



**Missouri Department of  
Transportation and Highway  
Patrol Employees' Retirement  
System (MPERS)**

**Audit of the June 30, 2019  
Actuarial Valuation Report and  
5-Year Experience Study July 1, 2012  
Through June 30, 2017**

**Produced by Cheiron**

**June 2020**

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*Via Electronic Mail*

June 10, 2020

Board of Trustees  
Missouri Department of Transportation  
and Highway Patrol Employees' Retirement System  
1913 William Street  
Jefferson City, MO 65102-1930

Members of the Board:

Cheiron is pleased to present the results of our actuarial audit of the June 30, 2019 Actuarial Valuation Report and the 5-Year Experience Study July 1, 2012 Through June 30, 2017 performed by Gabriel, Roeder, Smith & Company (GRS) for the Missouri Department of Transportation and Highway Patrol Employees' Retirement System (MPERS). We would like to thank GRS for providing us with information and explanations that facilitated the actuarial audit process and ensured that our findings are accurate and benefit MPERS.

We direct your attention to the executive summary section of our report which highlights the key findings of our review. The balance of the report provides details in support of these findings along with supplemental data, background information, and discussion of the process used in the evaluation of the work performed by GRS.

In preparing our report, we relied on information (some oral and some written) supplied by MPERS and GRS. This information includes, but is not limited to, actuarial assumptions and methods adopted by MPERS, plan provisions, employee data, and financial information. We performed an informal examination of the obvious characteristics of the data for reasonableness in accordance with Actuarial Standard of Practice No. 23. A detailed description of all information provided for this review is provided in the body of our report.

This report and its contents have been prepared in accordance with generally recognized and accepted actuarial principles and our understanding of the Code of Professional Conduct and applicable Actuarial Standards of Practice set out by the Actuarial Standards Board as well as applicable laws and regulations. Furthermore, as credentialed actuaries, we meet the Qualification Standards of the American Academy of Actuaries to render the opinion contained in this report. This report does not address any contractual or legal issues. We are not attorneys and our firm does not provide any legal services or advice.

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and Highway Patrol Employees' Retirement System  
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This report was prepared exclusively for the Missouri Department of Transportation and Highway Patrol Employees' Retirement System for the purpose described herein. This report is not intended to benefit any third party, and Cheiron assumes no duty or liability to any such party.

Sincerely,  
Cheiron



Steven M. Hastings, FSA, EA, FCA, MAAA  
Consulting Actuary



Michael J. Noble, FSA, EA, FCA, MAAA  
Principal Consulting Actuary

**ACTUARIAL AUDIT REPORT OF THE  
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**SECTION I – EXECUTIVE SUMMARY**

## **Scope of Assignment**

Cheiron performed a complete independent replication of the MPERS June 30, 2019 Actuarial Valuation Report and evaluated the accounting disclosures prepared by GRS. We also reviewed the actuarial methods and assumptions underlying those valuations.

We reviewed the census data provided by MPERS staff, and compared it to the information used by GRS in their valuations. We then performed full parallel valuations, including the calculation of the projected benefits, accrued liability, and normal cost for all MPERS members, and compared the results to those shown in GRS's actuarial valuation reports.

This audit provides MPERS confirmation that:

- The results reported by GRS can be relied upon,
- The communication of the actuarial valuation results is complete and reasonable, and
- The fees paid by MPERS to the current actuary appear to be reasonable based on the level of services received and typical of the industry.

## **Key Findings**

The main findings of our review are as follows:

1. As a result of our efforts, we are able to confirm that the liabilities and costs computed in the valuations as of June 30, 2019 are reasonably accurate and that the actuarial methods and assumptions generally comply with Actuarial Standards of Practice (ASOPs).
2. The signing actuaries certified that they meet the Qualification Standards of the American Academy of Actuaries to render an actuarial opinion, that the valuation is in accordance with generally accepted actuarial principles and practices, and that the procedures followed and results presented are in conformity with applicable actuarial standards of practice. The GRS consulting team includes Heidi Barry and Jamal Adora, each an Associate of the Society of Actuaries (ASA) and Member of the American Academy of Actuaries (MAAA). The Actuarial Directory website ([www.actuarialdirectory.org](http://www.actuarialdirectory.org)) indicates that both actuaries are compliant with relevant Continuing Professional Development (CPD) requirements for the most recent two years. We note that Kenneth Alberts of GRS is not a credentialed actuary and therefore does not meet the American Academy of Actuaries qualification standards for issuing statements of actuarial opinion in the United States.
3. The funding methods adopted by the Board of Trustees are appropriately funding the obligations of the System. In particular we commend the Board for adopting the Temporary Policy which accelerates the funding of the liability for retired members. In addition, the creation of a contribution stabilization fund has the potential to provide significantly reduced volatility in the contributions which becomes increasingly more important as the System gets closer to the end of closed amortization periods. The

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June 30, 2019 actuarial valuation report does not include stochastic projections or projections under alternative scenarios. The inclusion of such projections would help the users of the report understand the ongoing risks that may impact the system.

4. The Governmental Accounting Standards Board (GASB) reporting prepared by GRS is in compliance, as applicable, with GASB Statements Nos. 67 and 68 disclosure requirements.
5. The fixed fees paid to the current actuary for annual valuation services since July 1, 2016 and for the most recent 5-Year Experience Study appear to be reasonable. We also reviewed the blended hourly rates charged for actuarial consulting services during this period and found them to be in line with rates common in the industry.
6. We have reviewed the economic and demographic assumptions recommended in the most recent 5-Year Experience Study presented by GRS. In general, we have found them to be reasonable and in accordance with generally accepted actuarial principles and practices. However, we present several considerations in areas where assumptions could be refined or better supported.

Our primary items to consider:

- GRS should consider providing additional assessment of the risks to future contribution requirements identified in their 2019 actuarial report: amortization policy risk, investment risk, and mortality/longevity risk. For example, this assessment can be done through scenario testing or alternative projections of employer contribution rates.
- Cheiron determined the economic assumptions proposed in GRS's 5-Year Experience Study to represent a reasonable set of assumptions. We suggest GRS and the Board continue to monitor these assumptions, investment return, and payroll growth in particular, given recent volatility.
- GRS should consider adding credibility statistics such as confidence intervals to the next experience study analysis. It is important to communicate how much weight should be given to the observed data when developing assumptions.
- Cheiron determined the non-economic actuarial assumptions proposed in GRS's 5-Year Experience Study to be generally reasonable and in compliance with acceptable standards of actuarial practice. However, GRS should consider reviewing the methodology used to determine the mortality assumptions.
  - GRS should explain and justify their adjustment of preretirement mortality by a factor of 0.65. This represents a significant reduction in mortality rates and it does not appear that the data examined has adequate credibility to warrant this modification.

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- GRS should explain and justify their projection of the base mortality table to only 2022. Typical actuarial practice provides longer periods of mortality improvement projection.
- GRS should consider moving to full generational mortality improvement projection for the next experience study, if not sooner.
- GRS should consider the addition of a service component for retirement assumptions in the next experience study.
- GRS should consider an exception to the Closed Plan choice assumption for non-uniformed vested terminated members with under 15 years of service in the next experience study.
- GRS should directly value survivor benefits for disabled members, disabled retirees, and future terminated vested members. The current method of adding loads to member benefits is unnecessary given actuarial software and is not adequately supported in the report.

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**SECTION II – REVIEW OF ACTUARIAL VALUATION RESULTS**

**Valuation Procedures**

Overall, we find that the June 30, 2019 actuarial valuation procedures applied in the reporting of the funded status and the determination of the funding requirements based on the current funding policies and adopted assumptions are technically reasonable and conform to the ASOPs. This is based on our review of: the valuation report, the census data used in the valuation, and our parallel valuation. While full test life documentation was not available, we were able to reasonably match liabilities provided for 20 individual test life samples from various plan and status groups.

**Valuation Results**

Our independent replication of the June 30, 2019 actuarial valuation found no material difference in calculations of system liabilities, Actuarial Value of Assets, and overall contribution rates from the amounts calculated by GRS based on the adopted assumptions and methods. For the scope of this audit, materiality means the results in the aggregate were within industry standards of plus or minus 5%. Consequently, we conclude that the valuation prepared by GRS for MPERS as of June 30, 2019 is reasonable and can be relied on by the Board for its intended purpose. Our replication of the measures of system liabilities and costs is summarized in Table II-1 below.

<b>Table II-1</b>			
<b>Summary of Valuation Results as of June 30, 2019</b>			
<b>Grand Total</b>			
	<b>GRS</b>	<b>Cheiron</b>	<b>Ratio</b>
Present Value of Future Benefits	\$ 4,346,470,410	\$ 4,314,435,960	99.3%
Actuarial Liability	\$ 4,037,369,708	\$ 4,003,323,468	99.2%
Actuarial Value of Assets (AVA)	<u>2,415,343,431</u>	<u>2,415,343,431</u>	100.0%
Unfunded Actuarial Liability (UAL)	\$ 1,622,026,277	\$ 1,587,980,037	97.9%
Funded Percentage on AVA basis	59.8%	60.3%	100.9%
<b>Contribution Rate by Component</b>			
Gross Normal Cost Rate	11.37%	11.13%	97.9%
Member Normal Cost Rate	<u>-1.28%</u>	<u>-1.29%</u>	101.1%
Net Employer Normal Cost	10.09%	9.84%	97.5%
Administrative Expenses	1.15%	1.15%	100.0%
Disability Insurance	0.53%	0.53%	100.0%
UAL Amortization	<u>46.23%</u>	<u>46.48%</u>	100.5%
Total Rate	58.00%	58.00%	100.0%



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We note that all results are within 5% of GRS's calculation, including contribution rates. Additional detail for the uniformed group and non-uniformed group is shown below in Tables II-2 and II-3, respectively.

<b>Table II-2</b>			
<b>Summary of Valuation Results as of June 30, 2019</b>			
<b>Uniformed Total</b>			
	<b>GRS</b>	<b>Cheiron</b>	<b>Ratio</b>
<b>Present Value of Future Benefits</b>			
Active	\$ 555,633,195	\$ 538,867,343	97.0%
Deferred	15,075,261	15,893,533	105.4%
In Payment	<u>705,109,235</u>	<u>717,502,251</u>	101.8%
Total	\$ 1,275,817,691	\$ 1,272,263,127	99.7%
<b>Unfunded Actuarial Liability</b>			
Actuarial Liability	\$ 1,152,592,317	\$ 1,148,478,414	99.6%
Actuarial Value of Assets (AVA)	<u>707,378,769</u>	<u>707,378,769</u>	100.0%
Unfunded Actuarial Liability (UAL)	\$ 445,213,548	\$ 441,099,645	99.1%
Funded Percentage on AVA basis	61.4%	61.6%	100.4%
<b>Contribution Rate by Component</b>			
Gross Normal Cost Rate	16.63%	16.17%	97.2%
Member Normal Cost Rate	<u>-0.92%</u>	<u>-0.92%</u>	100.0%
Net Employer Normal Cost	15.71%	15.25%	97.1%
Administrative Expenses	1.15%	1.15%	100.0%
Disability Insurance	0.53%	0.53%	100.0%
UAL Amortization	<u>40.61%</u>	<u>41.07%</u>	101.1%
Total Rate	58.00%	58.00%	100.0%

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**Table II-3**

**Summary of Valuation Results as of June 30, 2019  
Non-Uniformed Total**

	GRS	Cheiron	Ratio
<b>Present Value of Future Benefits</b>			
Active	\$ 1,033,602,106	\$ 1,009,725,500	97.7%
Deferred	85,751,230	89,343,168	104.2%
In Payment	<u>1,951,299,383</u>	<u>1,943,104,166</u>	99.6%
Total	\$ 3,070,652,719	\$ 3,042,172,834	99.1%
<b>Unfunded Actuarial Liability</b>			
Actuarial Liability	\$ 2,884,777,391	\$ 2,854,845,054	99.0%
Actuarial Value of Assets (AVA)	<u>1,707,964,662</u>	<u>1,707,964,662</u>	100.0%
Unfunded Actuarial Liability (UAL)	\$ 1,176,812,729	\$ 1,146,880,392	97.5%
Funded Percentage on AVA basis	59.2%	59.8%	101.0%
<b>Contribution Rate by Component</b>			
Gross Normal Cost Rate	9.75%	9.58%	98.2%
Member Normal Cost Rate	<u>-1.39%</u>	<u>-1.41%</u>	101.4%
Net Employer Normal Cost	8.36%	8.17%	97.7%
Administrative Expenses	1.15%	1.15%	100.0%
Disability Insurance	0.53%	0.53%	100.0%
UAL Amortization	<u>47.96%</u>	<u>48.15%</u>	100.4%
Total Rate	58.00%	58.00%	100.0%

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**Census Data**

The MPERS Staff and GRS provided us with the data that was used in the June 30, 2019 actuarial valuation. GRS provided us with a *processed data file*. When compared to the *raw data*, we found no significant differences. No parameters or assumptions were used to fill in missing data. Based on our review of the information in both files, we find that the data used in the valuation is valid, complete, and contains the necessary data elements for purposes of performing the actuarial valuation of MPERS.

We also find that the methods and requirements provided in the Actuarial Standard of Practice No. 23 *Data Quality* have been adhered to, to the extent applicable for the valuation of pension system obligations.

In Table II-4 on the following page, we compare the June 30, 2019 processed data file provided by GRS to the raw data file provided by MPERS and used by Cheiron and found only very minor differences between the files.

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**Table II-4**

**Summary of Member Data as of June 30, 2019**

	GRS				Cheiron				Ratio			
	Non-Uniformed		Uniformed		Non-Uniformed		Uniformed		Non-Uniformed		Uniformed	
	Patrol	MoDOT	Patrol	Total	Patrol	MoDOT	Patrol	Total	Patrol	MoDOT	Patrol	Total
<b>Active</b>												
Closed Plan	265	1,460	493	2,218	265	1,460	493	2,218	100.0%	100.0%	100.0%	100.0%
Year 2000 Plan	402	1,577	368	2,347	402	1,577	367	2,346	100.0%	100.0%	99.7%	100.0%
Year 2011 Plan	446	2,060	350	2,856	446	2,060	350	2,856	100.0%	100.0%	100.0%	100.0%
<b>Total Actives</b>	<b>1,113</b>	<b>5,097</b>	<b>1,211</b>	<b>7,421</b>	<b>1,113</b>	<b>5,097</b>	<b>1,210</b>	<b>7,420</b>	<b>100.0%</b>	<b>100.0%</b>	<b>99.9%</b>	<b>100.0%</b>
Average Age	44.7	44.4	40.7	43.9	44.7	44.4	40.7	43.9	100.0%	100.0%	100.0%	100.0%
Average Service	12.1	12.5	15.5	12.9	12.0	12.4	15.4	12.8	99.2%	99.2%	99.4%	99.2%
Valuation Salary <sup>1</sup>	\$ 49,980	\$ 224,585	\$ 84,731	\$ 359,296	\$ 47,418	\$ 215,052	\$ 83,413	\$ 345,883	94.9%	95.8%	98.4%	96.3%
<b>Regular Pensioners</b>												
Closed Plan	488	3,374	971	4,833	488	3,374	971	4,833	100.0%	100.0%	100.0%	100.0%
Year 2000 Plan	583	3,465	8	4,056	583	3,465	8	4,056	100.0%	100.0%	100.0%	100.0%
Year 2011 Plan	3	2	-	5	3	2	-	5	100.0%	100.0%		100.0%
<b>Total</b>	<b>1,074</b>	<b>6,841</b>	<b>979</b>	<b>8,894</b>	<b>1,074</b>	<b>6,841</b>	<b>979</b>	<b>8,894</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>
<b>Other Inactives</b>												
Self Insured Disability	3	41	3	47	3	41	3	47	100.0%	100.0%	100.0%	100.0%
Fully Insured Disability	11	76	7	94	11	76	7	94	100.0%	100.0%	100.0%	100.0%
Vested Terms	240	1,626	176	2,042	240	1,626	176	2,042	100.0%	100.0%	100.0%	100.0%
<b>Total Inactives</b>	<b>1,328</b>	<b>8,584</b>	<b>1,165</b>	<b>11,077</b>	<b>1,328</b>	<b>8,584</b>	<b>1,165</b>	<b>11,077</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>
<b>Grand Total</b>	<b>2,441</b>	<b>13,681</b>	<b>2,376</b>	<b>18,498</b>	<b>2,441</b>	<b>13,681</b>	<b>2,375</b>	<b>18,497</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

<sup>1</sup>In thousands. After reflecting timing adjustments for valuation purposes.

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**Plan Provisions**

We compared the summary of plan provisions shown in Section B, Summary of Benefits, of GRS's June 30, 2019 Actuarial Valuation Report to the benefits outlined in the Closed Plan Retirement Handbook, Year 2000 Plan and 2011 Tier Retirement Handbook and Missouri statutes. In general, the plan provisions shown in GRS's exhibits match what is in the handbooks and statutes, and based on our close match of the GRS liabilities as part of our parallel valuation, we conclude that GRS has appropriately reflected these provisions in the actuarial valuation.

In addition, we agree with GRS's decision not to treat the MPERS BackDROP option as a DROP provision as defined in GASB Statement No. 67 because it does not permit members to be credited for benefit payments into an individual member account within the pension plan while continuing to provide services. The option is only available upon retirement.

**Actuarial Assumptions**

The June 30, 2019 actuarial valuation was based on the assumptions ultimately adopted by the MPERS Board, based on recommendations made by GRS in the actuarial experience study covering the five-year period ending June 30, 2017. As part of our actuarial audit review, we have performed a review of the assumptions as recommended in this study and have the following comments:

**Economic Assumptions**

Overall, the economic assumption alternatives proposed in GRS's 5-Year Experience Study represent reasonable sets of assumptions. In particular, we agree with GRS's recommendation to reduce the assumed rates of price inflation, wage inflation, and investment return. We see that the Board adopted Alternative 3, which includes a reduction in the assumed rate of price inflation from 3.00% to 2.25%, a reduction in the assumed rate of wage inflation from 3.50% to 3.00%, and a reduction in the assumed rate of investment return from 7.75% to 7.00%.

However, the 4.75% spread between price inflation and investment return assumptions is at the upper end of what we would expect to see, and while the rates adopted by the Board are reasonable at this time they should be evaluated annually. If wage inflation continues to remain low it may be necessary to reduce this spread and the level of investment risk being taken.

We provide additional comments and discussion of the economic assumptions below.

***Price Inflation***

We commend the Board for lowering the inflation assumption from 3.00% to 2.25%. GRS provides excellent supporting documentation for a long-term price inflation assumption in the 2.00% to 2.50% range in their Experience Study.

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Price inflation is an underlying component of economic assumptions, but it also directly determines cost-of-living adjustment (COLA) projections. We note that Closed Plan members employed before August 28, 1997 receive a guaranteed COLA of at least 4% until their benefit increases by 65% of the initial benefit at retirement. Afterwards, Closed Plan members receive the same COLA as other MPERS members, which is 80% of national CPI-U, capped at 5%. That means inflation rates of up to 6.25% directly impact the system. The guaranteed 4% COLA provision will apply to fewer and fewer members over time. Consequently, since in the future more of the COLA will be tied to CPI-U there will be an increase in inflation risk – the potential for actual inflation to be different from expectations. We suggest that GRS and the Board continue to closely monitor this assumption.

***Wage Inflation***

The wage inflation assumption of 3.00% is 0.75% higher than the price inflation assumption. In general, an increase of 75 basis points over price inflation represents a reasonable long-term wage inflation assumption.

However, GRS only examines a comparison of National Average Earnings and inflation data to support their wage inflation recommendation. We note that GRS's 2019 Actuarial Valuation Report shows the average percentage increase in active member average pay as only 1.2% over the past 10 years (averages for longer durations are under 3.00% as well). In future experience studies, GRS should consider a review of actual membership and regional data as well as national data in setting this assumption. We note additional considerations below as this assumption is tied to payroll growth.

***Payroll Growth***

The payroll growth assumption is separate from the wage inflation assumption. It estimates the rate of growth in active member payroll and impacts the pattern of Unfunded Actuarial Liability amortization payments. A lower rate increases near-term amortization payments and a higher rate decreases the near-term amortization payments and pushes more of the amortization to future years.

The payroll growth assumption has been set equal to the 3.00% wage inflation assumption, which is a common practice. However, we note that over the past five years, MPERS active member payroll growth has averaged about 1.6% annually. Payroll actually declined in years prior to that.

The MPERS funding policy utilizes closed amortization periods, which can lead to funding volatility during the final years of the period. Such volatility may be exacerbated if actual payroll growth is less than the 3.00% assumption. Given this dynamic and the recent experience of lower payroll growth, GRS and the Board should annually consider either a lower rate of payroll growth or an assumption for amortization payment growth that is separate from payroll growth.

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***Investment Return***

As part of their experience study, GRS recommended a reduction in the investment return assumption from 7.75% to either 7.25%, 7.00% or 6.75% depending in part on price inflation. We concur with the recommended reduction and the reasonability of the alternative assumptions, as well as the rationale and process that led to the recommendation.

We reviewed asset allocation documentation available on the MPERS website and concluded that GRS's mappings and application of the capital market assumptions onto the asset classes reflected in the target asset allocation (as disclosed for 2017) appear reasonable.

We independently calculated the expected return based on the 2017 target asset allocation and the 2017 average capital market assumption survey published by Horizon Actuarial Services. We agree with GRS that there is not always a perfect one-to-one mapping of the asset classes described in the MPERS target allocation with those included in the capital market assumptions by each investment consultant. However, the impact of any differences in the expectations for these classes should not significantly affect the overall portfolio expectations.

Our analysis leads to a slightly higher average net geometric nominal rate of return, 6.39% versus the 6.26% developed by GRS, assuming 2.25% price inflation over a 20-year horizon. This suggests a roughly 40% chance (38.47% in the GRS analysis) of achieving an average return of at least 7.00% over 20 years. Actuaries typically recommend assumptions with at least a 50% probability of achieving the assumed rate of investment return. GRS recognizes this in their study, stating that the preferred investment return assumption in the actuarial community is the forward-looking expected geometric return (i.e., 50<sup>th</sup> percentile). As such, the 7.00% return assumption at the time of the experience study represented the upper end of what would be considered reasonable given 2.25% price inflation. GRS justifies the deviation from the 50<sup>th</sup> percentile based on the lack of trend in similar analyses over the past several years.

We performed a similar independent analysis for 2019, using the 2019 target asset allocation and the 2019 survey published by Horizon Actuarial Services. The updated analysis shows the 7.00% investment return assumption to be approximately equal to the expected geometric return (i.e., the 50<sup>th</sup> percentile). Consequently, the 7.00% investment return assumption remains reasonable for the 2019 actuarial valuation. We suggest GRS and the Board continue to monitor this assumption given the volatility and significant decline in yields on fixed income that have occurred after most 2019 capital market assumptions were developed.

***Administrative Expenses***

GRS recommended no change to the administrative expenses assumption. Administrative expenses are added as a load to the normal cost based on actual administrative expenses for the preceding year. This is a common method to develop expected administrative expenses. We agree this is a reasonable assumption and method.

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***Interest on Member Accounts***

2011 Tier members contribute to the system at a rate of 4% of pay. Members meeting eligibility criteria receive interest on the accumulated value of these contributions each June 30. Interest was originally credited at a flat 4% rate, but the rate has been based on 52-week Treasury bill rates after June 30, 2014. These rates have been volatile over the past 25 years, with rates ranging from over 5% to near 0%. The average rate over the past 10 years ending June 30, 2019 has been under 1%.

In their experience study, GRS recommended lowering the assumed interest rate on member accounts from 4% to 3% without explanation. We suggest GRS include the analysis that was used to develop this recommendation in future experience studies.

We expect that the 3% rate is reasonable, given that in the short term it appears to include a margin conservatism and contribution refunds have minimal impact on the liabilities.

**Demographic Assumptions**

As part of our actuarial audit review, we also performed a review of the demographic assumptions recommended in GRS's 5-Year Experience Study. With the exception of mortality, the set of demographic assumption recommendations is reasonable. Where GRS proposes changes, adjustments generally move in the direction of actual experience. We do, however, see areas for improvement, particularly with regard to credibility, mortality projection, disclosure of assumption rationales, and the valuation of survivor benefits. We have the following comments:

***Experience Study Communication***

In future 5-Year Experience Study reports, it would be helpful to strengthen assumption rationales and more completely communicate why recommendations are appropriate.

GRS's 5-Year Experience Study includes tables showing the actual and expected decrements for many of the demographic assumptions. This could include the actual-to-expected ratio, or "A/E" ratio, in the tables of both the current and proposed assumptions. This simple statistic can demonstrate how the alternative assumptions fit with the experience during the study period.

It is also important to communicate how much weight should be given to the observed data when developing assumptions. One way this can be accomplished is for the graphs of actual experience to include confidence intervals around the observed rates. For example a 90% confidence interval is the range around the observed rate in which the true rate for the experience study period falls with 90% confidence. The range will be wide if there is little data and narrow if there is substantial data and can be easily shown in a graph that includes observed rates. Without considering the credibility of the data available, it is difficult to defend if an assumption change needs to be made based on the System's covered population or the reliance on outside assumptions.



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To track how well each assumption fits the pattern of the data, we suggest calculating an r-squared statistic for each assumption. R-squared can be thought of as the percentage of the variation in actual data explained by the assumption.

***Mortality Background***

Mortality is a key demographic assumption for pension liabilities because it determines how long members will receive benefit payments. Actuaries typically use the following approach to develop a mortality assumption:

1. Select a standard mortality table based on experience most closely matching the anticipated experience of the System.
2. Compare the actual experience of the System to that predicted by the selected standard table for the period of the experience study.
3. Adjust the standard table, either fully or partially, depending on the level of credibility for the System's experience. This adjusted table is called the base table.
4. Select and use an appropriate mortality improvement projection scale to reflect expected mortality at future dates.

Organizations such as the Society of Actuaries develop standard mortality tables based on large sets of experience data. The Retirement Plan Experience Committee of the Society of Actuaries (SOA) issued the Pub-2010 Public Retirement Plans Mortality Tables based specifically on public pension plan experience. Pub-2010 was issued in 2019, so it was not available at the time of GRS's experience study. At that time the RP-2014 Mortality Tables were the most recent tables released for retirement plans.

Very few pension plans have sufficient experience to develop their own mortality tables. Most plans instead adjust a standard table based on the plan's credibility (step 3 above). However, with approximately 1,000 deaths necessary for full credibility (defined by a 90% probability that the observed rate is within 5% of the true rate), many plans lack sufficient data to significantly adjust a standard table (i.e., adjust the tables so the actual-to-expected ratio based on the system's data is closer to 100%).

GRS's experience study report shows 23 active male and 3 active female deaths during the five-year study period (pages D-22 and D-23). In addition, the report shows 865 male retiree deaths and 61 female retiree deaths during the same period (pages E-1 and E-2). While male retiree deaths approach 1,000 and would be partially credible, the other groups show much less experience and the typical actuarial practice would be to not adjust the standard table.

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***Preretirement Base Mortality***

For preretirement base mortality, GRS recommended the RP-2014 Employee Mortality Table with mortality rates multiplied by 65%. There is no analysis explaining why such a large reduction in rates is appropriate, given only 23 male and 3 female deaths during the study period. This amount of data should not be considered fully credible, and caution should be used when applying adjustments to the standard tables. As GRS notes on page A-4, Actuarial Standard of Practice (ASOP) No. 35 cautions against giving undue weight to past experience when the data is not sufficiently credible. In this case it appears that GRS has given far too much weight for the preretirement mortality to past experience and over adjusted the mortality table. GRS should provide an explanation and justification for using the 65% adjustment factor that is applied to the proposed tables for preretirement mortality. However, we note that this assumption does not have a significant impact on liabilities given the infrequency of preretirement deaths.

***Postretirement Base Mortality***

For postretirement base mortality, GRS recommended the RP-2014 Healthy Annuitant Mortality Table. This represents a reasonable base table assumption given the exposures and actual deaths shown in the experience study. The central year of the experience study is the 2014-2015 plan year, which lines up with the 2014 base year of the RP-2014 tables as issued. (We comment on how mortality improvement adjustments are applied later in this report.)

For male retirees, the recommended mortality table predicts 725 deaths during the study period compared to 865 actual deaths, an A/E ratio of 1.193. It is not clear in the report if the 725 predicted deaths reflect mortality improvement projection. This should be communicated clearly. Our rough independent analysis shows a similar number of deaths using RP-2014 Healthy Annuitant rates as issued. Thus, the recommended rates shown on page E-1 of the report can be considered as 2014 rates. Consequently, if the experience was given full credibility there appears to be some margin for future mortality improvement in the recommended male base table because it is predicting fewer deaths than actually occurred during the study period.

For female retirees, the recommended mortality table predicts 67 deaths during the study period compared to 61 actual deaths, an A/E ratio of 0.910. That means there does not appear to be margin for future mortality improvement in the recommended female base table. However, the female retiree group is smaller and does not have the data to credibly adjust the table for experience.

***Disabled Base Mortality***

For disabled base mortality, GRS recommended the RP-2014 Disabled Retiree Mortality Table. This represents a reasonable base table assumption. With only 22 male and 7 female disabled

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retiree deaths during the study period, there is not enough data to credibly adjust the table for experience, thus it is appropriate that no adjustment was made to the standard table.

***Mortality Improvement Projection Scale***

Once a base table is established, actuarial practice is to use a mortality improvement projection scale to reflect future increases in longevity. This means that the mortality table is adjusted to a future year to reflect the mortality expected in that year. The starting point of this projection should be the “base year” of the table.

GRS recommended a static mortality projection of the base table to 2022 using the MP-2017 mortality improvement scale for both preretirement and postretirement mortality. At the time of the experience study, the MP-2017 was the most recent mortality improvement scale published by the Society of Actuaries and thus a good choice.

However, GRS provides no analysis to justify the selection of the static projection period which is much shorter than would be expected for most purposes. Our analysis shows the average remaining expected lifetime to be approximately 40 years for active MPERS members, and 16 years for retired members and beneficiaries. When using a static projection as GRS did here, one approach is to project the table to a future year which represents the average year of death of a population (16 years from the valuation year for current retirees and beneficiaries). Another approach is to project for a period equal to the duration of the liabilities, which reflects present value weighting of all benefits to be paid from the system. We calculate the liability duration to be approximately 13 years for the entire system. So a typical recommendation would be to project the base tables 13 years or more. We note that this static projection period should begin at the valuation year, not the base year of the mortality table. GRS should justify only projecting the table for four years beyond 2018, the first year these assumptions were used for the valuation. For the 2020 valuation, 2022 will represent just two years of projection.

The current best practice is to adopt fully generational mortality improvement projection. Fully generational mortality improvement projection reflects the expected improvement in mortality at each year into the future. For example, this means that a 2020 valuation mortality table reflects five years of mortality improvement for all death probabilities occurring in 2025, but 30 years of mortality improvement for all death probabilities occurring in 2050. Modern actuarial software makes this projection easy and allows actuaries to appropriately reflect the changing expectations of mortality in all future years.

GRS and the Board should consider moving to full generational mortality improvement projection for the next experience study, if not sooner. Doing so would increase liabilities by roughly 2% to 2.5% assuming no other changes. In the event that GRS does not recommend generational mortality improvement, it should disclose its rationale and whether or not the recommended mortality tables sufficiently cover anticipated longevity increases during the expected lifetimes of all members in the valuation.

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***Duty-Related Deaths***

GRS recommended no change to the assumption that 0% of active deaths are related to duty. Per the experience study, one of the 26 active deaths (i.e., approximately 4%) was related to duty during the study period. A non-zero assumption is justified given that non-vested members receive death benefits in the event of a duty-related death; however, we view the current assumption as acceptable given the infrequency of duty-related deaths.

***Withdrawal (Termination)***

As part of their Experience Study, GRS recommended active withdrawal rates that vary by age, service and uniform status. Rates for non-uniformed members also vary by sex. The rates recommended by GRS appear reasonable based on the experience presented in their report. GRS's approach to incorporate service – using service-based rates during the first five years of service – is preferable to reflecting solely age-based rates.

***Disability***

GRS recommended active member disability rates that vary by age and uniform status. Although there were few actual disabilities during the study period, the rates appear reasonable based on the experience presented in their report.

***Retirement***

GRS recommended retirement rates that vary by age and tier. Rates for non-uniformed members also vary by sex for the Closed Plan and Year 2000 Plan. The rates recommended by GRS appear reasonable based on the experience presented in their report, if the comparison of the actual and expected number of retirements looks *solely* at the member's age at retirement. We note that we usually see a correlation between retirement rates and years of service as well as age.

At a given age, members with higher levels of service typically retire at higher rates than members with lower levels of service. This makes sense intuitively. The discrepancy in rates matters, because all other things being equal, the liabilities will be more heavily weighted towards those with higher levels of service (and thus higher benefits). If the retirement rates accurately predict the number of retirements by age, but overestimate the number of retirements for those with low levels of service and underestimate the number of retirements for those with high levels of service, it is likely that the assumptions will underestimate the future liabilities and costs of the system. For this reason, we suggest considering an additional service component for retirement assumptions in the next experience study to better capture any differences based on service.

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For the 2011 Tier, we agree that there is not yet enough experience to calculate retirement rates. Without sufficient data, actuaries typically look to other tiers or other plans and rely more heavily on professional judgment in setting assumptions. We agree that the proposed rates for normal and early retirement appear reasonable in the absence of experience; although, adding a service component could improve the assumptions here as well.

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***BackDROP Election at Retirement***

Upon retirement, the valuation assumption is that eligible members pick the BackDROP period that when combined with the remaining annuity produces the highest liability. We agree that this is a reasonable assumption. The maximum BackDROP period is five years, and the retirement rates in the valuation continue beyond initial BackDROP eligibility to capture periods up to five years.

***Retirement Age for Deferred Members***

Per discussions with GRS, the retirement age assumption for vested deferred members is their earliest unreduced retirement age. This is a reasonable assumption; however, we do not see it mentioned in the experience study or valuation report. GRS should properly disclose the assumption in future reports.

***Merit and Longevity Pay Increases***

To help develop the assumption for merit and longevity pay increases, GRS examined whether the increases have a stronger correlation to age or length of service. We are not surprised to see a stronger correlation to service, and we agree the recommended change from age-based rates to service-based rates is reasonable. We also agree that GRS's decision to include prior experience study data in the analysis is reasonable.

For the uniformed group, we note that actual merit and longevity pay increases run roughly 1% to 2% higher than the proposed rates between 11 and 20 years of service. This does not necessarily mean the rates are inappropriate, because there are other considerations, including future pay increase expectations and the long-term nature of the assumption. The assumption is reasonable but ideally there would be more explanation as to the professional judgment used in setting it.

For the non-uniformed group, we note that the proposed merit and longevity pay increases drop to 0% after six years of service, meaning only wage inflation applies. Again, the assumption is reasonable but additional explanation would strengthen the rationale.

***Plan Choice***

GRS recommended an assumption that members eligible for the Closed Plan choose Closed Plan benefits at retirement. We agree that this is a reasonable assumption and should generally hold true as the Closed Plan typically provides the most valuable benefit.

However, for current and future Closed Plan non-uniformed vested terminated members with under 15 years of service, it appears the Year 2000 Plan provides a slightly better benefit (1.7%

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multiplier rather than 1.6%), unreduced at age 62 rather than age 65. If a member in this group retires at age 62 under the Year 2000 Plan, the liability would typically be higher than under a Closed Plan retirement at age 65, even with the Closed Plan's initial 4% COLA. GRS is valuing this group under the Closed Plan with commencement at age 65. We suggest considering an exception to the Closed Plan choice assumption as part of the next experience study.

***Normal Form of Payment***

The assumption for normal form of benefit is a 50% joint & survivor benefit for married members in the Closed Plan and a straight life benefit for all other members. We agree that this assumption is reasonable. The Closed Plan provides a 50% joint & survivor benefit to members with an eligible spouse at no cost (i.e., without reduction), so assuming a single life form of payment for Closed Plan members would understate liabilities.

In their 2019 valuation report, GRS states its belief that optional payment factors are reasonably close to actuarial equivalence based on valuation assumptions. Given this statement, it is reasonable to assume a straight life benefit for the Year 2000 Plan and the 2011 Tier.

***Other Miscellaneous and Technical Assumptions***

With the exception of the loads described below, the remaining assumptions outlined in the Miscellaneous and Technical Assumptions section of the experience study are reasonable. Additional discussion of rationale for setting these assumptions would be helpful to all stakeholders.

***Loads for Survivor Benefits.***

We note that for several items listed under Miscellaneous Adjustments GRS is adding a load to the liability of members to account for the benefits paid to their surviving spouses.

- Post disability benefit liabilities were increased by 50% for all future disabilities to account for potential survivor benefits payable by the retirement system during the period of disability.
- Current self-insured disability retiree liabilities are increased by 12% to account for future survivor benefits.
- Liabilities for future deferred members were increased by 2% to account for potential survivor benefits payable if the member dies during the deferred period.

These survivor benefits could be valued directly rather than through the use of loads. In particular, the load of 50% on post-disability benefit liabilities arising from future disabilities is a very rough approximation. Analysis should be provided to support these loads if they are maintained, but the more appropriate action would be to directly value the future survivor benefits.



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**SECTION III – REVIEW OF ACTUARIAL METHODS**

**Actuarial Methods**

Actuarial methods relate to the application of actuarial assumptions in the determination of System liabilities and contributions. These methods include the actuarial cost method, amortization policy, actuarial asset smoothing, and cost-sharing methodologies. The questions guiding our review of the actuarial methods were the following:

- Are the methods acceptable and appropriate for the intended purpose?
- Do the methods comply with relevant accounting and actuarial standards?

**Actuarial Cost Method**

The individual Entry Age Actuarial Cost Method is used in the June 30, 2019 actuarial valuation. Under this method, the expected cost of benefits for each individual member is allocated over that member's career as a level percentage of that member's expected salary. The normal cost for the system is the sum of the individual normal costs calculated for each member. We concur with this methodology and note that it is "Model Practice" under the Conference of Consulting Actuaries Public Plans Community (CCA PPC) "White Paper" on Actuarial Funding Policies and Practices for Public Pension Plans and a "Best Practice" based on guidance issued by the Government Finance Officers Association. GRS has also applied this method in a manner which complies with the disclosure requirements under GASB Statements 67 and 68.

**Asset Smoothing Method**

The Actuarial (or smoothed) Value of Assets is determined using a three-year period for investment gains and losses and incorporates an 80% to 120% corridor below and above the Market Value of Assets. We have confirmed that the GRS report applies the actuarial smoothing method as described.

In our opinion, the method used by MPERS satisfies the Actuarial Standard of Practice, which governs asset valuation methods (ASOP No. 44), which requires that the actuarial asset value should fall within a "reasonable range around the corresponding market value" and that differences between the actuarial and the market value should be "recognized within a reasonable period of time." The method is also a "Model Practice" under the CCA PPC "White Paper" on Actuarial Funding Policies and Practices.

We commend GRS for including the funded ratio and unfunded liability using both the market value and smoothed value of assets in their report.

**Funding Policies**

The Permanent Funding Policy for MPERS is to pay the System's normal cost, or benefits accrued during the year, plus an amortization of the balance of the unfunded liability as of June 30, 2020 amortized as a level percentage of payroll over a closed 16-year period. The closed period began as a 29-year period as of July 1, 2007. This funding method is expected to



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fully fund the System's obligations in a reasonable time frame and meets actuarial standards and guidance from GASB.

The Temporary Accelerated Policy contribution is based on normal cost plus amortizations using a 5-year amortization period for unfunded retiree liabilities and a 20-year amortization period for other unfunded liabilities as of July 1, 2020. The closed periods began as 15- and 30-year periods as of July 1, 2010. This policy will remain in effect until the retiree liability becomes 100% funded or the permanent policy produces a higher contribution rate. We commend the Board of Trustees for adopting a policy which accelerates the funding of liabilities for retirees. By fully funding the liabilities for retirees the System reduces intergenerational risk transfer.

We note that both the Permanent and Temporary Policies are approaching the end of their closed amortization periods. This means that gains and losses are amortized over a short time period and contributions have the potential to be very volatile. The Board may also consider modifying the periods to be rolling as they are determined to be sufficiently short.

The Board adopted a contribution stabilization reserve fund in September 2014, using experience gains to help keep the employer contribution rate at or near 58% in the near term. In February 2015, the Board established a maximum of \$250 million in the contribution stabilization reserve fund. This is a reasonable approach to stabilize contribution rates as the closed amortization periods shorten. We note, as GRS does, that the contribution stabilization reserve fund would be expected to result in the fund becoming more than 100% funded by the end of the amortization period, if experience is exactly as assumed.

We have confirmed that the GRS report applies the amortization method as described. The amortization methods are in accordance with recent funding policy guidance issued by the GFOA and meet "Model Practice" under the CCA PPC "White Paper" on Actuarial Funding Policies and Practices.

**Cost-Sharing Methods**

MPERS is a cost-sharing system, wherein the assets of the System are available to fund the benefits of all members. This is different from an approach in which specific asset pools are tracked and held separately for each employer. As a result, methods and assumptions must be used to assign portions of the assets and the resulting unfunded liability to the different employment groups (i.e., Missouri DOT, and Highway Patrol). The methods used to assign assets are appropriate for funding and GASB purposes.

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**SECTION IV – CONTENTS OF REPORT**

## **Contents of the Report**

We find the communication of the actuarial valuation results to be complete and reasonable. We comment on specific aspects of the report below.

### **Actuarial Standards of Practice**

Actuarial Standards of Practice (ASOPs) specify many items and disclosures that should appear in an actuarial report. With a few instances of exception noted below, the valuation complies with all applicable ASOPs, including No. 4 (*Measuring Pension Obligations*), No. 23 (*Data Quality*), No. 27 (*Selection of Economic Actuarial Assumptions*), No. 35 (*Selection of Demographic Actuarial Assumptions*), No. 41 (*Actuarial Communications*), No. 44 (*Selection and Use of Asset Valuation Methods*), and No. 51 (*Assessment and Disclosure of Risk Associated with Measuring Pension Obligations and Determining Pension Plan Contributions*).

ASOP No. 35 states that the actuary should disclose the information and analysis used in selecting each demographic assumption that has a significant effect on the measurement. GRS should include additional disclosure of their rationale with respect to mortality table adjustments and mortality improvement projection.

ASOP No. 41 states that actuarial reports should disclose assumptions with sufficient clarity that another actuary qualified in the same practice area could make an objective appraisal of the reasonableness of the actuary's work as presented in the actuarial report. We did not see mention of the retirement age assumption for vested deferred members in the experience study or valuation report. GRS should add this assumption to future reports.

ASOP No. 51 states that the actuary should both identify risks that may reasonably be anticipated to significantly affect the system's future financial condition and assess those risks. While GRS identifies risks to future contribution requirements including amortization policy risk, investment risk, and mortality/longevity risk in their report, we see little assessment of the potential impact of those risks (e.g., scenario testing or alternative projections of employer contribution rates).

### **Projections**

We commend GRS for including projections of payroll, the outstanding balance of the Unfunded Actuarial Liability (UAL), UAL payment projections and employer contributions, if all assumptions are met in future years.

However, GRS should include funded status and employee contributions in baseline projections, assuming all actuarial assumptions are met. This report represents to the public the current financial condition of MPERS, and as such, total projected contribution rate and funded status

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are essential to the communication of the valuation results. We also note that including a graphical representation of projection results would enhance the communication of results.

In addition, the inclusion of stochastic projections and projections under alternative scenarios would help the users of the report understand the ongoing risks that may impact the system and may help meet the requirement of ASOP 51 that significant risks to the System are assessed.

**Summary of Benefit Provisions Evaluated**

We highlight the summary of plan provisions valued, Section B of the 2019 report, as an especially clear, concise, and well laid out section of the report.

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**SECTION V – PROCESS DESCRIPTION**

An actuarial audit of an annual valuation of a retirement system provides key confirmation of results. For the Board of Trustees, these results may otherwise be viewed as a *black-box* process because of the complex computation and program systems customarily used to arrive at actuarial liabilities and costs. This audit process addresses:

- Review of the census data used in determining the System cost. There are typical and anticipated adjustments made to the data in preparing the valuation that impact the final results, that treatment should logically be consistent and rational, and explicitly defined in the valuation reporting. By comparing summary statistics from our treatment with the GRS valuation report we can highlight differences in the underlying processed data and the likely impact on cost.
- Review of the financial data and how it is addressed under that actuarial asset methodology in determining the System cost. There are adjustments made to the financial data provided by the State to determine the Actuarial Value of Assets. These adjustments impact the final results and future results and thus should be consistent with the prior years' calculations.
- Replication of the liability and cost values by separately programming our independent valuation system for the same benefits, using the same census data, valuation cost methods and assumption as reported in the 2019 valuation. We can compare and contrast the results presented by the Systems actuary. This provides an explicit check of that *black-box* process.
- Consider the reasonableness of the body of actuarial assumptions which are in part the result of actual experience of the System measured through explicit experience analysis and in part a reflection of judgment of the actuary and the Board. Our process provides additional insight into the trends, standard and emerging practice for future consideration.
- Comment on the effectiveness of the actuarial funding method, designed to provide a systematic and smooth scheme for the funding of the benefit obligations of the System.

The actual process for the audit ran through a number of steps identical to preparing the actuarial valuation.

1. We collected the same financial and demographic census data as to perform the same processes for a valuation.
2. We programmed our system to value the liabilities and costs of all benefits provided by the MPERS.
3. We applied the same set of assumptions as disclosed by the System's actuary to best replicate results.

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4. We also requested *sample life* valuations which represent year by year, benefit by benefit analysis of a single member which demonstrates how the assumptions are applied and the liabilities are determined through the member's career and thereafter throughout retirement. GRS claims such information is proprietary, so they only provided individual liabilities broken down by decrement. We were able to match these liability breakdowns reasonably well.

This process is conducted in accordance with generally accepted actuarial principles and methods.

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**APPENDIX A – GLOSSARY OF TERMS**

**1. Actuarial Assumptions**

Estimates of future experience with respect to rates of mortality, disability, turnover, retirement, investment income, and salary increases. Demographic assumptions (rates of mortality, disability, turnover, and retirement) are generally based on past experience, often modified for projected changes in conditions. Economic assumptions (salary increases and investment income) consist of an underlying rate in an inflation-free environment plus a provision for a long-term average rate of inflation.

**2. Actuarial Gain (Loss)**

The difference between actual experience and actuarial assumption anticipated experience during the period between two actuarial valuation dates, as determined in accordance with a particular actuarial funding method.

**3. Actuarial Liability**

The Actuarial Liability is the present value of all benefits accrued as of the valuation date using the methods and assumptions of the valuation. It is also referred to by some actuaries as the “accrued liability” or “actuarial accrued liability.”

**4. Actuarial Present Value**

The amount of funds currently required to provide a payment or series of payments in the future. It is determined by discounting future payments at predetermined rates of interest, and by probabilities of payment.

**5. Actuarial Value of Assets**

The Actuarial Value of Assets equals the Market Value of Assets adjusted according to the smoothing method. The smoothing method is intended to smooth out the short-term volatility of investment returns in order to stabilize contribution rates and the funded status.

**6. Actuarial Cost Method**

A mathematical budgeting procedure for allocating the dollar amount of the “actuarial present value of future plan benefits” between the actuarial present value of future normal costs and the Actuarial Liability. It is sometimes referred to as the “actuarial funding method.”

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**7. Funded Status**

The Actuarial Value of Assets divided by the Actuarial Liability. The funded status can also be calculated using the Market Value of Assets.

**8. Governmental Accounting Standards Board**

The Governmental Accounting Standards Board (GASB) defines the accounting and financial reporting requirements for governmental entities. GASB Statement No. 67 defines the system accounting and financial reporting for governmental pension systems, and GASB Statement No. 68 defines the employer accounting and financial reporting for participating in a governmental pension system.

**9. Market Value of Assets**

The fair value of the System's assets assuming that all holdings are liquidated on the measurement date.

**10. Normal Cost**

The annual cost assigned, under the actuarial funding method, to current and subsequent plan years. It is sometimes referred to as "current service cost." Any payment toward the Unfunded Actuarial Liability is not part of the normal cost.

**11. Present Value of Future Benefits**

The estimated amount of assets needed today to pay for all benefits promised in the future to current members of the System, assuming all actuarial assumptions are met.

**12. Present Value of Future Normal Costs**

The actuarial present value of retirement benefits allocated to future years of service.

**13. Unfunded Actuarial Liability (UAL)**

The difference between the Actuarial Liability and the Actuarial Value of Assets. This is sometimes referred to as the "unfunded accrued liability."



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