

## NAG Library Routine Document

### F08WWF (ZGGBAK)

**Note:** before using this routine, please read the Users' Note for your implementation to check the interpretation of *bold italicised* terms and other implementation-dependent details.

#### 1 Purpose

F08WWF (ZGGBAK) forms the right or left eigenvectors of the real generalized eigenvalue problem  $Ax = \lambda Bx$ , by backward transformation on the computed eigenvectors given by F08YXF (ZTGEVC). It is necessary to call this routine only if the optional balancing routine F08WVF (ZGGBAL) was previously called to balance the matrix pair  $(A, B)$ .

#### 2 Specification

```
SUBROUTINE F08WWF (JOB, SIDE, N, ILO, IHI, LSCALE, RSCALE, M, V, LDV, INFO)
```

```
INTEGER                N, ILO, IHI, M, LDV, INFO
REAL (KIND=nag_wp)    LSCALE(*), RSCALE(*)
COMPLEX (KIND=nag_wp) V(LDV,*)
CHARACTER(1)          JOB, SIDE
```

The routine may be called by its LAPACK name *zggbak*.

#### 3 Description

If the matrix pair has been previously balanced using the routine F08WVF (ZGGBAL) then F08WWF (ZGGBAK) backtransforms the eigenvector solution given by F08YXF (ZTGEVC). This is usually the sixth and last step in the solution of the generalized eigenvalue problem.

For a description of balancing, see the document for F08WVF (ZGGBAL).

#### 4 References

Ward R C (1981) Balancing the generalized eigenvalue problem *SIAM J. Sci. Stat. Comp.* **2** 141–152

#### 5 Parameters

1: JOB – CHARACTER(1) *Input*

*On entry:* specifies the backtransformation step required.

JOB = 'N'  
No transformations are done.

JOB = 'P'  
Only do backward transformations based on permutations.

JOB = 'S'  
Only do backward transformations based on scaling.

JOB = 'B'  
Do backward transformations for both permutations and scaling.

**Note:** this must be identical to the parameter JOB as supplied to F08WHF (DGGBAL).

*Constraint:* JOB = 'N', 'P', 'S' or 'B'.

- 2: SIDE – CHARACTER(1) *Input*  
*On entry:* indicates whether left or right eigenvectors are to be transformed.  
 SIDE = 'L'  
     The left eigenvectors are transformed.  
 SIDE = 'R'  
     The right eigenvectors are transformed.  
*Constraint:* SIDE = 'L' or 'R'.
- 3: N – INTEGER *Input*  
*On entry:*  $n$ , the order of the matrices  $A$  and  $B$  of the generalized eigenvalue problem.  
*Constraint:*  $N \geq 0$ .
- 4: ILO – INTEGER *Input*  
 5: IHI – INTEGER *Input*  
*On entry:*  $i_{lo}$  and  $i_{hi}$  as determined by a previous call to F08WVF (ZGGBAL).  
*Constraints:*  
     if  $N > 0$ ,  $1 \leq ILO \leq IHI \leq N$ ;  
     if  $N = 0$ ,  $ILO = 1$  and  $IHI = 0$ .
- 6: LSCALE(\*) – REAL (KIND=nag\_wp) array *Input*  
**Note:** the dimension of the array LSCALE must be at least  $\max(1, N)$ .  
*On entry:* details of the permutations and scaling factors applied to the left side of the matrices  $A$  and  $B$ , as returned by a previous call to F08WVF (ZGGBAL).
- 7: RSCALE(\*) – REAL (KIND=nag\_wp) array *Input*  
**Note:** the dimension of the array RSCALE must be at least  $\max(1, N)$ .  
*On entry:* details of the permutations and scaling factors applied to the right side of the matrices  $A$  and  $B$ , as returned by a previous call to F08WVF (ZGGBAL).
- 8: M – INTEGER *Input*  
*On entry:*  $m$ , the required number of left or right eigenvectors.  
*Constraint:*  $0 \leq M \leq N$ .
- 9: V(LDV,\*) – COMPLEX (KIND=nag\_wp) array *Input/Output*  
**Note:** the second dimension of the array V must be at least  $\max(1, M)$ .  
*On entry:* the matrix of right or left eigenvectors, as returned by F08WVF (ZGGBAL).  
*On exit:* the transformed right or left eigenvectors.
- 10: LDV – INTEGER *Input*  
*On entry:* the first dimension of the array V as declared in the (sub)program from which F08WVF (ZGGBAL) is called.  
*Constraint:*  $LDV \geq \max(1, N)$ .
- 11: INFO – INTEGER *Output*  
*On exit:* INFO = 0 unless the routine detects an error (see Section 6).

## **6 Error Indicators and Warnings**

Errors or warnings detected by the routine:

INFO < 0

If INFO =  $-i$ , argument  $i$  had an illegal value. An explanatory message is output, and execution of the program is terminated.

## **7 Accuracy**

The errors are negligible.

## **8 Further Comments**

The number of operations is proportional to  $n^2$ .

The real analogue of this routine is F08WJF (DGGBAK).

## **9 Example**

See Section 9 in F08XSF (ZHGEQZ) and F08YXF (ZTGEVC).

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