

### 1.3.3 → Aggregating exposures + premium

→ Overview In the previous subsection, we learned 4 common methods of date aggregation: CY, PY, AV & EY. Of the 4 methods, only CY are available to be aggregation of exposures + premium.

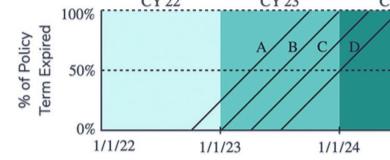
1) Calendar year / Calendar account year

2) Policy year

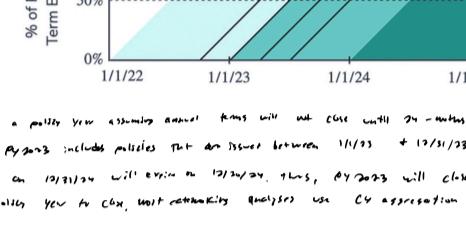
→ The following policies will be used to illustrate these methods. These policies are homeowners insurance policies that insure one home per policy & have annual policy terms.

Policy	Effective Date	Expiration Date	Exposure	Premium
A	10/01/2022	09/30/2023	1.00	\$600
B	01/01/2023	12/31/2023	1.00	\$500
C	04/01/2023	03/31/2024	1.00	\$700
D	07/01/2023	06/30/2024	1.00	\$650

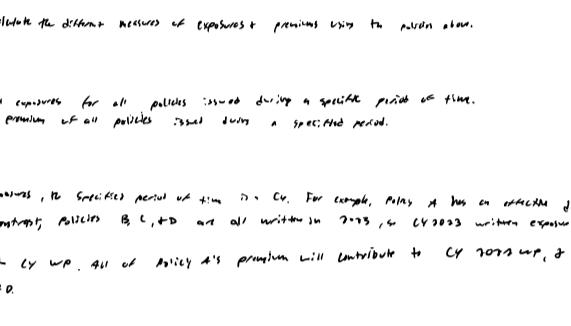
→ We can graph the policies using time on the x-axis & the % of policy term that has expired on the y-axis. For each policy, 0% of the policy term has expired on the effective date. Thus, the policy will start on the x-axis on its effective date. On the expiration date, 100% of the policy term has expired. The line that connects the starting & ending points represents the percentage of policy term that has expired throughout the policy term.



→ **CY aggregation**, which is the same as any aggregation for exposures + premiums, considers all policies issued during the 12-month calendar year regardless of when the policies were issued. CY exposures + premiums are fixed once the year begins. A calendar year is represented as a square on the graph.



→ **PY aggregation**, also calendar year aggregation, considers all policies issued during the 12-month period. A policy year is represented as a parallelogram on the graph below.



→ As shown in the above graph, a policy year assumes annual terms will not end until 24 months after the start of the policy year. For example, PY2023 includes policies that are issued between 1/1/23 & 12/31/23, assuming annual policy terms. The policies issued on 1/1/23 will expire on 12/31/23. Thus, PY2023 will end on 1/31/24. Since it takes significantly longer for a policy year to close, most actuaries use CY aggregation for exposures + premiums instead of PY aggregation.

→ Recall that exposures + premiums can be defined in 4 ways:

- 1) Written exposures/premium
- 2) Earned
- 3) Unearned
- 4) So-here

We will discuss how to calculate the different measures of exposures + premiums using the methods above.

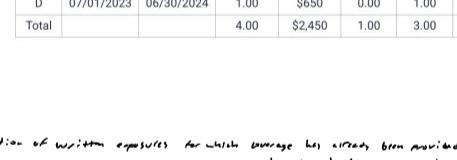
#### → Written exposures/premium

→ Written exposures are the total exposures for all policies issued during a specific period of time. Similarly, the WP is the total premium of all policies issued during a specified period.

#### → CY written exposures/premium

→ For the CY written exposures, the specified period of time is CY. For example, Policy A has an effective date in 2022, its entire exposure will contribute to CY2022 written exposure. In contrast, policies B, C, & D are all written in 2023, so CY2023 written exposure is the sum of the entire exposures from these policies. The same applies to CY WP. All of Policy A's premium will contribute to CY 2022 WP, & CY2023 WP is the sum of the entire premiums from policies B, C, & D.

→ The key to determining written exposures + premiums is the effective dates of the policies, which are shown as circles in the graph below. Policies w/ circles in the square of a CY will contribute their entire exposures + premiums to the written exposures + WP for that CY.

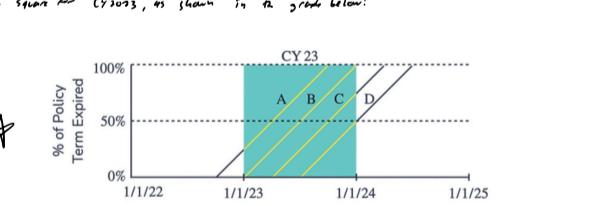


→ The following table summarizes the written exposures + WP by CY:

Policy	Effective Date	Expiration Date	Exposure	Premium	Written Exposures			Written Premium		
					CY2022	CY2023	CY2024	CY2022	CY2023	CY2024
A	10/01/2022	09/30/2023	1.00	\$600	1.00	0.00	0.00	\$600	\$0	\$0
B	01/01/2023	12/31/2023	1.00	\$500	0.00	1.00	0.00	\$0	\$500	\$0
C	04/01/2023	03/31/2024	1.00	\$700	0.00	1.00	0.00	\$0	\$700	\$0
D	07/01/2023	06/30/2024	1.00	\$650	0.00	1.00	0.00	\$0	\$650	\$0
Total			4.00	\$2,450	1.00	3.00	0.00	\$600	\$1,850	\$0

#### → Policy Year written exposures/premium

→ The PY written exposures + premium include all exposures + premiums transactions for policies written during the PY. This can be shown graphically as follows:



→ The following table summarizes the written exposures + WP by Policy Year

Policy	Effective Date	Expiration Date	Exposure	Premium	Written Exposures			Written Premium		
					PY2022	PY2023	PY2024	PY2022	PY2023	PY2024
A	10/01/2022	09/30/2023	1.00	\$600	1.00	0.00	0.00	\$600	\$0	\$0
B	01/01/2023	12/31/2023	1.00	\$500	0.00	1.00	0.00	\$0	\$500	\$0
C	04/01/2023	03/31/2024	1.00	\$700	0.00	1.00	0.00	\$0	\$700	\$0
D	07/01/2023	06/30/2024	1.00	\$650	0.00	1.00	0.00	\$0	\$650	\$0
Total			4.00	\$2,450	1.00	3.00	0.00	\$600	\$1,850	\$0

#### → Earned exposures/premium

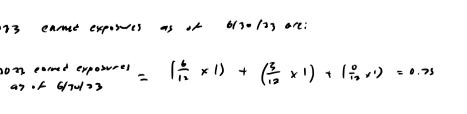
→ Earned exposures are the portion of written exposures for which coverage has already been provided as of a specific point in time. Similarly, EP represents the portion of WP for which coverage has already been provided as of a specific point in time. If a policyholder cancels their policy, the insurer is entitled to keep the EP since coverage has already been provided for that portion of the premium.

#### → CY earned exposures/premium

→ For CY earned exposures, the specified period of time is CY. For example, Policy A was issued on 10/1/22, so 3/12 of its exposure will expire as of 12/31/23. Thus, CY2023 earned exposure is  $\frac{3}{12} \times 1 = 0.25$ , & the CY2023 EP is  $\frac{3}{12} \times \$600 = \$150$ .



→ CY 2023 earned exposures are the total exposures for coverage provided between 1/1/22 & 12/31/23. This is the portion of the policy terms that overlaps the square for CY2023, as shown in the graph below:



→ CY 2023 earned exposures include  $\frac{6}{12} \times \text{Policy A's exposure}$ ,  $\frac{1}{12} \times \text{Policy B's exposure}$ ,  $\frac{3}{12} \times \text{Policy C's exposure}$ , &  $\frac{1}{12} \times \text{Policy D's exposure}$ .

$$\text{CY 2023 earned exposures} = \left(\frac{6}{12} \times 1\right) + \left(\frac{1}{12} \times 1\right) + \left(\frac{3}{12} \times 1\right) + \left(\frac{1}{12} \times 1\right) = 3.00$$

→ The calculation for CY2023 EP is the same as the calculation for CY2023 earned exposures, except the exposure for each policy is replaced w/ its policy's premium.

$$\text{CY 2023 EP} = \left(\frac{6}{12} \times \$600\right) + \left(\frac{1}{12} \times \$500\right) + \left(\frac{3}{12} \times \$700\right) + \left(\frac{1}{12} \times \$650\right) = \$1,800$$

Policy	Effective Date	Expiration Date	Exposure	Premium	Earned Exposures			Earned Premium		
					CY2022	CY2023	CY2024	CY2022	CY2023	CY2024
A	10/01/2022	09/30/2023	1.00	\$600	0.25	0.75	0.00	\$150	\$450	\$0
B	01/01/2023	12/31/2023	1.00	\$500	0.00	1.00	0.00	\$0	\$500	\$0
C	04/01/2023	03/31/2024	1.00	\$700	0.00	0.75	0.25	\$0	\$525	\$175
D	07/01/2023	06/30/2024	1.00	\$650	0.00	0.50	0.50	\$0	\$325	\$325
Total			4.00	\$2,450	0.25	3.00	0.75	\$150	\$1,800	\$500

#### → PY earned exposures/premium

→ For PY aggregation, all earned exposures + premiums are assigned to the year the policy was issued & increase w/ time. The point in time for the measurement of earned exposures + premiums does not have to be at the end of the policy year; it can any valuation date during the PY. For example, Policies B, C, & D all have effective dates in 2023, so their exposures will contribute to the CY2023 earned exposures. As of 6/30/23, six months of coverage have been provided for policy B, 3 months for policy C & 1 month for policy D. This is shown in the graph below:

