.0	47.358	46.453	46.528	46.528	.55323	A	.209	A 2.4542	WO
2701523	84.119	11.520	103.812	538.9	545-7-14	107	2309.2	47.362	46.457	46.532	46.532	.55317	A	.209	A 2.4556	WO
2701532	84.092	11.515	103.809	538.0	545-7-14	107	2308.6	47.349	46.445	46.520	46.520	.55320	A	.209	A 2.4543	WO
2701540	84.145	11.512	103.805	537.7	545-7-14	107	2311.0	47.399	46.493	46.568	46.568	.55343	A	.209	A 2.4561	WO
2701559	84.104	11.492	103.796	539.4	545-7-14	107	2308.6	47.349	46.445	46.520	46.520	.55312	A	.209	A 2.4555	WO
2701568	84.125	11.487	103.803	538.0	545-7-14	107	2310.6	47.390	46.485	46.560	46.560	.55346	A	.209	A 2.4560	WO
2701577	84.108	11.507	103.806	538.7	545-7-14	107	2310.0	47.378	46.473	46.548	46.548	.55343	A	.209	A 2.4561	WO
2701586	84.117	11.507	103.797	537.6	545-7-14	107	2311.8	47.415	46.509	46.584	46.584	.55380	A	.209	A 2.4567	WO
2701606	84.085	11.518	103.801	538.2	545-7-14	107	2308.9	47.356	46.451	46.526	46.526	.55332	A	.209	A 2.4547	WO
2701615	84.098	11.508	103.819	540.9	545-7-14	107	2306.6	47.308	46.405	46.480	46.480	.55268	A	.209	A 2.4551	WO
2701624	84.158	11.498	103.810	536.7	545-7-14	107	2311.6	47.411	46.505	46.580	46.580	.55349	A	.209	A 2.4557	WO
2701633	84.075	11.510	103.809	540.8	545-7-14	107	2309.0	47.358	46.453	46.528	46.528	.55341	A	.209	A 2.4571	WO
2701642	84.106	11.503	103.798	538.4	545-7-14	107	2309.7	47.372	46.467	46.542	46.542	.55337	A	.209	A 2.4556	WO
2701650	83.967	11.505	103.820	544.7	545-7-14	107	2306.0	47.296	46.393	46.467	46.467	.55340	A	.209	A 2.4579	WO
2701669	84.072	11.497	103.813	540.7	545-7-14	107	2309.0	47.358	46.453	46.528	46.528	.55343	A	.209	A 2.4570	WO
2701678	84.142	11.511	103.811	538.9	545-7-14	107	2311.0	47.399	46.493	46.568	46.568	.55345	A	.209	A 2.4571	WO
2701687	84.126	11.501	103.811	538.3	545-7-14	107	2311.5	47.409	46.503	46.578	46.578	.55367	A	.209	A 2.4570	WO
2701707	84.075	11.501	103.812	541.2	545-7-14	107	2309.3	47.364	46.459	46.534	46.534	.55348	A	.209	A 2.4577	WO
2701716	84.174	11.510	103.810	537.2	545-7-14	107	2307.4	47.325	46.421	46.496	46.496	.55238	A	.209	A 2.4526	WO
2701725	84.052	11.508	103.812	541.9	545-7-14	107	2306.8	47.312	46.409	46.484	46.484	.55303	A	.209	A 2.4562	WO
2701734	84.012	11.497	103.809	543.1	545-7-14	107	2307.0	47.317	46.413	46.488	46.488	.55334	A	.209	A 2.4574	WO
2701743	84.124	11.511	103.799	538.4	545-7-14	107	2310.5	47.388	46.483	46.558	46.558	.55345	A	.209	A 2.4563	WO
2701752	84.041	11.513	103.805	542.0	545-7-14	107	2307.6	47.329	46.425	46.500	46.500	.55330	A	.209	A 2.4570	WO

D.CLASS(3).TYPE(21) CONTAINS 362 RODS IN 4 BLOCKS.
 D.CLASS(3).TYPE(22) CONTAINS 423 RODS IN 5 BLOCKS.
 D.CLASS(3).TYPE(23) CONTAINS 523 RODS IN 6 BLOCKS.
 D.CLASS(3).TYPE(24) CONTAINS 507 RODS IN 6 BLOCKS.
 D.CLASS(3).TYPE(25) CONTAINS 1504 RODS IN 16 BLOCKS.
 D.CLASS(3).TYPE(26) CONTAINS 1652 RODS IN 17 BLOCKS.
 D.CLASS(3).TYPE(27) CONTAINS 144 RODS IN 2 BLOCKS.

5115 RODS TOTAL

D.CLASS(3).SIGWE HAS 2 SUB-NAMES
 D.CLASS(3).DSR HAS 4 SUB-NAMES

FILE TYPE 0 SAVED WITH SYNONYM PFBKOUT VERSION 0
 CLASS 3, FILE WITH SYNONYM PFBKOUT SAVED

A.II.i. Example 9 - Detailed Edit of DATATRAN Fuel Rod Lists (Including Portions of Output)

Example 9 uses the EDIT2 MODULE to display data stored in the DATATRAN Fuel Rod Lists for rod types 11 and 12 (low zone standard blanket) and rod types 21 and 22 (low zone power flattening blanket). The controlling list for EDIT2 (N.EDIT) contains the request for types 11, 12, 21 and 22. The output from this example will consist of all filed data for each rod of the requested type as shown on the sample page of output following the example 9 input listing. The parameters printed for each rod are defined in Section A.I.d.1.

INPUT FOR EXAMPLE 9

```
YHBB009,2,008,140,0001.ASBLT,BEAUD,U,P.
MERGE( I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=BLKT.RODS.2,T=446,V=1,S=BLKTIN,D=1)
FETCH(P=YHBB,I=PFBK.RODS.3,T=446,V=1,S=PFBKIN,D=1)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
      JOB ASBLT
      CALL DTTOC(5HASBLT)
      N.EDIT= 11 12 21 22
      KALL EDIT2
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 9

										YHBB009	78-02/27	DT2SYS	BEAUD	PG	2
1100006	N 75-12-10	1725 50099 41.923 53.527 103.815 549-3-85	1197.9	0.0	70 1993.5	0.0 16.4057	.191 1333.4 W O	33	1						
	533-3-03RS	154.5 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16008	.5719 1528012414 .0280 L-GT22-02 A36													
1100015	N 75-12-09	2255 50099 41.982 53.523 103.796 546-3-85RS	1202.4	0.0	70 2006.2	0.0 16.4709	.183 1337.7 W O	11	2						
	533-3-03RS	154.4 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16033	.5719 1528012894 .0278 L-GU52-01 B40													
1100024	N 75-11-24	1700 50099 41.927 53.517 103.794 520-3-11HR	1202.4	0.0	70 2007.0	0.0 16.4663	.182 1337.3 W O		3						
	533-3-01	153.9 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16563	.5710 1528013419 .0283													
1100033	N 75-11-09	1735 50083 41.961 53.506 103.802 520-3-01	1351.2	0.0	79 2012.5	0.0 16.4054	.237 1332.2 W O		4						
	15920	.5726 1528012842 .0281													
1100042	N 75-11-05	2112 50083 41.996 53.504 103.807 520-3-02	1354.4	0.0	79 1996.6	0.0 16.4306	.162 1335.4 W O	33	5						
	16213	.5722 1528015004 .0278 L-GT22-02 B40													
1100069	N 75-11-07	1344 50083 42.002 53.513 103.811 520-3-05	1356.5	0.0	79 1996.1	0.0 16.4294	.200 1337.5 W O		6						
	15933	.5714 1528012076 .0276													
1100078	N 75-11-09	520 50083 41.998 53.501 103.800 520-3-01	1351.5	0.0	79 2009.1	0.0 16.4090	.237 1332.5 W O	13	7						
	15980	.5718 1528012353 .0278 L-GU52-02 A17													
1100087	N 75-11-09	1411 0 41.991 53.517 103.798 520-3-01	1356.8	0.0	79 2006.3	0.0 16.4734	.237 1337.8 W O	33	8						
	15927	.5719 1528012067 .0282 L-GT22-02 B47													
1100107	N 75-11-09	1003 50083 42.005 53.517 103.811 520-3-01	1358.0	0.0	79 2003.1	0.0 16.4880	.237 1338.9 W O	34	9						
	15930	.5708 1528012063 .0273 L-GW53-01 A26													
1100116	N 75-11-09	1430 50083 41.984 53.521 103.795 520-3-01	1357.1	0.0	79 2005.7	0.0 16.4770	.237 1338.1 W O	26	10						
	15971	.5718 1528012351 .0277 L-GV51-01 B23													
1100125	N 75-12-14	2325 50099 41.982 53.519 103.793 533-3-04	1204.7	0.0	70 2003.7	0.0 16.5205	.189 1340.0 W O	14	11						
	520-3-09RS	154.4 0.0 9 0.0 0.0 0	0.0 0.0 0												
	15998	.5716 1528012376 .0280 L-GU51-01 B59													
1100143	N 75-11-05	1402 50083 42.011 53.512 103.799 520-3-02	1356.7	0.0	79 1997.7	0.0 16.4585	.162 1337.7 W O	12	12						
	15930	.5712 1528012063 .0275 L-GU52-02 B48													
1100152	N 75-11-21	1130 50099 41.976 53.506 103.792 533-3-05	1202.5	0.0	70 1996.2	0.0 16.4974	.200 1338.2 W O	11	13						
	131-3-02	154.8 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16065	.5717 1528012437 .0280 L-GU52-01 B23													
1100160	N 75-12-11	1321 50099 41.970 53.532 103.794 533-3-06XR	1203.3	0.0	70 2010.5	0.0 16.4743	.179 1338.0 W O	12	14						
	533-3-03RS	153.7 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16008	.5720 1528012414 .0282 L-GU52-02 B1													
1100179	N 75-12-13	1140 50083 41.992 53.516 103.811 550-3-85	1199.3	0.0	70 2006.0	0.0 16.3953	.199 1334.6 W O		15						
	131-3-01	154.3 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16063	.5713 1528012959 .0276													
1100188	N 75-11-24	1340 50099 41.970 53.519 103.812 520-3-11HR	1357.9	0.0	79 2004.6	0.0 16.4844	.203 1338.9 W O		16						
	16033	.5716 1528012894 .0280													
1100208	N 75-11-10	2210 50083 41.985 53.505 103.791 520-3-03	1200.0	0.0	70 1998.7	0.0 16.4513	.202 1335.9 W O	15	17						
	520-3-01	154.9 0.0 9 0.0 0.0 0	0.0 0.0 0												
	15923	.5716 1528012055 .0278 L-GU51-01 A35													
1100217	N 75-11-08	1755 50083 41.973 53.507 103.798 520-3-05	1354.6	0.0	79 1998.9	0.0 16.4064	.200 1335.6 W O	26	18						
	16008	.5724 1528012353 .0281 L-GV51-01 B18													
1100226	N 75-12-05	1800 50083 41.963 53.505 103.803 520-3-17	1198.0	0.0	70 2009.1	0.0 16.4234	.174 1333.9 W O		19						
	533-3-03RS	154.9 0.0 9 0.0 0.0 0	0.0 0.0 0												
	15964	.5708 1528012192 .0274													
1100235	N 75-12-14	1600 50099 41.979 53.517 103.798 545-3-85RS	977.3	0.0	57 2005.0	0.0 16.4665	.154 1336.5 W O	32	20						
	533-3-04	224.0 0.0 13 520-3-09RS 154.2 0.0 9	0.0 0.0 0												
	16062	.5716 1528012924 .0280 L-GW52-01 A36													
1100244	N 75-11-07	1735 50083 41.967 53.505 103.791 520-3-05	1353.1	0.0	79 1999.4	0.0 16.3882	.200 1334.2 W O	36	21						
	15933	.5716 1528012067 .0278 L-GW51-01 B50													
1100253	N 75-12-13	2125 50099 41.955 53.507 103.810 550-3-85	1198.5	0.0	70 2007.5	0.0 16.3838	.199 1333.9 W O	12	22						
	520-3-09RS	154.4 0.0 9 0.0 0.0 0	0.0 0.0 0												
	16061	.5713 1528012911 .0281 L-GU52-02 B58													
1100262	N 75-12-13	1125 50083 41.958 53.510 103.798 550-3-85	1199.4	0.0	70 2004.2	0.0 16.3868	.198 1334.1 W O		23						
	131-3-01	67.8 0.0 4 131-3-02 85.9 0.0 5	0.0 0.0 0												
	16044	.5717 1528012920 .0280													

A.II.j. Example 10 - Statistical Evaluations of As-Built Fuel Rod Data (No Output Included)

Example 10 requests statistical evaluations of the fuel rod data for each type of LWBR fuel rod using the RODTST MODULE. Three passes through RODTST are called for (3 KALL RODTST statements). The first execution of RODTST will compute means and variances of the data and discard outliers (outside $\bar{x}_2 \pm 4 \sigma_2$). Since N.PRINT is not defined for the first two RODTST executions, only the summary of discarded data will be printed. The third execution of RODTST will result in a third set of means and variances and a summary edit including the estimates of the effects of as-built data on projected breeding (FIR).

INPUT FOR EXAMPLE 10

```
YHBB010,1,060,140,0001.ASBLT,BEAUD,U,P.
MERGE( I=DTRAN2)
MERGE( P=YHBB, I=ASBLT)
FETCH( P=YHBB, I=SEED.RODS.1,T=446,V=1,S=SEEDIN,D=1)
FETCH( P=YHBB, I=BLKT.RODS.2,T=446,V=1,S=BLKTIN,D=1)
FETCH( P=YHBB, I=PFBK.RODS.3,T=446,V=1,S=PFBKIN,D=1)
FETCH( P=YHBB, I=REFL.RODS.4,T=446,V=1,S=REFLIN,D=1)
CCREAD( DTCC,SCNOUT=OUTPUT,PART=OFF)
EOR
  JOB ASBLT
  CALL DTTOC(5HASBLT)
  N.EDIT=   1  2  3  4  5  6  7  8 11 12 13 14 15 16 21 22 23
+ 24 25 26 27 31 32
  N.DEVIATE=4.000
  KALL RODTST
  KALL RODTST
  N.DEVIATE=
  N.PRINT=3
  KALL RODTST
  STOP
  END
  END JOB
EOF
```

A.II.k. Example 11 - Perform ASBLT Loading Assurance Checks on Binary Rods
(No Output Included)

Example 11 uses the ASBLT MODULE to perform the 16 checks on fuel rod data described in Section A.I.e.3. This job requires the binary blend file in TAPE11, the composite blend file in TAPE13 and the three DATATRAN files containing fuel rod data for seed, standard blanket and power flattening blanket. The controlling lists for ASBLT in the example job request

1. The loading assurance option,
2. Rod types 11 through 27 (blanket and power flattening blanket),
3. That rods in modules be included,
4. That TAPE12 be written containing the rods which were rejected.

INPUT FOR EXAMPLE 11

```
YHBB011,1,015,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=BLENDS.BIN,T=33,V=1,F=S,S=TAPE11)
FETCH(P=PCAN,I=DINARY.ROD.IMR.ALL,T=33,V=1,F=S,S=TAPE13)
FETCH(P=YHBB,I=SEED.RODS.1,T=446,V=1,S=SEEDIN)
FETCH(P=YHBB,I=BLKT.RODS.2,T=446,V=1,S=BLKTIN)
FETCH(P=YHBB,I=PFBK.RODS.3,T=446,V=1,S=PFBKIN)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
COPY(TAPE12,OUTPUT)
EOR
      JOB ASBLT
      CALL DTTOC(5HASBLT)
      N.OPTION=ASSURE
      N.TYPES= 11 27
      N.MODULE=INCLUDE
      N.EDITREJ=YES
      KALL ASBLT
      STOP
      END
      END JOB
EOF
```

A.II.2. Example 12 - ASBLT Loading Assurance Checks for a Module (Including Portions of OutPut)

Example 12 shows the input required to perform the 16 loading assurance checks for seed module L-BB01-04. Since seed modules contain rod types 1 through 8, these types are requested in the N.TYPES list. The output for example 12, a portion of which is included after the input listing, contains only those seed rods installed in module L-BB01-04. The first five pages of output summarize key information concerning the 16 loading assurance checks.

INPUT FOR EXAMPLE 12

```
YHBB012,2,008,140,0001.ASBLT,BEAUD,U,P.
MERGE( I=DTRAN2)
MERGE( P=YHBB, I=ASBLT)
FETCH(P=YHBB, I=BLENDS.BIN, T=33, V=1, F=S, S=TAPE11)
FETCH(P=PCAN, I=BINARY.ROD.IMR.ALL, T=33, V=1, F=S, S=TAPE13)
FETCH(P=YHBB, I=SEED.RODS.1, T=446, V=1, S=SEEDIN)
FETCH(P=YHBB, I=BLKT.RODS.2, T=446, V=1, S=BLKTIN)
FETCH(P=YHBB, I=PFBK.RODS.3, T=446, V=1, S=PFBKIN)
CCREAD(DTCC, SCNOUT=OUTPUT, PART=OFF)
COPY(TAPE12, OUTPUT)
EOR
      JOB ASBLT
      CALL DTTTC(5HASBLT)
      N.OPTION=ASSURE
      N.TYPES=      1      8
      N.MODULE=*L-BB01-04*
      N.EDITREJ=YES
      KALL ASBLT
      STOP
      END
      END JOB
EOF
```

PARTIAL OUTPUT FROM EXAMPLE 12

YHBB012 78/02/27 DT2SYS BEAUD PG

1

THE FOLLOWING CHECKS ARE PERFORMED ON BINARY RODS --

1. VALIDITY OF ROD S/N
2. OVERALL STACK LENGTH FROM IN-MOTION RADIOGRAPHY AGAINST DRAWING REQUIREMENT
3. BINARY STACK LENGTH FROM IN-MOTION RADIOGRAPHY AGAINST DRAWING NOMINAL AND TOLERANCE
4. BINARY PLUS BOTTOM THORIA (SEED) OR BOTTOM THORIA (BLANKET) STACK LENGTH FROM IN-MOTION RADIOGRAPHY AGAINST DRAWING NOMINAL AND TOLERANCE
5. IDENTITY HOLE LOCATION FROM IN-MOTION RADIOGRAPHY AGAINST DRAWING NOMINAL AND INSPECTION TOLERANCE
6. STEM LENGTH FROM IN-MOTION RADIOGRAPHY AGAINST DRAWING NOMINAL AND INSPECTION TOLERANCE
7. LENGTHS OF FIRST 2 PELLETS AGAINST REQUIREMENTS
8. LENGTHS OF LAST 2 PELLETS AGAINST REQUIREMENTS
9. END CONNECTORS
10. OVERALL STACK LENGTH FROM IN-MOTION RADIOGRAPHY WITHIN 0.050 INCH OF ROD LOADING SHEET VALUE
11. BINARY STACK LENGTH FROM IN-MOTION RADIOGRAPHY WITHIN 0.050 INCH OF ROD LOADING SHEET VALUE
12. BINARY PLUS BOTTOM THORIA (SEED) OR BOTTOM THORIA (BLANKET) STACK LENGTH FROM IN-MOTION RADIOGRAPHY WITHIN 0.050 INCH OF ROD LOADING SHEET VALUE
13. BINARY LINEAR DENSITY FROM ROD LOADING SHEET MUST MEET LIMITS IN DIP-3304D-32, PAGE 16
14. THORIA LINEAR DENSITY FROM ROD LOADING SHEET MUST MEET LIMITS IN DIP-3304D-32, PAGE 15
15. FISSILE GRAMS/INCH IN BINARY STACK MUST MEET SPEC REQUIREMENTS
16. ROD FISSILE LOADING PRECISION MUST MEET REQUIREMENT

REQUIREMENTS FOR STACK LENGTHS, ID HOLE LOCATION, AND STEM LENGTH --

ROD TYPE	OVERALL STK MIN	BINARY STACK.....				..BOTTOM THORIA CONTROL..				IDENTITY HOLE LOCATION				STEM LENGTH.....			
		NOM	TOL	MIN	MAX	NOM	TOL	MIN	MAX	NOM	TOL	MIN	MAX	NOM	TOL	MIN	MAX
01	103.740	42.000	.282	41.718	42.282	51.780	.060	51.720	51.840	1.100	.030	1.070	1.130	2.400	.040	2.360	2.440
02	103.740	42.000	.282	41.718	42.282	50.920	.060	50.860	50.980	.200	.030	.170	.230	2.400	.040	2.360	2.440
03	103.740	56.000	.282	55.718	56.282	65.780	.060	65.720	65.840	1.200	.030	1.170	1.230	2.525	.040	2.485	2.565
04	103.740	70.000	.282	69.718	70.282	78.920	.060	78.860	78.980	.300	.030	.270	.330	2.525	.040	2.485	2.565
05	103.740	84.000	.368	83.632	84.368	93.780	.060	93.720	93.840	1.300	.030	1.270	1.330	2.650	.040	2.610	2.690
06	103.740	84.000	.368	83.632	84.368	92.920	.060	92.860	92.980	.400	.030	.370	.430	2.650	.040	2.610	2.690
07	103.740	42.000	.282	41.718	42.282	51.780	.060	51.720	51.840	1.100	.030	1.070	1.130	1.750	.040	1.710	1.790
08	103.740	42.000	.282	41.718	42.282	50.920	.060	50.860	50.980	.200	.030	.170	.230	1.750	.040	1.710	1.790
11	103.690	42.000	.325	41.675	42.325	53.500	.060	53.440	53.560	1.400	.030	1.370	1.430	4.225	.040	4.185	4.265
12	104.740	42.000	.325	41.675	42.325	51.500	.060	51.440	51.560	.500	.030	.470	.530	4.225	.040	4.185	4.265
13	103.690	70.000	.452	69.548	70.452	25.500	.060	25.440	25.560	1.500	.030	1.470	1.530	4.350	.040	4.310	4.390
14	104.740	56.000	.495	55.505	56.495	37.500	.060	37.440	37.560	.600	.030	.570	.630	4.350	.040	4.310	4.390
15	103.690	84.000	.495	83.505	84.495	11.500	.060	11.440	11.560	1.600	.030	1.570	1.630	4.475	.040	4.435	4.515
16	104.740	84.000	.452	83.548	84.452	9.500	.060	9.440	9.560	.700	.030	.670	.730	4.475	.040	4.435	4.515
21	103.690	42.000	.495	41.505	42.495	53.500	.060	53.440	53.560	1.700	.030	1.670	1.730	4.225	.040	4.185	4.265
22	104.740	42.000	.495	41.505	42.495	51.500	.060	51.440	51.560	.800	.030	.770	.830	4.225	.040	4.185	4.265
23	103.690	70.000	.410	69.590	70.410	25.500	.060	25.440	25.560	1.800	.030	1.770	1.830	4.350	.040	4.310	4.390
24	104.740	56.000	.452	55.548	56.452	37.500	.060	37.440	37.560	.900	.030	.870	.930	4.350	.040	4.310	4.390
25	103.690	84.000	.410	83.590	84.410	11.500	.060	11.440	11.560	1.900	.030	1.870	1.930	4.475	.040	4.435	4.515
26	104.740	84.000	.410	83.590	84.410	9.500	.060	9.440	9.560	1.000	.030	.970	1.030	4.475	.040	4.435	4.515
27	103.690	84.000	.452	83.548	84.452	11.500	.060	11.440	11.560	2.000	.030	1.970	2.030	4.600	.040	4.560	4.640

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PC 2

REQUIREMENTS FOR FIRST AND LAST 2 PELLETS --

ROD TYPES	MIN	MAX	.EXCLUDING.
01 - 08	.235	.575	.405 - .490
11 - 16	.235	.650	.410 - .565
21 - 27	.235	.480	. 0 - . 0

BINARY LINEAR DENSITY LIMITS --

LOW SEED	7.785 TO 7.954
HIGH SEED	7.825 TO 7.995
LOW BLKT	31.729 TO 32.479
MED BLKT	32.037 TO 32.794
HIGH BLKT	31.996 TO 32.752
LOW PFBK	27.042 TO 27.681
MED PFBK	27.099 TO 27.739
HIGH PFBK	27.115 TO 27.756

THORIA LINEAR DENSITY LIMITS --

SEED	7.989 TO 8.197
BLKT	31.813 TO 32.640
PFBK	26.686 TO 27.475

REQUIREMENTS FOR LOADING AND LOADING PRECISION --

ROD TYPE	FISSILE GRAMS/INCH....				PRECISION
	NOM	TOL	MIN	MAX	MAX 0/0
01	.3379	.0081	.3298	.3460	.25
02	.3379	.0081	.3298	.3460	.25
03	.3379	.0081	.3298	.3460	.25
04	.3379	.0081	.3298	.3460	.25
05	.4078	.0098	.3980	.4176	.25
06	.4078	.0098	.3980	.4176	.25
07	.3379	.0081	.3298	.3460	.25
08	.3379	.0081	.3298	.3460	.25
11	.3843	.0115	.3728	.3958	.25
12	.3843	.0115	.3728	.3958	.25
13	.6425	.0193	.6232	.6618	.25
14	.5325	.0160	.5165	.5485	.25
15	.5325	.0160	.5165	.5485	.25
16	.6425	.0193	.6232	.6618	.25
21	.4463	.0134	.4329	.4597	.25
22	.4463	.0134	.4329	.4597	.25
23	.7423	.0223	.7200	.7646	.25
24	.5418	.0163	.5255	.5581	.25
25	.7423	.0223	.7200	.7646	.25
26	.7423	.0223	.7200	.7646	.25
27	.5418	.0163	.5255	.5581	.25

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PG 3

ROD O.D. AND WALL THICKNESS SPECS

ROD TYPE	AVERAGE ROD O.D.				AVERAGE WALL THICKNESS			
	NOM	TOL	MIN	MAX	NOM	TOL	MIN	MAX
01	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
02	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
03	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
04	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
05	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
06	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
07	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
08	.3060	.0015	.3045	.3075	.0220	.0013	.0208	.0232
11	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
12	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
13	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
14	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
15	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
16	.5715	.0020	.5695	.5735	.0278	.0015	.0263	.0292
21	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
22	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
23	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
24	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
25	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
26	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277
27	.5275	.0020	.5255	.5295	.0262	.0015	.0248	.0277

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PG 4

CLASS	1. FILE WITH SYNONYM SEEDIN	RECALLED					
YHBB012	YHBB01D DT2SYS	BEAUD	77/08/31	10.04.23	1.000000	1.000000	34.000000
CLASS	2. FILE WITH SYNONYM BLKTIN	RECALLED					
YHBB012	YHBB07Z DT2SYS	BEAUD	77/09/07	15.05.45	2.000000	1.000000	34.000000
CLASS	3. FILE WITH SYNONYM PFBKIN	RECALLED					
YHBB012	YHBB07Z DT2SYS	BEAUD	77/09/07	15.07.02	3.000000	1.000000	34.000000

SUMMARY OF RODS WITH ACCEPTED DSR-S OR MRT-S FOR ASBLT REJECT CONDITIONS
OR ACCEPT VIA ENGINEERING NOTICE (CODE D)

ROD S/N	CONDITION	ASBLT REJECT(S)	ACCEPTED
0318068		4	
0608625		2	
0413707		3	
0320003		4	
0318647		2	4
0318629		4	
0318602		2	4
0318537		4	
0318528		4	
0318436		4	
0317565		4	
0315062		4	
0313284		4	
0217382		3	
0215375		2	
0211600		2	
0506646		4	
0620588		13	
0620276		13	
0617535		13	
0617517		13	
0617333		10	11 12
0300663		5	
0700035		3	
0605105		2	
0604225	III	2	
0500688		2	
0607359	III	4	
0508754	III	4	
0508029	III	2	4
0507746	III	4	
0507544	III	4	
0505757	III	4	
0505472	III	4	
0210500	III	4	
0202800	III	4	
0102562	III	4	
0102350	III	4	
0100252	III	4	
0700044		3	
0605361		3	
0601163		3	
0600265		3	

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PC 5

0506747	3
0505564	3
1208473	13
1205485	13
1203543	13
1107715	13
1106348	13
1105688	13
1102747	13
2517814	10 11
2516806	10 11
2516584	10 11
2516539	10

BINARY BLEND FILE VERSION

24-JAN-78 16:55 06.2 869 LAST SCNOFF: 16-JUL-76 09:22 14.8
STORAGE NEEDED FOR BLEND DATA 116156 125001 OCTAL

ALL 87(3110,316)

INTERPRETATION OF SINGLE-LETTER CHECK INDICATORS

DATA COLUMNS

S -- STACKING DATA AVAILABLE
N -- NULL STACKING DATA WAS INPUT (USUALLY IDENTIFIES A ROD SCRAPPED AT LOADING)
I -- IN-PROCESS RADIOGRAPHY DATA AVAILABLE
F -- FINAL RADIOGRAPHY DATA AVAILABLE

COLUMNS 1 THRU 16

A -- ACCEPT
N -- CHECK NOT APPLICABLE (EQUIVALENT TO ACCEPT)
D -- DSR OR MRT ACCEPT OR ACCEPT VIA ENGINEERING NOTICE
R -- REJECT
I -- INCOMPLETE DATA (CHECK CANNOT BE PERFORMED)

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

																		YHBB012	78/02/27	DT2SYS	BEAUD	PG	6			
ROD S/N	DATA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ACC/REJ/INC	MODULE SN	CELL	D T	T(W)	N	ROD S/N	LDC	DATE
0100032	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q48		-1.3	1	0100032	74/ 5/ 8	
0100124	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q63		-1.7	1	0100124	74/ 5/ 8	
0100133	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q58		1.2	1	0100133	74/ 5/ 8	
0100178	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q15		-0.7	1	0100178	74/ 6/20	
0100260	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q62		-0.9	1	0100260	74/ 5/ 8	
0100472	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q22		-1.3	1	0100472	74/ 6/20	
0100528	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q14		-1.1	1	0100528	74/ 6/20	
0100564	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q35		-1.5	1	0100564	74/ 6/21	
0100629	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q60		-0.4	1	0100629	74/ 5/ 8	
0100775	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q59		-2.5	1	0100775	74/ 5/ 8	
0100813	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q50		-1.3	1	0100813	74/ 5/ 8	
0100821	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q51		-3.3	*	1	0100821	74/ 5/ 8
0100858	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q24		-0.8	1	0100858	74/ 7/ 1	
0100876	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q10		.5	1	0100876	74/ 6/21	
0101049	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q71		-1.3	1	0101049	74/ 5/ 8	
0101085	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q34		3.4	*	1	0101085	74/ 5/ 9
0101132	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q70		1.6	1	0101132	74/ 5/ 8	
0101215	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q36		2.8	1	0101215	74/ 5/10	
0101224	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q38		1.6	1	0101224	74/ 5/ 9	
0101242	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q72		5.0	*	1	0101242	74/ 5/10
0101250	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q11		1.3	1	0101250	74/ 5/10	
0101269	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q50		3.4	*	1	0101269	74/ 5/10
0101316	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q46		1.9	1	0101316	74/ 5/10	
0102535	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q2		-0.3	1	0102535	74/ 6/20	
0103157	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q27		-0.5	1	0103157	74/ 7/ 2	
0103305	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q3		-1.2	1	0103305	74/ 7/ 2	
0103377	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q47		1.1	1	0103377	74/ 7/ 2	
0103478	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q12		.8	1	0103478	74/ 7/ 2	
0103487	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q26		.5	1	0103487	74/ 7/ 2	
0103516	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q23		-0.8	1	0103516	74/ 7/ 2	
0200030	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q45		-1.1	1	0200030	74/ 5/ 6	
0200343	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P69		.5	1	0200343	74/ 6/13	
0200453	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P68		-1.1	1	0200453	74/ 6/13	
0200563	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P37		-0.8	1	0200563	74/ 6/13	
0200580	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q44		-0.3	1	0200580	74/ 6/13	
0200729	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P51		1.5	1	0200729	74/ 5/ 2	
0201057	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q29		2.0	1	0201057	74/ 6/13	
0201350	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P41		3.1	*	1	0201350	74/ 5/ 2
0201369	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P40		-3.5	*	1	0201369	74/ 6/14
0201443	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	P70		.0	1	0201443	74/ 5/ 2	
0201460	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q57		.8	1	0201460	74/ 6/14	
0201517	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q69		-0.7	1	0201517	74/ 5/ 3	
0201562	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P39		.4	1	0201562	74/ 5/ 2	
0201589	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q56		-0.1	1	0201589	74/ 6/13	
0201737	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P38		-0.4	1	0201737	74/ 5/ 2	
0201746	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q40		-0.1	1	0201746	74/ 6/13	
0201773	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q68		.3	1	0201773	74/ 5/ 3	
0201874	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q53		.1	1	0201874	74/ 5/ 3	
0202139	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	Q52		1.1	1	0202139	74/ 5/ 3	
0202204	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P50		1.2	1	0202204	74/ 6/11	
0202258	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	P63		-0.4	1	0202258	74/ 5/ 6	
0202305	S F	A	A	A	A	A	A	A	A	N	A	A	A	A	A	A	A	ACC	L-BB01-04	P62		-0.6	1	0202305	74/ 5/ 6	
0202424	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	Q65		-0.9	1	0202424	74/ 5/ 6	
0202507	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P49		-0.5	1	0202507	74/ 6/13	
0202543	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P27		.0	1	0202543	74/ 5/ 3	
0202552	S F	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	ACC	L-BB01-04	P61		-0.1	1	0202552	74/ 6/13	

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

[illegible]

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PG 17

SUMMARY FOR ROD TYPE 01

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABNORMAL DSP																	0
TOTAL																	30

SUMMARY FOR ROD TYPE 02

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABNORMAL DSP																	0
TOTAL																	84

SUMMARY FOR ROD TYPE 03

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABNORMAL DSP																	0
TOTAL																	72

SUMMARY FOR ROD TYPE 04

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABNORMAL DSP																	0
TOTAL																	66

SUMMARY FOR ROD TYPE 05

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABNORMAL DSP																	0
TOTAL																	181

SUMMARY FOR ROD TYPE 06

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	ALL
COMPLETE-A	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
COMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INCOMPLETE-I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PARTIAL OUTPUT FROM EXAMPLE 12 (CONTINUED)

YHBB012 78/02/27 DT2SYS BEAUD PG 18

ABNORMAL DSP
TOTAL

150

SUMMARY FOR ROD TYPE 07

[illegible]

SUMMARY FOR ROD TYPE 08

[illegible]

SUMMARY FOR ALL ROD TYPES

[illegible]

A.II.m. Example 13 - Module Orientation Specification (No Output Included)

Example 13 shows the input needed to execute the ORIENT MODULE to assign a core sector location indicator to each rod in module L-GW51-01. The job accesses the blanket and power flattening blanket files which contain the rod data for type III module L-GW51-01, enters 36 into characters 8 and 9 of word 24 for the rods in module L-GW51-01, and then stores the rod data files. The digit 3 identifies L-GW51-01 as a type III module, and the digit 6 identifies L-GW51-01 as a module contained in sector 6.

INPUT FOR EXAMPLE 13

```
YHBB013,2,005,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
FETCH(P=YHBB,I=ASBLT,T=62,F=S,S=ASBLT)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=BLKT.RODS.2,T=446,V=1,S=BLKTIN,D=4)
FETCH(P=YHBB,I=PFBK.RODS.3,T=446,V=1,S=PFBKIN,D=4)
STORE(I=BLKT.RODS.2,T=446,V=1,S=BLKTOUT,D=1N)
STORE(I=PFBK.RODS.3,T=446,V=1,S=PFBKOUT,D=1N)
CCREAD(DTCC,PART=OFF)
EOR
      JOB ASBLT
      CALL DTT0C(5HASBLT)
      N.ORIENT=*L-GW51-01*,6
      KALL ORIENT
      STOP
      END
      END JOB
EOF
```


A.II.n. Example 14 - Fuel Rod Disposition Codes (No Output Included)

Example 14 lists the input required to change the fuel rod disposition codes for specific fuel rods. Cards 3 and 4 in the second input record (DATATRAN scanner input) request that the DATATRAN fuel rod data lists for all four regions (seed, standard blanket, power flattening blanket and reflector blanket) be retrieved. The first N.CODES list identifies the following disposition codes to be assigned to specific rods:

1. G - end of life assay gage rod
2. T - test rod
3. S - unloaded rod.

The N.G, N.T and N.S lists identify the rods whose disposition codes are to be changed to G, T and S respectively. For example, list N.G(1) (applies to type 1 rods) specifies disposition code G for rods 0100500, 0101114 and 0101334. The N.FIX list is used to correct an earlier erroneous disposition code which identified one of the "G" rods as unloaded. The first execution of NEWROD modifies the disposition codes; the second edits the disposition codes for all rods.

INPUT FOR EXAMPLE 14

YHBB014,2,008,140,0001.ASBLT,BEAUD,U,P.

MERGE(I=DTRAN2)

MERGE(P=YHBB,I=ASBLT)

FETCH(I=SEED.RODS.1,T=446,S=SEEDIN,D=4)

STORE(I=SEED.RODS.1,T=446,S=SEEDOUT,D=1N)

FETCH(I=BLKT.RODS.2,T=446,S=BLKTIN,D=4)

STORE(I=BLKT.RODS.2,T=446,S=BLKTOUT,D=1N)

FETCH(I=PFBK.RODS.3,T=446,S=PFBKIN,D=4)

STORE(I=PFBK.RODS.3,T=446,S=PFBKOUT,D=1N)

FETCH(I=REFL.RODS.4,T=446,S=REFLIN,D=4)

STORE(I=REFL.RODS.4,T=446,S=REFLOUT,D=1N)

CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)

COPY(TAPE12,OUTPUT)

EOR

JOB ASBLT

CALL DTTOC(5HASBLT)

N.FETCH=1,2,3,4

KALL GETAFM

C

N.CODES=G,T,S

N.G(1)=RODS,500,1114,1334

N.G(2)=RODS,168,655,6263

N.G(3)=RODS,1754,5777,7748,728,2330,8702

N.S(3)=RODS,1130

N.G(4)=RODS,1863,8461,14466,204

N.G(5)=RODS,11165,27674,34366,708

N.T(5)=RODS,643

N.G(6)=RODS,17517,20276,20588

N.T(6)=RODS,1374

N.G(11)=RODS,713,2242,3425,4588,4780,6128,8108

N.G(12)=RODS,1049,4405,6017

N.S(12)=RODS,3097

N.G(13)=RODS,545,6254,6410

N.G(14)=RODS,11810,11856,12359

N.S(14)=RODS,5850

N.G(15)=RODS,1827,4034,10240,12019

N.S(15)=RODS,6472

N.G(16)=RODS,13623,13659,13834,14144

N.G(21)=RODS,117,153,869,1501,3022,3085,3140

N.G(22)=RODS,2628,3407,3443

N.G(23)=RODS,1325,2562,3222

N.S(23)=RODS,142

N.G(24)=RODS,2626,3174,3414

N.G(25)=RODS,452,553,2616,3128

N.S(25)=RODS,3539,6015,6482,8114,11416,11755,17603,18748

N.S(26)=RODS,11543,13265,13384,13889,14888,15355,17481,18435,18554

X,20085,20563,20186

N.G(27)=RODS,634,468,1624,1669

N.G(31)=RODS,10716,6718,8707,2143,4343,1456,27378

N.G(32)=RODS,2335,25701,16204

N.FIX=YES

KALL NEWROD

N.CODES=EDIT

KALL NEWROD

STOP

END

END JOB

EOF

A.II.o. Example 15 - Certification Listing for a Module (No Output Included)

Example 15 lists the input required to perform the certification checks and to produce the certification listing of fuel rods for seed module L-BB01-16 using CRTVER. As described in Section A.I.2, CRTVER requires three input files and a master deck of fuel rods assigned to a module. The 5th card in the control card record of example 15 retrieves the ASBLT seed fuel rod file required by the ASBLT option of CRTVER. The 4th and 7th cards in the control card record produce the LDVER file required by the LDVER option of CRTVER. The 6th and 8th control cards produce the MODDSR file required by the MODDSR option of CRTVER. The second input record controls the DATATRAN portion of the job. The controlling list for CRTVER (N.OPTION) requests that a final certification listing be generated using FORMA to read the master decks. The master deck, which was generated during the rod selection phase of module L-BB01-16, must be placed in the third input record. The deck is only partially listed in example 15. The rod installation master deck for module L-BB01-16 was generated in three sections as follows:

1. On May 19, 1976 installation sequences 1-100 were defined
2. On May 21, 1976 installation sequences 101-331 were defined
3. On May 27, 1976 installation sequences 332-619 were defined.

INPUT FOR EXAMPLE 15

```

YHBB015,3,004,140,0001.ASBLT,BEAUD,U,P.
MERGE(I=DTRAN2)
MERGE(P=YHBB,I=ASBLT)
FETCH(P=YHBB,I=PN83.MOD,T=34,F=S,S=TEMP1)
FETCH(P=YHBB,I=SEED.RODS.1,T=446,S=SEEDIN)
FETCH(P=DGCD,I=BB0116.SRT,T=34,F=S,S=TEMP2)
DECCDC(I=TEMP1,O=TAPE21,D=S)
DECCDC(I=TEMP2,O=TAPE23,D=S)
CCREAD(DTCC,SCNOUT=OUTPUT,PART=OFF)
COPY(TAPE24,OUTPUT)

```

```

EOR
      JOB ASBLT
      N.OPTION=FORMA,REPORT
      KALL CRTVER
      STOP
      END
      END JOB

```

```

EOR
19-MAY-76 09:38 27.7
L-BB01-16      A
      1100 SEED.ALL
      1 5A1 0535715
      2 6B1 0618204
      3 6B2 0613622

```

```

      .
      .
      .
      98 5C7 0532745
      99 5C8 0505537
      100 5C9 0537776
      21-MAY-76 10:25 19.5
      L-BB01-16      B
      101331 SEED.ALL
      101 5C100508644
      102 5C110537419
      103 5C120521644

```

```

      .
      .
      .
      329 5L580520012
      330 5L590500203
      331 5L600535219
      27-MAY-76 13:21 58.5
      L-BB01-16      C
      332619 SEED.ALL
      332 4M1 0416437
      333 4M2 0416253
      334 4M3 0415584

```

```

      .
      .
      .
      617 7P730705378
      618 7Q660705654
      619 7Q670705562
      EOF

```

A.III. Special DATATRAN Jobs Using the ASBLT Data Base

Sections I and II of Appendix A described the DATATRAN MODULES which comprise the ASBLT system and presented typical examples of the use of the ASBLT MODULES. During LWBR fabrication, needs arose to perform calculations and prepare data displays which were outside the framework of the ASBLT system. These were generally as-built data evaluations and displays which were done infrequently and, while important at the time, were not justified as permanent functions of ASBLT. DATATRAN and the ASBLT fuel rod data base were convenient to use for these special purpose as-built data evaluations and displays. Some of the more important special jobs will be described in this section.

A.III.a. Correction of Rod Fuel Weight Data for Balance Bias

During one of the fuel rod loading campaigns, a steadily increasing bias developed over time in a balance used to weigh fuel pellet stacks. Inspection procedures required that balances be checked each shift by obtaining balance readings for known weights. During the campaign the check readings for one balance gradually drifted, approximately linearly with time, yet remained within the Detailed Inspection Procedure (DIP) limits for balance calibration. Upon evaluation of the stack weight data recorded for the rods loaded during the campaign, it was concluded that a time-dependent balance bias correction should be made to the weight data stored in the ASBLT files for the rods affected. A special DATATRAN job was programmed to assist in the evaluation and to compute and file balance bias corrections for the rods loaded during the period when the balance bias drifted. Subsequently the bias limits allowed for the balances were reduced and this problem did not recur.

A.III.b. Edit of Binary Blends Used in Modules

To assist in core certification, a DATATRAN job was programmed to read the ASBLT fuel rod files, locate each rod installed in a module, record the identities of the binary blends in those rods and produce a listing by blend identity designating the modules which contained each blend. This listing was used to focus attention on the core blends at the time of certification. A similar job was programmed listing thorium blends in modules by using the ASBLT files and a file maintained in a separate system. Both of these special uses of DATATRAN and the ASBLT data base saved numerous man-hours of effort searching through inspection records to compile the needed lists.

A.III.c. Edits of Selected Data for Rods in a Module

To assist in the development of an end-of-life proof of breeding assay strategy, a DATATRAN job was programmed for producing a list of rods in a specified module showing the cell location, binary stack length, fissile content and fissile loading precision of each rod. Two versions of this job were programmed - one for seed and blanket modules and one for reflector modules. Variations of these jobs were programmed for other applications. One of special interest during core certification involved producing an edit of fuel rod diameters in high heat flux regions of a module. This edit was used to confirm that the as-built modules had sufficient flow area in limiting core locations.

A.III.d. Minimum and Maximum Rod Fissile Loading and Precision

A simple DATATRAN job was programmed to search through the ASBLT fuel rod files to locate the minimum and maximum fissile loading per unit length and the minimum and maximum fissile loading precision by binary fuel zone. These data were requested for rod certification for core rods alone and for core rods plus spares.

A.III.e. Fuel Inventory Adjustment

At the time a binary pellet blend was released for loading into rods, the inspection data for the blend were not yet complete for use in computing rod loadings. Therefore, after a rod was loaded with fuel, its uranium, uranium-233 and thorium contents were estimated based upon preliminary blend data. The rod was then transferred to a vault storage area and the rod serial number and corresponding vault location were input to a data file. This data file and the ASBLT rod files were used as input for a DATATRAN job which was programmed to calculate the as-built uranium, uranium-233 and thorium content of fuel rods in storage vaults at the time of inventory. The loading data was then stored in a master data file, to be used during the next inventory. This system eliminated much of the paperwork involved during the semiannual physical inventories.

The above examples of special DATATRAN jobs outside the framework of the ASBLT system demonstrate the flexibility of a modular programming system like ASBLT and a language like DATATRAN. In the above examples, the MODULES START and GETAFM were always used to initialize the DATATRAN lists defining LWBR and to retrieve the fuel rod data. Having done this, any special purpose operations

on the data were possible. It is anticipated that the proof-of-breeding phase of LWBR, when the expended core is dismantled and rods are examined, will make further use of the ASBLT data base and of the ASBLT system.

APPENDIX B - FUEL ROD LOADING PRECISION EQUATIONS

Appendix B presents the equations used to compute the rod fissile loading precision; that is, the uncertainty in rod fissile loading in relative percent at the two-sigma level (two times the standard deviation of the fissile loading uncertainty). The terms in the equations are defined in the glossary at the end of Appendix B.

The rod loading precision for a rod loaded with pellets from a single parent blend ($j=1$) is

$$PR = 2(\sigma\%)_{\hat{R}_j} \quad (1)$$

where

$$(\sigma\%)_{\hat{R}_j}^2 = (\sigma\%)_{W_j}^2 + (\sigma\%)_{I_j}^2 + (\sigma\%)_{T_{U_j}}^2 + \frac{(\sigma\%)_{P_j}^2}{N_j} \quad (2)$$

and

$$(\sigma\%)_W = \begin{cases} 0.05, & \text{if } W_j \geq 150.0 \\ \frac{7.5}{W_j}, & \text{if } W_j < 150.0 \\ \text{input, if an engineering change was made to} \\ \text{the binary weight} \end{cases} \quad (3)$$

If a rod is loaded with pellets from more than one parent blend ($j=1, \dots, 4$) the rod loading precision is

$$PR = 2(\sigma\%)_{\hat{R}} + B \quad (4)$$

where

$$B = \begin{cases} \text{input, if an engineering change was made to the binary weight and} \\ \text{if a bias correction was required for this rod} \\ 0.0, & \text{otherwise} \end{cases}$$

and

$$(\sigma\%)_{\hat{R}}^2 = \sum_j \frac{(\sigma\%)_{\hat{R}_j}^2}{\left(1 + \frac{R - R_j}{R_j}\right)^2} + 2 \left(\sum_j < \sum_i \frac{a_j a_i (\sigma\%)_{\text{cal}_i} (\sigma\%)_{\text{cal}_j}}{R_j R_i \left(\frac{1}{R_j} + \frac{1}{R_i} + \frac{R - R_j - R_i}{R_j R_i}\right)^2} \right) \quad (5)$$

where

$$R_j = 0.0001 \hat{\mu}_j W_j (U_j^{233} + U_j^{235}) \quad (6)$$

and

$$R = \sum_j R_j \quad (7)$$

The following equations are used to calculate rod loading precision for rods loaded with pellets from composite blends. There are three types of composite blends:

typical	(c = τ):	$n_i = HQ_i + OT_i$
high quality	(c = HQ):	$n_i = HQ_i + \hat{Q}(OT_i)$
regular	(c = r):	$n_i = OT_i(1 - \hat{Q})$

where

$$\hat{Q} = \frac{N_U - N_I}{N_T - N_I} \quad (8)$$

and

$$N_T = N_O + N_U \quad (9)$$

$$N_I = \sum_i HQ_i \quad (10)$$

$$f_{U_i}^{\hat{}} = \frac{(U_i^{233} + U_i^{235}) \hat{\mu}_i}{100.0} \quad (11)$$

$$f_{U_c}^{\hat{}} = \frac{\sum_i n_i f_{U_i}^{\hat{}}}{\sum_i n_i} \quad (12)$$

$$n'_c = \frac{\sum_i n_i - \sum_i \left(\frac{n_i}{k-1} \right)^2 / \sum_i \left(\frac{n_i}{k-1} \right)}{k-1} \quad (13)$$

$$MS(b)_c = \frac{\sum_i n_i (\hat{f}_{U_i} - \hat{f}_{U_c})^2}{k - 1} \quad (14)$$

$$(\sigma\%)_{p_c}^2 = \frac{MS(b)_c}{n'_c (\hat{f}_{U_c}/100)^2} + \left(1 - \frac{1}{n'_c}\right) \frac{\sum_i n_i \hat{f}_{U_i}^2 (\sigma\%)_{p_i}^2}{\hat{f}_{U_c}^2 \sum_i n_i} \quad (15)$$

$$(\sigma\%)_{\hat{f}_{U_i}}^2 = (\sigma\%)_{T_{U_i}}^2 + (\sigma\%)_{I_i}^2 \quad (16)$$

$$\begin{aligned} (\sigma\%)_{\hat{f}_{U_c}}^2 = & \frac{1}{\hat{f}_{U_c}^2 \left(\sum_i n_i\right)^2} \left[\sum_i \left(n_i \hat{f}_{U_i}\right)^2 (\sigma\%)_{\hat{f}_{U_i}}^2 \right. \\ & + 2 \sum_{i < j} \sum n_i n_j \hat{f}_{U_i} \hat{f}_{U_j} a_i a_j (\sigma\%)_{cal_i} (\sigma\%)_{cal_j} \\ & \left. + 100^2 \sigma_{\hat{Q}}^2 \left[\sum_i OT_i \left(\hat{f}_{U_i} - \hat{f}_{U_c}\right) \right]^2 \right] \end{aligned} \quad (17)$$

where

$$\sigma_{\hat{Q}}^2 = \begin{cases} \frac{\sum_i OT_i^2}{\left(\sum_i OT_i\right)^2} \sigma_b^2, & \text{for high quality and regular blends} \\ 0, & \text{for typical blends} \end{cases} \quad (18)$$

0, for typical blends

$$PR = 2(\sigma\%)_{\hat{R}_c} + b(\%)_{max} + B_e \quad (19)$$

where: for a single composite blend

$$(\sigma\%)_{\hat{R}_c}^2 = (\sigma\%)_W^2 + (\sigma\%)_{f\hat{U}_c}^2 + (\sigma\%)_{p_c}^2 / N \quad (20)$$

and: for a rod loaded with a composite and a parent blend

$$\begin{aligned} (\sigma\%)_{\hat{R}_c}^2 = & \frac{1}{(W_1 f\hat{U}_1 + W_c f\hat{U}_c)^2} \left[(W_1 f\hat{U}_1)^2 \left[(\sigma\%)_{f\hat{U}_1}^2 + (\sigma\%)_{W_1}^2 + \frac{(\sigma\%)_{p_1}^2}{N_1} \right] \right. \\ & + (W_c f\hat{U}_c)^2 \left[(\sigma\%)_{f\hat{U}_c}^2 + (\sigma\%)_{W_c}^2 + \frac{(\sigma\%)_{p_c}^2}{N_c} \right] \\ & \left. + 2 W_1 W_c f\hat{U}_1 f\hat{U}_c a_1(\sigma\%)_{cal_1} \left[\frac{\sum_i n_i f\hat{U}_1 a_i(\sigma\%)_{cal_i}}{\sum_i n_i} \right] \right] \quad (21) \end{aligned}$$

NOTE: If a parent blend i in the composite blend is the same as parent blend 1, then replace $a_1(\sigma\%)_{cal_1} a_i(\sigma\%)_{cal_i}$ with $(\sigma\%)_{T_{U_1}}^2$.

and: for a rod loaded with (1) a typical composite blend with a regular or high quality blend, (2) the HQ & REG portion of a subdivided composite blend, or (3) two typical blends.

$$\begin{aligned} (\sigma\%)_{\hat{R}_c}^2 = & \frac{1}{(W_1 f\hat{U}_{c_1} + W_2 f\hat{U}_{c_2})^2} \left[(W_1 f\hat{U}_{c_1})^2 \left[(\sigma\%)_{f\hat{U}_{c_1}}^2 + (\sigma\%)_{W_1}^2 + \frac{(\sigma\%)_{p_{c_1}}^2}{N_1} \right] \right. \\ & + (W_2 f\hat{U}_{c_2})^2 \left[(\sigma\%)_{f\hat{U}_{c_2}}^2 + (\sigma\%)_{W_2}^2 + \frac{(\sigma\%)_{p_{c_2}}^2}{N_2} \right] \\ & \left. + 2 W_1 W_2 f\hat{U}_{c_1} f\hat{U}_{c_2} \text{Cov}(f\hat{U}_{c_1}, f\hat{U}_{c_2})\% \right] \quad (22) \end{aligned}$$

where:

$$\text{Cov}(f_{\hat{U}_{c_1}}, f_{\hat{U}_{c_2}})_{\%} = \frac{\sum_i \sum_{i'} n_i n_{i'} f_{\hat{U}_i} f_{\hat{U}_{i'}} \text{Cov}(f_{\hat{U}_i}, f_{\hat{U}_{i'}})}{\left(\sum_i n_i\right) \left(\sum_{i'} n_{i'}\right)} \quad (23)$$

and:

$$\text{Cov}(f_{\hat{U}_i}, f_{\hat{U}_{i'}})_{\%} = \begin{cases} (\sigma\%)^2_{f_{\hat{U}_i}} & \text{if } i = i' \\ a_i a_{i'} (\sigma\%)_{\text{cal}_i} (\sigma\%)_{\text{cal}_{i'}} & \text{if } i \neq i' \end{cases} \quad (24)$$

$$B_e = \begin{cases} 0.0, & \text{if the rod is loaded with pellets from composite blends other than 900-l-01} \\ \frac{W_1 B_{c_1} + W_2 B_{c_2}}{W_1 + W_2}, & \text{if the rod is loaded with pellets from composite blend 900-l-01} \end{cases} \quad (25)$$

$$b(\%)_{\max} = \begin{cases} 0.0 & \text{if the pellets are randomized} \\ \frac{100 |f_{\hat{U}_c} - f_{\hat{U}_i}|_{\max_i}}{f_{\hat{U}_c}}, & \text{if the pellets for a single composite blend are not randomized,} \\ \frac{100 \left| W_1 (f_{\hat{U}_{c_1}} - f_{\hat{U}_{i_1}}) + W_2 (f_{\hat{U}_{c_2}} - f_{\hat{U}_{i_2}}) \right|_{\max_{i,i'}}}{W_1 f_{\hat{U}_{c_1}} + W_2 f_{\hat{U}_{c_2}}}, & \text{if the pellets for two composite blends are not randomized} \end{cases} \quad (26)$$

GLOSSARY OF TERMS

a	a weighting value for combining PAG and chemistry estimates of total U w/o from which the correlation between blends due to the common calibration curve of the PAG can be determined	Blend file word 32
B	the bias added to the rod loading precision if an engineering change was made to the binary weight	DATATRAN list input
B _e	the bias added to the rod loading precision for rods loaded with pellets from composite blend 900-1-01	Eq. 25
B _c	bias for blend 900-1-01	Composite blend file word 4
b(%) _{max}	the maximum absolute bias of a rod loading estimate using pellets from a composite blend that has not been randomized	Eq. 26
$Cov(\hat{f}_{U_i}, \hat{f}_{U_i})\%$	the covariance between the fissile loading estimates of two composite blends	Eq. 24
$Cov(\hat{f}_{U_{c_1}}, \hat{f}_{U_{c_2}})\%$	the covariance between the fissile loading estimates of two composite blends	Eq. 23
$\hat{f}_{U_i}, \hat{f}_{U_{c_i}}$	the estimate of the mean fissile w/o uranium for a parent/composite blend	Eq. 11, 12
HQ	the number of known high quality pellets of a parent blend in a composite blend before reinspection	composite blend file
k	the total number of parent blends in a composite	composite blend file
$\hat{\mu}_i$	U-total w/o for a blend	blend file word 28
MS(b)	the mean square for variation between blends	Eq. 14
n _i	the total number of pellets from a parent blend in a composite blend	composite blend file

GLOSSARY OF TERMS (Cont)

n'	an effective average number of pellets per blend for use in estimating pellet variance within a composite blend	Eq. 13
N	binary zone stacked pellet quantity	rod file words 16-19
N_O	the number of non-high quality pellets in a composite blend after reinspection	composite blend file word 6
N_I	the number of pellets known to be of high quality before reinspection	Eq. 10
N_U	the number of high quality pellets in a composite blend after reinspection	composite blend file word 5
N_T	the total number of pellets in the group	Eq. 9
OT_i	the number of pellets of a parent blend not identified as high quality before reinspection of composite blend pellets	composite blend file
PR	rod loading precision	Eq. 1, 4, 19
$\hat{Q}$	the after reinspection estimate of the proportion of high quality pellets from a parent blend that were not previously identified as being high quality	Eq. 8
R	the total weight in grams of fissile uranium in a rod	Eq. 7
R_j	the weight in grams of fissile uranium in a partial stack of binary pellets	Eq. 6
σ_b^2	the variance of the blend-to-blend differences in the proportion of high quality pellets resulting from the grinding process	0.00605673-low blkt 0.05917086-med. blkt 0.00196915-high blkt
$\hat{\sigma}_Q^2$	the variance of $\hat{Q}$	Eq. 18
$(\sigma\%)_{cal_j}^2$	the relative variance due to uncertainty in the PAG calibration curve for a blend	blend file word 21

GLOSSARY OF TERMS (Cont).

$(\sigma\%)_{f_{U_i}}^2, (\sigma\%)_{f_{U_{c_1}}}^2$	the variance of the blend mean fissile content for a parent/composite blend	Eq. 16, 17
$(\sigma\%)_{I_j}^2$	the relative variance of the estimated isotopic correction value for a blend	constant $(0.03)^2$
$(\sigma\%)_{p_j}$	the relative (to $\hat{\mu}$) variance of pellet-to-pellet differences within two parent blends	blend file word 20
$(\sigma\%)_{p_c}^2$	the relative variance of pellet-to-pellet differences within a composite blend	Eq. 15
$(\sigma\%)_{\hat{R}}^2$	the relative variance of the fissile content of a rod loaded with pellets from two or more parent blends	Eq. 5
$(\sigma\%)_{\hat{R}_c}^2$	the relative variance of the fissile content of a rod loaded from one or more composite blends	Eq. 20, 21, 22
$(\sigma\%)_{\hat{R}_j}^2$	the relative variance of the fissile content of a rod or partial stack of pellets from a single parent blend	Eq. 2
$(\sigma\%)_{T_{\hat{U}_j}}$	the relative standard deviation of $\hat{\mu}_j$	blend file word 29
$(\sigma\%)_{W_j}^2$	the relative variance of stack weight	Eq. 3
U_i^{233}	U^{233} w/o for a blend	blend file word 5
U_i^{235}	U^{235} w/o for a blend	blend file word 7
W_j	binary zone stack weight	rod file words 12-15

APPENDIX C - COMPOSITION LOADING PRECISION EQUATIONS

The composition fissile loading is calculated using the following equation:

$$\hat{C} = \sum_{i=1}^{NBB} \sum_{t=1}^{NRL} \sum_{j=1}^{NR} W_{itj} f_{U_i}^{\hat{}} + \sum_{c=1}^{NCB} \sum_{t=1}^{NRL} \sum_{v=1}^{NR} W_{ctv} f_{U_c}^{\hat{}}$$

where

$\hat{C}$ = the estimated composition fissile loading (grams)

NBB = the number of binary blends used in the composition

NRL = the number of different rod lengths in the composition (for example, the low zone seed composition has three different rod lengths; 42", 56", 70", so NRL would equal 3)

NR = the number of rods of a given rod length in the composition

NCB = the number of composite blends used in the composition

W_{itj} = the stack weight (grams) of all pellets in rod j of rod length t from binary blend i

W_{ctv} = the stack weight (grams) of all pellets in rod v of rod length t from composite blend c

$f_{U_i}^{\hat{}}$ = the estimated proportional fissile weight of binary blend i

$$= \left(\frac{U_i^{233} + U_i^{235}}{100.0} \right) \frac{T_{U_i}}{100}$$

where

U_i^{233} = the U^{233} weight percent of binary blend i

U_i^{235} = the U^{235} weight percent of binary blend i

T_{U_i} = the total weight percent of all uranium in binary blend i

$f_{U_c}^{\hat{}}$ = the estimated proportional fissile weight of composite blend c

$$= \frac{\sum_{i=1}^{NBB} N'_{ic} f_{U_i}^{\hat{}}}{N'_{ic}}$$

where

$N'_{ic} = N_{ic}$ = the initial number of pellets from binary blend i in composite blend c for "normal" composite blends

$= n_{ic} + m_{ic} \hat{Q}$ = the estimated initial number of high quality (HQ) pellets from binary blend i in composite blend c where composite blend c originated from the high quality part of a special composite blend
 $= m_{ic} (1 - \hat{Q})$ = the estimated initial number of non-high quality (non-HQ) pellets from binary blend i in composite blend c where composite blend c originated from the non-high quality part of a special composite blend

where

n_{ic} = the number of HQ pellets in binary blend i before reinspection
 m_{ic} = the number of non-HQ pellets in binary blend i before reinspection
 $\hat{Q} = \frac{N_{HQ_After} - N_{HQ_Before}}{N_{non-HQ_Before}}$

and

N_{HQ_After} = the total number of HQ pellets after reinspection
 N_{HQ_Before} = the total number of HQ pellets before reinspection
 N_{non-HQ_Before} = the total number of non-HQ pellets before reinspection

The variance in the composition fissile loading is calculated using the following equation:

$$\begin{aligned}
 \sigma_{\hat{c}}^2 = & \sum_i K_i^2 f_{U_i}^2 (\sigma\%)_{f_{U_i}}^2 \\
 & + \sum_{\substack{i \\ i \neq i'}} \sum_{\substack{i' \\ i' \neq i}} K_i K_{i'} f_{U_i} f_{U_{i'}} a_{i,i'} (\sigma\%)_{cal_i} (\sigma\%)_{cal_{i'}} \\
 & + \sum_i \left(\sum_t \sum_j W_{itj}^2 (\sigma\%)_{w_j}^2 \right) f_{U_i}^2 + \sum_c \left(\sum_t \sum_v W_{ctv}^2 (\sigma\%)_{w_v}^2 \right) f_{U_c}^2 \\
 & + \sum_i \left(\sum_t \sum_j \frac{W_{itj}^2}{N_{itj}} \right) f_{U_i}^2 (\sigma\%)_{P_i}^2
 \end{aligned}$$

$$+ \sum_c \left(\sum_t \sum_v \frac{W_{ctv}^2}{N_{ctv}} \right) f_{U_c}^2 (\sigma\%)_{P_c}^2 + \sum_c \left(\sum_t \sum_v W_{ctv} \right)^2 \frac{f_{U_c}^2}{N_c} \left[\sum_i P_{ic} (b\%)_{ic}^2 \right]$$

where

$$K_i = \sum_c \sum_j W_{itj} + \sum_c \left(\sum_t \sum_v W_{ctv} \right) P_{ic}$$

$$P_{ic} = \frac{N_{ic}}{\sum_i N_{ic}}$$

$$(\sigma\%)_{f_{U_i}}^2 = (\sigma\%)_{T_{U_i}}^2 + (\sigma\%)_{I_i}^2 = \text{the estimated relative variance of the proportional fissile content of binary blend } i$$

$$(\sigma\%)_{T_{U_i}}^2 = \text{the estimated relative variance of the total uranium content of binary blend } i$$

$$(\sigma\%)_{I_i}^2 = \text{the assumed relative variance of the isotopic content of binary blend } i$$

$$= (0.03)^2$$

$$a_i = \text{a measure of the information on } f_{U_i} \text{ that is due to the Pellet Assay Gage (PAG) data as compared to chemistry data}$$

$$(\sigma\%)_{cal_i} = \text{the relative standard deviation of the uncertainty in the PAG calibration curve for binary blend } i$$

$$(\sigma\%)_{W_j}^2 = \text{the relative standard deviation of a stack weighing (see Equation (3) of Appendix A) for rod } j$$

$$(\sigma\%)_{P_i} = \text{the relative pellet-to-pellet loading uncertainty of binary blend } i$$

$$(\sigma\%)_{P_c} = \text{the relative pellet-to-pellet loading uncertainty of composite blend } c \text{ (see Equations (13), (14) and (15) of Appendix B)}$$

$$N_c = \text{the total number of pellets from composite blend } c \text{ that actually were loaded into the core}$$

$$(b\%)_{ic} = 100. \left(\frac{f_{\hat{U}_i} - f_{\hat{U}_c}}{f_{\hat{U}_c}} \right) = \text{the relative difference between an estimated parent blend proportional fissile weight and the estimated composite blend proportional fissile weight.}$$

The precision is defined to be equal to

$$PR = 2(\sigma\%)_{\hat{c}} + (b\%)_{\text{composition}}$$

where

$$(\sigma\%)_{\hat{c}} = 100. (\sigma_{\hat{c}} / \hat{c})$$

$(b\%)_{\text{composition}}$ = a relative bias resulting from the inclusion in a given composition of rods made from non-randomized composite blends

$$= \sum_{r=1}^{NRC} \text{bias}_r$$

where

NRC = the total number of such rods in the composition

bias_r = the total bias in rod r due to all non-randomized composite blends in the rod

$$= \sum_{c=1}^{NNC} b_{\max_c} W_{rc}$$

NNC = the number of non-randomized composite blends in rod r

W_{rc} = the stack weight of pellets made from non-randomized composite blend c in rod r

$$b_{\max_c} = \left| f_{\hat{U}_c} - f_{\hat{U}_i} \right|_{\max}$$

= the maximum difference between the fissile weight of non-randomized composite blend c and all binary blends i which make up the composite blend

COMPUTER PROGRAM ABSTRACT

1. Program Name (and Title): ASBLT (LWBR As-Built Fuel Loading Analysis).
2. Computer and Languages: CDC-6600, DATATRAN, FORTRAN IV.
3. Problem Solved: ASBLT (Reference (a)) is a computer program consisting of DATATRAN MODULES (Reference (b)) which was used during the manufacturing phase of LWBR to collect and evaluate as-built data. The program was part of the LWBR fuel rod inspection process and produced sections of module assembly certification reports. ASBLT used fuel pellet, fuel rod and module assembly data to compute core inventories and to supply input to nuclear design programs for as-built core calculations.
4. Method of Solution: Fuel pellet blend data, fuel rod data and module assembly data are entered into the system as DATATRAN lists or system files. Inspection data are checked for consistency and against specification requirements. Average properties are computed by composition for use in nuclear design programs. The DATATRAN MODULES contained in the system are:
 - a. START - initialize the ASBLT system.
 - b. PUTAFM - store DATATRAN fuel rod files.
 - c. GETAFM - retrieve DATATRAN fuel rod files.
 - d. NEWROD - add new data to DATATRAN lists.
 - e. ASBLT - process new data, perform data checks.
 - f. EDIT1 - summary edits.
 - g. EDIT2 - detailed edits.
 - h. RODTST - statistical evaluation of rod data.
 - i. STATS - statistical evaluation of any population of data.
 - j. SPREAD - flag outliers.
 - k. GATHER - compute fuel rod loadings and precision, generate input for other programs.
 - l. ORIENT - define module orientations in the core.
 - m. SYMTRY - evaluate core symmetry.
 - n. COMPLP - compute composition loadings and precision.
 - o. CRTVER - final module certification checks.
5. Restrictions on Complexity of Problem: Depends on Extended Core Storage and system disks.
6. Related and Auxiliary Programs: None.

COMPUTER PROGRAM ABSTRACT (Cont)

7. Typical Running Times: 1-60 minutes depending on the program option being run.
8. References:
 - (a) B. R. Beaudoin, et al, "ASBLT - A System of DATATRAN MODULES Which Process Core Fuel Loading for Use in As-Built Calculations," WAPD-TM-1316, February 1979.
 - (b) H. J. Kopp, Editor, "DATATRAN User's Guide," KAPL-M-7372, October 1974.
 - (c) W. R. Cadwell, Editor, "Reference Manual - Bettis Programming Environment," WAPD-TM-1181, September 1974.
9. Status: Production.
10. Machine Requirements: CDC-6600 or equivalent.
11. Operating System or Monitor: SCOPE.
12. Other Programming, Restrictions, or Operating Information: Uses DATATRAN described in Reference (b), ECS sort routines described in Reference (c) and utilizes the 60-bit word characteristics of a CDC-6600.
13. Availability: Reference (a) is available from:

U. S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

Copies of the computer program may be obtained from:
National Energy Software Center (Argonne)
Attn: Mrs. Margaret Butler
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60440
14. Names and Establishment of Authors:

B. R. Beaudoin
W. J. Beggs
C. R. Case
R. Wilczynski
Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
West Mifflin, Pennsylvania 15122