

///AMLS Version 4.2.r22
*Automated
MultiLevelSubstructuring*

FAST///FRS Version 1.0.255
Fast Frequency Response Solver

Release Notes

December 11, 2011



INTRODUCTION

AMLS is available for MSC and NX Nastran, Altair RADIOSS linear and the newest addition, **ESI VPS2011**. For the current AMLS release, Delivery Data Bases will be provided for:

MSC	V2008(mdr3), V2010.1.3, and V2011.1
NX	V7.0, V7.1, and V8.0

Both short and long integer versions (i4, i8) are provided for each version of MSC and NX. If there is a need for another version of either MSC or NX, please contact: support@cdh-aq.com

Starting with this version, AMLS will be supported for the following operating systems:

- ibm_aix
- linux_x86_64
- linux_ia64

For the next major AMLS release, linux_ia64 and ibm_aix will not be supported, so please plan accordingly.

Users are reminded that each CDH/AMLS delivery package, amls_pack* also contains an executable program CDH/FastFRS (Fast Frequency Response Solver). It is a completely separate program that solves modal frequency response problems very efficiently. Even though it is separate from AMLS it is used in conjunction with AMLS. In other words, it cannot be executed by itself when the modes are calculated via other methods, e.g., Lanczos. To execute it with AMLS, the user must have a proper license feature that is the same license file as that used by AMLS. For further information about FastFRS, please contact: support@cdh-aq.com.



AMLS ERROR CORRECTION

CDH/AMLS V4.2.r22 contains one minor error correction that has been identified since the release of V4.1.r24 and occurs in very unusual circumstances. In most cases, the users will never see this error.

- 1) Corrected an error that may appear when residual vectors are present and there are mass rigid body modes in an up-stream substructure (other than a residual). This can be seen in the Nastran *.f04 file by searching for a string PHSA. If the number below NulCol is not zero, as in the following example, then this error has occurred.

```
Module  DMAP Matrix   Cols      Rows  F T  NzWds      Density  NulCol
INPUTT4 573  PHSA      10125   11360735  2 2    132 5.80948D-06      1
```

This error can be avoided in V4.1.r24 by simply forcing the grid point(s) associated with a mass rigid body mode into the last substructure as shown in AMLS User's Manual, Section 14.

AMLS ENHANCEMENTS

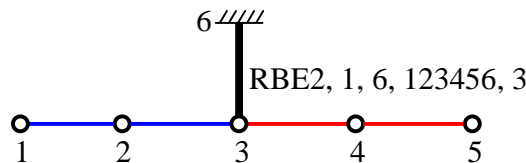
CDH/AMLS V4.2.r22 contains a number of enhancements shown below:

- 1) Slightly improved memory management in all phases. Most users won't notice this change.
- 2) Added an ability to allow for disjoint structures if the user requests it via a new Bulk Data parameter, [disjoint](#).

There are a number of reasons why a structure may be considered by AMLS to be disjoint. The first, and the most obvious, occurs when the model truly has two (or more) pieces that are simply not connected to each other. The only way a user may see this in the standard solver (Lanczos) is in the eigenvalue summary table. There should be $6*n$ rigid body modes, where n represents the number of separate pieces (assuming there are no SPC constraints).

However, AMLS will fail in phase 2 and list a set of grid points associated with each disconnected piece. The list is not shown for the largest disconnected piece. In most cases, CDH considers this to be a modeling error.

The second occurrence is more complicated and is shown in the figure below.



This simple model consists of 4 bar elements and one RBE2 element. Grid point 6 is fully constrained and all 6 DOFs of grid 3 are dependent on grid 6. Physically, this is not a disjoint structure. However, the motion of the two left bar elements has no impact on the motion of the two right bar elements, i.e., there is no connection in the stiffness matrix between grids 2 and 4, each is independently connected to grid 6.

A more confusing case occurs when grid 6 is a boundary point in the generation of an external superelement when using a Craig-Bampton method, i.e., all 6 DOFs of grid 6 are specified on ASET(i) data. In fact, this is the same as if point 6 is fully constrained. If a different method other than Craig-Bampton were used, e.g., MacNeal-Rubin (where the boundary DOFs are free) then AMLS would not consider this to be a disjoint structure.

When AMLS detects a disjoint structure it will fail in phase2 and return control to the solver. At this point, the user should carefully review the model to make sure that the structure is not truly disjoint. On the subsequent analysis, if the user wishes to override the disjoint failure, simply specify a parameter disjoint in the Bulk Data Deck, e.g.,



param, disjoint, 10. [default, 0.0: must be a floating point number where the number is greater than then number of disjoint pieces]

AMLS will still issue a message regarding disjoint pieces, however it will rerun phase2, modify the substructure tree, and continue with the solution.

- 3) Modified phase3 scratch file usage, resulting in lower file high water, less I/O transfer, and improved performance on I/O heavy models. In the future release this will also be done for phase4. The table below shows the comparison between V4.1 and V4.2 for 14 different models with different DOFs and normal modes.

TABLE 1 – File Size Comparison V4.1 vs. V4.2

Job	DOFs	No. Modes	file_size V4.1 (GB)	file_size V4.2 (GB)	4.1/4.2
24M	19182994	9590	486.1	141.7	3.4
cab	5745858	8631	92.9	66.8	1.4
470	6813747	10352	97.4	90.9	1.1
900	4422539	8890	68.5	68.5	1.0
ric	5282736	3913	32.7	30.7	1.1
nda	6776395	5056	69.0	38.4	1.8
ewe	12542968	11957	119.5	119.5	1.0
mcl	5637927	1390	13.6	8.0	1.7
son	12747572	8596	229.5	92.0	2.5
leo	15859846	6547	360.0	96.6	3.7
sol	12429057	3408	171.3	84.5	2.0
tra	4124342	19056	127.6	127.6	1.0
160	11360735	10125	102.9	102.9	1.0
350	17917588	9476	209.3	117.7	1.8
Average	10060307	8356	155.7	84.7	1.75

Numbers in green indicate that the maximum scratch space occurred during phase4 that has not yet been modified. This usually occurs when the model does not have large number of DOFs, but has a large number of modes.



- 4) Residual load/vector processing: Improved the handling of residual vectors especially when the residual loads are applied to massless DOFs. The table below shows the comparison between V4.1 and V4.2 for 14 different models with different DOFs and normal modes.

Previously, the user could overcome the problem by specifying a small mass on the massless DOFs. A unique algorithm has been developed that automatically corrects this problem.

There are new messages in the *.log file that indicate to the user how many residual vectors were specified and how many AMLS eliminated by orthogonalization with respect to other residual vectors or calculated eigenvectors, e.g.,

```
*****AMLS WARNING*****  
Residual flexibility eigenvalue not in acceptable range  
*****  
A residual flexibility eigenvalue equal to 1.684374E+21 was  
discarded because it was either negative or extremely large.
```

```
*****AMLS WARNING*****  
Residual flexibility vector annihilated by orthogonalization  
*****  
Residual flexibility vector 28 was discarded, because it was  
annihilated by making it orthogonal to the eigenvectors (normal  
modes) calculated for this analysis, and to other residual  
flexibility vectors.
```

```
73 residual flexibility vectors were specified in input data, and  
56 residual flexibility eigenpairs were returned by AMLS.
```

AMLS SCRATCH SPACE

There are many compute systems today with very large memories, e.g., linux_x86 with 256Gb of memory. AMLS v4.2.r22 now has significantly lower high-water mark for disk usage, as can be seen in Table 1. Thus, it is now possible to run the AMLS part of the analysis completely in memory.



Of the 14 example problems in Table 1, even for the model with ~20M DOFs (job name: 24M), requires a maximum of 142 Gb of disk space (compared to 486 Gb for v4.1). For a 256Gb linux_86 system typically ½ of the memory is reserved for “scratch” memory in /dev/shm. This can be confirmed by a simple linux command, `df -h /dev/shm`, and the output is:

```
Filesystem      Size  Used Avail Use% Mounted on
tmpfs           127G   0  127G   0% /dev/shm
```

For any AMLS analysis, the AMLS scratch directory is a sub-directory of the Nastran scratch directory. For large problems such as the 24M model, the Nastran disk high-water mark was 68 Gb. Clearly if one adds 68Gb and 142Gb the resulting scratch space exceed 127Gb shown above.

So for this problem, the first step is to increase the available memory for /dev/shm (which can only be done by the system manager). It is quite practical to make the /dev/shm ~80% of the total memory, e.g., 200Gb. The second step is to separate the Nastran and AMLS scratch directories. To accomplish this task, a new environment variable, `AMLS_SDIR`, has been introduced, as shown in a simple job execution script below,

```
#!/bin/sh
exe_dir=/appl/AMLS/4.2.r22_exe
SAVPATH=$PATH
export PATH=$SAVPATH:$exe_dir
export AMLS_SDIR=/dev/shm
nastran 24M.dat mem=4gb para=12 del=AMLS_2011
```

which points the AMLS scratch directory to /dev/shm. Using this approach, the total elapsed time is reduced by ~ 20%.



NASTRAN DELIVERY DATA BASE (DDB), (AMLS_****)

To use the new Delivery Data Base for Nastran, the user must have the 4.2 license file. The license file should have a number 4.2 in the following line in the file:

```
FEATURE phases2-5 amlsd 4.20 ...
```

This DDB will not work with previous versions of AMLS. To make sure that the most current DDB is being used, check the *.f06 file and near the top of the file should be a line:

```
CREATION DATE: 2011-12-11
```

DDB ERROR CORRECTIONS

- 1) Corrected an error in SOL 111 when the structure is represented by normal modes and the acoustic domain remains in its physical coordinates., i.e., only `method(structure) = sid` exists in the Case Control deck.
- 2) Some users have reported the following error when using Nastran with AMLS and the user specified only `FREQ3` or `FREQ4` or `FREQ5`. It does not occur with `FREQ`, `FREQ1`, or `FREQ2`.

```
USER FATAL MESSAGE 6647 (FRSRTD)
EXCITATION FREQUENCIES CAN NOT BE COMPUTED.
BECAUSE FREQUENCIES ARE NOT AVAILABLE.
USER ACTION: PROVIDE FREQ, FREQ1 OR FREQ2 CARDS
```

This error occurs before Nastran calls AMLS. The reason for this error is that before AMLS is called Nastran generates the applied loads so that the loaded DOFs can be determined. This is necessary so that AMLS recovers the appropriate eigenvector DOFs and subsequently Nastran performs the operation to reduce to loads to modal coordinates. However, `FREQ3`, `4`, and `5` require the knowledge of the natural frequencies. Naturally, these are not available before AMLS is called, thus one obtains the above error. As suggested by the message, the user should insert a single `FREQ` data record and the error will disappear, e.g.,

```
freq3, 77, 20.0, 760. $ desired specification
freq , 77, 20.0      $ necessary addition
```



- 3) Corrected an error when creating an external superelement. In subdmap AMLSCMP the generalized mass was wrongly calculated.
- 4) Corrected an error when generating an external superelement and using fixed boundary DOFs. The reduced mass matrix was not correct, it was correct when using free-free boundary condition.
- 5) Corrected an error when between V2008 and V2010 when loads are applied to Large Masses and the user requests residual loads, i.e., resvec = yes or param, resvec, yes.
- 6) Fixed a fatal error when using frequency dependent CAABSF from an external source via INPUTT4.
- 7) Fix the unsymmetric output from SMPYAD in standard NX Nastran in subdmap GMA and MPYAD for frequency dependent CBUSH in subdmap FREQRS.
- 8) Fix the error in SEDRCVR in NX Nastran in module SDR2 by adding the DIT input in the 4th position in SDR2.
- 9) Modified the DMAP for V2010+ to eliminate unnecessary long run times in module MODUG in subdmap DISPRS.

DDB ENHACEMENTS

- 1) A significant deficiency have been identified in Nastran in the user specifies:

param, shldamp, diff

From the MSC QRG:

Default = SAME

If SAME, then structural damping is obtained from MID1 material of PSHELL. If DIFF or any value not equal to SAME, each MIDi field of the PSHELL will have its own structural damping. See Remark 5. of the PSHELL.

When **param, shldamp, diff** is used then the structural damping matrix, K4JJX, is almost the same density as the stiffness matrix, KJJZ, even though only a small part of the model is structurally damped. This causes AMLS to run longer than necessary.



The current version of the DDB fixes this problem. The following example illustrates this fact:

Original KJJZ and K4JJX:

Matrix	Cols	Rows	F	T	NzWds	Density	NulCol
KJJZ	11233302	11233302	6	2	204	4.23213D-06	417907
K4JJX	11233302	11233302	6	2	204	4.10484D-06	831186

Because of the improvements in the DDB the density of K4JJX now is **9.35274D-08** vs. 4.10484D-06 before, or ~44 factor reduction!

K4JJX 11233302 11233302 6 2 142 9.35274D-08 10950710

The difference in the elapsed time for AMLS for the two cases is 5059 vs. 3385 secs, a factor of 1.5 improvement.

- 2) Some users with systems (specifically intel_x86) having 12 CPUs noticed that running AMLS with all 12 CPUs is slower than running with 8 or less. This is primarily owing to the deficient I/O subsystem. Also, the AMLS time does not linearly decrease with the increase in the number of CPUs. However, FastFRS elapsed time is almost linear with the number of CPUs. By default, the number of CPUs used by AMLS and FastFRS is the same, either by specifying `parallel=n` on the Nastran command line, or by specifying `param, amlsncpu, n` in the Bulk Data deck. Therefore a new parameter has been introduced, `ffrsncpu`.

`param, ffrsncpu, n [default =-1, use amlsncpu or parallel value, = n, means ffrs will use n CPUs]`

- 3) Generation of External Superelements. AMLS can be used in the generation of the external superelement, especially when the model to be reduced is quite large. There are only two choices for the selection of the constraints for the boundary DOFs, fixed-fixed or free-free. Fixed-free is not allowed when using AMLS. For most practical purposes, the free-free BC with residual vectors (an absolute requirement) is highly recommended, because it can be significantly more efficient computationally than the fixed-fixed, and in most cases, it is also physically the most meaningful. Below is a simple input file that illustrates the free-free case, where the model to be reduced includes the structure and fluid.



Release Note CDH/AMLS V 4.2r22 and CDH/FastFRS V1.0.255

```
ASSIGN OUTPUT2='body_cav_AMLS.op2' UNIT=90 DELETE
ID MSC 2011
SOL 103
CEND

TITLE = CMS Generation
METHOD(STRUC)=100
METHOD(FLUID)=300
RESVEC(RVDOF,NOINRL)=YES $ absolutely necessary
EXTSEOUT(ASMBULK=MANQ,EXTID=100,DMIGOP2=90)
set 1 = 269,689, 3001,3003,3005,3007 $ boundary and interior points
disp(plot) = 777
$
BEGIN BULK
param, amlscmp, yes $ required
param, autoqset,yes $ generates SPOINTS and QSETs automatically

rvdof1,123,689,3001,3003,3005,3007 $ required for residual vectors

$ Introduced in V2011
accsspt, 269,689
accsspt, 3001,3003,3005,3007

EIGRL          100          800.
EIGRL          300          800.

include 'air_cavity.bdf'
include 'box.bdf'
ENDDATA
```



FastFRS ENHANCEMENTS

FastFRS V1.0.255, in combination with DDB changes, supports frequency dependent matrices. Also required are some special DMAP alters to make this functionality fully operational. These can be obtained from CDH AG by contacting support@cdh-ag.com.

Frequency dependent matrices are created by the following Nastran Bulk Data entries:

PBUSHT
PELAST
PDAMPT
PAABSF (referencing either TZREID or TZIMID)

The previous versions of FastFRS did not support the frequency dependent matrices and the solution would revert to the standard Nastran FRRD1 module (Gaussian Elimination). Unfortunately, depending on the number of normal modes and excitation frequencies, the solution time could be quite long.

The new approach requires the user to first run a small job that contains only the frequency dependent elements and the associated grid points, properties, coordinate system, etc. This calculation saves the frequency dependent matrices, which are then read in the actual analysis of interest. This procedure is described in the CDH document, "[MODAL FREQUENCY RESPONSE WITH FREQUENCY DEPENDENT MATRICES.](#)" This document can also be obtained by contacting support@cdh-ag.com.

The result of this new approach and FastFRS 1.0.255 is that the modal frequency response solution time can be dramatically reduced, in some cases by several orders of magnitude. However, the reduction is very much dependent on the number of normal modes, number of excitation frequencies, and the number of loading conditions.