Purchase Cost of New Voting Equipment for New York City

A Study by the
Task Force on Election Integrity, Community Church of New York
Teresa Hommel, Chairwoman
November 6, 2006

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New York City is in the process of selecting new voting equipment to replace our lever voting machines. Members of the Task Force on Election Integrity of Community Church of New York have prepared this report to assist in evaluating purchase costs associated with the different types of equipment our Election Commissioners may choose. We hope that our methodology and estimates will prove useful.

We correlated seven factors:

1. number of registered voters per poll site as of August, 2006, obtained from the Board of Elections in the City of New York
2. number of registered voters to be served by each type of new machine
3. number of new machines needed in each poll site
4. cost of new machines
5. past poll site turnout (percentage of registered voters who voted at their poll site in November, 2004)
6. time required to vote on new electronic voting machines (DREs)
7. poll site turnout of voters with disabilities, including those who will use audio, sip-and-puff, or rocker paddle devices

Our analysis shows large differences in cost between the different types of equipment under consideration: DREs cost more than optical scanner systems. We are confident that our work is on the right track because our results are consistent with analyses and experiences of other jurisdictions.[1]

I. BACKGROUND

The federal Help America Vote Act of 2002 (HAVA) requires one voting device per poll site to assist voters with disabilities to cast a private, independent vote. HAVA does not ban lever machines.

New York's Election Reform and Modernization Act (ERMA) bans lever machines as of 9/1/07, and requires each county and the City of New York to choose new equipment. Our legal choices are:

- PBOS -- Paper Ballots, precinct-based Optical Scanners, and ballot marking devices (BMDs) usable by voters with disabilities.
- DREs -- "Direct Recording Electronic" voting machines which provide a "voter-verified paper audit record" or VVPAR.

II. COST PER BOROUGH

A. Methodology

Appendix 1 "Cost of New Voting Equipment" contains five spreadsheets (one per borough) that correlate the number of registered voters per poll site to the number of machines needed and their cost.

Bronx:			**How many machines are needed, if number of reg. voters served per machine is:**									
Page	**SiteID**	**Voters**	**DRE 200**	**DRE 300**	**DRE 400**	**DRE 500**	**DRE 600**	**OpScan 2000**	**OpScan 2500**	**OpScan 3000**	**BMD 1%**	**BMD 2%**
X078	00030	3145	16	11	8	7	6	2	2	2	2	4
	00036	619	4	3	2	2	2	1	1	1	1	1

Table 1

Table 1 above is a copy of the first five lines from the first borough spreadsheet, which is for the Bronx. The columns are:

- **Page**: Page number in the report obtained from the Board of Elections in the City of New York, included to facilitate our cross checking of numbers
- **SiteID**: Poll site ID number
- **Voters**: Total number of registered voters for all EDs located in that poll site
- **DRE**: We calculated the number of DREs needed based on 5 different assumptions: 200, 300, 400, 500, and 600 registered voters per DRE.
- **OpScan**: We calculated the number of optical scanners needed based on 3 different assumptions: 2000, 2500, and 3000 registered voters per optical scanner.
- **BMD**: We calculated the number of BMDs needed with optical scanner systems based on 2 different assumptions: 1% and 2% of registered voters using BMDs with audio, sip-and-puff, or rocker paddle devices, and requiring 37 minutes to vote.

We divided the number of registered voters per poll site by the different numbers of voters assumed to be assigned to each machine to determine how many units of equipment would be needed. For example, Bronx poll site 00030 has 3145 registered voters -- if DREs are used and each DRE can serve 200 registered voters, 16 DREs would be needed; if optical scanners are used and each optical scanner can serve 2000 registered voters, 2 optical scanners would be needed; if optical scanner systems are used and 1% of registered voters use BMDs with audio, sip-and-puff, or rocker paddle devices and require 37 minutes to vote, 2 BMDs would be needed.

B. Calculation of BMDs needed

To calculate the number of BMDs needed, first we assumed that 20% of registered voters have disabilities, and that half of them would wish to vote. We further assumed that half of these voters would use absentee ballots and half would vote at their poll site. These assumptions yield 5% of registered voters with disabilities who may wish to use BMDs at their poll site.

Of this 5%, we assumed that one or two fifths (1/5 or 2/5) of these voters may use audio, sip-and-puff, or rocker paddles, which yields 1% or 2% of registered voters using these devices.

In April, 2006, the New York State Board of Elections assessed that voters using these attachments on BMDs to be used in 2006 required 30 to 45 minutes to vote. We used 37 minutes as the average voting time for these voters. We estimated 5 minutes per voter for the other three or four fifths (3/5 or 4/5) of voters with disabilities using BMDs.

After calculating total minutes use of BMDs by the 5% of voters with disabilities, we then divided the total minutes by 900 minutes, which is the length of a 15-hour election day, to determine how many BMDs would be needed.

For example, here is a calculation for 1% for a poll site with 3145 registered voters: 1% of 3145 is 31.45 voters who would take 37 minutes each, yielding 1163.65 minutes which is rounded up to the next whole number, 1164 minutes. 4% of 3145 is 125.8 voters who would take 5 minutes each, yielding 629 minutes. 1164 plus 629 is 1793 total minutes use of BMDs. 1793 divided by 900 minutes per election day is 1.99, rounded up to the next whole number, 2 BMDs required to served these voters.

C. Calculation of cost per borough

To calculate total purchase cost for the equipment for each borough, we made assumptions about the cost per machine:

- DREs: cost per unit was calculated for $8,000, $9,000, and $10,000 each.
- Optical Scanners and BMD: cost per unit was calculated for $5,500 each.

Table 2 below is a copy of the last ten lines from the Bronx spreadsheet. It shows the total number of poll sites, registered voters, and units of equipment needed for each DRE, OpScan and BMD assumption. To facilitate reading we also copied the column headings.

Bronx:			**How many machines are needed, if number of reg. voters served per machine is:**									
			DRE	**DRE**	**DRE**	**DRE**	**DRE**	**OpScan**	**OpScan**	**OpScan**	**BMD**	**BMD**
Page	**SiteID**	**Voters**	**200**	**300**	**400**	**500**	**600**	**2000**	**2500**	**3000**	**1%**	**2%**
total:	**218 sites**	**578,490**	**3002**	**2040**	**1562**	**1269**	**1072**	**405**	**341**	**306**	**482**	**682**
	Prices											
DRE	**$8,000**		$24m	$16m	$12m	$10m	$9m					
DRE	**$9,000**		$27m	$18m	$14m	$11m	$10m					
DRE	**$10,000**		$30m	$20m	$16m	$13m	$11m					
					OpScan, BMD Prices:		**$5,500**	$2.2m	$1.9m	$1.7m	$2.7m	$3.8m
					OpScan, plus BMD for 1%:			$4.9m	$4.5m	$4.3m		
					OpScan, plus BMD for 2%:			$6.0m	$5.6m	$5.4m		

Table 2

Due to page width limitations on this page, we have rounded the dollar amounts to millions. The spreadsheets in Appendix 1 have the exact dollar amounts.

For DREs, we multiplied cost per unit by the number of units required. For example, if DREs cost $8,000 and 1072 DREs are needed because 600 registered voters are assigned to each DRE, the total cost would be $9 million. If DREs cost $10,000 and 3002 DREs are needed because 200 registered voters are assigned to each DRE, the total cost would be $30 million.

For optical scanners and BMDs, we multiplied cost per unit by the number of units required. However, optical scan systems include both scanners and BMDs. Therefore we added the cost of optical scanners plus the cost of BMDs for both 1% and 2% BMD assumptions. For example, if 2000 registered voters are assigned to each optical scanner and 1% of voters use BMDs as described earlier, the total cost would be $4.9 million. If 2000 registered voters are assigned to each optical scanner and 2% of voters use BMDs as described earlier, the total cost would be $6.0 million.

III. CITYWIDE COST

A. Citywide cost for DREs

Appendix 2 "Citywide Cost of New Voting Equipment" summarizes the totals for the five boroughs. The citywide total purchase cost for DREs ranges from $55.9 million to $195.9 million, varying according to the number of registered voters assigned to each DRE and the cost per DRE.

Table 3 below shows how many DREs are needed if each one can handle a given number of registered voters.

County	Num. DREs needed 200 Reg. Voters ea	Num. DREs needed 300 Reg. Voters ea	Num. DREs needed 400 Reg. Voters ea	Num. DREs needed 500 Reg. Voters ea	Num. DREs needed 600 Reg. Voters ea
Bronx	3002	2040	1562	1269	1072
Brooklyn	5899	3994	3054	2480	2098
Manhattan	4674	3173	2430	1979	1678
Queens	4795	3246	2478	2003	1706
Richmond	1215	828	630	517	437
Citywide	19,585	13,281	10,154	8,248	6,991

Table 3

Table 4 below shows the cost for the citywide number of DREs needed, for each number of registered voters, and for three different prices per DRE.

Cost per DRE	Citywide 200 reg voters each 19,585 DREs	Citywide 300 reg. voters each 13,281 DREs	Citywide 400 reg. voters each 10,154 DREs	Citywide 500 reg. voters each 8,248 DREs	Citywide 600 reg. voters each 6,991 DREs
$8,000 each	$156,680,000	$106,248,000	$81,232,000	$65,984,000	$55,928,000
$9,000 each	$176,265,000	$119,529,000	$91,386,000	$74,232,000	$62,919,000
$10,000 each	$195,850,000	$132,810,000	$101,540,000	$82,480,000	$69,910,000

Table 4

B. Citywide cost for Optical Scanners and BMDs

The citywide total purchase cost for PBOS systems ranges from $27.9 million to $38.6 million, varying according to the number of registered voters assigned to each optical scanner and the percentage of voters using BMDs as described earlier.

Table 5 shows the number of optical scanners and BMDs needed if each one can handle a given number of registered voters.

County	Number OpScans needed, 2000 Reg. Voters each	Number OpScans needed, 2500 Reg. Voters each	Number OpScans needed, 3000 Reg. Voters each	Number BMDs needed, if 1% of voters need 37 min	Number BMDs needed, if 2% of voters need 37 min
Bronx	405	341	306	482	682
Brooklyn	781	659	582	928	1316
Manhattan	637	544	484	749	1061
Queens	618	531	466	752	1066
Richmond	168	142	128	196	284
Citywide	2,609	2,217	1,966	3,107	4409

Table 5

Table 6 shows the citywide cost for this equipment, assuming $5,500 per unit.

Cost	Citywide OpScan 2000 reg voters ea	Citywide OpScan 2500 reg voters ea	Citywide OpScan 3000 reg voters ea	Citywide BMDs, 37 min for 1%	Citywide BMDs, 37 min for 2%
$5,500 each	$14,349,500	$12,193,500	$10,813,000	$17,088,500	$24,249,500

Table 6

Table 7 shows the costs for optical scanners and BMDs together.

	Citywide OpScan for 2000 + BMDs	Citywide OpScan for 2500 + BMDs	Citywide OpScan for 3000 + BMDs
OpScan and 37 min for 1%	$31,438,000	$29,282,000	$27,901,500
OpScan and 37 min for 2%	$38,599,000	$36,443,000	$35,062,500

Table 7

IV. VOTERS PER MACHINE

The major unknown variable in the "Cost of New Voting Equipment" spreadsheets is the number of registered voters that can be assigned to each machine. Determination of this number is dependent on three factors:

1. Minutes per election day: 900
2. Poll site turnout, that is, the percentage of registered voters who vote at the poll site
3. Average number of minutes per voter to vote

A. Poll Site Turnout

We assumed that New York City should have enough equipment to handle a high-turnout election, such as the general election of November, 2004. Using data from the websites of the City and State Boards of Elections, we compared the number of registered voters to the number who voted at their poll site (the sum of the public counter, emergency ballots, and valid affidavit ballots). Appendix 3 "Pollsite Voter Turnout by County, Nov. 2004" shows these details. The citywide average poll site turnout was 53.42%. The highest borough-wide turnout was 58.27% in Richmond.

New York	55.06%
Bronx	48.74%
Kings	50.71%
Queens	54.29%
Richmond	58.27%
Citywide	53.42%

B. Time per Voter

1. DREs

Informal observation at the timing tests in Brooklyn on October 26 and 27, 2006, are reported in Appendix 4 "Vote Timing Data." Only DREs were observed. The average voting times were:

Sequoia DRE: 4 minutes 59 seconds
Avante DRE: 6 minutes 15 seconds
Liberty DRE: 4 minutes 22 seconds

We observed that a staff person went into each voting booth with each test voter to provide individual instruction for 45 to 90 seconds immediately prior to the voting. For this reason, the times recorded for test voting may be shorter than that required for real voting in a real election in which poll workers will not give this kind of individual instruction.

Test voters reported that they were not instructed to look at or verify the VVPAR. In one case in which the test voter requested assistance because the VVPAR was not visible, she was told to just look at the face of the machine to see which selections were lit up. For this reason, if New York City voters in real elections with DREs are properly reminded to look for and verify their VVPAR, the time required may be longer that that recorded in the timing tests.

2. Optical Scanners

We regret that we were unable to observe timing tests for optical scanners. One national rule of thumb for optical scanners is 15 seconds per voter or four voters per minute. This would yield 3600 actual voters in our 900 minute election day; at 60% turnout, this would allow 6000 registered voters to be assigned to one optical scanner.

New Yorkers may require longer than 15 seconds time to insert their ballot into an optical scanner due to notification of undervotes. If we assume that average voters require 45 seconds to understand why their ballot was rejected and either press the override button on the scanner, or return after marking their ballot further and reinserting it, the following numbers apply:

2000	Registered voters
60%	Percent poll site turnout
1200	Actual voters
45	Seconds per voter at the optical scanner
900	Minutes required, assuming steady consistent flow of voters using the optical scanner

If we assume that average voters require 30 seconds to understand why their ballot was rejected and either press the override button on the scanner, or return after marking their ballot further and reinserting it, the following numbers apply:

2000	Registered voters
60%	Percent poll site turnout
1200	Actual voters
30	Seconds per voter at the optical scanner
600	Minutes required, assuming steady consistent flow of voters using the optical scanner

C. How much DRE equipment is enough?

To assess how much DRE equipment would be "enough" we made various assumptions:

- Turnout: projections were made for 50%, 60%, 70% and 80% turnout.
- DRE voting time per voter: projections were made for 3.25, 4 and 5 minutes per voter.

Appendix 5 "Number of Voters Served" shows these projections. Where the number of minutes required to serve voters exceeds 900, the number of minutes is underlined and italic. Table 8 below shows that if 300 registered voters are assigned to each DRE and average voters require 5 minutes each and 1% of voters require 37 minutes each, 900 minutes is exceeded when poll site turnout is between 50% and 60%.

Reg. Voters	% Turnout	Actual Voters	**1%** take 37 min	99% take 5 min	Total Min
300	50	150	2 * 37 = 74 min	148 * 5 = 740 min	814
	60	180	2 * 37 = 74 min	178 * 5 = 890 min	*964*

Table 8

Table 9 shows slightly worse results when 2% of voters require 37 minutes.

Reg. Voters	% Turnout	Actual Voters	**2%** take 37 min	98% take 5 min	Total Min
300	50	150	3 * 37 = 111 min	147 * 5 = 735 min	846
	60	180	4 * 37 = 148 min	176 * 5 = 880 min	*1028*

Table 9

Our straight-forward approach assumes that voters arrive at their poll sites in a steady consistent flow during the 900 minutes of the election day. This is unrealistic, however, because there are peak and slow hours. We hope that our city acquires enough equipment to handle peak hours without unreasonable voter wait times.

We suggest two different simple methods to adjust estimates to compensate for peak and slow times during election day. The spreadsheet "Number of Voters Served" in Appendix 5 facilitates both methods.

- Assume a slightly higher turnout than that of November, 2004, such as 60% to 70%.
- Assume a shorter election day. For example, if one hour in the morning and two hours in the afternoon are usually very slow, we can assume a 12-hour, 720-minute election day instead of our 15-hour, 900-minute day.

V. CONCLUSION[2]

Based on our study, if our Election Commissioners select DREs for New York City's new voting equipment, we should assign no more than 300 registered voters per DRE. Optical scanners may be expected to handle 2000 voters each. Therefore our final comparison is:

$106,248,000	DREs, $8,000, 300 registered voters served by each
$119,529,000	DREs, $9,000, 300 registered voters served by each
$132,810,000	DREs, $10,000, 300 registered voters served by each
$31,438,000	Optical scanners, 2000 registered voters served by each, 1% using BMD and requiring 37 minutes
$38,599,000	Optical scanners, 2000 registered voters served by each, 2% using BMD and requiring 37 minutes

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[1] For example: General Assembly of North Carolina, Legislative Fiscal Note for Senate Bill 223 (Fifth Edition), Public Confidence in Elections, Senator Kinnaird, 2005, estimated $45,957,546 for Optical Scanners for the state, but $135,130,995 for DREs. http://www.ncga.state.nc.us/Sessions/2005/FiscalNotes/Senate/PDF/SFN0223v5n1.pdf

[2] We urge prudent consideration of purchase cost, but we acknowledge that cost is not the only important factor. Other factors that require consideration are (1) transition and continuing costs; (2) lifespan of equipment and replacement cost; (3) the experience of other jurisdictions; (4) level of public confidence; (5) reliability of equipment; (6) incidence of inadvertent and built-in vulnerabilities that have been identified by researchers as well as other states during their certification efforts; (7) design flaws which make the equipment difficult to use (assessed by frequency of election problems blamed on "poorly trained poll workers, voters, and election staff"); (8) understandability to election management and staff, poll workers, voters, and election observers; (9) manageability to election management and staff, poll workers, and voters; (10) observability of vote recording and counting; (11) incidence of lawsuits in other jurisdictions; and (12) accessibility. We read the following publications to obtain information about these topics: Daily Voting News published by VotersUnite.org; Election Integrity News published by VoteTrustUSA.org.

This report is available at www.wheresthepaper.org/ny.html#costReports