AKUR8
RESERVING

Arius
Cash Flow Reports

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1. Introduction

Reserving actuaries are increasingly being asked to determine or evaluate discounted unpaid claim estimates. This document describes the tables and collections within the Arius Deterministic module applicable to calculating undiscounted and discounted cash flows.

To follow along with the steps included in this document, open Arius_Sample.apj found in the C:\Users*username*\Documents\Milliman\Arius\DemoFiles folder.

For more information on the calculations behind the formula-driven payment pattern discussed below, refer to the *Interpolation and Extrapolation* document found in Arius under HELP|USER DOCUMENTATION.

For further guidance on producing cash flow reports for purposes of calculating a provision for adverse deviations (PfAD) under the Canadian Institute of Actuaries (CIA) Standard of Practice, refer to the document *Canadian Provisions for Adverse Deviations* found in Arius under HELP|USER DOCUMENTATION.

For further guidance on producing cash flow reports for purposes of discounting loss and loss adjustment expense reserves, refer to the Actuarial Standard Boards Stand of Practice No. 20: *Discounting of Property and Casualty Loss and Loss Adjustment Expense Reserves,* which can be found at: http://www.actuarialstandardsboard.org/wp-content/uploads/2014/07/asop020_037.pdf

2. Calculating Discounted Unpaid Claim Estimates

Calculating discounted unpaid claim estimates (or claim liabilities) includes the following steps.

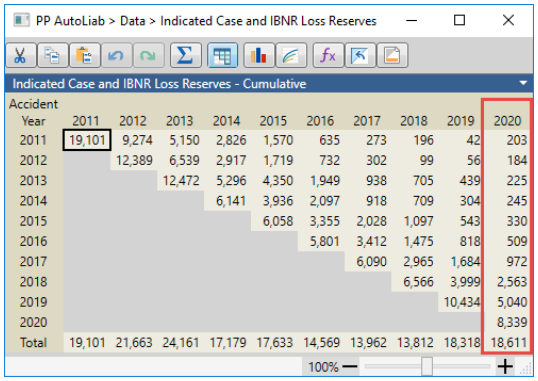
1. Estimate undiscounted reserves
2. Select payment patterns
3. Calculate the cash flows
4. Select the interest rate(s) for discounting
5. Calculate the present value
6. Sum the present values for all future payment periods

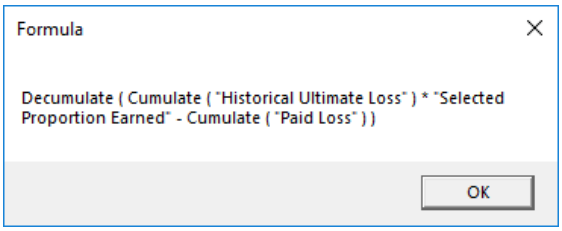
All the calculations necessary for calculating discounted unpaid claim estimates are included within Arius. Tables associated with the payout of loss, allocated loss adjustment expense (ALAE), salvage and subrogation, and unallocated loss adjustment expense (ULAE) are provided out of the box with your Arius installation. The following example references the loss component only, but the other components behave similarly. Also, the concepts throughout this document also apply to the calculation of user-defined cash flow reports.

ESTIMATE UNDISCOUNTED RESERVES

The first step in deriving discounted unpaid claim estimates is to estimate the undiscounted (or indicated) reserve.

1. To begin, drag the collections for **Future Payments of Indicated Loss Reserves** and **Present Value of Future Payments of Indicated Loss Reserves** (found under the DETERMINISTIC|ANALYSIS|LOSSES folder of the **Collection Library**) to the navigation pane in your Arius project.
2. Select the collection **Future Payments of Indicated Loss Reserves** and open Data #469 **Indicated Case and IBNR Loss Reserves.**



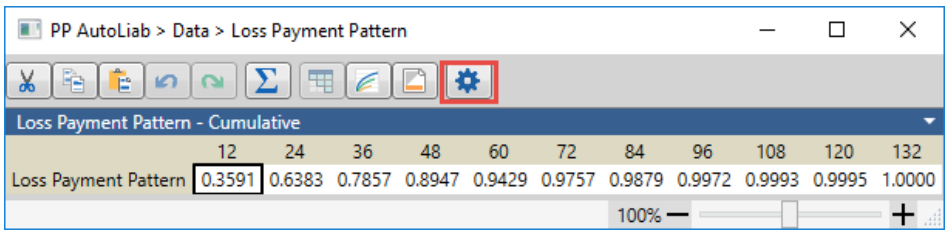


3. To populate this array, you need an ultimate loss (in report **#3 Comparison of Ultimate Loss Estimates)** and the selected proportion earned (in data assumption **#60 Selected Proportion Earned**).

SELECT PAYMENT PATTERNS

For a given segment, payment patterns may be consistent with assumptions used to estimate the undiscounted liabilities. For example, suppose an analysis is performed for Loss, ALAE, and Salvage & Subrogation separately. In that case, payment patterns should be selected independently using either the ratios of paid to selected ultimate or the selected paid development factors.

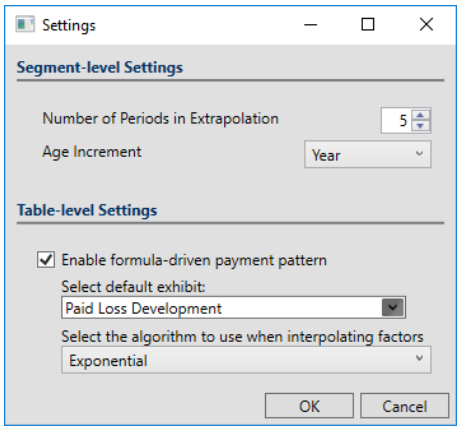
1. Select the collection **Future Payments of Indicated Loss Reserves** and open data assumption **#801 Loss Payment Pattern.** This array is a special resizable row type and contains several features that differentiate it from standard row arrays. These options are found under the Settings icon  . Other resizable arrays include #476 **ALAE Payment Pattern**, #477 **Salvage and Subrogation Payment Pattern**, #125 **ULAE Payment Pattern**, #802 **Effective Interest Rate**, #478 **Interest Rate Net of Margin**, #145 **Ratio of ALAE to Loss**, and #150 **Ratio of Salvage and Subrogation to Loss**.



2. Click the **Settings**  button. These settings allow you to extrapolate the payment pattern and modify the resulting cash flow reports' age increment. You can also make the array formula-driven and default the formula to a particular exhibit and extrapolation algorithm.


Note

If you need to create additional payment pattern arrays via user-defined tables, be sure to start from a copy of one of the Arius payment pattern arrays so that the new row array contains these resizable properties.



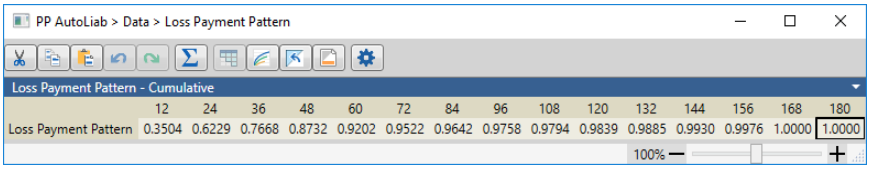
Note

Any changes to the Number of Periods in Extrapolation or Age Increment will be applied across all resizable arrays (e.g., payment patterns, effective interest rates) within the segment.

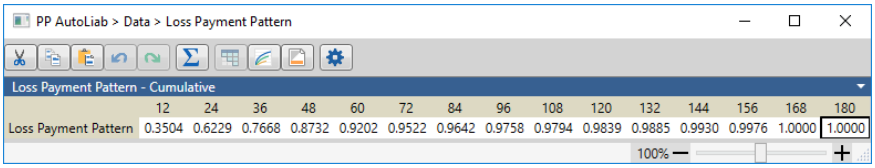
- **Number of Periods in Extrapolation** – this option allows you to extend the cash flow report so that claims can be paid out over more periods than your project's number of development periods.
- **Age Increment** – this selection allows you to produce cash flows at a more granular period than your project files (quarterly cash flows from an annual development triangle, for example). Arius defaults to the **Length of Development Periods** from the file's **Data Structure**. If necessary, you can select smaller age increments from the drop-down box.
- **Enable formula-driven payment pattern** – when checked, Arius uses the ratio-to-ultimate from the selected exhibit as the payment pattern. If necessary, Arius extrapolates the pattern using the selected interpolation algorithm.
- **Select Default Exhibit** – for the Loss Payment Pattern, exhibit **#40 Paid Loss Development** or exhibit **#65 Cumulative Paid Loss to Ultimate Loss** are common. Exhibit #40 represents the Paid Loss Development method's selected pattern, while Exhibit #65 represents the implied pattern that accounts for the selected ultimate loss.
- **Interpolation algorithm** – Arius extrapolates the chosen exhibit's tail factor using the system's interpolation algorithms and the selected curve fit. The algorithm selected here is also used to derive cash flows at an age increment smaller than the project's development period length.

3. When you select the **OK** button, Arius prompts you with the message, **Do you want to save these changes across all your segments?**.
   - Select **YES** if you want all of the settings within this dialog to be applied across all segments.
   - Select **NO** if you want these settings to remain unique for this particular segment.

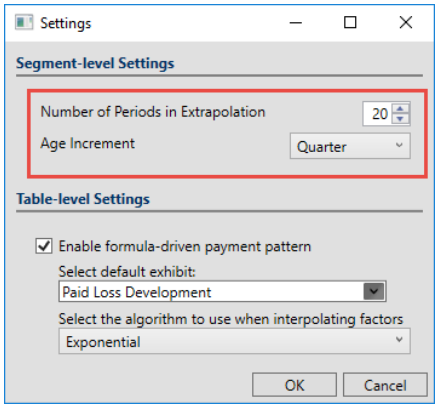
   Note: Changes to segment-level settings carry over to all resizable arrays within the segment, regardless of your selection in this prompt.
4. Verify the resulting formula-driven payment pattern.



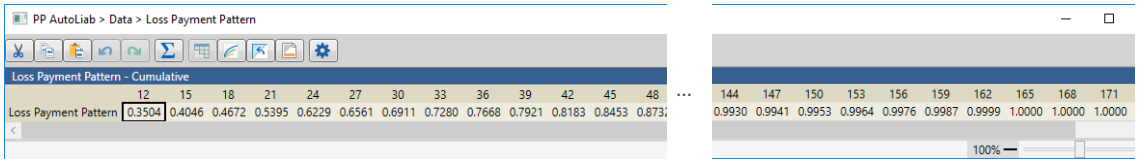
- The extrapolated values are determined by fitting a curve to the last 2 known values using the system's interpolation algorithm, the selected curve fit, and the **Exposure Period Type**. You can modify the resulting pattern by selecting a different curve fit or by returning to the selected source exhibit and changing the values that make up the last 2 known values.
- Suppose you want to make a manual selection or override the formula-driven payment pattern. In that case, you can return to the **Settings** dialog and uncheck the **Enable formula-driven payment pattern** checkbox.



5. Modify the **Age Increment** parameter if you need cash flows at a more granular level.



- Note Arius automatically interpolates and extrapolates the payment pattern if the **Enable formula-driven payment pattern** option is checked.

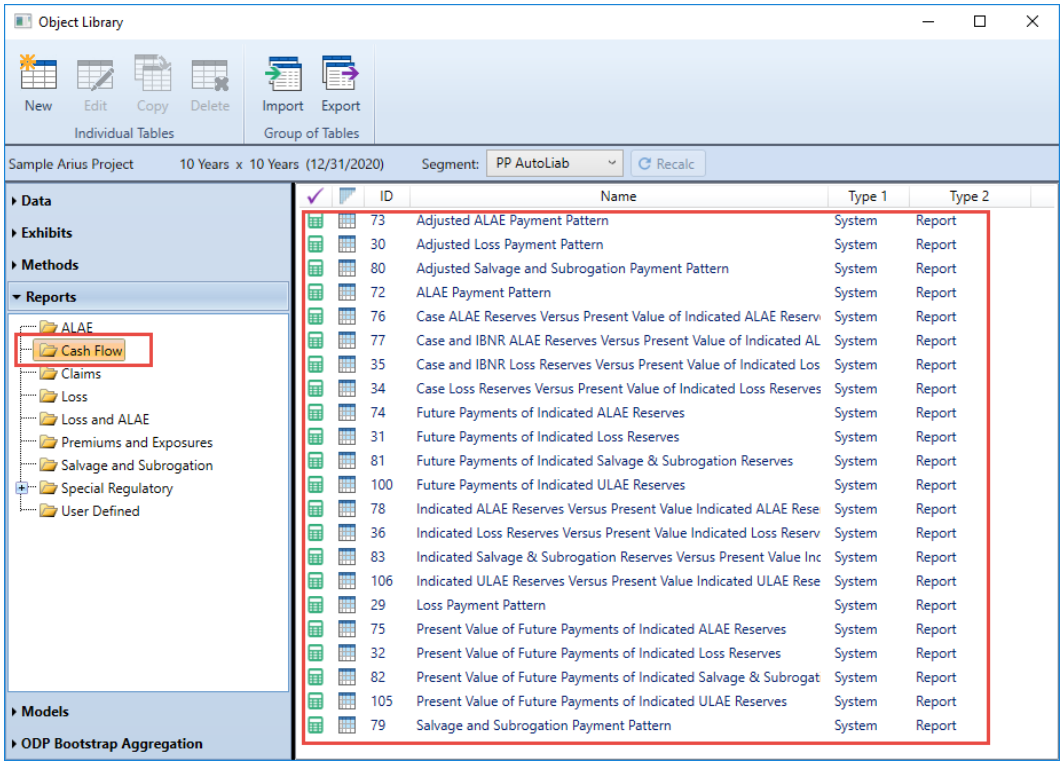


- For more information on the details behind the formula-driven payment pattern calculations, refer to the *Interpolation and Extrapolation* document found in Arius under HELP|USER DOCUMENTATION.

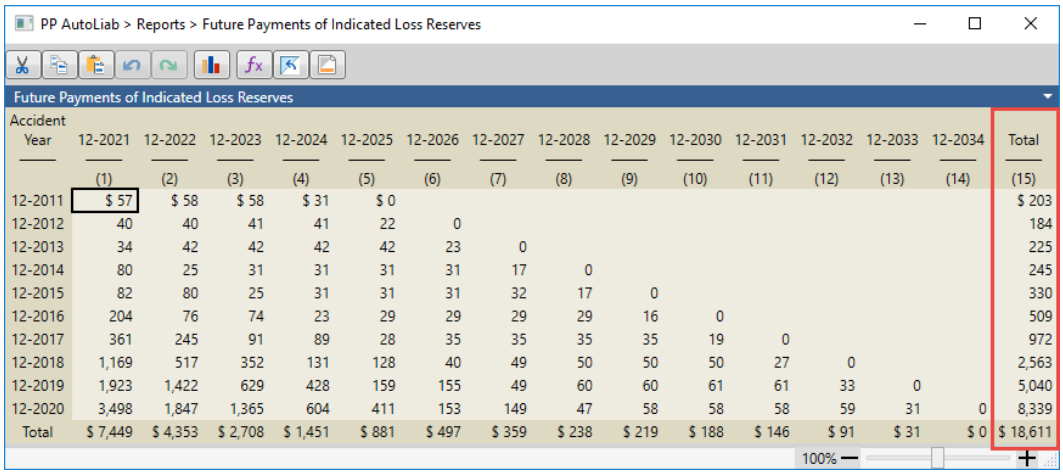
CALCULATE THE CASH FLOWS

After selecting and validating the payment pattern, use a cash flow report to derive the undiscounted reserves' allocation to future periods.

All of the Arius Cash Flow reports can be found in the **Object Library** in the REPORTS|CASH FLOW folder. Reports specific to the Canadian Provision for Adverse Deviations can be found in the REPORTS|SPECIAL REGULATORY folder.

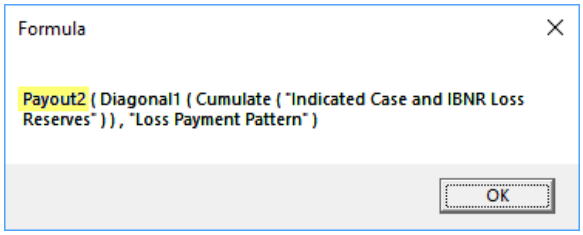


1. Open Report **#31 Future Payments of Indicated Loss Reserves** or navigate to this table from the **Future Payments of Indicated Loss Reserves** collection found in the DETERMINISTIC|ANALYSIS|LOSSES folder of the collection library.



Accident Year	12-2021	12-2022	12-2023	12-2024	12-2025	12-2026	12-2027	12-2028	12-2029	12-2030	12-2031	12-2032	12-2033	12-2034	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12-2011	$ 57	$ 58	$ 58	$ 31	$ 0										$ 203
12-2012	40	40	41	41	22	0									184
12-2013	34	42	42	42	42	23	0								225
12-2014	80	25	31	31	31	31	17	0							245
12-2015	82	80	25	31	31	31	32	17	0						330
12-2016	204	76	74	23	29	29	29	29	16	0					509
12-2017	361	245	91	89	28	35	35	35	35	19	0				972
12-2018	1,169	517	352	131	128	40	49	50	50	50	27	0			2,563
12-2019	1,923	1,422	629	428	159	155	49	60	60	61	61	33	0		5,040
12-2020	3,498	1,847	1,365	604	411	153	149	47	58	58	58	59	31	0	8,339
Total	$ 7,449	$ 4,353	$ 2,708	$ 1,451	$ 881	$ 497	$ 359	$ 238	$ 219	$ 188	$ 146	$ 91	$ 31	$ 0	$ 18,611

2. Click the **Show Formula** button. This report relies on the **Payout2** function, where the first parameter relates to the indicated reserves (what is to be paid), and the second parameter relates to the payment pattern.



3. Click the **Source Data** button. The Source Data window lists all objects used in the calculation of this report.

Details Behind the Calculations

1. The calculation of the incremental cash flows is determined by taking the Indicated Case and IBNR Loss Reserve as of the Valuation Date, multiplying it by the appropriate incremental payment percentage, and dividing by the percentage remaining to be paid as of the Valuation Date.

   For example, the payments for the 2020 accident year are derived as follows:

   Calendar year ending 12/2021: $\$8{,}339 * (.6229 - .3504) / (1 - .3504) = \$3{,}498$

   Calendar year ending 12/2022: $\$8{,}339 * (.7668 - .6229) / (1 - .3504) = \$1{,}847$

   Calendar year ending 12/2023: $\$8{,}339 * (.8732 - .7668) / (1 - .3504) = \$1{,}365$

   Etc.

   And the payments for the 2019 accident year are derived as follows:

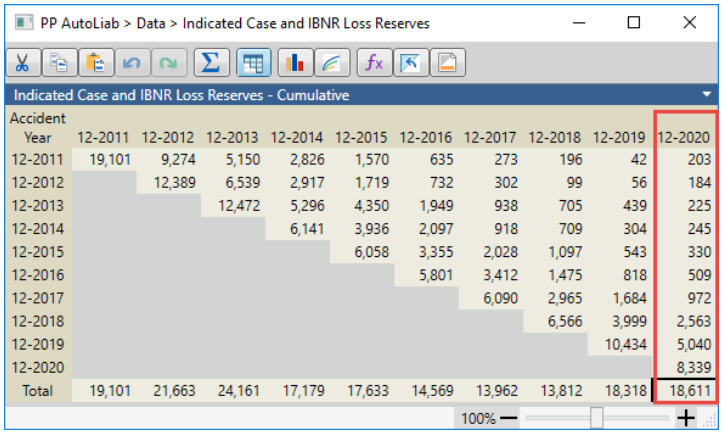
   Calendar year ending 12/2021: $\$5{,}040 * (.7668 - .6229) / (1 - .6229) = \$1{,}923$

   Calendar year ending 12/2022: $\$5{,}040 * (.8732 - .7668) / (1 - .6229) = \$1{,}422$

   Calendar year ending 12/2023: $\$5{,}040 * (.9202 - .8732) / (1 - .6229) = \$629$

   Etc.

2. Note the sum of all cash flow payments in the last column matches the total indicated loss reserves from Data table **#469 Indicated Case and IBNR Loss Reserves**.

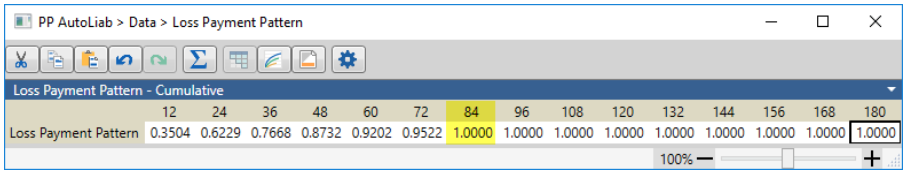


Accident Year	12-2011	12-2012	12-2013	12-2014	12-2015	12-2016	12-2017	12-2018	12-2019	12-2020
12-2011	19,101	9,274	5,150	2,826	1,570	635	273	196	42	203
12-2012		12,389	6,539	2,917	1,719	732	302	99	56	184
12-2013			12,472	5,296	4,350	1,949	938	705	439	225
12-2014				6,141	3,936	2,097	918	709	304	245
12-2015					6,058	3,355	2,028	1,097	543	330
12-2016						5,801	3,412	1,475	818	509
12-2017							6,090	2,965	1,684	972
12-2018								6,566	3,999	2,563
12-2019									10,434	5,040
12-2020										8,339
Total	19,101	21,663	24,161	17,179	17,633	14,569	13,962	13,812	18,318	18,611

Note on the payout of older clams: If the payment pattern hits 1.000 too soon, meaning outstanding reserves are remaining to be paid beyond the point at which the payment pattern

completes, Arius automatically pays these claims out in the next calendar period.

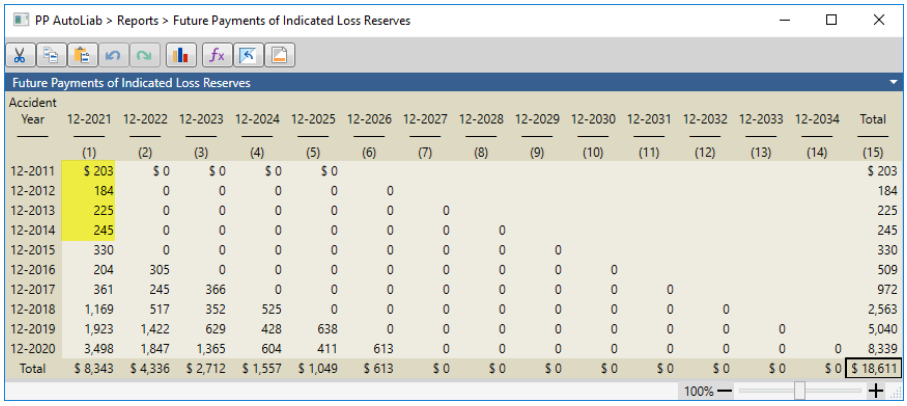
For example, referring to the tables below, if you were to modify the Loss Payment Pattern such that the pattern hits 1.000 at 84 months, but there are still outstanding reserves in Accident Years 2014 and prior ($245, $225, $184, and $203), these remaining reserves will all be paid out in the calendar year ending 12/2021 (as opposed to showing $0).



PP AutoLiab > Data > Loss Payment Pattern

Loss Payment Pattern - Cumulative

	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180
Loss Payment Pattern	0.3504	0.6229	0.7668	0.8732	0.9202	0.9522	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000



PP AutoLiab > Reports > Future Payments of Indicated Loss Reserves

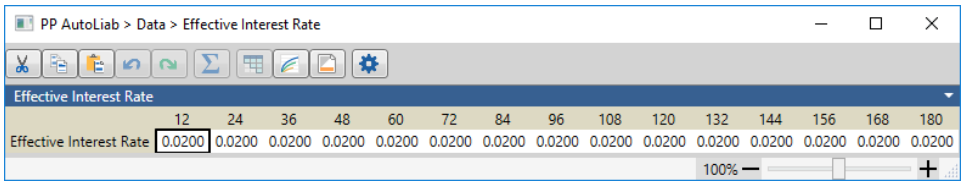
Future Payments of Indicated Loss Reserves

Accident Year	12-2021	12-2022	12-2023	12-2024	12-2025	12-2026	12-2027	12-2028	12-2029	12-2030	12-2031	12-2032	12-2033	12-2034	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12-2011	$ 203	$ 0	$ 0	$ 0	$ 0										$ 203
12-2012	184	0	0	0	0	0									184
12-2013	225	0	0	0	0	0	0								225
12-2014	245	0	0	0	0	0	0	0							245
12-2015	330	0	0	0	0	0	0	0	0						330
12-2016	204	305	0	0	0	0	0	0	0	0					509
12-2017	361	245	366	0	0	0	0	0	0	0	0				972
12-2018	1,169	517	352	525	0	0	0	0	0	0	0	0			2,563
12-2019	1,923	1,422	629	428	638	0	0	0	0	0	0	0	0		5,040
12-2020	3,498	1,847	1,365	604	411	613	0	0	0	0	0	0	0	0	8,339
Total	$ 8,343	$ 4,336	$ 2,712	$ 1,557	$ 1,049	$ 613	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 18,611

SELECT THE INTEREST RATE(S) FOR DISCOUNTING

The interest rates used for discounting may vary from one segment to the next or from one future period to the next.

1. Open Data table **#802 Effective Interest Rate** from the **Present Value of Future Payments of Indicated Loss Reserves** collection found under the DETERMINISTIC|ANALYSIS|LOSSES folder.



PP AutoLiab > Data > Effective Interest Rate

Effective Interest Rate

	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180
Effective Interest Rate	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200

Note: Arius requires annual interest rates and automatically adjusts for the selected interval. For example, if you enter an annual interest rate of 5.0%, Arius automatically adjusts it to (1.05)^.25 – 1 = 1.22% when discounting quarterly cash flows.

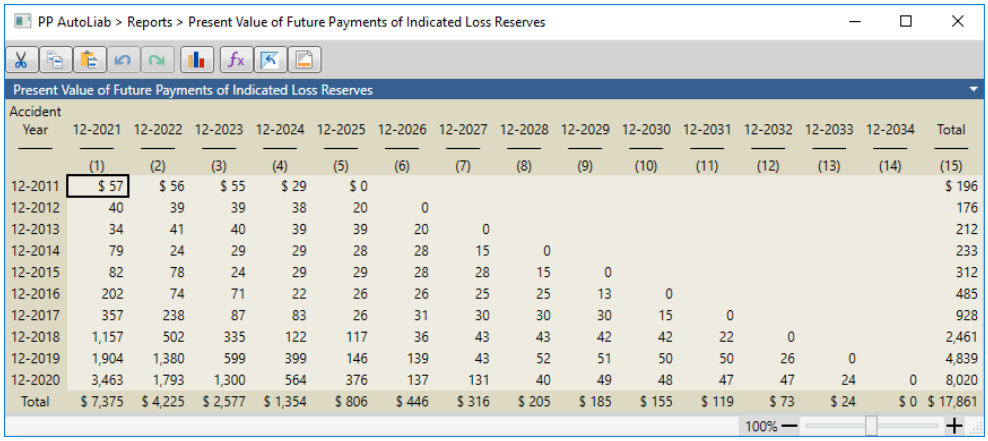
2. Notice that the **Effective Interest Rate** arrays also include the **Settings** button, similar to the payment pattern arrays. If you extend/resize your payment pattern or modify your cash flow reports' age increment, your effective interest rate array is also modified and vice versa.

   While this array is not formula-driven, if you are using a single discount rate, a common approach for populating this array is to utilize the DEFAULTS|DATA feature. For further guidance, refer to the document *Default Settings to Automate Analysis* found in Arius under HELP|USER DOCUMENTATION.

CALCULATE THE PRESENT VALUE

To calculate the discounted unpaid claim estimates, Arius calculates the present value of the future payments for each payment period, using the selected interest rate(s).

1. Open Report **#32 Present Value of Future Payments of Indicated Loss Reserves** from the **Present Value of Future Payments of Indicated Loss Reserves** collection found under the DETERMINISTIC | ANALYSIS | LOSSES folder.

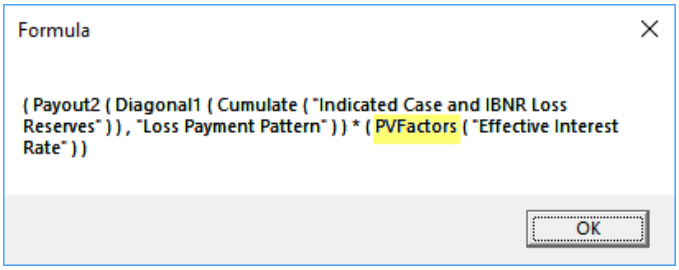

PP AutoLiab > Reports > Present Value of Future Payments of Indicated Loss Reserves

Present Value of Future Payments of Indicated Loss Reserves

Accident Year	12-2021	12-2022	12-2023	12-2024	12-2025	12-2026	12-2027	12-2028	12-2029	12-2030	12-2031	12-2032	12-2033	12-2034	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
12-2011	$ 57	$ 56	$ 55	$ 29	$ 0										$ 196
12-2012	40	39	39	38	20	0									176
12-2013	34	41	40	39	39	20	0								212
12-2014	79	24	29	29	28	28	15	0							233
12-2015	82	78	24	29	29	28	28	15	0						312
12-2016	202	74	71	22	26	26	25	25	13	0					485
12-2017	357	238	87	83	26	31	30	30	30	15	0				928
12-2018	1,157	502	335	122	117	36	43	43	42	42	22	0			2,461
12-2019	1,904	1,380	599	399	146	139	43	52	51	50	50	26	0		4,839
12-2020	3,463	1,793	1,300	564	376	137	131	40	49	48	47	47	24	0	8,020
Total	$ 7,375	$ 4,225	$ 2,577	$ 1,354	$ 806	$ 446	$ 316	$ 205	$ 185	$ 155	$ 119	$ 73	$ 24	$ 0	$ 17,861

100%

2. Click the **Show Formula** button. This report relies on the **PVFactors** function, which calculates the present value using the discount rates entered into Data table **#802 Effective Interest Rate** described above.



3. Click the **Source Data** button. The Source Data window lists all objects used in the calculation of this report.

Details Behind the Calculations

1. The discounted unpaid claim estimates are calculated by taking the present value of the incremental cash flows using the selected interest rates. Arius assumes payments are distributed uniformly over the future payment periods (i.e., payments are made, on average, halfway through a period).

   For example, the present value of the payments for the 2020 accident year is derived as follows:

   Calendar year ending 12/2021: $\$3{,}498 \,/\, (1.02)\text{^}0.5 = \$3{,}498 * .9901 = \$3{,}464$

   Calendar year ending 12/2022: $\$1{,}847 \,/\, (1.02)(1.02)\text{^}0.5 = \$1{,}847 * .9707 = \$1.793$

   Calendar year ending 12/2023: $\$1{,}365 \,/\, (1.02)(1.02)(1.02)\text{^}0.5 = \$1{,}365 * .9517 = \$1{,}300$

And the payments for the 2019 accident year are derived as follows:

Calendar year ending 12/2021: $1,923 / (1.02)^0.5 = $1,923 * .9901 = $1.904

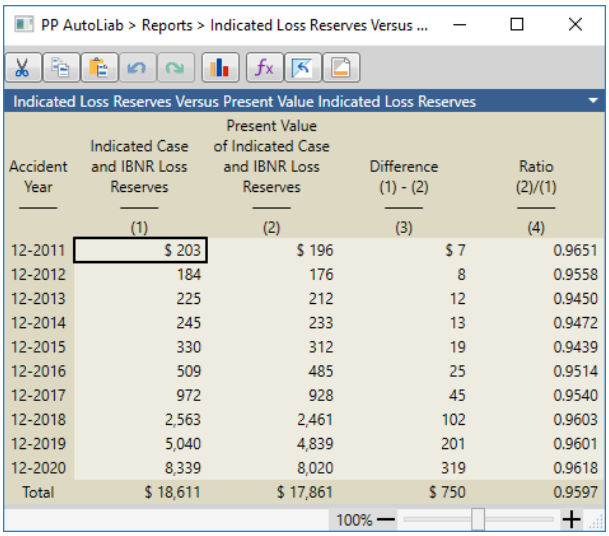
Calendar year ending 12/2022: $1,422 / (1.02)(1.02)^0.5 = $1,422 * .9707 = $1,380

Calendar year ending 12/2023: $629 / (1.02)(1.02)(1.02)^0.5 = $629 * .9517 = $599

SUM THE PRESENT VALUES

To calculate the sum of the present values of future payments, Arius leverages the **MatrixTotal** function.

1. Open Report **#36 Indicated Loss Reserves Versus Present Value Indicated Loss Reserves** from the **Present Value of Future Payments of Indicated Loss Reserves** collection found in the DETERMINISTIC|ANALYSIS|LOSSES folder of the collection library.



Accident Year	Indicated Case and IBNR Loss Reserves (1)	Present Value of Indicated Case and IBNR Loss Reserves (2)	Difference (1) - (2) (3)	Ratio (2)/(1) (4)
12-2011	$ 203	$ 196	$ 7	0.9651
12-2012	184	176	8	0.9558
12-2013	225	212	12	0.9450
12-2014	245	233	13	0.9472
12-2015	330	312	19	0.9439
12-2016	509	485	25	0.9514
12-2017	972	928	45	0.9540
12-2018	2,563	2,461	102	0.9603
12-2019	5,040	4,839	201	0.9601
12-2020	8,339	8,020	319	0.9618
Total	$ 18,611	$ 17,861	$ 750	0.9597

2. Highlight Column (2) and click the **Show Formula** button. This column relies on the **MatrixTotal** function, which returns the final total column from any Payout2 Matrix.