Comparison of Proposed Federal Election Audits

There are dozens of ways for undetected vote count error to alter election outcomes in the absence of independent checks (audits) of vote count accuracy. Yet 49 out of 50 states perform no *independent* audits of vote count accuracy for federal elections.[i] Therefore Congress has proposed auditing federal elections. This short paper compares the cost efficiency and effectiveness of three election audit proposals:

1. **HR811**, proposed in the US House with over 200 co-sponsors, requires *independently* auditing 10% of precincts in federal races with margins between leading candidates of under 1%, auditing 5% when margins are between 1 and 2%, and auditing 3% when margins are over 2%.
2. **S1487**, proposed by Senators Feinstein, Dodd, Sanders, Inouye, Obama, Brown, Leahy, Mendendez, Kennedy, and Clinton, requires *internal* auditing of a flat 2% of precincts in federal races.
3. **A 99% success rate election audit, with a 1% minimum audit**[ii] is an audit of sufficient precinct or batch vote counts to give a 99% chance to detect one or more miscounted vote counts if there are sufficient miscounted precincts to alter an election outcome. This method requires using a mathematical formula or numerical method to calculate audit sample sizes. (See Appendices C and E.) A 1% audit would be required whenever these calculations require less than a 1% audit.

This analysis tests the three election audit proposals against actual election data[iii] for all 2002 and 2004 US House and Senate races for

Comparison of Election Audits of HR811, S1487, and 99% Success Rate Audits			
US House & Senate Races in 2002 & 2004	HR811	S1487	99% success rate audit w/ 1% min
Min Success 2002	10.0%	2.2%	99.1%
Average Success 2002	97.9%	96.4%	99.9%
Margins Under 2% Avg Success 2002	53.3%	26.4%	99.5%
# Races with under 60% success 2002	8	14	0
% Precincts Audited Overall 2002	3.1%	2.1%	2.1%
Min Success 2004	42.8%	15.6%	99.1%
Average Success 2004	99.2%	98.4%	99.9%
Margins Under 2% Avg Success 2004	89.0%	69.1%	99.3%
# Races with under 60% success 2004	4	5	0
% Precincts Audited Overall 2004	3.1%	2.0%	1.5%

is

1. **effectiveness** by calculating the minimum and average probabilities that an audit would detect one or more miscounted precincts if the total amount of vote miscount were sufficient to alter the outcomes of federal House or Senate races; and

2. **cost-efficiency** by calculating the percentage of all precincts which would be audited.

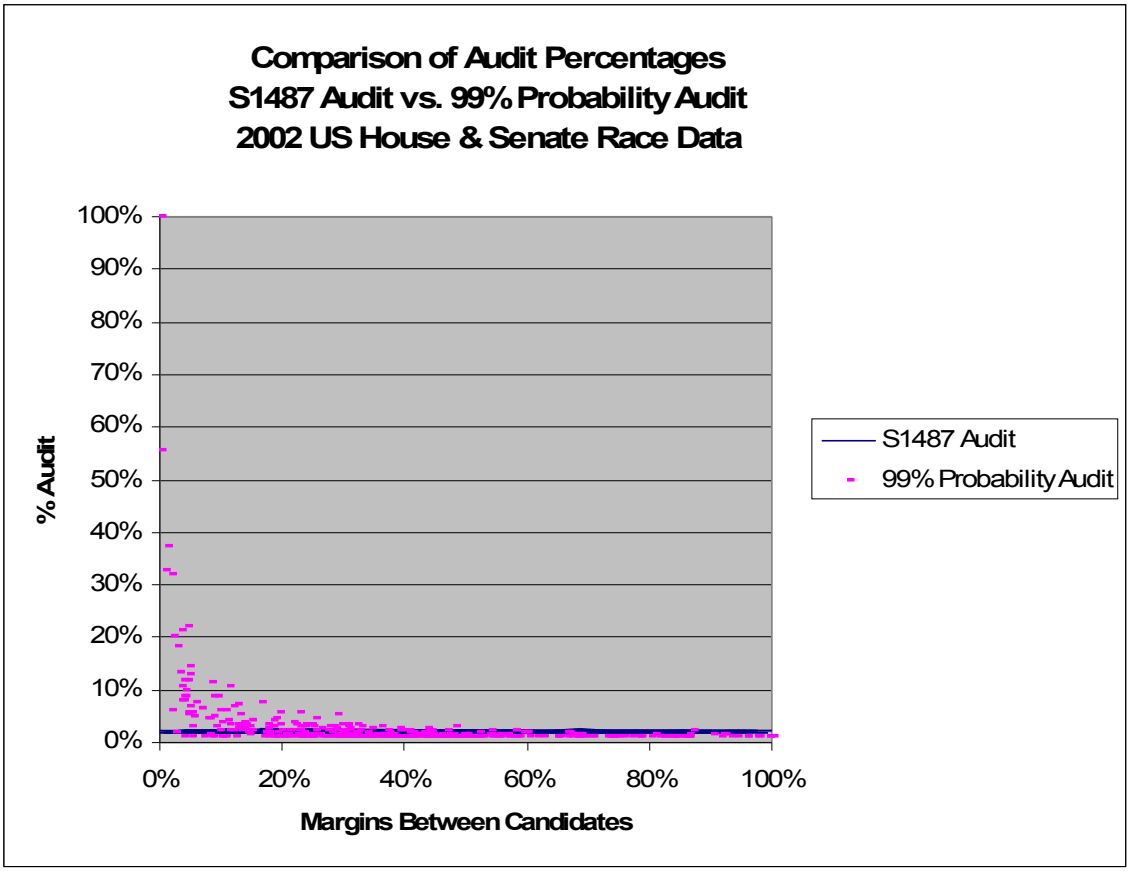
To understand how to read table 1 at left, let us look at the HR811 election audit column. In 2002, the minimum probability (success rate) to detect at least one miscounted precinct if sufficient precincts were miscounted to alter its outcome for one US House race for HR811 audits is 10% and in 2004 the minimum success rate for HR811 is 42.8%.[iv] In 2002, there are 8 federal races in which HR811 audits result in less than a 60% chance to detect an incorrect outcome and in 2004 there are 4 such races. In 2002, the success rate for the HR811 audits averaged for all US House and Senate races 97.9% and in 2004, its average probability of success is 99.2%. For close races with

margins under 2% HR811's audit average success rate is 53.3% in 2002 and 89% in 2004. HR811's audit would require manually counting roughly 3.1% of all precincts nationwide in both 2002 and 2004.

The S1487 audit results in the highest number of unprotected House and Senate races having less than 60% chance for detecting outcome-changing vote fraud. Adjusted for precinct-size variation, actual probabilities of audit success are more likely to be less than 50%. S1487 leaves 4 US House races and 1 South Dakota Senate race unprotected from possible outcome-altering vote fraud in 2004 and 13 House races and 1 New Hampshire Senate race unprotected in 2002.[v]

The total number of US House and Senate races was 437 in 2002 and 449 in 2004.

Chart 1



The 99% success rate audit (pink dashes) requires auditing a higher percentage of precincts when races are close (left side of chart) especially in districts with a small number of total precincts. However, when margins between leading candidates are large (right side of chart) or districts contain a large number of precincts then the 99% success rate audit requires auditing a smaller percentage of precincts than S1487 does (1% as compared to 2%).

Overall in 2002, the 99% success rate audit and the S1487 audit require auditing roughly the same number of precincts nationwide (7,146 and 7,148 precincts respectively). In 2004, the 99% success rate audit requires auditing 6,766 total precincts nationwide and the S1487 audit requires auditing 9,247. So, there are cost savings for the 99% success rate audits which also achieve higher probabilities for detecting outcome-altering vote miscount and protect all federal races.

Conclusions

1. The 99% success rate audit with a 1% minimum is the most effective and the most cost efficient audit. It achieves higher success probabilities than the HR811 and the S1487 audits and requires auditing the fewest precincts because the 99% success rate audit does not over-audit in races with larger margins and districts; and it audits more precincts to achieve higher success rates in closer races in districts with smaller number of total precincts.
2. The HR811 audit is more effective, i.e. protects more federal races than the S1487 audit, and audits on average 1% more precincts overall than the S1487 audit.

Recommendations

1. The US Congress could save U.S. taxpayer dollars and give higher assurance of the accuracy of federal election outcomes by requiring 99% success rate election audits with a minimum audit rate of 1% plus adding extra precincts as necessary to audit at least one precinct per county or township election administration jurisdiction.
2. Election audits should be *independently* conducted by persons who do not administer elections or manufacture or maintain voting equipment. S1487's audit is unlikely to be effective unless S1487 is amended to require independent audits.[vi]
3. Election audits should have mandatory, not voluntary, procedural standards set or approved jointly by experts in election audit mathematics, gaming, and by NIST and the US GAO. Without strict procedural standards, audits cannot detect election rigging.

Winners of federal elections control budgets in the trillions of dollars; and make decisions affecting millions of people. Without sufficient independent, verifiable audits U.S. elections are wide-open to electronic error and fraud. Audits provide the independent checks and balances which the founding fathers of the US constitution envisioned.[vii]

The National Election Data Archive is a nonprofit 501(c) (3) which needs donations to continue its operations. Donations may be made at: http://ElectionArchive.org

For more information on election audits see http://ElectionArchive.org or http://ElectionMathematics.org or contact Kathy Dopp.

APPENDIX A: Sample data from 2002 & 2004 US House and Senate Races

stabb	year	officename	estpreci	totalvotes	topcand_r	topcan	topcand_v	%_TopCa	seccand_r	seccan	seccand_v	%_2ndCar	margin
AL	2002	U.S. Congress I	394	181,223	ROGERS,	REP	91,169	50.31%	TURNHAM	DEM	87,351	48.20%	3,818
AL	2002	AL U.S. Senate	2,826	1,353,023	SESSIONS	REP	792,561	58.58%	PARKER,	DEM	538,878	39.83%	253,683
AL	2002	U.S. Congress I	296	178,687	BONNER,	REP	108,102	60.50%	BELK, JUD	DEM	67,507	37.78%	40,595
AL	2002	U.S. Congress I	531	187,965	EVERETT	REP	129,233	68.75%	WOODS, (	DEM	55,495	29.52%	73,738
AL	2002	U.S. Congress I	394	195,171	CRAMER,	DEM	143,029	73.28%	ENGEL, S	REP	48,226	24.71%	94,803
AL	2002	U.S. Congress I	524	161,101	ADERHOL	REP	139,705	86.72%	MCLENDO	LBR	20,858	12.95%	118,847
AL	2002	U.S. Congress I	245	198,346	BACHUS,	REP	178,171	89.83%	MCALLIST	LBR	19,639	9.90%	158,532
AL	2002	U.S. Congress I	439	166,309	DAVIS, AR	DEM	153,735	92.44%	MCCAY, L	LBR	12,100	7.28%	141,635
AR	2002	AR U.S. Senate	3,352	803,959	PRYOR, M	DEM	434,890	54.09%	HUTCHINS	REP	369,069	45.91%	65,821
AR	2002	U.S. Congress I	1,003	197,537	ROSS, MI	DEM	119,633	60.56%	DICKEY, J	REP	77,904	39.44%	41,729
AR	2002	U.S. Congress I	1,180	194,058	BERRY, R	DEM	129,701	66.84%	ROBINSO	REP	64,357	33.16%	65,344
AR	2002	U.S. Congress I	510	153,626	SNYDER,	DEM	142,752	92.92%	GARNER (	UNK	10,874	7.08%	131,878
AR	2002	U.S. Congress I	659	143,055	BOOZMAN	REP	141,478	98.90%	LYNE (WI)	UNK	1,577	1.10%	139,901
AZ	2002	U.S. Congress I	418	174,687	RENZI, RI	REP	85,967	49.21%	CORDOVA	DEM	79,730	45.64%	6,237
AZ	2002	U.S. Congress I	258	103,818	GRIJALVA	DEM	61,256	59.00%	HIEB, ROS	REP	38,474	37.06%	22,782
AZ	2002	U.S. Congress I	263	167,502	FRANKS, `	REP	100,359	59.92%	CAMACHO	DEM	61,217	36.55%	39,142
AZ	2002	U.S. Congress I	252	169,812	HAYWOR`	REP	103,870	61.17%	COLUMBU	DEM	61,559	36.25%	42,311
AZ	2002	U.S. Congress I	324	200,428	KOLBE, JA	REP	126,930	63.33%	RYAN, MA	DEM	67,328	33.59%	59,602
AZ	2002	U.S. Congress I	234	156,337	THOMAS,	DEM	103,094	65.94%	FLAKE, JE	REP	49,355	31.57%	53,739
AZ	2002	U.S. Congress I	244	155,751	SHADEGG	REP	104,847	67.32%	HILL, CHA	DEM	47,173	30.29%	57,674
AZ	2002	U.S. Congress I	218	66,065	PASTOR,	DEM	44,517	67.38%	BARNERT	REP	18,381	27.82%	26,136
CA	2002	U.S. Congress I	495	109,593	CARDOZA	DEM	56,181	51.26%	MONTEITH	REP	47,528	43.37%	8,653
CA	2002	U.S. Congress I	761	95,346	SANCHEZ	DEM	52,256	54.81%	ESCOBAR	REP	38,925	40.82%	13,331
CA	2002	U.S. Congress I	1,024	102,787	FILNER, B	DEM	59,541	57.93%	GARCIA, M	REP	40,430	39.33%	19,111
CA	2002	U.S. Congress I	656	162,222	CAPPS, L(	DEM	95,752	59.03%	ROGERS,	REP	62,604	38.59%	33,148
CA	2002	U.S. Congress I	636	173,956	POMBO, F	REP	104,921	60.31%	SHAW, EL	DEM	69,035	39.69%	35,886
CA	2002	U.S. Congress I	840	128,811	SHERMAN	DEM	79,815	61.96%	LEVY, RO	REP	48,996	38.04%	30,819
CA	2002	U.S. Congress I	1,282	116,180	DAVIS, SL	DEM	72,252	62.19%	VANDEWE	REP	43,891	37.78%	28,361
CA	2002	U.S. Congress I	471	70,178	SANCHEZ	DEM	42,501	60.56%	CHAVEZ, .	REP	24,346	34.69%	18,155
CA	2002	U.S. Congress I	867	143,751	HARMAN,	DEM	88,198	61.35%	JOHNSON	REP	50,328	35.01%	37,870
CA	2002	U.S. Congress I	637	176,265	ROHRABA	REP	108,807	61.73%	SCHIPSKE	DEM	60,890	34.54%	47,917
CA	2002	U.S. Congress I	604	194,918	OSE, DOU	REP	121,732	62.45%	BEEMAN,	DEM	67,136	34.44%	54,596
CA	2002	U.S. Congress I	869	121,541	SCHIFF, A	DEM	76,036	62.56%	SCILEPPI,	REP	40,616	33.42%	35,420
CA	2002	U.S. Congress I	779	74,770	DOOLEY,	DEM	47,627	63.70%	MINUTH, A	REP	25,628	34.28%	21,999
CA	2002	U.S. Congress I	666	149,530	DREIER, D	REP	95,360	63.77%	MIKELS, M	DEM	50,081	33.49%	45,279
CA	2002	U.S. Congress I	879	185,216	THOMPSO	DEM	118,669	64.07%	WIESNER,	REP	60,013	32.40%	58,656
CA	2002	U.S. Congress I	1,211	172,701	CUNNING	REP	111,095	64.33%	STEWART	DEM	55,855	32.34%	55,240
CA	2002	U.S. Congress I	494	120,463	CALVERT,	REP	76,686	63.66%	VANDENB	DEM	38,021	31.56%	38,665
CA	2002	U.S. Congress I	506	133,533	BONO, MA	REP	87,101	65.23%	KURPIEW	DEM	43,692	32.72%	43,409
CA	2002	U.S. Congress I	1,430	228,506	DOOLITTL	REP	147,997	64.77%	NORBERG	DEM	72,860	31.89%	75,137
CA	2002	U.S. Congress I	601	185,006	GALLEGL`	REP	120,585	65.18%	RUDIN, FE	DEM	58,755	31.76%	61,830
CA	2002	U.S. Congress I	678	124,336	MCKEON,	REP	80,775	64.97%	CONAWA`	DEM	38,674	31.10%	42,101
CA	2002	U.S. Congress I	666	133,022	HONDA, M	DEM	87,482	65.77%	HERMANN	REP	41,251	31.01%	46,231
CA	2002	U.S. Congress I	355	68,340	BACA, JOI	DEM	45,374	66.39%	NEIGHBOI	REP	20,821	30.47%	24,553
CA	2002	U.S. Congress I	707	178,985	HERGER,	REP	117,747	65.79%	JOHNSON	DEM	52,455	29.31%	65,292
CA	2002	U.S. Congress I	786	209,563	WOOLSE`	DEM	139,750	66.69%	ERICKSO	REP	62,052	29.61%	77,698
CA	2002	U.S. Congress I	639	107,986	LOFGREN	DEM	72,370	67.02%	MCNEA, D	REP	32,182	29.80%	40,188
CA	2002	U.S. Congress I	696	157,802	RADANO\	REP	106,209	67.31%	VEEN, JO	DEM	47,403	30.04%	58,806
CA	2002	U.S. Congress I	420	135,533	LEWIS, JE	REP	91,326	67.38%	JOHNSON	DEM	40,155	29.63%	51,171
CA	2002	U.S. Congress I	515	136,642	ROYCE, E	REP	92,422	67.64%	AVALOS, (	DEM	40,265	29.47%	52,157
CA	2002	U.S. Congress I	549	145,246	MILLER, G	REP	98,476	67.80%	WALDRON	DEM	42,090	28.98%	56,386
CA	2002	U.S. Congress I	541	179,549	COX, CHR	REP	122,884	68.44%	GRAHAM,	DEM	51,058	28.44%	71,826
CA	2002	U.S. Congress I	688	171,678	ESHOO, A	DEM	117,055	68.18%	NIXON, JO	REP	48,346	28.16%	68,709
CA	2002	U.S. Congress I	937	185,593	WAXMAN,	DEM	130,604	70.37%	GOSS, TO	REP	54,989	29.63%	75,615
CA	2002	U.S. Congress I	547	149,296	FARR, SA	DEM	101,632	68.07%	ENGLER, (	REP	40,334	27.02%	61,298
CA	2002	U.S. Congress I	779	85,079	SOLIS, HI	DEM	58,530	68.79%	FISCHBEC	REP	23,366	27.46%	35,164
CA	2002	U.S. Congress I	697	154,984	LANTOS, `	DEM	105,597	68.13%	MOLONEY	REP	38,381	24.76%	67,216
CA	2002	U.S. Congress I	561	131,578	MATSUI, F	DEM	92,726	70.47%	FRANKHU	REP	34,749	26.41%	57,977
CA	2002	U.S. Congress I	643	124,198	NUNES, D	REP	87,544	70.49%	LAPERE, D	DEM	32,584	26.24%	54,960
CA	2002	U.S. Congress I	685	138,376	MILLER, C	DEM	97,849	70.71%	HARGRAV	REP	36,584	26.44%	61,265
CA	2002	U.S. Congress I	1,189	169,010	HUNTER,	REP	118,561	70.15%	MOORE-K	DEM	43,526	25.75%	75,035
CA	2002	U.S. Congress I	770	88,027	NAPOLITA	DEM	62,600	71.11%	BURROLA	REP	23,126	26.27%	39,474
CA	2002	U.S. Congress I	762	65,824	ROYBAL-A	DEM	48,734	74.04%	MILLER, W	REP	17,090	25.96%	31,644
CA	2002	U.S. Congress I	806	103,326	BERMAN,	DEM	73,771	71.40%	HERNAND	REP	23,926	23.16%	49,845
CA	2002	U.S. Congress I	526	121,723	STARK, F(	DEM	86,495	71.06%	MAHMOOI	REP	26,852	22.06%	59,643
CA	2002	U.S. Congress I	649	164,285	THOMAS,	REP	120,473	73.33%	CORVERA	DEM	38,988	23.73%	81,485
CA	2002	U.S. Congress I	756	87,012	MILLENDE	DEM	63,445	72.92%	VELASCO,	REP	20,154	23.16%	43,291
CA	2002	U.S. Congress I	683	167,197	TAUSCHE	DEM	126,390	75.59%	HARDEN,	LBR	40,807	24.41%	85,583
CA	2002	U.S. Congress I	920	122,497	ISSA, DAF	REP	94,594	77.22%	DIETRICH,	LBR	26,891	21.95%	67,703
CA	2002	U.S. Congress I	757	93,407	WATERS,	DEM	72,401	77.51%	MOEN, RC	REP	18,094	19.37%	54,307
CA	2002	U.S. Congress I	790	67,243	BECERRA	DEM	54,569	81.15%	VEGA, LUI	REP	12,674	18.85%	41,895
CA	2002	U.S. Congress I	542	166,917	LEE, BARI	DEM	135,893	81.41%	UDINSKY,	REP	25,333	15.18%	110,560
CA	2002	U.S. Congress I	715	160,441	PELOSI, N	DEM	127,684	79.58%	GERMAN,	REP	20,063	12.50%	107,621
CA	2002	U.S. Congress I	853	118,449	WATSON,	DEM	97,779	82.55%	KIM, ANDI	REP	16,699	14.10%	81,080

APPENDIX B: Assumptions Used in Calculations

The calculations for table 1 assume that:

- the number of audited precincts is rounded up to the next integer whenever there is any fractional remainder after multiplying the audit percentage times the total number of precincts in districts, and
- the maximum amount of votes that are wrongly shifted in any one precinct is 20%, and
- precinct sizes are roughly equal within each district. (Actual average audit success probabilities for detecting outcome-altering vote fraud are lower than those given in table 1 because the number of ballots cast often vary considerably from precinct to precinct so that outcome-altering vote miscount could be hidden in a smaller number of the largest-size precincts. I suggest subtracting 10% from the average probabilities in table 1 to be conservative about the probabilities that audits would detect outcome-changing vote miscount.

APPENDIX C: Legislative Language for 99% Success Rate Audits[viii]

REQUIREMENT FOR MANDATORY AUDITS that:

a) at least 1% (one per centum) of each county's precinct or batch vote counts are audited; and

b) a sufficient number of vote counts shall be audited to give at least a 99% probability for detecting at least one corrupt vote count if the amount of corrupt vote counts were sufficient to alter the election outcome of any election contest, taking into account the margin between the candidates, the total number of vote counts and vote count sizes; and

c) in addition to randomly selected precincts in a), and b) above, at least one vote count shall be audited in each election contest submitted to the voters within each county or township where elections are separately administered; and four discretionary precinct vote counts selected by state-wide Senate or Presidential candidates and two discretionary precinct vote counts selected by House candidates, or alternatively, precinct vote counts which calculations show are "suspicious" according to voter history files shall also be manually audited,

d) As an alternate to the audit amounts required in a),b), and c) above, NIST and the GAO working with a US Election Audit & Recount Committee comprised of qualified mathematicians, statisticians, election integrity activists, gaming experts, and non-voting election official members[ix] may approve other election audit protocols and procedures.

APPENDIX D: Calculation of Audit Success Probabilities

The probability estimates are based on a "Hyper geometric" distribution which determines the probability of finding:

a) **x** corrupt (miscounted) precinct or batch vote counts (We let x = 0 to find the probability of detecting no corrupt precincts, and subtract that probability from 1, to find the probability of detecting one or more corrupt precincts.)
b) in an audit sample of size **n** (number of audited precincts),
c) when there are **X** (hypothetical number of corrupt precincts) For election audits, we want **X** to be the minimum number of corrupt precinct or batch vote counts necessary to alter an election outcome. The way to estimate X is N (the total number of vote counts) times m, the margin between leading candidates in the race, divided by two times v, the maximum percentage of corruption expected in any one audited vote count, to give the number of corrupt counts that could alter the election outcome.[x]
d) out of **N** (Total number of precinct or batch vote counts).

This distribution is calculated using the Excel Function:

$$\text{HYPGEOMDIST(x, n, X, N)} = \frac{\binom{X}{x}\binom{N-X}{n-x}}{\binom{N}{n}}$$

The probability that one or more of the n precincts in the sample will be a corrupted precinct is 1 or 100% minus the probability that none of the n precincts will be corrupted. So, the probability that *at least one* of the n is corrupted which equals:

$$P = 1 - \frac{\binom{X}{0}\binom{N-X}{n}}{\binom{N}{n}}$$ This equation can be solved using numerical methods for the sample size n.

APPENDIX E: Calculation of 99% Success Rate Audit Sample Size

Given:

N = the total number of vote counts (number of precinct or batch vote counts)
m = the margin between the leading two candidates in any election contest
P = the desired probability of detecting one or more corrupt vote counts (99%)
v = the maximum wrongful rate of miscount that could occur on any one vote-counting device without raising immediate suspicion[xi] (20%)
S = audit sample size – number of vote counts to manually count
C = the number of corrupt vote counts that could wrongly alter an outcome
c = the rate of corrupt vote counts that could wrongly alter an outcome

Note that the rate of corrupt vote counts that could wrongly alter an election outcome is $c = \frac{m}{2v}$ and[xii] that $C = cN$. See "The Election Integrity Audit"[xiii] for a more detailed explanation of how to calculate the minimum amount of corrupt vote counts that could wrongly alter an election outcome.

Then a formula for estimating sample sizes for manual audits of vote counts is:

Equation: $S = N(1 - e^{\frac{2v\ln(1-P)}{Nm}})$.[xiv]

This formula slightly over-estimates the election audit sample sizes required to achieve the desired probability, P for detecting one or more corrupt vote counts. There are two other methods to calculate election audit sample sizes which give closer approximations to the minimum necessary audit sample size for obtaining any desired probability, P. Also, a numerical method can be used to determine the exact number of precincts required to wrongly alter an election outcome using the precinct sizes.

[i] Only NM conducts 2% independent audits and only CT conducts sufficient 10% internal audits after the election results are certified.

[ii] Ron Rivest's first formula for estimating election audit sample sizes was used for this analysis. It slightly overestimates the necessary audit amounts needed to obtain 99% certainty of the audit successfully detecting outcome-changing fraud. See "How Big Should an Election Audit Be?" http://electionarchive.org/ucvAnalysis/US/paper-audits/ElectionAuditEstimator.pdf There are more accurate formulas and numerical methods available which would slightly reduce the size of the audit sample.

[iii] The National Election Data Archive purchased the data for US House and Senate 2002 & 2004 races from Election Data Services and has made it publicly available here:
http://electionarchive.org/ucvAnalysis/US/paper-audits/dopp_b.csv

[iv] These low success rates occur in US House races with close margins and small congressional districts.

[v] By "unprotected" I mean that the calculated probability of the S1487 audit to detect at least one corrupt precinct when there is outcome-altering vote fraud is less than 60%. Subtracting 10% to adjust for the reduced success rate due to precinct-size variations, brings the success rates for S1487 to less than 50% in these "unprotected" federal races.

[vi] Many current state election audit procedures are little more than shams that cover up any evidence of problems. For instance in Utah the voter verifiable paper ballot records are never compared with the actual unofficial electronic tallies; and in Ohio audits have manually counted the summary vote totals tapes rather than the voter verifiable paper ballot records. Such internal audits cover up problems rather than revealing them.

[vii] To conduct audits of election results in November 2008 would require replacing all paperless DRE voting with auditable precinct based optical scan voting equipment at approximately $550 fiscal note for one ballot marking device and one precinct based optical scan device for each deficient precinct. Post facto ballot records printed by touch-screen voting systems can be hacked in ways that are not detectable by manual audits, so that ideally DRE voting equipment should be replaced for manual election audits to be guaranteed effective.

[viii] Two detailed legislative proposals for 99% success rate audits may be found at:
http://electionarchive.org/ucvAnalysis/US/paper-audits/VoteCountAudit-UT.pdf
http://www.njappleseed.net/entity_pdfs/175.pdf

[ix] Independence of auditors from election officials or persons who build or maintain voting systems is necessary.

[x] For a more exact numerical calculation of the number of corrupt precincts which can alter an election outcome which takes into account the number of total ballots cast in each precinct see "The Election Integrity Audit"
http://electionarchive.org/ucvAnalysis/US/paper-audits/ElectionIntegrityAudit.pdf

[xi] It is assumed that if more than this amount of wrongful vote shift occurs in any vote count that comparison of vote counts with comparable results in prior elections or with partisan voter registration in the voter history files would raise immediate suspicion. Vote shift * 2 = Margin shift.

[xii] This formula was derived by Dopp in July, 2006.

[xiii] pp. 8-9 "The Election Integrity Audit" http://electionarchive.org/ucvAnalysis/US/paper-audits/ElectionIntegrityAudit.pdf

[xiv] This formula was originally suggested by MIT Professor Ronald Rivest. A paper by Aslam, Popa, and Rivest giving a rigorous derivation of this formula and some improvements to it will appear in the Proceedings of the second USENIX/ACCURATE Electronic Voting Technology (EVT07) workshop (Boston, MA, August 6, 2007) and is also available online at:
http://people.csail.mit.edu/rivest/AslamPopaRivest-OnEstimatingTheSizeAndConfidenceOfAStatisticalAudit.pdf