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# NASA TECH BRIEF



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## Subroutine Allows Easy Computation in Extended Precision Arithmetic

### The problem:

To devise a program that allows relatively simple computation of very large numbers or very small fractions with extreme accuracy. Ordinary double precision FORTRAN arithmetic is limited to numbers between  $10^{-38}$  and  $10^{+38}$ , and to 16 digits of accuracy.

### The solution:

A subroutine called NPREC that can perform mathematical operations in extended precision floating point arithmetic. This subroutine handles numbers that consist of 35 binary bits (1 word) for the exponent and 70 bits (2 words) for the fraction. A programmer can perform a variety of mathematical operations by writing standard FORTRAN statements within the NPREC routine instead of calling a separate routine to perform each operation.

### How it's done:

NPREC can be used on any of the IBM 709/7090/7094 computers. A statement, CALL NPREC, is used to enter the routine and subsequent statements are interpreted by the routine until the exit statement, CALL NPOUT, is encountered. Any statement that is interpreted in NPREC will take longer to execute than if it were executed outside of the routine, and thus all normal single or double precision statements should be executed outside of the routine.

The NPREC routine incorporates subroutines in converting to and from extended precision numbers and also includes the following extended precision elementary functions: square root, sine, cosine, arc tangent, natural log, and exponential. The only "built-in" library functions that may be used in NPREC are

ABSF, MAX1F, MIN1F, AND SIGNF. There is limited use of FORTRAN exponential notation in NPREC; and extended precision numbers may be raised to a fixed point power of 2, 3, 4, 5, or 6 only. Any other type of exponential operation must be performed using the exponential and natural log routines within NPREC. No more than 15 operations should appear in any single statement in NPREC.

The NPREC routine will detect 20 errors. When one of these errors is detected, a comment will be written in 1 of 2 formats on output tape 6, after which a core dump is given and the job is finished.

The time it takes to perform an arithmetic operation in NPREC varies with the values and relative values of the operands, and also depends on whether or not the operands are stored in COMMON. As an indication of the time requirements, an extended precision division takes approximately 1.4 milliseconds on the 7090 and a multiplication approximately 0.6 milliseconds. The natural log and exponential functions require approximately 36 and 48 milliseconds respectively. Multiplying the 7090 time by 6 gives the 709 time.

NPREC and its associated subprograms require 2053 storage locations.

### Note:

Inquiries concerning this innovation may be directed to:

Technology Utilization Officer  
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Huntsville, Alabama 35812  
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(continued overleaf)

**Patent status:**

No patent action is contemplated by NASA.

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