REPORT ON THE RESULTS OF THE

EXPERIENCE STUDY OF THE

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY RETIREMENT FUND

JANUARY 1, 2010 - DECEMBER 31, 2014

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Retirement Board
Massachusetts Bay Transportation Authority Retirement Fund
One Washington Mall, Fourth Floor
Boston, Massachusetts 02108

Dear Board Members:

The results of our experience study covering the five-year period ending December 31, 2014, are described in this report, along with our recommendations for changes in the present assumptions.

The Table of Contents, which immediately follows, outlines the information contained in this report.

This study was prepared under the supervision of David L. Driscoll, with analysis of the rate-of-return and inflation assumptions performed under the supervision of Kai Petersen. We are Fellows of the Society of Actuaries and Members of the American Academy of Actuaries. We meet the Qualification Standards of the Academy to render the actuarial opinions contained herein, and we are available to answer questions concerning them. Additionally, Mr. Petersen is a Chartered Financial Analyst (CFA) Charter holder and has performed the analyses in accordance with the professional standards of the CFA Institute.

Respectfully submitted,

David L. Driscoll, FSA, EA, MAAA   Kai Petersen, FSA, EA, MAAA, CFA
Principal and Consulting Actuary   Principal, National Asset-Liability Management Group Leader

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I. <u>INTRODUCTION</u>

In order to accumulate funds to pay retirement benefits on a reasonable and relatively stable basis, the actuary prepares annual valuations of the Fund's assets and liabilities to measure the funded status and to ensure that funding is progressing at a rate that is adequate to meet the Fund's obligations.

The main purposes of funding are to equitably allocate costs between generations and provide security to members, who view the funds set aside as assurance that their benefits will be paid.

While the ultimate cost of the Fund is not determinable until all benefits are paid and expenses provided for, each actuarial valuation attempts to estimate costs based on assumptions selected to predict, as accurately as possible, future experience in order to produce stable contribution rates.

Overly conservative or aggressive assumptions can result in unacceptably high actuarial gains or losses each year. When translated into contributions, this will result in decreasing or increasing contribution rates and an inequitable allocation of costs.

The major actuarial assumptions are:

(a)   Active service demographic assumptions,

(b)   Compensation increase assumptions,

(c)   Post-retirement mortality rates, and

(d)   Interest rate.

Before presenting our analysis of the Fund's experience and discussion of the proposed assumptions, it is important to outline considerations that should govern the selection of actuarial assumptions. Current Actuarial Standards of Practice offer the following guidance:

(i)   The actuarial assumptions selected should reflect the actuary's professional judgment as to the likelihood of future events. They should take into account actual experience to the extent possible, but they should also reflect long-term future trends rather than give undue weight to recent past experience.

(ii)   The actuary should consider the impact of inflation in selecting the actuarial assumptions to be used.

(iii)   The actuary should give consideration to the reasonableness of each actuarial assumption independently as well as the combined impact of all the assumptions.

(iv)   The actuary should give careful attention to changes in plan design or other circumstances that may significantly alter expected future experience. For example, a liberalization of early retirement benefits may make advisable a revision in the retirement assumption.

(v)   The actuary, in choosing assumptions, should take into account general or specific information available from other sources, including the plan sponsor, plan administrator, investment managers, accountants, economists, etc.

(vi)   The actuary should select or recommend assumptions that are suited to the purpose of the measurement.

The purpose of this Report is to provide the information necessary to decide on the appropriate assumptions to be used in future valuations. It should be noted that these decisions cannot be made "in a vacuum" but must reflect the present and expected situation within the Fund.

The balance of this Report deals in detail with the various assumptions. In each area we have made recommendations as to what we believe are appropriate assumptions. These recommendations reflect our best estimate of the likely future experience based on:

        (a)   the recent past experience,

        (b)   the general economic views prevailing at this time, and

        (c)   anticipated trends.

II.   ACTIVE SERVICE DEMOGRAPHIC ASSUMPTIONS

The active service demographic assumptions include rates of:

(a)   Termination,

(b)   Disability,

(c)   Death before retirement, and

(d)   Retirement.

Our review of active service demographic assumptions is based on the actuarial valuation data for the Fund.

The basis for analysis of the Fund's experience is a comparison of the actual number of separations from service under each category with those expected based on the assumptions currently in use.

The "expected" values are calculated by applying the various rates or probabilities to the individuals exposed to each respective event. For example, active members not yet eligible for early retirement would be exposed to the probabilities of withdrawal, death and disability. A member eligible for early retirement would be exposed to disability, death and retirement decrements.

Numerical summaries of the Fund's experience from December 31, 2009, through December 31, 2014, are presented in Appendix I. The tables show the ratios of the actual experience of the Fund as compared to that anticipated by the present actuarial assumptions. The results are shown separately by assumption and, where appropriate, by sex.

The ratios of actual to expected experience indicate the extent of deviation from the assumptions. A ratio of 1.0 would mean the experience has been exactly as anticipated.

As an aid to the Fund management in analyzing these results, we have also prepared a series of graphs, which present the statistical data summarized in Appendix I in visual form. Our comments will refer to these graphs, which immediately follow each of the following subsections.

Termination and Reduced Early Retirement

The graphs that follow present the termination and reduced early retirement experience separately for male and female employees.

It can be seen that the observed rates of termination and reduced early retirement were well below those expected within each age group, for both male and female participants, over the five-year period covered by the study.

We note that the time period covered by the study includes some years of relatively unfavorable labor market conditions for job seekers, and that this may have affected the termination experience of the Fund reflected in these statistics. With this in mind, we recommend that the assumed rates of termination and reduced early retirement be changed to 80% of their present values. The proposed rates are set forth in detail in Appendix II, Table 1.

Active Service Experience - Terminations and Reduced Early Retirement
December 31, 2009 through December 31, 2014

Males

Current Rate
Actual Rate
Proposed Rate

Females

Current Rate
Actual Rate
Proposed Rate
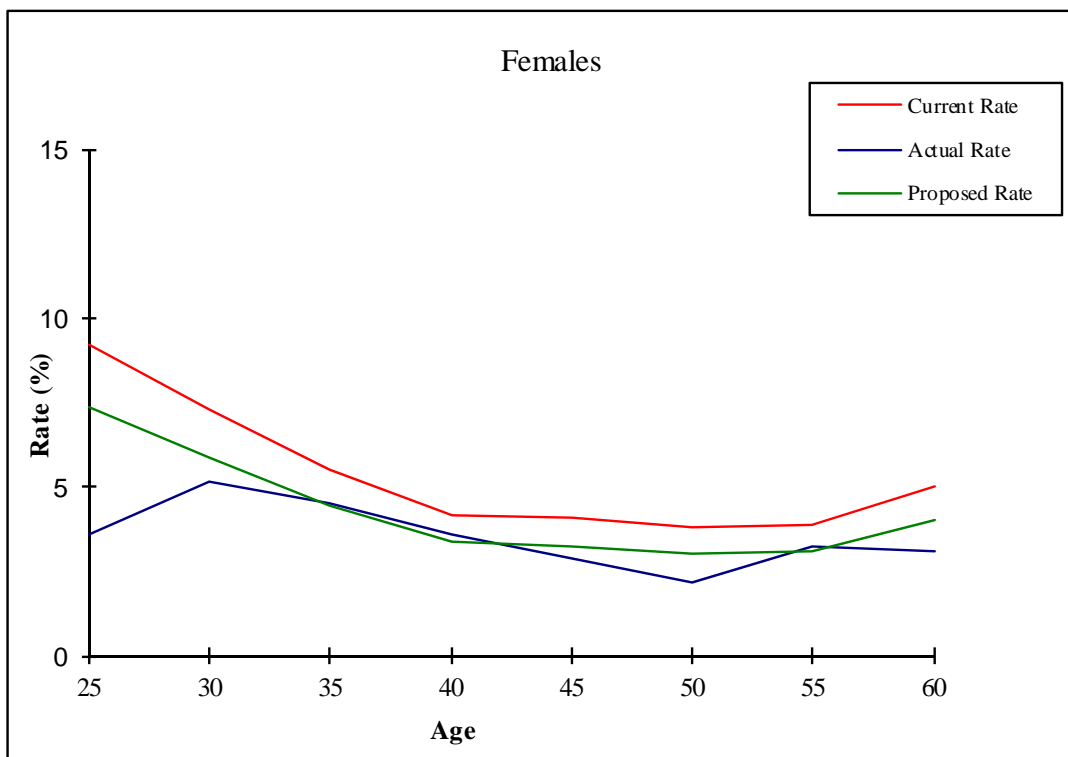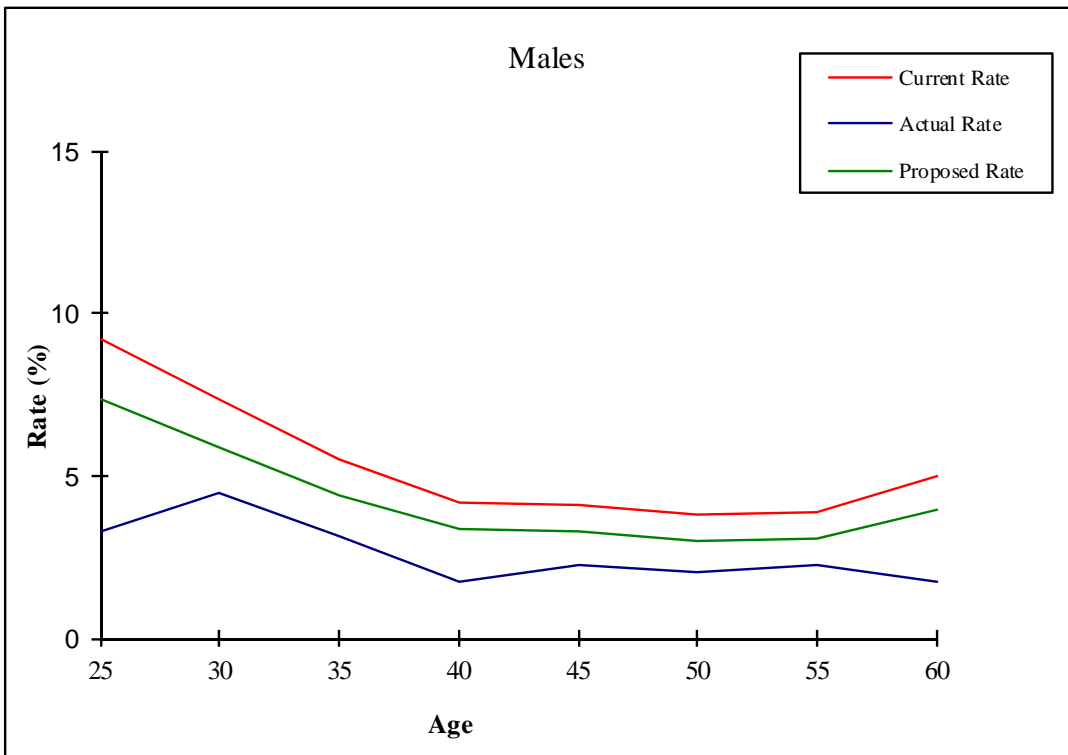
Disability

The incidence of disability by male and female are shown in the graphs that follow. The financial impact on the Fund resulting from this experience is relatively minor. However, it should be noted that the low incidence of actual disabilities makes this experience susceptible to rather large fluctuations from year to year. At the same time, such fluctuations have minimal impact on the funding of the plan. The present assumed rates of disability produce expected numbers of disabilities in excess of those actually observed among both male and female participants. We therefore recommend reductions in the assumed rates of disability at higher ages for both male and female active participants. The changes are detailed in Appendix II, Table II.

Death

Like disabilities, deaths among active members are a relatively small proportion of the overall incidence of departure from the active population. The graphs on page 10 present the incidence of death in active service among male and female members separately. As in the prior study, we recommend that the mortality tables used to forecast active-service mortality be set in accordance with those used to forecast retired-life mortality, which we are recommending be changed to the RP-2000 Blue Collar Mortality Tables with generational projection using Scale BB. Such an adjustment reflects both current and expected future improvements in in-service longevity. The recommended tables and projection scale are shown in Appendix III.

Active Service Experience - Disability Retirements
December 31, 2009 through December 31, 2014
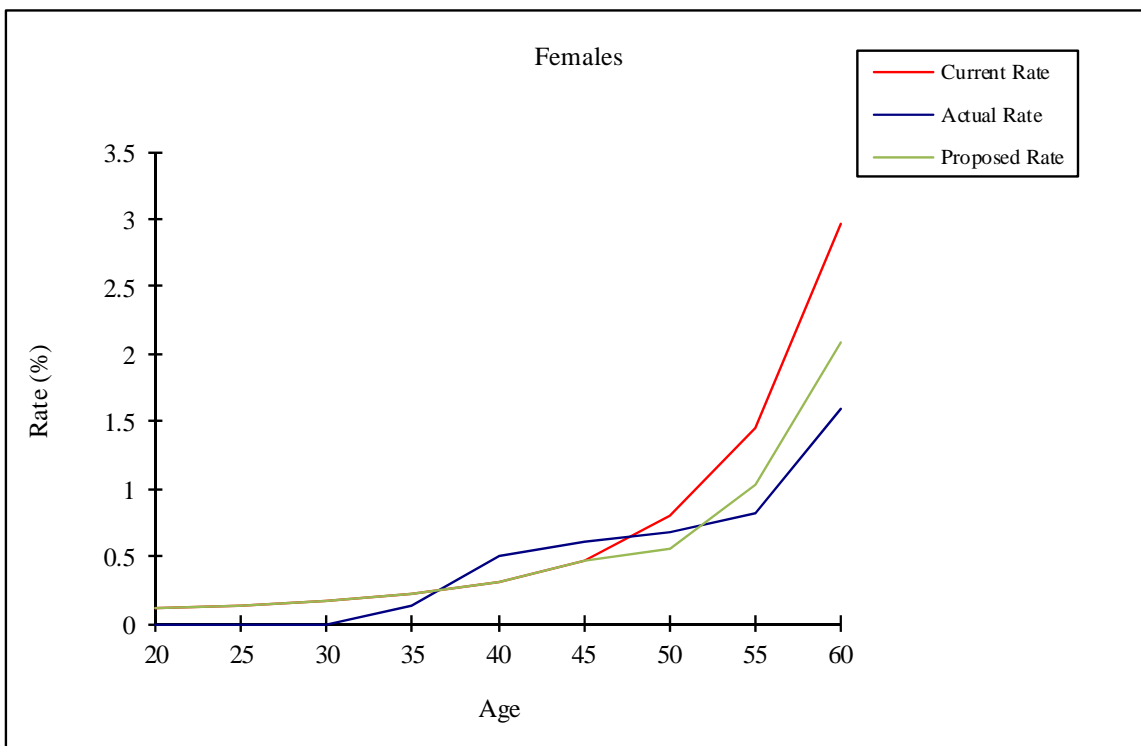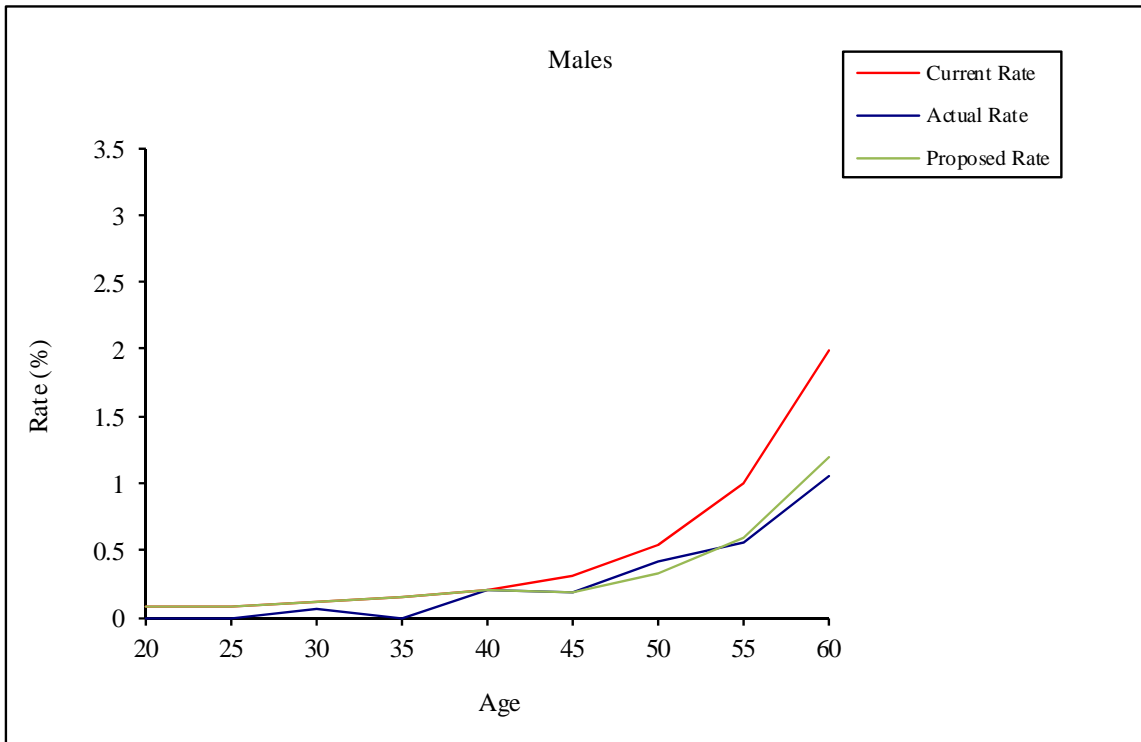
Active Service Experience - Deaths
December 31, 2009 through December 31, 2014
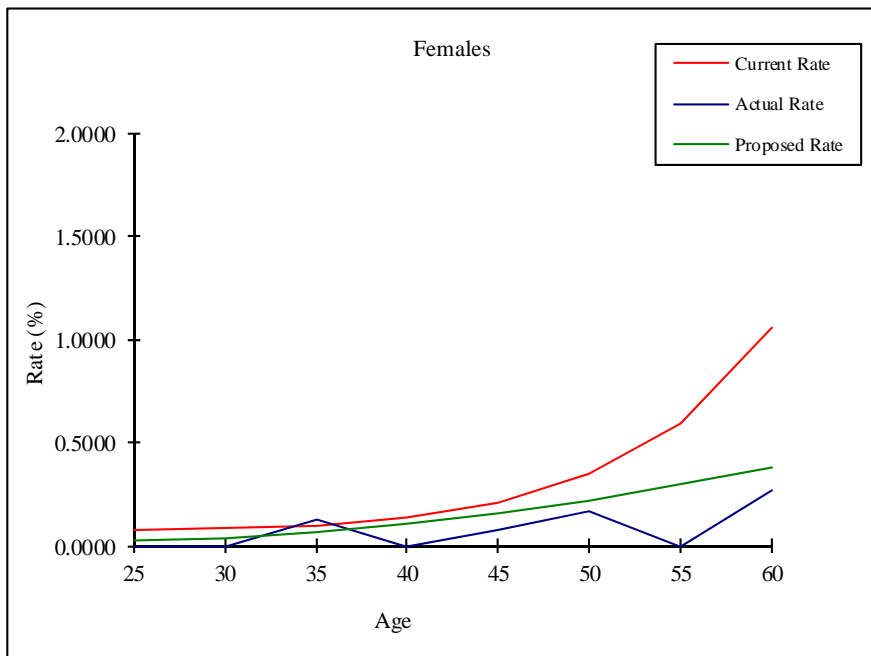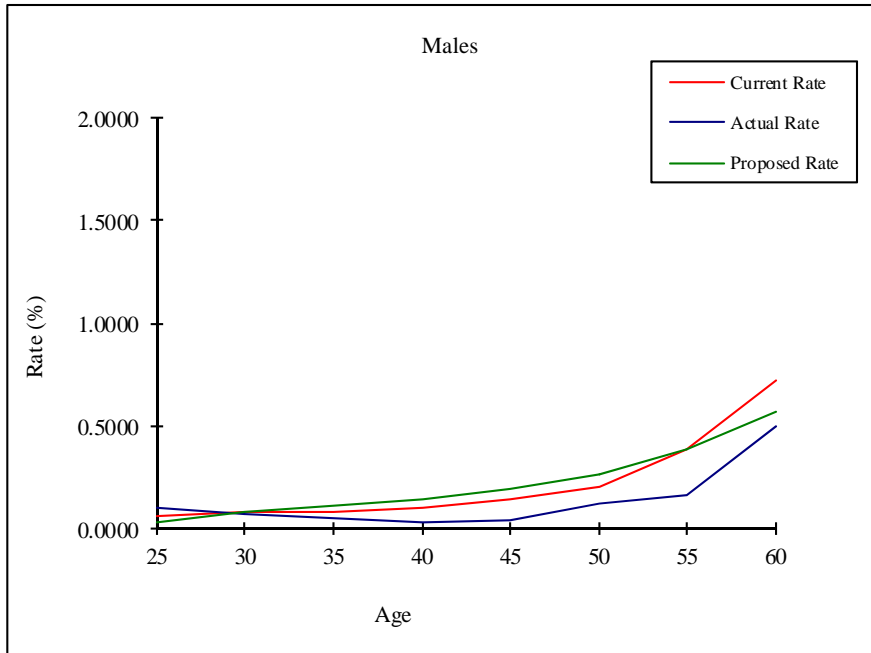
Note: The "Proposed Rates" shown in the graph above are those of the proposed base table (RP-2000 Employees With Blue Collar adjustment) with projection to the midpoint of the study period using Scale BB.

Service Retirement

On the basis of the last experience study, assumed rates of retirement were adopted that reflected participants' service as well as their ages.

Over the period covered by this study, observed rates of retirement were higher than expected at most ages. At the same time, we note the general tendency in recent years toward deferral of retirement among labor market participants generally. Taking the service-based definition of retirement eligibility into consideration, we recommend adjustment of both the assumed probabilities of service retirements for males and females in the year in which participants complete sufficient years of service for unreduced benefits as well as for subsequent years of service. Table 3 of Appendix II shows representative current and proposed tables of service retirement probabilities.

III.   POST-RETIREMENT MORTALITY RATES

A review of the statistics with regard to post-retirement mortality for both males and females is summarized in Table 5 of Appendix I. Overall, there were more deaths among both male retirees and female retirees than were expected. The ratio of actual to expected deaths among retirees varies by gender and by category of retirement (i.e., service retirement, disability retirement, receipt of survivor benefits)

Based on this experience, adjusted for statistical credibility, as well as the need under present applicable Actuarial Standards of Practice to reflect both current and expected future improvements in longevity in the selection of mortality assumptions, we recommend the following changes be made to the post-retirement mortality tables used in the valuation of the Fund:

- For service retirement, we recommend adoption of an assumption of 97.2% of the RP-2000 Blue-Collar Table for Healthy Males projected by Scale BB generationally.

- For dependents of deceased members, we recommend adoption of an assumption of 116.5% of the RP-2000 Blue-Collar Table for Healthy Females projected by Scale BB generationally.

- For disabled retirees, we recommend adoption of an assumption of the RP-2000 Tables for Disabled Lives projected by Scale BB generationally.

The recommended rates of mortality are shown in Appendix III.

IV.   ECONOMIC ASSUMPTIONS

Economic assumptions include:

(a)   rates of compensation increase,

(b)   investment income, and

(c)   inflation

Merit-Promotion Salary Increases

Currently a single compensation scale is used for both male and female members. The overall pattern of compensation increases appears to be generally consistent between males and females.

The graph on page 15 displays the levels of total compensation increase during the five-year period. These results include both merit-promotion increases and inflationary increases. The graph shows that pay increases have been higher than expected at ages below 40 and somewhat below expected levels at later ages. In the aggregate, they have been slightly below expected levels. Given present expectations for future employment conditions at the Authority, we recommend no changes in the Fund's salary increase assumption at this time. The statistics are summarized in Appendix I, table 4.

Active Service Experience - Salary Experience
December 31, 2009 through December 31, 2014

Males and Females
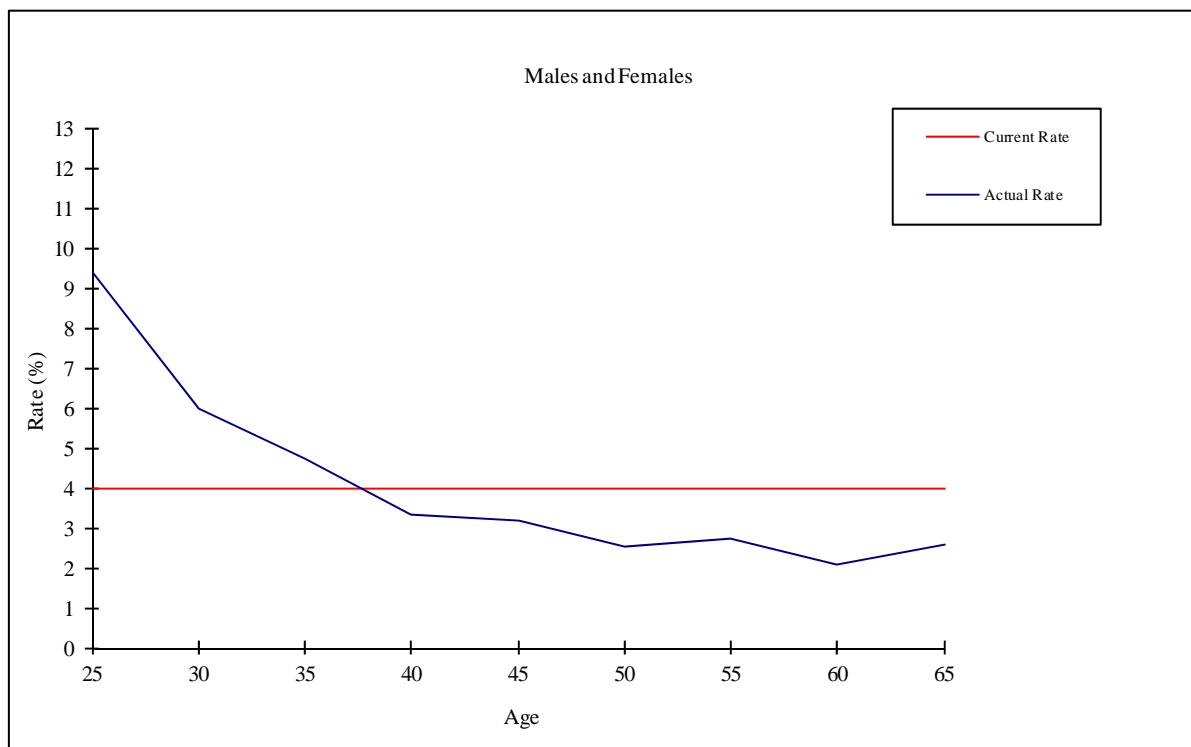
Interest Rate

The total rates of return earned by the MBTA Retirement Fund assets are shown below.

Year Ending December 31	Estimated Return Based on Market Value of Assets
2010	12.39%
2011	0.38%
2012	13.72%
2013	15.94%
2014	4.45%
2010-2014	9.38%

The average for the five-year period shown above is the arithmetic average of the estimated annual returns for each of the five years covered by the study. If the average is computed as a geometric average, the figure is 9.21%.

While a consideration of the experience of the Fund in the recent past is helpful in setting assumptions, the focus of the analysis here is most appropriately on the expected future return on the assets held by the Fund. In an effort to forecast the expected long-term rate of return on Fund assets, we use a capital market model known as GEMS (General Economy and Market Simulator, described in more detail in Appendix V), in which individual asset class returns are estimated under a wide variety of simulated economic environments based on their underlying relationships to key economic variables, and then incorporated into a forecast of the performance of a portfolio invested in accordance with the Fund's target asset allocation, which was recently updated to reflect the results of an asset-liability management study. The model is calibrated to current economic and market conditions, and trends to a state of equilibrium. Over a 20-year period, the 50th percentile annual rate of return forecast for such a

portfolio is approximately 8.32%, while the 75th and 25th percentiles are approximately 8.95% and 7.71%, respectively. The continued use of the Fund's present 8.00% annual assumed rate of return is thus consistent with our estimates of the expected return on assets held by the Fund under its present asset allocation policy. We do not recommend a change in this assumption.

We note that the Fund intends to conduct an asset-liability modeling study next year, in which the volatility of contributions called for under the Fund's funding policy will be examined and the asset allocation policy re-examined. We recommend that the investment return assumption be revisited once the study is completed and any revisions to asset allocation policy have been made.

Inflation

There is no need to set an explicit rate of inflation assumption, since the Fund does not provide automatic cost-of-living increases or other benefits directly related to inflation. However, it is appropriate to review the salary-increase and rate-of-return assumptions for consistency with respect to the rate of inflation embedded in each of them. We believe that the use of a rate-of-return assumption of 8.00% per year and a salary-increase assumption of 4.00% per year is consistent with an assumed rate of inflation of approximately 3.00% per year. This is consistent with the corresponding projections of the rate of inflation, whose 75th, 50th and 25th percentiles over 30 years are forecast by GEMS as 3.72%, 2.85% and 2.11%, respectively.

Expenses

For some time, it has been assumed that the expenses of the Fund will amount to 0.45% of the covered payroll. In recent years, the operating expenses of the Fund have stabilized at a level close to $4 million per year. This amounts to approximately 1% of the payroll covered by the Fund in

the most recent valuation. We therefore recommend that the expense assumption included in the

calculation of the annual contribution to the fund be raised from 0.45% of payroll to 1.00% of

payroll.

V.   COST ANALYSIS AND CONCLUSION

To assist the Board in selecting and approving the final package of valuation assumptions to be used prospectively from December 31, 2014, we have prepared a valuation of the Fund as of December 31, 2014, to reflect the potential impact of the revised assumptions.

Based on the proposed assumptions, the annual contribution rate developed in the December 31, 2014, valuation would increase from 21.82% to 22.98%. These results are summarized in Appendix IV.

We look forward to discussing the results of this experience investigation with the Board prior to the preparation of the December 31, 2015, valuation of the Fund.

APPENDIX I

ACTUAL AND EXPECTED EXPERIENCE

TABLE 1

COMPARISON OF ACTUAL AND EXPECTED SEPARATIONS
FROM ACTIVE SERVICE

TERMINATIONS

Age	Males			Females		
	Actual	Expected	Ratio of Actual To Expected	Actual	Expected	Ratio of Actual To Expected
Under 25	8	22.59	0.3541	3	7.63	0.3930
25-29	45	74.53	0.6038	27	38.14	0.7079
30-34	46	80.79	0.5694	32	39.35	0.8132
35-39	34	82.75	0.4109	29	33.63	0.8623
40-44	68	121.41	0.5601	28	40.04	0.6993
45-49	75	140.01	0.5357	26	45.40	0.5727
50-54	74	126.82	0.5835	32	37.91	0.8441
55-59	40	112.80	0.3546	19	30.88	0.6153
60 and over	71	97.21	0.7303	20	21.86	0.9147
Total	461	858.92	0.5367	216	294.85	0.7326

TABLE 2

**COMPARISON OF ACTUAL AND EXPECTED SEPARATIONS
FROM ACTIVE SERVICE**

DISABILITY RETIREMENTS

Age	Males			Females		
	Actual	**Expected**	**Ratio of Actual To Expected**	**Actual**	**Expected**	**Ratio of Actual To Expected**
Under 25	0	0.19	0.0000	0	0.10	0.0000
25-29	0	0.88	0.0000	0	0.68	0.0000
30-34	1	1.63	0.6148	0	1.18	0.0000
35-39	0	2.84	0.0000	1	1.72	0.5811
40-44	6	6.09	0.9860	5	2.98	1.6754
45-49	8	13.32	0.6008	8	6.17	1.2972
50-54	17	21.64	0.7856	8	9.49	0.8432
55-59	17	30.20	0.5630	7	12.40	0.5643
60 and over	19	42.14	0.4509	7	13.00	0.5383
Total	68	118.92	0.5718	36	47.72	0.7544

TABLE 3

**COMPARISON OF ACTUAL AND EXPECTED SEPARATIONS
FROM ACTIVE SERVICE**

SERVICE RETIREMENTS

Age	Males			Females		
	Actual	**Expected**	**Ratio of Actual To Expected**	**Actual**	**Expected**	**Ratio of Actual To Expected**
Under 46	34	19.60	1.7347	15	5.53	2.7125
46	10	10.34	0.9671	8	3.41	2.3460
47	18	10.62	1.6949	3	3.53	0.8499
48	17	12.19	1.3946	4	2.62	1.5267
49	11	10.96	1.0037	2	2.00	1.0000
50	19	12.26	1.5498	4	3.24	1.2346
51	22	14.02	1.5687	6	3.12	1.9231
52	14	11.76	1.1910	6	3.05	1.9704
53	29	15.89	1.8250	7	5.68	1.2324
54	31	14.49	2.1387	10	6.55	1.5279
55	24	13.10	1.8321	7	4.75	1.4737
56	19	15.63	1.2156	18	6.29	2.8617
57	20	16.28	1.2285	8	7.07	1.1315
58	29	18.64	1.5558	18	5.28	3.4091
59	22	19.24	1.1434	6	3.13	1.9200
60	36	20.60	1.7476	12	4.47	2.6846
61	43	22.87	1.8802	6	3.34	1.7964
62	33	33.65	0.9807	8	4.70	1.7021
63	18	25.15	0.7157	5	4.90	1.0204
64	19	22.20	0.8559	3	2.05	1.4634
65	56	59.60	0.9396	14	12.70	1.1024
66	42	39.50	1.0633	4	6.90	0.5797
67	12	22.40	0.5357	2	4.50	0.4444
68	12	18.15	0.6612	3	4.10	0.7317
69	12	15.25	0.7869	0	2.95	0.0000
70 and over	21	102.00	0.2059	9	26.00	0.3462
Total	623	596.39	1.0446	188	141.84	1.3254

TABLE 4

**COMPARISON OF ACTUAL AND EXPECTED
ANNUAL SALARIES OF MEMBERS**

Age	Males Annual Salaries (shown in 1,000s)			Females Annual Salaries (shown in 1,000s)		
	Actual	Expected	Ratio of Actual To Expected	Actual	Expected	Ratio of Actual To Expected
Under 25	19,771	18,350	1.077	6,763	6,363	1.063
25-29	62,995	60,019	1.050	30,760	29,111	1.057
30-34	98,556	97,172	1.014	40,090	38,894	1.031
35-39	139,646	139,049	1.004	48,260	47,514	1.016
40-44	219,574	221,514	0.991	64,206	64,169	1.001
45-49	297,530	300,529	0.990	80,014	80,062	0.999
50-54	261,983	266,211	0.984	68,742	69,246	0.993
55-59	192,557	195,126	0.987	42,865	43,223	0.992
60-64	93,151	94,909	0.981	16,733	17,048	0.982
65 and over	23,250	23,685	0.982	4,859	4,818	1.008
Total	1,409,013	1,416,564	0.995	403,292	400,449	1.007

TABLE 5

**SUMMARY OF MORTALITY EXPERIENCE
OF PENSIONERS**

Group	Males			Females			Total		
	Actual	Expected	Ratio of Actual To Expected	Actual	Expected	Ratio of Actual To Expected	Actual	Expected	Ratio of Actual To Expected
Service Retirees	615	546.11	1.126	38	67.85	0.560	653	613.96	1.064
Disability Retirees	74	104.96	0.705	25	35.37	0.707	99	140.33	0.705
Dependants of Deceased Members	6	2.04	2.941	407	327.71	1.242	413	329.75	1.252
Total	695	653.11	1.064	470	430.93	1.091	1,165	1,084.04	1.075

APPENDIX II

RECOMMENDED ACTIVE SERVICE TABLES

TABLE 1

**COMPARISON OF CURRENT AND RECOMMENDED SEPARATIONS
FROM ACTIVE SERVICE**

TERMINATIONS

Age	Males and Females	
	Withdrawal Vested and Early Reduced Retirement	
	Current	Recommended
25	8.75%	7.00%
30	6.22%	4.98%
35	4.66%	3.73%
40	4.53%	3.62%
45	4.09%	3.27%
50	3.77%	3.02%
55	4.22%	3.38%
60	5.04%	4.03%
64	8.64%	6.91%

TABLE 2

**COMPARISON OF CURRENT AND RECOMMENDED SEPARATIONS
FROM ACTIVE SERVICE**

DISABILITY

Age	Males		Females	
	Current	Recommended	Current	Recommended
25	0.08%	0.08%	0.12%	0.12%
30	0.10%	0.10%	0.15%	0.15%
35	0.13%	0.13%	0.20%	0.20%
40	0.17%	0.17%	0.26%	0.26%
45	0.25%	0.15%	0.38%	0.38%
50	0.42%	0.25%	0.63%	0.44%
55	0.76%	0.46%	1.14%	0.80%
60	1.50%	0.90%	2.25%	1.58%
64	2.80%	1.68%	4.20%	2.94%

TABLE 3

**COMPARISON OF CURRENT AND RECOMMENDED SEPARATIONS
FROM ACTIVE SERVICE**

SERVICE RETIREMENTS

Age	Males and Females			
	Current for the Year Eligible for Unreduced Benefits	Current for Years After First Eligible for Unreduced Benefits	Recommended for the Year Eligible for Unreduced Benefits	Recommended for Years After First Eligible for Unreduced Benefits
50	28%	3%	15%	4%
55	30%	5%	20%	5%
60	36%	11%	30%	10%
62	55%	30%	35%	10%
63	55%	30%	35%	10%
64	55%	30%	35%	20%
65	55%	30%	35%	30%
66	55%	30%	25%	25%
67	55%	30%	25%	25%
68	55%	30%	25%	25%
69	55%	30%	25%	25%
70	100%	100%	100%	100%

APPENDIX III

RECOMMENDED MORTALITY TABLES

RECOMMENDED MORTALITY RATES
POST RETIREMENT SERVICE RETIREES

97.2% of MALE RP-2000TABLE (with blue-collar adjustment) and PROJECTION SCALE BB

Mortality Table				Projection Scale			
Age	Probability	Age	Probability	Age	Rate of Improvement	Age	Rate of Improvement
45	0.002180	83	0.092526	45	0.003	83	0.015000
46	0.002633	84	0.101737	46	0.003	84	0.015000
47	0.003161	85	0.111855	47	0.003	85	0.015000
48	0.003765	86	0.122820	48	0.003	86	0.015000
49	0.004443	87	0.134746	49	0.003	87	0.014000
50	0.005436	88	0.147691	50	0.003	88	0.013000
51	0.005781	89	0.161599	51	0.003	89	0.012000
52	0.006094	90	0.176668	52	0.003	90	0.011000
53	0.006385	91	0.190875	53	0.003	91	0.010000
54	0.006677	92	0.205698	54	0.003	92	0.009000
55	0.007008	93	0.220987	55	0.003	93	0.008000
56	0.007452	94	0.236363	56	0.003	94	0.007000
57	0.007993	95	0.252201	57	0.004	95	0.006000
58	0.008646	96	0.275956	58	0.005	96	0.005000
59	0.009400	97	0.291456	59	0.006	97	0.004000
60	0.010260	98	0.306468	60	0.007	98	0.004000
61	0.011198	99	0.320961	61	0.008	99	0.003000
62	0.012239	100	0.334908	62	0.009	100	0.003000
63	0.013380	101	0.348586	63	0.01	101	0.002000
64	0.014664	102	0.361278	64	0.011	102	0.002000
65	0.016095	103	0.372315	65	0.012	103	0.001000
66	0.017718	104	0.381027	66	0.013	104	0.001000
67	0.019535	105	0.386745	67	0.014	105	0.000000
68	0.021529	106	0.388800	68	0.015	106	0.000000
69	0.023685	107	0.388800	69	0.015	107	0.000000
70	0.026009	108	0.388800	70	0.015	108	0.000000
71	0.028516	109	0.388800	71	0.015	109	0.000000
72	0.031291	110	0.388800	72	0.015	110	0.000000
73	0.034410	111	0.388800	73	0.015	111	0.000000
74	0.037960	112	0.388800	74	0.015	112	0.000000
75	0.041923	113	0.388800	75	0.015	113	0.000000
76	0.046358	114	0.388800	76	0.015	114	0.000000
77	0.051200	115	0.388800	77	0.015	115	0.000000
78	0.056490	116	0.388800	78	0.015	116	0.000000
79	0.062273	117	0.388800	79	0.015	117	0.000000
80	0.068572	118	0.388800	80	0.015	118	0.000000
81	0.075975	119	0.388800	81	0.015	119	0.000000
82	0.083943	120	1.000000	82	0.015	120	0.000000

RECOMMENDED MORTALITY RATES
FOR DEPENDENTS OF DECEASED MEMBERS
116.5 % of FEMALE RP-2000TABLE (with blue-collar adjustment) and PROJECTION SCALE BB

	Mortality Table				Projection Scale		
					Rate of		Rate of
Age	Probability	Age	Probability	Age	Improvement	Age	Improvement
45	0.001272	83	0.078062	45	0.003	83	0.012000
46	0.001418	84	0.086980	46	0.003	84	0.012000
47	0.001637	85	0.096812	47	0.003	85	0.012000
48	0.001928	86	0.107571	48	0.003	86	0.012000
49	0.002293	87	0.119303	49	0.003	87	0.012000
50	0.002327	88	0.132008	50	0.003	88	0.012000
51	0.002335	89	0.145338	51	0.003	89	0.012000
52	0.002427	90	0.159239	52	0.003	90	0.011000
53	0.002611	91	0.173181	53	0.003	91	0.010000
54	0.002883	92	0.186930	54	0.004	92	0.009000
55	0.003262	93	0.200342	55	0.005	93	0.008000
56	0.003750	94	0.212748	56	0.006	94	0.007000
57	0.004357	95	0.224337	57	0.007	95	0.006000
58	0.005103	96	0.239267	58	0.008	96	0.005000
59	0.005993	97	0.250755	59	0.009	97	0.004000
60	0.007006	98	0.260898	60	0.01	98	0.004000
61	0.008133	99	0.269566	61	0.011	99	0.003000
62	0.009325	100	0.276649	62	0.012	100	0.003000
63	0.010568	101	0.285232	63	0.012	101	0.002000
64	0.011832	102	0.296490	64	0.012	102	0.002000
65	0.013137	103	0.309941	65	0.012	103	0.001000
66	0.014507	104	0.325099	66	0.012	104	0.001000
67	0.015983	105	0.341480	67	0.012	105	0.000000
68	0.017647	106	0.358600	68	0.012	106	0.000000
69	0.019542	107	0.375975	69	0.012	107	0.000000
70	0.021709	108	0.393119	70	0.012	108	0.000000
71	0.024155	109	0.409549	71	0.012	109	0.000000
72	0.026867	110	0.424779	72	0.012	110	0.000000
73	0.029784	111	0.438327	73	0.012	111	0.000000
74	0.032832	112	0.449707	74	0.012	112	0.000000
75	0.035985	113	0.458436	75	0.012	113	0.000000
76	0.039358	114	0.464029	76	0.012	114	0.000000
77	0.042991	115	0.466000	77	0.012	115	0.000000
78	0.047083	116	0.466000	78	0.012	116	0.000000
79	0.051691	117	0.466000	79	0.012	117	0.000000
80	0.057030	118	0.466000	80	0.012	118	0.000000
81	0.063181	119	0.466000	81	0.012	119	0.000000
82	0.070174	120	1.000000	82	0.012	120	0.000000

APPENDIX IV

COMPARATIVE VALUATION RESULTS

APPENDIX IV

RESULTS FOR THE ACTUARIAL VALUATION
PREPARED AS OF DECEMBER 31, 2014 ON
CURRENT AND RECOMMENDED ASSUMPTIONS

Valuation Date	Current Assumptions	Recommended Assumptions
Number of active members	5,798	5,798
Annual compensation of all members	$417,957,007	$417,957,007
Annual compensation of active members below normal retirement age	$415,146,025	$415,146,025
Average age	47.55	47.55
Average service	11.44	11.44
Average compensation	$72,086	$72,086
Number of inactive members	134	134
Number of retired members, beneficiaries and disabled members	6,407	6,407
Annual retirement allowances	$185,827,100	$185,827,100
Assets for valuation purposes	$1,632,174,762	$1,632,174,762
Unfunded accrued liability	$815,556,295	$810,730,740
Contribution rates required:		
Accrued liability	12.38%	12.31%
Normal	8.99%	9.67%
Expenses	0.45%	1.00%
Total required rate	21.82%	22.98%
Member excess rate	0.00%	0.00%

<u>APPENDIX V</u>

ABOUT GEMS

ABOUT GEMS GENERAL ECONOMY AND MARKET SIMULATOR)

GEMS® is a cutting-edge Economic Scenario Generator (ESG) that enables users to simulate future states of the global economy and financial markets, including the pricing of derivatives and alternative assets. It uses financial models that are the most technologically advanced in the industry, ensuring that models perform consistently with history, provide a realistic representation of extreme events and support hedging strategies with market consistent pricing. GEMS includes comprehensive yield curve modeling and a multifactor arbitrage pricing model that develops asset-class return series based on asset-class relationships to underlying economic and capital market variables such as GDP, inflation, interest rates, credit spreads, and unemployment. The model is calibrated to current market conditions and trends the economic variables to longer-term historical norms – simulating a variety of economic environments and concomitant asset-class returns in the process.

Some of the other distinguishing features of GEMS are:

1. Many asset-class return distributions are non-normal even though many models historically have treated them as such. Asset classes exhibit non-normal return distribution characteristics such as skew and kurtosis. GEMS is more effective at capturing these characteristics. In doing so, it more effectively captures outlier fat-tail events (leptokurtosis) and positive or negative skew in a manner that more closely resembles what actually occurs.

2. Asset-class returns are linked to underlying economic conditions in the model so the user can relate a specific asset-class or portfolio return path to conditions that can be described in terms of economic variables.

3. Because GEMS is calibrated to current levels of economic activity and trends to a longer-term state of equilibrium, shorter-term asset returns forecasts in GEMS are more reflective

of recent market activity and short-term characteristics and trends in economic and market variables, and longer-term returns reflect asset performance over complete market cycles.

4. There is empirical evidence that asset correlations are dynamic and move closer to unity when markets are volatile and under stress. GEMS models asset correlations dynamically.