HEC-FDA
Version 1.4.3, June 2021
Release Notes

HEC-FDA Version 1.4.3 is a minor update to HEC-FDA Version 1.4.2, which was released in July 2017. This document describes the updates.

- HEC-FDA has become more unstable because of Windows 10. This occurs during the adding of configuration items such as plan, year, stream, reach, and category. When adding multiple values using the GUI for a given configuration item such as plans, the program sometimes aborts. While the issue of the program aborting is not feasibly resolvable (due to the instability of FDA in Windows 10), Version 1.4.3 now checks the database for integrity after the program aborts when the study is re-opened (and each time a study is opened), and repairs the database if necessary. A workaround is to import the configuration items through the Economics >> Import ASCII tab delimited text files, especially in the case that you are adding/revising many items.
- The import software was modified so that when probability exceedance functions are imported, HEC-FDA will compute confidence limits about the curve and store the limits in the FU_CALCTAB field in the exceedance probability function database PROBDATA.dbf.
- The number of "standard" probabilities internal to FDA has increased from 46 to 173 (graphical and analytical frequency curves). Previously, when entering a Log Pearson III analytical curve, the maximum number of calculation points was limited to 46. With the expansion to 173 points, greater accuracy was introduced. The two statements below show the standard probabilities, first for version 1.4.2 (analytical) and the second is for version 1.4.3 (graphical and analytical). When using graphical probability functions, FDA tried to add additional calculation points and performed a sophisticated error analysis to determine those points that should be added. This was not the case when analytical probability curves were used. The calculation points were fixed at 46 with some adjustments for fragility curves. Now, the 173 standard probabilities are the same for both graphical and analytical.

  Original standard probabilities for analytical probability functions.

```
 data pstand /.999,.99,.95,.90,.80,.70,.60,.50,  ! 8
*             .475,.45,.425,.40,                 !12
*             .375,.35,.325,.30,                 !16
*             .275,.25,.225,.20,                 !20
*             .175,.15,.125,.10,                 !24
*             .075,.05,.04,.025,                 !28
*             .02,.015,.01,0.0095,0.009,         !33
*              0.008, 0.007,0.006,0.005,0.0049,  !38
*              0.004,0.002,0.00195,0.0015,       !42
*              0.001,0.000195,0.00015,0.0001/    !46
```

  New standard probabilities for graphical and analytical probability functions

```
 data nstandG /173/
 data pstandG /
* 0.99900, 0.99000, 0.95000, 0.90000, 0.85000, 0.80000, 0.75000,
* 0.70000, 0.65000, 0.60000, 0.55000, 0.50000, 0.47500, 0.45000,
* 0.42500, 0.40000, 0.37500, 0.35000, 0.32500, 0.30000, 0.29000,
* 0.28000, 0.27000, 0.26000, 0.25000, 0.24000, 0.23000, 0.22000,
```

```
* 0.21000, 0.20000, 0.19500, 0.19000, 0.18500, 0.18000, 0.17500,
* 0.17000, 0.16500, 0.16000, 0.15500, 0.15000, 0.14500, 0.14000,
* 0.13500, 0.13000, 0.12500, 0.12000, 0.11500, 0.11000, 0.10500,
* 0.10000, 0.09500, 0.09000, 0.08500, 0.08000, 0.07500, 0.07000,
* 0.06500, 0.06000, 0.05900, 0.05800, 0.05700, 0.05600, 0.05500,
* 0.05400, 0.05300, 0.05200, 0.05100, 0.05000, 0.04900, 0.04800,
* 0.04700, 0.04600, 0.04500, 0.04400, 0.04300, 0.04200, 0.04100,
* 0.04000, 0.03900, 0.03800, 0.03700, 0.03600, 0.03500, 0.03400,
* 0.03300, 0.03200, 0.03100, 0.03000, 0.02900, 0.02800, 0.02700,
* 0.02600, 0.02500, 0.02400, 0.02300, 0.02200, 0.02100, 0.02000,
* 0.01950, 0.01900, 0.01850, 0.01800, 0.01750, 0.01700, 0.01650,
* 0.01600, 0.01550, 0.01500, 0.01450, 0.01400, 0.01350, 0.01300,
* 0.01250, 0.01200, 0.01150, 0.01100, 0.01050, 0.01000, 0.00950,
* 0.00900, 0.00850, 0.00800, 0.00750, 0.00700, 0.00650, 0.00600,
* 0.00550, 0.00500, 0.00490, 0.00450, 0.00400, 0.00350, 0.00300,
* 0.00250, 0.00200, 0.00195, 0.00190, 0.00185, 0.00180, 0.00175,
* 0.00170, 0.00165, 0.00160, 0.00155, 0.00150, 0.00145, 0.00140,
* 0.00135, 0.00130, 0.00125, 0.00120, 0.00115, 0.00110, 0.00105,
* 0.00100, 0.00095, 0.00090, 0.00085, 0.00080, 0.00075, 0.00070,
* 0.00065, 0.00060, 0.00055, 0.00050, 0.00045, 0.00040, 0.00035,
* 0.00030, 0.00025, 0.00020, 0.00015, 0.00010
*/
```

- The ASCII tab delimited exceedance probability function import/export file contains a new field for graphical exceedance probability functions labeled PROBMATH that represents the point (frequency) at and after which the standard deviation of error is held constant. We advise that this field is left blank so that the .01 exceedance probability default configuration is used globally. In rare instances, this field may be used to set the point at and after which the standard deviation of error is held constant by reach. An example of such a case is an instance in which the stage-probability function goes flat at the .01 exceedance probability (stage does not increase much as exceedance probability decreases) because of a physical barrier such as a railroad embankment or levee. In such a case, using the default setting may produce unreasonable uncertainties. **We advise the user to please contact HEC staff if you are interested in using this option.** To edit the default value for a given reach, enter an appropriate value in the PROBMATH field (one of the standard exceedance probabilities as listed above) in the ASCII tab delimited exceedance probability function import file. Upon import of the exceedance probability functions, the confidence limits about the curve will be calculated reflecting the given values of PROBMATHI. If the PROBMATHI field is left blank in the import file, then the global value for PROBMATHI defined in ECONPARM.dbf is used.
- The GUI now updates the standard probabilities in the database for water surface profiles when water surface profile probabilities are changed. Previously, it wasn't updated which resulted in erroneous probability output to the Fda_StrucDetail.txt file when the user changed the default exceedance probabilities in the water surface profiles.
- The default number of calculation points and simulations have been increased for the stage-aggregated damage function, and the default number of calculation points have been increased for exceedance probability functions. This increase is useful for input functions that are exceedingly non-linear; increasing the number of calculation points provides a better approximation of the curve. In the case of highly non-linear functions, and generally, increasing the number of simulations raises confidence in a representative estimate.
    - The stage-aggregated damage calculation software was changed to allow a maximum of 100 coordinates in the function. The previous limit was 60.

- For new studies, the stage-aggregated damage calculation software was changed to set the default minimum / maximum number of coordinates to 35/60 (previously it was 20/30).
- For new studies, the stage-aggregated damage calculation software was changed to set the default number of Monte Carlo simulations to 500 (previously it was 100).
- The number of probability coordinates of an exceedance probability function displayed in the GUI and written to the database have been increased to 44. Previously, the number of probability coordinates displayed in the GUI was 18 and 40 were stored in the database.
- If you convert a study from a previous version to version 1.4.3, you will need to manually update the minimum / maximum number of coordinates and simulations to the new default values and recalculate the functions.

- The stage-aggregated damage calculation software was changed to optionally calculate EAD without risk at each structure. It calculates probability-damage at 42 probabilities and truncates damage when a levee is present but doesn't calculate geotechnical failure. It is computed if:
    1. The compute stage-aggregated damage optional trace is set to 5 or greater and the Fda_StrucDetail.txt file is written. At this trace level, FDA produces a table of EAD by reach for each category and a flood zone summary table showing the incremental number of structures in each flood zone using the zero damage point.
    2. If the trace level is 7 or greater, FDA additionally produces one line for each structure with the EAD.
    3. If the trace level is 8 or greater, FDA produces one line for each structure that includes the EAD, the incremental EAD, the total damage, and the water surface elevation at each of the 42 probabilities.

  All of these numbers are calculated without uncertainty. They are written to the file "Fda_EadTrace.txt" which is located in the data directory with all of the .dbf files.

Structure	Category	Reach	Station	EAD	0.999	0.99	0.95	0.9	0.8
399	COMM	SF-8	9.9	0	0	0	0	0	0
402	APT	SF-8	9.75	0.03884	0	0	0	0	0
403	APT	SF-8	9.73	0.026866	0	0	0	0	0
404	APT	SF-8	9.71	0.010844	0	0	0	0	0
405	APT	SF-8	9.69	0.011847	0	0	0	0	0
406	APT	SF-8	9.66	0.008762	0	0	0	0	0
407	APT	SF-8	9.64	0.088299	0	0	0	0	0
408	APT	SF-8	9.62	0.051933	0	0	0	0	0
409	APT	SF-8	9.6	0.075227	0	0	0	0	0
410	APT	SF-8	9.58	0.015436	0	0	0	0	0
411	APT	SF-8	9.565	0.015773	0	0	0	0	0
412	APT	SF-8	9.5	0.015853	0	0	0	0	0
413	APT	SF-8	9.475	0.203308	0	0	0	0	0
414	APT	SF-8	9.45	1.83512	0	0	0	0	0
415	APT	SF-8	9.42	1.57188	0	0	0	0	0

Figure 1 Example EAD by Structure in File Fda_EadTrace.txt (partial table)

Expected Annual Damage by Reach and Category						
Reach	APT	AUTO	COMM	PUB	RES	Total
SF-8	36.52	0.00	0.55	0.00	1.56	38.63
SF-9	413.48	24.18	37.54	0.01	66.44	541.66
Total	450.01	24.18	38.09	0.01	68.00	580.29

Figure 2 Expected Annual Damage by Reach and Category in File Fda_EadTrace.txt

Flood Zone Summary, Reach: SF-9						
Probabilit	APT	AUTO	COMM	PUB	RES	Total
0.5	35	0	0	0	26	61
0.2	1	1	0	0	8	10
0.1	6	1	0	0	15	22
0.04	2	0	2	0	2	6
0.02	0	0	3	0	7	10
0.01	0	0	0	0	1	1
0.005	0	0	3	0	2	5
0.002	0	0	4	1	2	7
0.001	0	0	0	0	0	0
Above	0	0	0	0	0	0
Total	44	2	12	1	63	122

Figure 3 Example Flood Zone Summary Table in File Fda_EadTrace.txt

- All of the text output files that used to have the extension of .out now have the extension .txt. (Example, Fda_StrucDetail.out is now Fda_StrucDetail.txt). This eases the task of renaming an output text file when saved as an Excel file. Converting a study to Version 1.4.3 and re-computing will not delete existing files with the .out extension. Instead, the files with the new extension may be found alongside the existing files with the .out extension. Users are free to delete the files with the .out extension.
- The GUI now writes the full distribution of EAD and AEP to the text file "Fda_Results.txt". In HEC-FDA, the user selects "`Evaluation->Results->Damage by Analysis Year`" and then selects the Summary Type "`Damage Reduced Distribution`" and the Summary Information "`Damage Reaches`". After the user selects the appropriate plan and year, HEC-FDA will then display the damage reduced and distributed for each reach in the GUI, will write the same table to the file "Fda_Results.txt" followed by the full distribution of EAD and AEP for all reaches for the selected plan / year. For the full distributions, HEC-FDA does not write damage reduced but the actual damage distribution. Example output from the file "Fda_Results.txt" is shown below:

Report Expected Annual Damage Reduced and Distributed by Reaches.									
Study:	Bear Creek Based on BearWs5s								
Plan:	Plan 1								
Plan Description:	Detention + Channel Imp.								
Year:	2021								
Monetary Units:	$1,000's								
Version 1.4.3, June 1, 2018; Less Simple Method (0.010)									
Stream Name	Plan Description	Reach Name	Reach Description	Total Without Project	Total With Project	Damage Reduced	Prob Damg Reduced Exceeds Values 0.75	Prob Damg Reduced Exceeds Values 0.50	Prob Damg Reduced Exceeds Values 0.25
S Fork Bear	S. Fork Bear Creek	SF-8	BASHFORD	224.64	36.45	188.20	101.10	149.67	225.36
		SF-9	BARDSTOV	730.43	550.58	179.85	91.73	159.23	240.37
	Total for stream: S Fork Bear			955.07	587.02	368.05	192.83	308.90	465.73
Plan:	Plan 1								
Year:	2021								
Stream:	S Fork Bear	Descriptic	S. Fork Bear Creek						
Reach:	SF-8	Descriptic	BASHFORD MANOR LN TO BARDSTOWN RD SM. 9.0-9.96						
Bin Number	EAD	Hits	Frequency	1-Frequency					
1	0.310311	0	1	0					
2	2.7052	256	0.992686	0.007314					
3	5.10009	1169	0.959286	0.040714					
4	7.49498	2000	0.902143	0.097857					
5	9.88988	2277	0.837086	0.162914					
6	12.2848	2098	0.777143	0.222857					
7	14.6797	2007	0.7198	0.2802					
8	17.0745	1840	0.667229	0.332771					
9	19.4694	1616	0.621057	0.378943					
10	21.8643	1428	0.580257	0.419743					
11	24.2592	1392	0.540486	0.459514					
12	26.6541	1283	0.503829	0.496171					
13	29.049	1259	0.467857	0.532143					
14	31.4439	1083	0.436914	0.563086					
15	33.8388	1112	0.405143	0.594857					
16	36.2337	963	0.377629	0.622371					
17	38.6286	958	0.350257	0.649743					
18	41.0235	883	0.325029	0.674971					
19	43.4184	781	0.302714	0.697286					
20	45.8132	754	0.281171	0.718829					
21	48.2081	682	0.261686	0.738314					
22	50.603	663	0.242743	0.757257					
23	52.9979	624	0.224914	0.775086					
24	55.3928	588	0.208114	0.791886					
25	57.7877	539	0.192714	0.807286					
26	60.1826	514	0.178029	0.821971					
27	62.5775	461	0.164857	0.835143					
28	64.9724	455	0.151857	0.848143					
29	67.3673	450	0.139	0.861					
30	69.7622	397	0.127657	0.872343					
31	72.157	324	0.1184	0.8816					
32	74.5519	366	0.107943	0.892057					
33	76.9468	291	0.099629	0.900371					
34	79.3417	279	0.091657	0.908343					

Figure 4 Example EAD Distribution (partial table)

Plan:	Plan 1			
Year:	2021			
Stream:	S Fork Bear	Descriptic	S. Fork Bear Creek	
Reach:	SF-8	Descriptic	BASHFORD MANOR LI	
Bin Number	AEP	Hits	Frequency	1-Frequen
1	0.000273446	0	1	0
2	0.001444	256	0.988429	0.011571
3	0.00261456	1169	0.948457	0.051543
4	0.00378511	2000	0.884286	0.115714
5	0.00495567	2277	0.8544	0.1456
6	0.00612622	2098	0.838171	0.161829
7	0.00729678	2007	0.822829	0.177171
8	0.00846733	1840	0.809114	0.190886
9	0.00963789	1616	0.794771	0.205229
10	0.0108084	1428	0.771743	0.228257
11	0.011979	1392	0.746314	0.253686
12	0.0131496	1283	0.725371	0.274629
13	0.0143201	1259	0.708486	0.291514
14	0.0154907	1083	0.695	0.305
15	0.0166612	1112	0.688829	0.311171
16	0.0178318	963	0.681143	0.318857
17	0.0190023	958	0.673771	0.326229
18	0.0201729	883	0.665343	0.334657
19	0.0213434	781	0.662143	0.337857
20	0.022514	754	0.658371	0.341629
21	0.0236846	682	0.653257	0.346743
22	0.0248551	663	0.646057	0.353943
23	0.0260257	624	0.629514	0.370486
24	0.0271962	588	0.611543	0.388457
25	0.0283668	539	0.5936	0.4064
26	0.0295373	514	0.577	0.423
27	0.0307079	461	0.561771	0.438229
28	0.0318784	455	0.545086	0.454914
29	0.033049	450	0.529857	0.470143
30	0.0342196	397	0.514057	0.485943
31	0.0353901	324	0.4982	0.5018
32	0.0365607	366	0.4834	0.5166
33	0.0377312	291	0.4692	0.5308
34	0.0389018	279	0.456114	0.543886

Figure 5 Example AEP Distribution (partial table)

- The water surface profiles are now stored as tab-delimited text in the memo fields rather than as a binary. When using a dBASE file editor, the user can “see” the data and can cut / copy / paste between it and a spreadsheet. It also facilitates future development using other languages than the present C++ (e.g. C#).

- Version 1.4.3 will automatically upgrade the database from earlier versions 1.2.5, 1.4.0, 1.4.1, and 1.4.2. Once updated to version 1.4.3, the database cannot be used with earlier versions of the program.

Using a Study Created in a Previous Version of HEC-FDA

HEC-FDA Version 1.4.3 can directly import studies created in Versions 1.2.4, 1.2.5, 1.2.5a, 1.4.0, 1.4.1, and 1.4.2. However, once these studies are imported in to Version 1.4.3, the study database will be converted to a new format and will no longer be compatible with earlier Versions of the program. For earlier study versions, it is advisable that users save a copy of their Version 1.2.4, 1.2.5, 1.2.5a, 1.4.0, 1.4.1, or 1.4.2 studies before importing them into Version 1.4.3. To import a study into Version 1.4.3, open the study in Version 1.4.3. A notice will appear stating that "This study has a database for an older Version of HEC-FDA and must be converted for use with this Version of the program. You should make a backup of your database before proceeding. Do you want to update your database to the new Version?" If the user clicks **Yes**, the study will be converted into the Version 1.4.3 format. Studies created in earlier (than Version 1.2.4) versions of the program will have to be converted to Version 1.2.5a before they can be imported into Version 1.4.3.

Notes about HEC-FDA Versions 1.4.0, 1.4.1, 1.4.2 and 1.4.3

When running HEC-FDA Version 1.4.0, Version 1.4.1, Version 1.4.2 or Version 1.4.3 in the Windows 10 operating system, a command prompt (DOS) window containing the Galaxy® debug message opens. Galaxy® is the commercial library that was used to create the HEC-FDA GUI. This window can be minimized but not closed while running HEC-FDA. This is described further in the Version 1.4.0 release notes.

HEC-FDA is distributed with two primary executables: 1) fdaPerformance.exe, and 2) fda.exe. The difference between the two executables is that fdaPerformance.exe is the default program and is computationally faster than fda.exe. It is what is called a "release" version. Fda.exe is the alternative executable and is considered a "debug" version and produces the additional DOS window as described above. In a few instances, fda.exe is more stable than fdaPerformance.exe but those appear to be rare instances.

Starting with HEC-FDA Version 1.4.2, HEC-FDA is also distributed with two additional required executables: 1) CreateNewStudy.exe, and 2) ConvertDb.exe. These are required to create a new Version 1.4.3 study and to convert an old study to a Version 1.4.3 study in a Windows 10 operating system. HEC-FDA directly calls these executables and they are run in a command prompt (DOS) window that will automatically close once the program has completed the create / convert operation.

Starting with HEC-FDA Version 1.4.2, HEC-FDA is also distributed with several additional optional programs. These are "DOS" programs run in a command prompt window typically called using a script (*.bat) file. To use these, the user would want to create a script (*.bat) file that calls the script files stored with the HEC-FDA executables. See the separate document "HEC-FDA DOS Programs 2020" for more information.

The primary update implemented in Version 1.4.0 (change to Version 1.2.5a) is the computation methods used to define uncertainty distributions about graphical flow or stage frequency curves. These methods continue to be implemented in Version 1.4.3. This update is described in detail in the Version 1.4.0 release notes.