Description of cumulative (since initial certification) DOE-2.2 version 44d3 Bugfixes that Affect Title 24 Analysis:

1. The calculations for the change in extraction rate with zone temperature omitted the 0.5 factor in the X, Y, Z terms for the PVVT subzone case only. For those subzones this results in small changes in the max/min extraction rates (typically <1%), and small changes in hourly zone temperature (typically < 0.5F). Net effect on annual heat/cool energy is << 0.1% per zone.
2. In Dual Duct system problems with redistribution of HSUPPLY-FLOW were fixed. 1) If all ZONE's had their HASSIGNED-CFM specified the SYSTEM was getting zero OA (but OA is always wrong being low by the amount for ZONEs with A-CFM specified.) This can happen if the heating flow CFMAXH had to be made greater than the HASSIGNED-CFM due to the box min flow being larger than the assigned heating flow; this can happen when the MIN-CFM-RATIO time the maximum box flow (minus the CMIN-CFM-RATIO x cooling flow) is greater than the HASSIGNED-FLOW. 2) Also fix a bug related to the redistribution of SUPPLY-CFM out to ZONEs not having ASSIGNED-CFM specified; the amount being distributed out was not accounting for the SIZING-RATIO.
3. Fixed a problem with redistribution of SUPPLY-CFM to zones. In case when a ZONE ASSIGNED-CFM was specified the entire redistribution calculation was skipped, thus the summation of that ZONE's OA into the SYSTEM total OA was also skipped. In this case SYSTEM OA total is always wrong being low by the amount for ZONEs with ASSIGNED-CFM specified unless MIN-OUTSIDE-AIR was used (SYSTEM level) rather than ZONE keywords.
4. Fixed a problem with air-to-air heat pump formulations. The defrost calculation assumes that the defrost mode happens each hour for its full time as if PLRh was 1.0 each hour the heat pump operates in defrost mode; if HP is operating and OA temp < defrost T, the defrost time is independent of HP run time. We changed this method to estimate the HP heat PLR and then reduce the full defrost time by multiplying by the estimated HP heating mode PLR. **NOTE: In the results summary, certification tests involving heat pumps show the largest change in results.**
5. Fixed a bug in reporting fan power for fan coils in ZONEs with a MULTIPLIER or FLOOR-MULTIPLIER not equal to 1.0 In this case the SS-L report value was correct but the value placed on the meter (and thus PS-E/F, ES-x and BEPS) reports was not including the multipliers.

Description of cumulative (since initial certification) DOE-2.2 version 44d3 Bugfixes that do not Affect Title 24 Analysis:

1. Replace the mod in -044b1 for duct losses to unconditioned zones with a more general solution. Results should be identical. Hourly reports for HENOW, ERMAX, ERMIN, ERMAXM will be different, as these terms now include pipe/duct losses, rather than just representing active heating/cooling extraction.

2. Fixed bug in fan/heat/cool schedules that can have negative values. For example, if optimum start feature is used and the fan schedule has more than 6 -999's in a sequence, the FON on flag gets set to 999 rather than 0, which causes the fan to be on rather than off and FON is used as an on/off multiplier on some flows (especially in dual duct (DDS/MZS/PMZS) systems - this causes the result for that hour to be junk (999 times to high flows that can cause negative electric and gas consumptions).
3. Fixed a bug in crankcase heater energy calculation for the case of MIN-HGB-RATIO = 0.0 (default for PVVT and RESVVT) and also for all PMZS cases. When MIN-HGB-RATIO is zero the compressor runs for the entire hour if PLR > 0, thus crankcase heater does not run at all; code incorrectly had crankcase heater running for (1-PLR) fraction of the hour; for PMZS the crankcase heater ran for (1-plr) fraction of the hour independent of the MIN-HGB-RATIO value.
4. Added numerous Error/Warning messages and new sizing calculation for OA-FROM-SYSTEM referenced SYSTEMs. Previously, if a SYSTEM had an OA-FROM-SYSTEM specified, its MIN-OUTSIDE-AIR was reset to the MIN-OUTSIDE-AIR of the referenced OA-FROM-SYSTEM; this has been removed and replaced with the opposite action; the sum of the OA requirements for all SYSTEMs that reference an OA-FROM-SYSTEM is used to set the OA-FROM-SYSTEM MIN-OUTSIDE-AIR, SUPPLY-FLOW and adjust its ZONEs flows and minimum flows for both heating and cooling. Additionally the OA-FROM-SYSTEM has its calculated/specified cooling (total and sensible), heating, and preheat capacities adjusted if its SUPPLY flow was increased. If the OA-FROM-SYSTEM and its ZONEs have sufficient minimum OA specified (greater than that required by the referencing SYSTEMs) no adjustments are made. If any adjustments are made a warning is issued that informs the user of the adjustments and recommends the project be re-run with the values in the input corrected. Also, errors are issued (and the simulation terminated) if the OA-FROM-SYSTEM is either an incorrect type (a zonal system or a system that cannot have outside air) or the OA-FROM-SYSTEM is not placed into the input file before any referencing SYSTEM.
5. Fixed three inter-related issues relating to primary/secondary CIRCULATION loop interactions. 1) An expression sets the secondary valve type, when to specified by the user, to 0 when no secondary pump is specified; in the hourly calculation this 0 was not handled correctly. The result is that the primary pump “sees” constant flow from the secondary loop, in cases when it was specified to be variable. 2) During the hour a loop starts, the start-up calculations for a secondary loop did not take into account the correct loop thermal loss dT when calculating the required supply temperature. An entering CHW coil temperature could be unrealistically high, and exceed the limits of the coil temperature curve; this could result in the termination of the simulation (crash) with an X**Y where Y is non-integer and X < 0 error message. 3) During a start-up hour, a check was added to determine whether the coil loads are large enough to make the loop temperature float away from setpoint and make appropriate calculation adjustments as needed. Chiller energy may increase by 1% on an annual basis as a result of these changes

in projects that were running into these problems (mostly when the primary loop was incorrectly undersized relative to connected variable flow secondary loops.)

6. Fix inconsistency if metric/english conversion factor for btu/hr-sqft-f ... it was 5.67446 in BDL but other values in LOADS for reporting ... changed to be consistent with ASHRAE 2005 HF p 38.1 to be 5.67826.
7. Fixed bugs in LOADS reports. error in LS-I that caused more than 299 SPACEs defined when both LV-C and LS-I requested to cause the report generator to throw an error and terminate while creating the .sim reports after completing the LOADS. Start LV-C reports at 10000 rather than 1000 to prevent overlap with LS-I which starts at 1300. Fix LS-G, LS-H and LS-I incorrect values. The IDENT Time (done in 1999!) changed lines that collected data for these reports incorrectly. The flag value for the daylighting report schedule (=1 when on and 0 when off) was used as the collected quantity rather than the lighting schedule value ... so results were not very predictable and always wrong unless lighting was scheduled 1.0 and the daylight report schedule was not specified. Basically it always thought the lighting schedule was 1 and thus the power reduction it thought was in effect for the reports was reduced by (1-actual lighting schedule value). Energy reporting and hourly reports were not wrong only the daylighting LS- reports.
8. Fix divide-by-0 program crash when dhw loop has recirculation flow, but recirculation pump is on the dw-heater rather than attached to loop.
9. In cooling towers, excessive start-up loads resulting in large condenser loop temperature changes could result in a divide-by-zero in rare circumstances when bumping up against the upper limit of the range curve. No noticeable effect on simulation results.
10. Faulty (out of range) input for loop temperature setpoint could cause the coil temperature performance curve to produce a negative value, causing a program crash. No noticeable effect on simulation results.
11. DHW loop pump runs continuously even when a pump schedule is defined. Pump energy and loop thermal losses are overestimated by the difference in hours the pump should have been off.
12. Waterside economizer would crash due to a negative loop flow when attached to a LAKE/WELL loop. No impact on simulation results.
13. Cooling towers could generate a divide-by-zero if the low-speed-cfm or min-vfd-cfm was the same as the fan-off-cfm. No change in results.
14. When boilers and chillers cycle, a HW/CHW-PUMP attached to the unit also cycles if the loop has its own pump. This change will keep these equipment pumps on so that the units can detect the loop temperature. Depending on how much of the time the units are cycling, keeping the pumps on when the unit is cycled off may increase the energy for this pump by 10%-50%; the increased pump energy may also affect the loop heat/cool load and equipment loads by ~1%.
15. Previously, cycling losses for boilers and chillers are approximated by adding 50% of the START-UP-TIME to the equipment load at PLR=0, and prorating this penalty between 0 < PLR < MIN-RATIO. The cycling losses are now separated by the addition of a keyword that explicitly accounts for the operating loss at zero

PLR. The losses are prorated as before. The effect is most pronounced when LOOP-OPERATION is STANDBY, so equipment runs (cycles) a large fraction of the hours; energy consumption of the unit changes by 1%-5% for electric chillers, and 1%-10% for absorption chillers; depending on cycling characteristics. Net effect on building source energy is typically <1%.

16. When PVVT system with staged-volume control was combined with refrigeration casework input (old style) a negative airflow could be calculated when in the deadband floating state; this was fixed.
17. Energy recovery ventilators could attempt to size HX for effectiveness greater than the maximum theoretical; this put the design UA calculations into an infinite loop. No effect on results.
18. Fixed a bug in SYSTEM flow balancing into ZONEs. When the SUPPLY-FLOW or CFM/TON is specified for a SYSTEM such that the flow to the ZONEs needs to be "balanced" to ensure the ZONE flows sum to the SYSTEM specified value, the OA-FLOW/AREA keyword was ignored unless another ZONE level OA keyword was also specified (OA-CHANGES or OA-CFM/PER)
19. Changed model to allow whole house fan kw (NATURAL-VENT-KW) to modulate its power fraction based upon the fractional natural venting in the first zone. This is like an "ideal" control that turns the WHF on/off during the hour to match the venting cooling setpoint.
20. Fixed a problem in setting heating minimum flow when a zone flow is "allocated" from a specified total system flow: the minimum heating flow was defaulting to the minimum cooling flow ratio times the zone cooling flow rather than using the minimum heating flow.
21. An energy recovery ventilator could get trapped in an infinite loop when the ERV is bypassed (shut down) and exhaust condensate was happening (flag was set) in a previous iteration. No impact on results.
22. Fixed a bug that allowed the air heat capacity (the CONS()) variables during a start-up hour to be based on an entering coil temperature = 0, which was the previous hour's zeroed value for TM. Modify to use last start-up hour's value. Also, the heating and cooling coil loads in single and dual duct air handler routines were being calculated based on a density different than used in establishing the CONS() terms; this created an inconsistency in mass flow rates between the zones and the coil. Overall delta on annual energy is <0.5%; delta on peaks can be larger.
23. The default minimum CFM ratio for heating mode was not being adjusted when the SUPPLY-CFM was user-specified and thus zonal CFMs were calculated by reallocating the AHU flow. Negligible impact on heating/cooling energy.
24. The fan reports (SS-L) to allocate operating power to cooling when an evaporative cooler or desiccant system is operating.
25. Fixed a bug in the setting of supply temperature min/max (in DKTEMP) for single duct systems when the maximum heating flow is not equal to the minimum cooling flow and the min cooling flow is <1. In this case the heating coil flow rate was incorrectly getting set to the cooling coil flow rate. This then caused the maximum heating temperature to be incorrect. Usually heating flow was supposed

to be lower so the heating temperature is underestimated leading to long fan run times in cycling systems or possible unmet loads in constant operation systems.

26. Fix a bug in the sub-zone (those that are not CONTROL-ZONEs) in PVVT systems relating to VAV heating flow. If the control zone is in the heating mode ensure that all sub-zones are also using their heating mode flow rates. Prior to this fix the sub-zone flow minimum was being set by its temperature relative to its thermostat setpoint, thus if the control zone was in the heating mode but the sub-zone temperature put it into cooling, it would use its cooling minimum flow rather than heating minimum flow - in the case that the cooling minimum flow is above the heating minimum flow, the zone temperature would be further forced up and the fan flow would be too high. This was causing an over-estimate of heating energy and heating mode fan energy; the over-estimate could be a significant fractions of the correct amount.
27. Increased BDL memory for the maximum problem size from 80 to 100 megabytes.
28. Renamed report LS-SH to LS-P.
29. Fix LS-G, LS-H and LS-I incorrect values. The IDENT Time (done in 1999!) changed lines that collected data for these reports incorrectly. The flag value for the daylighting report schedule (=1 when on and 0 when off) was used as the collected quantity rather than the lighting schedule value ... so results were not very predictable and always wrong unless lighting was scheduled 1.0 and the daylight report schedule was not specified. Basically it always thought the lighting schedule was 1 and thus the power reduction it thought was in effect for the reports was reduced by (1-actual lighting schedule value). Energy reporting and hourly reports were not wrong only the daylighting LS- reports.
30. Fix warning message that prints "***" for time zone and says it does not agree with weather file value when T-Z was not specified. No effect on results.
31. Fix div-by-0 error that occurred when a dhw loop has a recirculation flow, but the recirculation pump is on placed onto the dw-heater rather than attached to loop.
32. Fix two staged-volume PVVT system issues: 1) Limit the staged-volume outlet temperature to maximum control value allowed. Has a very small effect on results since the zone thermostat will limit supply temperature to that needed. 2) Do not let staged-volume calculate negative airflow when floating. This problem is very rare and has only been observed only with concurrent use of the obsolete simplified refrigeration equipment models.
33. Message enhancements: 1) enhance the ZONE and SYSTEM “insufficient heating capability” messages and change ERRROR condition to a warning. No effect on results; 2) fix debug output of SPACE/ZONE name matching since LOADS does not pass full SPACE name, only first 16 character can be printed (rather than the 32 being output previously with the last 16 being junk.
34. The PTAC routine was incorrectly passing the values of the LOW-SPEED-RATIOS keyword into the air-to-air heat pump routine. This caused energy to be substantially over-estimated for a 2-speed heat pump during low-speed heating; possibly doubling the annual heating energy. Documentation was changed to indicate that TWO-SPEED compressors should not be used with PTAC.

35. Fixed a bug that caused the simulation to terminate due to a fan coil with intermittent fan and loop losses causing a negative CFM to be calculated due to parasitic round-off errors in TEMDEV. Very rare case and no effect on results as simulation was terminated by error.
36. Improve default expressions for PSZ/PVAVS/PVVT/RESYS2 for keywords that apply differently for water cooled vs. air cooled condensers: 1) Turn off defaults (make unused) crankcase heating keyword (but put them in for PMZS systems - they were missing); 2) Change PVVT zone thermostat to be proportional rather than reverse action when the min-flow-ratio is less than 1.0 3) Lower the MIN-UNLOAD-RATIO to 0.1 4) Set MIN-HP-T to MIN-ALARM-T for water cooled HP's. Also change default for MIN-UNLOAD-RATIO to 0.15 (from 0.25) for non-WLHP systems and set MIN-HGB-RATIO to 0.0 for PSZ when indoor fan is not intermittent (used to equal M-U-L) and also make M-H-R equal to M-U-R for PVVT when intermittent indoor fan (used to be zero.)
37. Fix default expressions for ZONE HEATING-CAPACITY and COOLING-CAPACITY for IU SYSTEMs. These were defaulting to a specified value at the SYSTEM level - that is incorrect - they now default to auto-sizing based on specified design conditions and peak loads.