Material burnup is by reactor zone. The burnup rate is determined by the zone and energy- (group-) averaged cross sections which are recomputed after each time step.

The isotopic chains, which can contain any number of isotopes, are formed by the user. The code does not contain built-in or internal chains.

5. Restrictions on Complexity: Since variable dimensioning is employed, no simple bounds can be stated. The current version, however, is nominally restricted to 50 energy groups in a 65K memory.
6. Running Time: A k_{eff} calculation with a 30×30 mesh and four energy groups requires ~ 2 min on a UNIVAC 1108. A typical burnup calculation requires roughly twice the machine time of a k_{eff} calculation.
7. Unusual Features: The input data are arranged so the code can be used easily for k_{eff} and search calculations without burdening the user with burnup parameters.
8. Related and Auxiliary Programs: The input data (e.g., cross sections, flux dumps, geometry, and composition specifications) are compatible with the Los Alamos one- and two-dimensional transport codes, DTF-IV[2] and 2DF,[3] and the Battelle perturbation code PERT-IV.[4] All four codes use the same input module. The logical flow of 2DB is patterned after the 2DF code.
9. Status: In use.
10. Machine Requirements: 65K memory and three peripheral storage devices.
11. Material Available: A source deck, sample problem, and operation instructions are available from the Argonne Code Center.
12. *References:*

[1]W. W. LITTLE, Jr., and R. W. HARDIE, "2DB, A Two-Dimensional Diffusion-Burnup Code for Fast Reactor Analysis," BNWL-640, Battelle Northwest Laboratory (1968).

[2]K. D. LATHROP, "DTF-IV, a FORTRAN-IV Program for Solving the Multigroup Transport Equation with Anisotropic Scattering," LA-3373, Los Alamos Scientific Laboratory (1965).

[3]2DF, A two-dimensional transport code from the Los Alamos Scientific Laboratory (unpublished).

[4]R. W. HARDIE and W. W. LITTLE, Jr., "PERT-IV, A Two-Dimensional Perturbation Code in FORTRAN-IV," BNWL-409, Battelle Northwest Laboratory (1967).

W. W. Little, Jr.
R. W. Hardie

Battelle Memorial Institute
Battelle Northwest Laboratory
Richland, Washington 99352

Received December 8, 1967
Revised January 17, 1968

GLUB-1

1. Name or Designation of Program: GLUB-1, Analysis of Waterlogged Fuel Elements.[1]
2. Computer for Which Program is Designed and Programming Languages Used: CDC-6600 FORTRAN IV and ASCENT. The program was written entirely in FORTRAN IV; however, some ASCENT subroutines which are part of the Bettis computing environment[2] are utilized.
3. Nature of Physical Problem Solved: The waterlogging transient caused by the existence of a fuel-element cladding defect during an increase in power is solved. The power is either: case (i), put in as an arbitrary function of time; case (ii), assumed to be a series of linear ramps to a new steady state with steeper and steeper slopes. All the geometry and metal properties are input quantities; water properties are obtained from internal tables. Clad and fuel thermal, stress, and strain computations are performed. The output consists of internal pressure and defect flow. For case (i), the clad stress vs time is output, and for case (ii), the new steady-state power which just causes clad failure is output.
4. Method of Solution: The transient is computed as a sequence of quasi-steady states, with fuel and clad temperatures, stresses, and strains being computed at 11 different values of steady-state volume average enthalpy. Linear interpolation then gives these quantities at any other volume average enthalpy. The computations must be done iteratively since all metal properties can be put in as temperature-dependent quantities. Then strains and enthalpy are used to calculate the fuel-element core, plenum, and annulus volumes and enthalpies vs time. Finally, this data is used to compute internal pressure, clad stresses, and defect flow. The fuel element is split into two parts, the fuel section and the plenum. The split occurs axially at the top of the fuel. The fuel section contains control volumes for the fuel, core (if one exists), annulus, and clad. The plenum section has control volumes for the plenum and clad. Heat convection due to water flowing between sections and out of the defect is small and assumed to be negligible. Stress and strain calculations are done elastically with allowance for interference between the fuel and clad.
5. Restrictions on Complexity of the Problem: For each metal property, up to 10 values vs temperature can be put in. If power or defect enthalpy is to be input, up to 30 values vs time can be given. Finally, to obtain allowable power as a function of defect diameter, up to 10 different diameters can be put in.
6. Related and Auxiliary Programs: None
7. Typical Running Time: For case (i) (see part 3), about one minute. For case (ii), five to ten minutes.
8. Unusual Features of the Program: GLUB-1 solves the one-dimensional heat-conduction equation and elastic stress-strain equations with temperature-dependent properties at internal pressures from atmospheric to around 15 000 psi.
9. Status: In production and may be obtained by domestic users from the Argonne Code Center.
10. Machine Requirements: The program requires 32 000 central memory locations.
11. Operating System or Monitor Under Which Program is Executed: The current version of GLUB-1 is designed to operate under the SCOPE 2.0 system. The FCHIP, CARDS, and INP routines[2] are called by the program.

12. Other Programming or Operating Information or Restrictions: Conversion to another computer necessitates the use of the Bettis software environment[2] or rewriting the input routine.

13. *References:*

[1]F. T. DUNCKHORST, L. L. LYNN, W. A. COFFMAN, and J. E. MEYER, "GLUB-1, A FORTRAN IV Digital Computer Program for Waterlogged Fuel Element Analysis," WAPD-TM-569, Bettis Atomic Power Laboratory (1966).

[2]C. J. PFEIFER, "CDC-6600 Fortran Programming—Bettis Environmental Report," WAPD-TM-668, Bettis Atomic Power Laboratory (1967).

L. L. Lynn

Westinghouse Electric Corporation
Bettis Atomic Power Laboratory
P. O. Box 79
West Mifflin, Pennsylvania 15122

Received November 8, 1967