

NAG Library Function Document

nag_opt_nlp_option_set_file (e04wec)

1 Purpose

nag_opt_nlp_option_set_file (e04wec) may be used to supply optional parameters to nag_opt_nlp_solve (e04wdc) from an external file. The initialization function nag_opt_nlp_init (e04wcc) **must** have been called before calling nag_opt_nlp_option_set_file (e04wec).

2 Specification

```
#include <nag.h>
#include <nage04.h>

void nag_opt_nlp_option_set_file (Nag_FileID fileid, Nag_E04State *state,
    NagError *fail)
```

3 Description

nag_opt_nlp_option_set_file (e04wec) may be used to supply values for optional parameters to nag_opt_nlp_solve (e04wdc). nag_opt_nlp_option_set_file (e04wec) reads an external file whose **fileid** has been returned by a call to nag_open_file (x04acc). nag_open_file (x04acc) must be called to provide **fileid**. Each line of the file defines a single optional parameter. It is only necessary to supply values for those arguments whose values are to be different from their default values.

Each optional parameter is defined by a single character string, consisting of one or more items. The items associated with a given option must be separated by spaces, or equals signs [=]. Alphabetic characters may be upper or lower case. The string

```
Print Level = 1
```

is an example of a string used to set an optional parameter. For each option the string contains one or more of the following items:

- a mandatory keyword;
- a phrase that qualifies the keyword;
- a number that specifies an Integer or double value. Such numbers may be up to 40 contiguous characters which can be read using C's d or g formats, terminated by a space if this is not the last item on the line.

Blank strings and comments are ignored. A comment begins with an asterisk (*) and all subsequent characters in the string are regarded as part of the comment.

The file containing the options must start with `Begin` and must finish with `End`. An example of a valid options file is:

```
Begin * Example options file
    Print level = 5
End
```

Optional parameter settings are preserved following a call to nag_opt_nlp_solve (e04wdc) and so the keyword **Defaults** is provided to allow you to reset all the optional parameters to their default values before a subsequent call to nag_opt_nlp_solve (e04wdc).

A complete list of optional parameters, their abbreviations, synonyms and default values is given in Section 12 in nag_opt_nlp_solve (e04wdc).

4 References

Hock W and Schittkowski K (1981) *Test Examples for Nonlinear Programming Codes. Lecture Notes in Economics and Mathematical Systems* **187** Springer–Verlag

5 Arguments

- 1: **fileid** – Nag_FileID *Input*
On entry: the ID of the option file to be read as returned by a call to nag_open_file (x04acc).
- 2: **state** – Nag_E04State * *Communication Structure*
state contains internal information required for functions in this suite. It must not be modified in any way.
- 3: **fail** – NagError * *Input/Output*
The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

6 Error Indicators and Warnings

NE_ALLOC_FAIL

Dynamic memory allocation failed.

See Section 2.3.1.2 in How to Use the NAG Library and its Documentation for further information.

NE_BAD_PARAM

On entry, argument *⟨value⟩* had an illegal value.

NE_E04_OPTION_INVALID

At least one line of the options file is invalid.

Could not read options file on unit **fileid** = *⟨value⟩*.

Could not read options file on unit fileid. This may be due to:

- (a) **fileid** is not a valid unit number;
- (b) a file is not associated with unit **fileid**, or if it is, is unavailable for read access;
- (c) one or more lines of the options file is invalid. Check that all keywords are neither ambiguous nor misspelt;
- (d) Begin was found, but end-of-file was found before End was found;
- (e) end-of-file was found before Begin was found.

NE_E04WCC_NOT_INIT

The initialization function nag_opt_nlp_init (e04wcc) has not been called.

NE_INTERNAL_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

An unexpected error has been triggered by this function. Please contact NAG.

See Section 2.7.6 in How to Use the NAG Library and its Documentation for further information.

NE_NO_LICENCE

Your licence key may have expired or may not have been installed correctly.
See Section 2.7.5 in How to Use the NAG Library and its Documentation for further information.

7 Accuracy

Not applicable.

8 Parallelism and Performance

nag_opt_nlp_option_set_file (e04wec) is not threaded in any implementation.

9 Further Comments

nag_opt_nlp_option_set_string (e04wfc), nag_opt_nlp_option_set_integer (e04wgc) or nag_opt_nlp_option_set_double (e04whc) may also be used to supply optional parameters to nag_opt_nlp_solve (e04wdc).

10 Example

This example is based on Problem 71 in Hock and Schittkowski (1981) and involves the minimization of the nonlinear function

$$F(x) = x_1 x_4 (x_1 + x_2 + x_3) + x_3$$

subject to the bounds

$$\begin{aligned} 1 &\leq x_1 \leq 5 \\ 1 &\leq x_2 \leq 5 \\ 1 &\leq x_3 \leq 5 \\ 1 &\leq x_4 \leq 5 \end{aligned}$$

to the general linear constraint

$$x_1 + x_2 + x_3 + x_4 \leq 20,$$

and to the nonlinear constraints

$$\begin{aligned} x_1^2 + x_2^2 + x_3^2 + x_4^2 &\leq 40, \\ x_1 x_2 x_3 x_4 &\geq 25. \end{aligned}$$

The initial point, which is infeasible, is

$$x_0 = (1, 5, 5, 1)^T,$$

and $F(x_0) = 16$.

The optimal solution (to five figures) is

$$x^* = (1.0, 4.7430, 3.8211, 1.3794)^T,$$

and $F(x^*) = 17.014$. One bound constraint and both nonlinear constraints are active at the solution.

The document for nag_opt_nlp_option_set_file (e04wec) includes an example program to solve the same problem using some of the optional parameters described in Section 12 in nag_opt_nlp_solve (e04wdc).

10.1 Program Text

```

/* nag_opt_nlp_option_set_file (e04wec) Example Program.
 *
 * NAGPRODCODE Version.
 *
 * Copyright 2016 Numerical Algorithms Group.
 *
 * Mark 26, 2016.
 */

#include <stdio.h>
#include <string.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nage04.h>

#ifdef __cplusplus
extern "C"
{
#endif
    static void NAG_CALL confun(Integer *mode, Integer ncnln, Integer n,
                                Integer ldcj, const Integer needc[],
                                const double x[], double ccon[], double cjac[],
                                Integer nstate, Nag_Comm *comm);

    static void NAG_CALL objfun(Integer *mode, Integer n, const double x[],
                                double *objf, double grad[], Integer nstate,
                                Nag_Comm *comm);
#ifdef __cplusplus
}
#endif

int main(void)
{
    const char *optionsfile = "e04wece.opt";

    /* Scalars */
    double bndinf, featol, objf;
    Integer elmode, exit_status, i, j, majits, n, nclin, ncnln, nctotal, pda;
    Integer pdcj, pdh;

    /* Arrays */
    static double ruser[2] = { -1.0, -1.0 };
    double *a = 0, *bl = 0, *bu = 0, *cccon = 0, *cjac = 0, *clamda = 0;
    double *grad = 0, *hess = 0, *x = 0;
    Integer *istate = 0, *iuser = 0;

    /* Nag Types */
    Nag_E04State state;
    NagError fail;
    Nag_Comm comm;
    Nag_FileID fileidin;
    Nag_FileID fileidout;

#define A(I, J) a[(I-1)*pda + J - 1]

    exit_status = 0;
    INIT_FAIL(fail);

    printf("%s", "nag_opt_nlp_option_set_file (e04wec) Example Program"
           " Results");
    printf("\n");

    /* For communication with user-supplied functions: */
    comm.user = ruser;

    fflush(stdout);

    /* This program demonstrates the use of routines to set and get values of
     * optional parameters associated with nag_opt_nlp_solve (e04wdc).
     */
}

```

```

/* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif

#ifdef _WIN32
    scanf_s("%" NAG_IFMT " %" NAG_IFMT " %" NAG_IFMT " ", &n, &nclin, &ncnln);
#else
    scanf("%" NAG_IFMT " %" NAG_IFMT " %" NAG_IFMT " ", &n, &nclin, &ncnln);
#endif
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif

pda = n;
pdcj = n;
pdh = n;

nctotal = n + nclin + ncnln;

if (!(a = NAG_ALLOC(ncnln * n, double)) ||
    !(b1 = NAG_ALLOC(nctotal, double)) ||
    !(bu = NAG_ALLOC(nctotal, double)) ||
    !(ccon = NAG_ALLOC(ncnln, double)) ||
    !(cjac = NAG_ALLOC(ncnln * n, double)) ||
    !(clamda = NAG_ALLOC(nctotal, double)) ||
    !(grad = NAG_ALLOC(n, double)) ||
    !(hess = NAG_ALLOC(n * n, double)) ||
    !(x = NAG_ALLOC(n, double)) ||
    !(istate = NAG_ALLOC(nctotal, Integer)) ||
    !(iuser = NAG_ALLOC(1, Integer)))
{
    printf("Allocation failure\n");
    exit_status = -1;
    goto END;
}

/* Read A, BL, BU and X from data file */
if (nclin > 0) {
    for (i = 1; i <= nclin; ++i) {
        for (j = 1; j <= n; ++j) {
#ifdef _WIN32
            scanf_s("%lf", &A(i, j));
#else
            scanf("%lf", &A(i, j));
#endif
        }
    }
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif
}

for (i = 1; i <= n + nclin + ncnln; ++i) {
#ifdef _WIN32
    scanf_s("%lf", &b1[i - 1]);
#else
    scanf("%lf", &b1[i - 1]);
#endif
}
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");

```

```

#endif

    for (i = 1; i <= n + nclin + ncnln; ++i) {
#ifdef _WIN32
        scanf_s("%lf", &bu[i - 1]);
#else
        scanf("%lf", &bu[i - 1]);
#endif
    }
#ifdef _WIN32
    scanf_s("%*[^\\n] ");
#else
    scanf("%*[^\\n] ");
#endif

    for (i = 1; i <= n; ++i) {
#ifdef _WIN32
        scanf_s("%lf", &x[i - 1]);
#else
        scanf("%lf", &x[i - 1]);
#endif
    }
#ifdef _WIN32
    scanf_s("%*[^\\n] ");
#else
    scanf("%*[^\\n] ");
#endif

    /* Call nag_opt_nlp_init (e04wcc) to initialize nag_opt_nlp_solve (e04wdc). */
    /* nag_opt_nlp_init (e04wcc).
     * Initialization function for nag_opt_nlp_solve (e04wdc)
     */
    nag_opt_nlp_init(&state, &fail);
    if (fail.code != NE_NOERROR) {
        printf("Initialization of nag_opt_nlp_init (e04wcc) failed.\\n%s\\n",
            fail.message);
        exit_status = 1;
        goto END;
    }
    /* By default nag_opt_nlp_solve (e04wdc) does not print monitoring
     * information. Call nag_open_file (x04acc) to set the print file fileid.
     */
    /* nag_open_file (x04acc).
     * Open unit number for reading, writing or appending, and
     * associate unit with named file
     */

    nag_open_file("", 2, &fileidout, &fail);
    if (fail.code != NE_NOERROR) {
        printf("Fileidout could not be obtained.\\n");
        exit_status = 1;
        goto END;
    }

    /* Use nag_opt_nlp_option_set_integer (e04wgc) to set the Integer-valued
     * option 'Print file' */
    /* nag_opt_nlp_option_set_integer (e04wgc).
     * Set a single option for nag_opt_nlp_solve (e04wdc) from
     * an integer argument
     */
    nag_opt_nlp_option_set_integer("Print file", fileidout, &state, &fail);
    if (fail.code != NE_NOERROR) {
        printf("nag_opt_nlp_option_set_integer (e04wgc) failed to set Print"
            "\\n File\\n");
        exit_status = 1;
        goto END;
    }

    /* Use nag_opt_nlp_option_set_file (e04wec) to read some options from
     * the options file. Firsr call nag_open_file (x04acc) to set the options file
     * fileid.

```

```

    */
    nag_open_file(optionsfile, 0, &fileidin, &fail);
    if (fail.code != NE_NOERROR) {
        printf("Fileidin could not be obtained.\n");
        exit_status = 1;
        goto END;
    }
    /* nag_opt_nlp_option_set_file (e04wec).
    * Supply optional parameter values for nag_opt_nlp_solve
    * (e04wdc) from external file
    */
    nag_opt_nlp_option_set_file(fileidin, &state, &fail);
    if (fail.code != NE_NOERROR) {
        printf("nag_opt_nlp_option_set_file (e04wec) could not read input"
            " File\n");
        exit_status = 1;
        goto END;
    }

    /* Use nag_opt_nlp_option_get_integer (e04wkc) to find the value of
    * Integer-valued option 'Elastic mode'.
    */
    /* nag_opt_nlp_option_get_integer (e04wkc).
    * Get the setting of an integer valued option of
    * nag_opt_nlp_solve (e04wdc)
    */
    nag_opt_nlp_option_get_integer("Elastic mode", &elmode, &state, &fail);
    if (fail.code != NE_NOERROR) {
        printf("nag_opt_nlp_option_get_integer (e04wkc) failed to find the value"
            " of Elastic Mode\n");
        exit_status = 1;
        goto END;
    }
    printf("Option 'Elastic mode' has the value ");
    printf("%3" NAG_IFMT ".\n", elmode);

    /* Use nag_opt_nlp_option_set_double (e04whc) to set the value of real-valued
    * option 'Infinite bound size'.
    */
    bndinf = 1e10;
    /* nag_opt_nlp_option_set_double (e04whc).
    * Set a single option for nag_opt_nlp_solve (e04wdc) from a
    * double argument
    */
    nag_opt_nlp_option_set_double("Infinite bound size", bndinf, &state, &fail);
    if (fail.code != NE_NOERROR) {
        printf("nag_opt_nlp_option_set_double (e04whc) failed to set Infinite"
            " bound size\n");
        exit_status = 1;
        goto END;
    }

    /* Use nag_opt_nlp_option_get_double (e04wlc) to find the value of real-valued
    * option 'Feasibility tolerance'.
    */
    /* nag_opt_nlp_option_get_double (e04wlc).
    * Get the setting of a double valued option of
    * nag_opt_nlp_solve (e04wdc)
    */
    nag_opt_nlp_option_get_double("Feasibility tolerance", &featol, &state,
        &fail);
    if (fail.code != NE_NOERROR) {
        printf("nag_opt_nlp_option_get_double (e04wlc) failed to find the value"
            " of a real-valued option\n");
        exit_status = 1;
        goto END;
    }
    printf("Option 'Feasibility tolerance' has the value %14.5e.\n", featol);

    /* Use nag_opt_nlp_option_set_string (e04wfc) to set the option 'Major
    * iterations limit'.

```

```

    */
/* nag_opt_nlp_option_set_string (e04wfc).
 * Set a single option for nag_opt_nlp_solve (e04wdc) from a
 * character string
 */
nag_opt_nlp_option_set_string("Major iterations limit 50", &state, &fail);
if (fail.code != NE_NOERROR) {
    printf("nag_opt_nlp_option_set_string (e04wfc) failed to set Major"
           " iterations limit\n");
    exit_status = 1;
    goto END;
}
fflush(stdout);

/* Solve the problem. */
/* nag_opt_nlp_solve (e04wdc).
 * Solves the nonlinear programming (NP) problem
 */
nag_open_file("", 2, &fileidout, &fail); /* Open library output */
nag_opt_nlp_option_set_integer("Print file", fileidout, &state, &fail);
fflush(stdout);
nag_opt_nlp_solve(n, nclin, ncnln, pda, pdcj, pdh, a, bl, bu,
                  confun, objfun, &majits, istate, ccon, cjac, clamda,
                  &objf, grad, hess, x, &state, &comm, &fail);

if (fail.code == NE_NOERROR) {
    printf("\nFinal objective value = %11.3f\n", objf);

    printf("Optimal X = ");
    for (i = 1; i <= n; ++i) {
        printf("%9.2f%s", x[i - 1], i % 7 == 0 || i == n ? "\n" : " ");
    }
}
else {
    printf("Error message from nag_opt_nlp_solve (e04wdc).\nno%s\n",
           fail.message);
}
END:
NAG_FREE(a);
NAG_FREE(bl);
NAG_FREE(bu);
NAG_FREE(ccon);
NAG_FREE(cjac);
NAG_FREE(clamda);
NAG_FREE(grad);
NAG_FREE(hess);
NAG_FREE(x);
NAG_FREE(istate);
NAG_FREE(iuser);

return exit_status;
}

static void NAG_CALL objfun(Integer *mode, Integer n, const double x[],
                           double *objf, double grad[], Integer nstate,
                           Nag_Comm *comm)
{
    /* Routine to evaluate objective function and its 1st derivatives. */

    /* Function Body */
    if (comm->user[0] == -1.0) {
        fflush(stdout);
        printf("(User-supplied callback objfun, first invocation.)\n");
        comm->user[0] = 0.0;
        fflush(stdout);
    }
    if (*mode == 0 || *mode == 2) {
        *objf = x[0] * x[3] * (x[0] + x[1] + x[2]) + x[2];
    }

    if (*mode == 1 || *mode == 2) {

```



```

    grad[0] = x[3] * (x[0] * 2. + x[1] + x[2]);
    grad[1] = x[0] * x[3];
    grad[2] = x[0] * x[3] + 1.;
    grad[3] = x[0] * (x[0] + x[1] + x[2]);
}

return;
} /* objfun */

static void NAG_CALL confun(Integer *mode, Integer ncnln, Integer n,
                           Integer ldcj, const Integer needc[],
                           const double x[], double ccon[], double cjac[],
                           Integer nstate, Nag_Comm *comm)
{
    /* Scalars */
    Integer i, j;

#define CJAC(I, J) cjac[(I-1)*ldcj + J-1]

    /* Routine to evaluate the nonlinear constraints and their 1st */
    /* derivatives. */

    /* Function Body */
    if (comm->user[1] == -1.0) {
        fflush(stdout);
        printf("(User-supplied callback confun, first invocation.)\n");
        comm->user[1] = 0.0;
        fflush(stdout);
    }
    if (nstate == 1) {
        /* First call to CONFUN. Set all Jacobian elements to zero. */
        /* Note that this will only work when 'Derivative Level = 3' */
        /* (the default; see Section 11.2). */
        for (j = 1; j <= n; ++j) {
            for (i = 1; i <= ncnln; ++i) {
                CJAC(i, j) = 0.;
            }
        }
    }

    if (needc[0] > 0) {
        if (*mode == 0 || *mode == 2) {
            ccon[0] = x[0] * x[0] + x[1] * x[1] + x[2] * x[2] + x[3] * x[3];
        }
        if (*mode == 1 || *mode == 2) {
            CJAC(1, 1) = x[0] * 2.;
            CJAC(1, 2) = x[1] * 2.;
            CJAC(1, 3) = x[2] * 2.;
            CJAC(1, 4) = x[3] * 2.;
        }
    }

    if (needc[1] > 0) {
        if (*mode == 0 || *mode == 2) {
            ccon[1] = x[0] * x[1] * x[2] * x[3];
        }
        if (*mode == 1 || *mode == 2) {
            CJAC(2, 1) = x[1] * x[2] * x[3];
            CJAC(2, 2) = x[0] * x[2] * x[3];
            CJAC(2, 3) = x[0] * x[1] * x[3];
            CJAC(2, 4) = x[0] * x[1] * x[2];
        }
    }

    return;
} /* confun */

```

10.2 Program Data

Begin nag_opt_nlp_option_set_file (e04wec) example options file

* Comment lines like this begin with an asterisk.

* Switch off output of timing information:

Timing level 0

* Allow elastic variables:

Elastic mode 1

* Set the feasibility tolerance:

Feasibility tolerance 1.0E-4

End

nag_opt_nlp_option_set_file (e04wec) Example Program Data

4	1	2						: N, NCLIN and NCNLN
1.0	1.0	1.0	1.0					: Matrix A
1.0	1.0	1.0	1.0	-1.0E+25	-1.0E+25	25.0		: Lower bounds BL
5.0	5.0	5.0	5.0	20.0	40.0	1.0E+25		: Upper bounds BU
1.0	5.0	5.0	1.0					: Initial vector X

10.3 Program Results

nag_opt_nlp_option_set_file (e04wec) Example Program Results

OPTIONS file

Begin nag_opt_nlp_option_set_file (e04wec) example options file

* Comment lines like this begin with an asterisk.

* Switch off output of timing information:

Timing level 0

* Allow elastic variables:

Elastic mode 1

* Set the feasibility tolerance:

Feasibility tolerance 1.0E-4

End

E04WEZ EXIT 100 -- finished successfully

E04WEZ INFO 101 -- OPTIONS file read

Option 'Elastic mode' has the value 1.

Option 'Feasibility tolerance' has the value 1.00000e-04.

Parameters

=====

Files

Solution file.....	0	Old basis file	0	(Print file).....	6
Insert file.....	0	New basis file	0	(Summary file).....	0
Punch file.....	0	Backup basis file.....	0		
Load file.....	0	Dump file.....	0		

Frequencies

Print frequency.....	100	Check frequency.....	60	Save new basis map.....	100
Summary frequency.....	100	Factorization frequency	50	Expand frequency.....	10000

QP subproblems

QPsolver Cholesky.....					
Scale tolerance.....	0.900	Minor feasibility tol..	1.00E-04	Iteration limit.....	10000
Scale option.....	0	Minor optimality tol..	1.00E-06	Minor print level.....	1
Crash tolerance.....	0.100	Pivot tolerance.....	2.04E-11	Partial price.....	1
Crash option.....	3	Elastic weight.....	1.00E+04	Prtl price section (A)	4
		New superbasics.....	99	Prtl price section (-I)	3

The SQP Method

Minimize.....		Cold start.....		Proximal Point method..	1
Nonlinear objectiv vars	4	Major optimality tol..	2.00E-06	Function precision.....	1.72E-13
Unbounded step size....	1.00E+10	Superbasics limit.....	4	Difference interval....	4.15E-07
Unbounded objective....	1.00E+15	Reduced Hessian dim....	4	Central difference int..	5.57E-05
Major step limit.....	2.00E+00	Derivative linesearch..		Derivative level.....	3
Major iterations limit..	50	Linesearch tolerance...	0.90000	Verify level.....	0
Minor iterations limit..	500	Penalty parameter.....	0.00E+00	Major Print Level.....	1

Hessian Approximation

Full-Memory Hessian....		Hessian updates.....	99999999	Hessian frequency.....	99999999
				Hessian flush.....	99999999

Nonlinear constraints

```

Nonlinear constraints..      2      Major feasibility tol..  1.00E-06      Violation limit.....  1.00E+06
Nonlinear Jacobian vars     4

```

Miscellaneous

```

-----
LU factor tolerance....     1.10      LU singularity tol.....  2.04E-11      Timing level.....      0
LU update tolerance....     1.10      LU swap tolerance.....  1.03E-04      Debug level.....      0
LU partial pivoting...      eps (machine precision)  1.11E-16      System information....  No

```

Matrix statistics

```

-----
                Total      Normal      Free      Fixed      Bounded
Rows            3          3          0          0          0
Columns         4          0          0          0          4

No. of matrix elements      12      Density      100.000
Biggest                    1.0000E+00 (excluding fixed columns,
Smallest                   0.0000E+00 free rows, and RHS)

```

```

No. of objective coefficients      0

Nonlinear constraints      2      Linear constraints      1
Nonlinear variables       4      Linear variables       0
Jacobian variables        4      Objective variables     4
Total constraints         3      Total variables         4

```

```

(User-supplied callback confun, first invocation.)
(User-supplied callback objfun, first invocation.)
The user has defined      8 out of      8 constraint gradients.
The user has defined      4 out of      4 objective gradients.

```

Cheap test of user-supplied problem derivatives...

The constraint gradients seem to be OK.

```
--> The largest discrepancy was 1.84E-07 in constraint 6
```

The objective gradients seem to be OK.

```

Gradient projected in one direction  4.99993000077E+00
Difference approximation             4.99993303560E+00

```

Itns	Major	Minors	Step	nCon	Feasible	Optimal	MeritFunction	L+U BSwap	nS	condHz	Penalty
2	0	2		1	1.7E+00	2.8E+00	1.6000000E+01	7	2	1.0E+00	— r
4	1	2	1.0E+00	2	1.3E-01	3.2E-01	1.7726188E+01	8	1	6.2E+00	8.3E-02 _n r
5	2	1	1.0E+00	3	3.7E-02	1.7E-01	1.7099571E+01	7	1	2.0E+00	8.3E-02 _s
6	3	1	1.0E+00	4	2.2E-02	1.1E-02	1.7014005E+01	7	1	1.8E+00	8.3E-02 _
7	4	1	1.0E+00	5	1.5E-04	6.0E-04	1.7014018E+01	7	1	1.8E+00	9.2E-02 _
8	5	1	1.0E+00	6 (3.3E-07)	2.3E-05	1.7014017E+01	7	1	1.9E+00	3.6E-01 _
9	6	1	1.0E+00	7 (4.2E-10)	(2.4E-08)	1.7014017E+01	7	1	1.9E+00	3.6E-01 _

```

E04WDM EXIT  0 -- finished successfully
E04WDM INFO  1 -- optimality conditions satisfied

```

```

Problem name      NLP
No. of iterations      9      Objective value      1.7014017287E+01
No. of major iterations      6      Linear objective      0.0000000000E+00
Penalty parameter    3.599E-01      Nonlinear objective    1.7014017287E+01
No. of calls to funobj      8      No. of calls to funcon      8
No. of superbasics         1      No. of basic nonlinears     2
No. of degenerate steps     0      Percentage                0.00
Max x                    2 4.7E+00      Max pi                    2 5.5E-01
Max Primal infeas        0 0.0E+00      Max Dual infeas          3 4.8E-08
Nonlinear constraint violn  2.7E-09

```

Variable	State	Value	Lower bound	Upper bound	Lagr multiplier	Slack
variable 1	LL	1.000000	1.000000	5.000000	1.087871	.
variable 2	FR	4.743000	1.000000	5.000000	.	0.2570
variable 3	FR	3.821150	1.000000	5.000000	.	1.179
variable 4	FR	1.379408	1.000000	5.000000	.	0.3794

Linear constrnt	State	Value	Lower bound	Upper bound	Lagr multiplier	Slack
lincon 1	FR	10.94356	None	20.00000	.	9.056

Nonlin constrnt	State	Value	Lower bound	Upper bound	Lagr multiplier	Slack
-----------------	-------	-------	-------------	-------------	-----------------	-------

nlncon	1	UL	40.00000	None	40.00000	-0.1614686	-0.2700E-08
nlncon	2	LL	25.00000	25.00000	None	0.5522937	-0.2215E-08

Final objective value = 17.014
Optimal X = 1.00 4.74 3.82 1.38
