

No more 'reference xxx not found in master'

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A debugging guide for heavily modded Morrowind games

Version 1.0

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Classic mod conflicts and how to deal with them are a well-known topic among players and modders and diagnostic tools and methods of repair are available, and the knowledge about this is well documented. However, when playing a heavily modded game, even after dealing with mod conflicts in the various possible ways, and without having done one of those things that are known to produce errors in saved games (e.g. ?dirty? saves), many players are still plagued by strange and totally baffling error messages that, at first, seem to appear with no logic whatsoever and afflict in-game items totally unrelated to any plugin conflict problems. In this document, I attempt to pave the way to a game free of these error messages and their probable causes. Since most of them are not real mod conflicts, but the consequences of bugs in the Morrowind game engine, but also in plugins that only become apparent when many plugins are used, which some fulfil a set of specific conditions, I call this a debugging guide rather than a guide to removing obscure mod conflicts.

This document consists of the following chapters:

- (1) What this document does, and does not, deal with
- (2) The tools you need.
- (3) Technical Background
- (4) The causes of most problems
- (5) A testing environment ? some practical considerations
- (6) Debugging, pass one: problems that appear without loading a saved game
- (7) Debugging, pass two: problems that appear when loading and re-saving a game
- (8) Debugging, pass three: illegal actions and remaining mysterious stuff

If anyone who reads this finds any mistakes, anything that has been left out or should be answered by this document, contact me by PM in the Elder Scrolls forums. I aim to make this guide as comprehensive as possible. Constructive criticism is always welcome, even if I might not always be able to answer to it, if you feel that my language is too technical. I'm a programmer, and I feel that technical matters need technical language, even at the cost of easy understanding.

Many thanks go to Wrye for his powerful debugging tool Wrye Mash, without which this would have been impossible and I would not now be playing a game totally untroubled by bad references so far, even of the invisible kind.

- (1) What this document does, and does not, deal with

Not covered in this post are

§ Classic mod conflicts. Classic mod conflicts are logical within the context of the mods' content. If two mods change the same aspect of an object in different ways, they cause a conflict. If two mods place something in the same place, probably they can't be used together without editing one. Things like this are well-documented and can be detected and removed by various utilities and common sense.

§ Classic dirty saves. Meaning the kind of dirty saves you may get by using an old saved game with a changed mod setup or a changed mod. This topic is also well documented, and [Wrye Mash](#) utility is available to remove most problems that result if you can't avoid changing your mod setup in a running game.

Now, if you're just a few hours into a new game, have never used an older save with a changed mod setup, and if you still get baffling error messages and strange things happen in your game that seemingly have nothing to do with anything that might cause a classic conflict, then this debugging guide may help you. It specifically covers the following symptoms and some of their possible causes:

- Objects are doubled, and/or objects that you have already taken reappear after loading a saved game. If you really didn't use an old save with changed plugins, this should never happen to you. It is possible that a mod does this by attempting something made illegal by another mod, but that is extremely rare. Most cases are caused by a bug.
- Objects are gone after loading a saved game. Mods can't easily, if at all, make an object added by another mod disappear. If this happens, it's most likely caused by a bug.
- Error messages like "Can't load " appear when loading a saved game, but not when starting a new one. Especially if the spell is well known and you suspect that many NPCs and/or creatures have it, like "resist disease_75".
- Error messages "Can't load script " appear when loading a saved game, but not when starting a new one.
- Error messages "Reference not found in master" appear in-game or while loading a saved game. Again, if you haven't changed your mod setup, this should never happen.
- Wrye Mash reports "Bad Refs" for an area you have entered for the first time and saved immediately.
- Wrye Mash reports "Bad Refs" in a savegame file you have saved after having loaded a saved game (or for the first save in a new game), and these "Bad Refs" reappear in your new save when you load the save and immediately save it again.

(2) The tools you need

In order to fix the problems associated with the aforementioned problems, you will need the following utilities:

- The [TES Plugin Tool 1.3](#) (TESTool) by Ghostwheel. For a multi-mod setup, likely leveled list and object merging is necessary. You will have to remerge your objects and leveled lists often while testing. Note that Wrye Mash's leveled list merger seems to have a problem with the Giants Ultimate plugin if you have it. I use TESTool to clean it (not advisable, I'm told, but I've had no ill effects), so I continue to use TESTool for merging leveled lists. In that case, you will also need [Leveled List Resequencer](#) that corrects the results of a bug in TESTool.
- [Wrye Mash](#) version 0.60 or later. Version 0.60 adds the new function "Renummer References", so earlier versions will not help you with the two problems being most often responsible for the aforementioned problems.
- [The Morrowind Enchanted Editor](#) (often abbreviated as EE from here on), version 0.91c, including [Ming's patch](#) (since the original link is dead, I have put it in on my homepage). If you find the time, familiarize yourself with the esp file structure somewhat. I'll explain the most important stuff below, but reading the manual may help in putting it into a context.

(3) Technical Background

Sorry, but this is really necessary. You can't debug your mod setup, especially not if you have the kind of problems that made you read this post up to this point, without a detailed understanding of what you're doing. You can get most of this knowledge from [Scripting for Dummies](#), [Wrye Notes](#), [Wrye's Doubling Explained](#), the [Enchanted Editor Manual](#), and the [UESP Wiki](#) (as I write this, the link is dead but will hopefully reappear soon) and if you'd like to go hardcore [ESP file structure documentation](#). I don't know the author ? it's not by me, but it will be very useful ? but I'll cover some of it again here. Here is what you should know:

- Objects and references and their differences. If you're a modder, you will already know this (and if you don't, learn it before you make your next mod. Immediately!). Anyway, familiarize yourself with the terms ?object? and ?reference? within the context of the Morrowind game engine. ?Scripting for Dummies? and other documents cover this in detail, so I'll give you the short version: a ?reference? is what you would call an ?object? in everyday language ? everything that you see in the render window of the Construction Set, or in the game world when you play, is a ?reference?, a realization of a template. The term ?object? refers to this template, and these are what you see in the objects window of the Construction Set.
- The Construction Set (often abbreviated as CS from here on). You should know how to work in the render window of the Construction Set. The best guide to the Construction Set is [The Morrowind Mod Maker Manual](#) by Jorin.
- You needn't know about landscaping or dialogue, only about the render window and what a ?cell? is.
- What esps and esms can and cannot do ([Wrye Notes](#)). In short, esp files cannot change references added by other esp files, and esm files cannot change references added by other esm files. Attempts to do so may result in doubling, and possibly ?Bad Ref?s reported by Wrye Mash. Note that illegal actions attempted with esms or esps are rare. Those I have discovered will probably have no negative in-game affect above the cosmetic level.
- The in-game console. You should know some of the commands you can use here, especially ?coc?, ?coo?, and ?ori? (see [Scripting for Dummies](#)).
- What ?master? files are. In short, within the context of the Morrowind game design, a master file is a file that is necessary to be present and loaded into memory for another one to load correctly. As a rule, a plugin file's masters are the Bethesda esm files and, if the plugin is an esp file, possibly one or more plugins that come in esm format. Most importantly, the masters of a saved game file (.ess) are all the original .esm files that were loaded when this game was saved.
- Mod indices and object indices. Every reference placed into the world has a unique identifier made up of a ?modindex? and an ?objectindex? (also see [Wrye Notes](#)). This is most important for this document, so I'll cover it in some more detail:
 - o The modindex: The modindex is the number of a mod in your list of activated mods. If you look into your Morrowind.ini, near the end you see a list of file names preceded by ?GameFilennn=filename.es*?. If the list is ordered alphabetically, start TESTool, select ?manage active plugins?, and in plugin selection window hit the ?Load Order? button, then OK. Your Morrowind.ini will be updated to present its plugin list sorted by load order. Look into it again: the number (given as ?nnn? above) following ?GameFile? is the modindex for the plugin activated with this line. Note that the numbers start with zero. Wrye Mash presents this modindex with a base of 1 instead, so when you interpret the modindices reported by Wrye Mash you must always subtract 1 from them to get to the right GameFile entry in Morrowind.ini. Furthermore, the modindex depends on load order only, not on the way the list in Morrowind.ini is ordered. If that list is ordered alphabetically, you will be able to interpret Wrye Mash's output correctly. Some utilities set the list order to alphabetical, most notably TESTool ? so when using TESTool, remember to always hit the ?Load Order? button before you leave the plugin selection window.
 - o The objectindex. When someone makes a plugin that adds at least one reference to the game (not a

the Construction Set gives those references numbers to identify them within this plugin. It numbers the references sequentially, always (!!!) starting with 1. Due to a bug in the Morrowind engine, this has some consequences that are responsible for a whole range of the symptoms mentioned in Chapter 1. The CS follows the same "geographic" pattern - it starts with exterior cells, from the upper right corner of the columns, so to speak, down to the lower left, then follows up with interior cells in alphabetical order. Unfortunately, this repeating pattern exacerbates the problems.

(4) The causes of most problems

The symptoms described in Chapter 1 above may appear in an otherwise clean game under certain conditions. Any one of the symptoms might result from any one of these conditions, and it is not predictable which will be outside of exactly defined testing conditions:

- (I) Two plugins place references in the same cell to which the Construction Set has assigned the same index, one of the pair has the "references persist" flag set, the other has not, and the latter has been saved and included into the saved game. This is covered in some more detail on the UESP Wiki under "Mod Conflicts: Local References".
- A plugin places a leveled creature into the same cell as another plugin places a leveled creature or NPC and the CS has assigned the same object index to both. This may be a permutation of (I), but current understanding is that creatures are always persistent, so leveled creatures shouldn't cause this. But mods indicate that they do. This usually results in vanished leveled creatures or NPCs.
- A plugin adds a reference to an object with a script on it to an existing area, or changes an existing reference in an area to have a script, and there is among these a reference with the same object index as one reference placed by another mod in the same cell. This may also be a permutation of (I).
- A plugin attempts to move a reference out of its original cell, instead of deleting it from its old cell and adding a new reference in the new cell. Moving references between cells might or might not be technically legal, whether or not it is, it causes bugs. Doing this with the CS in exterior cells is easy - and it's almost always overlooked that you have done it. My knowledge of the Construction Set is far from complete, but so far I have not found a way to move references out of interior cells.
- A plugin creates a second copy of an existing reference added by another plugin or esm file, but keeps it at exactly the same place and does not change it in any way. As a rule, this is considered "dirty", but it is technically legal and should not result in any errors. But sometimes it does.

(5) A testing environment - some practical considerations

This chapter gives some advice to make testing and debugging easier in practice. It's mostly common sense advice, but if you're frustrated by baffling error messages you'll possibly think of this only after all the other things already been done. Make your life easier and set up your game and tools like this.

- Setting dates on your mods. Your plugins should consist of - for the purposes of debugging - three groups of mods that should not be merged, like MultiMark, Private Mobile Base and a few others. Set their file dates to some day far in the future. (II) all other mods excepting merged_objects.esp and merged_leveled_lists.esp (or mashed_lists.esp). Set their dates to some day(s) in the recent past. Group and order as you prefer, as required by the mods themselves. (III) merged_objects.esp and merged_lists.esp. Set their dates to yesterday. If you use Wrye Mash for this, it will remember the dates and always automatically reset them if some mod changes them. The background for this is that whenever you remerge your objects and forget to run Wrye Mash to correct the dates (it happens in the heat of this work), the merged files will keep their place in the load order anyway. It also makes deselecting the mods which must be excepted from merging easier because

will always be at the end of the list. You could use Wrye Mash's list features for this, but in a testing environment the lists change often, changing Mash's load lists every time is a PITA, and attempts to use those lists that include mods that no longer exist result in error messages and do nothing. I find it easier to use TESTool and select and deselect manually.

- Convenient placement of tools. Place links to TESTool, Wrye Mash, Leveled List Resequencer and Enchanted Editor onto your desktop. You will be able to work so much faster...
- Running TESTool and Wrye Mash at the same time has some inconvenient consequences ? when you use TESTool to select/deselect mods this can cause Wrye Mash to report errors when you switch back to it. You must probably deselect some mods before any merge operation, and only TESTool can merge objects, it's most convenient to do both with TESTool. I always end Wrye Mash before any merge operation, and restart it after.
- You will be starting many new games. [ThickChar](#) plugin will enable you to do this without reducing your computer to scrap metal in frustration about the wasted time.
- While testing, you won't like being bothered by long travel times, the inconvenience of enemy encounters suchlike. The BAR_RingPack plugin will give you a set of cheating rings that enable you to fly fast and be much less vulnerable. And using the [Runestone](#) plugin for moving around is preferable to using ?coc? in the console for many locations because you arrive at meaningful places, not below the landscape line etc.. The RingPack will also very likely produce an additional error message if any other mods are active that add things to the Census and Excise Office. I'd say this makes for a good practice run for Debugging, pass two (see Chapter 6 below)

(6) Debugging, pass one: problems that appear without loading a saved game

One thing in advance: if I say: exit the game, restart it and load the save, then ~~re-load it~~ ^{exactly that}. Never, ever load a save from within the game, however time-saving and convenient it may seem. This is a good rule for running games (which I always follow when I play), but for testing it is essential. I won't go into the technical details here, but believe me, you won't get any meaningful results if you ignore this.

OK, now into the gory entrails... er... the messy details. You have a mod setup that should really function reasonably well together, you have played for a couple of hours, saved and re-loaded a few times, and without ever having changed your mod setup in this particular game, you get doubling and/or reappearing objects, strange error messages etc..etc.. as described. I assume that you're using all three of the convenience features mentioned above. Here's what you do now:

(6.1) Pass one, making the bugs appear

Start a new game. Talk to the Legion officer, go back to the tutorial building and get your ring of levitation and invulnerability from the small chest behind the table. Leave the Census and Excise building. Save your game in a new slot. ?COC? to ?Balmora, Guild of Mages?, then walk down and get the Runestone from the travel platform. Walk out of the Mages' Guild. Wait a few seconds and save your game in a new slot. Teleport to Sadrith Mora harbor (Runestone: boats M-Z). Walk down to Wolverine Hall (until the cell name ?Wolverine Hall? appears in the lower right corner of the screen, meaning you have entered the cell named ?Wolverine Hall?). Wait a few seconds and save your game in a new slot. Teleport to ?Vivec, Arena?. Go outside. Walk to the arena. Save your game in a new slot. Teleport to Gnisiss. Wait a few seconds and save your game in a new slot. Exit the game.

(6.2) Pass one, diagnosis

Run Wrye Mash. Click on the ?saves? tab, look for your latest save and select ?Repair All? from its context menu. This will take some time. You will be ?rewarded? with a list of error messages. If no messages appear, you can count yourself lucky. Unless you want to check some more popular locations like Dagon Fel or you can now proceed to (7) Debugging, pass two. But if you have two or more of Morrowind Comes Alive, Creatures, Vampire Realism and Amulet of Scrye, to name only a few ? namely, any two mods that add creatures to many locations, you?re unlikely to pass this with no error messages. If you get too many messages, that means that your game has many problems, and you might get confused. It might be advised to check and debug an earlier save first. It?s your choice.

Anyway, let?s have a look at those error messages. You will see one or more of three kinds of messages followed by a summary of the number of deleted and rematched references. In fact, it is possible that you will see something very similar to this combination (summary not quoted):

[18,4]

BAD REF>>REMATCHED 9 1 vr_ex_aundae_town_rare 102

[18,3]

BAD REF>>NO MASTER 9 9 _mca_imperial_soldiers_random

[18,3]

BAD REF>>DOUBLED 128 9 _ivza_04_npc_merc3_1

The numbers in square brackets point you to the cell where this error has occurred. In this case, since only numbers, you know this is an exterior cell. For an interior, a name would be given, for instance ?Baldern Guild of Mages?. ?BAD REF? does, of course, mean that a reference has gone bad. A ?bad reference? means that something in your saved game cannot be correctly matched to its source in the esp and esm files using. Since you haven?t changed your mod setup, this really shouldn?t happen. REMATCHED means that Wrye Mash has found another mod with a reference using the same ID and objectindex, that this combination is unique, and that it has assigned the reference to that mod. NO MASTER means that Wrye Mash found more than one reference in any of the savegame file?s masters (including all active plugins) that correspond to the reference, and couldn?t decide which one is correct. DOUBLED means that a unique corresponding reference has been found in a game file but it was already assigned to another reference in the saved game.

Now look at the numbers following the text. the first number is the modindex of the plugin that has the bad reference, according to the data in the saved game. The second number is the object index of the reference, and the number at the end of line in the REMATCHED message is the modindex of the plugin Wrye Mash has assigned to the lost reference to repair it, using data from the saved game?s master files (the plugin?s master files). The name in-between is the name of the reference?s object template. If you loaded all your mods in the Construction Set you could see this name somewhere in the objects window.

What to leave alone for now. If you see any object indices between 100000 and 500000, ignore them!!! These are references placed by the original game, and anything involving them will be dealt with in chapter 8.

Now look into your Morrowind.ini. Suppose an excerpt of it, using the modindex numbers reported by Wrye Mash, looks like this:

GameFile8=Morrowind Comes Alive.esm

GameFile101=Vampire Realism II.esp

GameFile127= Amulet of Scrye.esp

You have now identified the mods that, in combination, cause the problem. To check this, start Enchan Editor. Load up ?Amulet of Scrye.esp?. Select ?Edit/Find All? in the menu and type ?_ivza_O4_npc_merc into the search field. Then click on ?Find all?. You will get a list of instances where this ID appears in the file. In this case, there are only two: an NPC_ record and a CELL record. References only appear in CELL records, so the first one has to be the definition of that NPC, the second one tells you where this NPC is placed in the game world. We aren?t interested in that NPC?s details, so select the CELL entry in the list, click on ?Go to reference?, then cancel the search window. In the left part of the window, the CELL record ?Wolverine Hall, Azura?s Coast Region? has been opened. Click on the header ?CELL Wolverine Hall.....? to make a list appear in the right part of the window. This list contains everything this esp file adds to the cell, everything from an esm file it changes (nothing of the latter here ? all references have low objectindices). Look at the numbers in the GridX and GridY entries: 18,3 (if ?Find All? finds too many entries and you don?t know where to look, remember that the names of named exterior cells are shown in-game when you enter them, the cells list in Enchanted Editor is sorted alphabetically). If you scroll this part of the window down, you will find a NAME_NEXT subrecord containing ?_ivza_O4_npc_merc3_1?, preceded by an FRMR subrecord with the same objectindex of ? surprise ? 9, and a flags field you can ignore. Do the same with the Vampire Realism II and Amulet files.

You can now interpret the error messages as follows:

- A reference in 18,4 falsely assigned to Morrowind Comes Alive.esm by the savegame file was correctly rematched to Vampire Realism II.esp
- A reference in 18,3 assigned to Morrowind Comes Alive.esm by the savegame file could not be matched to a reference of any plugin with the same objectindex in a non-ambiguous way. The reference was deleted.
- A reference in 18,3 assigned to Amulet of Scrye.esp was found to be already matched. The double was deleted.

In-game, you probably would have never noticed that a leveled creature and an unimportant NPC have disappeared, but now you know. Take special note of the combination of error message 2 and 3. A NO_MASTER combined with DOUBLED tends to be rather common, and if you see this and notice that the objectindices of both references are the same and they appear in the same cell, you immediately suspect

- a modindex mixup has occurred ? a reference was matched with a wrong mod (this is called ?reference mismatching?)
- the saved game is at fault, since you haven?t changed any mods in your setup, and the mods you?re using are popular ones that should be reasonably bug-free.
- this wouldn?t happen if the two mods didn?t place references with the same objectindex.

Indeed, these hypotheses happen to be completely correct. The reference mismatching is a bug in the engine. I?ll tell you how to get rid of this next. For now, save your list of error messages, especially if it is a long one. If you forget this, this is what the double-save at the last stop was for :). If the list is long, the error messages appear for many cells, you might want to look at one cell after the other, group the error messages accordingly and deal with them. Or, as I said above, deal with an earlier of your saves with fewer error messages first.

(6.3) Pass one, repair

As opposed to pass two, for this there is only one way to get rid of the annoying, but most likely not game-breaking errors: renumber the references in the afflicted cells. You could do this manually ? in fact, I have

to do this ? but it is a very time-consuming way to do it. Wrye Mash, as of version 0.60, has a function that does this automatically. It is used just like the Repair All function ? start Wrye Mash, select the ?saves? tab, select ?Rename Refs? from the selected savegame file?s context menu. Here are some guidelines on how to use it:

- The Construction Set automatically assigns object indices when you save an esp file. You have no influence on the numbering. So when you prepare for playing, try to avoid using Rename Refs on mods which you are likely to edit. If you must edit a renamed mod, then you must rerun Rename Refs after you have saved and cleaned the mod. The new version will only be compatible with old saves if you haven?t removed or changed anything. Since the CS adds extraneous entries, this is a condition hard to fulfil unless you use TESTTool?s cleaning function before every renaming. Getting things wrong might be repairable by Wrye Mash?s Repair All function just like every other dirty save, but it might also mess up your saved game beyond recognition. Be careful.
- When renaming, you can type in a starting number of your choice. To ensure unique indices, you should choose yourself. Start with 10000 ? landscape mods with higher counts are unlikely to cause problems. Quest mods of that size are very rare. Add the number of renamed references Mash reports when it is finished, and add an additional small buffer of 50-100 to get the starting number for the next mod. Always remember this last number to have a starting point for the next renaming. Mash will remember all your starting numbers for you.
- To rename an esm file, change its file extension to esp (don?t use any conversion utility, just change the extension), then run Rename Refs, then change the file extension back. BUT: This will mess up all esp files that depend on that master and change any of its references, resulting in *correct* ?cannot find in master? messages. One example: If you Rename Morrowind Comes Alive, the mod that gives its NPCs names (MCAnames4.1lore.correct.esp) will still function because it changes no references (you can check this by loading it into Enchanted Editor), but the Redesigned Vivec compatibility patch will have to be completely remade because it moves leveled creatures. If you run Mash?s Repair Refs on a mod affected thusly, like Morrowind Comes Alive, now-orphaned references will be removed. As a result, the esp file will function without error messages, but will not do to the references what it intended to do. EXTREME DANGER NOTICE: don?t do this to Bethesda esms. If you do so accidentally, you must re-install the game and all expansions and plugins.
- Within pass one, the mods likely to cause trouble are those that add references to many exterior cells. If you?re at it and you?re going to start a new game anyway, rename a bunch of them, as a preventative measure, just in case. I have done this to MCA, Creatures, Expanded Sounds, Illuminated Windows, Redesigned Vivec and Complete Trade Fix, among others, with absolutely no ill effects.
- I don?t know if Mash is limited to starting numbers below 100000 as Wrye said it would be. Morrowind uses indices between 100000 and 1000000, so NEVER USE THESE, even if you can. Avoid numbers below 100000 because they may be used by too many other mods. If possible, I would prefer numbers above 1 mil. because of the wider range, but if it is not possible, then you only have a range of 90000 and need to be selective. In all, landmass mods are highly unlikely to cause these problems.

(6.4) Pass one, extension and conclusion

It is possible that you will find all bugs in one go. If you rename a bunch of wide-ranging mods after your first save, you might be reasonably sure to never encounter the problems corrected in this pass again. Check this: recreate your merged objects and merged leveled lists files, start a new game and do the steps described in (6.1). Run Wrye Mash on the latest save. If it?s clean, this pass has been successful for the locations you have visited. You might or might not want to check other popular locations. You can be a

thorough as you like. Only remember this: if you load a saved game even once and go on to save it again, messages will appear that have nothing to do with this pass. That may result in confusion. Anyway, it's possible that you can get to a point where no bad refs exist in a game you never re-loaded. It may also be that some problems, at another place, appear only in games that have been loaded at least once. This is what you will deal with next:

(7) Debugging, pass two: problems that appear after loading and re-saving a game

(7.1) Pass two, how to make the bugs appear

Start a new game with a sneaky character. Go back into the tutorial building and get the rings of Levitation, Chameleon and of The Gods from the chest behind the table. Make sure to empty all containers you can find, most especially any added by mods (you can use the console's ORI command to give you the name of a container that has placed a reference). Pick up Fargoth's ring and give it to him. Go to Arrille's. Buy and sell a few things. If necessary, cheat yourself to some gold (console: `player->additem gold_001 32750`). If you have a mod that changes Arrille's, put on the Ring of Chameleon and steal one item from every container in his house. You may skip this if it's too difficult. Go outside and use the console to unlock the door to Arrille's storage. Skip this only if you are sure you have no mods that place anything there. Go in and steal one item from every container. Go out and use the console to unlock the Census and Excise Warehouse. Go in and steal something from every container. If you run any mods that place containers out in the open, make sure to steal something from every one. Save your game and exit the game (I said EXIT!). Restart it and load your saved game. Some messages may appear during loading if you have problems. Ignore them and continue - even if none appear, that's no guarantee. After your game has loaded, wait a few seconds to give any delayed scripts the time to kick in, and save your game again. Save your game yet again in a new slot (as a backup). Exit.

(7.2) Pass two, diagnosis

Run Wrye Mash. By now you should know how to run Repair All. You should also be familiar with the error messages you can expect. They are all of the same type as mentioned above in Chapter 6. They are to be interpreted exactly as above in (6.2). The only difference is that this kind of error only appears after a game has been loaded once, the error messages may be localized, so debugging many areas in one go will not always work, and there is an additional method of removing the problems.

BTW: If you have any other mods besides BAR_Ringpack that add anything to the "tutorial" building, BAR_RingPack will probably appear in the error report - the chest it places is not set to persistent, and you can change it by removing the rings. Think of invisible activators - this bug can make them vanish! I've had no effect with the activator that starts Galsiah's Character Development's scripts.

What to leave alone for now (it isn't Chapter 8 yet): If you see any object indices between 100000 and 500000, ignore them!!!

(7.3) Pass two, repair

Again, you can always run Renumber Refs on any esp file that you find to cause problems. But if you want to edit a mod, that has its disadvantages (see (6.3)). That's why I present an additional method of bug removal. Yes, it is more time-consuming - but you will be able to edit the mod (this is also a good guideline for editing mods) without any ill effects.

You will now want to find the references responsible for the errors. You should still have Mash's error

onscreen. Look up the references with the identical object indices, using Enchanted Editor (see (6.3)). In the case of rematched bad refs, this is easy ? the mod causing the problem may be identified by the first ID in the report line, and the target by the second, or vice versa. In any other case, it might not be so easy. If an object is relatively rare, you might be able to find the problematical one by doing a text search on all your files. But if you can't find both references in the pair easily, ignore it. You only need to change one side to remove the bug.

When you have found the problematic reference, check if it is a container. It should appear in EE's list of containers if it is one. If it is, then start the CS and load the plugin in question if you haven't already done so. Focus on the object window and select ?Containers?. Look the ID up. Is the checkbox ?References Persist? checked? If no, check it and hit the ?save? button. Go back to the data file selection window and open the ?details? for this mod. Is there a line labeled TEMP_REFS? If yes, look up the IDs of everything below that line. If it is a container, or there is a script on it, then the ?References Persist? checkbox, if any exists for that object type, must be checked if it is unchecked. Don't forget to hit the button every mod tutorial tells you to hit the ?save? button in the object information dialogue. After you're done, save the plugin and exit the Construction Set. Run any necessary cleaning with TESTool, TESAME or whatever cleaning tool you prefer. Then run Wrye Mash to make it reset the file date. Repeat this for every mod that appears in any of the error messages.

...or you could just run Renumber Refs on them.

Some things to consider:

- Mods that add very many non-persistent containers and scripted objects are probably better served by renumbering the references. Setting references to Persistent may have an effect on performance, or increase the size of the savegame file, or something more. On the other side, this method survives the Construction Set intact, so if you're making a mod or frequently editing one, this is one method of avoiding future trouble for everyone who will use this ?persistent-ized? version of the plugin.
- Making things persistent will most likely not remove any bad reference problems that appear without saving and re-saving a saved game. Only renumbering will do that. But if any plugin has caused these and has been renumbered in Pass one, it shouldn't appear in this section at all.
- If you're the creator of a mod that causes this kind of problem, you could also choose to move the bad reference to another cell, preferably one not often changed by other mods.
- I have had at least one instance where my impression was that references in neighboring exterior cells were affected as well. I have not tested this, and I consider it unlikely that this impression is correct ? but it is mentioned.

(7.4) Pass two, repeat for other locations

As I have said, every location must be debugged separately. A successful debugging means that you start a new game (yet again, I know) and do everything else mentioned in (7.1), and Wrye Mash produces no more error messages that can be explained by reference mismatching. After you have debugged Seyda Neen, you can, of course, dispense with all the time-consuming stealing there and proceed to the same in Balmora. Sadrith Mora immediately. But remember to change the contents of containers added by mods if you can identify them without spending too much time on it.

Of course you will not want to check all of Vvardenfell this way, do you? No, even I didn't get that obnoxious. After Seyda Neen, I only did this in Sadrith Mora and Gnisis, where many things happen out in the open. In the Mages' Guild in Balmora, because many small mods add things there. In every other town I just said

once without having done anything, exited the game, re-started it, loaded the save and re-saved. This will find anything caused by containers changed manually, but it will find problems caused by items changed in script.

(7.5) Pass two, prevention measures

Mods that make changes to popular locations, and among these, those that make changes to exterior locations might be treated with the Renumber Refs function as a prevention measure. After those already mentioned, wide-ranging quest mods are good candidates. I did this to Black Queen Chronicles, Amulet of Scrye, and Suran Underworld. Maybe I should have done it to Illuminated Order as well.

Otherwise, you will, very likely, now be able to run a game with an much reduced frequency of baffling messages, inexplicable doublings and vanishings, and equally inexplicable CTDs. Most of your saved game files will have no bad references, not even hidden ones that you never notice in-game.

(7.6) Pass two: if anything happens after having played for 250 hours....

Then it might just be possible to correct this... if it works, consider this your final victory over the bugs of the Morrowind game engine. It might not work if you have interacted extensively with the reference in question in a non-reversible way, but then again, it deserves a try if that can prevent something important from vanishing into thin air ? just backup the esp files you're going to change and your saved games first (don't forget merged_objects.esp and merged_lists.esp). If it turns out that another mod needs extensive reference renumbering, then your luck is bad, but most likely it's just one reference that's gone bad. After you have identified the reference in question (you should know how to do this by now), open your saved game (with the Enchanted Editor). Look for the cell entry for the cell reported by Wrye Mash. If you find the reference in question in there, give it a new objectindex, something like 1200003 ? remember to use unique numbers, don't use anything above 2147483647 (the biggest number for a signed long integer, if that tells you anything). Save your ess file, then open the esp file that places this reference (if you don't know from the report, look either ORI it in-game or do a text search on all esp files in your Data Files folder), and give it the same objectindex. When you load that save you might get doubling and even an error message. If you do, then exit, again, exit and repair your save the usual way. After this the problem will be gone and will not reappear.

(8) Debugging, pass three: problems caused by illegal actions of esp and esm files

If you have a saved game, and Wrye Mash reports a bad reference on a reference with an objectindex between 100000 and ca. 500000, i.e. a reference that the original game places there, then here are two possibilities:

(8.1) Pass three: illegal actions by esm files

You can produce this easily by using the Unofficial Patch 1.6.3 together with the Wolverine Hall Mages Guild Expansion (Clean Guild Expansion WHM.esp). I don't recall if it is really necessary to load and re-save the game, but if you load a saved game in which you have been to the Wolverine Hall Mages' Guild at least once (interaction with anything needed), and immediately save it again, with the aforementioned mods active, Wrye Mash will report something like this:

```
Sadrith Mora, Wolverine Hall: Mage's Guild  
BAD REF>>REMATCHED 11 369090 chest_01_v_potion_al_02 116
```

The corresponding Morrowind.ini entries, in my case, have been:

GameFile10=Morrowind Patch v1.6.3.esm

GameFile115=Clean Guild Expansion WHM.esp

From the number, you know this is a reference placed by original Morrowind. If you look into the Unofficial Patch using the Construction Set, you will notice that it attempts to change ownership of this potion chest. Ownership is a data item that belongs to the reference, and one esm can't do this to a reference placed by another esm. Current understanding says that a new reference with the same objectindex will be created, resulting in confusion when loading the cell into memory. I suspect that things may be somewhat different because no doubling is reported, but however you look at it, the esm attempts something illegal, and it's not in the Enchanted Editor to remove the entry changing that chest from the Unofficial Patch, the problem will remain. Here's how you do this:

Open Enchanted Editor and load the Unofficial Patch. Go to the CELL record for "Sadrith Mora, Wolverine Hall: Mages' Guild". There is one NAME_NEXT entry in the list, and indeed it is this potion chest. Look at the entries highlighted in grey in the left part of the window. These are the entries that, combined, would, were they loaded, produce the desired changes of the reference. Check the boxes left to all of them, from the FRMR to the DATA_24 entry, then hit the DEL key. The entries will be removed. Please note that NAMO is highlighted in brown, not grey, so don't touch it. This entry contains the number of objects in the cell and will be updated automatically. But to be economical: It seems this is the only change attempted in this cell by this esm. The only thing that could change anything else here is the AMBI entry (ambient lighting), which most likely does nothing. In my case, I have deleted the whole subrecord for "Sadrith Mora, Wolverine Hall: Mages' Guild" from the Unofficial Patch.

You have now removed this bad reference problem, but you have to forego the (probably plausible and desirable) ownership change attempted by the Unofficial Patch. Or you could go to the Morrowind.esm (this is "need I say it" not recommended) and edit the entry directly.

It might also be that this problem never appears, even if the esm action is illegal, unless an esp attempts a (completely legal) change of the reference in question.

(8.2) Pass three: illegal actions by esp files

I don't know if it is technically illegal for an esp file to change an original Morrowind reference that another file has already changed, but I have found at least one instance where this seems to have been the cause of a bad reference. The best way to deal with this is to merge the plugins in question: load both plugins into the Construction Set, but mark neither as active. Select "Combine Loaded Plugins" from the File menu and will be able to save the combined plugin to a new file. Alternatively, you could use EE to remove one of the entries from one plugin, as described above for the Unofficial Patch.

(8.3) Pass three: remaining mysterious stuff

Sometimes you get a bad reference on an original Morrowind reference for no detectable reason at all. If it's reproducible, it happens to the same reference every time, but you track the mods responsible and can't find anything wrong. In one instance, I have been able to remove this by loading the plugin into the Construction Set, and saving it again without any change. In one other case, I have re-combined the plugins the affected reference was made up from, and the problem was gone. I don't know the cause, but sometimes this helps. Any of this kind have had no noticeable consequences apart from Wrye Mash's error message.

This concludes my debugging tutorial. It is, admittedly, somewhat technical, but if you've experienced frustration, you're probably ready for it. And many modders will probably be happy to know that they have nothing wrong. Have fun and enjoy your game!!